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MAINTENANCE MANUAL

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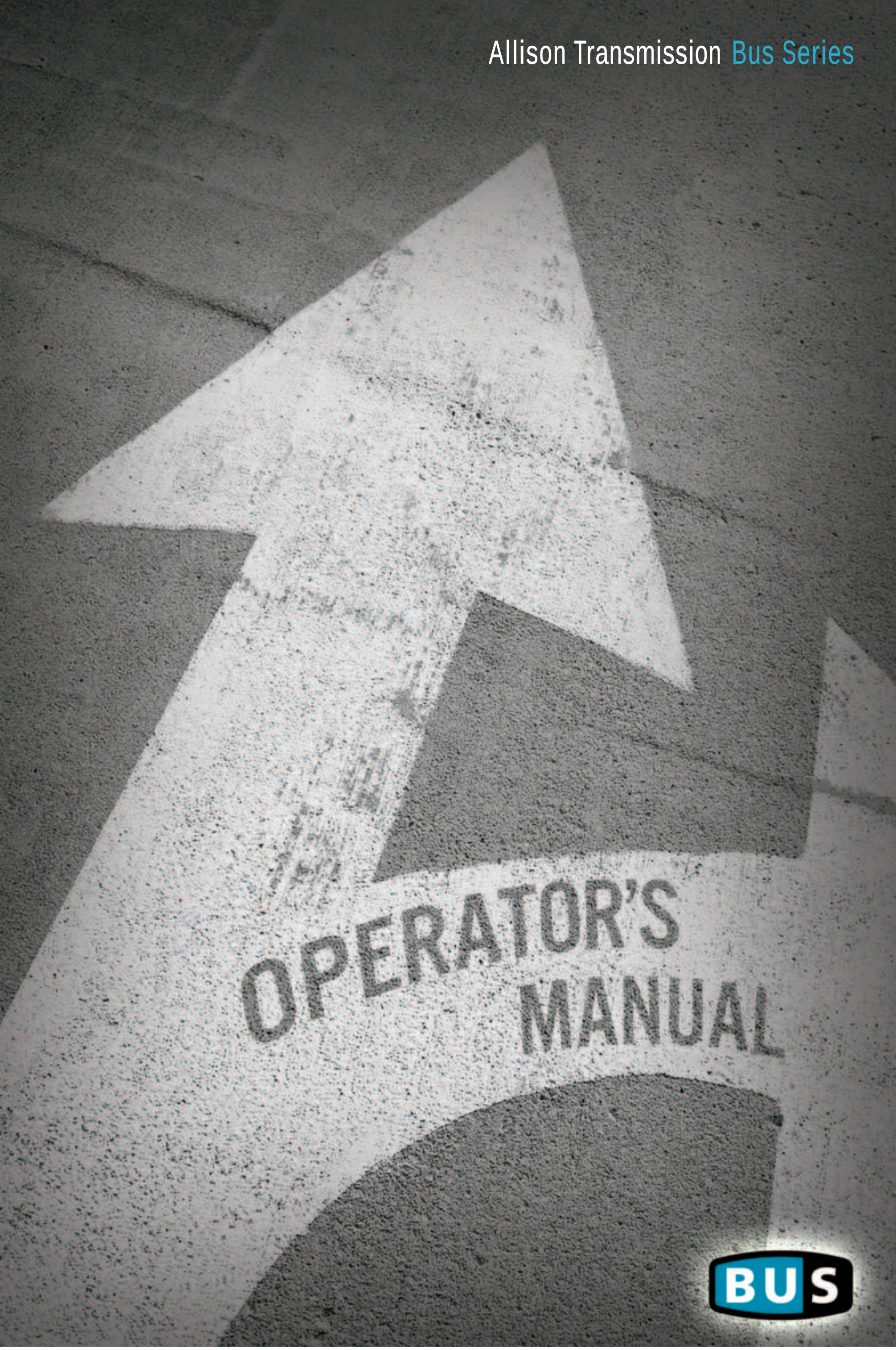
Allison Transmission Bus Series



OPERATOR'S MANUAL

BUS

3000 and 4000 Product Families

Operator's Manual

2003 DECEMBER

OM3749EN

Allison Transmission

VOCATIONAL MODELS

Bus Urban Series (BUS) Transmissions (WTEC III Controls)

B 300
B 400
B 500

Allison Transmission®

Allison Transmission, General Motors Corporation
P.O. Box 894 Indianapolis, Indiana 46202-0894
www.allisontransmission.com

NOTES

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DIAGNOSIS

CUSTOMER SERVICE

TRADEMARK USAGE

The following trademarks are the property of the companies indicated:

- Allison DOC™ is a trademark of General Motors Corporation.
- DEXRON® is a registered trademark of the General Motors Corporation.
- TranSynd™ is a trademark of Castrol Ltd.

WARNINGS, CAUTIONS, NOTES

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions described in this handbook. It is, however, important to understand that these warnings and cautions are not exhaustive. Allison Transmission could not possibly know, evaluate, and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. The vehicle manufacturer is responsible for providing information related to the operation of vehicle systems (including appropriate warnings, cautions, and notes). Consequently, Allison Transmission has not undertaken any such broad evaluation. Accordingly, **ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY ALLISON TRANSMISSION OR THE VEHICLE MANUFACTURER MUST** first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service methods selected.

Proper service and repair is important to the safe, reliable operation of the equipment. The service procedures recommended by Allison Transmission (or the vehicle manufacturer) and described in this handbook are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

Three types of headings are used in this manual to attract your attention. These warnings and cautions advise of specific methods or actions that can result in personal injury, damage to the equipment, or cause the equipment to become unsafe.

WARNING: A warning is used when an operating procedure, practice, etc., if not correctly followed, could result in personal injury or loss of life.

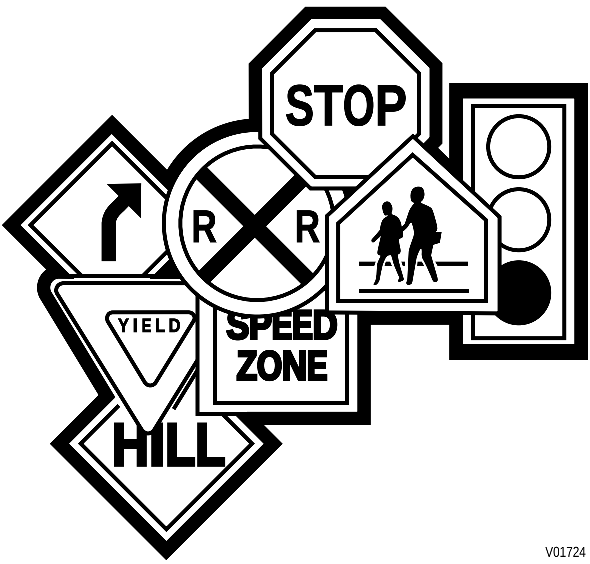
CAUTION: A caution is used when an operating procedure, practice, etc., if not strictly observed, could result in damage to or destruction of equipment.

NOTE: A note is used when an operating procedure, practice, etc., is essential to highlight.

INTRODUCTION

BUS

KEEPING THAT ALLISON ADVANTAGE



Bus Urban Series (BUS) transmissions are rugged and designed to provide long, trouble-free service. All BUS transmissions are available with optional retarders and engine driven PTO provisions.

This handbook will help the operator gain the maximum benefits from an BUS transmission-equipped vehicle.

Abbreviations

ABS	Anti-lock brake system
ATD	Allison Transmission Division
BUS	Bus Urban Series
DOC	Diagnostic Optimized Connection
ECU	Electronic Control Unit
EMI	Electromagnetic interference
FCC	Federal Communications Commision
KOH	Potassium Hydroxide
MIL	Military specifications
OEM	Original equipment manufacturer
OLS	Oil level sensor
PTO	Power Takeoff
RFI/EMI	Radio frequency interference/electromagnetic interference
TAN	Total acid number
TIR	Total indicated runout
TPS	Throttle position sensor
VIM	Vehicle interface module

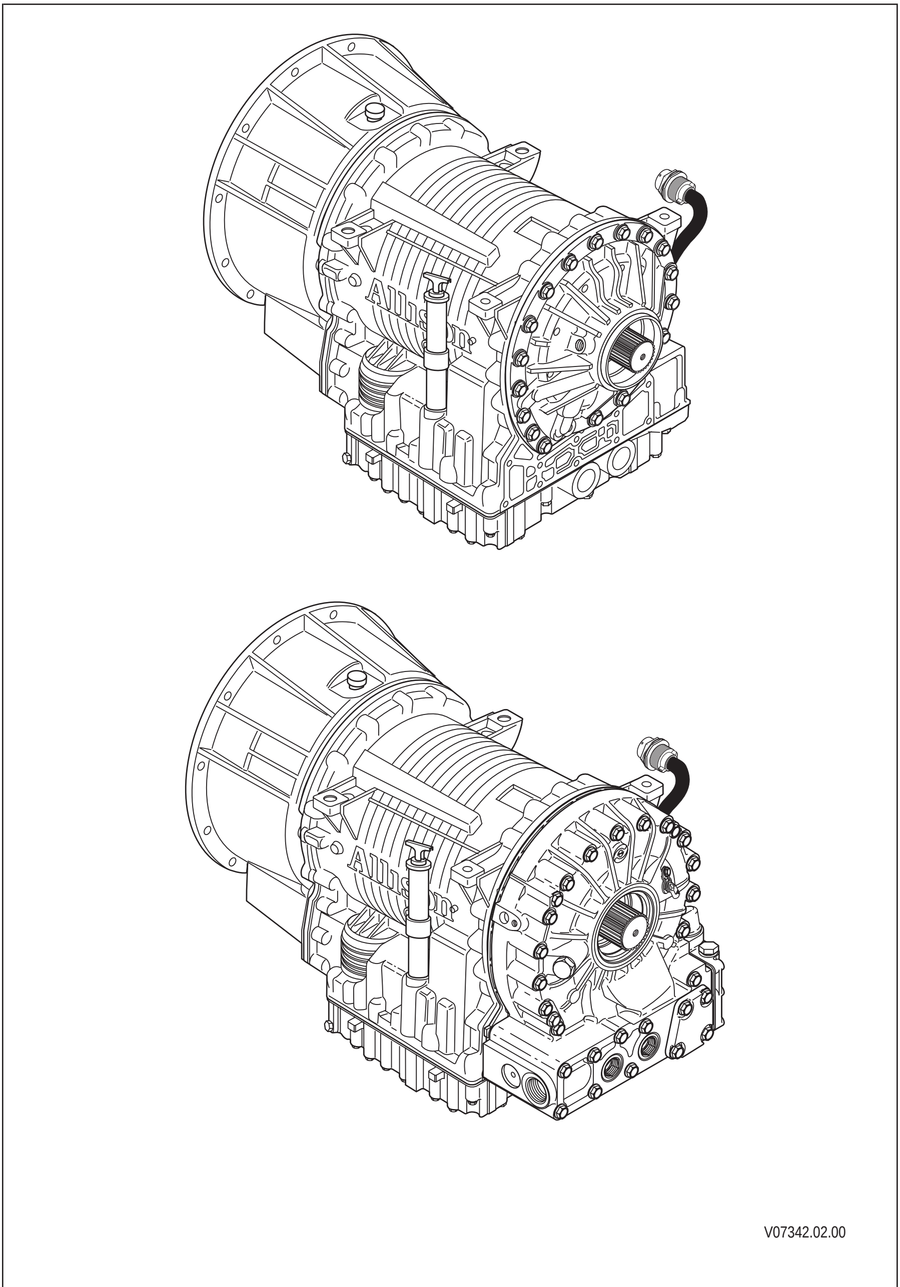


Figure 1. Bus Urban Series (BUS) Transmissions

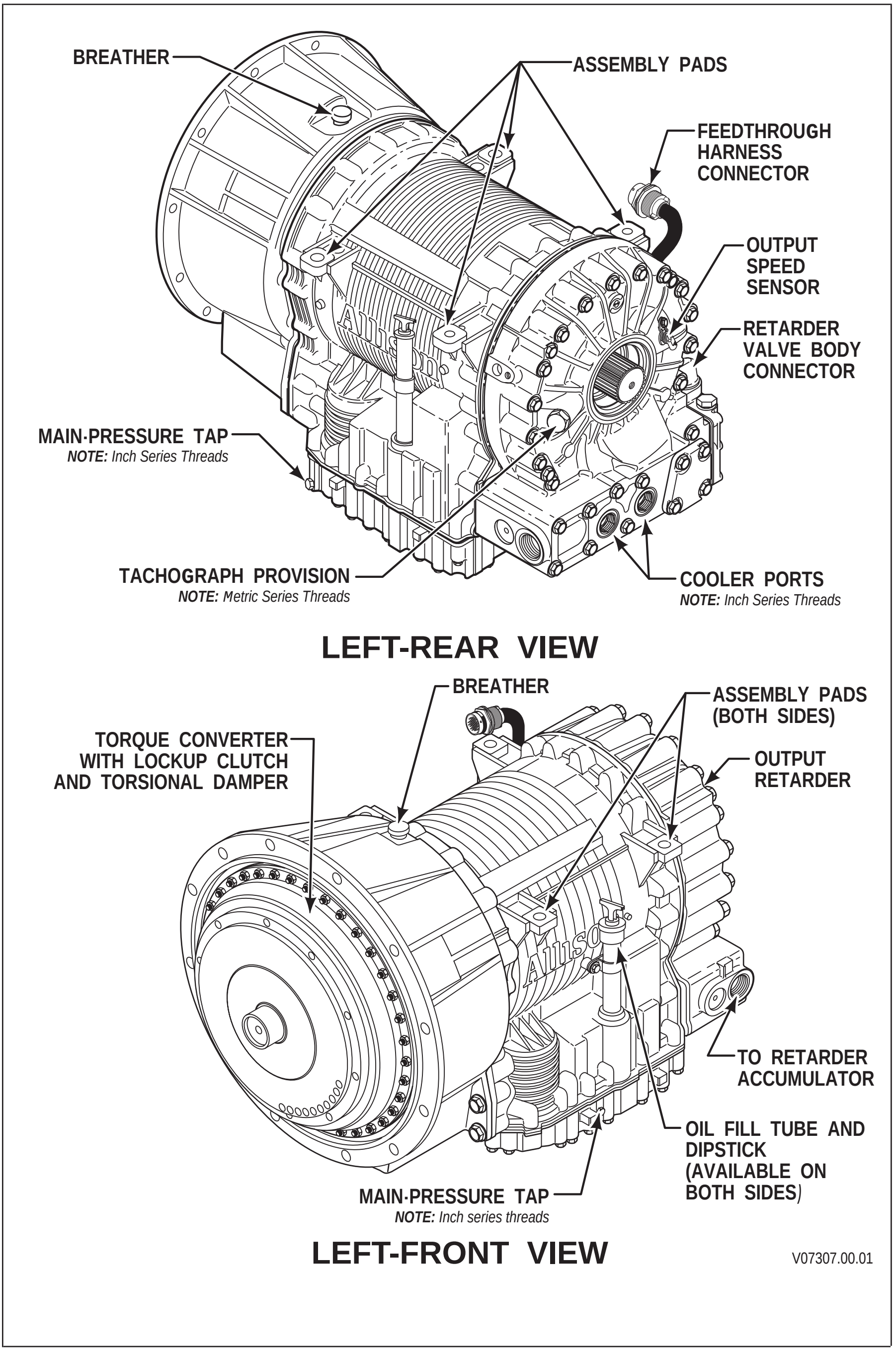


Figure 2. B 300 and B 400 With Retarder

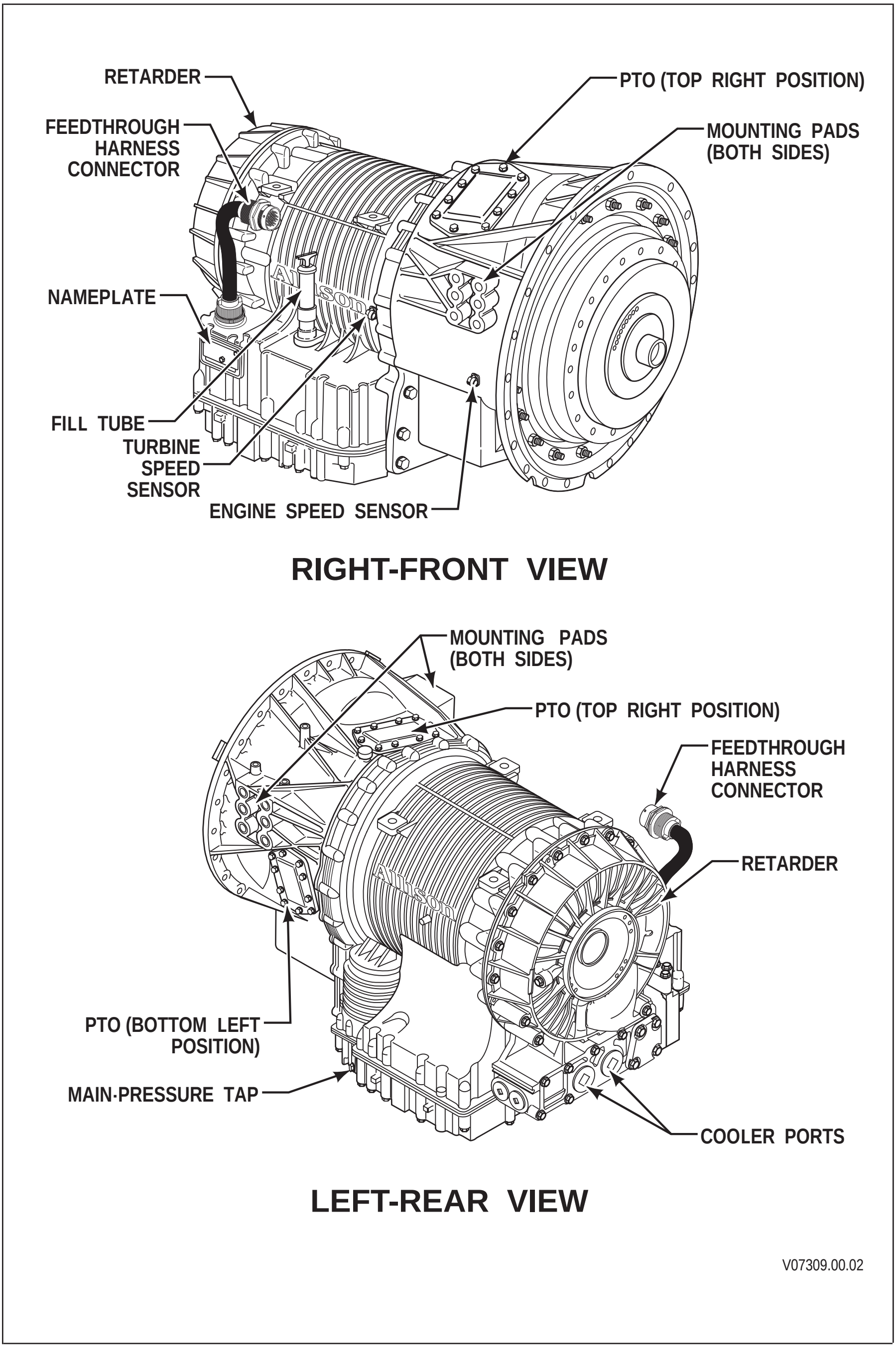


Figure 3. B 500 With Retarder

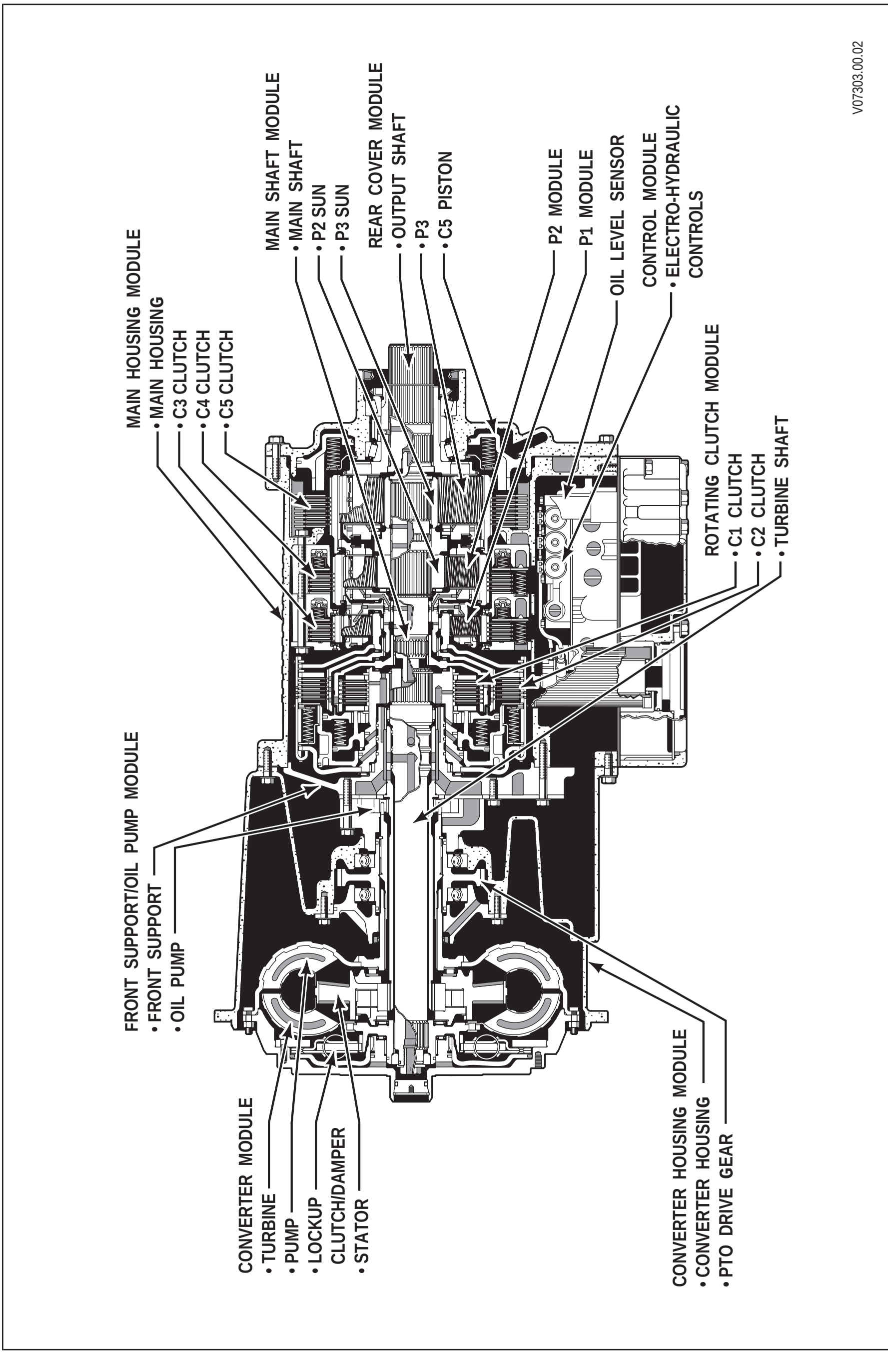


Figure 4. B 300 and B 400 With PTO — Cross Section

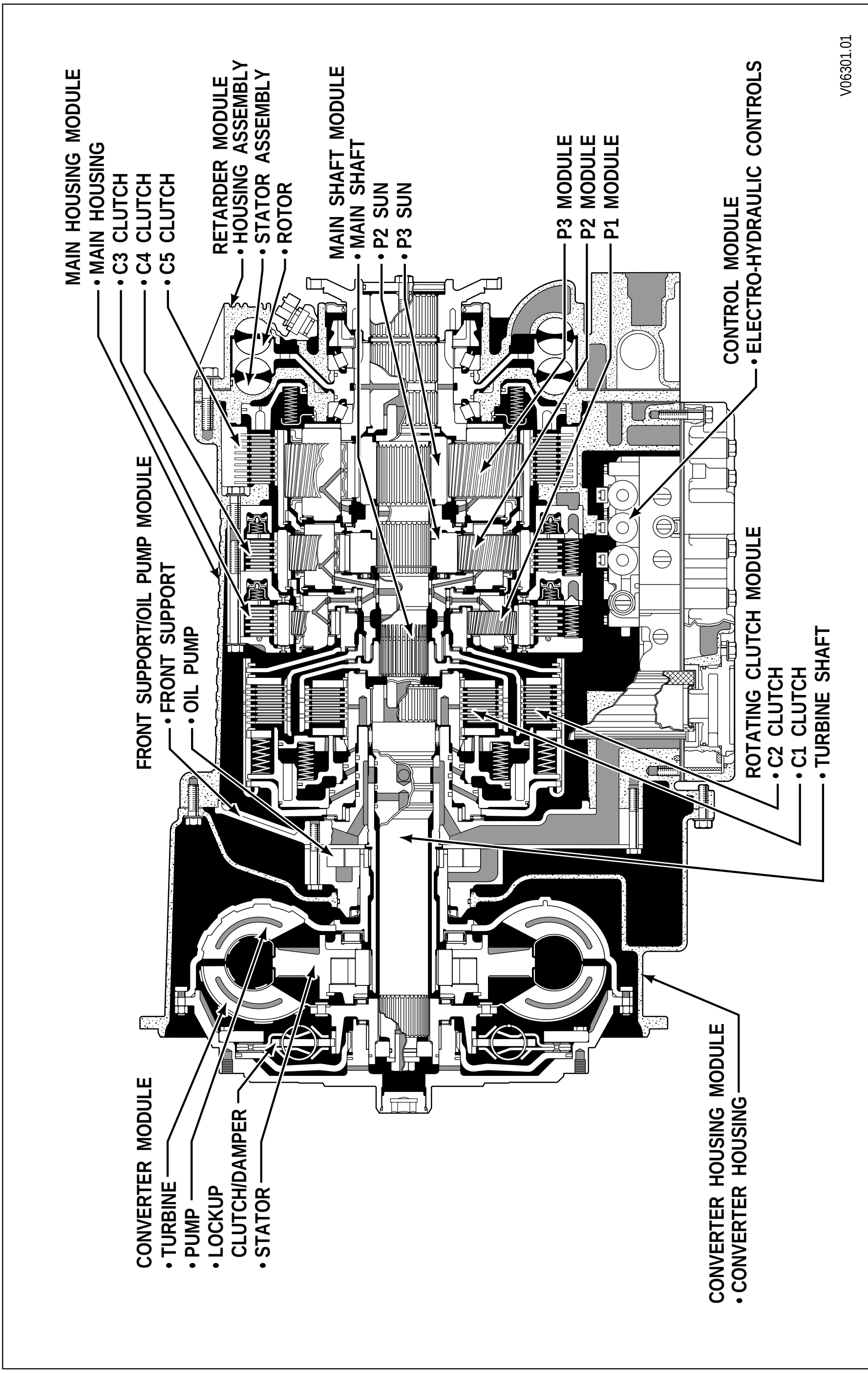


Figure 5. B 500 With Retarder — Cross Section

A BRIEF DESCRIPTION OF THE ALLISON BUS TRANSMISSIONS

Included in the Allison On-Highway Transmission family are the **BUS** transmissions. The transmissions described in this handbook include:

- The WTEC III control system
- A torque converter with lockup and torsion damper
- Three planetary gear sets.

These transmissions (refer to Figure 1 through Figure 5) may also contain an integral retarder or power takeoff (PTO).

WTEC III ELECTRONIC CONTROL SYSTEM

The WTEC III control system is standard on all BUS transmissions. The system consists of five major components connected by OEM furnished wiring harnesses. The five major components are:

- Electronic control unit (ECU)
- Engine throttle position sensor (engine-to-transmission communication link)
- Three speed sensors
- Remote shift selector
- Control module (which contains solenoid valves, a pressure switch, and oil level sensor).

The ECU receives information from the following:

- Throttle position sensor (or direct engine-to-transmission communication link)
- Speed sensors
- Pressure switch
- Shift selector

The ECU processes this information and then sends signals to actuate specific solenoids located in the transmission control module. These solenoids control both oncoming and offgoing clutch pressures to provide closed-loop shift control by matching rpm during a shift to a desired profile programmed into the ECU.

A feature of WTEC III controls is “autodetect.” Autodetect is active within the first several engine starts, depending upon the component or sensor being detected. These engine start cycles begin from when the transmission is installed during vehicle manufacture. Autodetect searches for the presence of the following transmission components or data inputs:

Transmission Components

Retarder	Present, Not Present
Oil Level Sensor (OLS)	Present, Not Present
Throttle	Analog, J 1587, J 1939
Engine Coolant Temperature	Analog, J 1939, J 1587

Seek help from the nearest Allison Transmission service outlet when any of the above components are present, but are not responding properly.

Another feature of the BUS transmission is its ability to adapt or “learn” as it operates. Each shift is measured electronically, stored, and used by the ECU to adapt or “learn” the optimum conditions for future shifts.

NOTE: If the shift quality of low mileage vehicles, or vehicles with new or recalibrated ECUs is unacceptable, follow the procedure in SIL 16-WT-96 to properly restore good shift quality.

NOTE: Allison WTEC III electronic control systems are designed and manufactured to comply with all FCC and other guidelines regarding radio frequency interference/electromagnetic interference (RFI/EMI) for transportation electronics. Manufacturers, assemblers, and installers of radio-telephone or other two-way communication radios have the sole responsibility to correctly install and integrate those devices into Allison BUS Transmission-equipped vehicles to customer satisfaction.

The ECU is programmed to provide the most suitable operating characteristics for a specific application. This handbook does not attempt to describe all of the possible combinations. The information contained herein describes only the operating characteristics most frequently requested by the vehicle manufacturer.

TORQUE CONVERTER

The torque converter consists of the following three elements:

- Pump — input element driven directly by the engine
- Turbine — output element hydraulically driven by the pump
- Stator — reaction (torque multiplying) element.

When the pump turns faster than the turbine, the torque converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the torque converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of the following elements:

- Piston and backplate — driven by the engine
- Clutch plate/damper (located between the piston and the backplate) — splined to the converter turbine.

The lockup clutch/torsional damper is engaged and released in response to electronic signals from the ECU. Lockup clutch engagement provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage and provides maximum fuel economy and vehicle speed. The lockup clutch releases at lower speeds or when the ECU detects conditions requiring it to be released.

The torsional damper absorbs engine torsional vibration to prevent transmitting vibrations through the powertrain.

PLANETARY GEARS AND CLUTCHES

A series of three helical planetary gear sets and shafts provides the mechanical gear ratios and direction of travel for the vehicle. The planetary gear sets are controlled by five multiplate clutches that work in pairs to produce up to six forward speeds and one reverse speed. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate solenoids.

COOLER CIRCUIT

The transmission fluid is cooled by an integral (transmission-mounted) or remote-mounted oil cooler. Connections to the cooling circuit are located at the front or rear of the transmission to facilitate installation of remote cooler lines. On retarder models, only the rear cooler ports may be used. The integral cooler is mounted on the lower rear portion of the transmission, replacing the remote cooler manifold. Integral cooler oil ports are internal requiring coolant to be routed to and from the cooler.

A new feature has been added on all retarder-equipped transmissions. The retarder housing now allows addition of either a remote or integral cooler for transmission sump fluid in addition to retarder out fluid. A cover is placed over the sump cooling ports when the provision is not used. The sump cooler ports are located on the lower right rear face of the retarder housing (refer to Figure 2 and Figure 3). This feature was available on 3000 Product Family and 4000 Product Family transmissions in June 2002.

RETARDER

The self-contained retarder is at the output of the transmission and consists of a vaned rotor which rotates in a vaned cavity. The rotor is splined to and driven by the output shaft. An external accumulator holds transmission fluid until the retarder is activated. When the retarder is activated, the fluid in the accumulator is pressurized by the vehicle air system and directed into the retarder cavity. The interaction of the fluid with the rotating and stationary vanes causes the retarder rotor and hence the output shaft speed, to decrease and slow the vehicle or to limit speed on a downhill grade. Refer to the Driving Tips section, USING THE HYDRAULIC RETARDER, for additional information.

When the retarder is deactivated, the retarder cavity is evacuated and the accumulator is recharged with fluid.

SHIFT SELECTORS

DESCRIPTION OF AVAILABLE TYPES

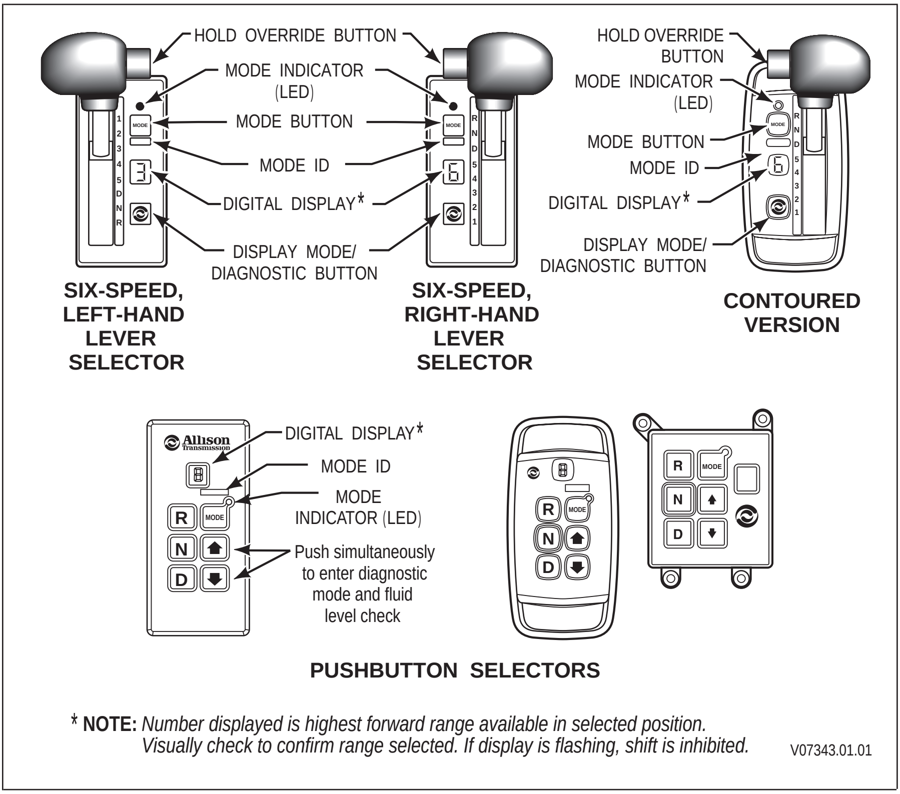


Figure 6. WTEC III Shift Selectors

INTRODUCTION

Vehicle manufacturers may choose different types of shift selectors for their vehicles. The shift selector in your Allison-equipped vehicle will be similar to the lever style or one of the pushbutton styles shown above.

With an Allison-equipped vehicle, it is not necessary to select the right moment to upshift or downshift during changing road and traffic conditions. The Allison BUS transmission does it for you. However, knowledge of the shift selector positions, ranges available, and when to select them, make vehicle control and your job even easier. Select lower ranges when descending long grades (with or without retarder) to reduce wear on service brakes. Refer to the Range Selection table at the end of this Section for related information.

LEVER SHIFT SELECTOR

General Description. The lever shift selector is an electro-mechanical control. Typical lever positions are:

- **R** (Reverse)
- **N** (Neutral)
- **D** (Drive)
- Some number of lower forward range positions.

BUS transmissions can be programmed to have four, five, or six forward ranges. Shift selector positions should agree with the programming of the transmission electronic control unit.

The lever selector includes a:

- Hold override button
- **MODE** button
- Digital display
- Display mode/diagnostic button.

Hold Override Button. The lever shift selector has three locked positions to prevent accidentally selecting **R** (Reverse), **N** (Neutral), and **D** (Drive). Select **R**, **N**, or **D** by pressing the hold override button and moving the lever to the desired position. Once **D** (Drive) is selected, lower forward range positions may be selected without pressing the hold override button.

MODE Button. The **mode** button can allow the driver to enable a secondary shift schedule or other special function that has been programmed into the electronic control unit at the request of the OEM. For example, an emergency vehicle OEM may have provided a secondary shift schedule for improved fuel economy. The name of the special function (ECONOMY) appears on the MODE ID label adjacent to the **MODE** button. Pressing the **MODE** button activates the ECONOMY shift schedule and illuminates the MODE INDICATOR (LED). Other special functions which can be activated by the **MODE** button are D1 selection or PTO enable. The **MODE** button is also used to view diagnostic code information. After viewing the first diagnostic code which appears in the digital display, press the **MODE** button to view the 2nd diagnostic code logged. Repeat this procedure to view the 3rd, 4th, and 5th code positions. The code displayed is active if the MODE INDICATOR (LED) is illuminated.

NOTE: Visually check the digital display whenever the lever is moved to be sure the range selected is shown. **N** should appear in the digital display if the **N** (Neutral) button is pressed.

Digital Display. During normal operation, if **D** (Drive) is selected, the digital display shows the highest forward range attainable for the shift schedule in use.

Abnormal operation is also indicated by the digital display as follows:

- When all segments of the digital display are illuminated for more than 12 seconds, the ECU did not complete initialization.
- When the digital display is blank, there is no power to the selector.
- When the display shows a “\/\” (cateye), a selector-related fault code has been logged.
- Conditions which illuminate the CHECK TRANS light disable the shift selector and the digital display displays the range actually attained. Refer to the Driving Tips section, CHECK TRANS LIGHT, for a detailed explanation.

The transmission will not shift into range if a CHECK TRANS code is active. When the display shows either **R** or **D** has been requested and the display is flashing, the requested range has not been achieved due to an inhibit function.

Some inhibit functions are vehicle-related and do not result in diagnostic codes. Some examples are mentioned in the Range Selection tables at the end of this Section.

Check for active codes if no other inhibit function has been located. Once **D** (Drive) is attained, the transmission will shift into the lowest range programmed for the **D** (Drive) position, usually first-range.

Display Mode/Diagnostic Button. The Display Mode/Diagnostic button allows access to optional fluid level check information and diagnostic code information. Press the Display Mode/Diagnostic button once to obtain transmission fluid level information and a second time to obtain diagnostic code information.

PUSHBUTTON SHIFT SELECTOR

General Description. The pushbutton shift selector has **R**, **N**, **D**, ↓, ↑, a **MODE** button, and a digital display.

R Pushbutton. Press this button to select Reverse.

N Pushbutton. Press this button to select Neutral.

D Pushbutton. Press this button to select Drive. The highest forward range available will appear in the digital display window. The transmission will start out in the lowest available forward range and advance automatically to the highest range.

↓, ↑ **(Arrow) Buttons.** When a lower range is desired, after **D** (Drive) has been pressed, press the ↓ (Down) arrow button until the desired range is shown in the display window. Likewise, if the transmission is held in a low range by the ↓ (Down) arrow, press the ↑ (Up) arrow to request the next higher range. Continuous pressing of either the ↑ (Up) or ↓ (Down) arrow buttons will request the highest or lowest range available.

NOTE: Fluid level information is displayed after pressing both the ↑ (Up) and ↓ (Down) arrow buttons simultaneously. Press both buttons again simultaneously to obtain diagnostic data.

Access fluid level data and diagnostic codes by pressing the ↑ (Up) and ↓ (Down) arrow buttons simultaneously. Refer to the Care And Maintenance section, FLUID LEVEL CHECK USING PUSHBUTTON OR LEVER SHIFT SELECTOR, for more information about fluid level data. Refer to the Driving Tips section, DIAGNOSTIC CODES and DIAGNOSTIC CODE DISPLAY PROCEDURE, for more information about diagnostic codes and display procedure.

MODE Button and Digital Display. This is the same function as described previously in LEVER SHIFT SELECTOR, **MODE Button** paragraph.

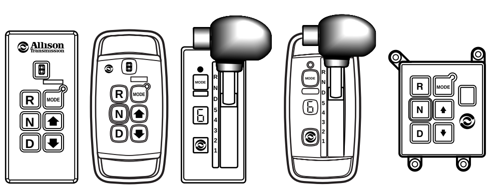


Figure 7. Typical BUS Shift Selectors

RANGE SELECTION

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY

Description of Available Ranges	
	WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures: • Put the transmission in **N** (Neutral) • Be sure the engine is at low idle (500–800 rpm) • Apply the parking brakes and emergency brake and make sure they are properly engaged • Chock the wheels and take any other steps necessary to keep the vehicle from moving.
	WARNING: R (Reverse) may not be attained due to an active inhibitor. Always apply the service brakes when selecting **R** (Reverse) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When the **"R"** is flashing, it indicates the shift to **R** (Reverse) is inhibited. Check for active diagnostic codes if **R** (Reverse) is not attained. See DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE in the DRIVING TIPS section.
	CAUTION: Do not idle in **R** (Reverse) for more than five minutes. Extended idling in **R** (Reverse) can cause transmission overheating and damage. Always select **N** (Neutral) whenever time at idle exceeds five minutes.
	NOTE: Visually check the digital display window whenever a button is pushed or the lever is moved to be sure the range selected is shown (i.e., if the **N** (Neutral) button is pressed, **"N"** should appear in the digital display). A flashing display indicates the range selected was not attained due to an active inhibit.
R	Completely stop the vehicle and let the engine return to idle before shifting from a forward range to **R** (Reverse) or from **R** (Reverse) to a forward range. The digital display will display **"R"** when **R** (Reverse) is selected.

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY *(cont'd)*

Description of Available Ranges	
	WARNING: When starting the engine, make sure the service brakes are applied. Failure to apply the service brakes can result in unexpected vehicle movement.
	Vehicle service brakes, parking brake, or emergency brake must be applied whenever **N** (Neutral) is selected to prevent unexpected vehicle movement. Selecting **N** (Neutral) does not apply vehicle brakes, unless an auxiliary system to apply the parking brake is installed (see the Operator's Manual for the vehicle).
	WARNING: If you let the vehicle coast in **N** (Neutral), there is no engine braking and you could lose control. Coasting can also cause severe transmission damage. To help avoid injury and property damage, do not allow the vehicle to coast in **N** (Neutral).
N	Use **N** (Neutral) when starting the engine, to check vehicle accessories, and for extended periods of engine idle operation (longer than five minutes). For vehicles equipped with the pushbutton selector, **N** (Neutral) is selected by the ECU during start-up. For vehicles equipped with the lever selector, the vehicle will not start unless **N** (Neutral) has been selected. If the vehicle starts in any range other than **N** (Neutral), seek service immediately. **N** (Neutral) is also used during stationary operation of the power takeoff (if the vehicle is equipped with a PTO). The digital display will show **"N"** when **N** (Neutral) is selected. Always select **N** (Neutral) before turning off the vehicle engine.
	WARNING: D (Drive) may not be attained due to an active inhibitor. Always apply the service brakes when selecting **D** (Drive) to prevent unexpected vehicle movement and because a service inhibit may be present. When **"D"** is flashing, it indicates the shift to **D** (Drive) is inhibited. Check for active diagnostic codes if **D** (Drive) is not attained. See DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE in the DRIVING TIPS section.

PUSHBUTTON AND LEVER SHIFT SELECTORS WITH DIGITAL DISPLAY *(cont'd)*

Description of Available Ranges	
	CAUTION: Do not idle in **D** (Drive) or any forward range for more than five minutes. Extended idling in **D** (Drive) can cause transmission overheating and damage. Always select **N** (Neutral) whenever time at idle exceeds five minutes.
	NOTE: Turn off the vehicle HIGH IDLE switch, if present, before shifting from **N** (Neutral) to **D** (Drive) or **R** (Reverse). **D** (Drive) or **R** (Reverse) will not be attained unless the shift is made with the engine at idle. Also, be aware of other interlocks that would prevent attaining **D** (Drive) or **R** (Reverse). Examples are "wheelchair lift not stored" and "service brakes not applied" (service brake interlock present).
D	The transmission will initially attain first-range when **D** (Drive) is selected (except for those units programmed to start in second-range). As vehicle speed increases, the transmission will upshift automatically through each range. As the vehicle slows, the transmission will downshift automatically through each range. The digital display will show the highest range available in **D** (Drive).
	WARNING: If you just downshift or just use service brakes when going downhill, you can lose control and cause injury and property damage. To help avoid loss of control, use a combination of downshift, braking, and other retarder devices. Downshift to a lower transmission range increases engine braking and helps to maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission may upshift to the next higher range. This will reduce braking and could cause loss of control. Apply the vehicle brakes or other retarding device to prevent exceeding engine governed speed in the lower range selected.

Description of Available Ranges	
6* 5* 4* 3 2	Lower ranges provide greater engine braking for going down grades (the lower the range, the greater the braking effect). Occasionally, it may be desirable to restrict automatic shifting to a lower range because of: • Road conditions • Load • Traffic conditions • Etc. The pushbutton shift selector arrow buttons access individual forward ranges. Push the ↑ (Up) or ↓ (Down) arrow for the desired range. The digital display shows the range chosen. Even though a lower range is selected, the **transmission may not downshift** until vehicle speed is reduced (this prevents excessive engine speed in the lower range).
1	First-range provides the vehicle with its maximum driving torque and engine braking effect. Use first-range when: • Pulling through mud and deep snow • Maneuvering in tight spaces • Driving up or down steep grades. For vehicles equipped with the pushbutton selector, push the ↓ (Down) arrow until first-range appears in the select window.
* Actual ranges available depend on programming by vehicle manufacturer.	

CHECK TRANS LIGHT

The electronic control system is programmed to inform the operator of a problem with the transmission system and automatically take action to protect the operator, vehicle, and transmission. When the Electronic Control Unit (ECU) detects a problem condition, the ECU:

- Restricts shifting
- Turns on the CHECK TRANS light on the instrument panel
- Registers a diagnostic code.

NOTE: For some problems, diagnostic codes may be registered without the ECU activating the CHECK TRANS light. Your Allison Transmission authorized service outlet should be consulted whenever there is a transmission-related concern. They have the equipment to check for diagnostic codes and to correct problems which arise.

Each time the engine is started, the CHECK TRANS light will illuminate, then turn off after a few seconds. This momentary lighting is to show that the status light circuits are working properly. If the CHECK TRANS light does not illuminate during ignition, or if the light remains on after ignition, the system should be checked immediately.

Continued illumination of the CHECK TRANS light during vehicle operation (other than start-up) indicates that the ECU has signaled a diagnostic code. Illumination of the CHECK TRANS light is accompanied by a flashing display from the shift selector. The shift selector display will show the actual range attained and the transmission will not respond to shift selector requests.

Indications from the shift selector are provided to inform the operator the transmission is not performing as designed and is operating with reduced capabilities. Before turning off the ignition, the transmission may be operated for a short time in the selected range in order to “limp home” for service assistance. Service should be performed immediately in order to minimize the potential for damage to the transmission.

When the CHECK TRANS light comes on and the ignition switch is turned off, the transmission will remain in **N** (Neutral) until the condition causing the CHECK TRANS light is corrected.

Generally, while the CHECK TRANS light is on, upshifts and downshifts will be restricted and **direction changes will not occur**. Lever and pushbutton shift selectors **do not respond** to any operator shift requests while the CHECK TRANS light is illuminated. The lockup clutch is disengaged when transmission shifting is restricted or during any critical transmission malfunction.

DIAGNOSTIC CODES

Diagnostic codes are numerical indications relating to a malfunction in transmission operation.

Each code consists of a two-digit main code and a two-digit subcode. These codes are logged in a list in the ECU memory with the most severe or most recent code listed first. A maximum of five codes (numbered d1–d5) may be listed in memory at one time. As codes are added, the oldest non-active code is dropped from the list. If all codes are active, the code with the lowest priority that is not included on the severity list is dropped from the list.

Diagnostic codes and code information may be accessed through the pushbutton and lever shift selectors or the Allison DOC™ for PC diagnostic tool.

