Differential Carriers
Single-Reduction

120 Series
145 Series
160 Series
186 Series
A176/177/187
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Service Notes

This service manual describes the service and repair procedures for single-reduction differential carriers. The information contained in this manual is current at the time of publication and is subject to change without notice or liability.

Follow all company procedures when you service or repair equipment or components. Understand all instructions before performing any product service. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as, damage to equipment and components.

The instructions contained in this service manual are intended for use by skilled and experienced mechanics knowledgeable in the installation, repair, and replacement of the AxleTech product described herein.

⚠️ DANGER

Installation, maintenance, and replacement of such products requires a high degree of skill and experience. The consequences of improper installation, maintenance, or replacement (including the use of inferior or substandard components) are grave and can result in product failure and resulting loss of control of the vehicle, possible injury or death of persons, and/or possible future or additional product damage.

AxleTech does not authorize anyone, other than highly skilled and experienced individuals, to attempt to utilize the instructions contained in this manual for the installation, maintenance, or replacement of the product described herein, and AxleTech shall have no liability of any kind for damages arising out of (or in connection with) any other use of the information contained in this manual.

Updates

For the latest version of this manual, please visit AxleTech International’s web site at www.axletech.com.

Notations

AxleTech International uses the following notation to warn the user of possible safety problems and to provide information that will prevent damage to equipment and components:

⚠️ DANGER

A DANGER indicates a procedure that you must follow exactly or it will cause death or serious injury.

⚠️ WARNING

A WARNING indicates a procedure that you must follow exactly or it may cause death or serious injury.

⚠️ CAUTION

A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components.

NOTE

A NOTE indicates an operation, procedure, or instruction that is important for proper service. A NOTE can also supply information that will help to make service quicker and easier.
Asbestos and Non-Asbestos Fibers Warning

OSHA* Toxic and Hazardous Substances 29 CFR 1910.1001

Work practices and engineering controls for automotive brake and clutch inspection, disassembly, repair and assembly -- Mandatory

This mandatory appendix specifies engineering controls and work practices that must be implemented by the employer during automotive brake and clutch inspection, disassembly, repair, and assembly operations.

Proper use of these engineering controls and work practices by trained employees will reduce employees’ asbestos exposure below the permissible exposure level during clutch and brake inspection, disassembly, repair, and assembly operations. The employer shall institute engineering controls and work practices using either the method set forth in paragraph [A] or paragraph [B] of this appendix, or any other method which the employer can demonstrate to be equivalent in terms of reducing employee exposure to asbestos as defined and which meets the requirements described in paragraph [C] of this appendix, for those facilities in which no more than 5 pairs of brakes or 5 clutches are inspected, disassembled, reassembled and/or repaired per week, the method set forth in paragraph [D] of this appendix may be used:

[A] Negative Pressure Enclosure/HEPA Vacuum System Method

(1) The brake and clutch inspection, disassembly, repair, and assembly operations shall be enclosed to cover and contain the clutch or brake assembly and to prevent the release of asbestos fibers into the worker's breathing zone.

(2) The enclosure shall be sealed tightly and thoroughly inspected for leaks before work begins on brake and clutch inspection, disassembly, repair, and assembly.

(3) The enclosure shall be such that the worker can clearly see the operation and shall provide impermeable sleeves through which the worker can handle the brake and clutch inspection, disassembly, repair and assembly. The integrity of the sleeves and ports shall be examined before work begins.

(4) A HEPA-filtered vacuum shall be employed to maintain the enclosure under negative pressure throughout the operation. Compressed-air may be used to remove asbestos fibers or particles from the enclosure.

(5) The HEPA vacuum shall be used first to loosen the asbestos containing residue from the brake and clutch parts and then to evacuate the loosened asbestos containing material from the enclosure and capture the material in the vacuum filter.

(6) The vacuum’s filter, when full, shall be first wetted with a fine mist of water, then removed and placed immediately in an impermeable container, labeled according to paragraph (j)(5) of this section and disposed of according to paragraph (k) of this section.

(7) Any spills or releases of asbestos containing waste material from inside of the enclosure or vacuum hose or vacuum filter shall be immediately cleaned up and disposed of according to paragraph (k) of this section.

[B] Low Pressure/Wet Cleaning Method

(1) A catch basin shall be placed under the brake assembly, positioned to avoid splashes and spills.

(2) The reservoir shall contain water containing an organic solvent or wetting agent. The flow of liquid shall be controlled such that the brake assembly is gently flooded to prevent the asbestos-containing brake dust from becoming airborne.

(3) The aqueous solution shall be allowed to flow between the brake drum and brake support before the drum is removed.

(4) After removing the brake drum, the wheel hub and back of the brake assembly shall be thoroughly wetted to suppress dust.
(5) The brake support plate, brake shoes and brake components used to attach the brake shoes shall be thoroughly washed before removing the old shoes.

(6) In systems using filters, the filters, when full, shall be first wetted with a fine mist of water, then removed and placed immediately in an impermeable container, labeled according to paragraph (j)(4) of this section and disposed of according to paragraph (k) of this section.

(7) Any spills of asbestos-containing aqueous solution or any asbestos-containing waste material shall be cleaned up immediately and disposed of according to paragraph (k) of this section.

(8) The use of dry brushing during low pressure/wet cleaning operations is prohibited.

[C] Equivalent Methods

An equivalent method is one which has sufficient written detail so that it can be reproduced and has been demonstrated that the exposures resulting from the equivalent method are equal to or less than the exposures which would result from the use of the method described in paragraph [A] of CFR 1910.1001. For purposes of making this comparison, the employer shall assume that exposures resulting from the use of the method described in paragraph [A] of this appendix shall not exceed 0.016 f/cc, as measured by the OSHA reference method and as averaged over at least 18 personal samples.

[D] Wet Method

(1) A spray bottle, hose nozzle, or other implement capable of delivering a fine mist of water or amended water or other delivery system capable of delivering water at low pressure, shall be used to first thoroughly wet the brake and clutch parts. Brake and clutch components shall then be wiped clean with a cloth. Any wastewater generated must be captured and properly disposed of without allowing it to dry on any surfaces.

(2) The cloth shall be placed in an impermeable container, labeled according to paragraph (j)(4) of the standard and then properly disposed of as an asbestos waste, or the cloth shall be laundered in a way to prevent the release of asbestos fibers in excess of 0.1 fiber per cubic centimeter of air.

(3) Any spills of solvent or any asbestos containing waste material shall be cleaned up immediately according to paragraph (k) of this section.

(4) The use of dry brushing during the wet method operations is prohibited.

[59 FR 40964, Aug. 10, 1994; 60 FR 33972, June 29, 1995; 77 FR 17778, March 26, 2012]

For more information, visit www.osha.gov, or call OSHA at 1-800-321-OSHA(6742), TTY 1-877-889-5627.

*References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.
DANGER

• ALWAYS WEAR PROPER EYE PROTECTION AND OTHER REQUIRED PERSONAL PROTECTIVE EQUIPMENT TO PREVENT PERSONAL INJURY WHEN PERFORMING VEHICLE SERVICE.

• WORK IN A WELL-VENTILATED AREA.

• NEVER USE GASOLINE, OR SOLVENTS CONTAINING GASOLINE. GASOLINE CAN EXPLODE.

• DO NOT USE HOT SOLUTION TANKS OR WATER AND ALKALINE SOLUTIONS TO CLEAN GROUND OR POLISHED PARTS. DOING SO WILL CAUSE DAMAGE TO THE PARTS.

• USE HOT SOLUTION TANKS OR ALKALINE SOLUTIONS CORRECTLY. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING HOT SOLUTION TANKS AND ALKALINE SOLUTIONS. THEN CAREFULLY FOLLOW THE INSTRUCTIONS.

• SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS, AND CAUSE BURNS. EXAMPLES OF SOLVENT CLEANERS ARE CARBON TETRACHLORIDE, EMULSION-TYPE, AND PETROLEUM-BASED CLEANERS. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SOLVENT CLEANER, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. ALSO FOLLOW THE PROCEDURES BELOW.

• PLACE THE VEHICLE ON A LEVEL FLOOR AND CHOCK THE WHEELS TO HELP PREVENT THE VEHICLE FROM MOVING. NEVER WORK UNDER A RAISED VEHICLE SUPPORTED BY ONLY A FLOOR JACK. ALWAYS SUPPORT A RAISED VEHICLE WITH SAFETY STANDS. CHOCK THE WHEELS AND MAKE SURE THE UNIT WILL NOT ROLL BEFORE RELEASING BRAKES. A JACK CAN SLIP OR FALL OVER. SERIOUS PERSONAL INJURY CAN RESULT.

• IMPROPER JACKING AND SUPPORT METHODS CAN CAUSE STRUCTURAL DAMAGE THAT RESULTS IN LOSS OF VEHICLE CONTROL, SEVERE PERSONAL INJURY OR DEATH. REFER TO THE VEHICLE MANUFACTURER FOR PROPER JACKING AND SUPPORT METHODS.

WARNING

FOLLOW THE SPECIFIED PROCEDURES IN THE INDICATED ORDER TO AVOID PERSONAL INJURY OR EQUIPMENT MALFUNCTION/DAMAGE.

BEFORE STARTING A VEHICLE:
• Sit in the driver’s seat
• Place the shift lever in neutral
• Set the parking brake

BEFORE WORKING ON A VEHICLE OR LEAVING THE CAB WITH ENGINE RUNNING:
• Place the shift lever in neutral
• Set the parking brake
• Chock the wheels

WHEN PARKING THE VEHICLE OR LEAVING THE CAB:
• Place the shift lever in neutral
• Set the parking brake

CAUTION

• DO NOT RELEASE THE PARKING BRAKE OR ATTEMPT TO SELECT A GEAR UNTIL THE AIR PRESSURE IS AT THE CORRECT LEVEL.

• TO AVOID DAMAGE TO THE TRANSMISSION DURING TOWING:
  • Place the shift lever in neutral
  • Lift the drive wheels off of the ground or disconnect the driveline

• DO NOT OPERATE VEHICLE IF THE ALTERNATOR LAMP IS LIT OR IF THE GAUGES INDICATE LOW VOLTAGE.

Towing

Due to the wide range of environments and applications for AxleTech axles, it is recommended to follow the towing instructions from the vehicle Original Equipment Manufacturer (OEM).
Repair Warnings

⚠️ DANGER

USE OF OTHER THAN RECOMMENDED TOOLS, PARTS, AND INSTRUCTIONS LISTED IN THIS PUBLICATION MAY PLACE THE SAFETY OF THE SERVICE TECHNICIAN OR VEHICLE DRIVER IN JEOPARDY.

DO NOT WELD REPAIR, HEAT, BEND, OR RECONDITION AXLE COMPONENTS. THIS WILL REDUCE COMPONENT STRENGTH, VOID AXLETECH’S WARRANTY, AND CAN RESULT IN SERIOUS PERSONAL INJURY AND DAMAGE TO COMPONENTS. ALWAYS REPLACE DAMAGED OR OUT-OF-SPECIFICATION COMPONENTS.

- When disassembling various assemblies, lay all parts on a clean bench in the same sequence as removed to simplify assembly and reduce the possibility of losing parts.
- Provide a clean work area. Make sure no dirt or foreign material enter the unit during repair and assembly.
- Disconnect the vehicle’s battery before removing or installing electronic parts.
- The location of components varies with each OEM.
- The removal and installation procedure described for each component may vary between vehicles.
- Use a rubber mallet for disassembly and assembly procedures. NEVER hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.
- Remove nicks, marks, and burrs from parts having machined or ground surfaces. Use a fine file, India stone, emery cloth or crocus cloth for this purpose.

Torque Specifications

- Tightening torque specifications indicated in this manual must be adhered to at all times.
- A tightening torque weaker than indicated may lead to a shearing stress and may break the bolt.
- A stronger tightening torque may lead to yielding of the bolt or an increasing risk of cracking.

Cleaning

- Remove gasket material using a gasket scraper taking care not to damage machined surfaces.
- Steam clean or pressure wash the assembly after plugging all breathers, vents, and hydraulic inlets.

**NOTE:** NEVER direct full pressure at any of the seals (input shaft, wheel hubs, or brakes).

- Use solvent cleaners or alkaline solutions to clean all metal parts with rough surfaces. Parts must remain in hot solution tanks until completely cleaned and heated. Rinse alkaline solution off with water after cleaning.
- Use solvent cleaners and a brush to clean all metal parts that have ground or polished surfaces.

**NOTE:** NEVER clean ground or polished surfaces with water, steam, alkaline solution, or place in a hot tank.

- Dry all parts after washing using clean rags or paper towels.
- Apply a light oil film to all parts to be reused and reassembled.
- If parts are being stored after cleaning, apply a corrosion-preventive material to all machined surfaces. Store the parts in a special paper or other material that prevents corrosion.

Damaged Components

- All damaged components must be replaced by new components.
- Clean and repair the threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.
- Replace any fastener if corners of the head are worn.
- Since the cost of a new part is generally a small fraction of the total cost of downtime and labor, avoid reusing a questionable part that could lead to additional repairs and expense.
- Always use genuine AxleTech replacement parts.
Repair Welding

⚠️ DANGER

THE HIGH TEMPERATURE CAUSED BY THE OPEN FLAME FROM A CUTTING TORCH CAN IGNITE THE OIL IN THE AXLE HOUSING AND CAN CAUSE SERIOUS PERSONAL INJURY.

In the interest of safety and preserving the service life of drive axle assemblies, AxleTech recommends that assemblies are not repair welded. Repair welding can detract from the structural integrity of a component, particularly to heat treated parts where the benefit of heat treatment may be nullified by welding.

Since it can be extremely hazardous and detrimental to repair weld components of any kind, repair welding can be approved only where stringent controls are imposed and equipment, customarily located at manufacturing facilities, is employed, so as to minimize the potentially detrimental effects of repair welding.

Please contact AxleTech if you believe that repair welding will work for your particular situation.

Omissions

Every effort has been made to ensure the accuracy of all information in this manual. However, AxleTech makes no expressed or implied warranty or representation based on the enclosed information. Any errors or omissions may be reported to AxleTech, 1400 Rochester Road, Troy, Michigan, 48083 USA.
General Assembly Instructions

Tapered Roller Bearings

**CAUTION**

**DRY BEARINGS WITH CLEAN PAPER OR RAGS. NEVER USE COMPRESSED AIR, WHICH CAN CAUSE ABRASIVE PARTICLES TO CONTAMINATE THE BEARINGS. DAMAGE TO COMPONENTS AND REDUCED LINING LIFE CAN RESULT.**

If parts are clean and properly lubricated, it is rare for bearings to be damaged. Proper installation is also critical to avoid vibration, noise, and reduced bearing life.

Bearings should be replaced when:

- Bearing surfaces show abnormal wear
- Bearings are chipped (due to improper cleaning during assembly, improper lubrication, or a broken component inside the case)
- Centers of the large diameter end of the rollers are worn level with or below the surface
- Centers of the large diameter end of the rollers are worn to a sharp edge
- A roller groove is worn in the cup or cone inner race surfaces visible at the small or large diameter ends of both parts
- Deep cracks or breaks are present in the cup, cone inner race, or roller surfaces
- Bright wear marks are present on the outer surface of the roller cage
- Etching and pitting is present on the rollers and on surfaces of the cup and cone inner race that touches the rollers
- Spalling or flaking is present on the cup and cone inner race surfaces that touch the rollers

During disassembly:

- Remove bearings with pullers designed for this purpose to avoid damaging the bearing.
- Carefully wash and re-lubricate all bearings as removed and protectively wrap until ready for use.
- Store all bearings in a dry and clean area to minimize the possibility of corrosion, contamination, or other damage.

During assembly:

- Install bearings in a clean environment, free from dust, debris, moisture, and other contaminants.
- Machining, filing, soldering, grinding, etc. should be kept away from the assembly area to prevent contaminating the bearings.
- Check the cleanliness of the bearing:
  - If the bearing is new, unpack it immediately before assembly.
  - Used bearings should be cleaned with petrol or benzine and then oiled.
- Verify the bore is deburred and cleaned before installing the bearing. Use 180-grit emery cloth to remove small imperfections in the metal.
- Bearings are installed the easiest by cooling or heating (in hot oil to 80°C) instead of using a press. Do not apply any shock or impact techniques (like hammering) to install the bearings.
- When a bearing has been heated for assembly, apply a small amount of grease or oil after assembly.
- When installing on a tight shaft, force is to be applied to the inner ring only.

**Castings**

- Inspect for damage or cracking. Replace as required. NEVER weld to repair the casting.

**Gears**

- Inspect for pitting or damage. Replace as required.
- Replace beveled gear set, as required, with a matched set.
- Replace thrust washer, differential side gear, and pinion gear with a new matched set. Do not mix old and new parts. Damage to components can result.
Seals

⚠️ WARNING

WHEN APPLYING SOME SILICONE GASKET MATERIALS, SMALL AMOUNTS OF ACID VAPOR ARE PRESENT. TO PREVENT POSSIBLE SERIOUS INJURY, THE WORK AREA MUST BE WELL-VENTILATED. IF THE SILICONE GASKET MATERIAL GETS INTO YOUR EYES, FLUSH THEM WITH WATER FOR 15 MINUTES. HAVE YOUR EYES CHECKED BY A DOCTOR AS SOON AS POSSIBLE.