The ECU separately stores the active and historical (non-active) codes. An active code is any code that is current in the ECU decision-making process.

Historical codes are codes that are retained in the ECU's memory and will not necessarily affect the ECU decision-making process. Historical codes are useful in determining if a problem:

- Is isolated
- Is intermittent
- Results from a previous malfunction.

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

- Code 13 12 is displayed as d,1,1,3,1,2 (each item appears for about one second)
- d,1 is the first position
- Main codes are listed first and provide the general condition or area of a fault detected by the ECU.
- Subcodes are listed second and provide specific areas or conditions within the main code that cause the fault.

- Example — Code 13 12:
  - — 13 (main code) indicates a problem with ECU voltage
  - — 12 (subcode) indicates the problem is caused by low voltage.

Pressing the **MODE** button momentarily displays code positions d2 through d5.

After a fixed number of ignition cycles, a code may be deleted from memory if it has not recurred. The shift selector diagnostic mode will end automatically after two minutes without operator input.

If the mode indicator (LED) is illuminated, the displayed code is active. If the mode indicator (Figure 7) is not illuminated, the displayed code is not active. An illuminated mode indicator during normal operation signifies secondary mode operation.

DIAGNOSTIC CODE DISPLAY PROCEDURE

Diagnostic codes can be read and cleared by two methods:

- Allison DOC™ for PC diagnostic tool. Refer to Allison Transmission publication number GN3434EN, Allison DOC™ for PC User Guide, for specific instructions on how to use of this diagnostic tool.
- With the pushbutton or lever shift selector.

Pushbutton Shift Selector (Figure 7).
To begin the Diagnostic Process:

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To Display Stored Codes:

1. Simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons once to access the diagnostic display mode — press the buttons twice if a transmission oil level sensor is installed.
2. Observe the digital display for codes (codes will appear one digit at a time).
3. Press the **MODE** button to see the next code — repeat for subsequent codes.

NOTE: Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

To Clear Active Indicators and Resume Vehicle Operation:

1. Press and hold the **MODE** button for approximately three seconds until the mode indicator (LED) flashes.
2. Release the **MODE** button and active indicators such as the CHECK TRANS light will not be illuminated. Some codes are self-clearing and others require ignition cycles to clear.

Lever Shift Selector (Figure 7).

To Begin the Diagnostic Process:

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To Display Stored Codes:

1. Press the **DISPLAY MODE** button once to access the diagnostic display mode — press the button twice if a transmission oil level sensor is installed.
2. Observe the digital display for codes (codes will appear one digit at a time).
3. Press the **MODE** button to see the next code — repeat for subsequent codes.

NOTE: Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

To Clear Active Indicators and Resume Vehicle Operation:

1. Press and hold the MODE button for approximately three seconds until the mode indicator (LED) flashes.
2. Begin operating as normal — have the transmission checked at the earliest opportunity by an Allison Transmission distributor or dealer.

NOTE: If the condition that caused the code is still present, the code will again become active.

ACCELERATOR CONTROL

> **WARNING:** To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) when the throttle pedal is depressed. If you shift while the throttle pedal is depressed too far, the transmission will only engage if the throttle pedal is released in the next three seconds. This may cause a sudden movement of the vehicle. Leaving the throttle pedal depressed longer than three seconds causes the transmission to remain in **N** (Neutral). Avoid this condition by making shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) only when the throttle is closed.

The position of the accelerator pedal influences the timing at which automatic shifting occurs. An electronic throttle position signal tells the ECU how much the operator has depressed the pedal. When the pedal is fully depressed, upshifts will occur automatically at high engine speeds. A partially depressed position of the pedal will cause upshifts to occur at lower engine speeds. Excessive throttle position affects directional changes — shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse).

DOWNSHIFT AND DIRECTION CHANGE INHIBITOR FEATURE

> **NOTE:** Turn off the vehicle HIGH IDLE switch, if present, before shifting from **N** (Neutral) to **D** (Drive) or **R** (Reverse). The shift from **N** (Neutral) to **D** (Drive) or **R** (Reverse) is inhibited when engine speed is above idle.

There is no speed limitation on upshifting, but there is a limitation on downshifting and for shifts which cause a direction change such as **D** (Drive) to **R** (Reverse) or **R** (Reverse) to **D** (Drive).

Manual range downshifts will not occur until a calibration output speed (preset) is reached. When a range downshift is manually selected and the transmission output speed is above the calibration speed, the transmission will stay in the range it was in even though a lower range was requested. Apply the vehicle service brakes or a retarding device to reduce the transmission output speed to the calibration speed and then the shift to the lower range will occur.

- Directional shifts, **D** (Drive) to **R** (Reverse) or **R** (Reverse) to **D** (Drive), will not occur if selected when throttle position, engine speed, or transmission output speed is above the calibration limit for a calibration time period. The current calibration time period for engine speed is 0.5 seconds and for throttle position and output speed is three seconds.

- Shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) are also inhibited when the ECU has been programmed (by input/output function) to detect that auxiliary equipment is in operation and the shift should not be allowed.
- When a directional shift is inhibited, the ECU will put the transmission in **N** (Neutral) and the digital display, if present, will flash the letter of the range selected (D or R). Reselect **D** (Drive) or **R** (Reverse) when engine throttle, engine speed, and transmission output speed are below the calibration value.
  - — With a pushbutton selector, depress the desired pushbutton again.
  - — With a lever selector, move the lever to **N** (Neutral) and then to the desired range.
- When a direction change shift is requested and engine throttle, engine speed, and transmission output speed drop below the calibration value during the calibration time interval, the shift to **D** (Drive) or **R** (Reverse) will occur.
  - — For example, if the transmission output speed was just above the calibration limit when **R** (Reverse) was selected, but dropped below the limit during the next three seconds, the shift to **R** (Reverse) would occur (assuming the engine was at idle and the throttle was closed).

USING THE ENGINE TO SLOW THE VEHICLE

> ! **WARNING:** If you just downshift or just use service brakes when going downhill, you can lose control and cause injury or property damage. To help avoid loss of control, use a combination of downshifting, braking, and other retarding devices. Downshifting to a lower transmission range increases engine braking and helps you to maintain control.The transmission has a feature to, prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission may upshift to the next higher range. This will reduce braking and could cause a loss of control. Apply the vehicle brakes or other retarding device top prevent exceeding engine governed speed in the lower range selected.

Engine braking provides good speed control for going down grades. When the vehicle is heavily loaded, or the grade is steep, it may be desirable to pre-select a lower range before reaching the grade. If engine-governed speed is exceeded, the transmission will upshift automatically to the next range.

To use the engine as a braking force, select the next lower range. If the vehicle is exceeding the maximum speed for this range, use the service brakes and/or retarder to slow the vehicle. When a lower speed is reached, the ECU will automatically downshift the transmission.

USING THE HYDRAULIC RETARDER

WARNING: DO NOT USE THE RETARDER DURING INCLEMENT WEATHER OR WHEN ROAD SURFACES ARE SLIPPERY. De-energize the retarder at the master control switch.To help avoid injury or property damage caused by loss of vehicle control, be ready to apply vehicle brakes or other retarding device if the transmission retarder does not apply. If a retarder is present but is not detected by "autodetect", the retarder will not function. Be sure to check for proper retarder function periodically. Whenever the retarder does not apply, seek service help immediately.On vehicles which have the primary retarder control based upon closed throttle position, brake pedal position, or brake apply pressure, always manually disable the retarder controls during inclement weather or slippery road conditions.

Regardless of the type of Allison retarder controls on your vehicle, the following safety features are common to each configuration:

- The retarder can be disabled when inclement weather or slippery road conditions are present.
- Vehicle brake lights should always be on when the retarder is applied (periodically verify that they are working).
- Anti-lock brake systems send a signal to the transmission ECU to indicate that the brake system is activated.

NOTE: The retarder is automatically disabled and the lockup clutch is disengaged whenever the vehicle anti-lock brake system (ABS) is active. However, in case the ABS system malfunctions, it is recommended that the retarder enable switch, if present, be disabled.

An hydraulic retarder is available on all of the models covered in this manual. The retarder is activated and controlled in various ways. The control depends upon the vehicle type and particular duty cycle. Both manual and automatic controls are available. Automatic controls are applied by the ECU. Some types of controls and the amount of retarder application are shown in Types of Retarder Control table that follows.

The presence of a retarder must be "autodetected" as part of the WTEC III control system.

NOTE: If your transmission has a retarder but it is not functioning, it may not have been “autodetected” during vehicle manufacture. Go immediately to your nearest Allison Transmission service outlet to have “autodetect” reset or the retarder enabled using the Allison DOC™ for PC diagnostic tool.

NOTE: When reduced retarder performance is observed, be sure the transmission fluid level is within the operating band on the dipstick (refer to Figure 9). Low fluid level is a common cause for retarder performance complaints.

NOTE: The retarder requires about one second to reach full capacity requested. Be sure to anticipate this delay when using the retarder. Anticipation will prevent unnecessary service brake applications during non-emergency stops.

Types of Retarder Control

Type	Description	Amount of Application
Manual	Separate apply pedal	Zero to Full apply
	Hand lever *	Six levels based on lever position
Automatic	Auto “Full On” *	“Full On” when closed throttle sensed
Brake Pressure Apply**	Single pressure switch	Off or “Full On” (based on brake pressure)
	Three pressure switches	$^1/_3$, $^2/_3$, or “Full On” (based on brake pressure)
Pedal Position **	Special brake pedal	$^1/_3$, $^2/_3$, or “Full On” (based on pedal position)

Types of Retarder Control *(cont'd)*

Type	Description	Amount of Application
Combinations of the above systems **	Auto "half-on" plus pressure switch *	Half capacity at closed throttle or "Full On" with brake pressure
	Auto " $^1/_3$ on" plus two pressure switches *	$^1/_3$, capacity at closed throttle or $^2/_3$ and "Full On" with brake pressure
	Hand lever plus pressure switch *	6 levels of modulation with lever, or "Full On" with brake pressure
	Foot pedal plus pressure switch	Full modulation with separate pedal, or "Full On" with brake pressure
	Hand lever plus interface for special pedal *	6 levels of modulation with lever, or 3 levels of modulation based on pedal position

* These control systems may apply the retarder at high speed on grades when the vehicle has road speed limiting and the retarder is enabled.

** For retarder apply systems integrated with the service brake system, the retarder is most effective when applied with light brake pedal pressure for 1–2 seconds to allow the retarder to fully charge. Added pedal pressure can be applied when more aggressive braking is desired.

NOTE: When the transmission fluid or engine water temperature (engine water is an OEM option) exceeds programmed limits, retarder capacity is automatically gradually reduced to minimize or avoid possible system overheating.

Contact your vehicle manufacturer to understand how the retarder controls have been integrated into your vehicle.

CAUTION: Observe the following cautions when driving a vehicle equipped with a retarder:

- THE RETARDER WORKS ONLY WHEN THE ENGINE IS AT CLOSED THROTTLE.
- OBSERVE TRANSMISSION AND ENGINE TEMPERATURE LIMITS AT ALL TIMES. Select the lowest possible transmission range to increase the cooling system capacity and total retardation available.
- In the event of OVERHEATING, DECREASE THE USE OF THE RETARDER; USE THE SERVICE BRAKES TO SLOW THE VEHICLE.
- OBSERVE THE RETARDER/SUMP "OVERTEMP" LIGHT to be sure it responds properly to retarder temperature.

NOTE: Transmission fluid level must be set correctly for highest retarder effectiveness. As much as 2 liters (2 quarts) too high or too low can reduce retarder effectiveness and increase transmission temperature.

RANGE PRESELECTION

NOTE: Preselecting during normal operation may result in reduced fuel economy.

Range preselection means selecting a lower range to match driving conditions encountered or expect to be encountered. Learning to take advantage of preselected shifts will give you better control on slick or icy roads and on downgrades.

Downshifting to a lower range increases engine braking. The selection of a lower range often prevents cycling between that range and the next higher range on a series of short up-and-down hills.

COLD WEATHER STARTS

All BUS transmissions are programmed to restrict full operation until specific fluid temperatures are reached. Refer to the following table for temperature restrictions.

Minimum Fluid Operating Temperatures

Sump Fluid Temperature	CHECK TRANS Light	Operation
–32°C (–25°F) to –7°C (19°F)	OFF	Neutral, Reverse, Second
–7°C (19°F)	OFF	Full operation in all ranges

NOTE: When sump temperature is below 10°C (50°F) and transmission fluid is C4 (**not DEXRON® or TranSynd™**), follow these procedures when making directional shift changes:

- To shift from forward to reverse, select **N** (Neutral) and then **R** (Reverse).
- To shift from reverse to forward, select **N** (Neutral) and then **D** (Drive) or other forward range.

Failure to follow these procedures may cause illumination of the CHECK TRANS light and the transmission will be restricted to **N** (Neutral).

Transmission operation at cold ambient temperatures may require preheating or the use of a lower viscosity transmission fluid. Refer to RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE in the Care And Maintenance section.

DRIVING ON SNOW OR ICE

WARNING: Using the retarder on wet or slippery roads may cause loss of traction on the drive wheels — your vehicle may slide out of control. To help avoid injury or property damage, turn the retarder enable to OFF when driving on wet or slippery roads.

NOTE: The retarder is automatically disabled whenever the vehicle ABS is active. However, in case the antilock brake system (ABS) malfunctions, it is recommended that the retarder enable switch, if present, be disabled.

If possible, reduce vehicle speed and select a lower range before losing traction. Select the range that will not exceed the speed expected to be maintained.

Accelerate or decelerate very gradually to prevent the loss of traction. It is very important to slow gradually when a lower range is selected. It is important that you reach the lower range selected before attempting to accelerate. This will avoid an unexpected downshift during acceleration.

ROCKING OUT

WARNING: To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) when the throttle is open. The vehicle will lurch forward or rearward and the transmission can be damaged. Avoid this condition by making shifts from **N** (Neutral) to a forward range or **R** (Reverse) only when the throttle is closed and the service brakes are applied.

CAUTION: DO NOT make **N** (Neutral) to **D** (Drive) or directional shift changes when the engine rpm is above idle. Also, if the wheels are stuck and not turning, do not apply full power for more than 30 seconds in either **D** (Drive) or **R** (Reverse). Full power for more than 30 seconds under these conditions will cause the transmission to overheat. If the transmission overheats, shift to **N** (Neutral) and operate the engine at 1200–1500 rpm until it cools (2–3 minutes).

If the vehicle is stuck in deep sand, snow, or mud, it may be possible to rock it out using the following procedure:

1. Shift to **D** (Drive) and apply steady, light throttle (**never full throttle**).
2. When the vehicle has rocked forward as far as it will go, apply and hold the vehicle service brakes.
3. When engine has returned to idle, select **R** (Reverse).
4. Release the brakes and apply a steady, light throttle allowing the vehicle to rock in **R** (Reverse) as far as it will go.
5. Again, apply and hold the service brakes and allow the engine to return to idle.

This procedure may be repeated in **D** (Drive) and **R** (Reverse) if each directional shift continues to move the vehicle a greater distance. **Never** make **N** (Neutral)-to-**D** (Drive) or directional shift changes when the engine rpm is above idle.

HIGH FLUID TEMPERATURE

The transmission is considered to be overheated when any of the following temperatures are exceeded:

Sump fluid	121°C (250°F)
Fluid to cooler	149°C (300°F)
Retarder out fluid	165°C (330°F)

If the transmission overheats during normal operations, check the fluid level in the transmission. Refer to the fluid level check procedures described in the Care And Maintenance section.

CAUTION: The engine should never be operated for more than 30 seconds at full throttle with the transmission in range and the output stalled. Prolonged operation of this type will cause the transmission fluid temperature to become excessively high and will cause severe overheat damage to the transmission.

If the engine temperature gauge indicates a high temperature, the transmission is probably overheated. Stop the vehicle and check the cooling system. If it appears to be functioning properly, run the engine at 1200–1500 rpm with the transmission in **N** (Neutral). This should reduce the transmission and engine temperatures to normal operating levels in 2 or 3 minutes. If temperatures do not decrease, reduce the engine rpm.

If the engine temperature indicates a high temperature, an engine or radiator problem is indicated. If high temperature in either the engine or transmission persists, stop the engine and have the overheating condition investigated by maintenance personnel.

PARKING BRAKE

WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, **DO NOT LEAVE** the vehicle until you have completed all of the following procedures:

- Put the transmission in **N** (Neutral)
- Be sure the engine is at low idle (500–800 rpm)
- Apply the parking brake and emergency brake and make sure they are properly engaged
- Chock the wheels and take other steps necessary to keep the vehicle from moving.

The parking brake is only intended to secure an unattended vehicle with the engine ignition **OFF**. Always maintain the vehicle parking brake system according to the manufacturer's specifications. The parking brake may not have sufficient capacity to restrain a vehicle with the engine running and the transmission in a forward or reverse-range. When the vehicle is unattended and the engine is in operation, the transmission **must be in N** (Neutral) with the **brakes fully applied** and the **wheels chocked**.

TOWING OR PUSHING

CAUTION: Failure to lift the driving wheels off the road, disconnect the driveline, or remove the axle shafts before pushing or towing can cause serious transmission damage.

The engine cannot be started by pushing or towing. Before pushing or towing a vehicle do one of the following:

- Disconnect the driveline.
- Lift the drive wheels off the road.
- Remove the axle shafts from the drive wheels.

An auxiliary air supply will usually be required to actuate the vehicle brake system.

When the axle shafts are removed, be sure to cover the wheel openings to prevent loss of lubricant and entry of dust and dirt.

TURNING OFF THE VEHICLE

Always select **N** (Neutral) prior to turning off the vehicle engine.

CRUISE CONTROL OPERATION

Operating an Allison WTEC III-equipped vehicle on cruise control may cause the transmission to shift cycle if the cruise control speed setting is set too close to a scheduled shift point. One of the following actions may eliminate shift cycling:

- Select a different shift schedule by pushing the MODE button Figure 7 on the shift selector.
- Select a lower range by pushing the ↓ (Down) arrow or moving the lever on the shift selector.
- Change the cruise control setting away from the shift point.

Some vehicles equipped with an engine brake and an Allison WTEC III-equipped transmission will have the engine brake controlled by the ECU. This is done so the transmission will automatically select a lower range when the engine brake is turned on and the throttle is near idle position.

Operating a vehicle on cruise control with the engine brake turned on and controlled by the transmission ECU, may cause an unwanted application of the engine brake when the cruise control decelerates for downhill grades. Eliminate this condition by turning off the engine brake while operating the vehicle on cruise control.

POWER TAKEOFF OPERATION

ENGINE-DRIVEN POWER TAKEOFF (PTO)

CAUTION: Do not exceed the engagement and operational speed limits imposed on the driven equipment during the operation of the PTO. Exceeding the speed limits produces high hydraulic pressure in the PTO that can damage the PTO components. Consult the vehicle manufacturer's literature for these speed limits.

If a PTO is present, it will normally be mounted on either the left or right side of the 3000 Product Family transmission (refer to Figure 3). On the 4000 Product Family transmission, the PTO will be located on the left side or on the top of the transmission (refer to Figure 3). The PTO drive gear is engine-driven and therefore provides direct engine power. The PTO can be operated when the vehicle is either moving or stopped.

The PTO gear is in constant mesh with the drive gear in the converter housing (refer to and Figure 4). However, the PTO may either be constant drive (output always powered) or clutched drive. When the PTO is clutch driven, the clutch is part of the PTO, not the transmission. A clutch driven PTO is powered only when the PTO clutch is engaged.

All 3000 Product Family and 4000 Product Family equipped vehicles with PTO enable have engagement and operational speed limits programmed into the ECU to help protect PTO equipment. Be sure the limits for PTO engagement speed and operational speed are not exceeded. Consult the vehicle manufacturer's literature for these speed limits. Some speed limits have default values which are programmed out of the operating range and will need to be set for your particular PTO duty cycle. Consult your vehicle manufacturer to see if your transmission has been programmed and what operational limits have been established.

When the programmed engagement speed is exceeded, the PTO will not engage. The PTO engagement must be retried after the speed has been reduced. When operational speeds (either engine or transmission output) are exceeded, the PTO will deactivate and the PTO engagement process must be repeated.

PERIODIC INSPECTIONS

Allison BUS transmissions require minimum maintenance. However, careful attention to the fluid level and connections for the electronic and hydraulic circuits is very important.

For easier inspection, the transmission should be kept clean. Make the following regular periodic inspections:

- For loose bolts and leaking fluid around fittings, lines, and transmission openings
- The condition of the electrical harnesses.
- The engine cooling system for evidence of transmission fluid which would indicate a faulty oil cooler.
- Breather (refer to Figure 2) is clean and free from dirt or debris.

Report any abnormal condition to maintenance personnel.

PREVENT MAJOR PROBLEMS

Help the WTEC III control system oversee the operation of the transmission. Minor problems can be kept from becoming major problems if an Allison Transmission distributor or dealer is notified when one of these conditions occur:

- Shifting feels odd
- Transmission leaks fluid
- Unusual transmission-related sounds (changes in sound caused by normal engine thermostatic fan cycling, while climbing a long grade with a heavy load, have been mistaken for transmission-related sounds)
- CHECK TRANS light comes on frequently

IMPORTANCE OF PROPER FLUID LEVEL

It is important that the proper fluid level be maintained at all times because the transmission fluid cools, lubricates, and transmits hydraulic power. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluid. If fluid level is too high, the fluid can aerate. Aerated fluid can cause the transmission to shift erratically or overheat.

BUS transmissions have an oil level sensor (OLS) that allows the operator to obtain an indication of fluid level from the shift selector. However, no oil level sensor diagnostics take place unless the OLS is “autodetected” by the WTEC III control system.

Frequently check for the presence of oil level diagnostics if the transmission is known to contain an OLS. If an OLS is not detected during a fixed number of engine starts, the WTEC III system concludes that no OLS is present. If an OLS is known to be present, but has not been detected, then troubleshooting of the OLS circuit is required. After the OLS circuit is repaired, reset “autodetect” or manually select the OLS function using Allison DOC™ for PC diagnostic tool. Refer to Allison Transmission publication number TS2973EN, WTEC III Troubleshooting Manual, for detailed troubleshooting procedures.

NOTE: To correctly check the transmission fluid level using the dipstick, the transmission fluid must be at operating temperature.The oil level sensor method of checking the fluid level compensates for transmission fluid temperature between 60°C–104°C (140°F–220°F). Any temperature below 60°C (140°F) or above 104°C (220°F) will result in an **Invalid for Display** condition.

FLUID LEVEL CHECK USING PUSHBUTTON OR LEVER SHIFT SELECTOR

The transmission must be equipped with the oil level sensor to be able to read fluid level information.

NOTE: Pushbutton and lever selectors can display one character at a time.

1. Park the vehicle on a level surface, shift to **N** (Neutral), and apply the parking brake.
2. **Pushbutton shift selector** — If equipped with an oil level sensor, simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons.
3. **Lever shift selector** — If equipped with an oil level sensor, press the display mode button one time.

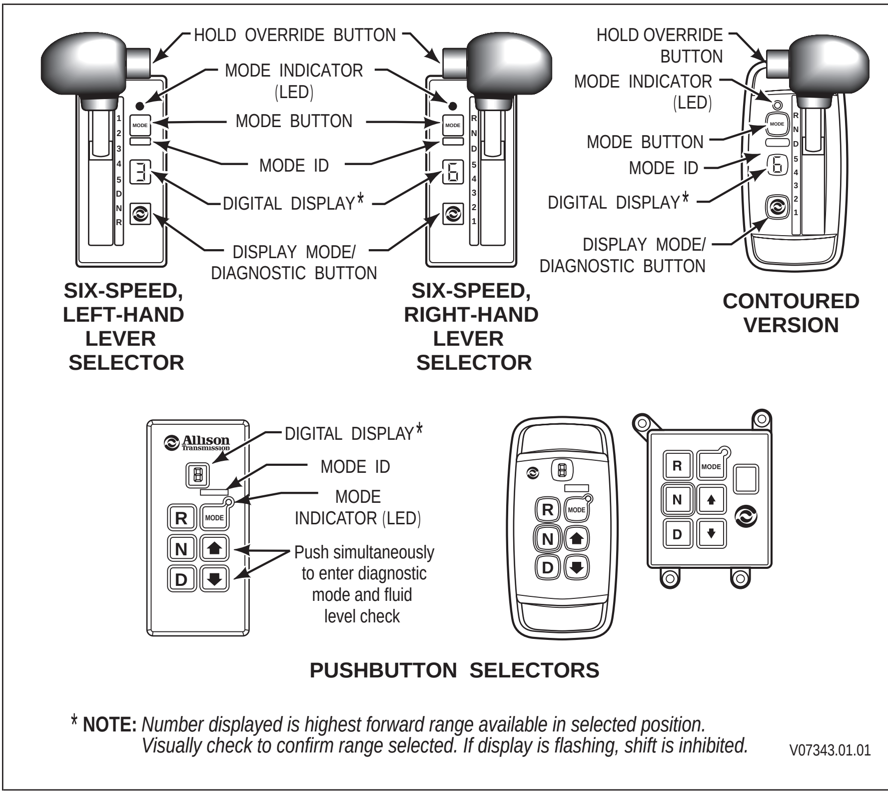


Figure 8. WTEC III Shift Selectors

NOTE: The fluid level check may be delayed until the following conditions are met:

- The fluid temperature is above 60°C (140°F) and below 104°C (220°F).
- The transmission is in **N** (Neutral).
- The engine is at idle.
- The transmission output shaft is stopped.
- The vehicle has been stationary for approximately two minutes to allow the fluid to settle.

The indication of a delayed fluid level check is a "—" in the display window followed by a numerical countdown display. The countdown, starting at 8, indicates the time remaining in the two minutes setting period.

- **Correct Fluid Level** — "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "o,K." The "o,K" display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.

NOTE: Fluid level diagnostic displays occur one character at a time.

- **Low Fluid Level** — "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "Lo" ("Lo" represents "Low Oil Level") and the number of quarts the transmission fluid is low. Example: "2" indicates 2 additional quarts of fluid will bring the fluid level within the middle of the "oK" zone.
- **High Fluid Level** — "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "HI" ("HI" represents "High Oil Level") and the number of quarts the transmission is overfilled. Example: "1" indicates 1 quart of fluid above the full transmission level.
- **Invalid for Display** — "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "—" and a numerical display. The numerical display is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction. The fault codes that may be encountered are shown in the following table, Fluid Level Fault Codes.

Fluid Level Fault Codes

Display	Cause of Code
o,L, —, 0, X	Settling time too short
o,L, —, 5, 0	Engine speed (rpm) too low
o,L, —, 5, 9	Engine speed (rpm) too high
o,L, —, 6, 5	Neutral must be selected
o,L, —, 7, 0	Sump fluid temperature too low
o,L, —, 7,9	Sump fluid temperature too high
o,L, —, 8, 9	Output shaft rotation
o,L, —, 9, 5	Sensor failure*

* Report sensor failure display to a distributor or dealer in your area (check the telephone directory for an Allison Transmission distributor or dealer).

CAUTION: A low or high fluid level can cause overheating and irregular shift patterns. Incorrect fluid level can damage the transmission.

NOTE: To exit the fluid level display mode, press any range button on the pushbutton shift selector, or press the display mode (diagnostic) button once on the lever shift selector.

FLUID LEVEL CHECK USING DIAGNOSTIC TOOLS

The transmission must be equipped with the optional oil level sensor to be able to read fluid level information.

1. Park the vehicle on a level surface and shift to **N** (Neutral). Apply the parking brake and/or emergency brakes.
2. Obtain fluid level information by following the procedure in the Allison DOC™ For PC User Guide, GN3433EN or by using the OEM-supplied auxiliary display.
3. Fluid level information may be delayed when certain conditions are not met. The Allison DOC™ for PC diagnostic tool will display a message showing which conditions have not been met. These conditions are:
   - — Settling time too short
   - — Engine speed (rpm) too low
   - — Engine speed (rpm) too high
   - — **N** (Neutral) must be selected
   - — Sump fluid temperature too low (below 60°C or 140°F)
   - — Sump fluid temperature too high (above 104°C or 220°F)
   - — Output shaft rotation

MANUAL FLUID CHECK PROCEDURE

Refer to Figure 2 and Figure 3 for the location of the fill tube and dipstick.

WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures:

- Put the transmission in **N** (Neutral)
- Be sure the engine is at low idle (500–800 rpm)
- Apply the parking brakes and emergency brake and make sure they are properly engaged
- Chock the wheels and take any other steps necessary to keep the vehicle from moving.

Clean around the end of the fill tube before removing the dipstick (refer to Figure 9). This will aid in preventing dirt or foreign matter from entering the hydraulic system, which can cause:

- Valves to stick
- Undue wear of transmission parts
- Clogged passages.

Check the fluid level using the procedures in COLD CHECK and HOT CHECK. Report an abnormal fluid level to maintenance personnel.

COLD CHECK

The Cold Check determines if the transmission has enough fluid to be operated safely until a Hot Check can be made.

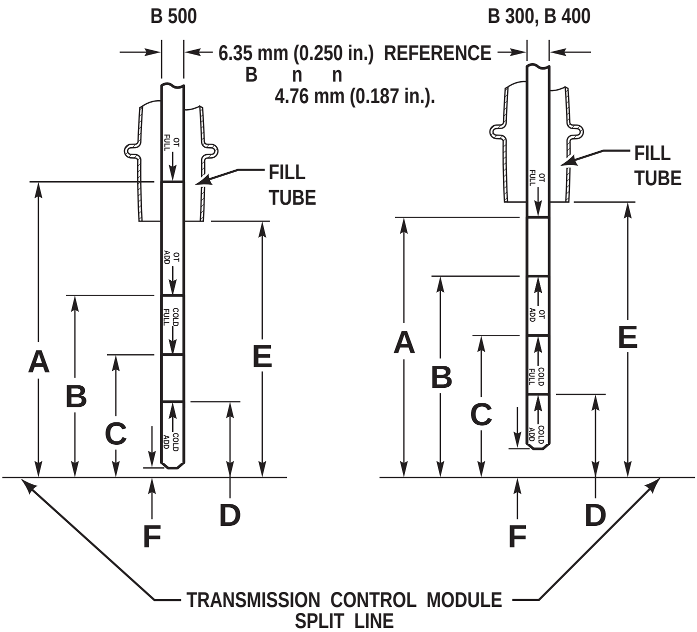
NOTE: The correct fluid level **can not be determined** unless the transmission is in a level position.

CAUTION: DO NOT start the engine until the presence of sufficient transmission fluid has been confirmed. Remove the transmission fluid dipstick and be sure the static fluid level is near the HOT FULL mark.

CAUTION: The fluid level rises as fluid temperature rises. DO NOT fill the transmission above the "COLD CHECK" band if the transmission fluid is below normal operating temperatures. During operation, an overfull transmission can become overheated, leading to transmission damage.

A cold check may be made after initial start-up and the presence of transmission fluid has been confirmed (the sump fluid temperature is then typically 16°–49°C (60°–120°F). To perform a COLD CHECK, do the following:

1. Start the engine and run it at idle (500–800 rpm) in **N** (Neutral) for about one minute. Shift to **D** (Drive) and then to **R** (Reverse) to clear the hydraulic circuits of air. Shift to **N** (Neutral) and leave engine at idle.
2. Move the vehicle to a level surface, put transmission in **N** (Neutral), and set the parking brake.
3. With the engine idling (500–800 rpm), shift to **D** (Drive) and then to **R** (Reverse) to clear air from the hydraulic circuits.
4. Shift to **N** (Neutral) and leave engine at idle.



OIL SUMP	TRANSMISSION/SUMP DESCRIPTION	DIMENSION A	DIMENSION B	DIMENSION C	DIMENSION D	DIMENSION E	DIMENSION F**
N/A	B 500	106.7 mm (4.20 in.)	76.2 mm (3.00 in.)	66.0 mm (2.60 in.)	*	132.6 mm (5.22 in.)	13.8 mm (0.54 in.)
2.00 in.***	B 300, B 400	101.6 mm (4.00 in.)	73.7 mm (2.90 in.)	50.8 mm (2.00 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
4.00 in.***	B 300, B 400	101.6 mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)

NOTE: *Calibrate level marking locations with respect to transmission control module split line and fill tube.*
Scale none.
** Dimension determined by installation.*
*** Reference dimension only. Actual dimension to be determined by installation.*
**** Reference drawing AS66-60.*
***** Reference drawing AS67-60.*

V07310.01.01

Figure 9. Standard BUS Transmission Dipstick Markings

5. Remove the dipstick and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
6. Remove the dipstick and observe the fluid level. If the fluid on the dipstick is within the COLD RUN band (refer to Figure 9), the level is satisfactory. If the fluid level **is not** within this band, add or drain fluid as necessary to bring the level within the COLD RUN band.
7. Perform a Hot Check at the first opportunity after normal operating temperature (71°–93°C; 160°–200°F) is reached.

CAUTION: DO NOT operate the transmission for extended periods of time until a Hot Check has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.

CAUTION: Obtain an accurate fluid level by imposing the following conditions:

- Engine is idling (500–800 rpm) in **N** (Neutral)
- Transmission fluid is at the proper temperature
- The vehicle is on a level surface.

HOT CHECK

The transmission fluid **must be hot** to obtain an accurate check, because the fluid level rises as temperature increases.

To perform a HOT CHECK, do the following:

1. Be sure fluid has reached normal operating temperature (71°–93°C; 160°–200°F). If a transmission temperature gauge is not present, check fluid level when the engine water temperature gauge has stabilized and the transmission has been operated under load for at least one hour.
2. Park the vehicle on a level surface and shift to **N** (Neutral). Apply the parking brake and allow the engine to idle (500–800 rpm).
3. Remove the dipstick and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
4. Remove the dipstick and observe the fluid level. The safe operating level is anywhere within the HOT RUN band (refer to Figure 9) on the dipstick.
5. If the level is not within this band, add or drain fluid as necessary to bring the level within the HOT RUN band.

6. Be sure fluid level checks are consistent. Check level more than once and if readings are not consistent, check to be sure the transmission breather is clean and not clogged. If readings are still not consistent, contact your nearest Allison distributor or dealer.

RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE

- Hydraulic fluids used in the transmission are important influences on transmission performance, reliability, and durability. TranSynd™ and DEXRON®-III fluids are recommended for on-highway applications. TranSynd™ and DEXRON®-III fluids are recommended for all BUS applications.
- TranSynd™ is a full synthetic transmission fluid developed by Allison Transmission and Castrol Ltd. This fluid meets Allison specifications for Severe Duty and Extended Drain Intervals. TranSynd™ is fully qualified to the Allison TES 295 specifications and is available through Allison distributors and dealerships.
- To be sure a fluid is qualified for use in Allison transmissions check for the DEXRON®-III license numbers on the container or consult the lubricant manufacturer. Consult your Allison Transmission dealer or distributor before using other fluid types.

CAUTION: Disregarding minimum fluid temperature limits can result in transmission malfunction or reduced transmission life.

- When choosing the optimum viscosity grade of fluid, duty cycle, preheat capabilities, and/or geographical location must be taken into consideration. The Transmission Fluid Operating Temperature Requirements table lists the minimum fluid temperatures at which the transmission may be safely operated without preheating. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in neutral for a minimum of 20 minutes before attempting range operation.

Transmission Fluid Operating Temperature Requirements

SAE Viscosity Grade* or Fluid Type	Minimum Operating Temperature	
	Celsius	Fahrenheit
MIL-PRF-46167	–32	–25
SAE 0W–20 or TranSynd™	–30	–22
DEXRON® III	–25	–13
SAE 10W	–20	–4
SAE 15W–40	–15	5
SAE 30W	0	32
SAE 40W	10	50
* SAE "W" designation indicates winter weight based on cold temperature properties.		

KEEPING FLUID CLEAN

CAUTION: Containers or fillers that have been used for antifreeze solution or engine coolant must NEVER be used for transmission fluid. Antifreeze and coolant solutions contain ethylene glycol which, if put into the transmission, can cause the clutch plates and some seals to fail.

It is absolutely necessary that transmission fluid be clean. The fluid **must be handled** in clean containers to prevent foreign material from entering the transmission.

FLUID AND INTERNAL FILTER CHANGE INTERVAL RECOMMENDATIONS

CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes can be necessary than recommended in the general guidelines when operating conditions create high levels of contamination or overheating.

Refer to the following tables for guidelines for fluid and filter change intervals.

Recommended Fluid/Filter Change For B 300/B 400 Transmissions*

NOTE: Severe and General Vocations — Local conditions, severity of operation, or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Transmission protection and fluid change intervals can be optimized by using fluid analysis. Filters **must be changed** at or before recommended intervals. Flushing machines are not recommended or recognized due to variations and inconsistencies with 100 percent removal of used fluid.

SEVERE VOCATION**				GENERAL VOCATION***			
	Filters				Filters		
Fluid	**Main**	**Internal**	**Lube/ Auxiliary**	**Fluid**	**Main**	**Internal**	**Lube/ Auxiliary**
Schedule 1 — Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2† — TranSynd™/TES 295 Fluid							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

* Change fluid/filters after recommended mileage, months, or hours have elapsed, whichever comes first.

** BUS Transmissions with retarders, on/off highway

*** BUS Transmissions without retarders, on highway only.

† Recommendations in Schedule 2 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission Gold Series filters.

Recommended Fluid/Filter Change For B 500 Transmissions*

NOTE: Severe and General Vocations — Local conditions, severity of operation, or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Transmission protection and fluid change intervals can be optimized by using fluid analysis. Filters **must be changed** at or before recommended intervals. Flushing machines are not recommended or recognized due to variations and inconsistencies with 100 percent removal of used fluid.

SEVERE VOCATION**				GENERAL VOCATION***			
	Filters			Fluid	Filters		
Fluid	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
Schedule 1 — Non-TranSynd™/Non-TES 295 Fluid							
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	25,000 Miles (40 000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40 000 km) 12 Months 1000 Hours
Schedule 2† — TranSynd™/TES 295 Fluid **4 Inch Control Module (3.5 Inch Approximately) — Requires Filter Kit P/N 29540494**							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

Recommended Fluid/Filter Change For B 500 Transmissions* *(cont'd)*

SEVERE VOCATION**				GENERAL VOCATION***			
	Filters			Fluid	Filters		
Fluid	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
Schedule 3† — TranSynd™/TES 295 Fluid							
50,000 Miles (80 000 km) 24 Months 2000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours

* Change fluid/filters after recommended mileage, months, or hours have elapsed, whichever comes first.

** HS with retarders, on/off highway.

*** BUS Transmissions without retarders, on highway only.

† Recommendations in Schedules 2 and 3 are based on the transmission containing 100 percent TranSynd™ fluid and Allison Transmission Gold Series filters.

CAUTION: Transmission fluid and filters **must be changed** whenever there is evidence of dirt or a high temperature condition. A high temperature condition is indicated when the transmission fluid is discolored, has a strong odor or has exceeded oil analysis limits.

Fluid Analysis

Transmission protection and fluid change intervals may be optimized by monitoring fluid oxidation according to the tests and limits shown in the Fluid Oxidation Measurement Limits table. Consult your local telephone directory for fluid analysis firms. To be sure of consistent and accurate fluid analysis, use only one fluid analysis firm. Refer to Technician's Guide for Automatic Transmission Fluid, GN2055EN, for additional information.

Fluid Oxidation Measurement Limits

Test	Limit
Viscosity	±25 percent change from new fluid
Total Acid Number (TAN)	+3.0* change from new fluid
* mg of potassium hydroxide (KOH) to neutralize a gram of fluid.	

DIAGNOSTIC CODES

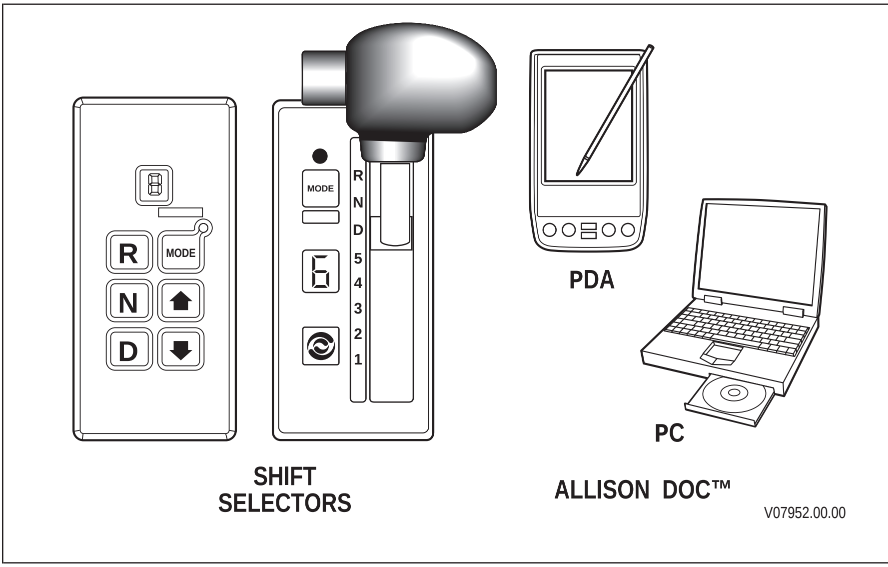


Figure 10. Shift Selectors/PDA/Allison DOC™ For PC Diagnostic Tool

Poor performance may activate a code without illuminating the **CHECK TRANS** light. Continued illumination of the **CHECK TRANS** light during vehicle operation (not start-up) indicates the ECU has signaled a diagnostic code. Up to five diagnostic codes may be recorded. Diagnostic codes may be read and cancelled by using the Allison DOC™ for PC diagnostic tool or shift selectors shown in Figure 10. Refer to Allison Transmission publication number GN3433EN, Allison DOC™ for PC User Guide, for instructions on how to use the diagnostic tool. Code reading, clearing methods, and complete code descriptions are presented in Allison Transmission publication number TS2973EN, WTEC III Troubleshooting Manual.

BUS	CUSTOMER SERVICE

OWNER ASSISTANCE

The satisfaction and goodwill of the owners of Allison transmissions are of primary concern to Allison Transmission Division (ATD), its distributors, and their dealers.

There are Allison transmission service locations throughout the world that are eager to meet your parts and service needs with:

- Expert service by trained personnel
- Emergency service 24 hours a day in many areas
- Complete parts support
- Sales teams to help determine your transmission requirements
- Product information and literature

Normally, any situation that arises in connection with the sale, operation, or service of your transmission will be handled by the distributor or dealer in your area (check the telephone directory for the Allison Transmission service outlet nearest you).

Refer to Worldwide Sales and Service Directory (SA2229EN) for the current listing of Allison Transmission authorized distributor and service dealers. This directory is available from SGI, Inc.

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. To further assure your complete satisfaction, we have developed the following three-step procedure to be followed in the event a problem has not been handled satisfactorily.

Step One — Discuss the problem with a member of management from the distributorship or dealership. Frequently, complaints are the result of a breakdown in communication and can quickly be resolved by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager.

All ATD dealers are associated with an ATD distributor. If the problem originates with a dealer, explain the matter to a management member of the distributorship with whom the dealer has his service agreement. The dealer will provide his ATD distributor’s name, address, and telephone number on request.

Step Two — When it appears the problem cannot be resolved readily at the distributor level without additional assistance, **contact the Allison Transmission Regional Office responsible for the local distributor.** You will be assisted by a member of the Regional Service Manager's staff, depending on the nature of your problem.

For prompt assistance, please have the following information available.

- Name and location of authorized distributor or dealer
- Type and make of equipment
- Transmission model number, serial number, and assembly number (if applicable). This data is available on the nameplate located on the right side of the transmission. Also provide the ECU identification number which may be located elsewhere in the vehicle.
- Transmission delivery date and accumulated miles and/or hours of operation
- Nature of problem
- Chronological summary of unit's history

Step Three — If you contacted a regional office and you are still not satisfied, **present the entire matter to the Home Office by writing to the following address or calling the phone number below:**

Allison Transmission
Manager, Warranty Administration – PF9
P.O. Box 894
Indianapolis, IN 46206-0894
1–800–524–2303

The inclusion of all pertinent information will assist the Home Office in expediting the matter. If an additional review by the Home Office of all the facts involved indicates that some further action can be taken, the Regional Office will be advised.

When contacting the Regional or Home Office, please keep in mind that ultimately the problem will likely be resolved at the distributorship or dealership utilizing their facilities, equipment, and personnel. Therefore, it is suggested the above steps be followed in sequence when experiencing a problem.

Your purchase of an Allison Transmission product is greatly appreciated, and it is our sincere desire to assure complete satisfaction.

SERVICE LITERATURE

Additional service literature is available as shown in the service literature table. This service literature provides fully illustrated instructions for the operation, maintenance, service, overhaul, and parts support of your transmission. To be sure that you get maximum performance and service life from your unit, you may order publications from:

SGI, Inc.
Attn: Allison Literature Fulfillment Desk
8350 Allison Avenue
Indianapolis, IN 46268
TOLL FREE: 888-666-5799
INTERNATIONAL: 317-471-4995

Available Service Literature

Transmission Model	B 300 amd B 400	B 500
Automatic Transmission Fluid Technician's Guide	GN2055EN	GN2055EN
Mechanic's Tips	MT3657EN	MT3657EN
Operator's Manual	OM3749EN	OM3749EN
Parts Catalog	PC2150EN	PC2456EN
Parts Catalog CD-ROM	CD2150EN	CD2456EN
Principles of Operation	PO2454EN	PO2454EN
Service Manual	SM2148EN	SM2457EN
Electronic Troubleshooting Manual	TS2973EN	TS2973EN
Worldwide Sales and Service Directory	SA2229EN	SA2229EN

ALLISON TRANSMISSION DISTRIBUTORS

EASTERN REGION

Atlantic Detroit Diesel-Allison, LLC
180 Route 17 South
Lodi, NJ 07644
201-489-5800

Covington Detroit Diesel-Allison
8015 Piedmont Triad Parkway
Greensboro, NC 27409
663–292–9240

Johnson & Towers, Inc.
2021 Briggs Road
Mount Laurel, NJ 08054
856-234-6990

Penn Detroit Diesel-Allison, Inc.
8330 State Road
Philadelphia, PA 19136-2986
215-335-0500

Western Branch Diesel, Inc.
3504 Shipwright Street
Portsmouth, VA 23703
757–673–7000

Williams Detroit Diesel-Allison
Southeast, Inc.
2849 Moreland Avenue, S.E
Atlanta, GA 30315-0037
404-366-1070

New England Detroit Diesel-Allison, Inc.
90 Bay State Road
Wakefield, MA 01880–1095
781–246–1810

CENTRAL REGION

Caribe Detroit Diesel-Allison
Division of GT Corporation
Ceramic Ind. Park, Campo Rico Ave.,
Block C
Carolina, Puerto Rico 00982
787-750-5000

Central Detroit Diesel-Allison, Inc.
9200 Liberty Drive
Liberty, MO 64068
816-781-8070

Clarke Detroit Diesel-Allison, Inc.
3133 East Kemper Road
Cincinnati, OH 45241
513-771-2200

Florida Detroit Diesel-Allison, Inc.
5105 Bowden Road
Jacksonville, FL 32216
904-737-7330

Inland Detroit Diesel-Allison, Inc.
210 Alexandra Way
Carol Stream, IL 60188
630-871-1111

Inland Diesel, Inc.
13015 West Custer Avenue
Butler, WI 53007-0916
262-781-7100

Interstate Detroit Diesel
2501 East 80th Street
Minneapolis, MN 55425
952-854-5511

Williams Detroit Diesel-Allison
Midwest, Inc.
1176 Industrial Parkway
North Brunswick, OH 44212-2342
330-225-7751

SOUTHWESTERN REGION

Detroit Diesel-Allison De Mexico S.A. de C.V.
Av. Santa Rosa No. 58
Col. Ampliacion Norte
Tlalnepantla, Estado de Mexico
C.P. 54160
(525)6-333-1800

Stewart & Stevenson Services, Inc.
2707 North Loop West
Houston, TX 77008
713-868-7700

Stewart & Stevenson Power, Inc.
5840 Dahlia Street
Commerce City, CO 80022
303-287-7441

United Engines, LLC
5555 West Reno Avenue
Oklahoma City, OK 73127
405-947-3321

WESTERN REGION

Pacific Detroit Diesel-Allison Company
7215 South 228th Street
Kent, WA 98032
253-854-0505

Valley Detroit Diesel-Allison, Inc.
425 South Hacienda Boulevard
City of Industry, CA 91745-1123
626-333-1243

Smith Detroit Diesel-Allison, Inc.
250 West 3900 South
Salt Lake City, UT 84107
801-415-5000

Williams Detroit Diesel-Allison Southwest, Inc.
2602 S. 19th Avenue
Phoenix, AZ 85009
602-257-0561

Stewart & Stevenson
1755 Adams Avenue
San Leandro, CA 94577-1001
510-635-8991

CANADIAN REGION

Detroit Diesel-Allison
British Columbia Ltd.
9300 192nd Street
Surrey, British Columbia V4N 3R8
604-888-1211

Detroit Diesel-Allison Canada East
Div. of Integrated Power Systems Corp
2997 Rue Watt
Ste. Foy, Quebec G1X 3W1
418-651-5371

Harper Detroit Diesel Ltd.
10 Diesel Drive
Toronto, Ontario M8W 2T8
416-259-3281

Midwest Detroit Diesel-Allison Ltd.
1460 Waverley Street
Winnipeg, Manitoba R3T OP6
204-452-8244

Waterous Detroit Diesel-Allison (Div.
of Integrated Power Systems Corp)
10025 51st Avenue
Edmonton, Alberta T6E OA8
780-437-3550

ALLISON TRANSMISSION REGIONAL OFFICES

EASTERN REGION
P.O. Box 400
Colunbus, NJ 08022–0400
609–298–2541

CENTRAL REGION
P. O. Box 894, Speed Code PF06
Indianapolis, IN 46206-0894
317-242-2327

SOUTHWESTERN REGION
Av. Ejercito Nacional No. 843
Colonia Granada
Mexico, D.F. C.P. 11520
525-901-3057
Texas Office: 936-321-4248
Fax: 936-321-4278

WESTERN REGION
39465 Paseo Padre Parkway Suite 3500
Fremont, CA 94538
510-498-5208

CANADIAN REGION
P. O. Box 5160 Station A
London, Ontario N6A 4N5
519-452-5256

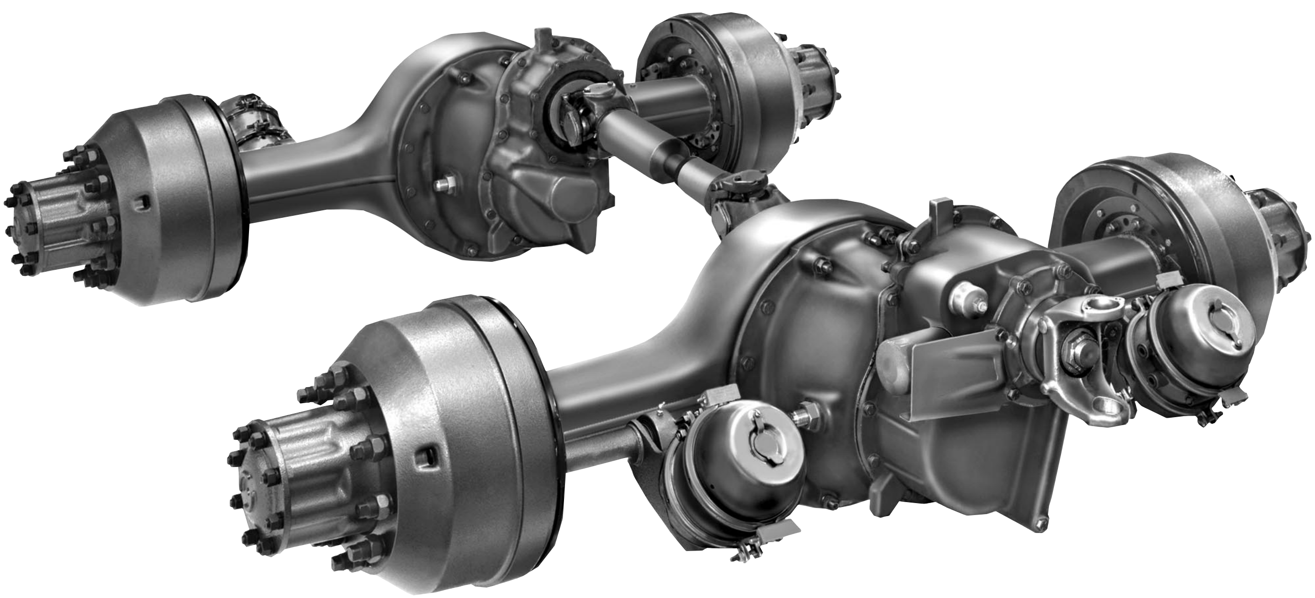
NOTES

NOTES

Revised 08-00
$2.50

Tandem Axle Forward Carriers and Single Axle Carriers
Including Double-Reduction Carriers

Maintenance Manual 5E



RT- and RP-180 Series
RT- and RP-380 Series
RS-23, -26, -30 and -38-380 Series
SR-170/270/280
ST-170/270/280
SU-170/270/280
SW-170/270/280
SPR-570
SPRC-1927
SPRC-4806

Before You Begin

This manual provides instructions for Meritor's heavy-duty large ring gear single and tandem axles, including the SR-, ST-, SU-, SW-170/270/280, RT-, RP-180/380, SPR-570, SPRC-1927 and SPRC-4806 series axles. Before you begin procedures:

1. Read and understand all instructions an procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

⚠ *WARNING*	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
⚠ *CAUTION*	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious injury.
T	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

Access Information on ArvinMeritor's Web Site

Additional maintenance and service information for ArvinMeritor's commercial vehicle systems component lineup is also available at www.arvinmeritorinc.com.

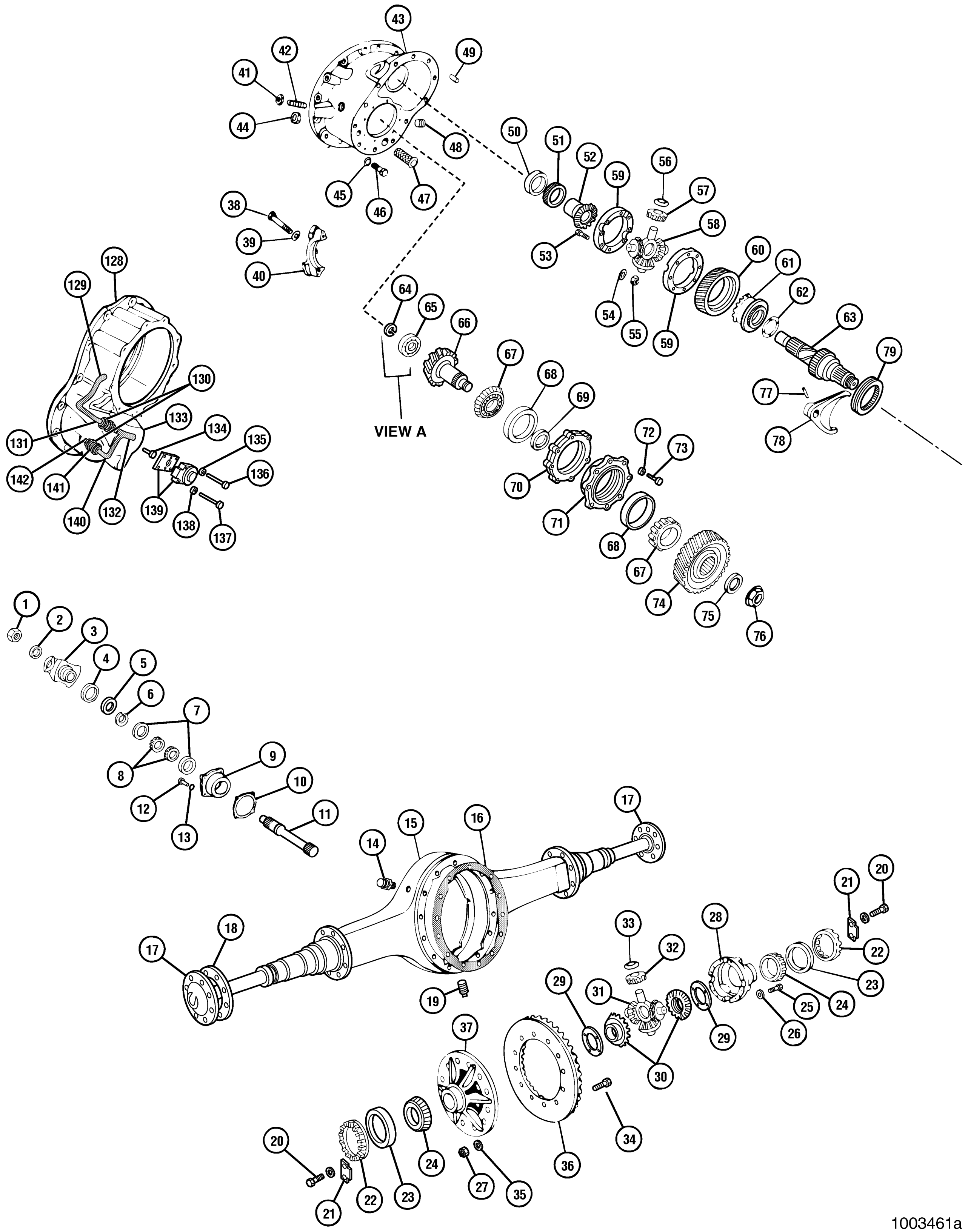
To access information, click on Products & Services/Tech Library Icon/HVS Publications. The screen will display an index of publications by type.

Additional Information

For complete maintenance and service procedures for all single reduction differential carriers, call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following publications.

- *Traction Controls* video. Order T-95125V.
- *Splitting the Difference* video. Order T-87127V.
- *Driver-Controlled Full Locking Main Differential* video. Order T-9007V.
- *Technical Electronic Library* on CD. Features product and service information on most ArvinMeritor, ZF Meritor and Meritor WABCO components. $20. Order TP-9853.

SR-, ST-, SU, SW-170/270/280 and RT-, RP-180/380 Forward Rear Axle
(SPR-570, SPRC-1927 and SPRC-4806 Carrier Only)



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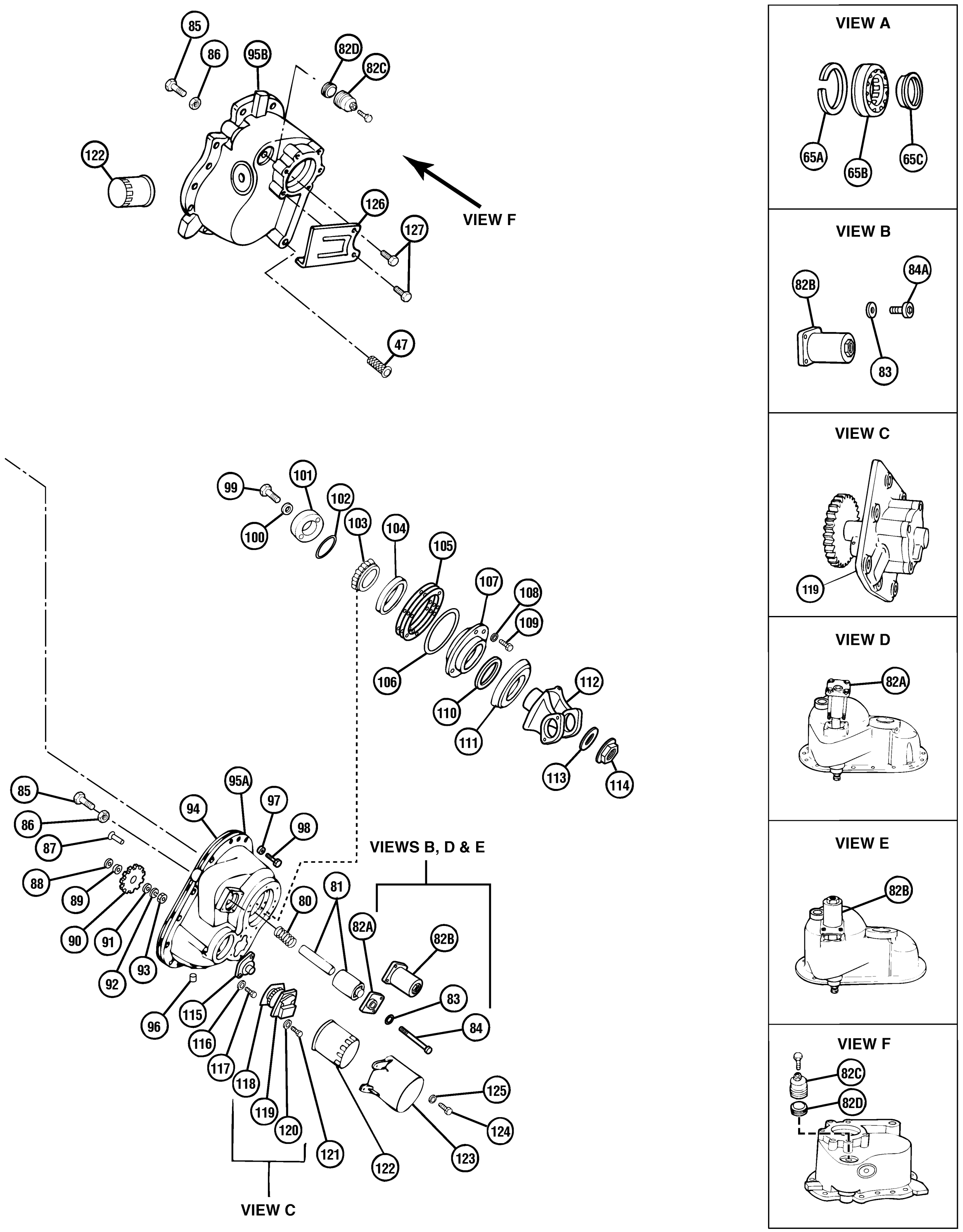

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Item	Description
1	Nut — Output Yoke
2	Washer — Output Yoke
3	Output Yoke
4	Oil Seal
5	Spacer
6	Snap Ring
7	Cup — Output Bearing
8	Cone — Output Bearing
9	Output Bearing Cage
10	Gasket — Output Bearing Cage
11	Thrushaft
12	Capscrew — Output Bearing Cage
13	Washer — Output Bearing Cage
14	Breather Vent
15	Axle Housing
16	Gasket — Axle Housing
17	Axle Shaft
18	Gasket — Axle Shaft
19	Drain Plug — Axle Housing
20	Capscrew — Adjusting Ring Lock
21	Adjusting Ring Lock
22	Bearing Adjusting Ring
23	Cup — Main Differential Bearing
24	Cone — Main Differential Bearing
25	Bolt — Main Differential Case Halves
26	Washer — Differential Case Halves
27	Nut — Main Differential Case Halves
28	Main Differential Case Half
29	Thrust Washer — Main Differential Case
30	Side Gear — Main Differential Case
31	Spider — Main Differential Case
32	Pinion Gear — Spider
33	Thrust Washer — Spider
34	Capscrew — Ring Gear
35	Washer — Ring Gear
36	Ring Gear
37	Main Differential Case Half
38	Capscrew — Differential Bearing Cap
39	Washer — Differential Bearing Cap
40	Differential Bearing Cap
41	Nut — Drive Gear Thrust Screw
42	Drive Gear Thrust Screw
43	Differential Carrier
44	Nut — Differential Carrier
45	Washer — Differential Carrier
46	Bolt — Differential Carrier
47	Screen — Oil Filter
48	Fill Plug
49	Dowel
50	Rear Bearing Cup — Input Shaft
51	Rear Bearing Cone — Input Shaft
52	Rear Side Gear — Inter-Axle Differential
53	Capscrew — Inter-Axle Differential
54	Washer — Inter-Axle Differential
55	Nut — Inter-Axle Differential
56	Thrust Washer — Spider
57	Pinion Gear — Spider
58	Spider — Inter-Axle Differential
59	Case Halves — Inter-Axle Differential
60	Helical Drive Gear
61	Front Side Gear — Inter-Axle Differential
62	Thrust Washer — Front Side Gear
63	Input Shaft
64	Snap Ring — Drive Pinion
65	One-Piece Spigot Bearing — Drive Pinion
65A	Snap Ring — Two-Piece Spigot Bearing
65B	Outer Race — Two-Piece Spigot Bearing
65C	Inner Race — Two-Piece Spigot Bearing
66	Drive Pinion
67	Cone — Drive Pinion Bearing
68	Cup — Drive Pinion Bearing
69	Shim Spacer — Drive Pinion Bearing
70	Shims — Drive Pinion Bearing Cage
71	Drive Pinion Bearing Cage
72	Washer — Drive Pinion Bearing Cage
73	Capscrew — Drive Pinion Bearing Cage
74	Helical Driven Gear
75	Washer — Drive Pinion
76	Nut — Drive Pinion
77	Roll Pin — Shift Fork
78	Shift Fork — Clutch Collar
79	Clutch Collar — Input Shaft
80	Spring — Push Rod
81	Push Rod
82A	Bolt-on DCDL Air Shift Assembly Cover
82B	Bolt-on DCDL Air Shift Assembly Cover
82C	Screw-in DCDL Air Shift Assembly Cover
82D	Plug — Non DCDL Threaded Assembly
83	Washer — Air Shift Cover
84	Capscrew (Long) — Air Shift Cover
84A	Allen-Head Capscrew — Bolt-on Cover
85	Stopscrew — Push Rod
86	Nut — Stopscrew Push Rod
87	Shaft — Oil Pump Idler Gear
88	Washer — Oil Pump Idler Gear
89	Bearing — Oil Pump Idler Gear
90	Oil Pump Idler Gear
91	Spacer — Oil Pump Idler Gear
92	Snap Ring — Oil Pump Idler Gear
93	Nut — Oil Pump Idler Gear
94	Gasket — Helical Gear Cover
95A	Helical Gear Cover — Older Models
95B	Helical Gear Cover — Current Models
96	Plug — Helical Gear Cover
97	Washer — Helical Gear Cover
98	Capscrew — Helical Gear Cover
99	Capscrew — Rotor Type Oil Pump
100	Washer — Rotor Type Oil Pump
101	Oil Pump — Rotor Type
102	O-Ring — Rotor Type Oil Pump
103	Cone — Input Shaft Forward Bearing
104	Cup — Input Shaft Forward Bearing
105	Shims — Input Bearing Cage
106	O-ring — Input Bearing Cage
107	Input Bearing Cage
108	Washer — Input Bearing Cage
109	Capscrew — Input Bearing Cage
110	Oil Seal — Input Shaft
111	Oil Deflector
112	Input Yoke
113	Washer — Input Yoke
114	Nut — Input Yoke
115	Oil Filter Adapter
116	Washer — Oil Filter Adapter
117	Capscrew — Oil Filter Adapter
118	Driven Gear — Oil Pump
119	Oil Pump — Gear Type
120	Washer — Oil Pump
121	Capscrew — Oil Pump
122	Oil Filter
123	Cover — Oil Filter
124	Capscrew — Oil Filter Cover
125	Washer — Oil Filter Cover
126	Shield — Oil Filter
127	Bolt — Oil Shield
128	Cover Assembly — Helical Gear, Rear Carriers with Oil Pump
129	Tube — Finished Steel 11.88 inch Long
130	Hose Clamps
131	Hose — 7/16 inch x 2 inch
132	Tube — Finished Steel 0.94 inch Radius
133	O-Ring
134	Button — Pump Drive
135	Washer — Oil Pump Bolt 11/32 inch I.D. x 5/8 inch O.D.
136	Bolt — Oil Pump 5/16 inch Diameter x 2.25 inch Long
137	Bolt — Oil Pump 3/8 inch Diameter x 2.25 inch Long
138	Washer — Oil Pump Bolt 13/32 inch I.D. x 13/16 inch O.D.
139	Oil Pump Assembly
140	Tube — Finished Steel 1.25 inch Radius
141	Hose — 3/8 inch x 2 inch
142	Tube — Finished Steel 2 inch Long

MERITOR®

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Table of Contents

MERITOR®

Introduction

The SR/ST/SU/SW-170 and RT-, RP-180 single-reduction carriers are used in on-highway forward rear tandem axles. A single reduction exists between the ring gear and the drive pinion. **Figure 1.1**.

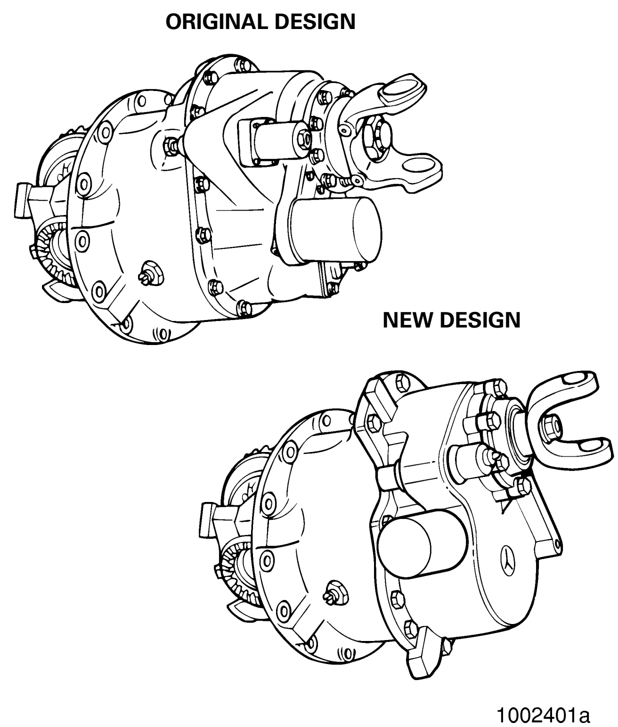
The SR/ST/SU/SW-270-280 and RT-, RP-380 double-reduction carriers are used in on-highway forward rear axles. The first reduction occurs between the helical drive gear on the input shaft and the helical driven gear on the drive pinion. The second reduction occurs between the ring gear and the drive pinion.

The SPR-570, SPRC-1927 and SPRC-4806 carriers are used in off-highway, forward rear tandem axles. The reduction for this axle series occurs between the ring gear and the drive pinion. An oil seal on the input shaft with a cast-iron outer protector and a"labyrinth-type,"one-piece, inner oil seal can be used in these carriers used in off-highway service.

The rear rear axles of the 170 and 180 Series tandem axles utilize the R-170 and R-180 single axle carrier. For more specific information, refer to Maintenance Manuals 5 (MM5) and 5A (MM5A) *Single Reduction Rear Differential Carriers.*

The rear rear tandem axles of the 270, 280, 380, 570, 1927 and 4806 Series tandems utilize the R-270 or R-280 single axle carrier. For maintenance information, refer to Maintenance Manual 6C, *Model 270 Series Double Reduction Differential Carriers.*

Figure 1.1



Axle and Carrier Identification Tags

The axle identification tag is located on the rear of the axle housing. The carrier identification tag is located on the differential carrier next to the fill plug. Use the model number and the ratio number from the identification tag located on the carrier when replacement parts are required. **Figure 1.2** and **Figure 1.3**.

Refer to **Figure 1.4** and **Figure 1.5** for information about the model number.

Figure 1.2

AXLE IDENTIFICATION TAG INFORMATION

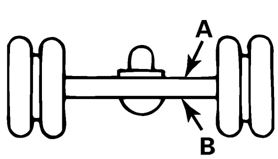
Model No. ....
Customer No. ....

Serial No. .... Plant ....
Ratio .... Date ....

IDENTIFICATION TAG

LOCATION OF IDENTIFICATION TAG FOR AXLES

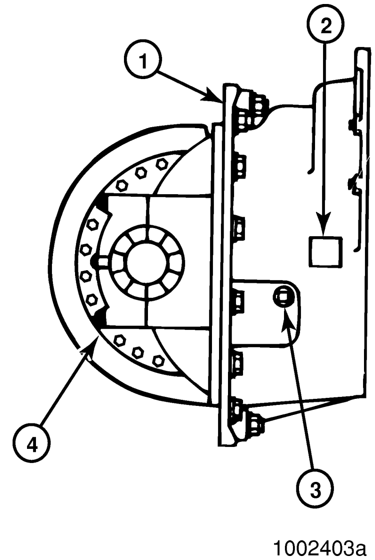
The drawing illustrated below shows the location of the identification tag (or stamp number) for the axles. Location is determined from the LEFT (driver) side looking toward front of vehicle.



A — Front engine drive —
Right rear, next to cover.
B — Rear engine drive —
Left or right rear, next to drive unit.

1003463a

Figure 1.3



1 DIFFERENTIAL CARRIER
2 IDENTIFICATION NUMBER
3 FILL PLUG
4 RING GEAR BACKSIDE

CARRIER IDENTIFICATION TAG

Figure 1.4

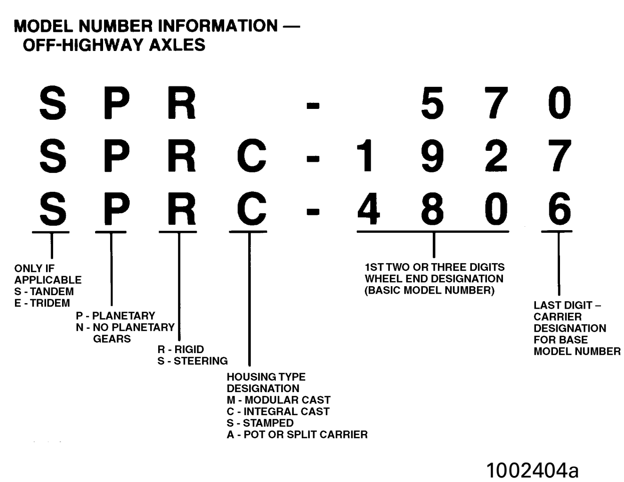
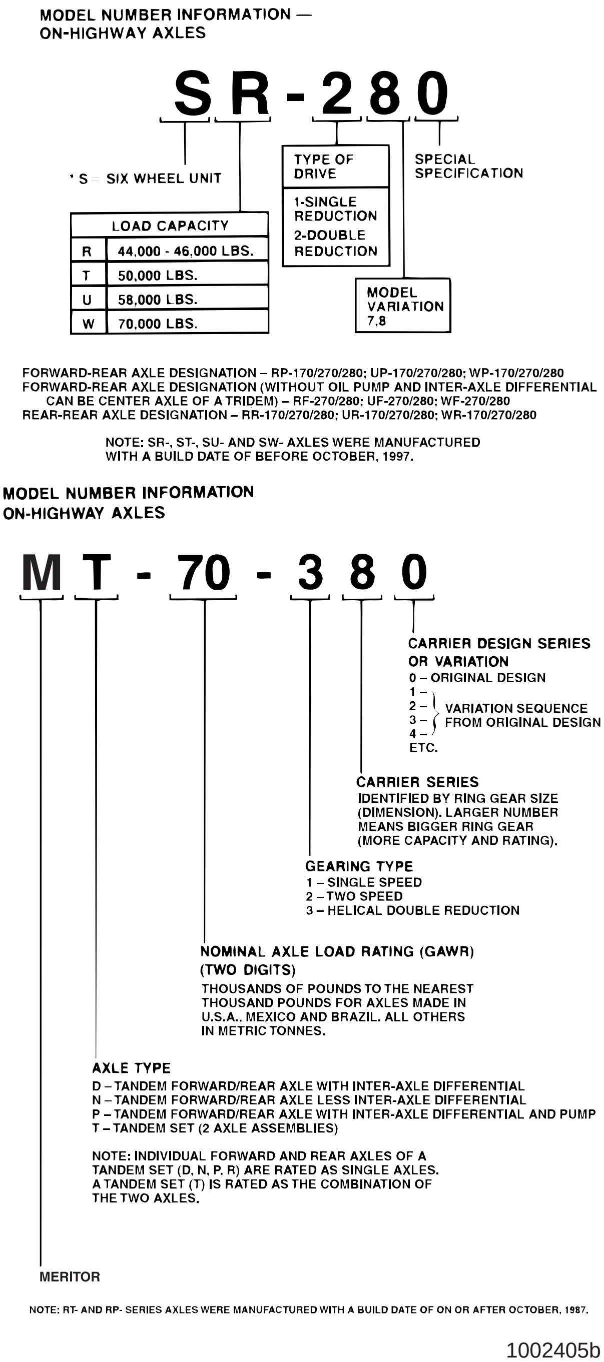


Figure 1.5


MODEL NUMBER INFORMATION —
ON-HIGHWAY AXLES
SR-280
* S = SIX WHEEL UNIT
LOAD CAPACITY
R 44,000 - 46,000 LBS.
T 50,000 LBS.
U 58,000 LBS.
W 70,000 LBS.
TYPE OF DRIVE
1-SINGLE REDUCTION
2-DOUBLE REDUCTION
MODEL VARIATION 7,8
SPECIAL SPECIFICATION
FORWARD-REAR AXLE DESIGNATION – RP-170/270/280; UP-170/270/280; WP-170/270/280
FORWARD-REAR AXLE DESIGNATION (WITHOUT OIL PUMP AND INTER-AXLE DIFFERENTIAL
CAN BE CENTER AXLE OF A TRIDEM) – RF-270/280; UF-270/280; WF-270/280
REAR-REAR AXLE DESIGNATION – RR-170/270/280; UR-170/270/280; WR-170/270/280
NOTE: SR-, ST-, SU- AND SW- AXLES WERE MANUFACTURED
WITH A BUILD DATE OF BEFORE OCTOBER, 1997.
MODEL NUMBER INFORMATION
ON-HIGHWAY AXLES
MT - 70 - 3 8 0
CARRIER DESIGN SERIES OR VARIATION
0 – ORIGINAL DESIGN
1 –
2 –
3 –
4 –
ETC.
VARIATION SEQUENCE FROM ORIGINAL DESIGN
CARRIER SERIES
IDENTIFIED BY RING GEAR SIZE (DIMENSION). LARGER NUMBER MEANS BIGGER RING GEAR (MORE CAPACITY AND RATING).
GEARING TYPE
1 – SINGLE SPEED
2 – TWO SPEED
3 – HELICAL DOUBLE REDUCTION
NOMINAL AXLE LOAD RATING (GAWR) (TWO DIGITS)
THOUSANDS OF POUNDS TO THE NEAREST THOUSAND POUNDS FOR AXLES MADE IN U.S.A., MEXICO AND BRAZIL. ALL OTHERS IN METRIC TONNES.
AXLE TYPE
D – TANDEM FORWARD/REAR AXLE WITH INTER-AXLE DIFFERENTIAL
N – TANDEM FORWARD/REAR AXLE LESS INTER-AXLE DIFFERENTIAL
P – TANDEM FORWARD/REAR AXLE WITH INTER-AXLE DIFFERENTIAL AND PUMP
T – TANDEM SET (2 AXLE ASSEMBLIES)
NOTE: INDIVIDUAL FORWARD AND REAR AXLES OF A TANDEM SET (D, N, P, R) ARE RATED AS SINGLE AXLES. A TANDEM SET (T) IS RATED AS THE COMBINATION OF THE TWO AXLES.
MERITOR
NOTE: RT- AND RP- SERIES AXLES WERE MANUFACTURED WITH A BUILD DATE OF ON OR AFTER OCTOBER, 1997.
1002405b

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Preparing the Axle Before Removing the Differential Carrier

1. Use a jack to raise the end of the vehicle where the axle is mounted.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

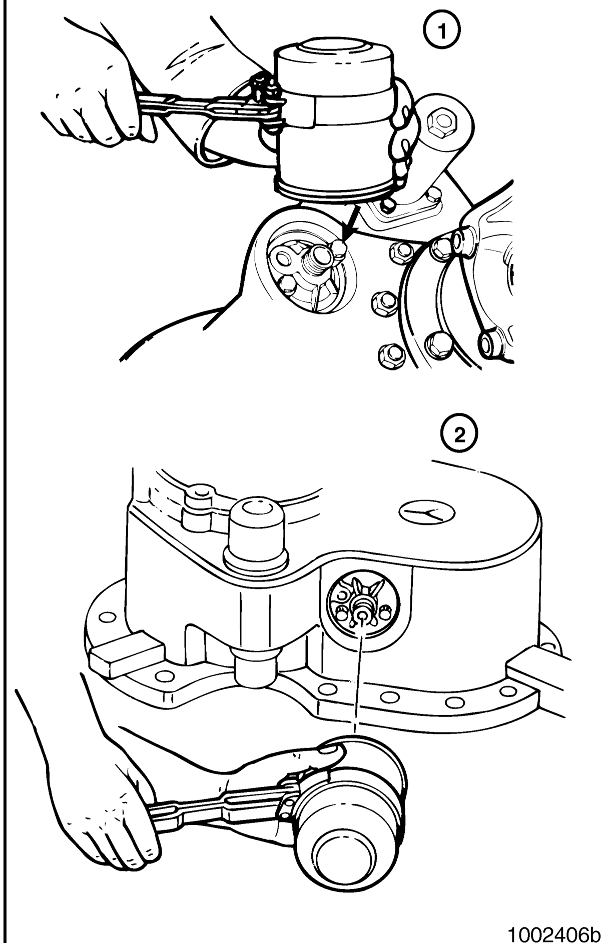
2. Place jack stands under each spring seat of the axle to hold the vehicle in the raised position.
3. Remove the plug from the bottom of the axle housing and drain the lubricant from the axle housing.

CAUTION

The filter contains approximately one pint of fluid. Make sure that you do not spill any fluid when the oil filter is removed.

4. On forward rear drive carriers, the oil filter can be removed at this time. Remove the bolts that hold the oil filter cover to the helical gear cover. Remove the oil filter cover. Use an oil filter wrench to remove the oil filter. Discard the oil filter. **Figure 2.1**.

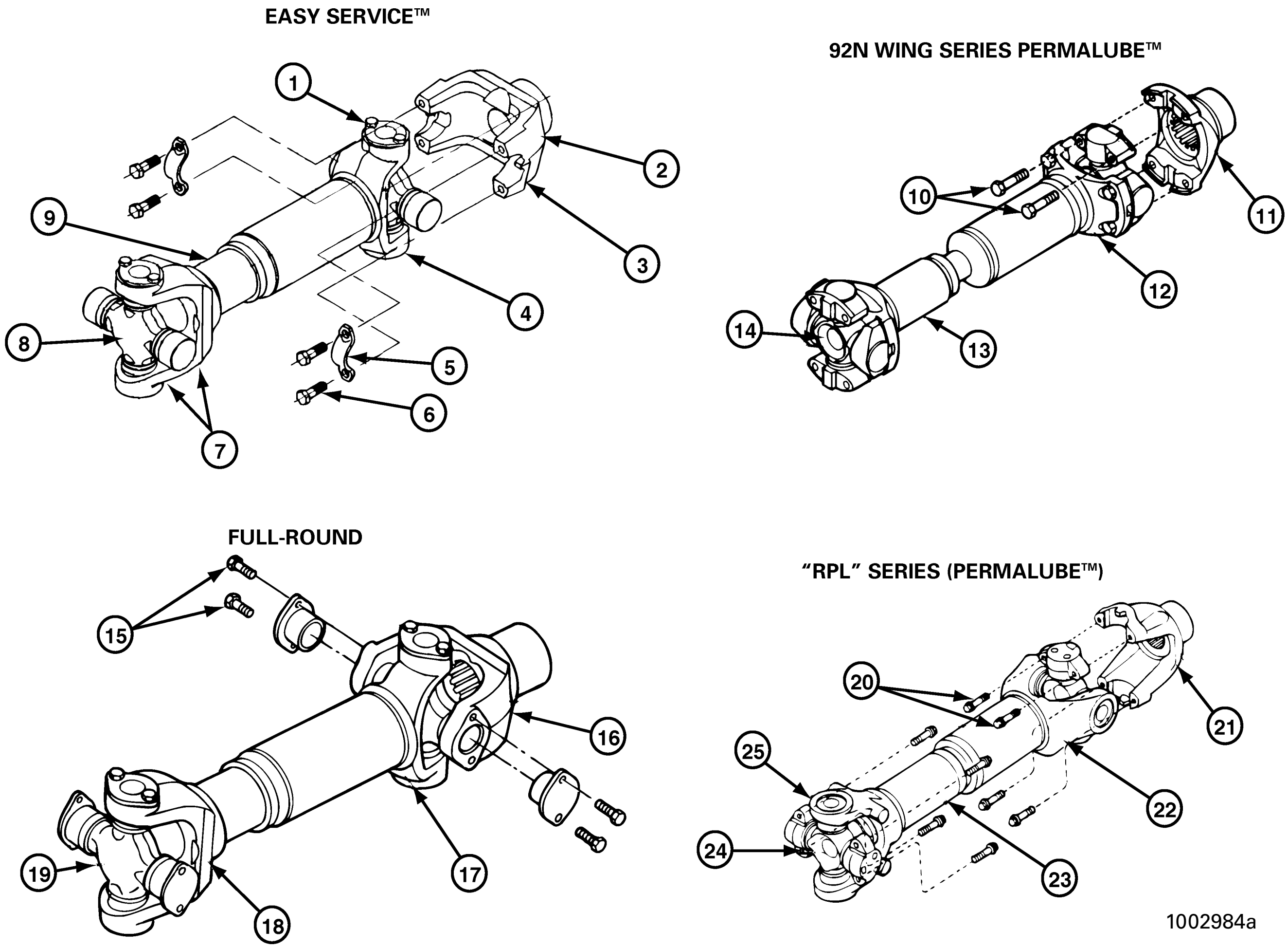
Figure 2.1



1 ORIGINAL DESIGN
2 NEW DESIGN

5. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier. **Figure 2.2**.
6. Remove the capscrews and washers or stud nuts and washers from the flanges of both axle shafts.
7. Loosen the tapered dowels in the flanges of both axle shafts according to one of the following procedures.

Figure 2.2



1 FULL ROUND BEARING CUPS
2 END YOKE
3 YOKE SADDLE
4 WELD YOKE
5 BEARING STRAP
6 CAPSCREWS
7 EASY-SERVICE BEARING CUPS
8 U-JOINT CROSS
9 SLIP YOKE
10 CAPSCREWS
11 END YOKE
12 WELD YOKE
13 SLIP YOKE
14 U-JOINT CROSS
15 CAPSCREWS
16 END YOKE
17 WELD YOKE
18 SLIP YOKE
19 U-JOINT CROSS
20 CAPSCREWS
21 END YOKE
22 SLIP YOKE
23 TUBING
24 U-JOINT CROSS
25 WELD YOKE

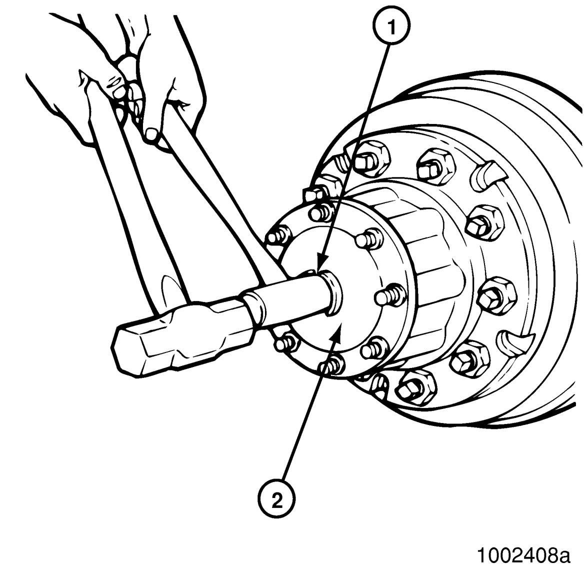
Brass Drift Method

WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

1. Hold a 1-1/2-inch diameter brass drift inside the round driving lugs and against the center of the axle shaft. **Figure 2.3**.

Figure 2.3



1 BRASS HAMMER INSIDE LUGS
2 ROUND OR "C"-SHAPED DRIVING LUGS

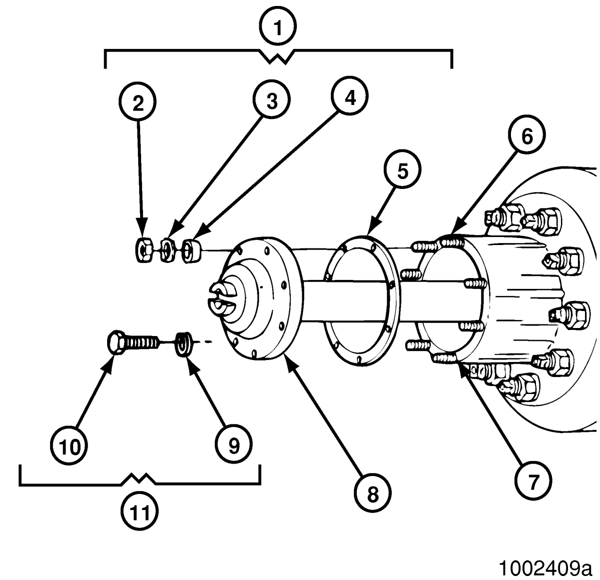
CAUTION

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/or the axle hub.

NOTE: A 1-1/2-inch diameter brass hammer can be used as a drift.

2. Strike the end of the brass drift with a large hammer (five to six pounds) to loosen the axle shaft and the tapered dowels (if applicable). **Figure 2.3**.
3. Remove the tapered dowels (if applicable) and both axle shafts from the axle assembly. **Figure 2.4**.

Figure 2.4



1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET
6 STUD
7 AXLE SHAFT HUB
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

Air Hammer Vibration Method

WARNING

Wear safe 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/or the axle hub.

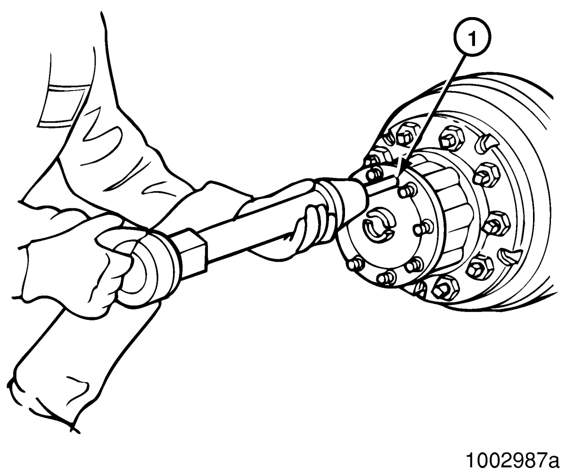
1. Use a round hammer bit and an air hammer such as Chicago Pneumatic CP-4181-Puller, or equivalent, to loosen tapered dowels and axle shaft.

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/or the axle hub.

2. Place the round hammer bit between the hub studs and against the axle shaft (flange). Operate the air hammer while pressing the round hammer bit at alternate locations between the studs to loosen the tapered dowels (if applicable) and axle shaft from the hub. **Figure 2.5**.

Figure 2.5



1 ROUND HAMMER BIT BETWEEN HUB STUDS

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

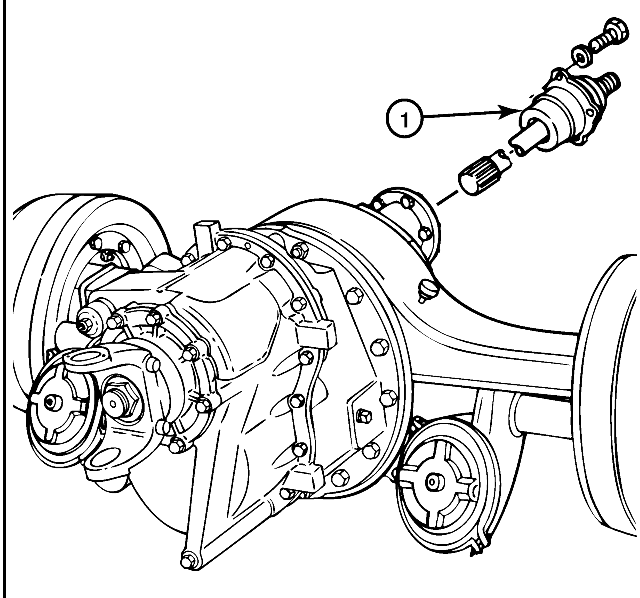
NOTE: Meritor recommends replacing the split tapered dowels with current design solid tapered dowels.

4. Remove the tapered dowels (if applicable) and separate the axle shaft from the main axle hub assembly. **Figure 2.4**.

Removing the Carrier from the Axle Housing

1. Disconnect the air line to the DCDL shift unit.
2. Remove the nut and washer that fasten the output yoke on the thru-shaft. Use a puller to remove the yoke from the thru-shaft. Remove the spacer from the thru-shaft.
3. Remove the capscrews and washers that fasten the output bearing cage to the axle housing. Pull the cage, thru-shaft and bearing assembly from the housing. If necessary, tap on the thru-shaft and cage with a plastic or leather mallet to separate the cage from the housing. Make sure the oil seal is not damaged when the thru-shaft is removed. **Figure 2.6**.
4. Remove and discard the gasket between the output bearing cage and the RTV axle housing.

Figure 2.6

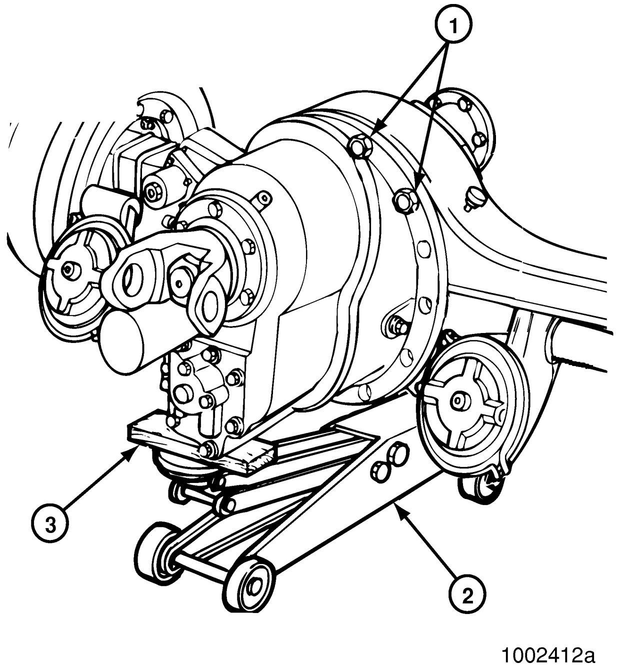


1 THRU-SHAFT AND BEARING CAGE ASSEMBLY

CURRENT DESIGN HELICAL GEAR COVER

5. Place a hydraulic rollerjack under the differential carrier to support the assembly. **Figure 2.7**.
6. Remove all of the carrier-to-housing fasteners except for the top two carrier-to-housing fasteners. **Figure 2.7**.

Figure 2.7



1 TWO FASTENERS REMAIN IN PLACE
2 HYDRAULIC ROLLER JACK
3 WOOD BLOCK

ORIGINAL DESIGN HELICAL GEAR COVER

7. Loosen the differential carrier in the axle housing. Use a leather or plastic mallet to hit the mounting flange of the carrier at several points.
8. After the carrier is loosened, remove the top two fasteners.

CAUTION

Do not damage the mating surfaces between the axle housing and the differential carrier flange. Damage to these surfaces can result in oil leaks.

9. 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.
10. Use a chain hoist and a lifting hook to lift the differential carrier by the input yoke. Place the carrier in a repair stand. Do not lift the carrier by hand.