Recommended Lubricant: Gear Oil

- O-rings: After removal, always replace with new ones.
- Lipped seals: All disassembled seals shall be discarded and replaced by a new seal.
- Gaskets: After disassembly, always install a new paper or silicone gasket.
  - Silicone Gaskets - Apply a 0.125" (3.18 mm) diameter continuous bead of silicone gasket material around one surface. Also apply the gasket material around the edge of all the fastener holes on that surface. Assemble immediately and wait 20 minutes before filling the assembly with lubricant.

⚠️ CAUTION

TOO MUCH GASKET MATERIAL CAN BLOCK LUBRICATION PASSAGES. DAMAGE TO COMPONENTS CAN RESULT.

During assembly:
- Verify the seal bearing surface edges are free of burrs and nicks that may damage seals.
- Lubricate properly:
  - Lubricate the entire interior surface of the ring and primarily the seal lips.
  - Pack the space between the lips with grease.
  - NOTE: Do not use an excessive quantity of lubricant since liquefaction may occur during operation and appear outside the housing. This could easily be mistaken for a leak.
- The ring shall be engaged in its housing perpendicularly and concentrically to the shaft.
- Do not damage the seal lips and turn them over during installation.

Mounting Surfaces

For all mounting surfaces that do not use an o-ring seal, use Loctite 5699 RTV Silicone Gasket.

Product characteristics:
- Color: Grey
- Adhesive power: Weak, nevertheless, do not use on centering; only on the faces.
- Temperature Resistance:
  -67 to 392°F (-55 to 200°C)
- TO BE USED WITH CARE:
  - Avoid any contact with eyes and skin.

During disassembly:
- In the event of sticking, tap the parts to break the Loctite film.
- Remove particles of Loctite as thoroughly as possible.
- Clean and carefully degrease surfaces (any lubricant prevents setup therefore making the product ineffective) using a solvent or by washing the parts.
- Let all components dry completely.

During assembly:
- Apply a single bead to one of the mating surfaces well around the attachment holes.
- Assemble the parts and tighten to the required torque.
- Leave to dry: Parts can be handled after 30 minutes.
- Total setup time: 18 to 24 hours
Fasteners

When installing fasteners without pre-applied adhesive, Loctite 243 Blue Threadlocker must be used unless otherwise stated.

**NOTE:** Do not apply adhesives or sealants to fasteners with pre-applied adhesive, or to fastener holes.

Product characteristics:
- Color: Pale blue
- Temperature Resistance:
  - -67 to 302°F (-55 to 150°C)
- TO BE USED WITH CARE:
  - Avoid any contact with eyes and skin.

During disassembly:
- If the removal of a capscrew becomes difficult due to a worn head or unusually high breakaway torque, the locking strength can be reduced by heating the threaded area to approximately 300°F (150°C). Heat slowly to avoid thermal stresses on the differential case and gears.
- Clean excess material off all surfaces as thoroughly as possible.
- Clean and carefully degrease surfaces (any lubricant prevents setup therefore making the product ineffective) using a solvent or by washing the parts.
- Let all components dry completely.
- Replace any fastener if corners of the head are worn.
- Replace washers if damaged.
- Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

**CAUTION**

**THREADS MUST BE WITHOUT DAMAGE AND CLEAN SO THAT ACCURATE ADJUSTMENT AND CORRECT TORQUE VALUES CAN BE APPLIED TO FASTENERS AND PARTS.**

During assembly:
- Apply one drop to the threads, preferably at the end of the screw, of Loctite 243 Blue Threadlocker.
- Assemble the parts and tighten to the required torque.
- All screws shall be tightened within 5 minutes following assembly of the parts. The unit can be used 10 minutes after assembling.

**NOTE:** To reduce setup time, spray Loctite 7649 Locquic Primer N activator on the threads, allow to evaporate, and then apply Loctite 243.

Tapered Ball Joint Removal

Carriage ball joints use a tapered attachment fit to their mating component. Often, it is not practical to procure a special tool to split the taper and separate the components. AxleTech Service recommends that ball joint tapered joints housed within steel or ductile iron components can be split using a “shock method”. The shock method involves impacting the component, with a steel hammer, close to the tapered location. (DO NOT directly impact the ball joint or stud directly.) This action tends to “shock” the tapered joint loose and is a common practice by AxleTech Service.
Introduction

Operation

AxleTech’s 120 Series Carriers are specifically designed to meet the rugged demands of off-highway and on-highway applications including mobile cranes, fertilizer spreaders, harvesters, lift trucks, and more. The 120 Series Carriers are an aftermarket product offering from our line of heavy-duty rear carriers which are available in a wide range of ratios and manufactured with all new carrier shells and gearing.

AxleTech’s new 145 differential carrier assemblies are core-free. We offer a complete line of new carriers and you keep the core. Our wide range of coverage for off-highway and on-highway applications is manufactured with all new carrier shells and gearing. We stand behind every one of our products with a comprehensive two-year warranty. AxleTech carriers are the perfect answer to replenish your core bank needs, assist with sporadic rebuild demands, and quickly satisfy unit-down customer demands. Get AxleTech carriers and build a solid advantage.

AxleTech’s 160 carrier is used in common on-highway vehicle applications. Thru-drive and single drive configurations are available.

From capscrews to carriers, and everything in between; that’s our game. AxleTech offers new carriers completely assembled. We also offer you the flexibility of ordering a Rebuilder Carrier Kit: all the components you need to build a new carrier, except shims and spacers. With our comprehensive inventory of carrier assemblies, rebuilder kits, and individual components, you can always count on us for all your differential needs.

When replacing parts, only use factory original parts and parts sets. Parts must be ordered from AxleTech. Any damage to parts not described in this manual must be repaired or replaced using original parts.

Technical Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Ratio</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A176/177</td>
<td>4.89 - 6.14</td>
<td>For 28,600 lbs. GAWR*</td>
</tr>
<tr>
<td>A187</td>
<td>3.42-6.14</td>
<td>For 30,000 lbs. GAWR</td>
</tr>
<tr>
<td>120 Series</td>
<td>3.73-6.14</td>
<td>For 15,000 lbs. GAWR</td>
</tr>
<tr>
<td>145 Series</td>
<td>2.64 – 7.17</td>
<td>For 21,000 lbs. GAWR</td>
</tr>
<tr>
<td>160 Series</td>
<td>3.73-6.14</td>
<td>For 25,000 lbs. GAWR</td>
</tr>
<tr>
<td>186 Series</td>
<td>3.42-6.14</td>
<td>For 30,000 lbs. GAWR</td>
</tr>
</tbody>
</table>

*Direct replacement for Meritor 61000 and 71000 Series used in transit and coach applications.
Identification Tag

All products are identified by the model and serial number. This information is stamped on the identification tag and affixed to the case. Have reference numbers handy when ordering replacement parts or requesting service repairs.

DO NOT REMOVE OR DESTROY THE IDENTIFICATION TAGS.

Stall Testing with Automatic Transmissions

Stall testing is an experimental test procedure sometimes used for automatic transmission diagnostics, vehicle performance evaluation or to test service and park brake hold. During stall testing or a similar procedure, the drive axle input receives multiplied torque that can greatly exceed the axle torque rating. This can cause drive axle damage and result in immediate axle failure or shortened axle life.

AxleTech regards stall testing to be outside the scope of normal vehicle operation. Axle damage or failure caused by stall testing or a similar procedure voids AxleTech’s warranty.

For questions related to stall testing, contact AxleTech’s Customer Service Center at 877-547-3907.
**Lubrication**

With any product containing gears, lubrication is possibly the most important component effecting the product life cycle. It is critical to use the correct lubricant, follow oil change intervals, and check the oil level regularly.

**Lubricant Capacity**

Check the lubricant level in the axles and hubs. Add the correct type and amount of lubricant if necessary.

<table>
<thead>
<tr>
<th>AxleTech Lubricant Specification</th>
<th>Description</th>
<th>Cross Reference</th>
<th>Minimum Outside Temperature</th>
<th>Maximum Outside Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-76-A</td>
<td>Hypoid Gear Oil</td>
<td>GL-5, S.A.E. 85W/140</td>
<td>+10°F (−12.2°C)</td>
<td>- - -*</td>
</tr>
<tr>
<td>0-76-B</td>
<td></td>
<td>GL-5, S.A.E. 80W/90</td>
<td>−15°F (−26.1°C)</td>
<td>- - -*</td>
</tr>
<tr>
<td>0-76-D</td>
<td></td>
<td>GL-5, S.A.E. 75W/90</td>
<td>−40°F (−40°C)</td>
<td>+35°F (+1.6°C)</td>
</tr>
<tr>
<td>0-76-E</td>
<td></td>
<td>GL-5, S.A.E. 75W</td>
<td>- - -*</td>
<td>- - -*</td>
</tr>
<tr>
<td>0-76-J</td>
<td></td>
<td>GL-5, S.A.E. 75W/140</td>
<td>- - -*</td>
<td>- - -*</td>
</tr>
</tbody>
</table>

*There is no upper limit on these outside temperatures, but the axle sump temperature must never exceed 250°F (+121°C).

**Oil Change Intervals**

The oil change interval varies depending on the type of vehicle, operating duty cycle, and application.*

<table>
<thead>
<tr>
<th>Vocational or Vehicle Operation</th>
<th>Linehaul</th>
<th>Motorhome</th>
<th>Intercity Coach</th>
<th>City Delivery</th>
<th>School Bus</th>
<th>Fire Truck</th>
<th>Construction</th>
<th>Transit Bus</th>
<th>Refuse</th>
<th>Mining</th>
<th>Logging</th>
<th>Rescue</th>
<th>Oil Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Oil Change</td>
<td>No longer required as of January 1, 1993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Oil Level &amp; Breather</td>
<td>Every 25,000 miles (40,000 km) or the fleet maintenance interval, whichever comes first</td>
<td>Every 10,000 miles (16,000 km), once a month or the fleet maintenance interval, whichever comes first</td>
<td>Every 5,000 miles (8,000 km), once a month or the fleet maintenance interval, whichever comes first</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petroleum based oil change on axle WITH or WITHOUT pump and filter system</td>
<td>Every 100,000 miles (160,000 km) or annually, whichever comes first</td>
<td>Every 50,000 miles (80,000 km) or annually, whichever comes first</td>
<td>Every 25,000 miles (40,000 km) or annually, whichever comes first</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthetic oil change on axle WITHOUT pump and filter system***</td>
<td>Every 250,000 miles (400,000 km) or 3 years, whichever comes first</td>
<td>Every 100,000 miles (160,000 km) or annually, whichever comes first</td>
<td>Every 50,000 miles (80,000 km) or annually, whichever comes first</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthetic oil change on axle WITH pump and filter system***</td>
<td>Every 500,000 miles (800,000 km)</td>
<td>Every 250,000 miles (400,000 km)</td>
<td>Every 100,000 miles (160,000 km)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filter change on axle with pump and filter system</td>
<td>Every 100,000 miles (160,000 km)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If a No-Spin differential is installed, change the oil, petroleum or synthetic, at a minimum interval of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).

**For continuous heavy-duty operation, check the oil level every 1,000 miles (1600 km). Add the correct type and amount of oil as required.

***This interval applies to approved semi-synthetic and full synthetic oils only. For a list of approved extended-drain axle oils, refer to TP-9539 - Approved Rear Drive Axle Lubricants.
Standard Single-Reduction Carriers

AxleTech single-reduction standard carriers are used in most AxleTech single axles, rear of tandem axles and front drive steer axles.

The single-reduction carriers are front-mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing or spigot is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels at all times.

Single-Reduction Carriers with DCDL

AxleTech single-reduction carriers with driver-controlled differential lock (DCDL) have the same type of gears and bearings as the standard-type carriers. The differential lock is operated by an air-actuated shift assembly mounted on the carrier.

- When the differential lock is activated, the shift collar moves along the splines of the axle shaft toward the differential case.
- When the splines on the collar are engaged with splines on the differential case, the axle shafts and differential assembly are locked together.
- When the carrier operates with the DCDL in the locked position, there is no differential action between the wheels.
- When the carrier is operated in the unlocked position, there is normal differential action between the wheels at all times.

STANDARD CARRIER WITHOUT DIFFERENTIAL LOCK (DCDL)

1 Tapered Roller Bearings
2 Carrier
3 Straight Roller Bearing
4 Tapered Roller Bearing
5 Bevel Differential Gears
6 Housing
7 Tapered Roller Bearing
8 Hypoid Drive Pinion & Ring Gear

STANDARD CARRIER WITH DIFFERENTIAL LOCK (DCDL)

1 Bolt-in Style
2 Screw-in or Threaded Style
Exploded Views

Carrier
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nut* - Drive Pinion</td>
</tr>
<tr>
<td>2</td>
<td>Washer* - Drive Pinion</td>
</tr>
<tr>
<td>3</td>
<td>Input Yoke* or Flange*</td>
</tr>
<tr>
<td>4</td>
<td>Deflector</td>
</tr>
<tr>
<td>5</td>
<td>Seal</td>
</tr>
<tr>
<td>6</td>
<td>Triple Lip Seal</td>
</tr>
<tr>
<td>7</td>
<td>Bearing Cone, Outer</td>
</tr>
<tr>
<td>8</td>
<td>Bearing Cup, Outer</td>
</tr>
<tr>
<td>9</td>
<td>Sensor Switch</td>
</tr>
<tr>
<td>10</td>
<td>Lock Nut - Sensor Switch</td>
</tr>
<tr>
<td>11</td>
<td>Washer - Differential Bearing Cap</td>
</tr>
<tr>
<td>12</td>
<td>Capscrew* - Lock Plate</td>
</tr>
<tr>
<td>13</td>
<td>Washer * - Lock Plate</td>
</tr>
<tr>
<td>14</td>
<td>Lock Plate* - Adjusting Ring</td>
</tr>
<tr>
<td>15</td>
<td>Differential Bearing Cap</td>
</tr>
<tr>
<td>16</td>
<td>Capscrews - Differential Bearing Cap</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Carrier</td>
</tr>
<tr>
<td>18</td>
<td>Adjusting Ring</td>
</tr>
<tr>
<td>19</td>
<td>Cotter Pin - Adjusting Ring</td>
</tr>
<tr>
<td>20</td>
<td>Jam Nut* - Thrust Screw*</td>
</tr>
<tr>
<td>21</td>
<td>Thrust Screw*</td>
</tr>
<tr>
<td>22</td>
<td>Snap Ring</td>
</tr>
<tr>
<td>23</td>
<td>Spigot Bearing</td>
</tr>
<tr>
<td>24</td>
<td>Drive Pinion</td>
</tr>
<tr>
<td>25</td>
<td>Bearing Cone, Inner</td>
</tr>
<tr>
<td>26</td>
<td>Bearing Cup, Inner</td>
</tr>
<tr>
<td>27</td>
<td>Spacer - Pinion Bearing</td>
</tr>
<tr>
<td>28</td>
<td>Shims</td>
</tr>
<tr>
<td>29</td>
<td>Bearing Cage</td>
</tr>
<tr>
<td>30</td>
<td>Clip &amp; Cable Holder</td>
</tr>
<tr>
<td>31</td>
<td>Washer - Bearing Cage</td>
</tr>
<tr>
<td>32</td>
<td>Capscrew - Bearing Cage</td>
</tr>
</tbody>
</table>