Removing the Thru-Shaft, the Bearings and the Seal from the Output Cage

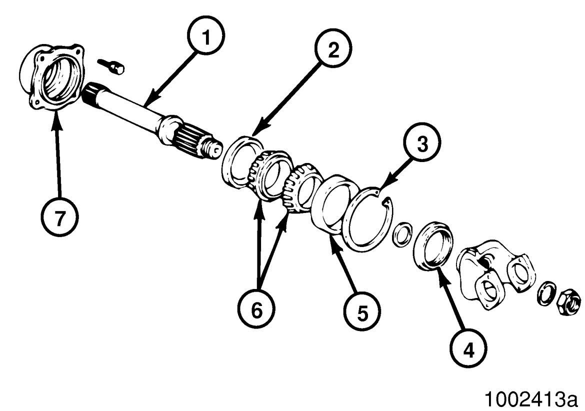
WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

NOTE: The diameter of the spacer used in the press, must be smaller than the outer diameter of the thru-shaft to prevent damage to the oil seal and the bearing.

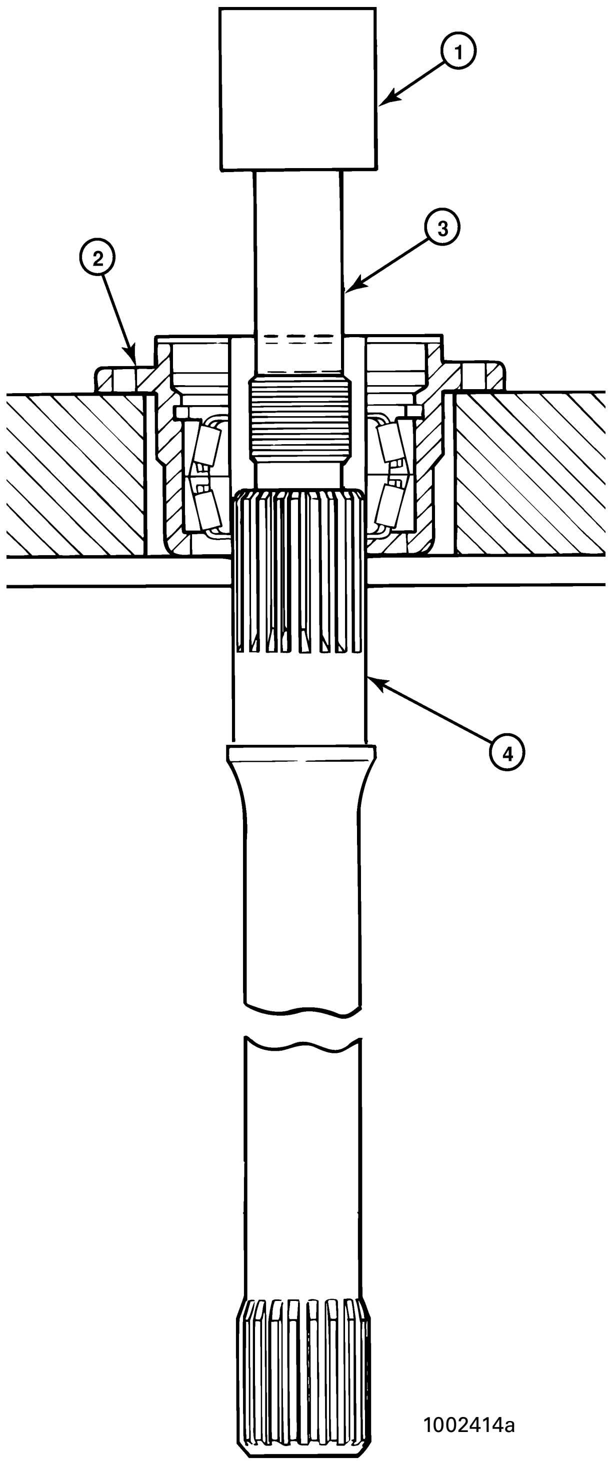
1. Use a press and a spacer to remove the thru-shaft from the bearing and cage assembly. Place a spacer on the threaded part of the thru-shaft. Press the thru-shaft from the cage and bearing assembly. **Figure 2.8** and **Figure 2.9**.

Figure 2.8



1 THRU-SHAFT
2 OUTPUT BEARING CAGE
3 SELECTIVE SNAP RING
4 OIL SEAL
5 INNER BEARING CUP
6 BEARING CONES
7 OUTER BEARING CUP

Figure 2.9



1 PRESS
2 BEARING CAGE
3 SPACER
4 THRU-SHAFT

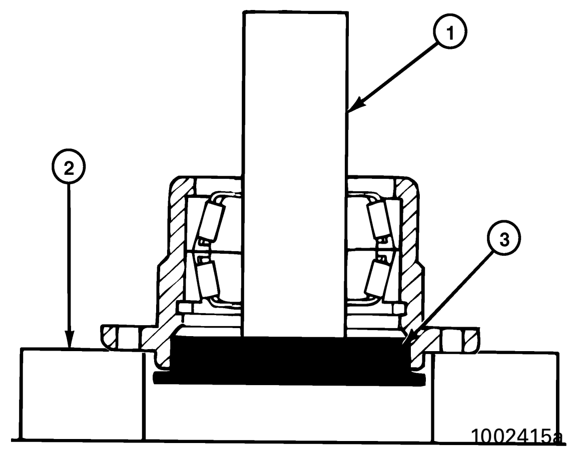
2. Use a press and a sleeve to remove the oil seal from the output bearing cage. Place the yoke side of the cage on the press. Place the sleeve on the oil seal and press the seal from the cage. **Figure 2.10**.

   Discard old seal. Always replace seals that have been removed with a triple-lip seal.

NOTE: Meritor recommends replacing all original seals with the current design unitized pinion (main) oil seal.

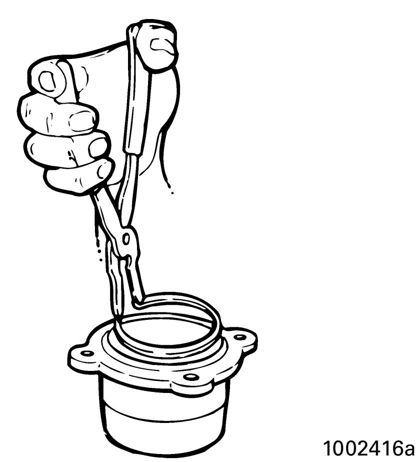
3. Remove the snap ring that holds the bearings in the cage. **Figure 2.11**.

Figure 2.10



1 PRESS
2 SUPPORT
3 OIL SEAL

Figure 2.11



NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

4. Remove the inner and outer bearing cones from the bearing cage.
5. Remove the bearing cups from the cage. The cups should remain in the cage.

Removing the Helical Gear Cover Assembly — Current Design Helical Cover

NOTE: Do not remove helical gears without marking before disassembly. Refer to "Disassembling the Inter-Axle Differential" in this section.

1. Use a chain hoist to lift the helical gear cover assembly by the input yoke. Place the cover assembly in a repair stand. To make a repair stand, refer to Section 9.
2. Move the cover assembly so that the inside of the cover is toward the floor.
3. Place a yoke holding tool on the input yoke. Loosen but **do not remove** the nut that holds the yoke on the input shaft. Remove the yoke holding tool.
4. Remove the capscrews and the washers that retain the helical gear cover to the carrier assembly.

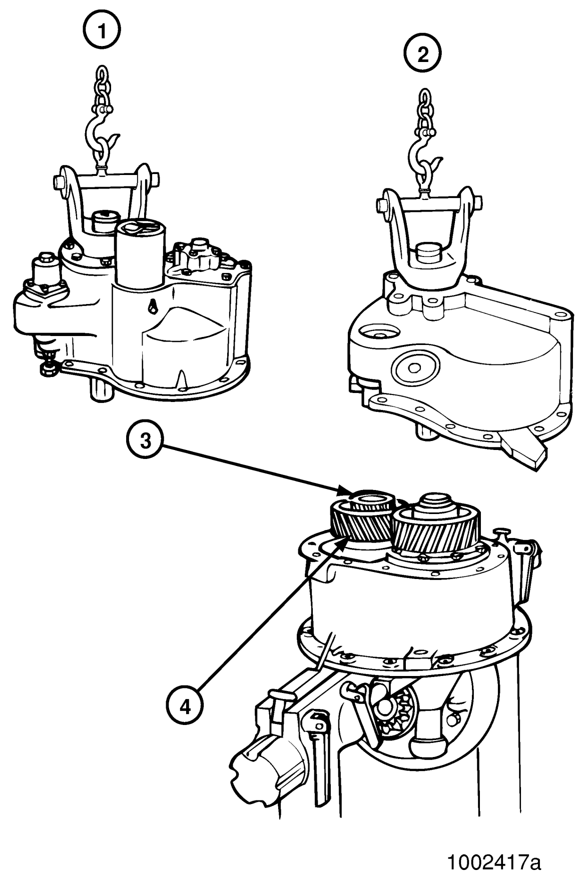
NOTE: The thrust washer, the helical drive gear, and the differential side gear are loosely installed in the differential carrier. Make sure the gears and the thrust washer do not fall from the carrier.

CAUTION

Do not use pry bars, chisels or wedges to separate the helical cover from the carrier. Using these tools can cause damage to the mating surfaces between the helical gear cover and the differential carrier and result in oil leakage.

5. Attach a chain hoist to the input yoke. Lift the helical gear cover from the differential carrier. Tap with a plastic or leather mallet to help separate the cover from the carrier. **Figure 2.12**.
6. Remove all gasket material from the cover-to-carrier surfaces. Do not score or gouge.

Figure 2.12



1 ORIGINAL DESIGN HELICAL COVER
2 CURRENT DESIGN HELICAL COVER
3 THRUST WASHER
4 HELICAL DRIVE GEAR

CAUTION

Do not remove the helical gears without marking their positions. Refer to "Disassembling the Inter-Axle Differential" in this section.

Removing the Oil Filter and the Adapter — Original Design Helical Cover

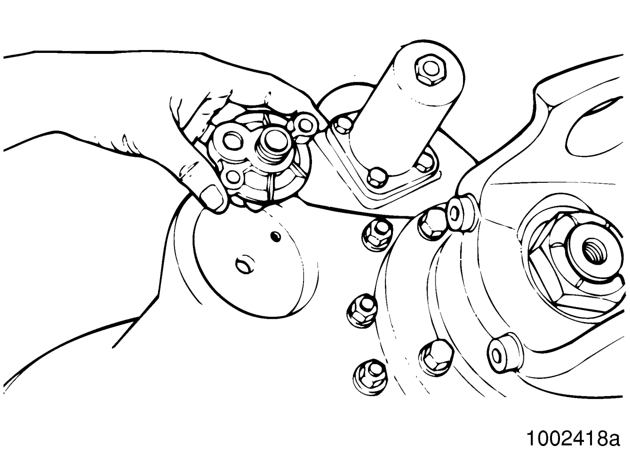
1. Remove the two capscrews that fasten the oil filter cover to the helical gear cover. Remove the cover.

CAUTION

The filter contains approximately one pint of fluid. Make sure that you do not spill any fluid when the oil filter is removed.

2. Use a filter wrench to remove the oil filter. Discard the oil filter.
3. Remove the capscrews and washers that fasten the adapter to the helical gear cover. Remove the oil filter adapter. **Figure 2.13**.
4. Inspect the oil filter adapter threads and the adapter casting. Replace with a new adapter if the threads or the casting are damaged.

Figure 2.13



Removing the Oil Filter — Current Design Helical Cover

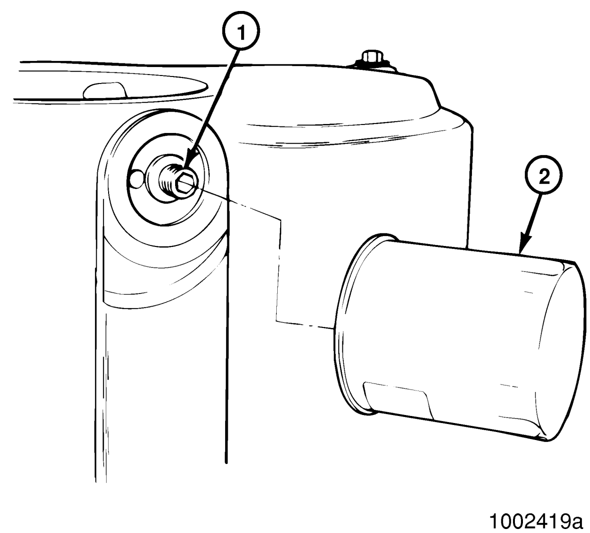
1. Remove the two capscrews that fasten the oil filter guard to the helical cover. Remove the guard.

CAUTION

The filter contains approximately one pint of fluid. Make sure that you do not spill any fluid when the oil filter is removed.

2. Use a filter wrench to remove the oil filter. Discard the oil filter.
3. Inspect the oil filter adapter threads. If the adapter threads are damaged, remove and replace with a new adapter. **Figure 2.14**.

Figure 2.14



1 OIL FILTER ADAPTER
2 OIL FILTER

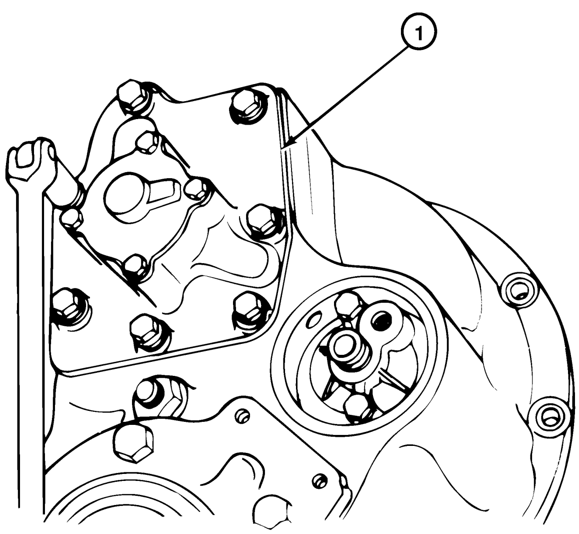
Removing the Oil Pump — Original Design Helical Cover

CAUTION

Do not use a pry bar when pulling the oil pump from the helical cover. The pump must be removed carefully in a straight direction. If the pump is forcefully removed in a direction that is not straight, the pump driveshaft and gears will be damaged.

1. Remove the capscrews and washers that fasten the oil pump to the helical gear cover. Pull the oil pump in a straight line from the helical gear cover. If necessary, tap the pump with a leather or plastic mallet to loosen the pump from the cover. Do not use a pry bar to loosen the pump from the gear cover. **Figure 2.15**.
2. Remove and discard the gasket or the gasket material. Remove all gasket material from the mounting surfaces between the oil pump and the helical gear cover. Make sure the mounting surface and all oil pump passages are clean and free of obstructions.

Figure 2.15



1 OIL PUMP

Disassembling the Oil Pump — Original Design Helical Cover

Two different design oil pumps exist.

- Oil Pump with a Gear Pumping System. **Figure 2.16**.
- Oil Pump with a Rotor Pumping System. **Figure 2.17**.

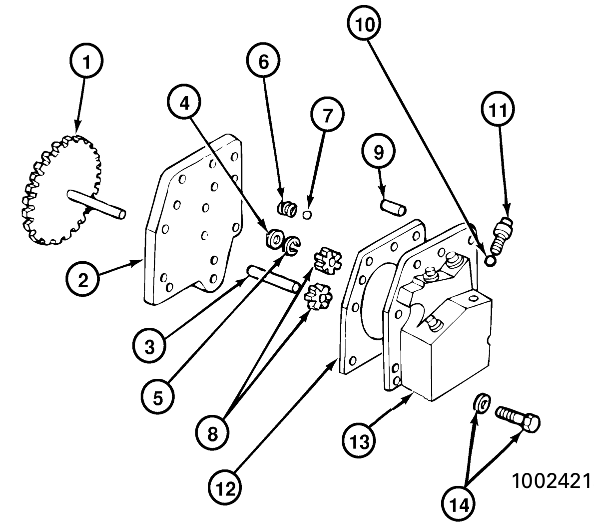
Gear Pump System Disassembly

1. The pump cover is fastened to the pump plate by two dowels. Tap on the cover with a leather or plastic hammer to separate the plate from the cover. Remove and discard the gasket. Remove the spring and the check ball for the pressure relief valve from the cover. **Figure 2.16**.

NOTE: Place the cover on a flat surface so that the ball and spring for the pressure relief valve do not fall from the cover.

2. Remove the two pump gears from the plate.

Figure 2.16



1 PUMP DRIVEN GEAR AND GEAR SHAFT
2 PUMP PLATE
3 PUMP GEAR SHAFT
4 WASHER
5 SNAP RING
6 SPRING
7 BALL
8 PUMP GEARS
9 DOWEL
10 BALL (4) 2 SMALL — 2 LARGE
11 PLUG (4) 2 SMALL — 2 LARGE ASSEMBLY
12 GASKET
13 PUMP COVER
14 ATTACHING CAPSCREWS AND WASHERS (7)

CAUTION

The pipe plugs have depth pins that hold the check valve balls at the correct position in the oil passages. Do not bend or damage the pins.

3. Remove the two large and two small pipe plugs from the cover. Use a magnet to remove the two large and the two small check-valve balls from the pipe plug bores.
4. Remove the snap ring and washer from the driven gear shaft. Remove the shaft and driven gear from the pump plate.
5. Inspect the shaft and pump driven-gear assembly. Replace the shaft and gear as a complete assembly if the gear teeth are worn or damaged.

Rotor Pump System Disassembly

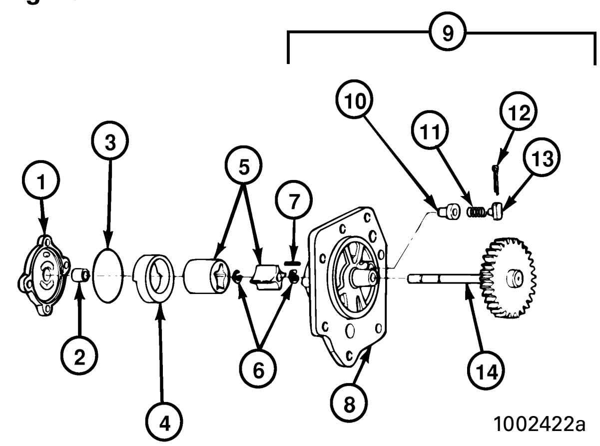
1. Remove the capscrews that hold the cap on the pump body. Remove the cap. Remove the O-ring seal from the cap. **Figure 2.17**.
2. Remove the retaining ring that holds the inner rotor on the shaft.
3. Remove the inner rotor, outer rotor and reversing ring from the oil pump body. Remove the inner rotor key from the shaft.
4. Remove the retaining ring that holds the gear and shaft assembly in the pump body. Remove the shaft and gear assembly.
5. Inspect the driven gear and shaft of the pump. Replace the shaft and gear as a complete assembly if the gear teeth are worn or damaged.
6. Use a punch to press down on the pressure relief valve cap. Remove the cotter pin. Slowly release pressure on the cap until the spring extends to its full length. Remove the cap and spring.
7. Use a magnet to remove the poppet from the relief valve bore.

Removing the Input Shaft, the Forward Bearing and the Clutch Collar — Original Design Helical Cover

NOTE: The input yoke must be removed before the inter-axle differential is disassembled.

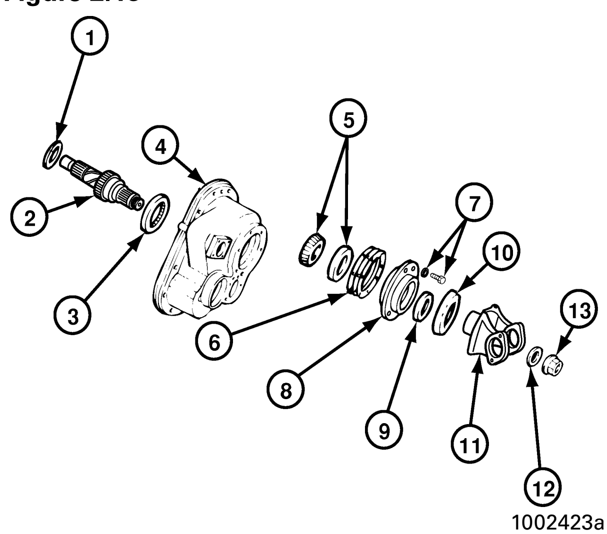
1. Place a holding tool on the yoke.
2. Remove the yoke to input shaft nut. **Figure 2.18**.

Figure 2.17



1 CAP
2 BUSHING
3 O-RING
4 REVERSING RING
5 2-PIECE ROTOR SET
6 SNAP RINGS
7 KEY
8 PUMP BODY
9 RELIEF VALVE ASSEMBLY
10 POPPET
11 SPRING
12 COTTER PIN
13 CAP
14 GEAR AND SHAFT ASSEMBLY

Figure 2.18



1 THRUST WASHER
2 INPUT SHAFT
3 CLUTCH COLLAR
4 HELICAL GEAR COVER
5 INPUT FRONT BEARING CUP AND CONE
6 SHIMS
7 CAPSCREW AND WASHER
8 BEARING CAGE
9 OIL SEAL
10 SLINGER
11 YOKE
12 WASHER
13 NUT

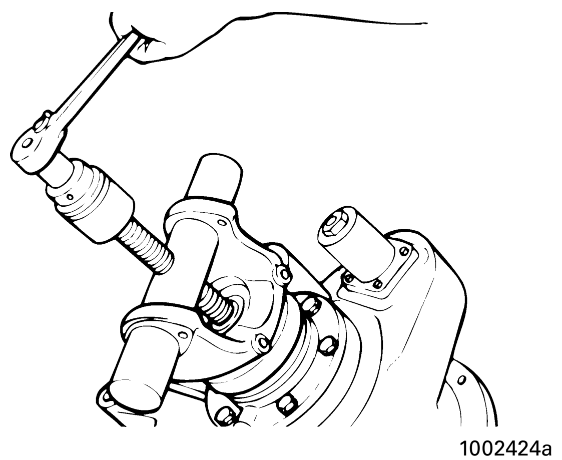
CAUTION

Do not tap the yoke with a hammer to loosen from the input shaft. Tapping with a hammer:

- ***May damage the yoke and the splines.***
- ***May cause the runout of the yoke to exceed specifications.***
- ***May result in yoke-to-shaft imbalance or misalignment.***

3. Using a puller tool, remove the yoke from the input shaft. **Figure 2.19**.

Figure 2.19



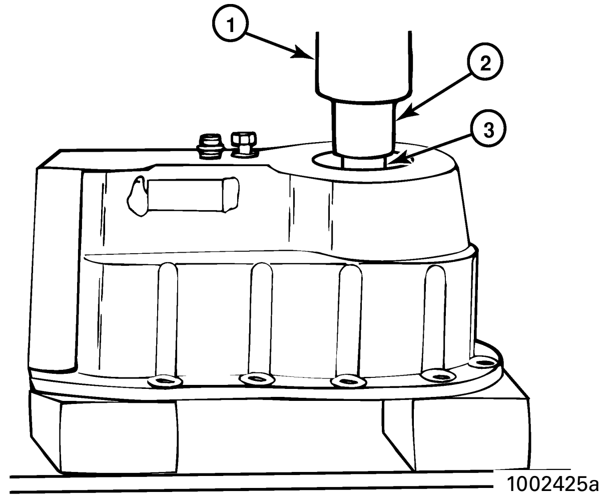
NOTE: The clutch collar will drop from the shift fork and shaft as the input shaft is removed from the assembly. The input bearing will be loose inside the cover.

4. Remove the capscrews and washers from the bearing cage to the helical gear cover. Remove the bearing cage, the bearing and the shim pack. The bearing cup should remain inside the cage.

NOTE: Keep all shims from the shim pack together. Replace any damaged shims with shims of the same size.

5. Use a press and a sleeve to remove the input shaft from the helical gear cover. Place the sleeve on top of the shaft and press the shaft from the bore in the cover. Do not damage the threads on the input shaft. **Figure 2.20**.

Figure 2.20



1 PRESS
2 SLEEVE
3 INPUT SHAFT

WARNING

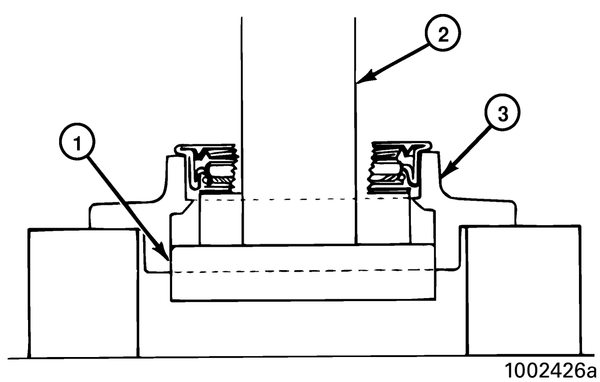
Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

6. Use a press and a sleeve to remove the bearing cup from the cage. **Figure 2.21**.

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

7. Remove the bearing cage oil seal from the carrier using the following procedures:

Figure 2.21



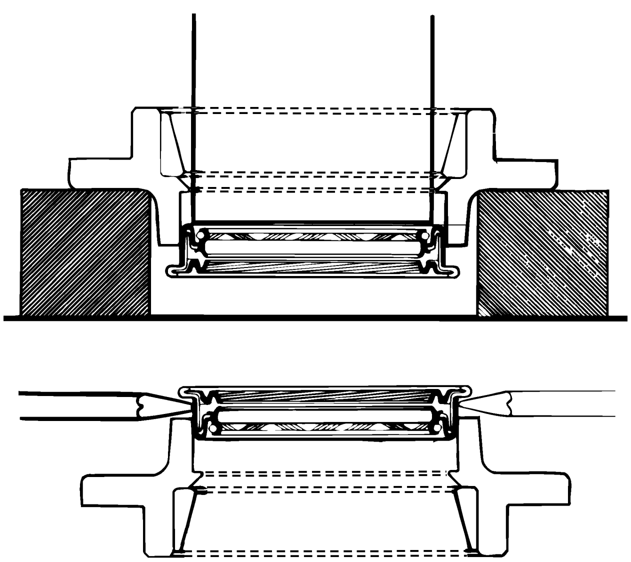
1 CUP
2 PRESS
3 BEARING CAGE

Triple-Lip and Unitized Pinion (Main) Oil Seal

NOTE: Meritor recommends replacing all original seals with the current design unitized pinion (main) oil seal.

A. Use a press and a sleeve to remove the triple-lip (main) 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. **Figure 2.22**.

Figure 2.22



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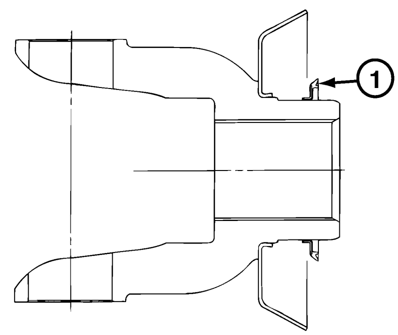
Triple-Lip Plus POSE™ Seal

1. Following yoke removal, separate the POSE™ seal from the yoke hub by pulling it off by hand. **Figure 2.23**.
2. Use a press and a sleeve to remove the triple-lip (main) oil seal in the same manner as described earlier.

Figure 2.23



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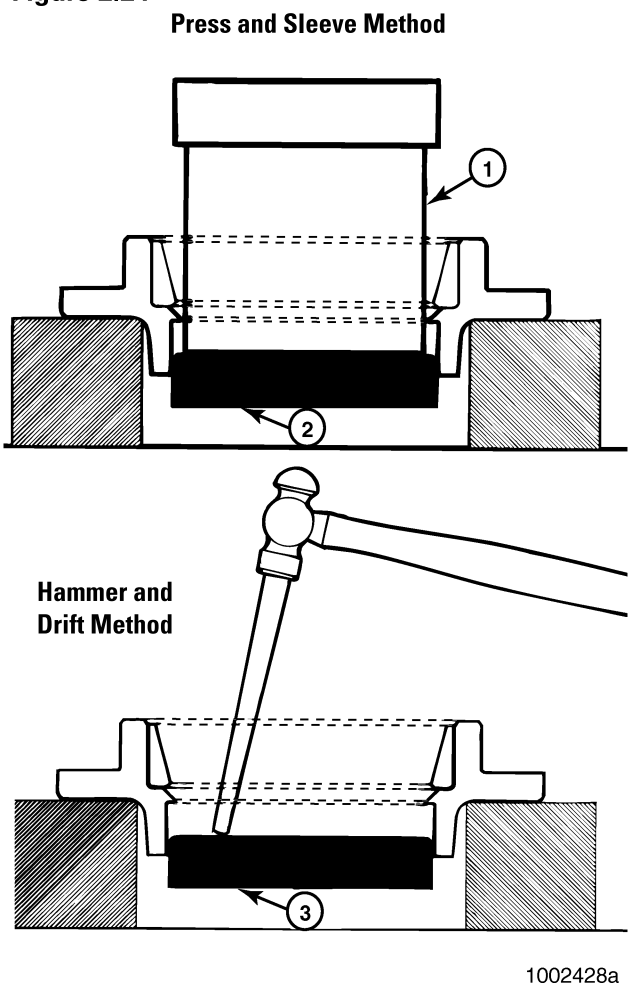
1 POSE™ SEAL

One-Piece (Single Lip) Oil Seal

A. Use a press and a sleeve, or a drift and a hammer to remove the one-piece seal from the bearing cage. **Figure 2.24**.

NOTE: Meritor recommends replacing all original seals with the current design unitized pinion (main) oil seal.

Figure 2.24



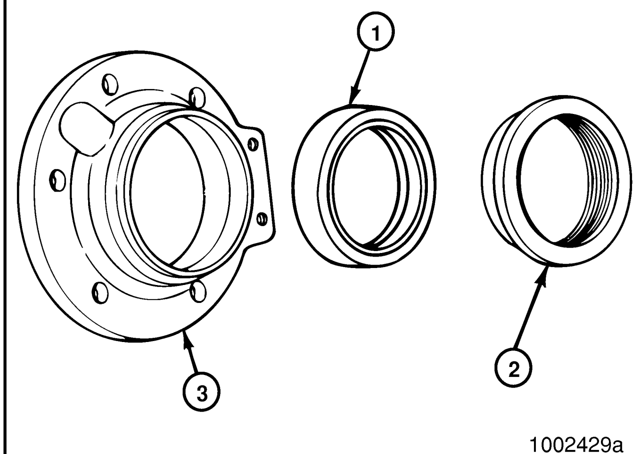
1 SLEEVE
2 OIL SEAL
3 OIL SEAL

Cast-Iron Outer Protector and One-Piece (Labyrinth-Type) Inner Oil Seal

A. Pull the cast-iron outer protector from the bearing cage. **Figure 2.25**.

B. Use a press and a sleeve to remove the inner seal from the cage.

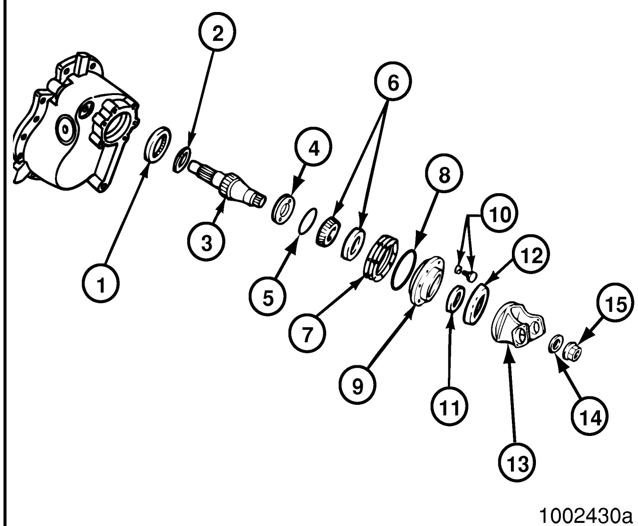
Figure 2.25



1 ONE-PIECE INNER OIL SEAL
2 CAST-IRON OUTER PROTECTOR
3 INPUT BEARING CAGE

Removing the Input Shaft and Clutch Collar — Current Design Gear Pumps

Figure 2.26



1 CLUTCH COLLAR
2 THRUST WASHER
3 INPUT SHAFT
4 OIL PUMP
5 O-RING
6 FORWARD INPUT SHAFT BEARING CUP & CONE
7 SHIMS
8 O-RING
9 BEARING CAGE
10 CAPSCREW & WASHER
11 OIL SEAL
12 SLINGER
13 YOKE
14 WASHER
15 NUT

NOTE: The clutch collar drops from the shift fork and shaft as the input shaft is removed from the helical gear cover.

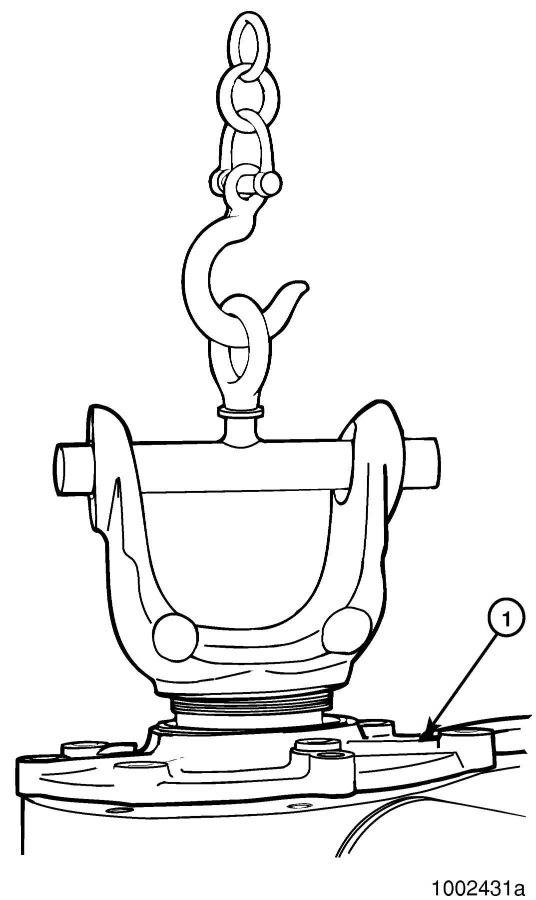
1. Remove the capscrews and the washers that fasten the bearing cage to the helical gear cover.

CAUTION

Do not use pry bars, chisels or wedges to separate the bearing cage from the helical gear cover. This causes damage to the surfaces between the helical gear cover and the bearing cage.

2. Attach a chain hoist to the input yoke. Lift the yoke, removing the bearing cage from the helical gear cover. Tap with a plastic or leather mallet to help separate the bearing cage from the cover. **Figure 2.27**.

Figure 2.27

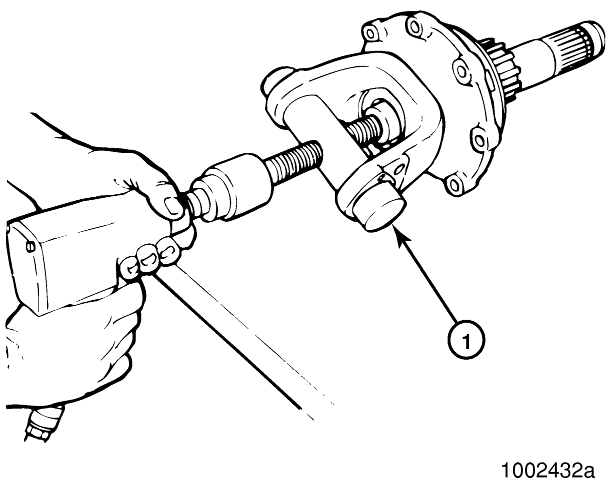


1 INPUT BEARING CAGE

Disassembling the Input Shaft, the Bearing Cage and the Oil Pump — Current Design

1. Use the correct tool to remove the yoke or flange from the input shaft. **Figure 2.28.**

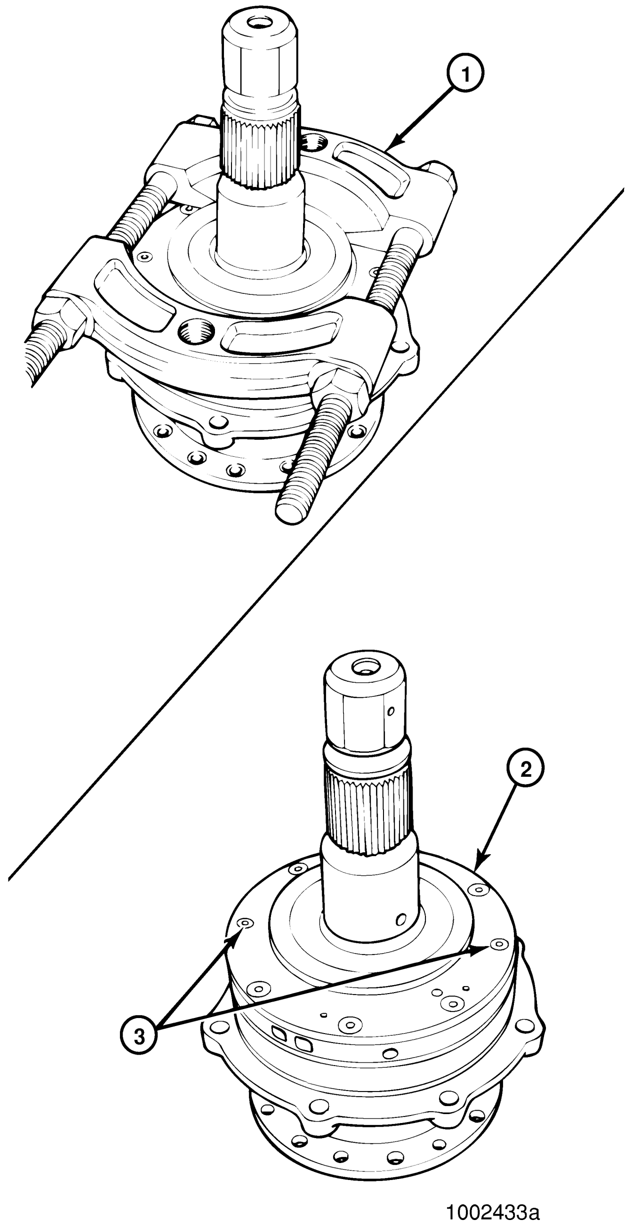
Figure 2.28



1 YOKE PULLER

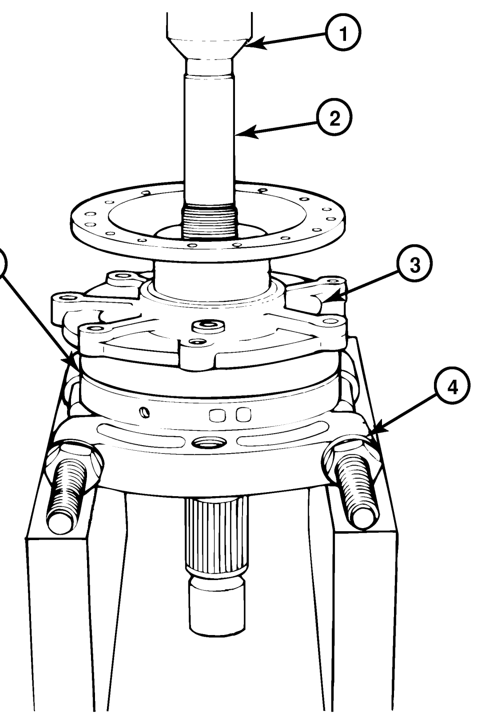
2. Install bearing puller onto input shaft. Make sure that oil pump rivets do not touch or contact the bearing puller. **Figure 2.29.**
3. Place the assembly on a press so that the assembly rests on the puller. **Figure 2.30.**
4. Place a protector on top of the threaded part of the shaft. Press the input shaft from the assembly. Remove the bearing puller. **Figure 2.31.**
5. Remove the capscrews that fasten the oil pump to the input bearing cage. Separate the oil pump from the cage. **Figure 2.31.**

Figure 2.29



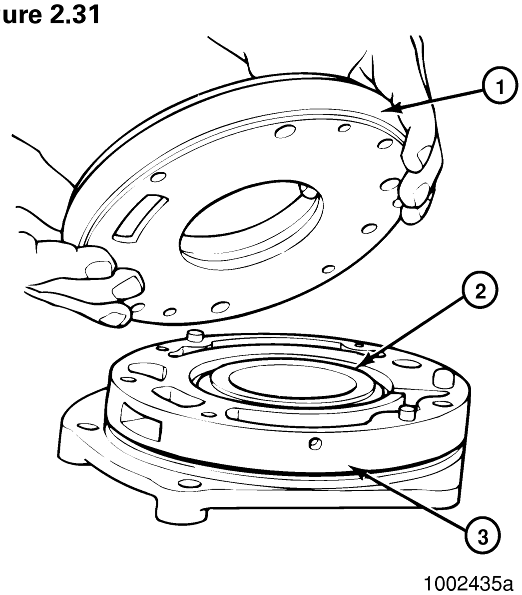
1 BEARING PULLER
2 OIL PUMP — SERVICED AS NEW ASSEMBLY ONLY
3 RIVETS MUST NOT TOUCH BEARING PULLER

Figure 2.30



1	PRESS	4	BEARING PULLER
2	PROTECTOR	5	OIL PUMP
3	BEARING CAGE		

Figure 2.31



1 OIL PUMP
2 BEARING CONE
3 BEARING CAGE

6. Replace the pump if the pump is worn or damaged. If the splines in the pump do not move, replace the entire pump assembly. This current design oil pump cannot be serviced.

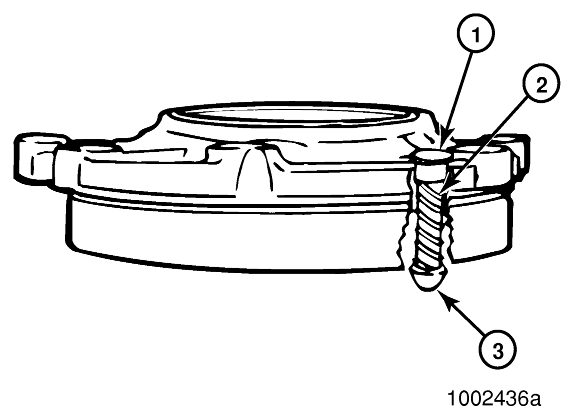
   Remove the O-rings from the bearing cage and the oil pump assembly.

   Remove the cone from the input bearing cage.

NOTE: If either the bearing cup or cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

7. If necessary, use a press and a sleeve to remove the cup from the input bearing cage.
8. If necessary, remove the pressure-relief valve assembly from the front of the bearing cage. Remove the plug, the spring and the relief valve from the bore. **Figure 2.32**.

Figure 2.32



1 PLUG
2 SPRING
3 RELIEF VALVE

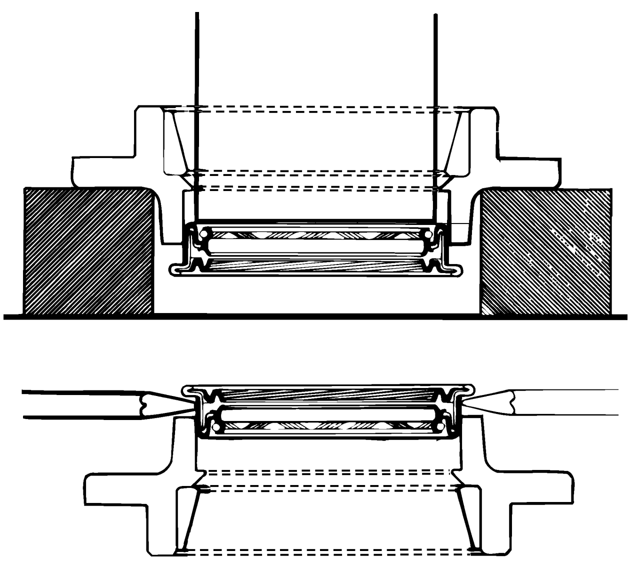
Triple-Lip and Unitized Pinion (Main) Oil Seal

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

Use a press and a sleeve to remove the triple-lip (main) 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. **Figure 2.33**.

Figure 2.33



Removing the Shift Unit, the Shift Fork and the Shift Shaft

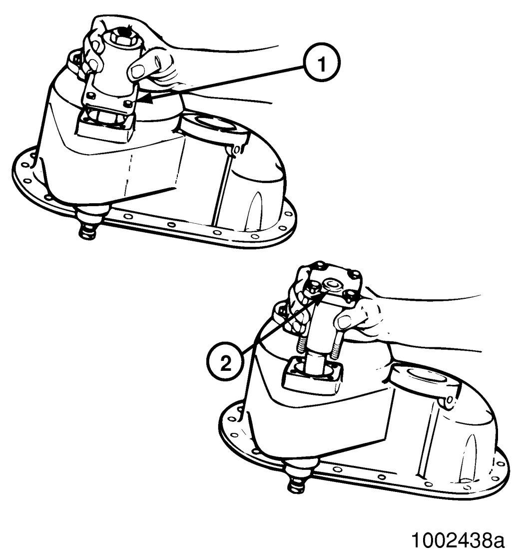
NOTE: If any parts of the shift unit are damaged, replace the shift unit as a complete assembly.

NOTE: Two types of shift are used:

- Shift Units with Long Capscrews and Tab Retainers
- Shift Units with Allen-Head Capscrews

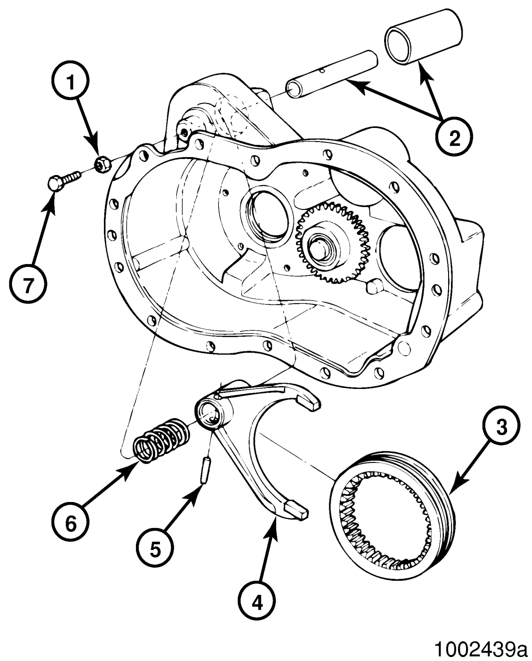
1. On units that have long capscrews with tab retainers, use a tool with a flat blade to bend back the retainer tabs. Each capscrew has a three-tab retainer. One tab of the retainer is bent against the head of the capscrew. The other two tabs are bent against the top of the shift unit. Remove the long capscrews.
2. On units that have Allen-head capscrews, remove the four capscrews.
3. Remove the shift unit from the helical gear cover. **Figure 2.34**.
4. From inside the helical gear cover, remove the roll pin that fastens the shift fork to the shift shaft. Use a small diameter drift and a hammer to tap the pin from the fork and the shaft.
5. Pull the shift shaft out from the shift unit bore. The fork and the spring fall when the shaft is removed. Remove the fork and spring. **Figure 2.35**.
6. Remove the jam nut and the adjusting screw for the shift shaft on the helical gear cover. **Figure 2.35**.

Figure 2.34



1 ALLEN-HEAD CAPSCREW SHIFT UNIT
2 LONG CAPSCREW AND TAB RETAINER SHIFT UNIT

Figure 2.35



1 JAM NUT
2 PUSH ROD
3 COLLAR
4 SHIFT FORK
5 ROLL PIN
6 SPRING
7 ADJUSTING SCREW

Removing the Idler Gear of the Rotor Oil Pump from the Original Design Helical Gear Cover

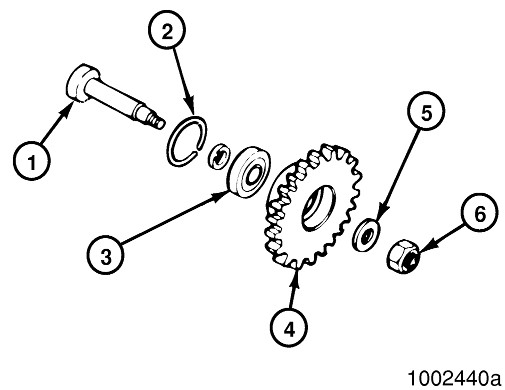
NOTE: Remove the shift unit before you remove the idler gear of the oil pump.

- Ball Bearing. **Figure 2.36**.
- Cone and Roller Bearing with Idler Sleeve. **Figure 2.37**.
- Cone and Roller Bearing with Solid Idler Shaft. **Figure 2.38**.

Oil Pump Idler Gear — Ball Bearing

1. Remove the nut and the washer from the idler gear shaft on the outside of the helical gear cover. **Figure 2.36**.

Figure 2.36



1 IDLER GEAR SHAFT
2 SNAP RING
3 BEARING
4 PUMP IDLER GEAR
5 WASHER
6 LOCK NUT

2. Tap on the idler gear shaft with a brass drift and hammer to remove the shaft and gear assembly from the cover.
3. Remove the spacer from the idler gear shaft.
4. Remove the snap ring that holds the bearing in the idler gear bore. Remove the shaft and bearing assembly from the gear.
5. Support the bearing on the inner race. Use a press or tap with a brass drift and hammer on the shaft to separate the shaft from the bearing.

Oil Pump Idler Gear — Cone and Roller Bearing with Idler Sleeve

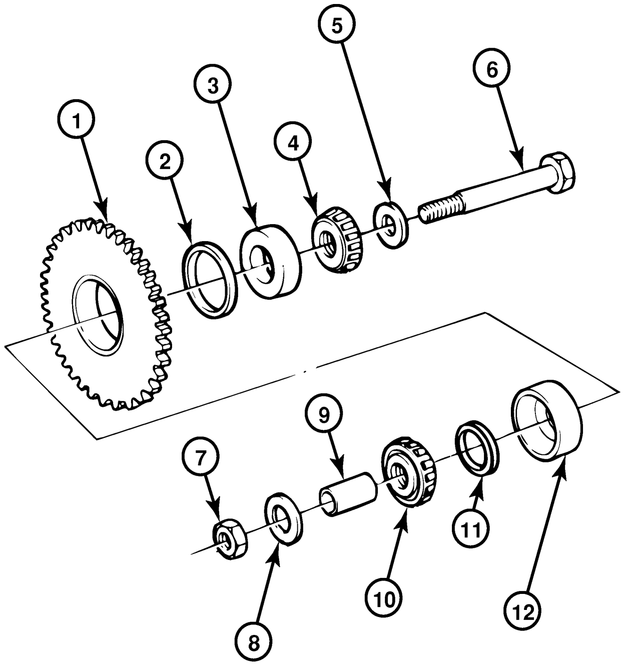
1. Remove the nut and the washer from the idler gear bolt on the outside of the helical gear cover. Remove the bolt. **Figure 2.37**.
2. Remove the idler gear and sleeve assembly from the inside of the helical gear cover.
3. Remove the cone and roller bearings and the spacer from the idler gear.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

4. Use a press and a sleeve to remove the idler sleeve from the helical gear cover.
5. Use a press and a sleeve to remove both bearing cones and the spacer from the gear.

Figure 2.37

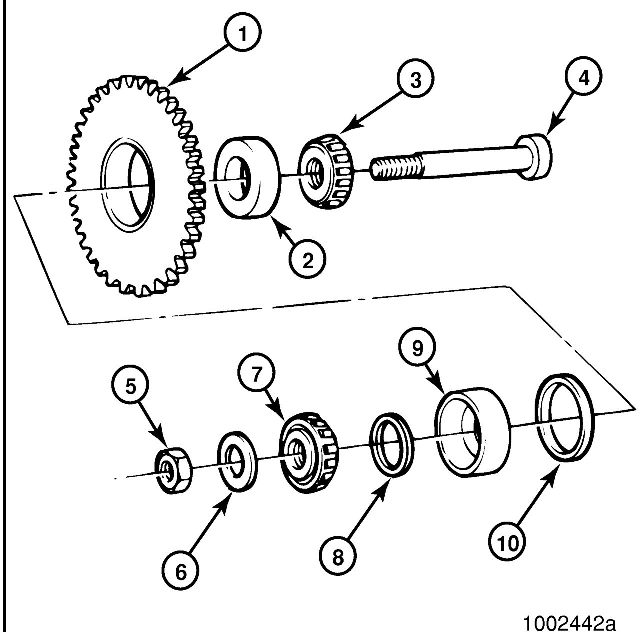


1	PUMP IDLER GEAR	8	WASHER
2	CUP SPACER	9	SLEEVE
3	BEARING CUP	10	BEARING CONE
4	BEARING CONE	11	CONE SPACER
5	WASHER	12	BEARING CUP
6	IDLER SHAFT		
7	NUT		

Oil Pump Idler Gear — Cone and Roller Bearing with Solid Idler Shaft

1. Remove the nut and washer from the idler gear shaft on the outside of the helical gear cover. Remove the idler gear shaft. **Figure 2.38**.
2. Remove the idler gear and sleeve assembly from the inside of the helical gear cover.
3. Remove the cone and roller bearings and the spacer from the idler gear.
4. Use a press and a sleeve to remove both bearing cones and the spacer from the gear.

Figure 2.38

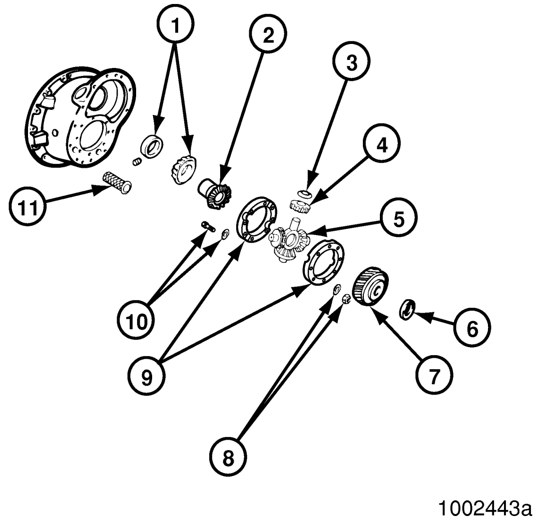


1	PUMP IDLER GEAR
2	BEARING CUP
3	BEARING CONE
4	IDLER GEAR SHAFT
5	NUT
6	WASHER
7	BEARING CONE
8	SPACER–BEARING CONES
9	BEARING CUP
10	SPACER–BEARING CUPS

Disassembling the Inter-Axle Differential

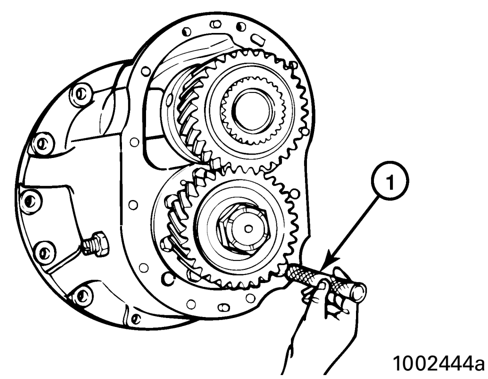
1. Remove the oil filter screen from the carrier housing. The screen is in the lower left of the housing next to the helical driven gear. **Figure 2.39**.
2. Separate the screen from the seat. Inspect the screen for damage. If damaged, replace the screen. If the screen is in good condition, clean the screen. **Figure 2.40**.

Figure 2.39



1 INPUT REAR BEARING CUP AND CONE
2 DIFFERENTIAL SIDE GEAR
3 DIFFERENTIAL PINION THRUST WASHER
4 DIFFERENTIAL PINION
5 DIFFERENTIAL SPIDER
6 THRUST WASHER
7 HELICAL DRIVE GEAR AND DIFFERENTIAL SIDE GEAR ASSEMBLY
8 WASHER AND NUT
9 DIFFERENTIAL CASE HALF
10 CAPSCREW AND WASHER
11 OIL FILTER SCREEN

Figure 2.40



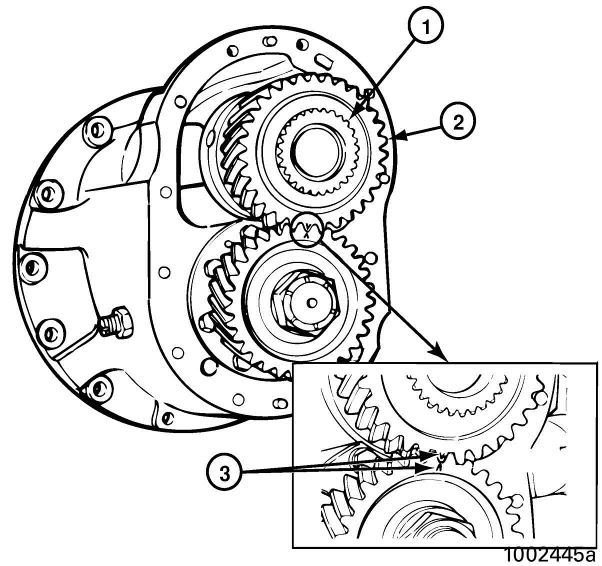
1 OIL FILTER SCREEN

WARNING

Do not use a punch and hammer or attempt to strike and mark the helical driven gears. Striking hardened steel gears with a hammer and punch can damage the gear and result in personal injury. Grind the marks on the gear or use a file to mark the gears.

3. Before removing the helical drive and the driven gears, rotate them until the alignment marks are opposite each other as shown. **Figure 2.41**.

Figure 2.41



1 FORWARD SIDE GEAR
2 HELICAL DRIVE GEAR
3 MARKS

CAUTION

Do not apply pressure to the teeth of the side gear. Pressing on the teeth will damage the side gear.

NOTE: Aligning the helical gear marks opposite one another before removal from carrier will facilitate the carrier reassembly operation.

4. Remove the forward side gear and the helical drive gear assembly and the thrust washer from the top of the differential case.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

5. On some single-reduction carriers only, remove the side gear from the helical drive gear. Use a press and a sleeve to separate the side gear from the drive gear. The outer diameter of the sleeve must fit the front hub of the side gear. **Figure 2.42**.

   When the gear is removed from the drive gear, the Woodruff key falls from the slot in the side gear. **Figure 2.43**.

6. Remove the inter-axle differential case from the carrier housing. **Figure 2.44**.

Figure 2.42

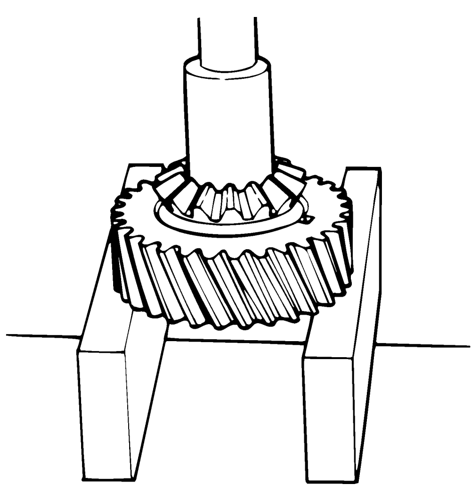


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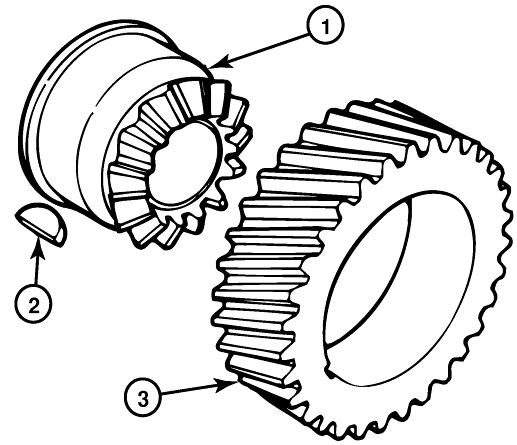
Figure 2.43



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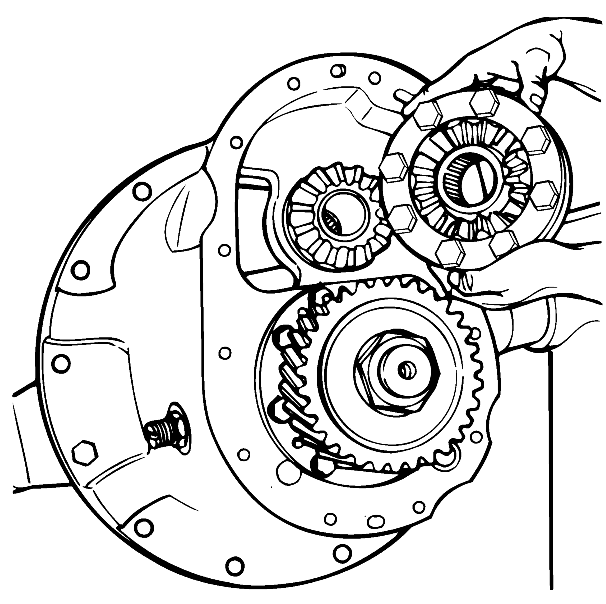
1 INTER-AXLE DIFFERENTIAL FORWARD SIDE GEAR
2 WOODRUFF KEY
3 HELICAL DRIVE GEAR

NOTE: CURRENTLY SERVICED AS A ONE-PIECE ASSEMBLY

Figure 2.44



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NOTE: On all double-reduction carriers and some single-reduction carriers, do not separate the side gear from the helical drive gear. The side gear and the drive gear are replaced as an assembly.

NOTE: The rear side gear and the rear input bearing remain loose in the carrier housing.

7. Use a punch and a hammer to alignment marks on the case halves for marking the inter-axle differential. The alignment marks permit correct assembly of the case halves. **Figure 2.45**.
8. Remove the bolts, nuts and washers that fasten the case halves together. Separate the case halves. Remove the spider, the four pinions and the thrust washers.

NOTE: If either the bearing cup or cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

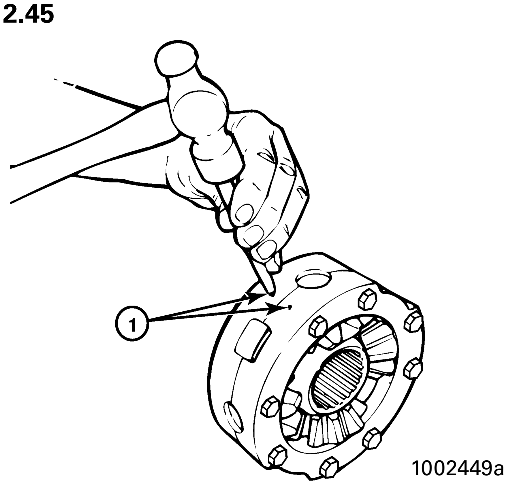
9. Remove the side gear and the bearing cone from the carrier housing. The bearing cup stays in the housing. If the bearing cup needs to be replaced, use a bearing puller to remove the cup from the housing. **Figure 2.46**.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

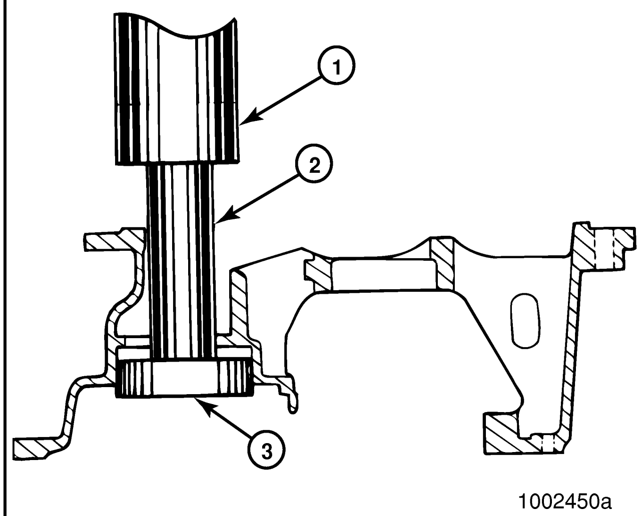
10. If the bearing cone needs to be replaced, use a press and a sleeve to remove the cone from the rear side gear. If a press is not available, use a bearing puller to remove the cone from the gear. **Figure 2.47**.

Figure 2.45



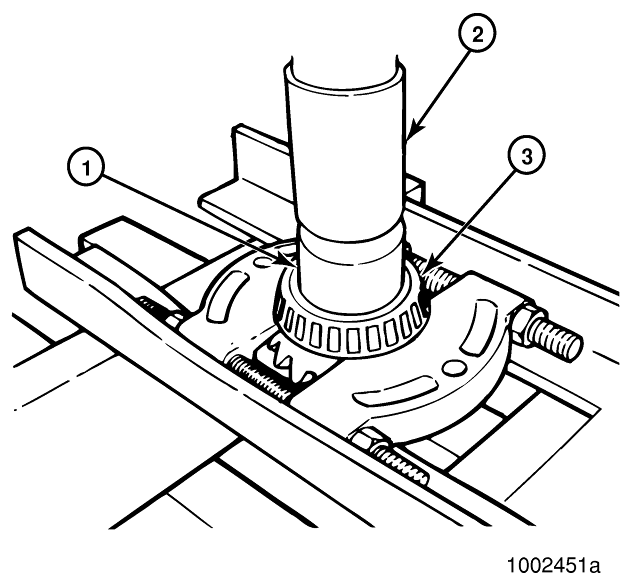
1 ALIGNMENT MARKS

Figure 2.46



1 PRESS
2 SLEEVE
3 REAR SIDE GEAR BEARING CUP

Figure 2.47

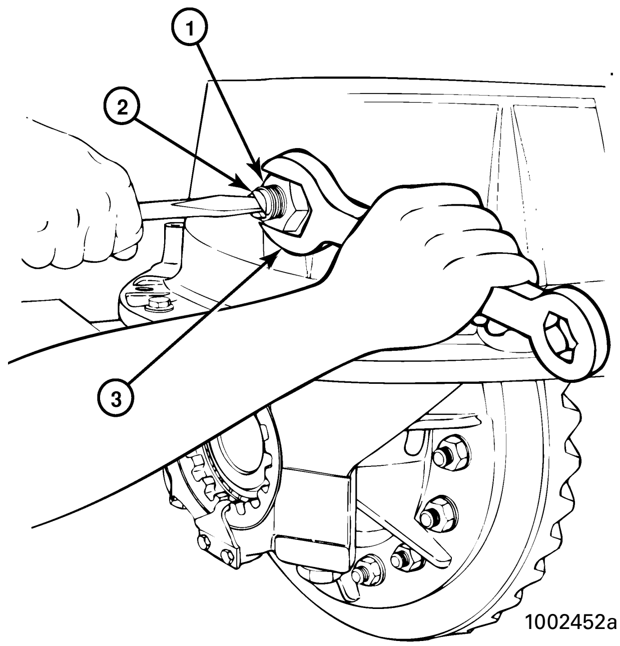


1 REAR SIDE GEAR
2 SLEEVE
3 BEARING CONE

Removing the Main Differential Case and Ring Gear Assembly

1. Place the carrier in a repair stand. Move the carrier so that the helical drive and drive gears are toward you. Loosen the jam nut first and then loosen the thrust screw. **Figure 2.48**.

Figure 2.48



1 JAM NUT
2 THRUST SCREW
3 OPEN END WRENCH

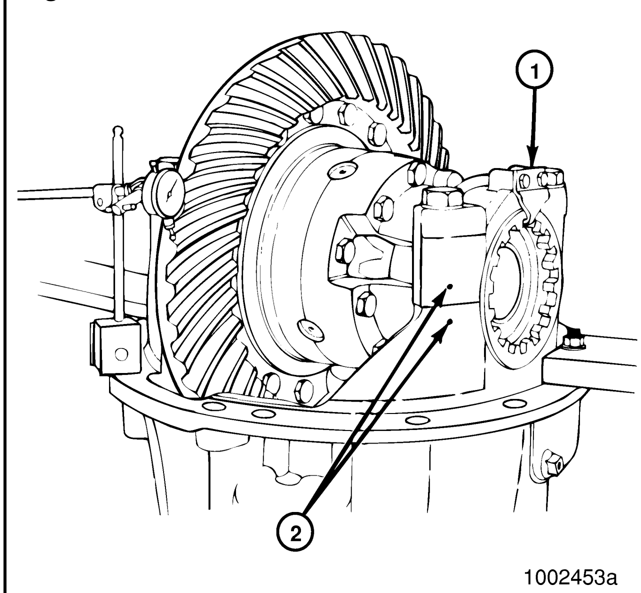
NOTE: To make a repair stand, refer to Section 9.

2. Turn the carrier upside down so that the ring gear is toward you.
3. Unless a new ring gear and drive pinion are being installed, inspect and record the ring gear backlash. Install a dial indicator on the carrier-to-housing surface. Move the ring gear so that the ring gear teeth fully engage the drive pinion teeth. Place the tip of the dial indicator against a tooth on the ring gear. Record the reading of the backlash. The backlash reading is required to correctly install the ring gear and the drive pinion in the carrier. **Figure 2.49**.
4. Use a punch and a hammer to mark the position of the bearing caps on the carrier legs. Mark each bearing cap. **Figure 2.49**.

NOTE: The bearing cap must be installed on the carrier leg from which it was removed. The cap is matched to the carrier leg. Do not mix bearing caps on carrier legs.

5. Remove the capscrews and the bearing adjusting ring locks. **Figure 2.49**.

Figure 2.49



1 BEARING ADJUSTING RING LOCK
2 MARKS

6. Use a "T" bar wrench or equivalent tool to loosen the bearing adjusting rings. Do not remove the adjusting rings. **Figure 2.50**.
7. If used, remove the cotter pins from the bearing cap. Remove the capscrews and washers from the bearing caps.

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

8. Remove the bearing caps, bearing cones and adjusting rings from the carrier. **Figure 2.51**.
9. Use a lifting device to remove the main differential case and ring gear assembly from the carrier. **Figure 2.52**.
10. If the bearing cones on the differential case need to be replaced, remove the bearings. Use a bearing puller tool to remove the bearings from the case. **Figure 2.53**.

Figure 2.50

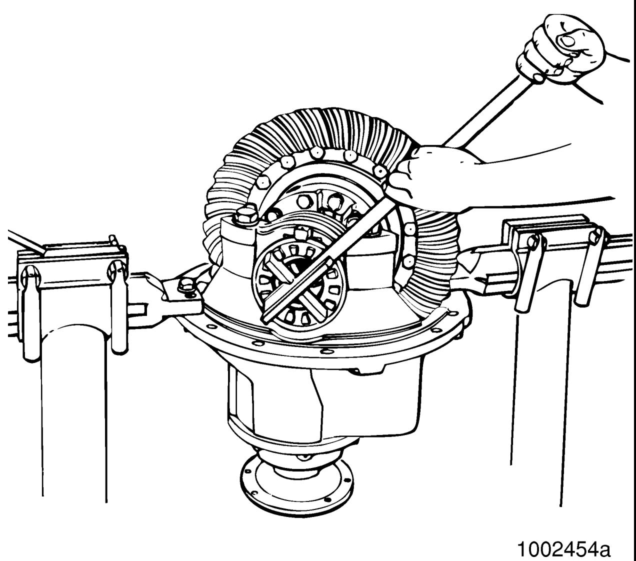
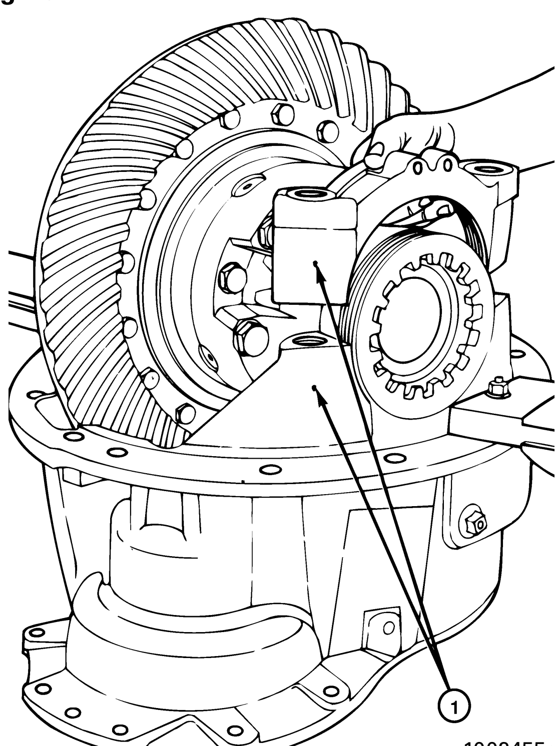


Figure 2.51



1 MATCH MARKS

Figure 2.52

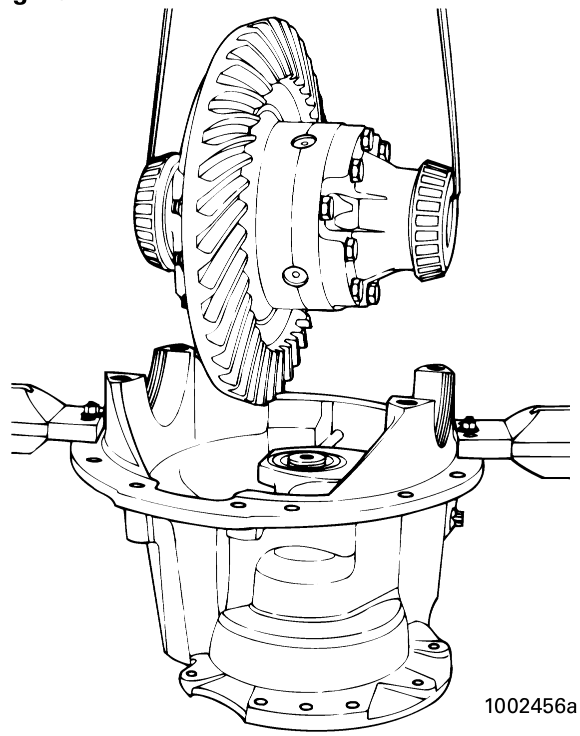
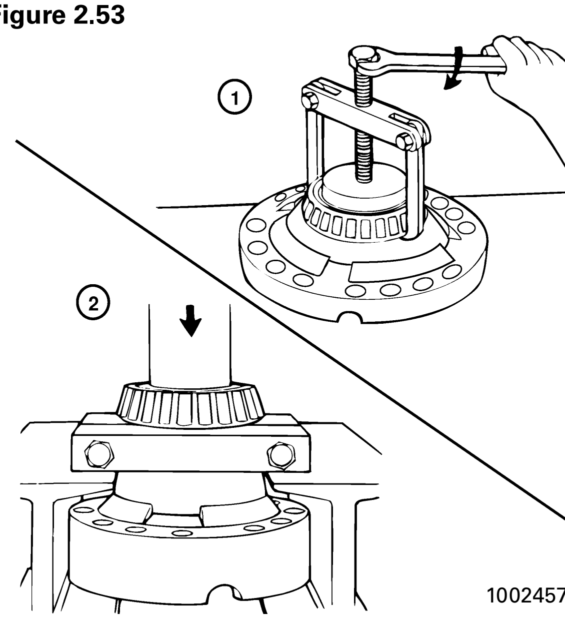


Figure 2.53

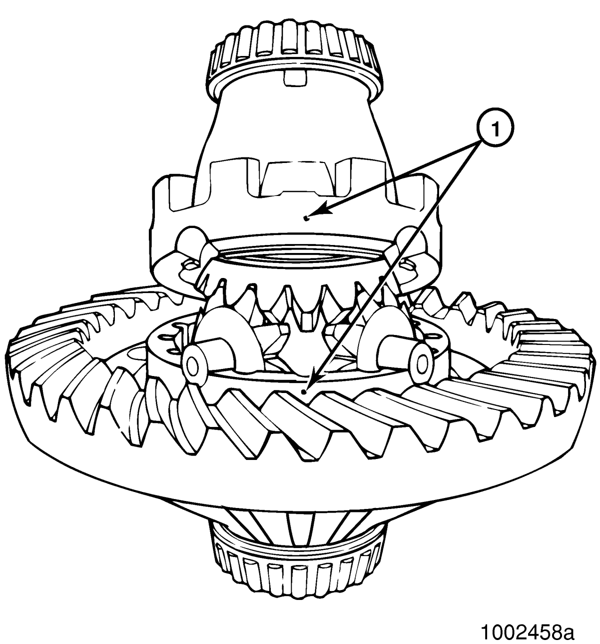


1 PULLER
2 PRESS

Disassembling the Main Differential Case and the Ring Gear

1. If the alignment marks on the case halves are not visible, use a punch and a hammer to mark each case half. The alignment marks permit correct assembly of the case halves. **Figure 2.54**.

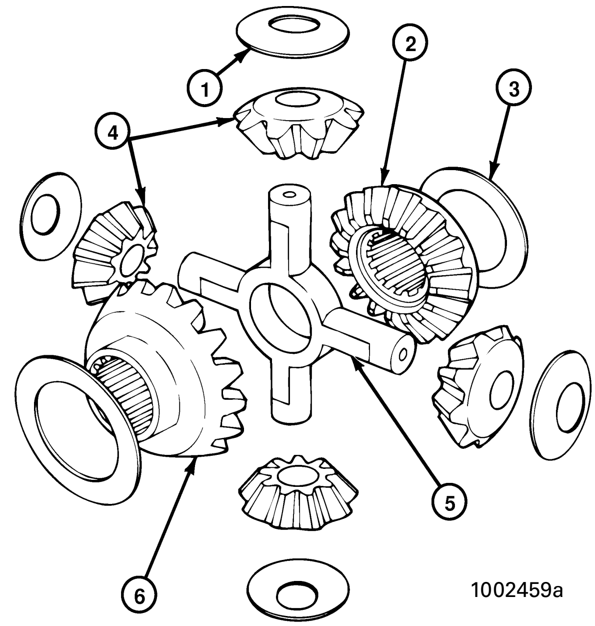
Figure 2.54



1 MARKS

2. On all single-reduction carriers and some double-reduction carriers, remove the capscrews and washers that fasten the case halves together. On some double-reduction carriers, remove the thru-bolts, washers and lock nuts that fasten the case halves together. Separate the differential case.
3. Remove the spider, the pinions, the side gear and the thrust washers from each case half. **Figure 2.55**.

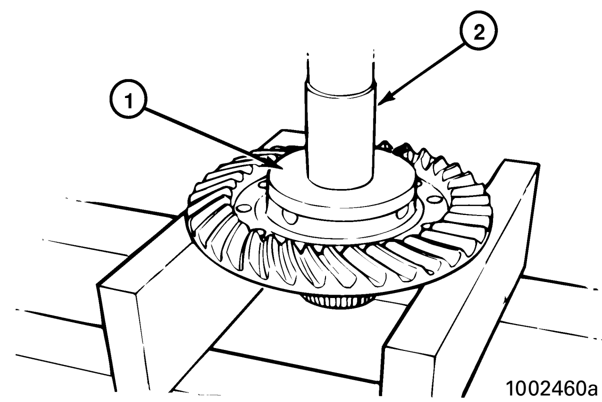
Figure 2.55



1	THRUST WASHER	4	PINION
2	SIDE GEAR	5	SPIDER
3	THRUST WASHER	6	SIDE GEAR

4. If the ring gear needs to be replaced, remove the ring gear from the differential case. Remove the bolts, nuts or lock nuts and washers that fasten the ring gear to the differential case.
5. Use a press and a plate to remove the ring gear from the case half. **Figure 2.56**.

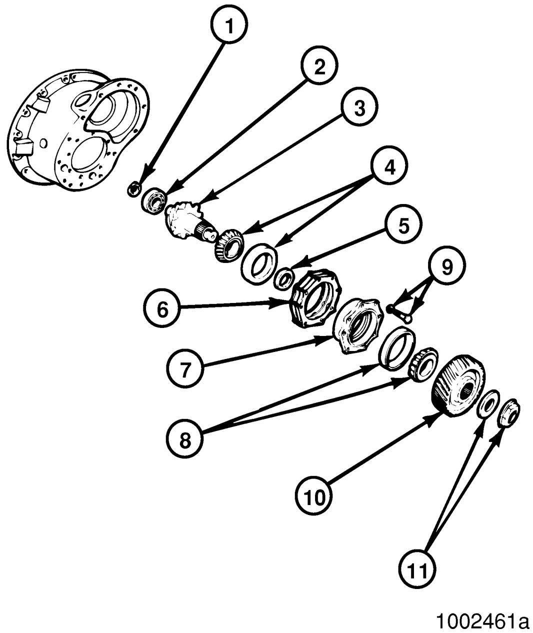
Figure 2.56



1 PLATE
2 PRESS

Removing the Drive Pinion and the Cage Assembly

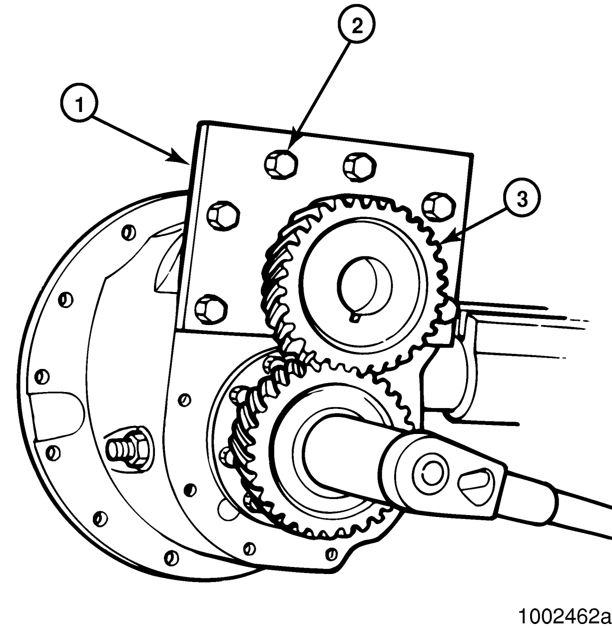
Figure 2.57



1 SNAP RING
2 SPIGOT BEARING
3 DRIVE PINION
4 PINION BEARING CUP AND CONE
5 SPACER
6 SHIMS
7 PINION BEARING CAGE
8 PINION BEARING CUP AND CONE
9 CAPSCREW AND WASHER
10 HELICAL DRIVEN GEAR
11 PINION NUT AND WASHER

1. Use the following suggested holding fixture to remove the pinion gear assembly from the carrier. **Figure 2.58**.
2. Weld an old helical gear to a steel plate. Mesh or engage the plate gear with the drive pinion gear.
3. Tighten down the plate to the carrier using six 1/2-13 capscrews to bolt the tool/fixture to the carrier. **Figure 2.58**.
4. Loosen the drive pinion shaft nut at this time.
5. On single-reduction carriers, remove the capscrews that fasten the cage to the main carrier housing.

Figure 2.58



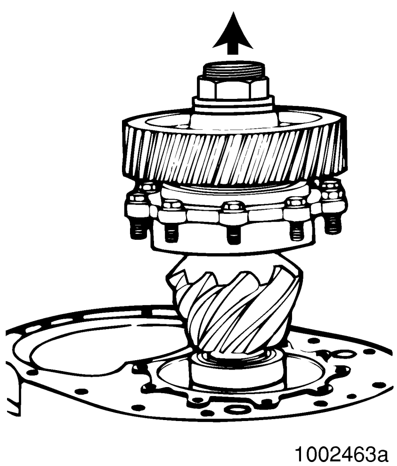
1 3/8 STEEL PLATE
2 1/2-13 CAPSCREWS – 6 REQUIRED
3 ORIGINAL HELICAL DRIVE GEAR

6. On double-reduction carriers, remove the capscrews that fasten the cage to the main carrier housing according to the following procedures:
   A. Loosen the capscrews until the head of each capscrew touches the helical driven gear.
   B. Evenly loosen each capscrew three turns. When the capscrews are loosened, the cage is pulled straight from out of the carrier. The capscrews become a puller when the heads are against the helical driven gear.
   C. Continue to evenly loosen the capscrews until the capscrews and the cage are removed from the housing.

NOTE: If the gear, the pinion and the cage assembly is difficult to remove, use a brass drift and a hammer. Place the brass drift on the pinion shaft and use a hammer to tap the assembly from the housing. <u>DO NOT</u> tap directly on the spigot bearing or the retaining ring or damage to the pinion cage may occur and result in drive pinion failure after carrier reassembly and while in service.

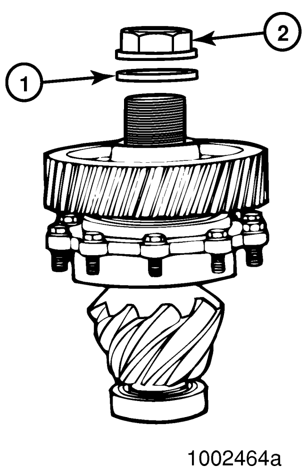
7. Remove the gear, the pinion and the cage as an assembly from the housing. **Figure 2.59**.

Figure 2.59



8. Remove the shims from under the cage. Keep the shims together for assembly. Replace any damaged shims with new shims of the same thickness.
9. Remove the nut and washer that fasten the helical driven gear to the drive pinion. **Figure 2.60**.

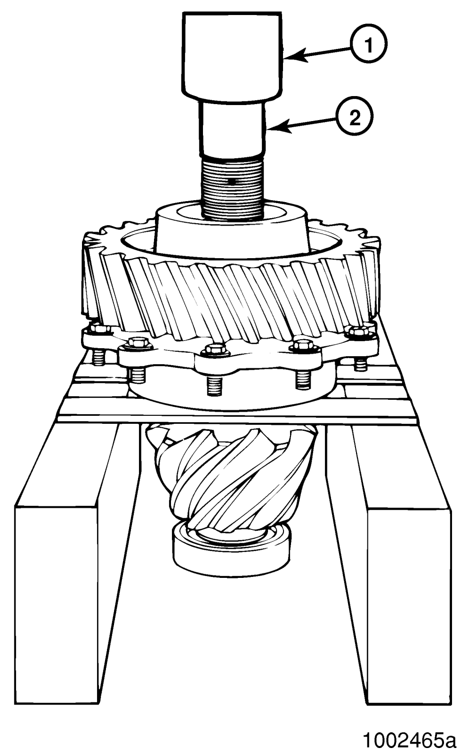
Figure 2.60



1 WASHER
2 FLANGED NUT

10. Use a press and a spacer to remove the pinion from the gear and the cage. Place the spacer on top of the threaded part of the pinion. The spacer must be larger than the outer diameter of the pinion shaft. Press the pinion from the gear and the cage. **Figure 2.61**.
11. Remove the spacer from the pinion shaft.
12. Remove the outer bearing cone from the cage.

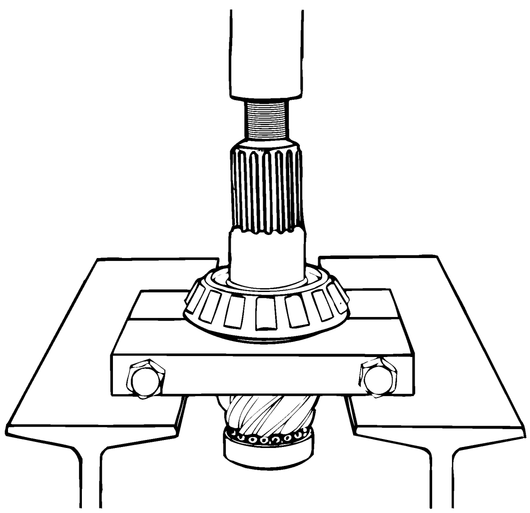
Figure 2.61



1 PRESS
2 SLEEVE

13. If the inner bearing cone needs to be replaced, use a bearing puller to remove the cone from the pinion. Discard the cone. **Figure 2.62**.

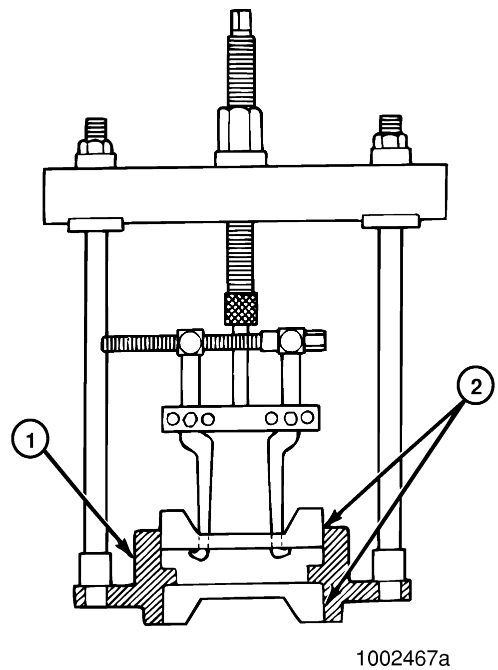
Figure 2.62



NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

14. If the bearing cups need to be replaced, use a bearing puller to remove the cups from the cage. Discard the cups. **Figure 2.63**.
15. If the spigot bearing needs to be replaced, remove the bearing from the pinion. Refer to the following procedures to remove the type of spigot bearing that is used on the right pinion.

Figure 2.63



1 DRIVE PINION BEARING CAGE
2 BEARING CUPS

One-Piece Spigot Bearing

A. Remove the snap ring that fastens the spigot bearing to the drive pinion. **Figure 2.64**.

B. Use a bearing puller to remove the spigot bearing from the drive pinion. **Figure 2.65**.

C. Discard the spigot bearing.

Figure 2.64

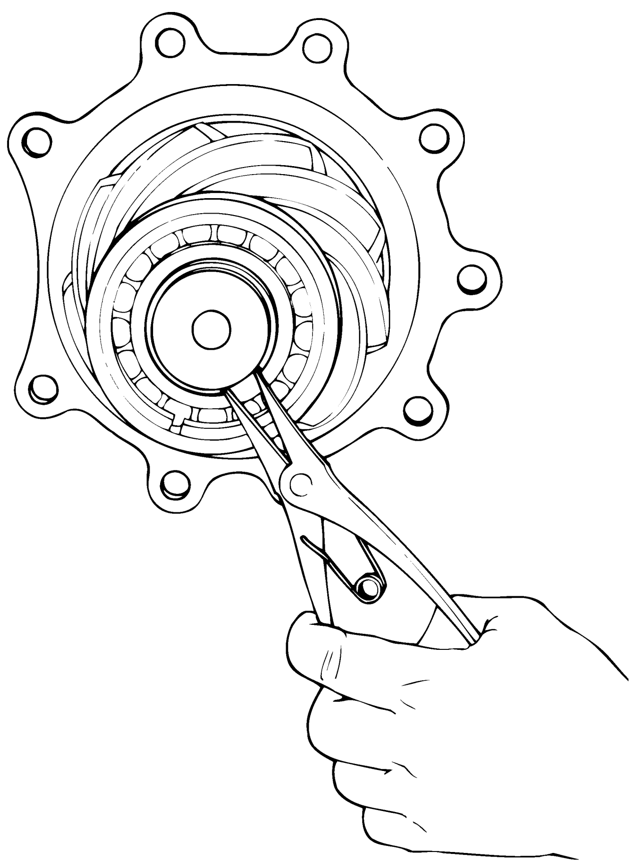


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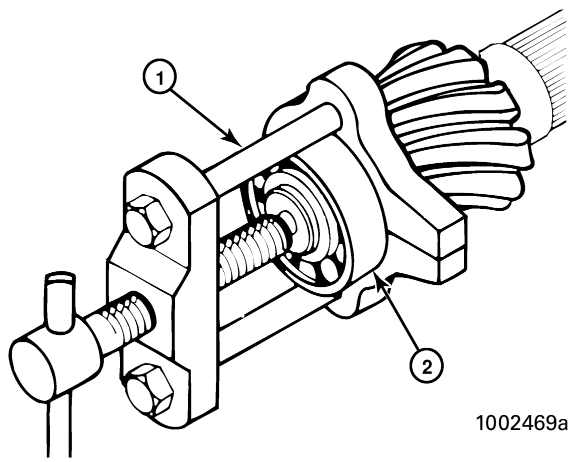
Figure 2.65



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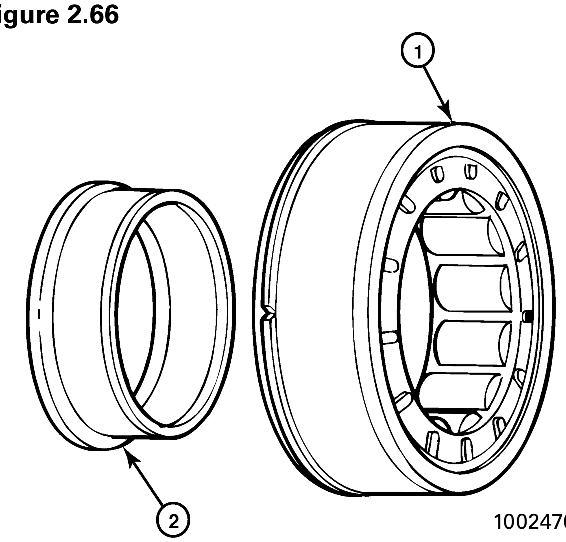
1 BEARING PULLER
2 SPIGOT BEARING

Two-Piece (Separable Race) Spigot Bearing — 280/380 Series Only

A. Remove the inner race if it is damaged, or the outer race and roller if damaged. Use a press, a bearing puller and a sleeve to remove the inner race from the drive pinion. Discard the inner race.

B. Remove the snap ring and outer race and roller assembly from the bore in the differential carrier. Remove the snap ring from the outer race and roller. Discard the outer race and roller when the inner race is removed.

Figure 2.66



1002470a

1 OUTER RACE INSTALLED IN CARRIER
2 INNER RACE PRESSED ON DRIVE PINION

Clean and Inspect Yokes

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

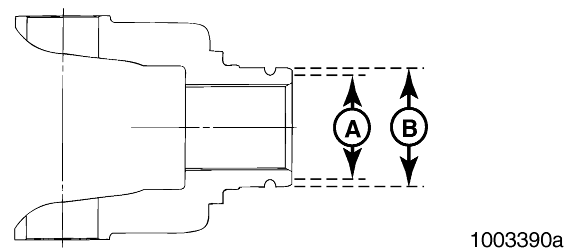
Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. Do not use abrasive cleaners, towels, or scrubbers to clean yoke or flange surface. DO NOT USE GASOLINE.
2. Inspect the original yoke seal surface for any grooves.
   A. The rubber inner sleeve of the unitized pinion seal (UPS) allows the reuse of yokes with grooves unless the groove depths are excessively deep. If grooves are present, measure the groove diameters with calipers. Refer to **Figure 3.1** to determine if the yoke is usable.
   B. If grooves are present on yoke hubs which are used with single or triple lip seals, then the yokes must be replaced.
3. If any of the yoke grooves measure less than the dimensions in **Figure 3.1**, replace the yoke. The rubber inner sleeve of the unitized pinion seal (UPS) is designed to seal on the yoke and rotate with the yoke.

Figure 3.1

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)

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.

Cleaning Ground and Polished Parts

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. DO NOT USE GASLINE.
2. Use a tool with a flat blade, if required, to remove sealant material from parts. Be careful not to damage the polished or smooth surfaces.
3. DO NOT clean ground or polished parts with water or steam. Do not immerse ground or polished parts in a hot solution tank or use strong alkaline solutions for cleaning, or the smooth sealing surface may be damaged.

Cleaning Rough Parts

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean rough parts with the same method as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak or diluted alkaline solution.
3. Parts must remain in hot solution tanks until heated and completely cleaned.
4. Parts must be washed with water until all traces of the alkaline solution are removed.