* Not present on all carriers
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cover - Screw-In</td>
</tr>
<tr>
<td>2</td>
<td>Plug</td>
</tr>
<tr>
<td>3</td>
<td>Washer</td>
</tr>
<tr>
<td>4</td>
<td>Cotter Pin</td>
</tr>
<tr>
<td>5</td>
<td>Shift Fork</td>
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<tr>
<td>6</td>
<td>Spring - Shift Shaft</td>
</tr>
<tr>
<td>7</td>
<td>Shift Shaft</td>
</tr>
<tr>
<td>8</td>
<td>Pin - Spring Retaining</td>
</tr>
<tr>
<td>9</td>
<td>Tube - Air Cylinder</td>
</tr>
<tr>
<td>10</td>
<td>Screw-In Differential Lock Cylinder</td>
</tr>
<tr>
<td>11</td>
<td>Cylinder Cover</td>
</tr>
<tr>
<td>12</td>
<td>Capscrew - Manual Actuation</td>
</tr>
<tr>
<td>13</td>
<td>Gasket - Cover Plug</td>
</tr>
<tr>
<td>14</td>
<td>Plug - Cylinder Cover</td>
</tr>
<tr>
<td>15</td>
<td>Capscrew - Cylinder Cover</td>
</tr>
<tr>
<td>16</td>
<td>Washer - Cylinder Cover</td>
</tr>
<tr>
<td>17</td>
<td>Gasket - Cover Plug</td>
</tr>
<tr>
<td>18</td>
<td>Plug - Cylinder Cover</td>
</tr>
<tr>
<td>19</td>
<td>Copper Gasket - Cylinder Cover</td>
</tr>
<tr>
<td>20</td>
<td>O-ring - Piston</td>
</tr>
<tr>
<td>21</td>
<td>Piston</td>
</tr>
<tr>
<td>22</td>
<td>Washer* or Silastic* - Air Cylinder</td>
</tr>
<tr>
<td>23</td>
<td>Shift Collar</td>
</tr>
<tr>
<td>24</td>
<td>Pin - Shift Fork</td>
</tr>
<tr>
<td>25</td>
<td>Adjusting Ring - Right-Hand</td>
</tr>
<tr>
<td>26</td>
<td>Bolt</td>
</tr>
<tr>
<td>27</td>
<td>Cover - Bolt-On</td>
</tr>
<tr>
<td>28</td>
<td>Bearing Cup - Differential Left-Hand</td>
</tr>
<tr>
<td>29</td>
<td>Nut - Thru-Bolt</td>
</tr>
<tr>
<td>30</td>
<td>Washer - Thru-Bolt</td>
</tr>
<tr>
<td>31</td>
<td>Thrust Washer - Differential Side Gear</td>
</tr>
<tr>
<td>32</td>
<td>Differential Side Gear</td>
</tr>
<tr>
<td>33</td>
<td>Thrust Washer - Differential Pinion</td>
</tr>
<tr>
<td>34</td>
<td>Differential Pinion</td>
</tr>
<tr>
<td>35</td>
<td>Thru-Bolt</td>
</tr>
<tr>
<td>36</td>
<td>Bearing Cone - Differential Right-Hand</td>
</tr>
<tr>
<td>37</td>
<td>Bearing Cup - Differential Right-Hand</td>
</tr>
<tr>
<td>38</td>
<td>Bolt* - Differential Case</td>
</tr>
<tr>
<td>39</td>
<td>Washer - Differential Case</td>
</tr>
<tr>
<td>40</td>
<td>Differential Case - Plain Half</td>
</tr>
<tr>
<td>41</td>
<td>No-Spin Assembly</td>
</tr>
<tr>
<td>42</td>
<td>Differential Spider</td>
</tr>
<tr>
<td>43</td>
<td>Bolt* or Rivet* - Ring Gear &amp; Case</td>
</tr>
<tr>
<td>44</td>
<td>Ring Gear</td>
</tr>
<tr>
<td>45</td>
<td>Differential Case - Flange Half</td>
</tr>
<tr>
<td>46</td>
<td>Washer - Differential Case</td>
</tr>
<tr>
<td>47</td>
<td>Nut* - Differential Case</td>
</tr>
<tr>
<td>48</td>
<td>Bearing Cone - Differential Left-Hand</td>
</tr>
</tbody>
</table>

* Not present on all carriers
**Removal & Disassembly**

**DANGER**

PARK THE VEHICLE ON A LEVEL SURFACE. BLOCK THE WHEELS TO PREVENT THE VEHICLE FROM MOVING. SUPPORT THE VEHICLE WITH SAFETY STANDS. NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY JACKS. JACKS CAN SLIP AND FALL OVER. SERIOUS PERSONAL INJURY CAN RESULT.

**WARNING**

- TO PREVENT SERIOUS EYE INJURY, ALWAYS WEAR EYE PROTECTION WHEN PERFORMING VEHICLE MAINTENANCE OR SERVICE.

- USE A BRASS OR LEATHER MALLET FOR ASSEMBLY AND DISASSEMBLY PROCEDURES. NEVER HIT STEEL PARTS WITH A STEEL HAMMER. PIECES OF A PART CAN BREAK OFF CAUSING SERIOUS PERSONAL INJURY.

---

**Removing the Differential Carrier**

**NOTE:** If the vehicle is equipped with a driver-controlled differential lock (DCDL), the collar must be engaged before removing the axle shafts. See "Driver-Controlled Differential Lock (DCDL)" on page 58.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.

2. Use a jack or other lifting tool to raise the vehicle so the wheels to be serviced are off the ground. Support the vehicle with safety stands.

3. Place a drain pan under the rear axle.

4. Remove the plug from the bottom of the axle housing and drain lubricant from the assembly.

5. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier.

6. Remove the capscrews and washers or stud nuts and washers, if equipped, from the flanges of both axle shafts.

7. Loosen the tapered dowels, if equipped, in the axle flanges of both axle shafts using either the "Brass Drift Method" or the "Air Hammer Vibration Method".
Brass Drift Method

**WARNING**

DO NOT STRIKE THE ROUND DRIVING LUGS ON THE FLANGE OF AN AXLE SHAFT. PIECES CAN BREAK OFF CAUSING SERIOUS PERSONAL INJURY.

1. Hold a 1-1/2" diameter brass drift or brass hammer against the center of the axle shaft, inside the round driving lugs.

2. Strike the end of the drift with a large hammer, five to six pounds, and the axle shaft and tapered dowels will loosen.

3. Mark each axle shaft before it is removed from the axle assembly.

4. Remove the tapered dowels and separate the axle shafts from the main axle hub assembly.

5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.
Air Hammer Vibration Method

**WARNING**

WEAR EYE PROTECTION WHEN USING AN AIR HAMMER. WHEN USING POWER TOOLS, AXLE COMPONENTS CAN LOOSEN AND BREAK OFF CAUSING SERIOUS PERSONAL INJURY.

**CAUTION**

DO NOT USE A CHISEL OR WEDGE TO LOOSEN THE AXLE SHAFT AND TAPERED DOWELS. USING A CHISEL OR WEDGE CAN RESULT IN DAMAGE TO THE AXLE SHAFT, THE GASKET AND SEAL, AND THE AXLE HUB.

1. Use a round hammer bit and an air hammer to loosen tapered dowels and axle shaft.

2. Place the round hammer bit against the axle shaft or flange between the hub studs. Operate the air hammer at alternate locations between the studs to loosen the tapered dowels and axle shaft from the hub.

3. Mark each axle shaft before it is removed from the axle assembly.

4. Remove the tapered dowels and separate the axle shaft from the main axle hub assembly.

5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

Removing the Carrier from the Axle

1. Place a hydraulic roller jack under the differential carrier to support the assembly.

2. Remove all but the top two carrier to housing capscrews or stud nuts and washers.

3. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.

4. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.

5. After the carrier is loosened, remove the top two fasteners.

**CAUTION**

WHEN USING A PRY BAR, BE CAREFUL NOT TO DAMAGE THE CARRIER OR HOUSING FLANGE. DAMAGE TO THESE SURFACES WILL CAUSE OIL LEAKS.

6. Use the hydraulic roller jack to remove the carrier from the axle housing. Use a pry bar with a round end to help remove the carrier from the housing.

7. Using a hoist, lift the differential carrier by the input yoke or flange and place the assembly in a repair stand. NEVER lift by hand. A carrier stand can be built by referring to page 71 or ordering one from Kent Moore part number J-3409-D.
Removing the Differential

**NOTE:** Before working on the differential carrier, inspect the hypoid gear set for damage. If inspection shows no damage, the same gear set can be used again. Measure the backlash of the gear set and make a record of the dimension. "Checking Tooth Contact Patterns (Backlash)" on page 45.

1. Loosen and remove the thrust screw and jam nut, if equipped, from the differential carrier.

2. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.

3. Mark one carrier leg and bearing cap to correctly match the parts during carrier assembly. Mark the parts using a center punch and hammer.

4. Remove the cotter keys, pins, or lock plates, if equipped, holding the bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews.

5. Remove the capscrews and washers attaching the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers.
6. Remove the bearing caps and bearing adjusting rings from the carrier.

7. Safely lift the differential and ring gear assembly from the carrier. Place the assembly on a work bench.

---

**Disassembling the Differential**

**DANGER**

**OBSERVE ALL WARNINGS AND CAUTIONS PROVIDED BY THE PRESS MANUFACTURER TO AVOID DAMAGE TO COMPONENTS AND SERIOUS PERSONAL INJURY.**

1. If the match marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer.

2. Remove the capscrews and washers or bolts, nuts, and washers, if equipped, mounting the case halves together.

3. Separate the case halves. If necessary, use a brass, plastic, or leather mallet to loosen the parts.

4. Remove the differential spider or cross, four pinion gears, two side gears, and six thrust washers from inside the case halves.

5. If the ring gear needs to be replaced, remove the bolts, nuts, and washers, if equipped, holding the gear to the flange case half.
**CAUTION**

**DO NOT REMOVE THE RIVETS OR RIVET HEADS WITH A CHISEL AND HAMMER. USING A FLAT EDGE TOOL CAN CAUSE DAMAGE TO THE FLANGE CASE.**

6. **If rivets hold the ring gear to the flange case half,** remove the rivets as follows.

   a. Carefully center punch each rivet head in the center, on the ring gear side of the assembly. **NEVER** use a chisel and hammer.

   ![Correct Drilling Rivets](image1.png) ![Wrong Drilling Rivets](image2.png)

   b. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 0.03125" (0.79375 mm) smaller than the body diameter of the rivets.

   c. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

7. **Use a press to separate the case half and ring gear.** Support the assembly under the ring gear with metal or wood blocks. Press the case half through the gear.

8. If the differential bearings need to be replaced, use a bearing puller or press to remove the bearing cones from the case halves.
Removing the Drive Pinion

1. Fasten a flange bar to the input yoke or flange. When the nut is removed, the bar will hold the drive pinion in position.

2. Remove the nut and washer, if equipped, from the drive pinion.

3. Remove the yoke or flange bar.

**CAUTION**

NEVER USE A HAMMER OR MALLET TO LOOSEN AND REMOVE THE YOKE OR FLANGE. A HAMMER OR MALLET CAN DAMAGE THE PARTS CAUSING DRIVELINE RUNOUT, OR DRIVELINE IMBALANCE PROBLEMS AFTER CARRIER TO DRIVELINE ASSEMBLY.

4. Remove the yoke or flange from the drive pinion. Do not use a hammer or mallet.

   **If the yoke or flange is tight on the pinion:**
   Use a puller for removal.

5. Remove the capscrews and washers holding the bearing cage in the carrier.

**CAUTION**

DO NOT USE A PRY BAR TO REMOVE THE BEARING CAGE FROM THE CARRIER. A PRY BAR CAN DAMAGE THE BEARING CASE, SHIMS, AND CARRIER.

6. Remove the drive pinion, bearing cage and shims from the carrier. **NEVER** use a pry bar.

   **If the bearing cage is tight in the carrier:**
   Hit the bearing cage at several points around the flange area with a leather, plastic, or rubber mallet.

7. If the shims are in good condition, keep the shims together to use when the carrier is assembled.

8. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.
Disassembling the Drive Pinion

**WARNING**

OBSERVE ALL WARNINGS AND CAUTIONS PROVIDED BY THE PRESS MANUFACTURER TO AVOID DAMAGE TO COMPONENTS AND SERIOUS PERSONAL INJURY.

1. Place the drive pinion and bearing cage in a press. The pinion shaft must be toward the top of the assembly.

2. Support the bearing cage under the flange area with metal or wood blocks.

3. Press the drive pinion through the bearing cage. The inner bearing cone and bearing spacer will remain on the pinion shaft.

   **If a press is not available:** Use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

4. Use a press and a sleeve to remove the triple-lip or unitized oil seal from the bearing cage.

   **If a press is not available:** Place a tool with a flat blade under the flange to remove the oil seal from the cage.

---

1. Drive Pinion
2. Oil Seal
3. Outer Bearing, Cup & Cone
4. Inner Bearing, Cup & Cone
5. Spigot Bearing
6. Snap Ring
7. Bearing Spacer

---

1. Press
2. Drive Pinion
3. Oil Seal
4. Bearing Cage
5. Supports
6. Spigot Bearing
5. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of cage. Use a press and sleeve, bearing puller, or a small drift hammer. The type of tool used depends on the design of the bearing cage.

When a press is used, support the bearing cage under the flange area with metal or wood blocks.

6. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller MUST fit under the inner race of the cone to remove the cone correctly without damage.

8. Remove the snap ring, if equipped, from the end of drive pinion with snap ring pliers that expand.

9. Remove the spigot bearing from the drive pinion with a bearing puller.

Some spigot bearings are fastened to the drive pinion with a special peening tool.

10. If the spigot bearings are a two-piece assembly, remove the inner race from the pinion with a bearing puller. Remove the outer race and roller assembly from the carrier with a drift or a press.

7. If the spigot bearing needs to be replaced, place the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.
Preparing Parts for Assembly

Clean and Inspect Yokes

**CAUTION**

- **DO NOT INSTALL A PRESS ON SHAFT EXCLUDER OR POSE™ SEAL AFTER INSTALLATION OF A UNITIZED PINION SEAL.** THE USE OF A POSE SEAL WILL PREVENT CORRECT SEATING OF THE UNITIZED PINION SEAL ON THE YOKE AND WILL RESULT IN LUBRICANT LEAKAGE AT THE SEAL. POSE SEAL INSTALLATION IS RECOMMENDED ONLY FOR TRIPLE LIP AND OTHER PREVIOUS DESIGN SEALS.

- **DO NOT USE THIN METAL WEAR SLEEVES TO REFRESH THE YOKE SURFACE.** WEAR SLEEVES PRESSED ONTO THE YOKE WILL PREVENT CORRECT SEATING OF THE PINION SEAL AND DAMAGE THE PINION SEAL ASSEMBLY. WEAR SLEEVE USAGE WILL CAUSE THE SEAL TO LEAK.

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. NEVER use abrasive cleaners, towels, or scrubbers to clean yoke or flange surface. NEVER use gasoline.

2. Inspect the yoke seal surface for any grooves.
   a. If grooves are present on yoke hubs used with single or triple lip seals, the yokes must be replaced.
   b. If grooves are present, use calipers to measure the groove diameters. If any of the yoke grooves measure less than the dimensions shown below, replace the yoke.

```plaintext
Yoke Seal Diameter  Minimum Yoke Diameter at Groove (inches)
3.000/3.005" 2.990"
3.250/3.255" 3.240"

A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER
UNITIZED PINION SEAL (UPS)
```

Inspect Differential

Inspect the following main differential assembly parts for wear or stress and replace any damaged parts:

- Inside surfaces of both case halves
- Both surfaces of all thrust washers
- The four trunnion ends of the spider or cross
- Teeth and splines of both differential side gears
- Teeth and bore of all differential pinions

Inspect Axle Shafts

Inspect axle shafts at the flange, shaft, and splines for wear and cracks. Replace the axle shaft, if necessary.

Inspect Breather

Inspect the breather using the following procedure:

a. Remove the breather from the axle housing.

b. Clean the breather. If the breather remains dirty after cleaning, replace the breather.

c. Apply compressed air to the breather. If compressed air does not pass through the breather, replace the breather.

d. Install the breather in the axle housing.
Clean Axle Housing

1. Use a tool with a flat blade, if required, to remove all old gasket material from surfaces.

2. Use a rotary tool with a ScotchBrite™ pad to clean all silicone residue from the housing and carrier faces. Surfaces must be clean, dry and free of foreign matter. The surfaces must not be oily to the touch.

3. Use a wire brush to clean the oil and dirt from the threaded holes.

4. Use a cleaning solvent to clean the surfaces where silicone gasket material was applied. Remove all oil, grease, dirt, and moisture without damaging the mating surfaces.

5. Dry surface thoroughly.

6. Remove metal filings from the magnets inside the housing.

7. Use a tap to clean the internal threads in the housing.

8. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps.

9. Remove all debris from inside the housing.

10. Use solvent to clean the inside of the housing.

11. Inspect the axle housing for damage. Repair or replace the axle housing.
Install Tight Fit Yokes & the POSE Seal

1. Apply the same lubricant used in the axle housing to the hub of the yoke or flange.

2. Inspect and verify the lips of the POSE seal and the outer retainer of the triple-lip seal or main seal are clean and free from dirt and particles that may cause lubricant leakage between the seals.

3. Install the POSE seal on the hub of the yoke or flange by hand. The lips of the seal must face toward the end of the hub or the opposite shoulder. Slide the POSE seal on the hub until the lips are from 0.25-0.50" (6.4-12.7 mm) from the end of the hub.

   **NOTE:** Do not install the POSE seal against the shoulder. The POSE seal will position itself correctly as the yoke or flange is pressed on the shaft.

4. Before installing the yoke or flange on the shaft, apply the same lubricant used in the axle housing to the hub.

5. Install the yoke or flange using the correct procedure. The yoke must be completely seated before tightening the pinion nut to the input shaft.

Install a Unitized Pinion Seal (UPS)

**CAUTION**

Once the yoke is partially or fully installed and then removed for any reason, the unitized pinion seal will be damaged and unusable. If the yoke and unitized pinion seal are removed after partial or full installation, remove and discard the original unitized pinion seal and replace it with another new unitized pinion seal.

If the inner sleeve of the seal is removed, the seal is not usable. A new seal is required. This will occur if a yoke is installed into the seal and then removed.

1. Remove the new unitized seal from the package only when prepared for immediate installation.

2. Select a seal driver designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal.

<table>
<thead>
<tr>
<th>Model</th>
<th>Seal Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 Series</td>
<td>TC-80320</td>
</tr>
<tr>
<td>145 Series</td>
<td>TC-80167 det 2</td>
</tr>
<tr>
<td>160 Series</td>
<td>TC-80167 det 1</td>
</tr>
<tr>
<td>186 Series</td>
<td>TC-80167 det 1</td>
</tr>
<tr>
<td>A176</td>
<td>Varies - Contact AxleTech</td>
</tr>
<tr>
<td>A177</td>
<td>Varies - Contact AxleTech</td>
</tr>
<tr>
<td>A178</td>
<td>Varies - Contact AxleTech</td>
</tr>
</tbody>
</table>

3. Position the seal on the driver.
Preparing Parts for Assembly

CAUTION
USE A RUBBER MALLET TO INSTALL THE SEAL. DO NOT USE A STEEL, BRASS, OR PLASTIC HAMMER. DAMAGE TO THE SEAL AND DRIVER TOOL CAN RESULT.

4. Use a rubber mallet to drive the seal into or against the bearing cage. The seal must fully seat into or against the bearing cage.

The seal must fully seat into or against the bearing cage

5. Use a 0.010" shim to check for clearance between the entire seal flange circumference and the bearing cage.

If the 0.010" shim slides between the seal flange and bearing cage: Correctly position the seal driver and drive the seal into the bore until the 0.010" shim cannot slide between the seal flange and bearing cage at any point around the seal flange.

MEASURING SEAL GAP

Install the Yoke

WARNING
SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS, AND CAUSE BURNS. EXAMPLES OF SOLVENT CLEANERS ARE CARBON TETRACHLORIDE, AND EMULSION-TYPE AND PETROLEUM-BASE CLEANERS. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SOLVENT CLEANER, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. ALSO FOLLOW THE PROCEDURES BELOW.

• Wear eye protection.
• Wear clothing that protects the skin.
• Work in a well-ventilated area.
• NEVER use gasoline or solvents containing gasoline. Gasoline can explode.
• ALWAYS use hot solution tanks or alkaline solutions correctly. Read the manufacturer’s instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.

1. Use a clean shop towel and cleaning solvent to clean the ground and polished surface of the yoke journal.

NOTES:
• NEVER use gasoline, abrasive cleaners, towels, or scrubbers to clean the yoke. Do not attempt to polish the yoke.
• The unitized seal features a rubber inner sleeve designed to seal and rotate with the yoke. This feature allows a yoke with minor grooves to be reused.
2. Inspect the yoke seal surface for grooves.

**If there are grooves on the yoke:** Use calipers to measure the groove diameters.

**If any of the yoke grooves measure less than the dimensions shown below:** Replace the yoke.

<table>
<thead>
<tr>
<th>Yoke Seal Diameter</th>
<th>Minimum Yoke Diameter at Groove (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.000/3.005&quot;</td>
<td>2.990&quot;</td>
</tr>
<tr>
<td>3.250/3.255&quot;</td>
<td>3.240&quot;</td>
</tr>
</tbody>
</table>

**CAUTION**

**DO NOT INSTALL A POSE SEAL AFTER INSTALLING A UNITIZED PINION SEAL.** *The use of a pose seal will prevent correct seating of the unitized pinion seal on the yoke and can result in lubricant leakage at the seal. Pose seal installation is recommended only for triple lip and other previous design seals.*

**DO NOT USE THIN METAL WEAR SLEEVES TO REFRESH THE YOKE SURFACE.** *Wear sleeves pressed onto the yoke can prevent correct seating of the pinion seal, damage the pinion seal assembly and can cause the seal to leak.*

3. Before installing the yoke, lightly lubricate or coat the yoke seal journal with axle oil.

4. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

**General Yoke & U-Joint Reassembly**

1. Install the end yoke hub capscrews by hand after seating the u-joint.

2. Tighten the capscrews according to manufacturer’s torque specifications.

**Gear Sets**

Refer to the following examples for information on identifying gear sets with matched parts. Always check match numbers to verify the gear set being installed has matched parts.

**ALTERNATE LOCATIONS:**

1. Part Number, Tooth Combination Number, Gear Set Match Number, Pinion Cone Variation Number
2. Part Number, Tooth Combination Number
3. Gear Set Match Number, Pinion Cone Variation Number
4. Part Number, Tooth Combination Number, Gear Set Match Number
5. Part Number, Tooth Combination Number, Gear Set Match Number
**Examples**

**Gear Set**

<table>
<thead>
<tr>
<th>Part</th>
<th>Number</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring gear</td>
<td>36786</td>
<td>On the front face or outer diameter</td>
</tr>
<tr>
<td>Drive pinion</td>
<td>36787</td>
<td>At the end at threads</td>
</tr>
</tbody>
</table>

**Gear Set Tooth Combination Number**

<table>
<thead>
<tr>
<th>Gear Set Teeth</th>
<th>Drive Pinion Location</th>
<th>Ring Gear Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-37 = gear set has a 5-tooth drive pinion and a 37-tooth ring gear</td>
<td>At the end at threads</td>
<td>On the front face or outer diameter</td>
</tr>
</tbody>
</table>

**Gear Set Match Number**

**NOTE:** AxleTech’s drive pinions and ring gears are only available as matched sets. Each gear in a set has an alpha-numeric match number.

<table>
<thead>
<tr>
<th>Match Number</th>
<th>Drive Pinion Location</th>
<th>Ring Gear Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>M29</td>
<td>At the end of the gear head</td>
<td>On the front face or outer diameter</td>
</tr>
</tbody>
</table>

**Pinion Cone Variation Number**

<table>
<thead>
<tr>
<th>Pinion Cone (PC) Variation Number</th>
<th>Drive Pinion Location</th>
<th>Ring Gear Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC+3</td>
<td>At the end of the pinion gear head</td>
<td>On the outer diameter</td>
</tr>
<tr>
<td>+2 +0.01 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1 -0.02 mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assembly

**WARNING**

- TO PREVENT SERIOUS EYE INJURY, ALWAYS WEAR EYE PROTECTION WHEN PERFORMING VEHICLE MAINTENANCE OR SERVICE.
- USE A BRASS OR LEATHER MALLET FOR ASSEMBLY AND DISASSEMBLY PROCEDURES. DO NOT HIT STEEL PARTS WITH A STEEL HAMMER. PIECES OF A PART CAN BREAK OFF CAUSING SERIOUS PERSONAL INJURY.
- OBSERVE ALL WARNINGS AND CAUTIONS PROVIDED BY THE PRESS MANUFACTURER TO AVOID DAMAGE TO COMPONENTS AND SERIOUS PERSONAL INJURY.

**Drive Pinion, Bearings, & Bearing Cage**

1. Place the bearing cage in a press.

2. Support the bearing cage with metal or wood blocks.

3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup.

   **NOTE:** Use the same procedure for both bearing cups.

4. Place the drive pinion in a press with the gear head or teeth toward the bottom.

5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

   **NOTE:** Spigot bearings are usually fastened to the drive pinion with a snap ring. Some are fastened with a peening tool, and some are a two-piece bearing assembly with the inner race pressed on the nose of the pinion and the outer race pressed into its bore in the carrier.

6. Install the spigot bearing using one of the following three procedures.
One-Piece Spigot Bearing on the Drive Pinion with Snap Ring

1. Place the drive pinion in a press with the gear head or the teeth toward the top.

2. Press the spigot bearing on the end of drive pinion. The bearing must be flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

3. Use snap ring pliers to install the snap ring, if equipped, into the groove in the end of the drive pinion.

One-Piece Spigot Bearing on the Drive Pinion Without Snap Ring

NOTE: The following procedure applies to some rear-rear tandem axles with existing snap ring components.

Use a staking tool to complete this procedure.

1. Place the drive pinion and the tube of the staking tool in a press with the spigot bearing toward the top.

2. When using a staking tool and press, apply 6,614 lbs. (3,000 kg) force on a 0.375" (10 mm) ball. Calculate the force required on the tool as follows.

\[
\text{Force} = 6,614 \text{ lbs. (3,000 kg)} \times \text{amount of balls in tool}
\]

Example

\[
6,614 \text{ lbs. (3,000 kg)} \times 3 \text{ balls} = 19,842 \text{ lbs. (9,000 kg)}
\]
3. Place the punch of the staking tool over the end of the pinion and spigot bearing. Apply the required amount of force on the punch.

**CAUTION**

DO NOT ALIGN NEW POINTS WITH THE GROOVES IN THE END OF THE DRIVE PINION OR IN OLD POINTS. IF THE NEW STAKED POINTS ARE PLACED IN THE WRONG AREAS, THE SPIGOT BEARING WILL NOT BE HELD CORRECTLY ON THE PINION SHAFT.

**NOTE:** If a three-ball stake tool is used, rotate the tool 180°.

4. Stake the end of the drive pinion at a minimum of five points. Rotate the punch as many times as required for a minimum of five points. Repeat Step 3 for each point.

---

**Two-Piece Spigot Bearing on the Drive Pinion**

**NOTE:** This procedure applies to some single rear axles and rear-rear tandem axles. These axles may also use a one-piece spigot bearing with a snap ring retainer.

**NOTE:** The inner race of two-piece spigot bearings must be staked in place. Before staking the pinion, the pinion stem must be heated to soften it.

1. Apply two stripes of temperature indicating liquid on the pinion stem from the top to the bottom. Apply a green stripe to indicate 400°F (205°C) and a blue stripe to indicate 500°F (260°C).

![Temperature indicating liquid application](image)

**CAUTION**

THE HEAT SHIELD IS REQUIRED WHEN HEATING THE PINION STEM. DO NOT HEAT THE PINION STEM WITHOUT THE HEAT SHIELD IN PLACE. DAMAGE TO COMPONENTS CAN RESULT.

2. Place the heat shield over the pinion stem so the temperature indicating liquid is visible through the hole in the shield.
WARNING
READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A TORCH. ALWAYS WEAR PROTECTIVE CLOTHING, GLOVES, AND EYE PROTECTION WHEN WORKING WITH A TORCH FOR HEATING PARTS TO PREVENT SERIOUS PERSONAL INJURY DURING ASSEMBLY.

3. Put on protective clothing, gloves, and eye protection.

CAUTION
DO NOT OVERHEAT THE PINION STEM OR THE METAL WILL WEAKEN. DAMAGE TO COMPONENTS CAN RESULT.

NOTE: Correct heating will take approximately 25-35 seconds, depending on how hot the torch is.

4. Light and adjust the torch until the white part of the flame is approximately 0.25” (6 mm) long. Keep the white part of the flame approximately 0.125” (3 mm) from the top of the stem. Move the flame around the outer diameter of the top of the pinion stem. The green temperature indicating liquid will turn black before the blue liquid does. Heat the stem until the blue liquid turns black at a point in the middle of the window.

5. Remove the flame and the heat shield from the pinion. Let the pinion air cool for 10 minutes. Use a razor blade to remove the temperature indicating liquid.

CAUTION
DO NOT PRESS OR DIRECTLY STRIKE THE NEW INNER RACE. DAMAGE TO THE BEARING WILL RESULT.

6. Use a press, if available, or a brass hammer to install the new inner race. Use the old inner race as a sleeve. The face is completely seated when a 0.002” (0.0508 mm) feeler gauge will not fit between the race and the pinion shoulder.

NOTE: To hold the races in place, use a staking tool, not the old race, to start the new race on the stem. The old race can be used to completely seat the new race.

7. Place the staking tool over the bearing race. Cut a 1” (25 mm) piece from the green plastigage strip and place in between the punch and the staking tool. The plastigage is not necessary for every stake. Use the plastigage to confirm the punch is being hit with the correct amount of force.

8. Strike the punch with a 2-3 lbs. (0.9-1.4 kg) brass hammer to upset the end of the pinion stem. Remove the strip and measure its thickness against the gauge on the strip’s wrapper. The strip must not be less than 0.003” (0.0762 mm) thick. This thickness indicates if enough force is being used when the punch is struck. If the strip is too thin, then the punch must be struck harder so the stake will hold the race in place. Rotate the tool and repeat this procedure until there are six evenly spaced stake marks around the stem.

9. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve the same size as the outer race. Press the bearing until it is squarely against the shoulder in the bottom of its bore.
Drive Pinion

1. Apply axle lubricant to the bearing cups and to the bearing cones in the cage.
2. Install the drive pinion into the bearing cage.
3. Install the bearing spacer or spacers onto the pinion shaft against the inner bearing cone. The spacer or spacers control the preload adjustment of the drive pinion bearings.
4. Install the outer bearing cone onto the pinion shaft against the spacer. Do not install the pinion seal in the bearing cage.

Adjustment

Pinion Bearing Preload

Press Method

If a press is not available, or the press does not have a pressure gauge, use the yoke or flange method to adjust pinion bearing preload. Refer to the "Yoke or Flange Method" on page 30.

NOTE: Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give an incorrect reading.

1. Place the drive pinion and cage assembly in a press with the gear head or teeth toward the bottom.
2. Install a sleeve of the correct size against the inner race of the outer bearing.
3. Apply and hold the correct amount of pressure to the pinion bearings. As pressure is applied, rotate the bearing cage several times so the bearings make normal contact.

<table>
<thead>
<tr>
<th>Thread Size of Pinion Shaft</th>
<th>Press Pressure Needed on Bearings for Correct Preload</th>
<th>Torque Value Needed on Pinion Nut for Correct Bearing Preload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs./tons</td>
<td>kg/ metric tons</td>
</tr>
<tr>
<td>7/8&quot;-20</td>
<td>22,000/1</td>
<td>9979/10</td>
</tr>
<tr>
<td>1&quot;-20</td>
<td>30,000/15</td>
<td>13,608/13.6</td>
</tr>
<tr>
<td>1-1/4&quot;-12</td>
<td>54,000/27</td>
<td>24,494/24.5</td>
</tr>
<tr>
<td>1-1/4&quot;-18</td>
<td>54,000/27</td>
<td>24,494/24.5</td>
</tr>
<tr>
<td>1-1/2&quot;-12</td>
<td>54,000/27</td>
<td>24,494/24.5</td>
</tr>
<tr>
<td>1-1/2&quot;-18</td>
<td>54,000/27</td>
<td>24,494/24.5</td>
</tr>
<tr>
<td>1-3/4&quot;-12</td>
<td>50,000/25</td>
<td>22,680/22.7</td>
</tr>
<tr>
<td>2&quot;-12</td>
<td>50,000/25</td>
<td>22,680/22.7</td>
</tr>
</tbody>
</table>
4. While pressure is held against the assembly, wind a cord around the bearing cage several times.

5. Attach a spring scale to the end of the cord.

6. Pull the cord on a horizontal line. As the bearing cage rotates, read the value indicated on the scale. Record the reading.

7. Measure the diameter of the bearing cage where the cord was wound. Measure in inches or centimeters.

8. Divide the dimension in half to get the radius. Record the radius dimension.

9. Use the following procedure to calculate the bearing preload or torque.

   - Pounds Pulled x Radius (inches) = lbs. in. Preload
     Preload x 0.113 = N·m Preload
   - Kilograms Pulled x Radius (cm) = kg-cm lbs. in. Preload
     Preload x 0.098 = N·m Preload

   Examples
   - Reading from spring scale = 7.5 lbs. (3.4 kg)
   - Diameter of bearing cage = 6.62" (16.8 cm)
   - Radius of bearing cage = 3.31" (8.4 cm)
     7.5 lbs. x 3.31" = 24.8 in. lbs. Preload
     Preload x 0.113 = 2.8 N·m Preload
     or
     3.4 kg x 8.4 cm = 28.6 kg-cm Preload
     Preload x 0.098 = 2.8 N·m Preload

10. If the preload or torque of pinion bearings is not within 5-45 lbs. in. (0.56-5.08 N·m) for new pinion bearings or 10-30 lbs. in. (1.13-3.39 N·m) for used pinion bearings in good condition, adjust the spacer and repeat Steps 1 through 9.

   - To increase preload:
     Install a thinner bearing spacer.
   - To decrease preload:
     Install a thicker bearing spacer.

11. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Use the following procedure to adjust pinion bearing preload with the yoke or flange method.
Yoke or Flange Method

CAUTION

DO NOT INSTALL TIGHT FITTING YOKES OR FLANGES ON SHAFTS USING A HAMMER OR MALLET. A HAMMER OR MALLET WILL DAMAGE THE YOKE OR FLANGE.

1. Use a press to install the input yoke or flange, nut and washer, if equipped, onto the drive pinion. The yoke or flange must be seated against the outer bearing.

2. Install the drive pinion and cage assembly into the carrier. Do not install shims under the bearing cage.

3. Install the bearing cage-to-carrier capscrews. Washers are not required at this time. Hand-tighten the capscrews.

4. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened.

5. Tighten the drive pinion nut to the correct torque value shown in the table on page 28.

6. Remove the yoke or flange bar.

7. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench.