Cleaning the Axle Assembly

1. The axle assembly can be steam cleaned on the outside to remove dirt, and grease.
2. Before the axle is steam cleaned, place a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Drying Parts After Cleaning

CAUTION

Damage to bearings can result when they are rotated and dried with compressed air.

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.
3. Except for bearings, parts can be dried with compressed air.

Preventing Corrosion on Cleaned Parts

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be reused or assembled.
2. To store parts, apply a special material that prevents corrosion to all surfaces. Wrap cleaned parts in a special paper that will protect the parts from moisture and prevent corrosion.

Inspecting the Parts

It is important to carefully inspect all parts before the carrier is reassembled. Inspect all parts for wear and replace damaged parts. Replacement of damaged or worn parts now, will prevent failure of the assembly later.

1. Inspect the Tapered Roller Bearings:

   Inspect the cup, cone, rollers and cage of all tapered roller bearings. If any of the following conditions exist, the bearing **must** be replaced.

   A. The center of the large diameter end of the rollers is worn level with or below the outer surface. **Figure 3.2**.

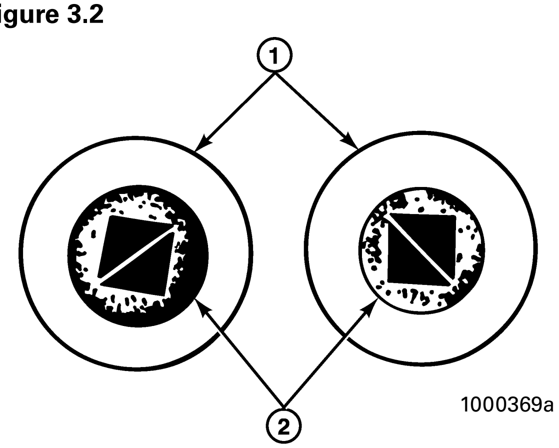
   B. The radius at the large diameter end of the rollers is worn to a sharp edge. **Figure 3.2**.

   C. A visible roller groove is worn in the inner race surfaces of the cup or cone. The groove can be seen at the small or large diameter end of both parts. **Figure 3.3**.

   D. Deep cracks or breaks in the surface of the roller cage. **Figure 3.4**.

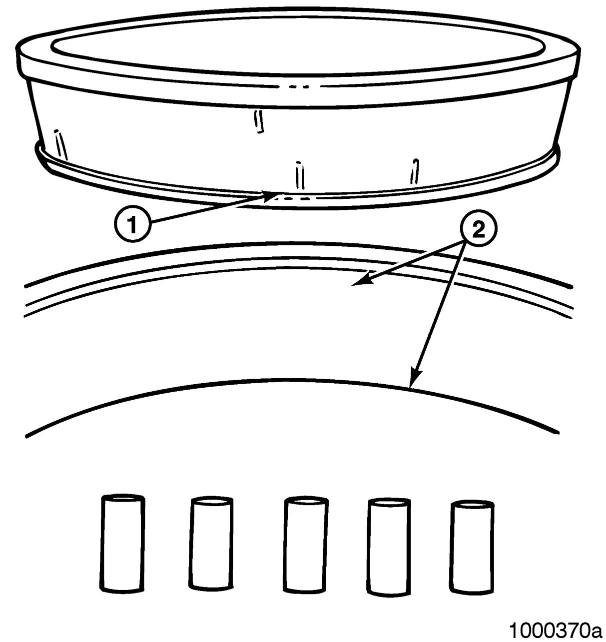
   E. Bright wear marks on the outer surface of the roller cage. **Figure 3.4**.

Figure 3.2



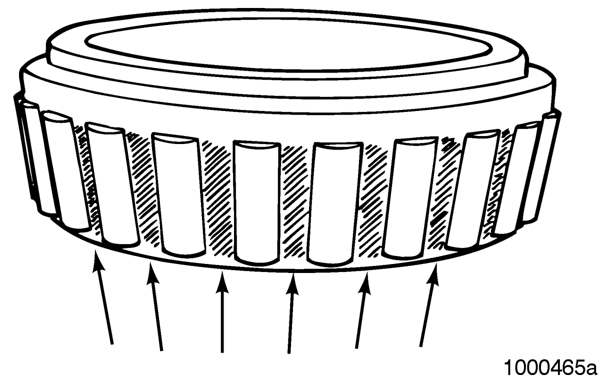
1 WORN RADIUS
2 WORN SURFACE

Figure 3.3



1 CRACK
2 WEAR GROOVE

Figure 3.4

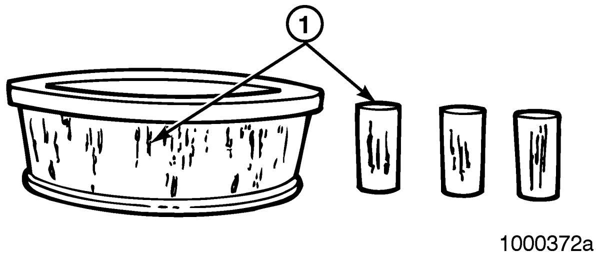


WEAR MARKS

F. Etching or pitting on rollers and on the surfaces of the cup and cone inner race that touch the rollers. **Figure 3.5**.

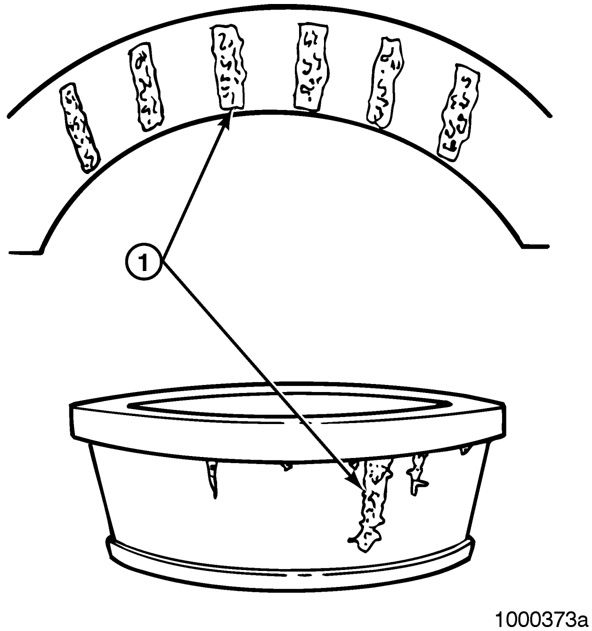
G. Spalling or flaking on the cup and cone inner race surfaces that touch the rollers. **Figure 3.6**.

Figure 3.5



1 ETCHING AND PITTING

Figure 3.6



1 SPALLING AND FLAKING

CAUTION

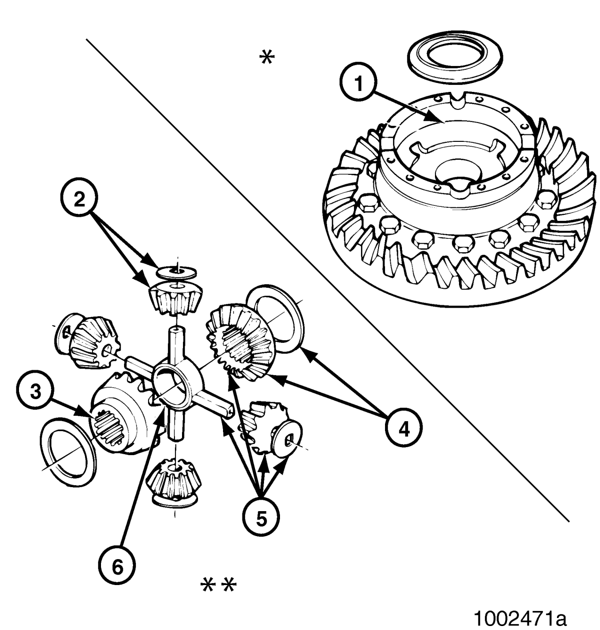
Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both the ring gear and the drive pinion must be replaced at the same time.

2. Inspect the Hypoid Drive Pinion and Ring Gear Sets. Check hypoid pinions and gears for wear or damage. Gears that are worn or damaged **must** be replaced.

3. Inspect the Main Differential Assembly.

   Carefully check the parts for wear. Parts that are worn or damaged **must** be replaced. **Figure 3.7**.

Figure 3.7



1 INSPECT INSIDE SURFACES
2 PINION AND THRUST WASHER
3 INSPECT
4 SIDE GEAR AND THRUST WASHER
5 INSPECT
6 SPIDER (CROSS)
*** DIFFERENTIAL CASE HALVES**
**** DIFFERENTIAL GEAR NEST ASSEMBLY**

CAUTION

Always replace thrust washers, differential side gears and pinion gears in sets. A higher stress on parts and early failure of the assembly will occur if a new part is used with a worn part.

A. Inside surfaces of both case halves.
B. Both surfaces of all thrust washers.
C. The four trunnion ends of the spider (cross).
D. Teeth and splines of both differential side gears.
E. Teeth and bore of all differential pinions.

4. Inspecting the Helical Drive and the Driven Gears.

   Inspect the helical drive and the driven gears for wear or damage. Replace gears that are worn or damaged. On double-reduction carriers, the helical drive gear and the helical driven gear must be replaced as a set. They are not serviced separately.

5. Inspecting the Axle Shafts.

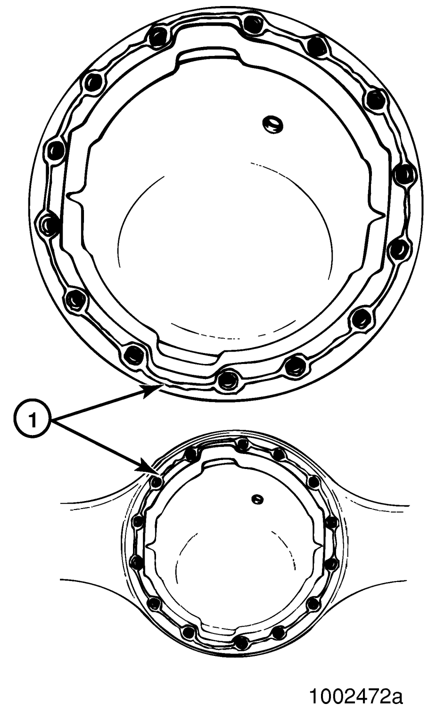
   Inspect axle shafts for wear, stress and cracks at the flange, shaft and splines. Replace axle shaft if required.

Repairing or Replacing Axle Components

Replace worn or damaged parts of the axle assembly. The following are some examples of checking the axle assembly for repair or replacement.

1. Replace any fastener if the corners of the head are worn.
2. Replace the washers if damaged.
3. Replace the gaskets, oil seals or grease seals at the time of axle or carrier repair.
4. Clean the parts and apply new silicone gasket material where required when the axle or carrier is assembled. **Figure 3.8**.

Figure 3.8



1 SILICONE

5. Remove nicks, mars and burrs from parts having machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.
6. 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.

CAUTION

Threads must be clean and undamaged so that accurate adjustments and correct torque values can be applied to fasteners and parts.

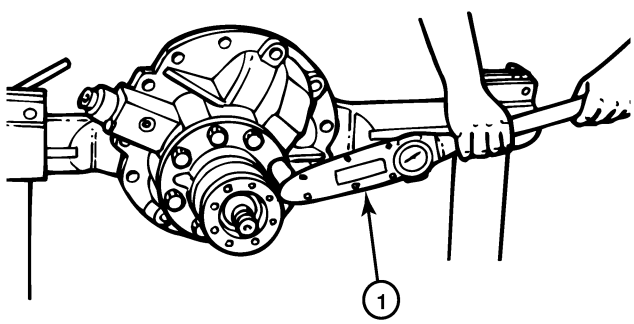
7. Tighten all fasteners to the correct torque values. Refer to **Table H** in Section 7, for torque values of fasteners. **Figure 3.9.** T

WARNING

Repair of axle housings by bending or straightening will cause poor performance, early failure and unsafe operation of the axle.

8. **Do not** repair rear axle housings by bending or straightening.

Figure 3.9



1 ALWAYS USE TORQUE WRENCHES

Repairing the Axle Housing by Welding

1. Meritor will permit welding on drive axle housing assemblies **only** in the following areas:
   - A. Only RT-46-160 axles housing to cover weld joints. Refer to TP-9599.
   - B. Snorkel welds.
   - C. Housing seam welds between the suspension attaching brackets.
   - D. Bracket welding to drive axle housing. Refer to TP-9421.
   - E. Refer to Maintenance Manual 8 for approved axle welding procedures.

WARNING

Using wrong welding procedures or welding at locations other than the three areas permitted by Meritor will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the axle and early failure. The following procedure must be used.

CAUTION

Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A repaired housing must be used in correct applications.

2. Welding Procedure
   - A. Drain the lubricant from the axle assembly.
   - B. Remove hub, drum, wheel bearing and brake air chambers.
   - C. Remove the axle shafts and differential carrier from the axle housing.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

   - D. Clean the damaged area inside and outside the housing. Cleaning solvent can be used.
   - E. Grind the damaged weld to the base material.
   - F. Warm the complete axle housing to a temperature of 70°F to 80°F (21°C-27°C) or higher.
   - G. Before you start welding, heat the damaged area to be repaired to approximately 300°F (149°C).

CAUTION

If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in correctly sealed containers must be heated at 300°F (371°C) for one hour before welding. Wet electrodes must be dried at 180°F (82°C) for one to two hours and then heated at 700°F (371°C) for one hour before welding.

H. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rod that can be used are E-7018 or ER-70S-3.

I. Fill in the Weld Gap as follows:

CAUTION

Do not connect the ground cable at any point on the axle assembly that will place a wheel bearing between the ground cable and weld area. If a wheel bearing is between the ground cable and weld, the bearing will be damaged because of electricity arcing.

A good location to connect the ground cable is the spring mounting pad of the housing.

1. The snorkel weld **must** be a 0.375-inch (9.500 mm) fillet.
2. The opening in cover welds **must** be filled level with the old weld.
3. The opening in seam welds **must** be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of the housing.
4. Clean the new weld area. Carefully remove all rough weld material.
5. Fill the axle assembly with the correct amount of lubricant. Refer to Maintenance Manual 1, *Lubrication*, for information on using lubricants.

NOTE: To weld brackets or other components to the axle housing, use the procedure in Technical Bulletin, TP-9421.

Bending or Straightening Drive Axle Housings

Meritor is emphatically opposed to any attempt to correct or modify drive axle housings by bending or straightening. All damaged drive axle housings should be replaced.

WARNING

Do not bend or straighten damaged drive axle housings. Any bending or straightening process may result in misalignment or weakening of the axle housing and result in component damage or serious personal injury.

Removing Dri-Loc® Fasteners

If it is difficult to remove fasteners from components, the strength of Dri-Loc®, Meritor adhesive or Loctite® 277 can be decreased by heating. Use the following procedure:

1. Heat the fastener for three to five seconds **only** and try to loosen the fastener with a wrench. **Do not** use an impact wrench to loosen the fastener or hit the fastener with a hammer.

CAUTION

Do not exceed 350°F (177°C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

2. Repeat Step 1 until the fastener can be removed.

Installing Fasteners with Pre-applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent

Installing New Fasteners with Pre-applied Adhesive Patches

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Clean the oil and dirt from threaded holes. Use a wire brush. There is no other special cleaning required.

CAUTION

Do not apply adhesives or sealants on new fasteners with pre-applied adhesive patches or inside closed threaded holes. If other adhesives or sealants are used, the new adhesive will not function correctly.

2. Assemble parts using the new pre-applied adhesive fasteners.

NOTE: There is no drying time required for fasteners with pre-applied adhesive.

3. Tighten the fasteners to the required torque value for that size fastener.

Installing Original or Used Fasteners Using Meritor Liquid Adhesive 2297-C-7049 or Loctite® 680 or Equivalent

CAUTION

Threads must be clean and undamaged so that accurate adjustments and correct torque values can be applied to fasteners and parts.

1. Clean the oil, dirt and old adhesive from all threads and threaded holes. Use a wire brush.

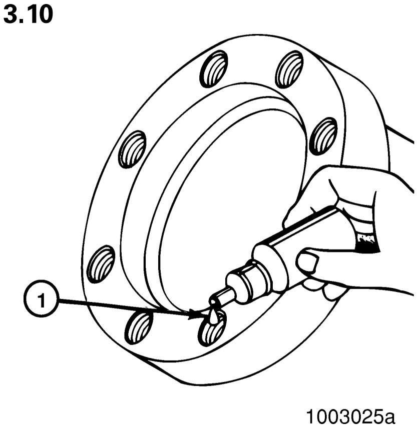
CAUTION

Do not apply adhesive directly to the fastener threads. Air pressure in a closed hole will push the adhesive out and away from mating surfaces as the fastener is installed.

NOTE: There is no drying time required for Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 or equivalent.

2. Apply four or five drops of Meritor Liquid Adhesive, Loctite® 680 or equivalent inside each threaded hole or bore ONLY. Make sure the adhesive is applied inside to the bore threads. **Figure 3.10**.
3. Tighten the fasteners to the required torque value for that size fastener.

Figure 3.10



1 4 TO 5 DROPS ON BORE THREADS

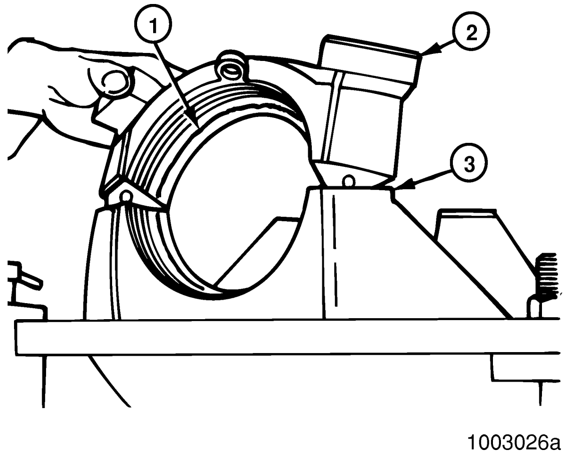
Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential

Use adhesive 2297-T-4180 for all axles.

1. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. **Do not** get oil on the outer diameter of the bearing cup and **Do not** permit oil to drip on the bearing bores.

3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360° around the smooth, ground surfaces only. **Do not** place adhesive on threaded areas. **Figure 3.11**.

Figure 3.11



1 ADHESIVE BEAD
2 BEARING CAP
3 CARRIER LEG

NOTE: Meritor adhesive 2297-T-4180 will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the adhesive from the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure, refer to "Installation of the Main Differential Case and Ring Gear Assembly into the Carrier" in Section 4.
5. Adjust preload of the differential bearings and the ring gear backlash. Perform a tooth contact pattern check of the gear set, as required. Refer to "Adjusting the Preload on the Differential Side Bearings" in Section 4.

Application of Three Bond 1216 or Equivalent Silicone Gasket Material

WARNING

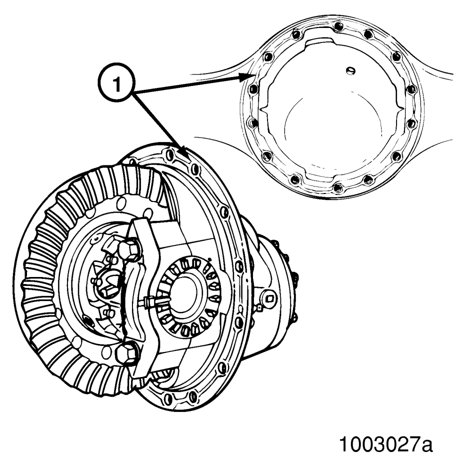
Take care when you use silicone gasket materials to avoid serious personal injury. Follow the manufacturer's instructions to prevent irritation to the eyes and skin.

NOTE: The following silicone gasket products or equivalent can be used for Meritor components:

- Three Bond Liquid Gasket No. TB 1216 (Grey)
- Loctite® Ultra Grey Adhesive/Sealant #18581
- From Meritor:
  — Ten-ounce tubes, Part No. 2297-F-7052
  — Three-ounce tubes, Part No. 2297-Z-7098

1. Remove all old gasket material from both surfaces. **Figure 3.12**.
2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture without damaging the mating surfaces. **Figure 3.12**.

Figure 3.12



1 REMOVE OLD SEALANT MATERIAL

HOUSING AND CARRIER SHOWN

3. Dry both surfaces.

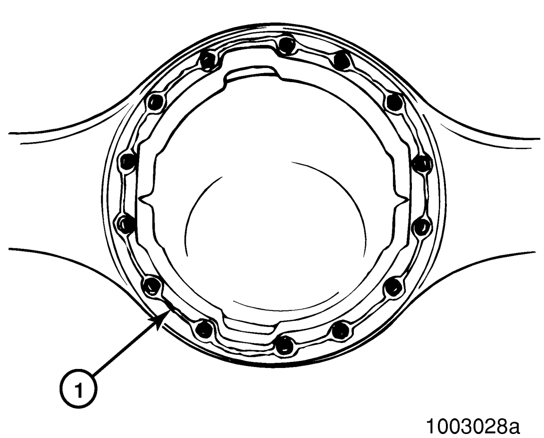
CAUTION

The amount of silicone gasket material applied must not exceed 0.125-inch (3 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the components.

NOTE: Meritor adhesive products are available from ArvinMeritor's Commercial Aftermarket. Call 888-725-9355 for more information.

4. Apply 0.125-inch (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 that surface. **Figure 3.13**.
5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. There is no special procedure or additional torque value required. Refer to **Table H** in Section 7.
6. Wait 20 minutes before filling the assembly with lubricant.

Figure 3.13



1 0.125" (3 MM) DIAMETER SILICONE GASKET BEAD

Gear Set Information — Markings on the Drive and the Ring Gear

WARNING

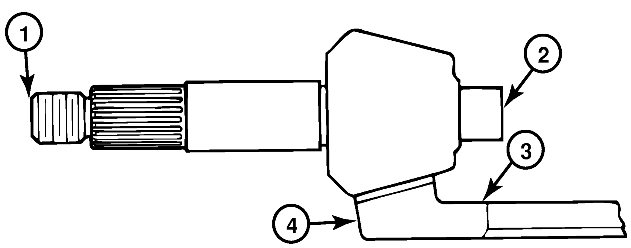
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE: Before a new gear set is installed in the carrier, read the following information. ALWAYS INSPECT THE GEAR SET FOR CORRECT MARKS TO MAKE SURE THE GEARS ARE A MATCHED SET.

The location of the marks are shown in **Figure 4.1**.

Figure 4.1



1002474a

1	**1, 2**
2	**3, 4**
3	**1, 2, 3**
4	**1, 2, 3, 4**

1. **Part Number**
   A. **Examples of gear set part numbers:**
      - Conventional ring gear, 36786.
      - Conventional drive pinion, 36787.
      - Generoid ring gear, 36786 K.
      - Generoid drive pinion, 36787 K.

NOTE: The last digit in part numbers for Generoid gears is a letter.

   B. **Location on drive pinion:** end of pinion shaft.
   C. **Location on ring gear:** front face or outer diameter of ring gear.
2. **Tooth Combination Number**
   A. **Example of a tooth combination number:**
      - 5-37. The "5-37" number indicates that the drive pinion has five teeth and the ring gear has 37 teeth.
   B. **Location on drive pinion:** end of pinion shaft.
   C. **Location on ring gear:** front face of outer diameter of ring gear.
3. **Gear Set Match Number**

   Meritor drive pinions and ring gears are available only in matched sets. The ring gear and the drive pinion in a set have a match number.

   A. **Example of a gear set match number:** M29.

NOTE: A gear set match number has any combination of a letter and a number.

   B. **Location on drive pinion:** on the end of the gear head on the drive pinion.
   C. **Location on ring gear:** front face or outer diameter of ring gear.

NOTE: The pinion cone variation number is not used when checking for a matched gear set. The number is used when you adjust the depth of the pinion in the carrier. Refer to "Adjusting the Thickness of the Shim Pack for the Pinion Cage (Depth of Pinion)" in this section.

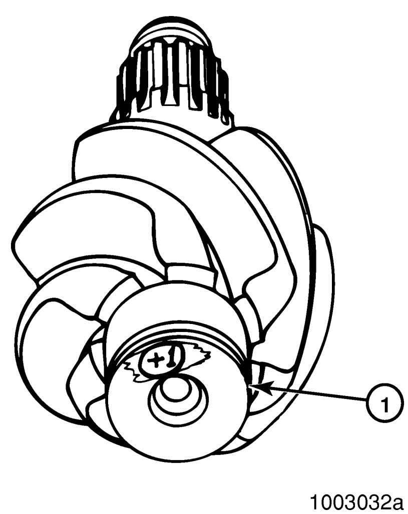
4. **Pinion Cone Variation Number**

   A. **Examples of pinion cone variation numbers**:

   - PC+3
   - PC–5
   - +2
   - +1
   - +.01 mm
   - –.02 mm **Figure 4.2**.

   B. **Location on gear set:** on the end of the gear head of the drive pinion or the outer diameter of the ring gear. **Figure 4.2**.

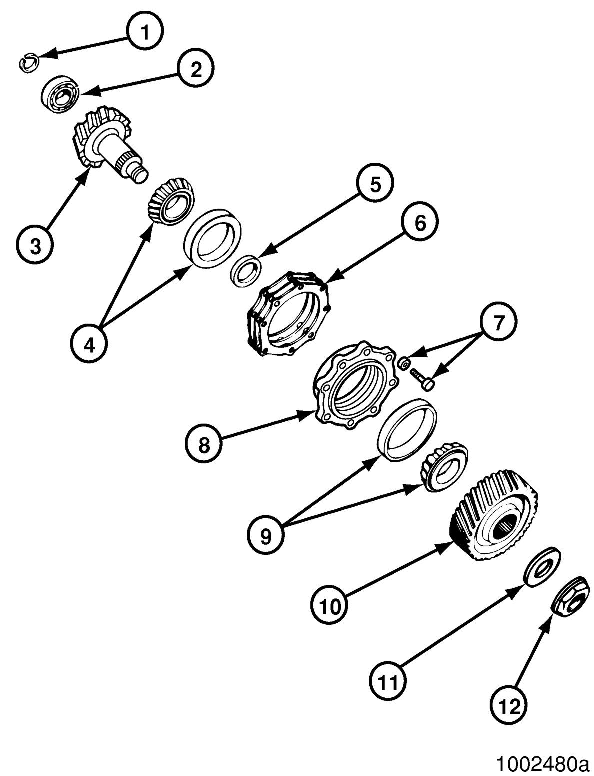
Figure 4.2



1 PINION CONE VARIATION NUMBER

Assembling the Drive Pinion and the Cage Assembly

Figure 4.3



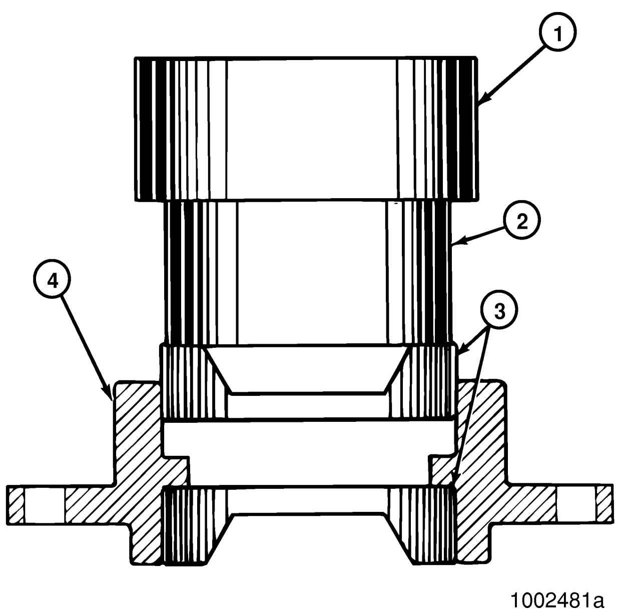
1 SNAP RING
2 SPIGOT BEARING
3 DRIVE PINION
4 PINION BEARING CUP AND CONE
5 SPACER
6 SHIMS
7 CAPSCREW AND WASHER
8 PINION BEARING CAGE
9 PINION BEARING CUP AND CONE
10 HELICAL DRIVEN GEAR
11 PINION WASHER
12 PINION NUT

1. Lubricate all bearings and cups with the fluid that is used in the axle housing.

NOTE: Use this procedure to install both bearing cups in the cage.

2. If the bearing cups were removed from the cage, replace the bearing cups and cones in a matched set from the same manufacturer. Use the following procedure:
   A. Place the bearing cage in a press.
   B. Support the bearing cage with metal or wood blocks.
   C. Place a sleeve on the outer face of the bearing cup.
   D. Press the bearing cup into the bore of the bearing cage until the cup is flat against the cage shoulders. **Figure 4.4**.

Figure 4.4

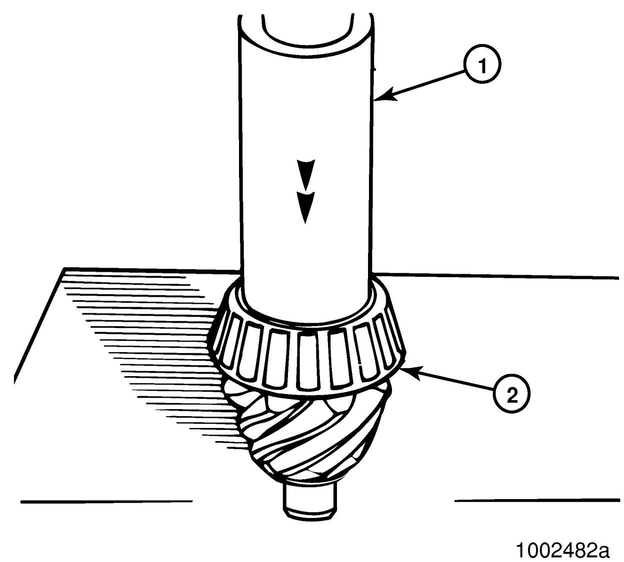


1 PRESS
2 SLEEVE
3 BEARING CUP
4 DRIVE PINION BEARING CAGE

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

3. If the inner bearing cone was removed, install a new cone on the drive pinion and a new cup in the cage. Install the inner bearing cone on the drive pinion according to the following procedure:
   A. Place the drive pinion in a press with the head of the gear (teeth) toward the bottom.
   B. Place a new bearing cone on the shaft of the drive pinion.
   C. Place a sleeve on the inner race of the bearing cone.
   D. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the head of the gear. **Figure 4.5**.

Figure 4.5

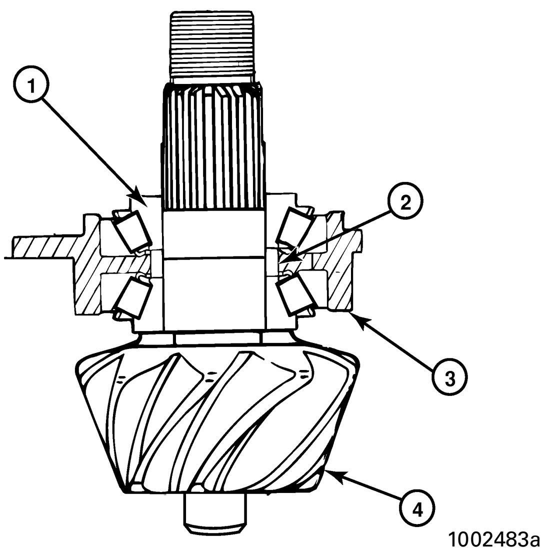


1 SLEEVE
2 INNER BEARING CONE

4. Install the spacer on the shaft of the drive pinion. **Figure 4.6**.
5. Install the drive pinion and bearing assembly in the cage. **Figure 4.6**.

NOTE: The helical driven gear and the drive pinion nut and washer are installed during the preload adjustment of the drive pinion bearings.

Figure 4.6



1 OUTER BEARING CONE
2 BEARING SPACER
3 BEARING CAGE
4 DRIVE PINION

Adjusting the Bearing Preload on the Drive Pinion

Specification:

- New drive pinion bearings:
  — 5 to 25 lb-in (0.56-2.82 N•m) rotational torque. T
- Used drive pinion bearings:
  — 5 to 15 lb-in (0.56-1.69 N•m) rotational torque. T

There are two methods of adjusting the preload on the drive pinion:

- Press Method
- Drive Pinion Nut Method

Use the drive pinion nut method to adjust preload, if a press is not available or if the press does not have a pressure gauge.

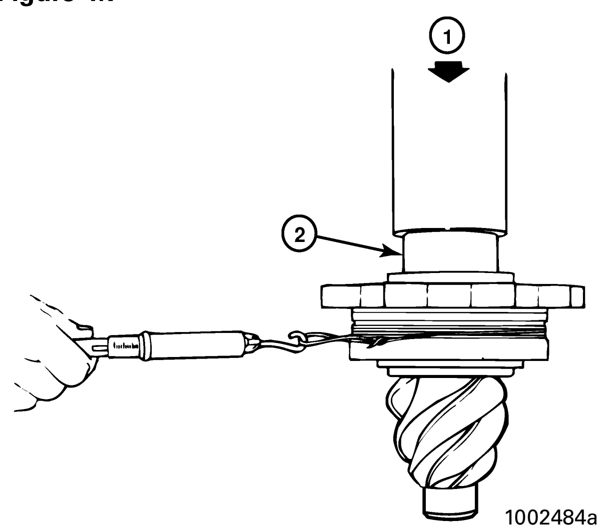
Setting Preload — Press Method

1. Place the drive pinion and the cage assembly in a press so that the gear head (teeth) of the drive pinion is toward the bottom of the press.
2. Place a sleeve against the inner race of the outer bearing. **Figure 4.7**.
3. Apply the press and hold 25 tons of pressure on the bearings. Apply pressure and rotate the bearing cage several times so that the bearings make normal contact.
4. While pressure is held against the assembly, wind a cord around the bearing cage several times. **Figure 4.7**.
5. Attach a spring scale to the end of the cord. **Figure 4.7**.

NOTE: Do not read the torque when the cage starts to rotate. Read the torque after the cage starts to rotate. Reading the starting torque gives a false measurement.

6. On a horizontal line, pull the scale so that the bearing cage rotates. Read and record the rotational torque of the bearing cage. **Figure 4.7**.

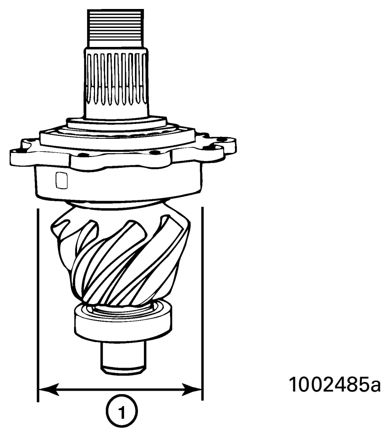
Figure 4.7



1 PRESS
2 SLEEVE

7. Measure the outer diameter of the bearing cage where the cord was wound. Measure in inches or centimeters. **Figure 4.8**.

Figure 4.8



1 MEASURE DIAMETER OF CAGE

8. Divide the diameter of the bearing cage by two to get the radius of the bearing cage. Make a note of the radius dimension.
9. Use the following procedure to calculate the bearing preload (torque):
   - Pounds pulled x Cage Radius in inches = lb-in preload.

     or
   - Kilograms pulled x Cage Radius in centimeters = kg-cm preload

     To convert kg-cm to N•m, multiply kg-cm preload by 0.098.

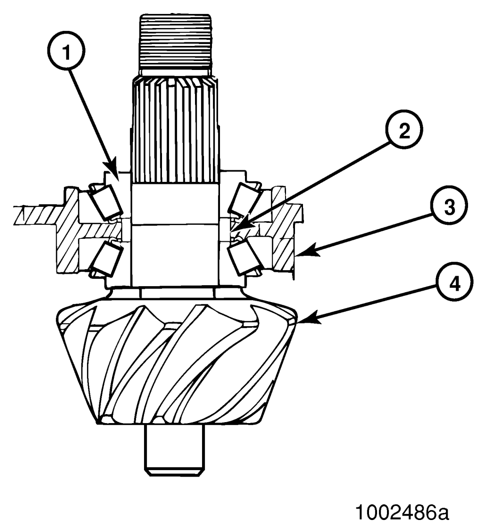
NOTE: To change the lb-in preload to N•m preload, multiply the lb-in preload by 0.113.

Examples:

Reading from spring scale:	7.50 pounds (3.40 kg)
Diameter of bearing cage:	6.62 inches (16.80 cm)
Radius of bearing cage:	3.31 inches (8.40 cm)
7.500 lb x 3.310 inches = 24.80 in-lb preload x 0.113 = 2.800 N•m preload	
3.400 kg x 8.400 cm = 28.60 kg-cm preload x 0.098 = 2.800 N•m preload	

10. If the preload (torque) of the pinion bearings is not within specifications:
    A. Install a different spacer on the drive pinion shaft. To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer. **Figure 4.9**.
    B. Repeat the preload reading as described in Steps 1-9.
11. Inspect the bearing preload after the drive pinion and cage assembly are installed in the carrier. Follow the procedures to adjust the preload of the pinion bearings.

Figure 4.9



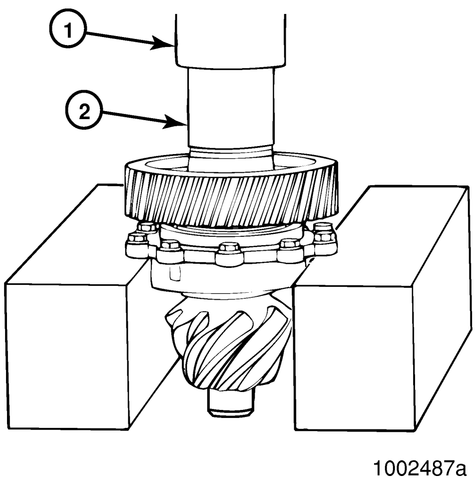
1 OUTER BEARING CONE
2 BEARING SPACER
3 BEARING CAGE
4 DRIVE PINION

INCREASE PRELOAD = INSTALL THINNER SPACER /
DECREASE PRELOAD = INSTALL THICKER SPACER

Helical Gear to Drive Pinion Press Method

1. Place the helical driven gear on the drive pinion so that the mark on the gear is away from the bearing cage. Use a press and a sleeve to install the driven gear on the drive pinion. Apply pressure until the gear is against the outer bearing cone. **Figure 4.10**.
2. Install by hand the washer and the nut on the shaft of the drive pinion.

Figure 4.10



1 PRESS
2 SLEEVE

Helical Gear to Drive Pinion Heat Method

1. Expand the helical gear by heating the gear in a tank of water to a temperature of 160 to 180°F (71-82°C) for 10 to 15 minutes. **Do not use an open flame such as a torch for this procedure.**

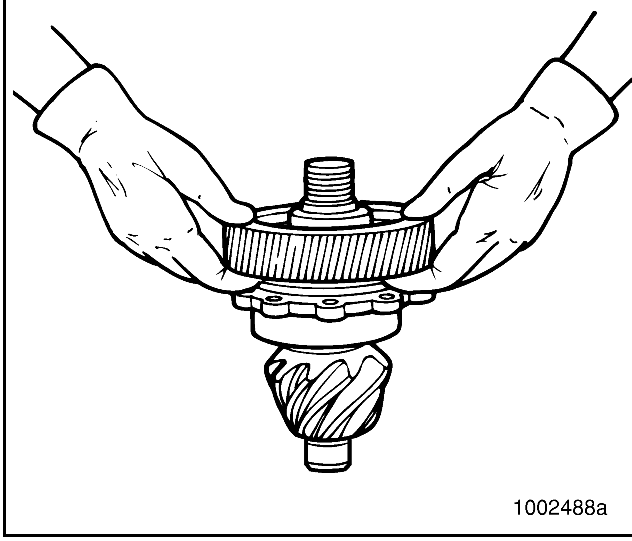
WARNING

Wear safe clothing such as gloves and a shop coat for protection from personal injury in case accidental contact with the hot ring gear does occur.

2. Use a lifting tool to safely lift the helical gear from the tank of water.
3. Immediately install the helical driven gear onto the drive pinion. **Figure 4.11**. If the helical gear does not fit easily on the flange, heat the gear again in a tank of hot water. Repeat Step 1.
4. Install by hand the drive pinion nut.

NOTE: If the transfer drivetrain has a 1:1 ratio, replace both the helical drive and driven gears as a newly-matched set.

Figure 4.11

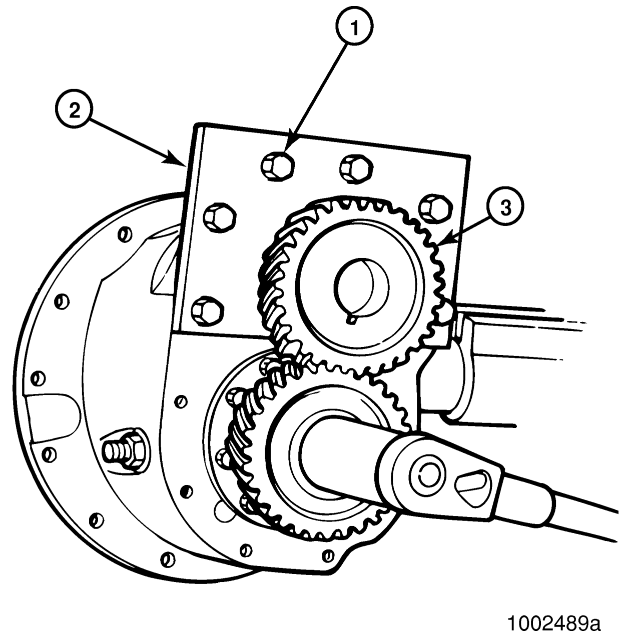


Setting Preload — Drive Pinion Nut Method

1. Place the drive pinion and cage assembly in the differential carrier. Install and hand tighten the capscrews that fasten the cage to the differential carrier.
2. Using the holding fixture shown in **Figure 2.58**, mesh or engage the plate gear with the drive pinion gear.
3. Tighten down the plate to the carrier using six 1/2-13 capscrews to bolt the tool/fixture to the carrier. **Figure 2.58**.
4. Tighten the drive pinion shaft nut at this time.
5. On **single-reduction** carriers, remove the capscrews that fasten the cage to the main carrier housing.

6. On **double-reduction** carriers, remove the capscrews that fasten the cage to the main carrier housing according to the following procedures:
   A. Loosen the capscrews until the head of each capscrew touches the helical driven gear.
   B. Evenly loosen each capscrew three turns. When the capscrews are loosened, the cage is pulled straight from out of the carrier. The capscrews become a puller when the heads are against the helical driven gear.
   C. Continue to evenly loosen the capscrews until the capscrews and the cage are removed from the housing.
7. Using a torque wrench with a torque multiplier, tighten the holding tool into the carrier and tighten the nut on the shaft of the drive pinion from 1200 to 1500 lb-ft (1627-2033 N•m). **Figure 4.12**. T

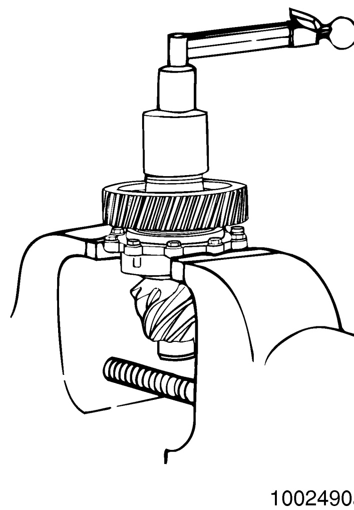
Figure 4.12



1 1/2-13 CAPSCREWS – 6 REQUIRED
2 3/8 STEEL PLATE
3 ORIGINAL HELICAL DRIVE GEAR

8. Place an inch-pound torque wrench and a socket on the pinion nut. Rotate the drive pinion and read the value indicated on the torque wrench. **Figure 4.13**.

Figure 4.13

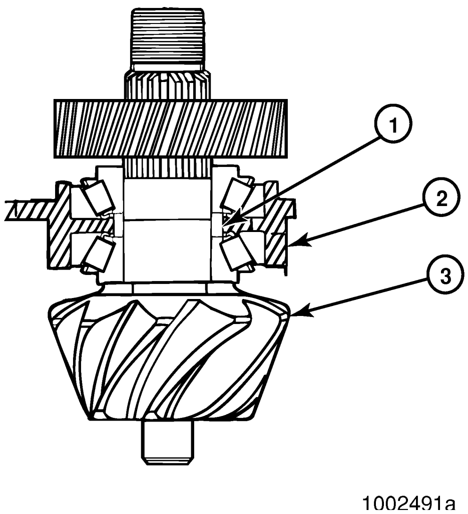


NOTE: The preload or rotational torque of the pinion bearings can be increased or decreased by tightening or loosening the pinion nut within the torque range from 1200 to 1500 lb-ft (1627-2033 N•m). T

9. If the preload or rotational torque of the bearings on the drive pinion is not within specifications:
   A. Remove the nut and washer from the drive pinion.
   B. Use a press and a sleeve to remove the helical drive gear from the drive pinion, or heat the assembly in a hot solution tank from 160 to 180°F (71-82°C) for 10 to 15 minutes. Do not use a torch or an open flame for this procedure.

C. Remove the spacer from the shaft of the drive pinion and install a different spacer. Install a thinner bearing spacer to increase preload or rotational torque. Install a thicker bearing spacer to decrease preload or rotational torque. **Figure 4.14**.

Figure 4.14



1 BEARING SPACER
2 BEARING CAGE
3 DRIVE PINION

INCREASE PRELOAD = INSTALL THINNER SPACER
DECREASE PRELOAD = INSTALL THICKER SPACER

D. Repeat Steps 1-9 of this procedure.

CAUTION

Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.

E. Partially install the seal onto the yoke to 1/4- to 1/2-inch but not snug against yoke flange.

NOTE: Do not install seal against shoulder. Seal is designed to position itself as yoke is installed.

F. Before installing the yoke onto the drive pinion, lubricate the yoke again with the same lubricant used in the axle housing.

10. If preload or rotational torque is within the specified range, go to "Adjusting the Thickness of the Shim Pack for the Pinion Cage (Depth of Pinion)" in this section.

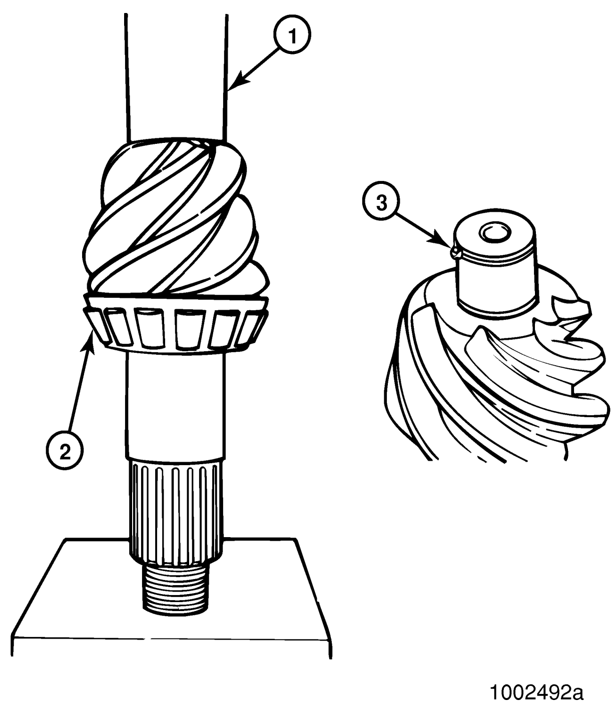
Spigot Bearing Installation

If the spigot bearing was removed, install a new spigot bearing. Refer to the following procedure for the spigot bearing that is used on the drive pinion.

One-Piece Spigot Bearing

1. Use a press and a sleeve to install the spigot bearing.
2. Place the sleeve on the inner race of the spigot bearing. Press the bearing onto the head of the drive pinion. **Figure 4.15**.
3. Install the snap ring on the spigot bearing. **Figure 4.15**.