8. If the pinion bearing preload or torque is not within 5-45 lbs. in. (0.56-5.08 N·m) for new pinion bearings or 10-30 lbs. in. (1.13-3.39 N·m) for used pinion bearings in good condition, remove the pinion and cage assembly from the carrier. Adjust the spacer and repeat Steps 1 through 7.
   - To increase preload:
     Install a thinner bearing spacer.
   - To decrease preload:
     Install a thicker bearing spacer.

9. After adjusting pinion bearing preload, remove the drive pinion and bearing cage from the carrier. "Removing the Drive Pinion" on page 15.
10. Install a new triple-lip seal.

**CAUTION**

The seal lips must be clean. Dirt and particles may cause a leak between the yoke and the seal.

- **a.** Apply the same lubricant used in the axle housing to the outer surface of the seal and the seal bore in the bearing cage.

- **b.** Place the drive pinion and cage assembly in a press with the seal bore toward the top.

- **c.** Press the seal into the bearing cage. The seal flange must be flat against the top of the bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal seal flange. The diameter of the sleeve or driver must be larger than the flange diameter.

- **d.** After the triple-lip seal is installed, a gap of approximately 0.015-0.030" (0.38-0.76 mm) between the flange and bearing cage is normal.

- **e.** Check the gap with a feeler gauge at several points around the seal. The gap must be within 0.015-0.030" (0.38-0.76 mm). The difference between the largest and smallest gap measurement must not exceed 0.010" (0.0254 mm).

**If a press is not available:**

Use a mallet and the sleeve or driver to install the seal.
Shim Pack Thickness for a New Drive Pinion

NOTE: Use this procedure if a new drive pinion and ring gear set is being installed or if the depth of the drive pinion is being adjusted.

1. Use a micrometer to measure the thickness of the shim pack removed from under the pinion cage and record the measurement.

2. Find the pinion cone (PC) variation number on the drive pinion being replaced and record the number. The pinion cone number can be one of the following values:
   - PC +3, PC -3, +3 or -3 = 0.003”
   - PC +.03, PC 0.03 mm, +0.03 mm or -0.03 = 0.03 mm

3. If the PC number cannot be located or is unreadable, install a new shim pack of the same thickness as measured in Step 1.

4. If the old pinion cone number is a plus (+) number, subtract the number from the old shim pack thickness measured in Step 2.

5. If the old pinion cone number is a minus (–) number, add the number to the old shim pack thickness measured in Step 2.

6. Find the pinion cone (PC) variation number on the new drive pinion being installed and record the number.

7. If the new pinion cone number is a plus (+) number, add the number to the standard shim pack thickness calculated in Step 4 or Step 5. Use new shims to make a shim pack to the correct thickness. Refer to the following table.

8. If the new pinion cone number is a minus (–) number, subtract the number from the standard shim pack thickness calculated in Step 4 or Step 5. Use new shims to make a shim pack to the correct thickness. Refer to the following table.
### Examples

<table>
<thead>
<tr>
<th></th>
<th>inches</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Old Shim Pack Thickness</td>
<td>0.030 – 0.002</td>
<td>0.760 – 0.050</td>
</tr>
<tr>
<td>Old PC Number, PC +2 inches (+0.05 mm)</td>
<td>0.032 + 0.005</td>
<td>0.710 + 0.130</td>
</tr>
<tr>
<td></td>
<td>0.033</td>
<td>0.840</td>
</tr>
<tr>
<td>Standard Shim Pack Thickness. New PC Number, PC +5 inches (+0.13 mm)</td>
<td>0.028 – 0.005</td>
<td>0.710 + 0.130</td>
</tr>
<tr>
<td></td>
<td>0.023</td>
<td>0.580</td>
</tr>
<tr>
<td>New Shim Pack Thickness</td>
<td>0.028 – 0.005</td>
<td>0.710 + 0.130</td>
</tr>
<tr>
<td>2. Old Shim Pack Thickness</td>
<td>0.030 + 0.002</td>
<td>0.760 + 0.050</td>
</tr>
<tr>
<td>Old PC Number, PC –2 inches (–0.05 mm)</td>
<td>0.032 + 0.005</td>
<td>0.810 + 0.130</td>
</tr>
<tr>
<td></td>
<td>0.037</td>
<td>0.940</td>
</tr>
<tr>
<td>Standard Shim Pack Thickness. New PC Number, PC +5 inches (+0.13 mm)</td>
<td>0.028 – 0.005</td>
<td>0.710 + 0.130</td>
</tr>
<tr>
<td></td>
<td>0.027</td>
<td>0.580</td>
</tr>
<tr>
<td>New Shim Pack Thickness</td>
<td>0.028 – 0.005</td>
<td>0.710 + 0.130</td>
</tr>
<tr>
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<td>0.030 – 0.002</td>
<td>0.760 – 0.050</td>
</tr>
<tr>
<td>Old PC Number, PC +2 inches (+0.05 mm)</td>
<td>0.028 – 0.005</td>
<td>0.710 – 0.130</td>
</tr>
<tr>
<td></td>
<td>0.023</td>
<td>0.580</td>
</tr>
<tr>
<td>Standard Shim Pack Thickness. New PC Number, PC –5” (–0.13 mm)</td>
<td>0.032 – 0.005</td>
<td>0.810 – 0.130</td>
</tr>
<tr>
<td></td>
<td>0.027</td>
<td>0.680</td>
</tr>
<tr>
<td>New Shim Pack Thickness</td>
<td>0.028 – 0.005</td>
<td>0.710 – 0.130</td>
</tr>
<tr>
<td>4. Old Shim Pack Thickness</td>
<td>0.030 + 0.002</td>
<td>0.760 + 0.050</td>
</tr>
<tr>
<td>Old PC Number, PC –2 inches (–0.05 mm)</td>
<td>0.032 – 0.005</td>
<td>0.810 – 0.130</td>
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<td></td>
<td>0.027</td>
<td>0.680</td>
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</tr>
<tr>
<td></td>
<td>0.027</td>
<td>0.580</td>
</tr>
</tbody>
</table>

### Installing the Drive Pinion

**NOTE:** If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. Refer to the procedure "Shim Pack Thickness for a New Drive Pinion" on page 32.

1. Select the correct shim pack.
2. Apply Loctite 518 Gasket Eliminator to the carrier face.
3. Align the oil slots in the shims with oil slots in the bearing cage and carrier and install shims. Use guide studs to help align the shims.
4. Apply Loctite 518 Gasket Eliminator to the top of the shim pack.
5. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic, or leather mallet to hit the assembly into position.

6. Install the bearing cage-to-carrier capscrews and washers. Tighten the capscrews to the correct torque value. See "Torque Specifications" on page 52.

---

**Tight Fit Yokes and the POSE Seal**

**CAUTION**

DO NOT INSTALL TIGHT FIT YOKES ON SHAFTS USING A HAMMER OR MALLET. USING A HAMMER OR MALLET CAN DAMAGE THE YOKE.

THE SEAL LIPS MUST BE CLEAN. DIRT AND PARTICLES MAY CAUSE A LEAK BETWEEN THE YOKE AND THE POSE SEAL.

**NOTE:** NEVER install the POSE seal all the way against the yoke shoulder. This seal is designed to position itself as yoke is installed.

1. Apply axle lubricant on the yoke seal.
2. Check all surfaces of the yoke hub for damage.
3. If the carrier uses a POSE seal element, install a new POSE seal.
   a. Lightly lubricate the yoke journal with the same lubricant used in the axle housing.
   b. Partially install the POSE seal onto the yoke 0.25-0.5\" (6-13 mm).
4. Slide the yoke over the input shaft pinion. Align the yoke splines with the shaft splines.
CAUTION

DO NOT USE A HAMMER OR MALLET TO INSTALL THE YOKE TO THE INPUT PINION SHAFT. USING A HAMMER OR MALLET CAN DAMAGE THE YOKE OR FLANGE.

5. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing before the nut is tightened to specifications.

6. Install the drive pinion nut and washer on the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. See "Torque Specifications" on page 52.

Yoke with Unitized Pinion Seal (UPS)

NOTE: Once the yoke is partially or fully installed and then removed for any reason, the unitized pinion seal will be damaged and unusable. If the yoke and unitized pinion seal are removed after partial or full installation, remove and discard the original unitized pinion seal and replace it with another new unitized pinion seal.

If the inner sleeve of the seal is removed, the seal is not usable. A new seal is required. This will occur if a yoke is installed into the seal and then removed.

1. Remove the new unitized seal from the package only when prepared for immediate installation.

2. Select a seal driver designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal.

3. Position the seal on the driver.
CAUTION

USE A RUBBER MALLET TO INSTALL THE SEAL. DO NOT USE A STEEL, BRASS, OR PLASTIC HAMMER. DAMAGE TO THE SEAL AND DRIVER TOOL CAN RESULT.

4. Use a rubber mallet to drive the seal into or against the bearing cage. The seal must fully seat into or against the bearing cage.

5. Use a 0.010” (0.25 mm) shim to check for clearance between the entire seal flange circumference and the bearing cage.
   - If the 0.010” (0.25 mm) shim slides between the seal flange and bearing cage: Correctly position the seal driver and drive the seal into the bore until the 0.010” (0.25 mm) shim cannot slide between the seal flange and bearing cage at any point around the seal flange.

WARNING

SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS, AND CAUSE BURNS. EXAMPLES OF SOLVENT CLEANERS ARE CARBON TETRACHLORIDE, AND EMULSION-TYPE AND PETROLEUM-BASE CLEANERS. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SOLVENT CLEANER, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. ALSO FOLLOW THE PROCEDURES BELOW:

- Wear eye protection.
- Wear clothing that protects the skin.
- Work in a well-ventilated area.
- NEVER use gasoline or solvents containing gasoline. Gasoline can explode.
- ALWAYS use hot solution tanks or alkaline solutions correctly. Read the manufacturer’s instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.

1. Use a clean shop towel and a safe cleaning solvent to clean the ground and polished surface of the yoke journal. NEVER use gasoline, abrasive cleaners, towels, or scrubbers to clean the yoke. Do not attempt to polish the yoke.
   - NOTE: The unitized seal features a rubber inner sleeve designed to seal and rotate with the yoke. This feature allows a yoke with minor grooves to be reused.

2. Inspect the yoke seal surface for grooves.
If there are grooves on the yoke:
Use calipers to measure the groove diameters. If any groove diameter measures less than the dimensions shown below, replace the yoke.

<table>
<thead>
<tr>
<th>Yoke Seal Diameter</th>
<th>Minimum Yoke Diameter at Groove (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.000/3.005&quot;</td>
<td>2.990&quot;</td>
</tr>
<tr>
<td>3.250/3.255&quot;</td>
<td>3.240&quot;</td>
</tr>
</tbody>
</table>

UNITIZED PINION SEAL (UPS)

**CAUTION**

- DO NOT INSTALL A POSE SEAL AFTER INSTALLING A UNITIZED PINION SEAL. THE USE OF A POSE SEAL WILL PREVENT CORRECT SEATING OF THE UNITIZED PINION SEAL ON THE YOKE AND CAN RESULT IN LUBRICANT LEAKAGE AT THE SEAL. POSE SEAL INSTALLATION IS RECOMMENDED ONLY FOR TRIPLE LIP AND OTHER PREVIOUS DESIGN SEALS. DAMAGE TO COMPONENTS CAN RESULT.

- DO NOT USE THIN METAL WEAR SLEEVES TO REFRESH THE YOKE SURFACE. WEAR SLEEVES PRESSED ONTO THE YOKE CAN PREVENT CORRECT SEATING OF THE PINION SEAL, DAMAGE THE PINION SEAL ASSEMBLY AND CAN CAUSE THE SEAL TO LEAK. DAMAGE TO COMPONENTS CAN RESULT.

3. Before installing the yoke, lightly lubricate or coat the yoke seal journal with axle oil.

4. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

5. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing before the nut is torqued to specifications.

6. Install the drive pinion nut and washer, if required, on the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. See "Torque Specifications" on page 52.
Assembling the Differential

⚠️ CAUTION

HEAT THE RING GEAR BEFORE SEATING IT ONTO THE DIFFERENTIAL CASE. DO NOT PRESS A COLD RING GEAR ON THE FLANGE CASE HALF. A COLD RING GEAR WILL DAMAGE THE CASE HALF BECAUSE OF THE TIGHT FIT.

1. Heat the ring gear in a tank of water to a temperature of 160°F-180°F (71°C-82°C) for 10 to 15 minutes.

⚠️ WARNING

WEAR PROTECTIVE CLOTHING AND GLOVES WHEN WORKING WITH THE HOT RING GEAR TO PREVENT SERIOUS PERSONAL INJURY.

2. Use a lifting tool to safely lift the ring gear from the tank of water.

3. Install the ring gear on the flange case half immediately after the gear is heated.

   • If the ring gear does not fit easily on the case half: 
     Heat the ring gear again.

4. Align the ring gear and the flange case half fastener holes. Rotate the ring gear as necessary.

   NOTE: If rivets were used to hold the ring gear to the flange case half, replace them with bolts, nuts, and washers.

5. Install the bolts, nuts, and washers attaching the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads must be against the ring gear.

6. Tighten the bolts and nuts to the correct torque value. See "Torque Specifications" on page 52.

7. Use a 0.003” (0.08 mm) feeler gauge to check for gaps between the back surface of the ring gear and the case flange. Check for gaps at four points around the assembly.

   • If the gaps exceed specifications:
     Check the flange case half and ring gear for the cause of the gap. Repair or replace parts. Assemble the ring gear on the flange case half. Repeat the procedure in "Tight Fit Yokes and the POSE Seal" on page 34.

8. Use a press and the correct size sleeve to install the bearing cones on both of the case halves.

9. Apply axle lubricant on the inside surfaces of both case halves, spider or cross, thrust washers, side gears, and differential pinions.
10. Place the flange case half on a bench with the ring gear teeth facing upward.

11. Install one thrust washer and side gear into the flange case half.

**CAUTION**

THE SIDE GEARS IN SOME CARRIER MODELS HAVE HUBS OF DIFFERENT LENGTHS. INSTALL THE CORRECT LENGTH SIDE GEAR INTO THE FLANGE CASE HALF. DAMAGE TO COMPONENTS CAN RESULT.

12. Install the spider or cross, differential pinions, and thrust washers into the flange case half.

13. Install the second side gear and thrust washer over the spider and differential pinions.

14. Place the plain half of the differential case over the flange half and gears. Rotate the plain half to align the match marks.

15. Install Dri-Loc fasteners into the case halves. Refer to "Fasteners" on page xi.
   a. Install four capscrews and washers or bolts, nuts, and washers, if equipped, into the case halves. The distance between the fasteners must be equal. Tighten the fasteners to the correct torque value in a progressive criss-cross pattern opposite each other. See "Torque Specifications" on page 52.
   b. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. See "Torque Specifications" on page 52.

16. Check the differential gears rotating resistance.
Check Differential Rotating Resistance

1. Make an inspection tool using an axle shaft matching the spline size of the differential side gear. Cut the shaft to approximately 12” (304.8 mm). Weld a nut onto the end of the shaft.

2. Place the differential and ring gear assembly in a vise. Install soft metal covers over vise jaws to protect the ring gear.

3. Install the tool into the differential until the splines of the tool are engaged with one side gear.

4. Place a torque wrench onto the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench.

   • If the torque value exceeds 50 lbs. ft. (67.8 N·m): Disassemble the differential gears from the case halves. Inspect the case halves, spider, gears, and thrust washers. Repair or replace parts. Assemble the parts and repeat Steps 2 to 4.
Installing the Differential Assembly

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.

2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones assembled on the case halves.

3. Apply adhesive into the bearing bores of the carrier legs and bearing caps. Adhesive must not contact the adjusting ring threads.

4. Install the bearing cups over the bearing cones assembled on the case halves.

5. Safely lift the differential and ring gear assembly and install it into the carrier. The bearing cups must be flat against the bores between the carrier legs.

6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand-tight against the bearing cup.

7. Install the bearing caps over the bearings and adjusting rings. Align the match marks made when the caps were removed.

8. Seat each bearing cap with a light leather, plastic, or rubber mallet. The caps must fit easily against the bearings, adjusting rings, and carrier. **NEVER** force the bearing caps into position.

   - **If bearing caps do not correctly fit into position:** Check the alignment of match marks between caps and carrier. Remove the caps and repeat Steps 6-8.

9. Install the capscrews and washers attaching the bearing caps to the carrier. Hand-tighten the capscrews four to six turns. Then tighten the capscrews to the correct torque value. See "Torque Specifications" on page 52.

   **NOTE:** Do not install the cotter keys, pins, or lock plates, if equipped, holding the bearing adjusting rings in position.

10. Adjust the differential bearing preload and hypoid gear backlash and check the tooth contact patterns, as shown in the following pages.
Adjust Differential Bearing Preload

**Method 1**

1. Attach a dial indicator onto the carrier mounting flange so the plunger or pointer is against the ring gear back surface.

![DIAL INDICATOR](image)

**CAUTION**

WHEN TURNING THE ADJUSTING RINGS, ALWAYS USE A TOOL THAT ENGAGES TWO OR MORE OPPOSITE NOTCHES IN THE RING. A T-BAR WRENCH CAN BE USED FOR THIS PURPOSE. IF THE TOOL DOES NOT CORRECTLY FIT INTO THE NOTCHES, DAMAGE TO THE LUGS WILL OCCUR.

2. Use a T-bar wrench to loosen the bearing adjusting ring opposite the ring gear. A small amount of end play will show on the dial indicator.

![T-BAR WRENCH](image)

3. Use one of the following methods to move the differential and ring gear to the left and right while reading the dial indicator:
   a. Insert two pry bars between the bearing adjusting rings and ends of the differential case. The pry bars must not touch the differential bearings.

![Bars must not touch bearings](image)

   b. Insert two pry bars between the differential case or ring gear and the carrier at locations other than described in Step A. The pry bars must not touch the differential bearings.

4. Tighten the bearing adjusting ring until the dial indicator reads ZERO end play. Move the differential and ring gear to the left and right as needed. If necessary, repeat Step A or B.

5. Tighten each bearing adjusting ring one notch from ZERO.

6. Proceed to check ring gear runout.
**Method 2**

1. Hand-tighten both adjusting rings against the differential bearings.

2. Use a micrometer to measure distance X or Y between the opposite surfaces of the bearing caps. Record the measurement.

3. Tighten each bearing adjusting ring one notch.

4. Measure distance X or Y again. Compare the measurement with the one obtained in Step 2. The difference between the two dimensions is the amount the bearing caps have expanded.

**Example**

- Distance X or Y — before tightening adjusting rings = 13.927" (353.74 mm)

- Distance X or Y — after tightening adjusting rings = 13.936" (353.97 mm)

- 13.936" – 13.927" = 0.009" (0.23 mm) difference

- **If the dimension is within specifications:**
  Continue by checking ring gear runout.

- **If the dimension is less than specifications:**
  Repeat Steps 3 and 4 as needed.

---

**Check Ring Gear Runout**

1. Attach a dial indicator onto the carrier mounting flange.

2. Adjust the dial indicator so the plunger or pointer is against the back surface of the ring gear. Set the dial indicator to ZERO.

3. Rotate the differential and ring gear. Read the dial indicator. Runout must not exceed 0.008" (0.20 mm).

- **If runout exceeds specifications:**
  Remove the differential and ring gear assembly from the carrier. Refer to "Removing the Differential" on page 12 and Steps 4 and 5 below.

- **If runout is within specifications:**
  Proceed to "Ring Gear Backlash Adjustment" on page 44.

4. Check the differential parts including the carrier for wear and damage. Repair or replace parts.

5. Install the differential and ring gear into the carrier. Refer to "Installing the Differential Assembly" on page 41. Repeat preload adjustment of differential bearings.
Ring Gear Backlash Adjustment

<table>
<thead>
<tr>
<th>Ring Gear Pitch Diameter</th>
<th>Range of Backlash Setting</th>
<th>Backlash Setting for New Gear Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 17&quot; (431.8 mm)</td>
<td>0.008-0.018&quot; (0.20-0.46 mm)</td>
<td>0.012&quot; (0.30 mm)</td>
</tr>
<tr>
<td>Greater than 17&quot; (431.8 mm)</td>
<td>0.010-0.020&quot; (0.25-0.51 mm)</td>
<td>0.015&quot; (0.38 mm)</td>
</tr>
</tbody>
</table>

1. Measure the outer diameter of ring gear for approximate pitch diameter.

   • **If the old gear set is installed:**
     Adjust the backlash to the setting measured before the carrier was disassembled.

   • **If a new gear set is installed:**
     Adjust the backlash to the correct specification for new gear sets.

2. After checking the tooth contact patterns, the backlash can be adjusted within specification limits, if needed. To change the location of the pattern use the following procedures.

   a. Attach a dial indicator onto the mounting flange of the carrier.

   b. Adjust the dial indicator so the plunger or pointer is against the tooth surface.

   c. Adjust the indicator dial to ZERO. Hold the drive pinion in position.

   d. After reading the dial indicator, rotate the differential and ring gear a small amount in both directions against the drive pinion teeth.

   • **If the backlash reading is within specifications:** Check the tooth contact patterns.

   • **If the backlash reading is not within specifications:** Adjust backlash as needed.

   e. Loosen one bearing adjusting ring one notch then tighten the opposite ring the same amount.

   • **To increase backlash:**
     Move the ring gear away from the drive pinion.

   • **To decrease backlash:**
     Move the ring gear toward the drive pinion.

   f. Repeat Steps 2-5 until the backlash is within specifications.

   **NOTE:** When adjusting backlash, move the ring gear only. NEVER move the drive pinion.
Checking Tooth Contact Patterns (Backlash)

The tooth contact patterns for each type of gear set are different. Check the part numbers to determine what type of gear set is in the carrier. Refer to the illustration below for part number locations.

In the following procedures, movement of the contact pattern in the length of the tooth is indicated as toward the heel or toe of the ring gear.

Always check tooth contact patterns on the drive side of the gear teeth.

1. Adjust the backlash of a new gear set to either 0.012” (0.305 mm) or 0.015” (0.380 mm) depending on the size of the ring gear. Adjust the backlash of an old gear set to the setting measured before the carrier was disassembled. Refer to "Ring Gear Backlash Adjustment" on page 44.

2. Apply a marking compound onto approximately 12 gear teeth of the ring gear. Rotate the ring gear so the 12 gear teeth are next to the drive pinion.

3. Rotate the ring gear forward and backward so the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a clearer pattern.

4. Look at the contact patterns on the ring gear teeth. Compare the patterns in the following illustrations. The location of good hand-rolled contact patterns for gear sets is toward the toe of the gear tooth and in the center between the top and bottom of the tooth.
When the carrier is operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth.

**GOOD PATTERN IN OPERATION**

The location of a good hand-rolled contact pattern for an old gear set must match the wear pattern in the ring gear. The new contact pattern will be smaller in area than the old wear pattern.

A high contact pattern indicates the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates the drive pinion was installed too deep in the carrier.

- **If the contact patterns require adjustment:** Continue by following Step 5 to move the contact patterns between the top and bottom of the gear teeth.

- **If the contact patterns are in the center of the gear teeth:** Continue by following Step 6.

5. Change the thickness of the shim pack under the bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure:

a. Remove the drive pinion and bearing cage from the carrier. See "Removing the Drive Pinion" on page 15.

- **To correct a high contact pattern:** Decrease the thickness of the shim pack under the bearing cage. When decreasing the thickness of the shim pack, the drive pinion will move toward the ring gear.

- **To correct a low contact pattern:** Increase the thickness of shim pack under the bearing cage. When increasing the thickness of the shim pack, the drive pinion will move away from the ring gear.
b. Install the drive pinion, bearing cage, and shims into the carrier. See "Shim Pack Thickness for a New Drive Pinion" on page 32.

c. Repeat Steps 2-5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within the specification range to move the contact patterns to the correct location in the length of the gear teeth. See "Ring Gear Backlash Adjustment" on page 44.

a. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth.

![Decrease backlash diagram]

Loosen adjusting ring this side

Decrease backlash

Tighten adjusting ring this side

b. Increase backlash to move the contact patterns toward the heel of the ring gear teeth.

![Increase backlash diagram]

Increase backlash

Loosen adjusting ring this side

Tighten adjusting ring this side

b. Repeat Steps 2-4 and Step 6 until the contact patterns are at the correct location in the length of the gear teeth.

7. Install the cotter keys, pins, or lock plates, if equipped, holding the two bearing adjusting rings in position. Use the following procedure:

a. Install cotter keys between the lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss.

![Cotter key diagram]

PIN

COTTER KEY

LOCK PLATE

b. Use a drift and hammer to install the pin through the boss of the bearing cap until the pin is between the lugs of the adjusting ring.

c. Install the lock plate on the bearing cap so the tab is between the lugs of the adjusting ring. Install the two capscrews holding the lock plate to the bearing cap. Tighten the capscrews to correct torque value.

---

**CAUTION**

IF THE CARRIER HAS COTTER KEYS, LOCK THE ADJUSTING RINGS ONLY WITH COTTER KEYS. IF THE CARRIER HAS ROLL PINS, REUSE THE ROLL PINS OR LOCK THE ADJUSTING RINGS WITH COTTER KEYS. DO NOT FORCE A ROLL PIN INTO A COTTER KEY HOLE. DAMAGE TO COMPONENTS CAN RESULT.
Installing the Thrust Screw

1. Rotate the carrier in the repair stand until the back surface of ring gear is toward the top.

2. Install the jam nut on the thrust screw, if equipped, one half the distance between both ends.

3. Install the thrust screw. Clearance between the thrust screw and the ring gear must be 0.025-0.045” (0.65-1.14 mm).

4. Loosen the thrust screw 1/2 turn, 180°.

5. Tighten the jam nut, if equipped, to the correct torque value against the carrier. See "Torque Specifications" on page 52.

Axle Housing Preparation

**WARNING**

**WHEN APPLYING SOME SILICONE GASKET MATERIALS, A SMALL AMOUNT OF ACID VAPOR IS PRESENT. TO PREVENT SERIOUS PERSONAL INJURY, ENSURE THE WORK AREA IS WELL-VENTILATED. READ THE MANUFACTURER'S INSTRUCTIONS BEFORE USING A SILICONE GASKET MATERIAL, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. IF A SILICONE GASKET MATERIAL GETS INTO YOUR EYES, FOLLOW THE MANUFACTURER'S EMERGENCY PROCEDURES. HAVE YOUR EYES CHECKED BY A PHYSICIAN AS SOON AS POSSIBLE.**

**SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS AND CAUSE BURNS. EXAMPLES OF SOLVENT CLEANERS ARE CARBON TETRACHLORIDE, AND EMULSION-TYPE AND PETROLEUM-BASE CLEANERS. READ THE MANUFACTURER'S INSTRUCTIONS BEFORE USING A SOLVENT CLEANER, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. ALSO FOLLOW THE PROCEDURES BELOW.**

- Wear eye protection.
- Wear clothing that protects the skin.
- Work in a well-ventilated area.
- NEVER use gasoline or solvents containing gasoline. Gasoline can explode.
- ALWAYS use hot solution tanks or alkaline solutions correctly. Read the manufacturer’s instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.
CAUTION

APPLY SILICONE GASKET MATERIAL IN A CONTINUOUS 0.125" (3 MM) BEAD. IF MORE IS USED, GASKET MATERIAL CAN BREAK OFF AND PLUG LUBRICATION PASSAGES. DAMAGE TO COMPONENTS CAN RESULT.

1. Ensure "Clean Axle Housing" on page 19 has been completed.

2. Check for loose studs, if equipped, in the mounting surface of the housing where the carrier fastens. Remove and clean loose studs.

3. Apply 0.125" (3 mm) diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes on the surface.

4. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the differential. Do not get oil on the outer diameter of the bearing cup and do not permit oil to drip onto the bearing bores.

Installing the Carrier into the Housing

NOTE: To complete the assembly of axles equipped with driver-controlled differential locks, refer to "Installing the DCDL Assembly into Carrier" on page 63.

1. Apply liquid adhesive to the threaded holes.

2. If the studs are not installed already, install two long studs in the carrier to guide the carrier into the housing.

3. Tighten the studs to the correct torque value. See "Torque Specifications" on page 52.

CAUTION

DO NOT INSTALL THE CARRIER USING A HAMMER OR MALLET OR DAMAGE TO THE MOUNTING FLANGE CARRIER WILL OCCUR CAUSING OIL LEAKS.

4. Use a hydraulic roller jack or a lifting tool to immediately install the carrier into the housing to permit the silicone gasket material to compress evenly between the faces.

5. Carefully push the carrier into position.
6. Apply a 0.125” (3 mm) bead of Loctite® 242 threadlocker around the capscrew threads approximately 0.25” (6 mm) from the end.

7. Apply a 0.125” (3 mm) bead of Loctite® 242 threadlocker across the length of the threads.

8. Install nuts and washers or capscrews and washers, if equipped, in the four corner locations around the carrier and axle housing. Hand-tighten the fasteners.

9. Install the remaining capscrews using a crisscross pattern to tighten the capscrews evenly. The capscrews must be tightened within 10 minutes of initial application of Loctite 242 threadlocker. For more information, see "Torque Specifications" on page 52.

   - Tighten 1/2” capscrews to 140 lbs. ft. (190 N·m)
   - Tighten 5/8” capscrews to 225 lbs. ft. (306 N·m)

10. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts must fit flat against the wheel hub.

---

**Straight Holes, Nuts, & Hardened Washers**

a. Clean the mating surfaces of the axle shaft and the wheel hub.

b. If silicone gasket material is used, apply a 0.125” (3 mm) diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole.

c. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft must fit flat against the wheel hub.

d. Install the Grade 8 nuts and hardened washers on the stud. Lock washers are an acceptable alternative. Tighten the stud nuts to the torque specified in the table below.

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Thread Size</th>
<th>Torque Value - Grade 8 Nut (lbs. ft. / N·m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plain Nut</td>
</tr>
<tr>
<td>Stud Nut, Axle Shaft</td>
<td>0.62-18</td>
<td>150-230 (244-312)</td>
</tr>
<tr>
<td></td>
<td>0.75-16</td>
<td>310-400 (420-542)</td>
</tr>
<tr>
<td>Studs All</td>
<td>All</td>
<td>Install the course thread end of stud into hub and tighten to last thread.</td>
</tr>
</tbody>
</table>
Tapered Dowel, Hardened Washer, & Hardened Nut

a. Clean the mating surfaces of the axle shaft and the wheel hub.

b. If silicone gasket material is used, apply a 0.125” (3 mm) diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole.

c. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft must fit flat against the wheel hub.

d. Install solid tapered dowels over each stud and into the flange of the axle shaft. Use a punch or a drift and hammer, if necessary.

e. Install the Grade 8 nuts and hardened washers on the stud. Lock washers are an acceptable alternative. Tighten the stud nuts to the torque specified in the table below.

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Thread Size</th>
<th>Torque Value - Grade 8 Nut (lbs. ft. / N·m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Plain Nut</td>
</tr>
<tr>
<td>Stud Nut, Axle Shaft</td>
<td>0.44-20</td>
<td>50-75 (81-102)</td>
</tr>
<tr>
<td></td>
<td>0.50-20</td>
<td>75-115 (115-156)</td>
</tr>
<tr>
<td></td>
<td>0.56-18</td>
<td>110-165 (176-224)</td>
</tr>
<tr>
<td></td>
<td>0.62-18</td>
<td>150-230 (244-312)</td>
</tr>
<tr>
<td>Studs</td>
<td>All</td>
<td>Install the course thread end of stud into hub and tighten to last thread.</td>
</tr>
</tbody>
</table>

11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.