Figure 4.15

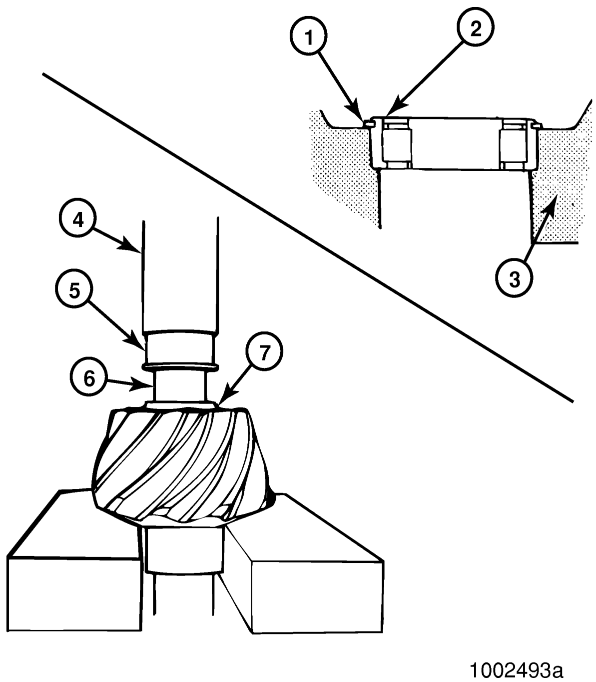


1 SLEEVE
2 REAR BEARING
3 SNAP RING

Two-Piece (Separate Race) Spigot Bearing 280/380 Series Only

1. Remove any old adhesive from the nose of the pinion. Then, apply a thin layer of Loctite 635 (Meritor part No. 1199-A-3250) to the outer diameter of the nose of the pinion. **Figure 4.16**.
2. Press the inner race on the nose of the drive pinion until the race is against the shoulder of the pinion. **Figure 4.16**.
3. Install the snap ring on the outer race and roller assembly. **Figure 4.16**.
4. Push the other race and roller assembly into the bore in the carrier until the snap ring is against the shoulder of the carrier. **Figure 4.16**.
5. Lubricate the rollers in the inner race with the lubricant that is used in the axle housing.

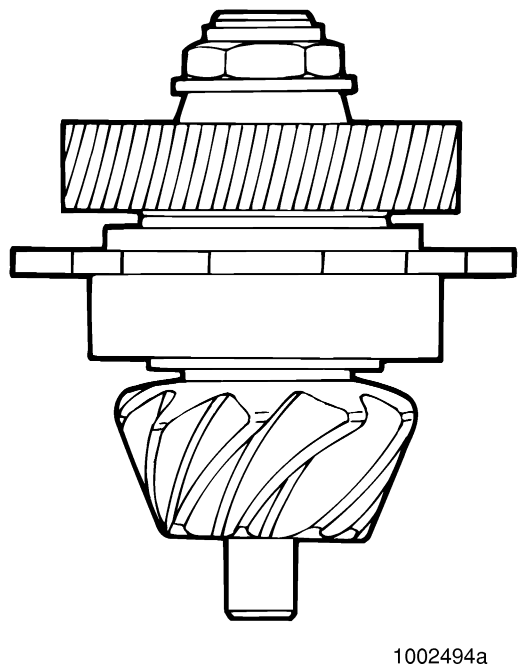
Figure 4.16



1 SNAP RING–TOWARD DRIVE PINION
2 OUTER RACE
3 CARRIER
4 SLEEVE
5 INNER RACE
6 APPLY ADHESIVE HERE
7 SHOULDER OF DRIVE PINION

Adjusting the Thickness of the Shim Pack for the Pinion Cage (Depth of Pinion)

Figure 4.17

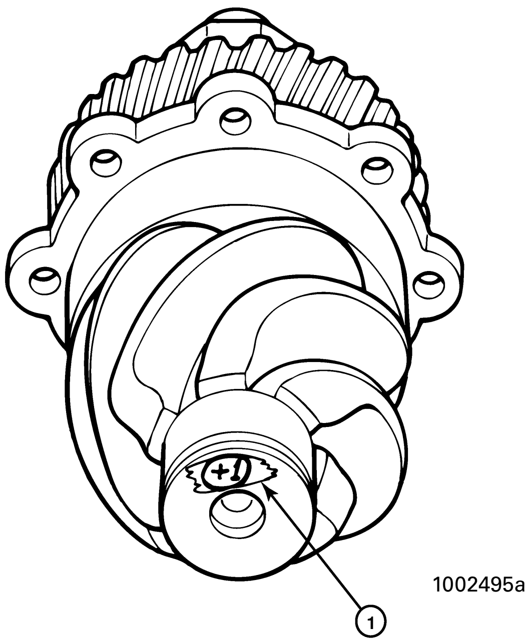


NOTE: Use this procedure if a new drive pinion and a ring gear set is installed, or if the depth of the drive pinion has to be adjusted.

1. Use a micrometer to measure the thickness of the shim pack that was removed from the bearing cage. Record the measurement for later use. **Figure 4.17**.

2. Look at the pinion cone (PC) variation number on the drive pinion that is being replaced. Refer to Step 4 under "Gear Set Information — Markings on the Drive and the Ring Gear" in this section for examples and location of the number. Record the number for later use. **Figure 4.18**.

Figure 4.18



1 PINION CONE VARIATION NUMBER

NOTE: The pinion cone number can be either 1,000ths of an inch (0.000-inch) or 100ths of a millimeter (0.00 mm). Refer to the following examples:

- PC +3, PC–3, +3 or –3 equal 0.003-inch.
- PC +.03, PC –.03 mm, +.03 mm or –.03 equal 0.03 mm.

NOTE:
- To change inches to millimeters, multiply inches by 25.400.
- To change millimeters to inches, multiply millimeters by 0.039.

3. If the old pinion cone number is a plus (+), subtract the cone number from the thickness of the old shim pack that was measured in Step 2.
4. If the old pinion cone number is a minus (–), add the cone number to the thickness of the old shim pack that was measured in Step 2.
5. Look at the pinion cone (PC) variation number on the new drive pinion that will be installed. Record the number for later use.
6. If the new pinion cone number is a plus (+), add the number to the standard shim pack thickness that was calculated in Step 3 or 4. Make a shim pack of new shims to the determined thickness. For an example, refer to **Table A**.
7. If the new pinion cone number is a minus (–), subtract the number from the standard shim pack thickness that was calculated in Step 3 or 4. Make a shim pack of new shims to the determined thickness. For an example, refer to **Table A**.

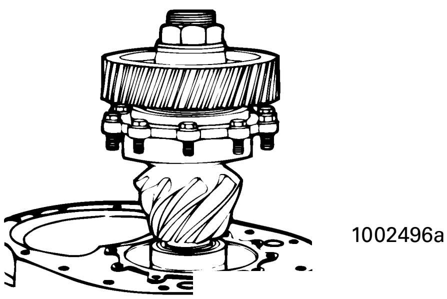
Table A

Examples:	Inches	mm
1. Old Shim Pack Thickness Old PC Number, PC +2 Standard Shim Pack Thickness New PC Number, PC +5 New Shim Pack Thickness	.030 – .002 = .028 + .005 = .033	.760 – .050 = .710 + .130 = .840
2. Old Shim Pack Thickness Old PC Number, PC –2 Standard Shim Pack Thickness New PC Number, PC +5 New Shim Pack Thickness	.030 + .002 = .032 + .005 = .037	.760 + .050 = .810 + .130 = .940
3. Old Shim Pack Thickness Old PC Number, PC +2 Standard Shim Pack Thickness New PC Number, PC –5 New Shim Pack Thickness	.030 – .002 = .028 – .005 = .023	.760 – .050 = .710 – .130 = .580
4. Old Shim Pack Thickness Old PC Number, PC –2 (–.05 mm) Standard Shim Pack Thickness New PC Number, PC –5 (–.13 mm) New Shim Pack Thickness	.030 + .002 = .032 – .005 = .027	.760 + .050 = .810 – .130 = .680
NOTE: Drive pinions and ring gears **must** be replaced as matched sets.		

Installation of the Drive Pinion and the Bearing Cage Assembly

1. Place the drive pinion and cage assembly in the pinion bore of the differential carrier. Use a plastic or leather hammer and tap on the cage to install the cage against the carrier. Make sure that the capscrew holes in the cage are aligned with the holes in the carrier. Make sure the cage is installed flat against the carrier. **Figure 4.19**.

Figure 4.19

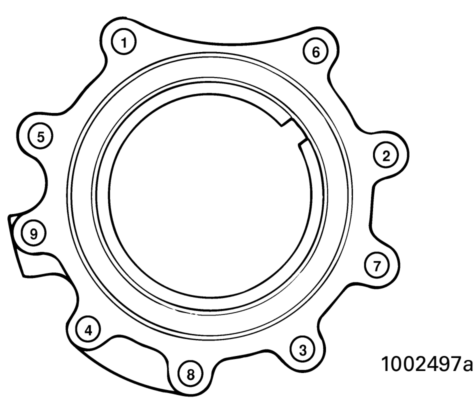


NOTE: Meritor recommends use of Loctite® on fastener retention. Refer to Section 3.

NOTE: The capscrews that fasten the cage to the carrier were installed in the cage during the preload adjustment of the drive pinion bearings.

2. Apply Loctite 680 and tighten each capscrew three turns according to the progressive torque sequence shown in **Figure 4.20**. Continue to tighten in this sequence until the cage is flat against the carrier, loosen the capscrews and tighten from 180 to 230 lb-ft (244-311 N•m). T

Figure 4.20



TORQUE SEQUENCE

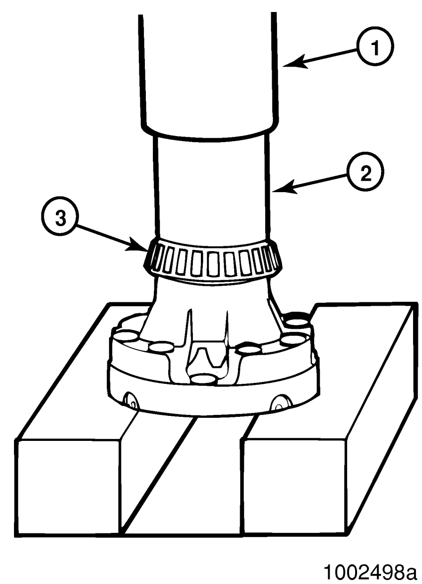
Assembling the Main Differential Case and the Ring Gear

CAUTION

Do not press a cold ring gear on the flanged half of the differential case. A cold ring gear will damage the case because of the tight fit. Metal particles between the parts will cause gear runout that exceeds Meritor specification of 0.008-inch (0.200 mm).

1. If the bearing cones on the main differential case were removed, install a new cone and new cup in a fully matched set from the same manufacturer. Use a press and a sleeve to install the cones on the case. Press on the inner race of the bearing. **Figure 4.21**.

Figure 4.21



1 PRESS
2 SLEEVE
3 BEARING CONE

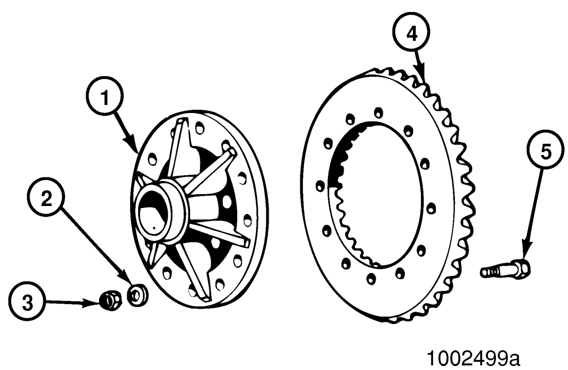
2. Expand the ring gear by heating the gear in a tank or oven of water to a temperature of 160 to 180°F (71-82°C) for 10 to 15 minutes. **Do not use an open flame such as a torch for this procedure.**

WARNING

Wear safe clothing such as gloves and a shop coat for protection from personal injury in case accidental contact with the hot ring gear does occur.

3. Use a lifting tool to safely lift the ring gear from the tank of water.
4. Immediately install the ring gear on the flanged half of the differential case. If the ring gear does not fit easily on the flange, heat the gear again in a tank of hot water. Repeat Step 2. Rotate the ring gear to align the fastener holes in the case with the holes in the gear case.
5. Replace with new bolts, new washers and new nuts to fasten the ring gear to the flange. Refer to the following procedure.
   A. Install the bolts from the gear side of the assembly. The heads of the bolts must be installed through the tooth side of the ring gear. **Figure 4.22**.

Figure 4.22



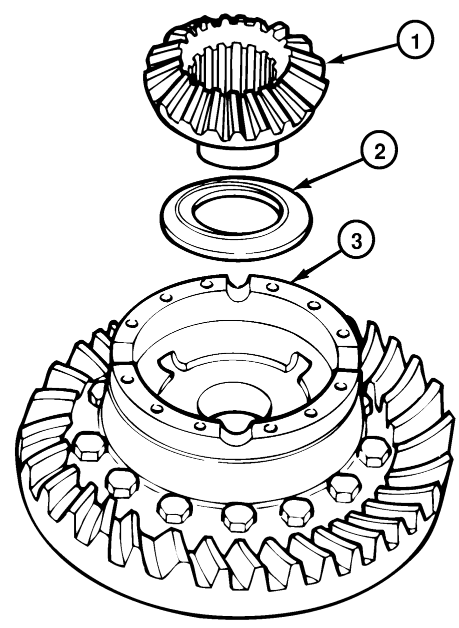
1 DIFFERENTIAL CASE — FLANGE
2 WASHER
3 NUT
4 RING GEAR
5 BOLT — INSTALL FROM RING GEAR SIDE

NOTE: A flange nut is used on some axle models instead of a nut and a washer.

   B. Install the washers on the bolts from the flange side of the assembly.
   C. Install the nuts and tighten to the specified torque. Refer to **Table H**.

6. Lubricate the following parts with the lubricant used in the axle housing:
   - Inner Walls of the Differential Case
   - Thrust Washers
   - Side Gears
   - Spider
   - Pinions
   - Bearing Cups and Cones
7. Place a thrust washer and a side gear in each half of the differential case. **Figure 4.23**.

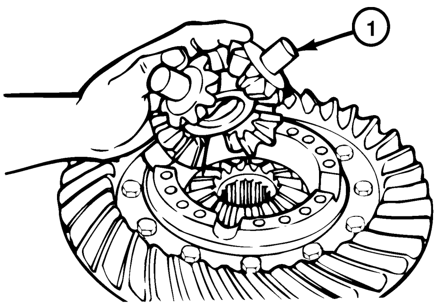
Figure 4.23



1 SIDE GEAR
2 THRUST WASHER
3 FLANGE CASE HALF

8. Install the four pinions and four thrust washers on the spider. **Figure 4.24**.
9. Install the spider and pinion assembly in the plain half of the differential case. **Figure 4.24**.

Figure 4.24



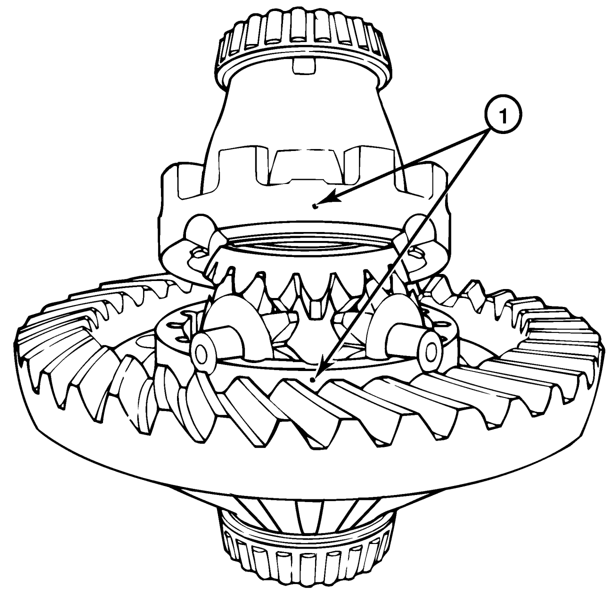
1 SPIDER, PINIONS AND THRUST WASHERS

10. Assemble the halves of the differential case together. Make sure the original match marks on each case half are aligned prior to differential case disassembly. **Figure 4.25**.

NOTE: Meritor recommends the application of Loctite® to the fasteners to ensure differential assembly integrity. Refer to "Installing Fasteners with Pre-applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent" in Section 3.

11. Install one center capscrew into each quadrant of differential case assembly first. Tighten the four capscrews in progressive steps to evenly pull the case halves together.
12. Install the remaining capscrews and tighten all the capscrews to the specified torque. Refer to **Table H**. T
13. Inspect the rotating resistance of the side gears in the main differential case as described below.

Figure 4.25



1 MARKS

Inspecting the Rotating Resistance of the Side Gears on the Main Differential Case

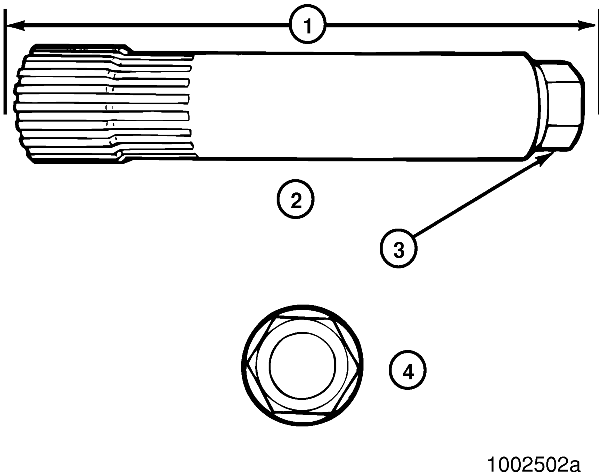
Specification:

- 50 lb-ft (67 N•m) maximum torque applied to one side gear. T

NOTE: Make a tool for inspecting the rotating resistance of the side gears in the main differential case. The tool can be made from an axle shaft that matches the spline size of the differential side gear. **Figure 4.26**.

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

Figure 4.26



1 APPROXIMATELY 12 INCHES (304.8 mm)
2 SIDE VIEW
3 WELD NUT TO END OF SHAFT
4 END VIEW

3. Install the tool into the differential until the splines of the tool and one side gear are engaged. **Figure 4.27**.
4. Attach a torque wrench to the nut of the tool and rotate the gears in the differential case. When the gears rotate, read the value indicated on the torque wrench. **Figure 4.28**.

Figure 4.27

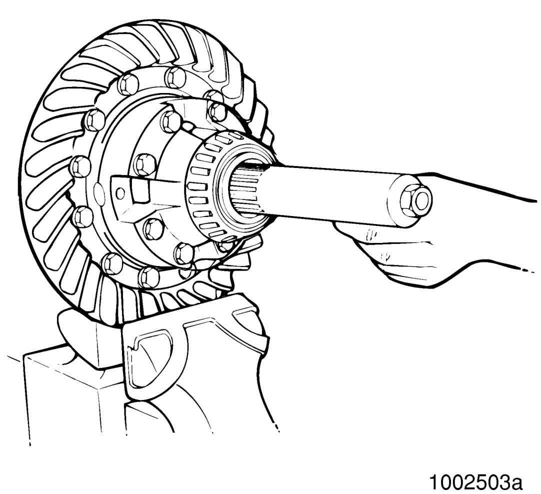
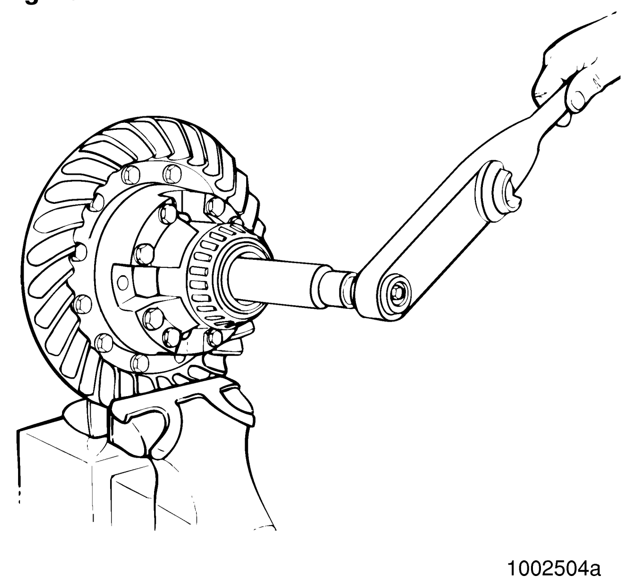


Figure 4.28

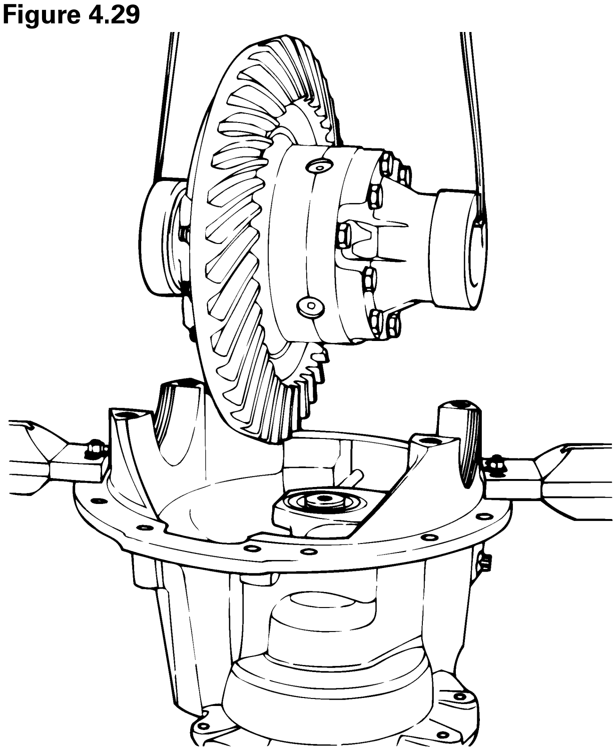


5. If the torque value exceeds the specification, separate the halves of the differential case. Check the following for the problem that caused the torque value to be exceeded:
   - Thrust Washers
   - Side Gears
   - Differential Pinions
   - Spider
   - Case Halves
6. After the parts are repaired or replaced, assemble the main differential case and repeat Steps 1-5.

Installation of the Main Differential Case and Ring Gear Assembly into the Carrier

1. Lubricate the bearing cups and cones with the lubricant used in the axle housing.
2. Install the cups over the bearing cones.
3. Place the main differential case and ring gear assembly in the carrier. **Figure 4.29**.

Figure 4.29



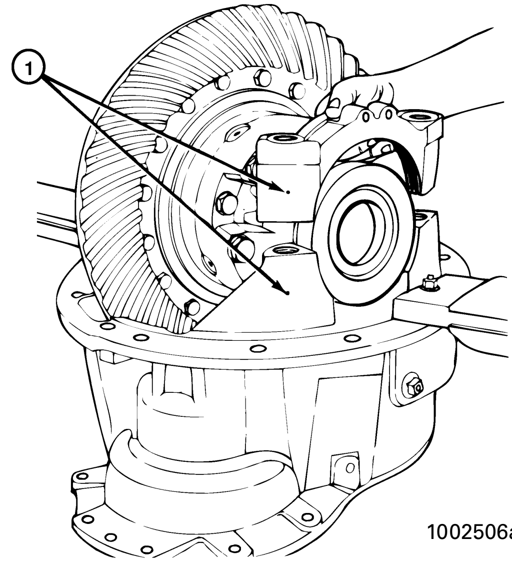
1002505a

CAUTION

The bearing caps must be correctly installed or the adjusting rings will be damaged by cross-threading. Forcing the caps into position damages the caps and the carrier housing.

4. Install the bearing caps on the correct legs in the carrier. The caps must be installed in the position marked during removal. If necessary, use a plastic or leather hammer to tap the caps in position. **Figure 4.30**.

Figure 4.30



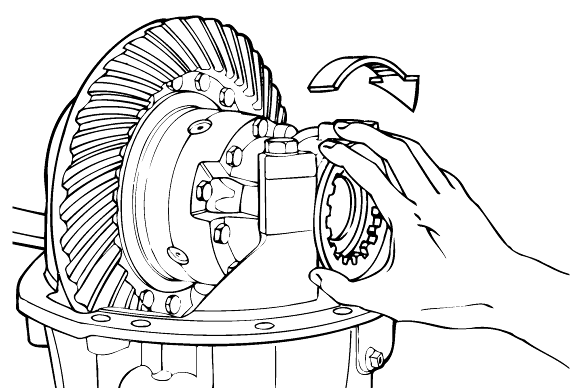
1002506a

1 MARKS

NOTE: The capscrews and locks for the bearing adjusting rings are installed after the preload for the differential side bearings is adjusted.

5. Install the capscrews that fasten the bearing caps to the carrier housing. Tighten the capscrews from 290 to 350 lb-ft (393-474 N•m). T
6. Install and hand tighten the adjusting rings in the housing. **Figure 4.31**.

Figure 4.31



1002507a

Adjusting the Preload on the Differential Side Bearings

Specification:

- Preload of Differential Side Bearings: from 15- to 35 lb-in (1.7-3.9 N•m) torque T
- Expansion Between Bearing Caps: 0.006- to 0.013-inch (0.152-0.330 mm)

There are two methods for inspecting and adjusting the preload on the differential side bearings:

- Dial Indicator Method
- Micrometer Method

Dial Indicator Method

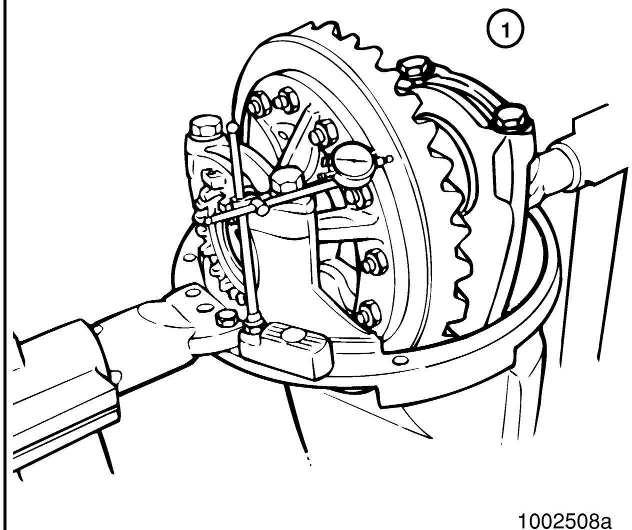
1. Attach a dial indicator on the mounting flange of the carrier.
2. Adjust the dial indicator so that the plunger or the pointer is against the back surface of the ring gear. **Figure 4.32**.

CAUTION

When you turn 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. **Figure 4.33**.

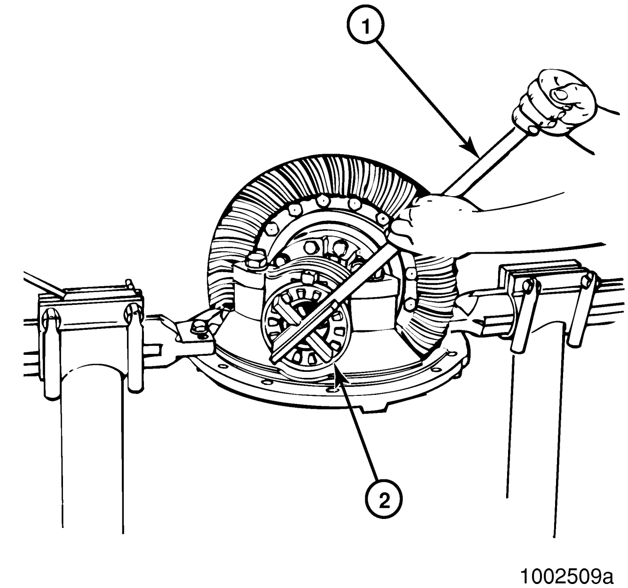
3. Loosen the bearing ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator. Move the differential and the ring gear to the left and right with pry bars while you read the dial indicator. Use one of the following methods:

Figure 4.32



1 DIAL INDICATOR

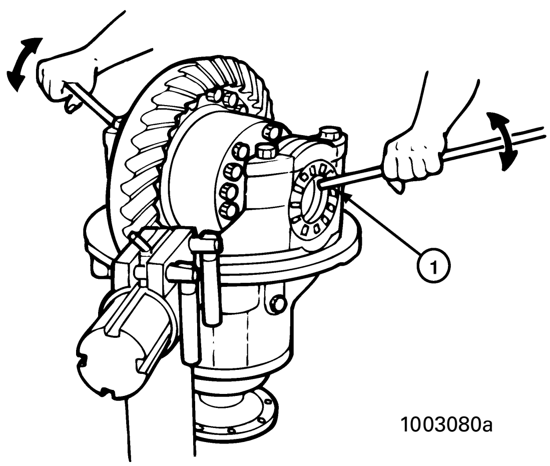
Figure 4.33



1 "T" BAR WRENCH
2 ADJUSTING RING OPPOSITE RING GEAR

A. Use two pry bars that fit between the bearing adjusting rings and the ends of the differential case. The pry bars must not touch the differential bearings. **Figure 4.34**.

Figure 4.34

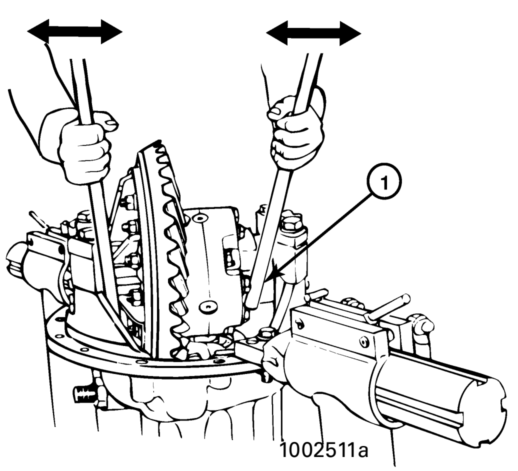


1 BARS MUST NOT TOUCH BEARINGS

B. Use two pry bars between the differential case or the ring gear and the carrier at locations other than those described in Step A. The pry bars must not touch the differential bearings. **Figure 4.35**.

4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential with the pry bars to the left and right as needed to measure end play. Repeat Steps A and B.

Figure 4.35



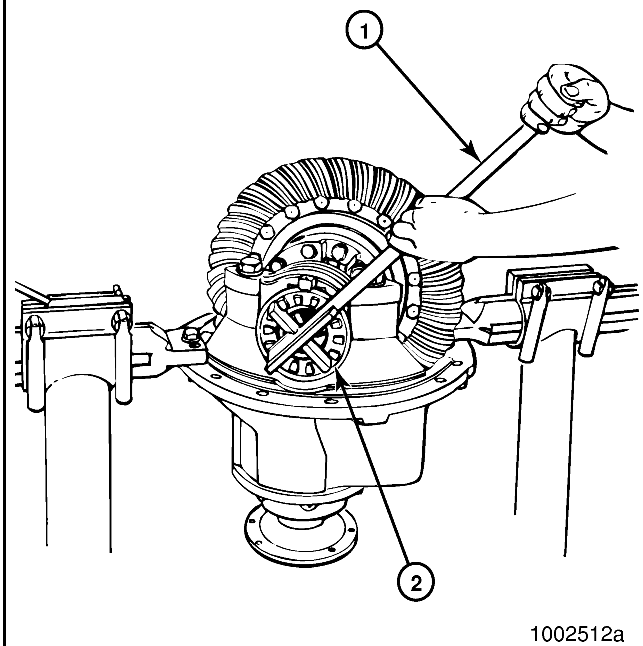
1 BARS MUST NOT TOUCH BEARINGS

5. Tighten each adjusting ring one notch from the zero end play measured in Step 4. The side bearings of the differential now have a preload from 15 to 35 lb-in (1.7-3.9 N•m). **Figure 4.36**.

T

6. Continue by checking runout of the ring gear.

Figure 4.36



1 "T" BAR WRENCH
2 TIGHTEN EACH RING ONE NOTCH

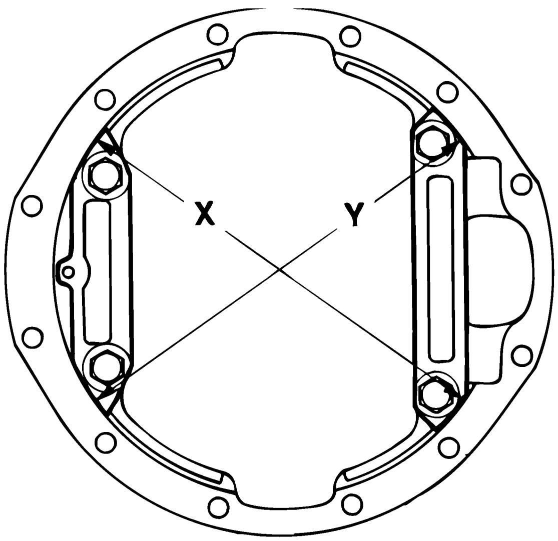
Micrometer Method

A second method of checking preload is to measure the expansion between the bearing caps after you tighten the adjusting rings. Use the following procedure:

1. Turn both adjusting rings hand tight against the differential bearings.

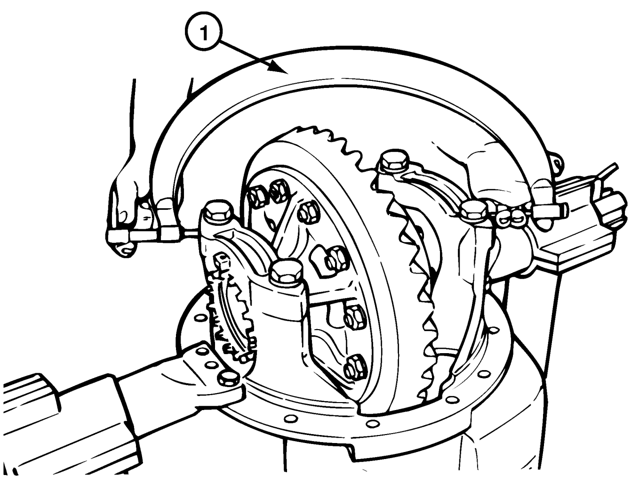
2. Measure the distance X or Y between opposite surfaces of the bearing caps. Use a large micrometer of the correct size. Make a note of the measurement. **Figure 4.37** and **Figure 4.38**.

Figure 4.37



1003082a

Figure 4.38



1003083a

1 MICROMETER

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 ring notches, damage to the lugs will occur.

3. Tighten each adjusting ring one notch. **Figure 4.36**.
4. Measure the distance X or Y again. Compare the dimensions with the distance X or Y measured 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 = 17.498-inch (444.450 mm)

   - Distance X or Y

     — after tightening adjusting rings = 17.509-inch (389.230 mm)

     17.507-inch – 17.498-inch = 0.009-inch difference

     444.680 mm – 444.450 mm = 0.230 mm difference

5. If the dimension is within specifications, continue by checking runout of the ring gear. If the dimension is less than specifications, repeat Steps 3 and 4 as needed.

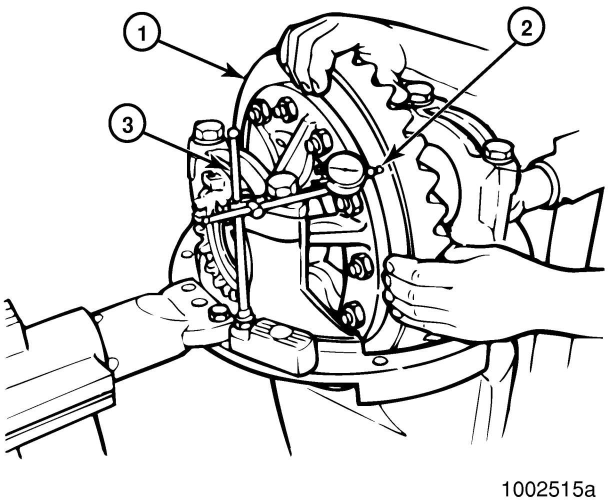
Inspecting the Runout of the Ring Gear

Specification:

- 0.008-inch (0.200 mm) maximum

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 4.39**.
2. Adjust the dial indicator so that the plunger or the pointer is against the back surface of the ring gear. **Figure 4.39**.

Figure 4.39



1 ROTATE RING GEAR
2 PLUNGER OR POINTER
3 DIAL INDICATOR

3. Adjust the dial of the indicator to zero (0).
4. Rotate the differential and ring gear assembly while you read the dial indicator. The runout of the ring gear must not exceed 0.008-inch (0.020 mm).

   If the runout of the ring gear exceeds specification, as in the example, remove the differential and ring gear assembly from the carrier. Refer to the procedure under “Removing the Main Differential Case and Ring Gear Assembly” in Section 2.
5. Inspect the differential parts, including the carrier, for the problem that caused the runout of the ring gear to exceed specifications. Repair or replace parts.
6. After the parts are repaired or replaced, install the main differential case and ring gear assembly into the carrier. Refer to the procedure under “Installation of the Main Differential Case and Ring Gear Assembly into the Carrier” in this section.
7. Repeat the preload adjustment of the differential side bearings, starting under “Adjusting the Preload on the Differential Side Bearings” in this section.

Adjusting the Backlash of the Ring Gear

Specification:

- **Range of Backlash Setting:** 0.008- to 0.020-inch (0.200-0.510 mm)
- **Backlash Setting for New Gear Sets:** 0.014-inch (0.355 mm)

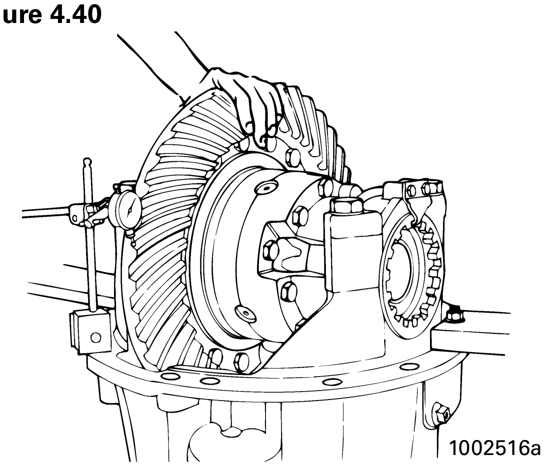
If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gear set is installed, adjust the backlash to the correct specification for new gear sets.

During the inspection of the tooth contact patterns, the backlash can be adjusted within specification limits, if needed, to change the location of the pattern.

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 4.40**.
2. Adjust the dial indicator so that the plunger or the pointer is against a tooth surface. **Figure 4.40**.

Figure 4.40

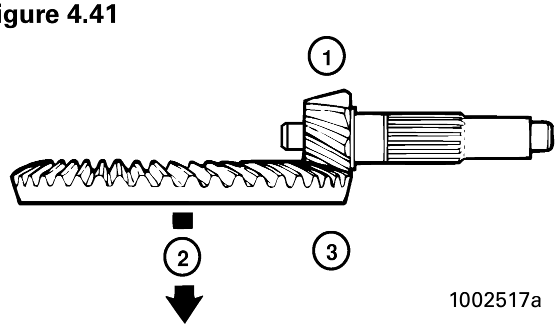


3. Adjust the dial indicator to zero (0).
4. Hold the drive pinion in position.
5. While you read the dial indicator, rotate the differential and ring gear a small amount in both directions, against the teeth of the drive pinion. If the backlash reading is within specifications, continue by inspecting tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed.
6. Loosen one bearing adjusting ring one notch, then, tighten the opposite ring the same amount. **Figure 4.41** and **Figure 4.42**.

   Backlash is increased by moving the ring gear away from the drive pinion.

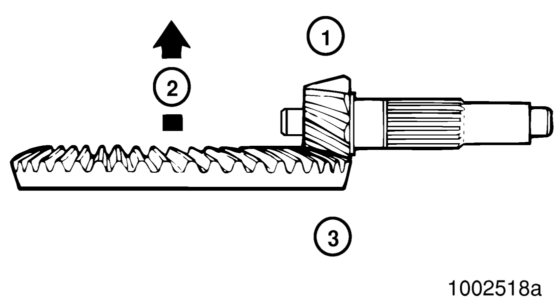
   Backlash is decreased by moving the ring gear toward the drive pinion.

Figure 4.41



1 TIGHTEN ADJUSTING RING THIS SIDE
2 INCREASE BACKLASH
3 LOOSEN ADJUSTING RING THIS SIDE

Figure 4.42



1 LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 TIGHTEN ADJUSTING RING THIS SIDE

NOTE: When you adjust backlash, only move the ring gear. Do not move the drive pinion.

7. Repeat Steps 2-6 until the backlash is within specifications.

Inspecting the Tooth Contact Patterns of the Gear Set

General Information

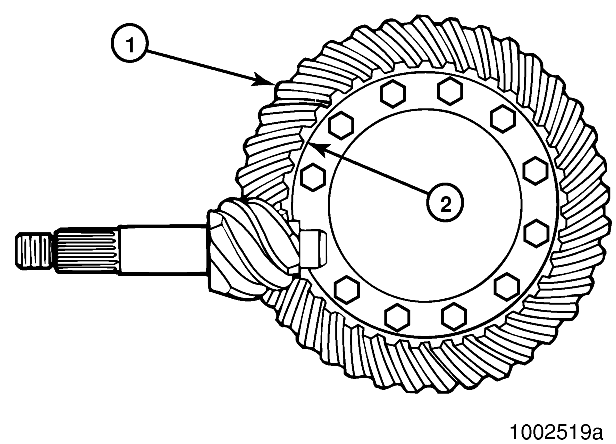
Meritor carrier can have a conventional hypoid gear set or a **generoid** hypoid gear set. The tooth contact patterns for each type of gear set are different. Look at the part numbers to see what type of gear set is in the carrier. Refer to **Figure 4.1** for the location of part numbers.

Examples:

- Part numbers for conventional gear sets
  — 36786 for the ring gear
  — 36787 for the drive pinion
- Part numbers for **generoid** gear sets
  — 36786-K for the ring gear
  — 36787-K for the drive pinion

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. **Figure 4.43**.

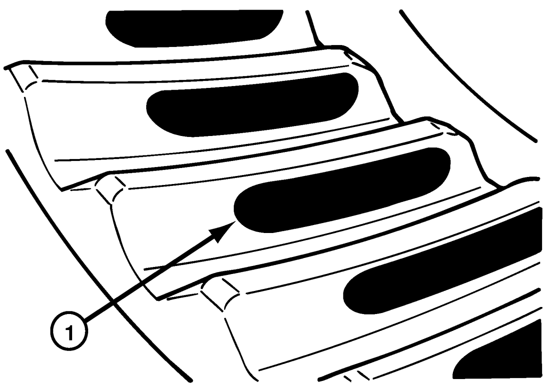
Figure 4.43



1 HEEL
2 TOE

Always inspect tooth contact patterns on the drive side of the gear teeth. **Figure 4.44**.

Figure 4.44

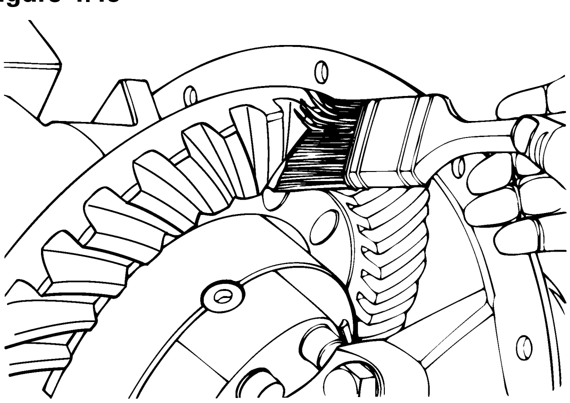


1 DRIVE SIDE (CONVEX)

Tooth Contact Patterns of Conventional Hypoid and Generoid Hypoid Gear Sets

1. Adjust the backlash of a new gear set to 0.014-inch (0.355 mm). Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. Refer to Step 3 under "Removing the Main Differential Case and Ring Gear Assembly" in Section 2.
2. Apply a marking compound to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion. **Figure 4.45**.

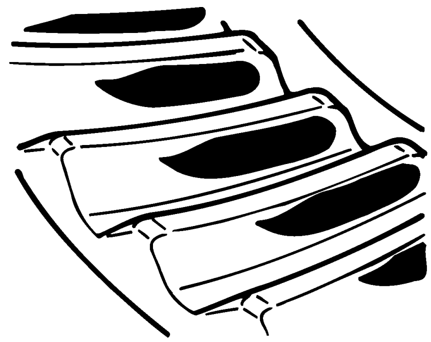
Figure 4.45



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

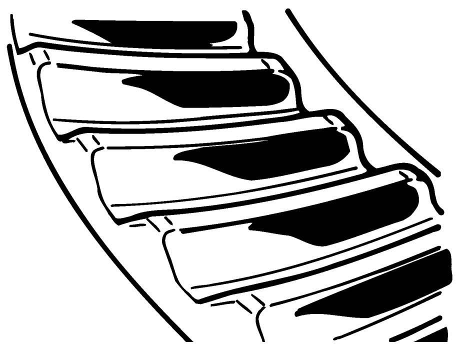
Conventional Gears

Figure 4.46



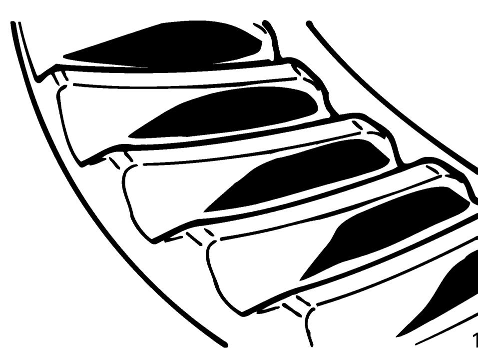
GOOD HAND-ROLLED PATTERN

Figure 4.47



HIGH PATTERN

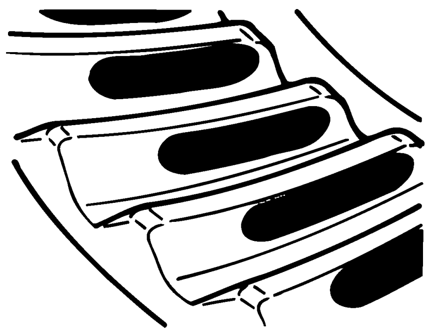
Figure 4.48



LOW PATTERN

Generoid Gears

Figure 4.49

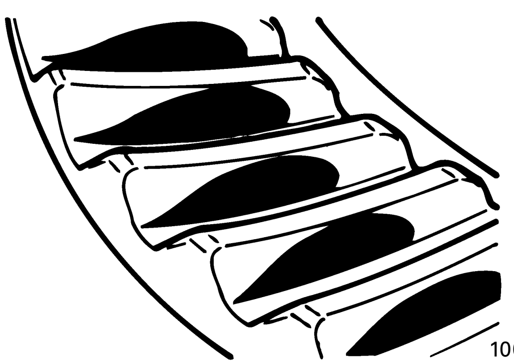


GOOD HAND-ROLLED PATTERN

Figure 4.50

HIGH PATTERN

Figure 4.51



LOW PATTERN

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to the patterns above.

   The Location of Good Hand-Rolled Contact Patterns

   New Conventional Gear Sets — toward the toe of the gear tooth and in the center between the top and bottom of the tooth. **Figure 4.46.**

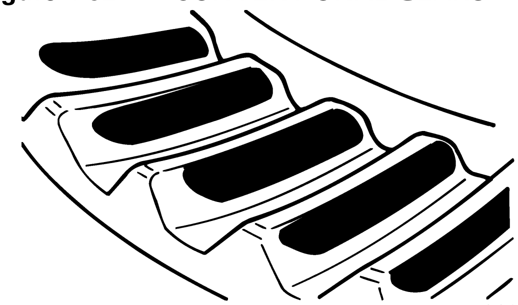
   New Generoid Gear Sets — between the center and toe of the tooth and in the center between the top and bottom of the tooth. **Figure 4.49**.