12. Wait 20 minutes before filling the assembly with lubricant. See "Lubrication" on page 3.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Size</th>
<th>Torque Range</th>
<th>Torque Range</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Plug, Heat Indicator</td>
<td>.50-14</td>
<td>25 minimum</td>
<td>34 minimum</td>
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<tr>
<td>2</td>
<td>Plug, Oil Fill, Housing</td>
<td>.75-14</td>
<td>35 minimum</td>
<td>47.5 minimum</td>
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<td>3</td>
<td>Breather</td>
<td>.38-18</td>
<td>20 minimum</td>
<td>27 minimum</td>
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<td>4</td>
<td>Nut, Axle Shaft Stud</td>
<td>Plain Nut</td>
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<td>.44-20</td>
<td>50-75</td>
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<td>.56-18</td>
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<td>150-230</td>
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<td></td>
<td>Lock Nut</td>
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<td>.62-18</td>
<td>130-190</td>
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<td>Item</td>
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<td>Torque Range</td>
<td>Size</td>
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<td>5</td>
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<td>18-24</td>
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<td>.50-13</td>
<td>85-115</td>
<td>115-156</td>
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<td>6</td>
<td>Capscrew, Differential Case</td>
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<td>35-50</td>
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<td>lbs. ft.</td>
<td>N·m</td>
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<td>Capscrew, Bearing Cage</td>
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<td>.56-12</td>
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<td>.62-11</td>
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<td>Input Yoke-to-Input Shaft Nut</td>
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<td>Sensor Switch</td>
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<td>Capscrew, Carrier to Housing</td>
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<td>181-221</td>
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<tr>
<td>16</td>
<td>Plug, Oil Drain</td>
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<td>25 minimum</td>
<td>34 minimum</td>
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<tr>
<td>17*</td>
<td>Lock Nut, Sensor Switch</td>
<td>M16 x 1</td>
<td>25-35</td>
<td>35-45</td>
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<td>18</td>
<td>Plug, Oil Fill, Carrier</td>
<td>.75-14</td>
<td>25 minimum</td>
<td>34 minimum</td>
</tr>
<tr>
<td></td>
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<td>1.5-11.5</td>
<td>120 minimum</td>
<td>163 minimum</td>
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<td>M24 x 1.5</td>
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<td>47 minimum</td>
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<td>19**</td>
<td>Screw-In DCDL Cylinder Plug or Cap</td>
<td>M60 x 2.0</td>
<td>80-100</td>
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<td>Air Cylinder</td>
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<td>21*</td>
<td>Capscrew, Manual Actuation, Storage Position</td>
<td>M10 x 1.5</td>
<td>15-25</td>
<td>20-35</td>
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<td>22*</td>
<td>Adapter, Air Cylinder</td>
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<td>23*</td>
<td>Capscrew/Plug, Air Cylinder Cover</td>
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<td>15-25</td>
<td>20-35</td>
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<td>Operating Position</td>
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<td>15-25</td>
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<td>Storage Position</td>
<td>M10 x 2.0</td>
<td>7-11</td>
<td>10-15</td>
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<td>24**</td>
<td>Capscrew, Manual Actuation, Storage Position</td>
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<td>25*</td>
<td>Capscrew, Air Cylinder Cover</td>
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<td>Capscrew, Lock Plate</td>
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<td>M8 x 1.25</td>
<td>21-26</td>
<td>28-35</td>
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</table>

* Carriers with bolt-on style differential lock cylinders

**Carriers with screw-in style differential lock cylinders
## Adjustments & Specifications

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<tr>
<th>Component</th>
<th>Specification</th>
<th>Adjustment</th>
</tr>
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<tbody>
<tr>
<td>Drive Pinion</td>
<td><strong>Bearing Preload</strong>&lt;br&gt;(See page 28)&lt;br&gt;New bearings 15 - 25 lbs. in. 1.7 - 2.8 N·m</td>
<td>Preload is controlled by the thickness of the spacer between bearings.&lt;br&gt;• To increase preload, install a thinner spacer&lt;br&gt;• To decrease preload, install a thicker spacer</td>
</tr>
<tr>
<td></td>
<td>Used bearings 5 - 25 lbs. in. 1.7 - 2.8 N·m</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Preload is controlled by the thickness of the spacer between bearings.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• To increase preload, install a thinner spacer&lt;br&gt;• To decrease preload, install a thicker spacer</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Depth in Carrier</strong>&lt;br&gt;Install the correct amount of shims between the bearing cage and carrier.&lt;br&gt;To calculate, use old shim pack thickness and new and old pinion cone numbers.</td>
<td>Change the thickness of the shim pack to get a good gear tooth contact pattern.</td>
</tr>
<tr>
<td></td>
<td><strong>Tooth Contact Patterns</strong>&lt;br&gt;(Hand Rolled)&lt;br&gt;(See page 45)&lt;br&gt;Toward the toe of the gear tooth and in the center between the top and bottom of the tooth</td>
<td>Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash&lt;br&gt;• To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage&lt;br&gt;• To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage&lt;br&gt;• To move the contact pattern toward the toe of the tooth, decrease backlash of the ring gear&lt;br&gt;• To move the contact pattern toward the heel of the tooth, increase backlash of the ring gear</td>
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<tr>
<td>Component</td>
<td>Specification</td>
<td>Adjustment</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
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<tr>
<td>Differential</td>
<td><strong>Bearing Preload</strong> &lt;br&gt;(See page 42)</td>
<td>Preload is controlled by tightening both adjusting rings after zero end play is reached</td>
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<tr>
<td></td>
<td><strong>Differential Bearing Preload</strong> &lt;br&gt;15-35 lbs. in. (1.7-3.9 N-m) or Expansion between bearing caps</td>
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<tr>
<td></td>
<td><strong>Expansion between bearing caps</strong> &lt;br&gt;RS-140, RS-145, RS-160 models — 0.002-0.009” (0.05-0.229 mm) All other carrier models — 0.006-0.013” (0.15-0.33 mm)</td>
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<tr>
<td>Gear Rotating Resistance</td>
<td><strong>50 lbs. ft. (68 N·m) torque applied to one side gear</strong></td>
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</tr>
<tr>
<td>(See page 40)</td>
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<tr>
<td>Ring Gear</td>
<td><strong>Backlash</strong> &lt;br&gt;(See page 44)</td>
<td>Backlash is controlled by the position of the ring gear. Change backlash within specifications to get a good tooth contact pattern.</td>
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<td><strong>Range for ring gears with a pitch diameter of less than 17” (431.8 mm):</strong></td>
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<tr>
<td></td>
<td>• 0.008-0.018” (0.20-0.46 mm) or  • 0.012” (0.30 mm) for a new gear set</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Range for ring gears with a pitch diameter of 17” (431.8 mm) or greater:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 0.010-0.020” (0.25-0.51 mm) or  • 0.015” (0.38 mm) for a new gear set</td>
<td></td>
</tr>
<tr>
<td>Runout</td>
<td><strong>0.008” (0.20 mm) maximum</strong></td>
<td>--</td>
</tr>
<tr>
<td>(See page 43)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDL Sensor Switch</td>
<td><strong>Installation</strong> &lt;br&gt;(See page 65)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Shift the differential to the locked position. Tighten the sensor switch into the carrier until the test light comes on. Tighten the sensor switch one additional turn and tighten lock nut to correct torque value.</strong></td>
<td></td>
</tr>
<tr>
<td>Spigot Bearing</td>
<td><strong>Peening on the Drive Pinion</strong> &lt;br&gt;(page 26)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Apply 6,614 lbs. (3000 kg) load on a 0.375” (10 mm) ball. Peen the end of the drive pinion at a minimum of five points. Softening of the pinion stem end by heating may be required.</strong></td>
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</tbody>
</table>
## Troubleshooting

<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tires wear out quickly or have uneven tread wear</td>
<td>Tires have incorrect air pressure</td>
<td>Infl ate tires to correct PSI</td>
</tr>
<tr>
<td></td>
<td>Tires out of balance</td>
<td>Balance or replace tires</td>
</tr>
<tr>
<td></td>
<td>Incorrect tandem axle alignment</td>
<td>Align tandem axles</td>
</tr>
<tr>
<td></td>
<td>Incorrect toe-in setting</td>
<td>Adjust toe-in to specified setting</td>
</tr>
<tr>
<td></td>
<td>Incorrect steering arm geometry</td>
<td>Service steering system as necessary</td>
</tr>
<tr>
<td></td>
<td>Excessive wheel end play</td>
<td>Readjust wheel bearings</td>
</tr>
<tr>
<td>Vehicle is hard to steer</td>
<td>Power steering system pressure low</td>
<td>Repair power steering system</td>
</tr>
<tr>
<td></td>
<td>Steering gear linkage not assembled correctly</td>
<td>Assemble steering gear correctly</td>
</tr>
<tr>
<td></td>
<td>Steering linkage needs lubrication</td>
<td>Lubricate steering linkage</td>
</tr>
<tr>
<td></td>
<td>King pins binding</td>
<td>Replace king pins</td>
</tr>
<tr>
<td></td>
<td>Incorrect steering arm geometry</td>
<td>Service steering system as necessary</td>
</tr>
<tr>
<td></td>
<td>Caster out of adjustment</td>
<td>Adjust caster as necessary</td>
</tr>
<tr>
<td></td>
<td>Tie rod ends hard to move</td>
<td>Replace tie rod ends</td>
</tr>
<tr>
<td></td>
<td>Worn thrust bearing</td>
<td>Replace thrust bearing</td>
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<tr>
<td>Tie rod ends are worn and require replacement</td>
<td>Tie rod ends need lubrication</td>
<td>Lubricate cross tube ends following the</td>
</tr>
<tr>
<td></td>
<td>Severe operating conditions</td>
<td>recommended maintenance schedule</td>
</tr>
<tr>
<td></td>
<td>Damaged boot on tie rod end</td>
<td>Replace boot</td>
</tr>
<tr>
<td>Bent or broken cross tube, tie rod end ball stud,</td>
<td>Too much pressure in the power steering system / pressure</td>
<td>Adjust power steering system to specified</td>
</tr>
<tr>
<td>steering arm or tie rod end requiring component</td>
<td>excesses OEM specification</td>
<td>pressure</td>
</tr>
<tr>
<td>replacement</td>
<td>Power steering system cut-off pressure / out of adjustment</td>
<td>Adjust power steering system to specified</td>
</tr>
<tr>
<td></td>
<td>Severe operating conditions</td>
<td>pressure</td>
</tr>
<tr>
<td></td>
<td>Add-on power steering system not installed correctly</td>
<td>Correct the add-on power steering system</td>
</tr>
<tr>
<td></td>
<td>Drag link fasteners tightened higher than OEM specification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of lubrication / incorrect lubricant</td>
<td>Lubricate linkage with specified lubricant</td>
</tr>
<tr>
<td>Worn or broken steering ball stud</td>
<td>Power steering stops out of adjustment</td>
<td>Adjust stops to correct specification</td>
</tr>
<tr>
<td></td>
<td>Worn or missing seals and gaskets</td>
<td>Replace seals and gaskets</td>
</tr>
<tr>
<td></td>
<td>Incorrect lubricant</td>
<td>Lubricate axle with specified lubricant</td>
</tr>
<tr>
<td></td>
<td>Axle not lubricated at recommended maintenance schedule</td>
<td>Lubricate following the recommended maintenance</td>
</tr>
<tr>
<td></td>
<td>Incorrect lubrication procedures</td>
<td>schedule</td>
</tr>
<tr>
<td></td>
<td>Lubrication schedule does not match operating conditions</td>
<td>Adjust lubrication schedule to match</td>
</tr>
<tr>
<td></td>
<td>Caster out of adjustment</td>
<td>Adjust caster</td>
</tr>
<tr>
<td>Worn king pins and king pin bushings</td>
<td>Wheel assembly out of balance</td>
<td>Balance or replace wheels and/or tires</td>
</tr>
<tr>
<td></td>
<td>Worn shock absorbers</td>
<td>Replace shock absorbers</td>
</tr>
<tr>
<td>Vibration or shimmy of front axle during operation</td>
<td>Caster out of adjustment</td>
<td>Adjust caster</td>
</tr>
<tr>
<td></td>
<td>Wheel assembly out of balance</td>
<td>Balance or replace wheels and/or tires</td>
</tr>
<tr>
<td></td>
<td>Worn shock absorbers</td>
<td>Replace shock absorbers</td>
</tr>
</tbody>
</table>
Driver-Controlled Differential Lock (DCDL)

Exploded View

<table>
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<tr>
<th>Item</th>
<th>Description</th>
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<td>Lock Nut - Sensor Switch</td>
</tr>
<tr>
<td>2</td>
<td>Sensor Switch</td>
</tr>
<tr>
<td>3</td>
<td>Shift Fork</td>
</tr>
<tr>
<td>4</td>
<td>Shift Shaft Spring</td>
</tr>
<tr>
<td>5</td>
<td>Shift Shaft</td>
</tr>
<tr>
<td>6</td>
<td>Spring Retaining Pin</td>
</tr>
<tr>
<td>7</td>
<td>Flat Washer or Silastic, as required</td>
</tr>
<tr>
<td>8</td>
<td>Air Cylinder Tube</td>
</tr>
<tr>
<td>9</td>
<td>Screw-in Differential Lock</td>
</tr>
<tr>
<td>10</td>
<td>Cylinder Cover</td>
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<tr>
<td>11</td>
<td>Capscrew - Manual Actuation, Storage Position</td>
</tr>
<tr>
<td>12</td>
<td>Washer, Operating Position</td>
</tr>
<tr>
<td>13</td>
<td>Plug Gasket, Operating Position</td>
</tr>
<tr>
<td>14</td>
<td>Cover Capscrews</td>
</tr>
<tr>
<td>15</td>
<td>Washers</td>
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<tr>
<td>16</td>
<td>Plug Gasket, Storage Position</td>
</tr>
<tr>
<td>17</td>
<td>Cover Plug, Storage Position</td>
</tr>
<tr>
<td>18</td>
<td>Cover Copper Gasket</td>
</tr>
<tr>
<td>19</td>
<td>Piston O-ring</td>
</tr>
<tr>
<td>20</td>
<td>Piston</td>
</tr>
<tr>
<td>21</td>
<td>Shift Collar</td>
</tr>
<tr>
<td>22</td>
<td>Shift Fork Roll Pins</td>
</tr>
</tbody>
</table>
WARNING

TO PREVENT SERIOUS EYE INJURY, ALWAYS WEAR EYE PROTECTION WHEN PERFORMING VEHICLE MAINTENANCE OR SERVICE.

Some AxleTech drive axle models have a Driver-Controlled Differential Lock (DCDL). This differential lock is operated by a carrier-mounted, air-actuated shift unit. When activated, the shift unit moves a sliding collar which is installed on the splines of the axle shaft. When engaged, the collar locks the axle shafts together with a second set of splines on the differential case. When the DCDL is engaged, there is no differential action.

NOTE: The AxleTech carrier models with driver-controlled differential lock equipment are manufactured in metric dimensions and sizes. When these carriers are serviced, it is important to use the correct metric size tools on the fasteners. See “Torque Specifications” on page 52.

CAUTION

IF THE VEHICLE MUST BE TOWED TO A SERVICE FACILITY WITH THE DRIVE AXLE WHEELS ON THE GROUND, REMOVE THE AXLE SHAFTS BEFORE THE VEHICLE IS TOWED. DAMAGE TO COMPONENTS CAN RESULT.

1. Remove the axle shafts before the vehicle is towed. See “Towing” on page vi.
2. Install the axle shafts after the vehicle is towed.
3. If the differential carrier must be removed from the axle housing, use the following procedures.

Removing the Differential from Axle Housing

WARNING

PARK THE VEHICLE ON A LEVEL SURFACE. BLOCK THE WHEELS TO PREVENT THE VEHICLE FROM MOVING. SUPPORT THE VEHICLE WITH SAFETY STANDS. NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY JACKS. JACKS CAN SLIP AND FALL OVER. SERIOUS PERSONAL INJURY AND DAMAGE TO COMPONENTS CAN RESULT.

Before the differential carrier can be removed or installed, the differential lock must be shifted and held in the locked or engaged position to provide enough clearance between the shift collar and the axle housing to permit the removal or installation of the carrier.

NOTE: If the axle shafts were removed for towing with the differential in the unlocked or disengaged position, install the right-hand axle shaft into the housing before removing the differential carrier. See “Towing” on page vi.

To shift into the locked position, see “DCDL Assembly Manual Engaging Methods” on page 60.
Axle Setup for DCDL Disassembly

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Remove the drain plug from the bottom of the housing and drain the lubricant.

**WARNING**

**DURING DCDL DISASSEMBLY, WHEN THE DCDL IS IN THE LOCKED OR ENGAGED POSITION AND THE VEHICLE'S WHEELS ARE RAISED FROM THE FLOOR, DO NOT START THE ENGINE AND ENGAGE THE TRANSMISSION. THE VEHICLE CAN MOVE AND CAUSE SERIOUS PERSONAL INJURY. DAMAGE TO COMPONENTS CAN RESULT.**

3. Use a jack to raise the vehicle so the wheels being serviced are off the ground. Place a safety stand under the spring seats to hold the vehicle in the raised position.
4. Disconnect the driveline from the pinion input yoke.
5. Disconnect the vehicle air line from the differential lock actuator assembly.

DCDL Assembly Manual Engaging Methods

1. Follow Steps 2-5 of “Axle Setup for DCDL Disassembly” on page 60.
2. Remove the plug and gasket from the hole in the center of the cylinder cover.

**NOTE:** The storage hole for the plug and gasket is located on the opposite side of the cylinder cover where the storage hole for the manual engaging capscrew is located.

3. Remove the manual engaging cap screw from the top storage hole in the cylinder cover.
4. Install the plug and gasket into the bottom storage hole in the cylinder cover.
5. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.
6. Turn the manual adjusting capscrew to the right until the head is approximately 0.25-0.5" (6-13 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. If the 0.25-10.5" (6-13 mm) service position of the capscrew is achieved, the differential lock is completely engaged.

A high resistance on the capscrew indicates the splines of the shift collar and the differential case half are not aligned or engaged. To align the splines, use the following procedure.

a. Rotate the drive pinion or right-hand wheel to align the splines of the shift collar and case half while turning the manual engaging capscrew.

b. When a normal amount of spring resistance is felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the head is approximately 0.25" (6 mm) from the cylinder cover.

7. Remove the carrier from the axle housing. See “Removing the Carrier from the Axle” on page 11.

8. Follow Steps 2-5 of “Axle Setup for DCDL Disassembly” on page 60.

9. Remove the manual engaging capscrew from the storage hole in the carrier casting, next to the cylinder.

10. Remove air line and fitting. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

11. Turn the manual adjusting capscrew to the right until the head is approximately 0.25" (6 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. The capscrew is now in the service position and the differential lock is completely engaged.

12. Remove the carrier from the axle housing. See “Removing the Carrier from the Axle” on page 11.
Differential and Gear Assembly

**Differential Lock Sliding Collar**

1. For carriers with roll pins, tap out the two retainer roll pins, if equipped, until they are level with the inner face of the shift fork. Release the differential lock if it is manually engaged.

2. For carriers without roll pins, snap out collar from fork.

3. If required, remove the DCDL assembly at this time.

**Bolt-On Style Differential Lock Cylinder**

**NOTE:** On some bolt-on assemblies, a roll pin is installed in the shift shaft and is used as a stop for the shift shaft spring. It is not necessary to remove this roll pin during a normal disassembly.

a. Remove the sensor switch and lock nut.

b. Remove the four capscrews and washers holding the cylinder cover to carrier. Remove the cylinder cover and copper gasket.

c. Remove the sensor switch and lock nut. Remove the o-ring from the piston.

d. Remove the shift shaft from the shift fork. The shaft may be secured with liquid adhesive or pre-applied adhesive material. For more information, see “Fasteners” on page xi.

e. Remove the shift shaft spring and flat washer. Some models use silastic seal instead of the flat washer.

f. Remove the shift fork.

**BOLT-ON SHIFT ASSEMBLY**
**Screw-In Style Differential Lock Cylinder**

a. Remove the sensor switch.

b. Remove the cylinder by turning hex nut at the top of the cylinder with a wrench. The cylinder may be secured to the carrier casting with Loctite adhesive or equivalent pre-applied liquid adhesive. For more information, see “Fasteners” on page xi.

c. Remove the shift shaft, spring and shift fork.

4. Remove the cotter keys, pins, or lock plates, if equipped, holding the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews.

5. Mark one bearing cap and one carrier leg so these parts will be assembled in the correct positions. Remove the bearing cap capscrews and washers, the bearing caps and the adjusting rings.

6. Lift the differential and gear assembly from the carrier. Tilt the assembly as required to permit the ring gear to clear the support for the pinion spigot bearing.

Further disassembly of these carriers is the same as axles without the driver-controlled differential lock. To continue disassembly, follow the procedures in “Disassembling the Differential” on page 13.

---

**Installing the DCDL Assembly into Carrier**

**BOLT-ON DCDL ASSEMBLY - CROSS-SECTION VIEW**

1. Flat Washer or Silastic, as required
2. Cylinder
3. Electric Connection for Sensor
4. Air Line
5. O-ring
6. Piston
7. Disengaged
8. Engaged
9. Copper Gasket
10. Pin
11. Shift Fork
12. Collar
13. Shift Shaft & Spring

**Bolt-On Style Differential Lock Assembly**

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are completed.

1. On carrier models with shift fork roll pins, install the two roll pins into the ends of the shift fork. Tap the pins into position until they are level with the inner yoke face. Do not install the pins completely at this time.
2. On models without roll pins, snap the fork into position.

**WARNING**

BE CAREFUL WHEN USING LOCTITE ADHESIVE TO AVOID SERIOUS PERSONAL INJURY. READ THE MANUFACTURER'S INSTRUCTIONS BEFORE USING THIS PRODUCT. FOLLOW THE INSTRUCTIONS CAREFULLY TO PREVENT IRRITATION TO THE EYES AND SKIN.

3. Apply Loctite 222 threadlocker to the threads of the shift shaft.

4. Install the shift fork into its correct position in the carrier case.

5. Hold the shift fork in position. Install the shift shaft spring into the shift shaft opening in the carrier, through the shift fork bore and into the bore for the shift shaft spring.

6. Slide the shift shaft over the spring. Install the shaft into the shift fork. Tighten to 20-25 lbs. ft. (27-34 N·m).

7. Install the flat washer, when used, or apply silastic sealant to the bottom of the cylinder bore.

8. Install the o-ring into its groove on the piston. Lubricate the o-ring with axle lubricant. Install the piston into the air cylinder.

9. Install the cylinder into the housing bore. Verify the pilot journal on the piston is against its bore on the shift shaft.

10. Install the copper gasket into its bore on the inside of the cylinder cover. Place the cover in position over the cylinder so the air intake port will point up when the carrier is installed into the housing. Install the cover with the four attaching capscrews and washers. Tighten the capscrews to 7.4-8.9 lbs. ft. (10-12 N·m).
BOLT-ON STYLE

11. Slide the shift collar into the fork. Engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to “DCDL Assembly Manual Engaging Methods” on page 60.

12. Hold the shift collar in the locked or engaged position. If employed, tap the two roll pins into the shift fork ends until they are level with the outer yoke faces.

BOLT-ON STYLE

13. While the shift collar is still in the locked position, place the sensor switch, with the jam nut loosely attached into its hole.

14. Connect a battery or bulb tester to the sensor switch. Rotate the switch into its hole until contact with the shift fork causes the testing light to go on. Turn the switch one additional revolution. Tighten the jam nut to 26-33 lbs. ft. (34-45 N·m).

Screw-In Style Differential Lock Assembly

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are completed.

SCREW-IN DCDL ASSEMBLY - CROSS-SECTION VIEW

1. Shift Shaft & Spring  5. Engaged
3. Piston  7. O-ring
4. Disengaged  8. Shift Fork

1. Install the shift spring and fork into the correct position in the carrier case. Compress the spring slightly while installing the fork.

2. Install the shift shaft into the shaft bore of the carrier. Slide the shaft through the shift fork bore and shift spring inside diameter.

3. Inspect the piston o-ring. Replace the o-ring if there is any evidence of cuts, cracks, abrasion or wear.

4. Lightly lubricate the o-ring and DCDL cylinder bore with the same lubricant used in the axle housing.

5. Install the piston and o-ring assembly into the DCDL cylinder. Slide the piston to the port end of the cylinder.

6. Coat the DCDL cylinder threads with Loctite 518 Gasket Eliminator.
7. Screw the DCDL cylinder in place. Tighten the cylinder to 80-100 lbs. ft. (109-136 N·m).

8. Snap the shift collar into the fork. Engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. See “DCDL Assembly Manual Engaging Methods” on page 60.

9. Install the sensor switch into its hole. Tighten the switch to 25-35 lbs. ft. (35-45 N·m).

10. Connect a battery or bulb tester to the sensor switch. With the DCDL engaged, the tester light should go on.

**If the light does not go on:** Check the following:

a. Verify the fork is aligned with the sensor switch when it is in the engaged position.

b. Check for a loose wiring connection. The connector must be tightly seated.

c. Verify the sensor switch is fully seated against the carrier.

**If light fails to go on after these checks:** The sensor switch should be replaced.

---

### Differential Lock Assembly Cover Plates

**WARNING**

*WHEN APPLYING SOME SILICONE GASKET MATERIALS, A SMALL AMOUNT OF ACID VAPOR IS PRESENT. TO PREVENT SERIOUS PERSONAL INJURY, ENSURE THE WORK AREA IS WELL-VENTILATED. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SILICONE GASKET MATERIAL, THEN CAREFULLY FOLLOW THE INSTRUCTIONS.*

*IF A SILICONE GASKET MATERIAL GETS INTO YOUR EYES, FOLLOW THE MANUFACTURER’S EMERGENCY PROCEDURES. HAVE YOUR EYES CHECKED BY A PHYSICIAN AS SOON AS POSSIBLE.*

*TAKE CARE WHEN USING LOCTITE ADHESIVE TO AVOID SERIOUS PERSONAL INJURY. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING THIS PRODUCT. FOLLOW THE INSTRUCTIONS CAREFULLY TO PREVENT IRRITATION TO THE EYES AND SKIN.*

**NOTE:** For carriers without the differential lock or air shift, assemble the sensor switch plug and cover plate as follows.
**Bolt-On Cover Plate Assemblies**

1. Install the washer and plug into the hole for the sensor switch. Tighten the plug to 45-55 lbs. ft. (60-74 N·m).
2. Apply silicone gasket material to the cover plate mounting surface on the carrier. See “Seals” on page 67.
3. Install the four washers and capscrews. Tighten the capscrews to 7.4-8.9 lbs. ft. (10-12 N·m).

**Screw-In Cover Plate Assemblies**

1. Apply Loctite 518 liquid adhesive to the plate threads.
2. Install the bolts and washers. Tighten the plate into the carrier opening to 7.5-9.0 lbs. ft. (10-12 N·m).

**Installing the Carrier into Axle Housing**

![Warning]

**WARNING**

SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS AND CAUSE BURNS. EXAMPLES OF SOLVENT CLEANERS ARE CARBON TETRACHLORIDE, AND EMULSION-TYPE AND PETROLEUM-BASE CLEANERS. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SOLVENT CLEANER, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. ALSO FOLLOW THE PROCEDURES BELOW.

- Wear safe eye protection.
- Wear clothing that protects your skin.
- Work in a well-ventilated area.
- Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.
- Always use hot solution tanks or alkaline solutions correctly. Read the manufacturer’s instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.

1. Use a cleaning solvent and rags to clean the inside of the axle housing and the mounting surface. Blow dry the cleaned areas with compressed air. See “Clean Axle Housing” on page 19.
2. Inspect the axle housing for damage. If necessary, repair or replace the housing. See “Clean Axle Housing” on page 19.
3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and replace any studs where required.
4. Install the differential carrier into the housing, using the Manual Engaging Method on page 60.
Manual Engaging Method

1. Align the splines of the shift collar and the differential case half by hand or by installing the right-hand axle shaft through the shift collar and into the side gear.

2. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

**CAUTION**

THERE WILL BE A SMALL AMOUNT OF SPRING RESISTANCE WHEN TURNING THE MANUAL ENGAGING CAPSCREW. IF A HIGH RESISTANCE IS FELT BEFORE REACHING THE LOCKED OR ENGAGED POSITION, STOP TURNING THE CAPSCREW. DAMAGE TO COMPONENTS CAN RESULT.

3. Turn the manual adjusting capscrew to the right until the distance from the head of the capscrew is approximately 0.25-0.50” (6-13 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. When the capscrew head is in the service position 0.25-0.50-inch (6-13 mm) from top of DCDL, the differential lock is manually engaged.

A high resistance on the capscrew indicates the splines of the shift collar and the differential case half are not aligned or engaged.

Lift the shift collar as required and rotate to align the splines of collar and case half while turning the manual engaging capscrew inward. When the normal amount of spring resistance is again felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the 0.25-0.50” (6-13 mm) service position is achieved.

4. Clean both the DCDL actuator and the housing mounting surfaces.

**WARNING**

WHEN APPLYING SOME SILICONE GASKET MATERIALS, A SMALL AMOUNT OF ACID VAPOR IS PRESENT. TO PREVENT SERIOUS PERSONAL INJURY, ENSURE THE WORK AREA IS WELL-VENTILATED. READ THE MANUFACTURER’S INSTRUCTIONS BEFORE USING A SILICONE GASKET MATERIAL, THEN CAREFULLY FOLLOW THE INSTRUCTIONS. IF A SILICONE GASKET MATERIAL GETS INTO YOUR EYES, FOLLOW THE MANUFACTURER’S EMERGENCY PROCEDURES. HAVE YOUR EYES CHECKED BY A PHYSICIAN AS SOON AS POSSIBLE.

5. Apply silicone gasket material to the cleaned housing surface for the DCDL actuator. See “Seals” on page x.

6. Remove the short plug and gasket from the storage hole of the DCDL.

7. Remove the long manual engaging capscrew from the center of the DCDL.

**NOTE:** When the manual engaging capscrew is removed from the service position in the center of the DCDL actuator, the differential lock is disengaged.

8. Clean the plug, gasket, cylinder cover, and threaded service position hole in the center of the DCDL cylinder cover.
9. Install the manual engaging capscrew into the DCDL storage hole in the bolt-on or the screw-in DCDL assembly. The sealing gasket must be under the head of the capscrew.

   a. On a bolt-on DCDL shift assembly, remove the short plug and gasket from the storage hole of the DCDL. Install the short plug and gasket into the service position hole in the center of the DCDL.

   b. On a screw-in DCDL shift assembly, install the short screw or plug into the storage hole located in the top of the screw-in DCDL shift assembly.

10. Tighten the plug, if equipped, to 44-55 lbs. ft. (60-75 N·m). Tighten the manual engaging capscrew to 22-28 lbs. ft. (30-38 N·m) for bolt-on style cylinders and to 7-11 lbs. ft. (10-15 N·m) for screw-in type reverse shifters.

11. Connect the vehicle air line to the differential lock actuator assembly.

12. Install the electrical connection on the sensor switch located in the carrier, below the actuator assembly.

13. Install the right and left-hand axle shafts. See “Towing” on page vi.

14. Remove the safety stand from under the drive axle. Lower the vehicle to the floor.

15. Proceed to Check the Differential Lock.
Check the Differential Lock

1. Shift the vehicle transmission to neutral. Start the engine to get the system air pressure to the normal level.

WARNING

DURING DCDL DISASSEMBLY, WHEN THE DCDL IS IN THE LOCKED OR ENGAGED POSITION AND ONE OF THE VEHICLE’S WHEELS IS RAISED FROM THE FLOOR, DO NOT START THE ENGINE AND ENGAGE THE TRANSMISSION. THE VEHICLE CAN MOVE AND CAUSE SERIOUS PERSONAL INJURY.

2. Place the differential lock switch, in the cab of the vehicle, in the unlocked or disengaged position.

3. Drive the vehicle at 5-10 mph (8-16 km/h) and check the differential lock indicator light. The light must be off when the switch is in the unlocked or disengaged position.

4. Continue to drive the vehicle and place the differential lock switch in the locked or engaged position. Let up on the accelerator to remove the driveline torque and permit the shift. The light must be on when the switch is in the locked position.

• If the indicator light remains ON with the switch in the unlocked position: The differential is still in the locked position. Verify the manual engaging cap screw was removed from the cylinder cover of the actuator assembly. Refer to Steps 6-12 of “DCDL Assembly Manual Engaging Methods” on page 60.

Driver Caution Label

Verify the driver caution label is installed in the vehicle cab. The caution label must be placed in a location easily visible to the driver. The recommended location is on the instrument panel, next to the differential lock switch and lock indicator light.

Driver caution labels are available from AxleTech’s Customer Service Center at 877-547-3907.

CAUTION

This vehicle is equipped with the AXLETECH DRIVER CONTROLLED FULL LOCKING DIFFERENTIAL.

ENGAGE FULL LOCKING DIFFERENTIAL ONLY UNDER POOR TRACTION CONDITIONS. DO NOT USE DURING DOWNHILL OPERATION. DO NOT USE AT SPEEDS ABOVE 25 M.P.H.

WHEN ENGAGED, YOUR VEHICLE’S STEERING CHARACTERISTICS WILL BE AFFECTED. THIS “UNDERSTEER” CONDITION REQUIRES CAREFUL DRIVING PROCEDURES.

WHEN DISENGAGED, NORMAL VEHICLE HANDLING WILL RESUME.

For further information on this system, see your vehicle operator’s manual or AxleTech Driver Instruction Kit TP-9646.
**Tools**

### Carrier Repair Stand

1. **PLATES 8’ LONG x 3/4” THICK x 1-1/4” WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR**
2. **HANDLE 7” LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW**
3. **BAR 2” DIAMETER x 9” LONG WITH ONE END SLOTTED TO FIT PLATE**
4. **WELD ALL AROUND AFTER PRESSING PLUG IN PIPE**
5. **WELD**
6. **SHAPE AND SIZE OF HOLES TO FIT CARRIER**
7. **23-1/2” CENTER TO CENTER OF PIPE**
8. **CHAMFER END OF PIPE FOR WELDING**
9. **4” DIAMETER PIPE**
10. **PLUG 4” DIAMETER x 7” LONG WITH ONE END TURNED 3” LONG TO FIT PIPE DRILL 2” HOLE AND MILL 3/16” WIDE SLOT 2” FROM TOP**
11. **SCREW 3-1/2” LONG x 5/8” DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2” LENGTH OF THREAD ON OTHER END**
12. **DRILL 3/8” HOLE THROUGH HANDLE AND SCREW**

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### Yoke Bar

1. **Measure dimensions A and B of the yoke being serviced.**

![Yoke diagram]

2. **Calculate dimensions C and D of the yoke bar by adding 0.125-0.250” to dimensions A and B of the yoke.**

![Yoke Bar diagram]

**WARNING**

WEAR PERSONAL PROTECTIVE EQUIPMENT INCLUDING CLOTHING AND EYE PROTECTION WHEN WELDING. WELDING EQUIPMENT CAN BURN AND CAUSE SERIOUS PERSONAL INJURY. FOLLOW THE OPERATING INSTRUCTIONS AND SAFETY PROCEDURES RECOMMENDED BY THE WELDING EQUIPMENT MANUFACTURER.

3. To make the box section, cut, and weld 1.0-inch x 2.0-inch mild steel square stock according to dimensions C and D.

4. Cut a 4.0-foot x 1.25-inch piece of mild steel round stock to make the yoke bar handle. Center weld this piece to the box section.

- **To increase yoke bar rigidity:**
  Weld two angle pieces onto the handle.
Unitized Pinion Seals & Seal Drivers

Refer to the figures below for information on installing unitized pinion seals and using seal drivers correctly.

Position the seal driver to prevent the driver spokes from hitting the fastener heads on the forward tandem output seals.