   When the carrier is being 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. **Figure 4.52** or **Figure 4.53**.

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

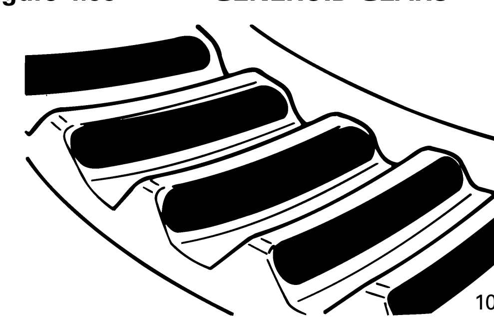
   If the contact pattern requires adjustment, continue by following Step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following Step 6.

Figure 4.52 CONVENTIONAL GEARS



GOOD PATTERN IN OPERATION

Figure 4.53 GENEROID GEARS



GOOD PATTERN IN OPERATION

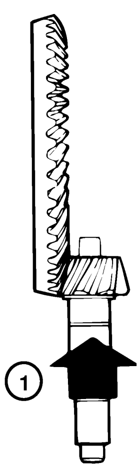
5. Change the thickness of the shim pack under the bearing cage to move the contact patterns between the top and the bottom of the gear teeth. Use the following procedure:

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

   A. Remove the drive pinion and the bearing cage from the carrier. Refer to the procedure under “Removing the Drive Pinion and the Cage Assembly” in Section 2.
   B. To correct a high contact pattern, decrease the thickness of the shim pack under the bearing cage. When you decrease the thickness of the shim pack, the drive pinion will move toward the ring gear. **Figure 4.54**.

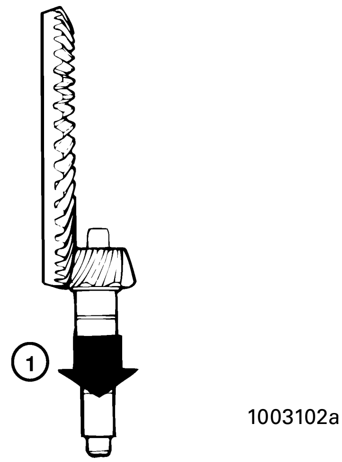
      To correct a low contact pattern, increase the thickness of the shim pack under the bearing cage. When you increase the thickness of the shim, the drive pinion will move away from the ring gear. **Figure 4.55**.

Figure 4.54



1 DECREASE SHIM PACK

Figure 4.55

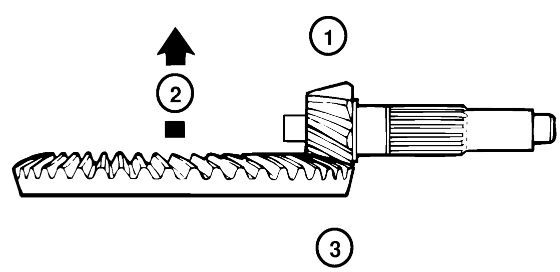


1 INCREASE SHIM PACK

   C. Install the drive pinion, bearing cage and shims into the carrier. Refer to the procedure under “Installation of the Drive Pinion and the Bearing Cage Assembly” in this section.
   D. Repeat Steps 2-4 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust the backlash of the ring gear with the specification range to move the contact patterns to the correct location in the length of the gear teeth. Refer to the procedure under “Adjusting the Backlash of the Ring Gear” in this section.
   A. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth. **Figure 4.56**.

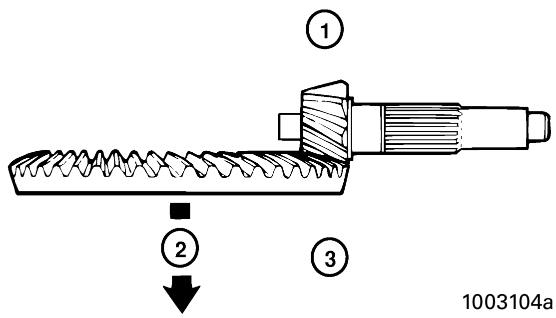
Figure 4.56



1 MOVE PATTERN TOWARD TOE LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 TIGHTEN ADJUSTING RING

B. Increase backlash to move the contact patterns toward the toe of the ring gear teeth. **Figure 4.57**.

Figure 4.57



1 MOVE PATTERN TOWARD TOE LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 LOOSEN ADJUSTING RING

C. Repeat Steps 2-4 until the contact patterns are at the correct location in the length of the gear teeth.

7. Install the lock plate on the bearing cap so that the tab is between the lugs of the adjusting ring. Install the two capscrews that fasten the lock plate to the adjusting ring. Tighten the capscrews from 20 to 30 lb-ft (28-40 N•m). Install the lock plate on the opposite bearing cap. T

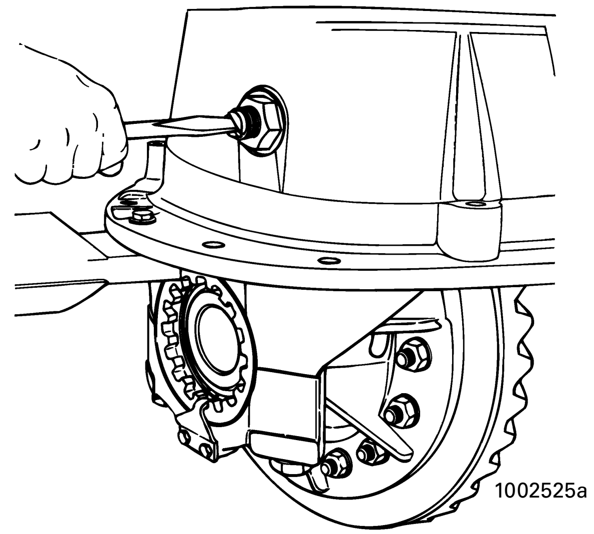
Installing and Adjusting the Thrust Screw for the Ring Gear

Specification:

- Clearance between the ring gear and the thrust screw
  — 0.025 to 0.045-inch (0.635-1.143 mm)

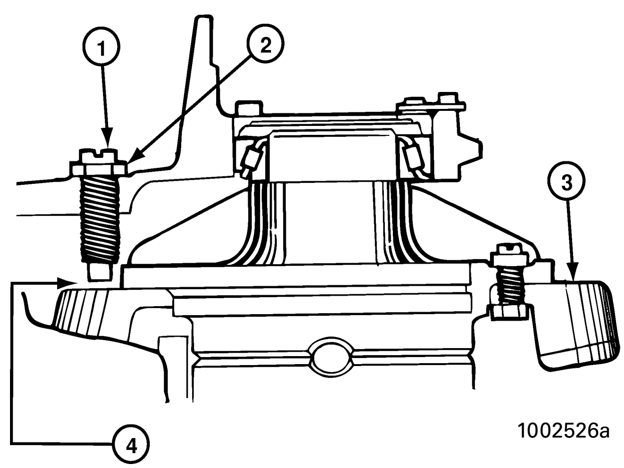
1. If the thrust screw is installed in the differential carrier, remove the thrust screw and the jam nut.
2. Lubricate the end of the thrust screw that touches the ring gear with grease.
3. Install the thrust screw and the jam nut in the carrier.
4. Loosen the jam nut on the thrust screw.
5. Tighten the thrust screw until the end of the screw touches the ring gear. If necessary, loosen the jam nut. **Figure 4.58**.

Figure 4.58



6. Loosen the thrust screw 1/4 turn. Place a feeler gauge between the thrust screw and the ring gear. Inspect for a clearance of 0.025 to 0.045-inch (0.635-1.143 mm). If necessary, adjust the thrust screw to get the specified clearance. **Figure 4.59**.
7. Tighten the jam nut from 150 to 190 lb-ft (204-257 N•m). T

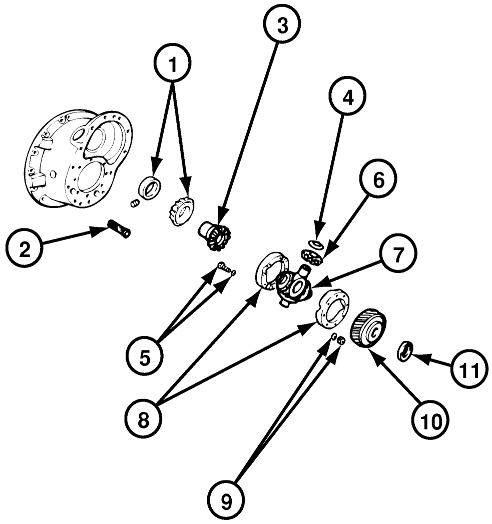
Figure 4.59



1 THRUST SCREW
2 JAM NUT
3 RING GEAR
4 0.025-0.45 INCH (0.635-1.443 MM) CLEARANCE

Assembling the Inter-Axle Differential

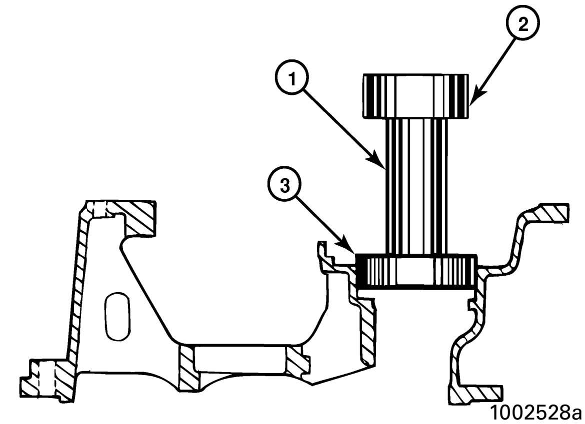
Figure 4.60



1 INPUT REAR BEARING CUP AND CONE
2 OIL FILTER SCREEN
3 DIFFERENTIAL SIDE GEAR
4 DIFFERENTIAL PINION THRUST WASHER
5 CAPSCREW AND WASHER
6 DIFFERENTIAL PINION
7 DIFFERENTIAL SPIDER
8 DIFFERENTIAL CASE HALF
9 WASHER AND NUT
10 HELICAL DRIVE GEAR AND DIFFERENTIAL SIDE GEAR ASSEMBLY
11 THRUST WASHER

1. Place the carrier in a repair stand so that the ring gear is away from you.
2. Lubricate the following parts with the lubricant that is used in the axle housing:
   - Inner Walls of the Inter-Axle Differential Case
   - Spider
   - Differential Pinions
   - Thrust Washers
   - Rear Side Gear
   - Bearing Cup and Cone of the Rear Side Gear
3. If the bearing cup for the rear side gear was removed, install a new cup in the differential carrier. Use a press and a sleeve to install the cup in the carrier. Make sure the cup touches the bottom of the bore in the carrier. **Figure 4.61**.

Figure 4.61

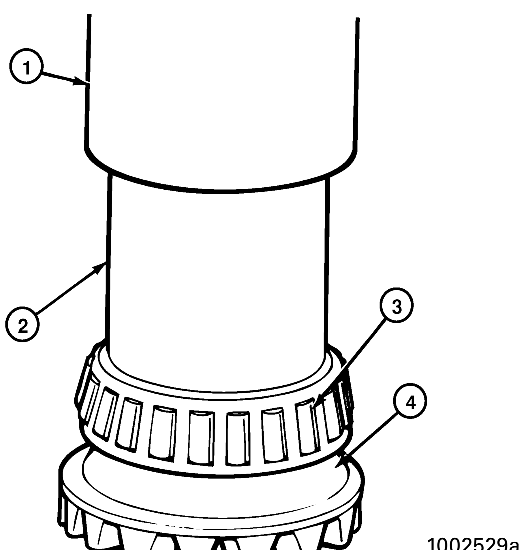


1 SLEEVE
2 PRESS
3 REAR SIDE GEAR BEARING CUP

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

4. If the bearing cone on the rear side gear was removed, install a new cone on the gear. Use a press and a sleeve to install the cone on the gear. Make sure the bottom of the cone touches the hub on the gear. **Figure 4.62**.

Figure 4.62

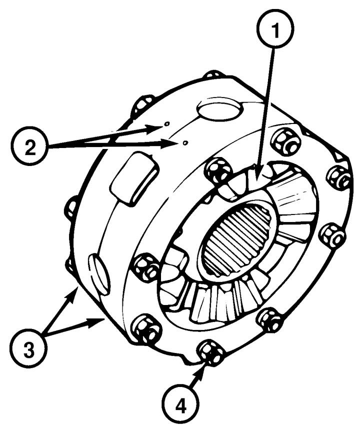


1 PRESS
2 SLEEVE
3 BEARING CONE
4 REAR SIDE GEAR

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

5. Place the rear side gear and bearing cone assembly in the differential carrier.
6. Install the pinions and the thrust washers on the spider.
7. Place the spider and pinion assembly in one of the case halves of the inter-axle differential.
8. Install the other case half over the case half and spider assembly. Make sure the marks on each case half are aligned with each other. **Figure 4.63**.

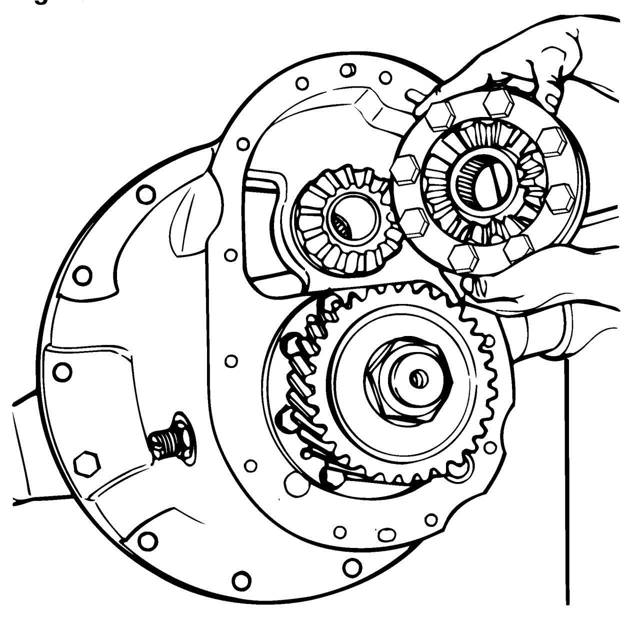
Figure 4.63



1 SPIDER, PINIONS & THRUST WASHERS
2 MATCH MARKS
3 CASE HALVES
4 BOLTS, NUTS & WASHERS

9. Loctite and install the bolts, washers and nuts that fasten the case halves together. Install a washer under each nut and bolt head. Tighten the bolts and nuts from 35 to 50 lb-ft (48-67 N•m). T
10. Install the inter-axle differential assembly in the case so that the nuts are toward the case. Make sure the pinion gears engage the rear side gear. **Figure 4.64**.

Figure 4.64



NOTE: On single-reduction carriers, the helical drive gear, the helical driven gear and the forward side gear are replaced as an assembly.

11. On single-reduction carriers, install the helical drive gear on the forward drive gear as follows:
    A. Expand the helical drive gear by heating the gear in a tank of hot water to a temperature of 160 to 180°F (71-82°C) for 10-15 minutes. **Do not use an open flame like a torch for this procedure.**

WARNING

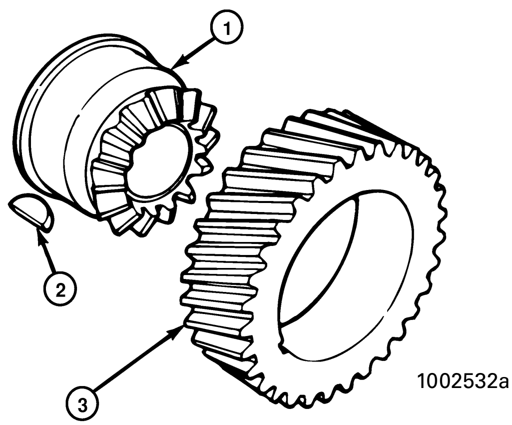
Wear safe clothing such as gloves that will protect you from injury when you touch the hot helical drive gear.

    B. Use a lifting tool to remove the helical drive gear from the tank of hot water. Place the gear on a press so that the flat side of the gear is against the press.
    C. Install the Woodruff key in the side gear.

D. Place side gear in the helical drive gear so that the Woodruff key is aligned with the slot in the drive gear. **Figure 4.65**.

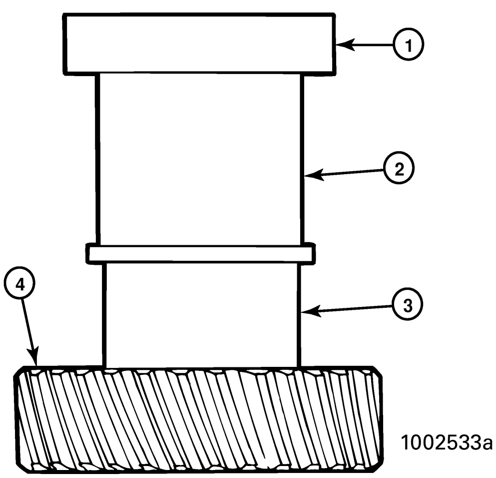
E. Use a press to install the side gear in the helical drive gear. Make sure the side gear touches the bottom of the drive gear. **Figure 4.66**.

Figure 4.65 TWO-PIECE ASSEMBLY ONLY



1 INTER-AXLE DIFFERENTIAL FORWARD SIDE GEAR
2 WOODRUFF KEY
3 HELICAL DRIVE GEAR

Figure 4.66 TWO-PIECE ASSEMBLY ONLY



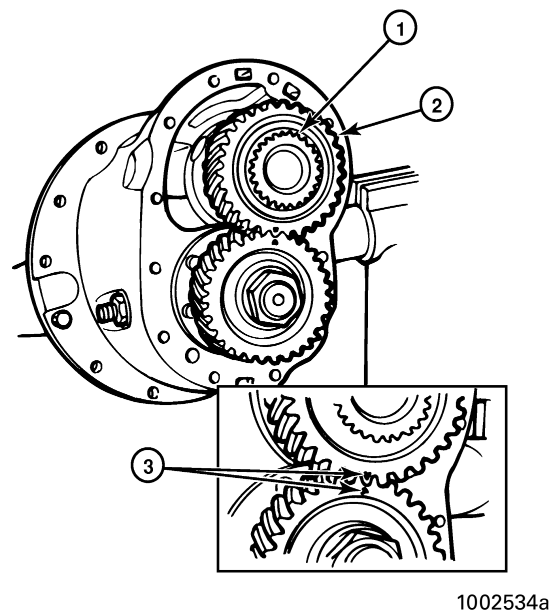
1 PRESS
2 SLEEVE
3 FRONT SIDE GEAR
4 HELICAL DRIVE GEAR

NOTE: The replacement helical drive gear and helical driven gears are replaced as a one-piece assembly.

12. Place the helical drive gear and forward side gear assembly in the inter-axle differential case. Make sure the marks on the helical drive gear and the helical driven gear are aligned. Make sure the pinions of the inter-axle differential engage the forward side gear. Make sure all the gears rotate freely. **Figure 4.67**.

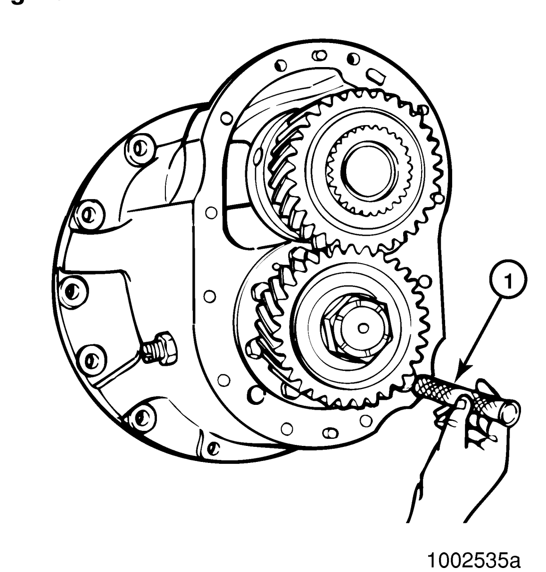
13. Install the oil filter screen in the differential carrier. **Figure 4.68**.

Figure 4.67



1 FORWARD SIDE GEAR
2 HELICAL DRIVE GEAR
3 MATCH MARKS

Figure 4.68



1 OIL FILTER SCREEN

Installing the Oil Pump Idler Gear — Original Design

There are three types of oil pump idler gears:

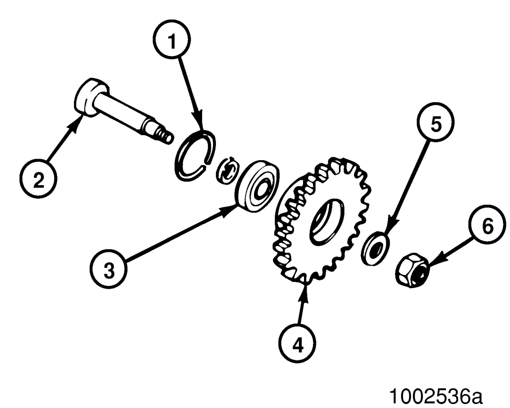
- Ball Bearing. **Figure 4.69**.
- Cone and Roller Bearing with Idler Sleeve. **Figure 4.70**.
- Cone and Roller Bearing with Solid Idler Shaft. **Figure 4.71**.

NOTE: If a rotor-type oil pump is being installed on a cover that uses the gear-type oil pump, refer to Section 5 of this manual.

Oil Pump Idler Gear — Ball Bearing

1. Support the bearing on the inner race. Use a press to install the idler gear shaft in the bearing. Make sure the bearing rotates freely. **Figure 4.69**.
2. Install the shaft and bearing assembly in the gear. Install the snap ring that holds the bearing in the idler gear bore.
3. Install the spacer on the idler gear shaft.
4. Place the idler gear and shaft assembly in the helical gear cover.
5. Install the washer and the nut on the idler gear shaft. Tighten the nut according to specifications. Refer to **Table H**. T

Figure 4.69

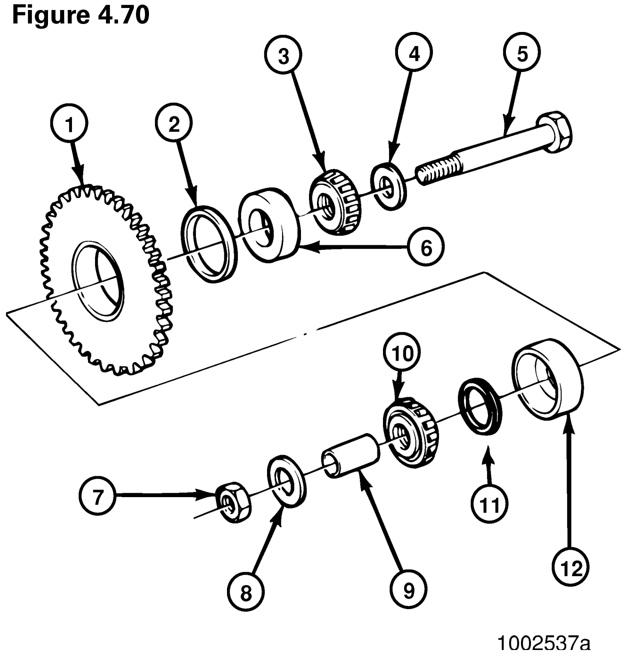


1 SNAP RING
2 IDLER GEAR SHAFT
3 BEARING
4 PUMP IDLER GEAR
5 WASHER
6 LOCK NUT

Oil Pump Idler Gear — Cone and Roller Bearing with Idler Sleeve

1. Place the spacer in the center slot of the idler gear bore. **Figure 4.70**.
2. Place the bearing cone in the gear bore. Use a press and a sleeve to install the cone in the bore. Press the cone until it touches the spacer. Make sure the spacer remains in the center slot of the gear bore. Repeat this procedure for the other bearing cone.
3. Use a press and a sleeve to install the idler sleeve in the helical gear cover.
4. Install the cone and roller bearings and spacer in the idler gear. Make sure the spacer is between the bearing cones.
5. Place the idler gear and shaft assembly in the helical gear cover.
6. Install the bolt that fastens the gear and sleeve assembly to the cover. Install the nut and washer. Tighten the nut according to specifications. Refer to **Table H**. T

Figure 4.70

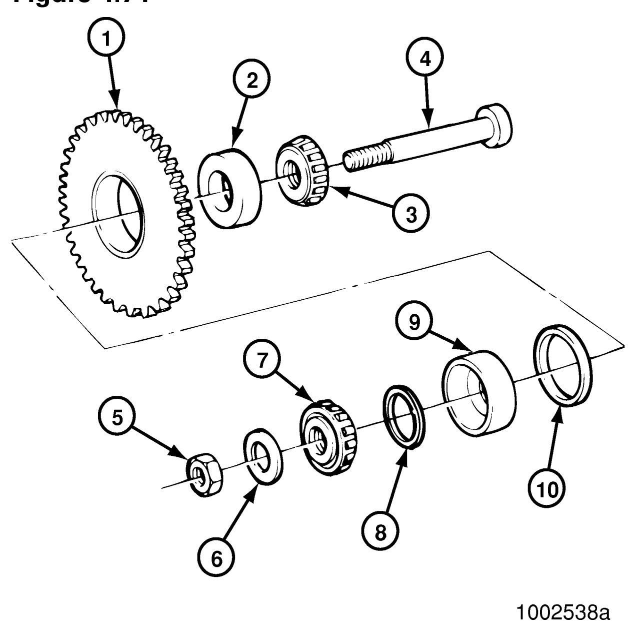


1	PUMP IDLER GEAR	7	NUT
2	CUP SPACER	8	WASHER
3	BEARING CONE	9	SLEEVE
4	WASHER	10	BEARING CONE
5	IDLER SHAFT	11	CONE SPACER
6	BEARING CUP	12	BEARING CUP

Oil Pump Idler Gear — Cone and Roller Bearing with Solid Idler Shaft

1. Place the spacer in the center slot of the idler gear bore. **Figure 4.71**.
2. Place the bearing cone in the gear bore. Use a press and a sleeve to install the cone in the bore. Press the cone until it touches the spacer. Make sure the spacer remains in the center slot of the gear bore. Repeat this procedure for the other bearing cone.
3. Install the cone and roller bearings and spacer in the idler gear. Make sure the spacer is between the bearing cones.
4. Place the idle gear assembly in the helical gear cover.
5. Install the idler gear shaft through the gear and cover. The threaded part of the shaft must extend outside the cover.
6. Install the nut and washer. Tighten the nut according to specifications. Refer to **Table H**. T

Figure 4.71



1	PUMP IDLER GEAR	7	BEARING CONE
2	BEARING CUP	8	SPACER — BEARING CUPS
3	BEARING CONE	9	BEARING CUP
4	IDLER SHAFT	10	SPACER — BEARING CONES
5	NUT		
6	WASHER		

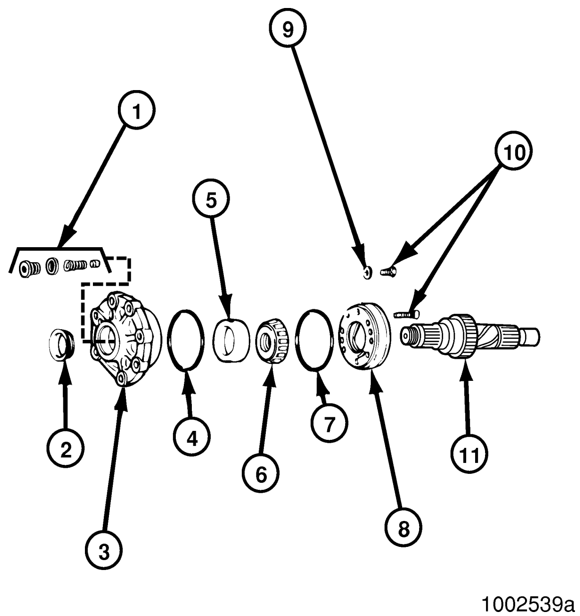
Assembling the Input Shaft, Bearing Cage, Oil Pump and Yoke — Current Design

1. Apply axle lubricant to the parts as they are being assembled.
2. If removed, install the bearing cup in the input bearing cage. Use a press and a sleeve to install the cup in the cage. The cup is correctly installed when the bottom of the cup is fully seated in the cage bore. **Figure 4.72**.
3. If removed, install the oil seal in the input bearing cage according to the following procedure:

Triple Lip Seal

A. Apply axle lubricant to the inner bore of the bearing cage.

Figure 4.72



1	PRESSURE RELIEF VALVE ASSEMBLY
2	OIL SEAL
3	BEARING CAGE
4	O-RING
5	BEARING CUP
6	BEARING CONE
7	O-RING
8	OIL PUMP (SERVICED AS COMPLETE ASSEMBLY ONLY)
9	WASHER
10	CAPSCREWS
11	INPUT SHAFT

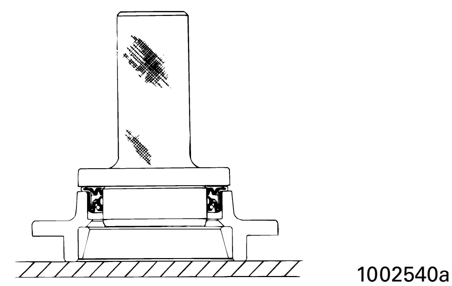
CAUTION

Hold the seal only on the outer diameter. Do not touch the lips in the inner diameter of the seal. If you touch the lips on the inner diameter of the seal, you will contaminate the lips and could cause a leak between the shaft and the seal.

B. Place the oil seal in the bearing cage so that the flange is parallel to the top of the cage.

C. Use a press and a driver or a flat metal plate to install the oil seal in the bearing cage. **Figure 4.73**.

Figure 4.73



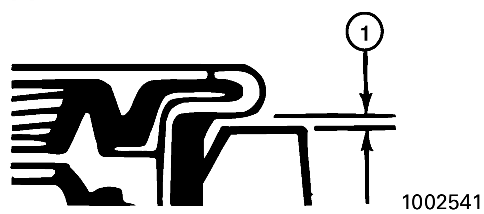
CAUTION

Do not apply pressure after the seal flange touches the top of the cage, or you will damage the cage.

D. Apply pressure until the metal flange of the seal is seated to the top of the cage.

E. After the seal is installed, a gap of 0.015- to 0.030-inch (0.381-0.762 mm) can exist between the flange and the cage. The gap is a normal condition because of the flexible coating on the flange of the seal. Use a feeler gauge to measure the gap between the complete flange-to-cage area. If the gap varies more than 0.010-inch (0.254 mm) between the highest and lowest measurement, remove and again install the seal. **Figure 4.74**.

Figure 4.74



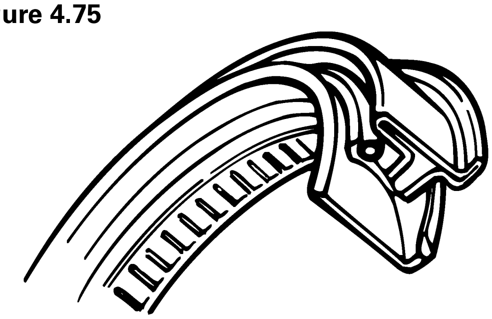
1 0.015-0.030 INCH (0.38-0.76 MM)

Unitized Pinion Seal (UPS)

A. Remove the replacement unitized seal from the package. Avoid particle contamination to the seal surfaces. Handle the seal by the outside edges only. Take care and avoid touching the inside area of the seal. **Figure 4.75**.

B. Select the proper seal driver for seal installation from the table below. Each driver is designed to properly install a specific diameter seal. To determine yoke seal diameter, measure the yoke journal. Refer to the table below.

Figure 4.75



1003397a

UNITIZED SEAL

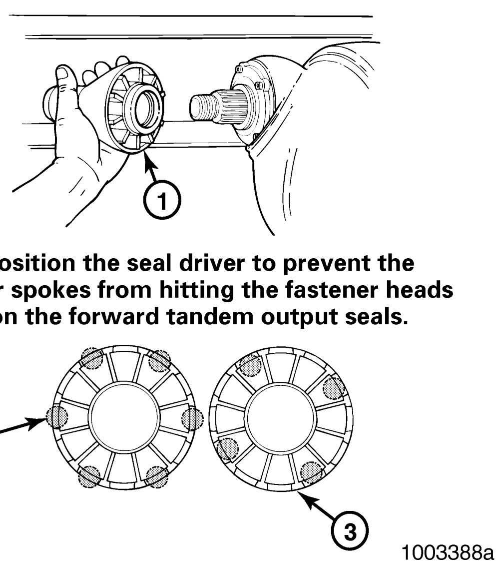
Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145 RS-19-145 RS-21-145 RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A RS-23-186 RS-26-185 RS-30-185	RT-34-144 /P RT-34-145 /P RT-40-145 /A /P RT-40-149 /A /P RT-44-145 /P RT-40-160 /A /P RT-40-169 /A /P RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	A-1205-R-2592	Tandem Forward Input (145 models from 11-93 to present)	R4422402	3.250 3.255
		A-1205-P-2590	Tandem Forward Output (Tandem Forward Input 145 models before 11-93 with seal A-1205-F-2424)	R4422401	3.000 3.005
		A-1205-N-2588	Tandem and Single Rear Input (145 models)	R4422401	3.000 3.005
		A-1205-Q-2591	Tandem and Single Rear Input (160/164/185 models)	R4422402	3.250 3.255
To obtain Meritor seal driver KIT 4454, call 888-725-9355.					

* Forward and rear input only.

C. Position the driver and seal on the bearing cage seat. Refer to **Figure 4.76**.

NOTE: On the forward tandem axle output position the R4422401 driver tool outer spokes or fins MUST fit between the bearing cage bolts. Be sure that the bolts on the bottom of the bearing cage are not in the path of the driver spokes. If the driver spokes contact the bearing cage bolts, the driver will not properly install the seal into the bearing cage seat and will also result in damage to driver tool. The reference mark on the driver tool should be in the 12 o'clock or the 6 o'clock positions when installing the new seal.

Figure 4.76



1 SEAL DRIVER
2 FASTENER HEADS
3 SEAL DRIVER R4422401

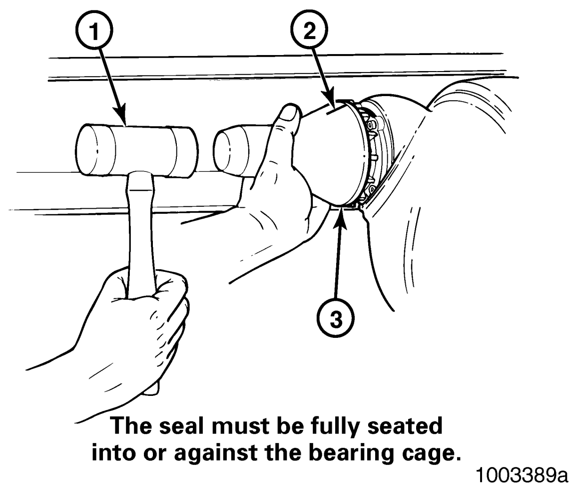
SEAL DRIVER

⚠ CAUTION

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 and cause serious personal injury.

D. Drive the seal into the bearing cage using a soft head mallet to seat the seal into the bearing cage. The seal must be fully seated into or against the bearing cage. **Figure 4.77**.

Figure 4.77

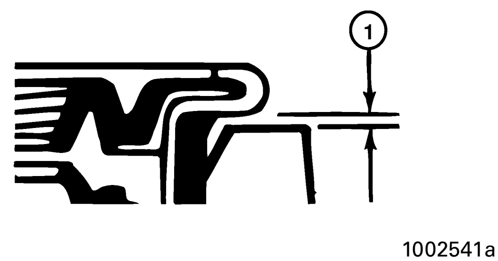


1 SOFT HEAD MALLET
2 REFERENCE MARK
3 SEAL DRIVER R4422401

SEATING SEAL

E. Use a .010-inch shim to feel for a gap between the flange of the seal and the bearing cage. If the .010-inch shim slides into a gap between the seal flange and bearing cage, this indicates that the seal is not fully seated into the bearing bore. Reinstall the seal driver and seat the seal into the bore until a .010-inch shim can not slide into a gap between the seal flange and the bearing cage. **Figure 4.78**.

Figure 4.78



1 0.015- TO 0.030-INCH (0.380-0.760 MM)

MEASURING SEAL GAP

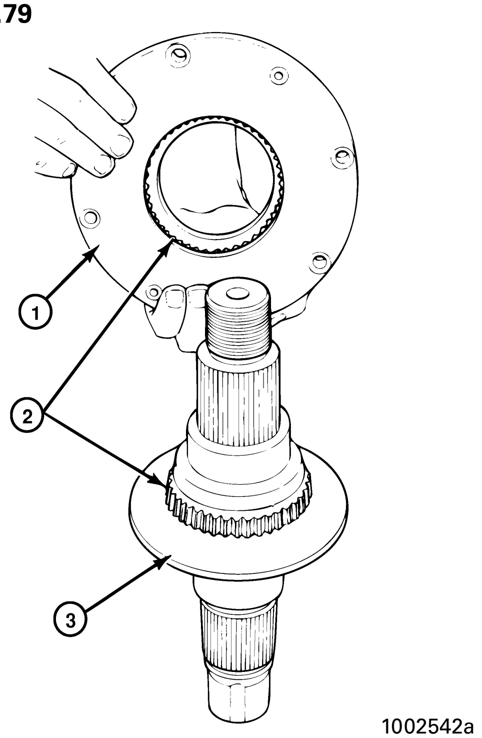
CAUTION

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.

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

4. Install the input bearing cage and oil pump according to the following procedure:
   A. Place the input shaft so that the threads are toward you. Install the oil pump on the shaft, making sure the splines in the pump are aligned with the splines on the shaft. **Figure 4.79**.

Figure 4.79



1 OIL PUMP
2 SPLINES
3 INPUT SHAFT

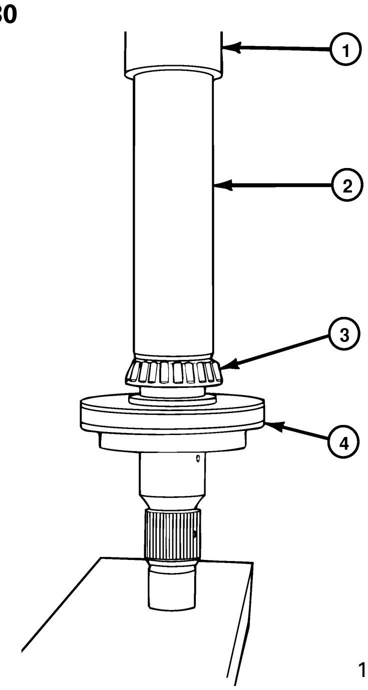
"SPLINE-DRIVE" DESIGN OIL PUMP

CAUTION

When the bearing cone and the oil pumps are installed on the input shaft, place supports under the input shaft. Do not place supports under the oil pump. The oil pump will be damaged if pressure is applied to the body of the pump.

   B. Place supports under the input shaft.
   C. Use a press and a sleeve to install the bearing cone on the input shaft. The cone is correctly installed when the bottom of the cone touches the shoulder on the shaft. **Figure 4.80**.
   D. Install the input bearing cage over the input shaft on the oil pump. If dowel pins are used, make sure that the dowel pins in the cage are aligned with the holes in the oil pump.
   E. Apply Loctite® to the capscrews and install the oil pump to the input bearing cage. Tighten the capscrews from 22 to 33 lb-ft (30-45 N•m). T
   F. Install the O-rings on the oil pump and the input bearing cage.

Figure 4.80



1 PRESS
2 SLEEVE
3 BEARING CONE
4 OIL PUMP

5. If removed, install the pressure relief valve assembly in the input bearing cage. Install the relief valve, the spring and the plug in the bore. Tighten the plug from 20 to 40 lb-ft (27-54 N•m). **Figure 4.81**. T

CAUTION

Never use a hammer or a mallet to install the yoke or the flange. Using a hammer or mallet can damage the yoke or flange.

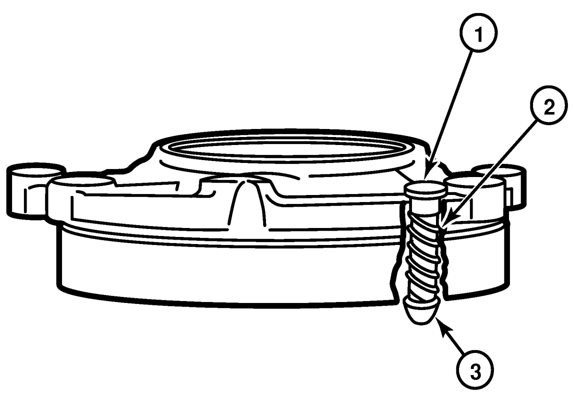
6. Use a press and a sleeve or an installation tool to install the yoke or the flange on the input shaft. If a press and a sleeve are used, make sure that the input shaft is well supported. **Figure 4.82**.

CAUTION

Do not use the nut to draw the yoke onto the input shaft. Possible thread damage and probable incorrect yoke seating will result.

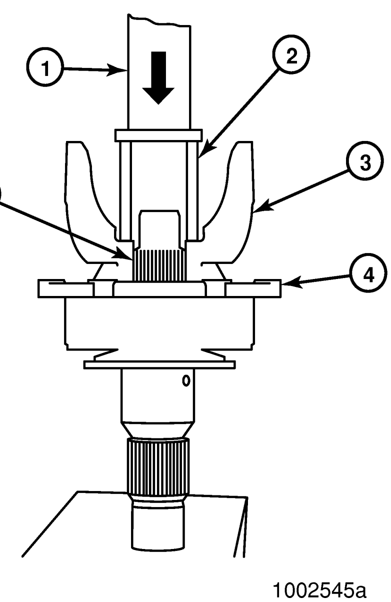
7. Install the nut that fastens the yoke or the flange to the input shaft. Tighten the nut by hand. **Do not tighten the nut to the specified torque until the bearing cage and pump assembly is installed in the helical gear cover.**

Figure 4.81 CURRENT DESIGN



1 PLUG
2 SPRING
3 RELIEF VALVE

Figure 4.82

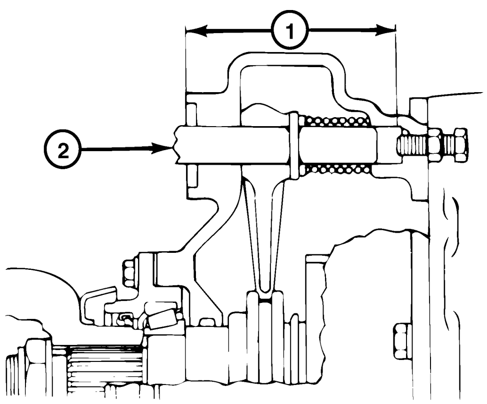


1 PRESS
2 SLEEVE
3 YOKE (SHOWN)
4 INPUT BEARING CAGE
5 INPUT SHAFT

Installing the Shift Unit, Shift Fork and Shift Shaft

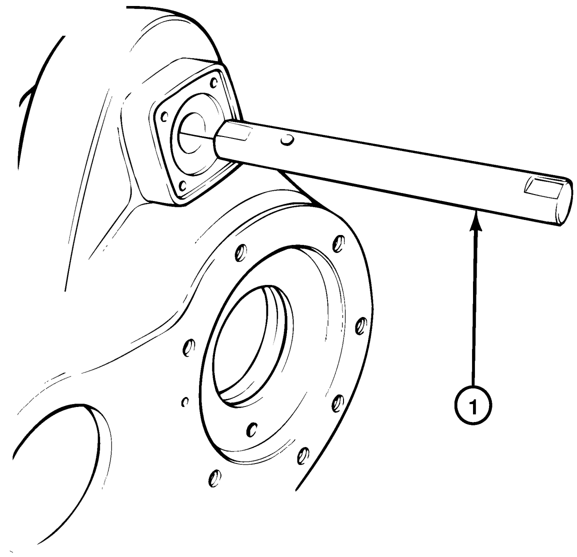
1. Inspect the shift shaft for damage. Remove any small damage with an emery cloth. If necessary, replace the shift shaft.
2. Install the adjusting screw for the shift shaft in the helical gear cover. Adjust the screw until there is a 5.300- to 5.360-inch (13.462-13.614 mm) clearance between the end of the adjusting screw and the end of the shift shaft bore. Install the jam nut and tighten from 40 to 55 lb-ft (55-74 N•m). **Figure 4.83.** T
3. Measure the shift shaft to determine the smaller side of the shaft. Measure from the roll pin hole to the end of the shaft. **Figure 4.84**.
4. Place the small side of the shift shaft in the bore. Install the shaft until the small side of the shaft comes out of the bore inside the cover. If necessary, use a plastic or leather hammer to install the shift shaft. **Figure 4.84.**
5. Place the shift fork in the cover so that the long boss and the roll-pin hole are toward the rear (open side) of the cover. Align the bore in the fork with the shift shaft. **Figure 4.85**.

Figure 4.83



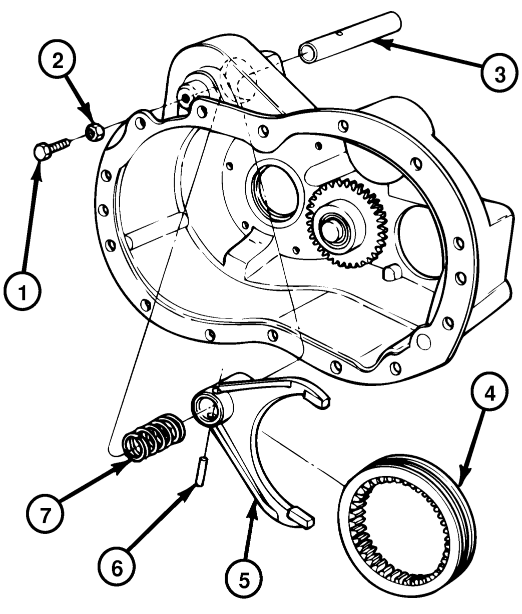
1 5.30" – 5.36"
2 SHIFT SHAFT

Figure 4.84



1 SHIFT SHAFT

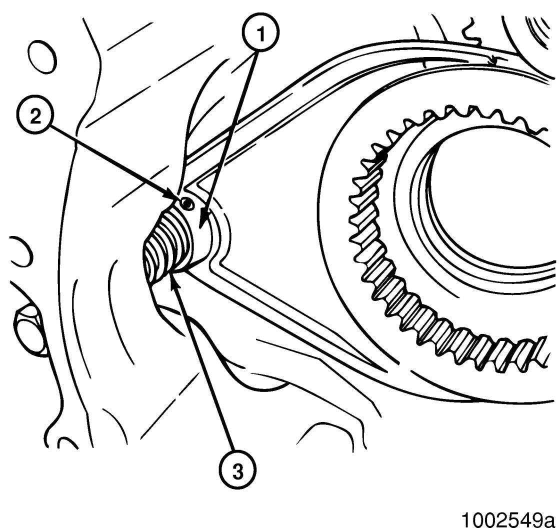
Figure 4.85



1	**ADJUSTING SCREW**	**5**	**SHIFT FORK**
2	**JAM NUT**	**6**	**ROLL PIN**
3	**SHIFT SHAFT**	**7**	**SPRING**
4	**COLLAR**		

6. Hold the shift fork in position and rotate the shift shaft to align the roll-pin hole in the shaft with the roll-pin hole in the fork. Use a plastic or leather hammer to tap the shaft into the fork. Continue to tap on the shaft until the shaft supports the fork. Do not tap the shaft through the fork.
7. Place the return spring of the shift shaft between the fork and the rear bore of the shaft in the cover. Make sure the inner diameter of the spring coils are aligned with the bores of the fork and the gear cover. **Figure 4.86**.

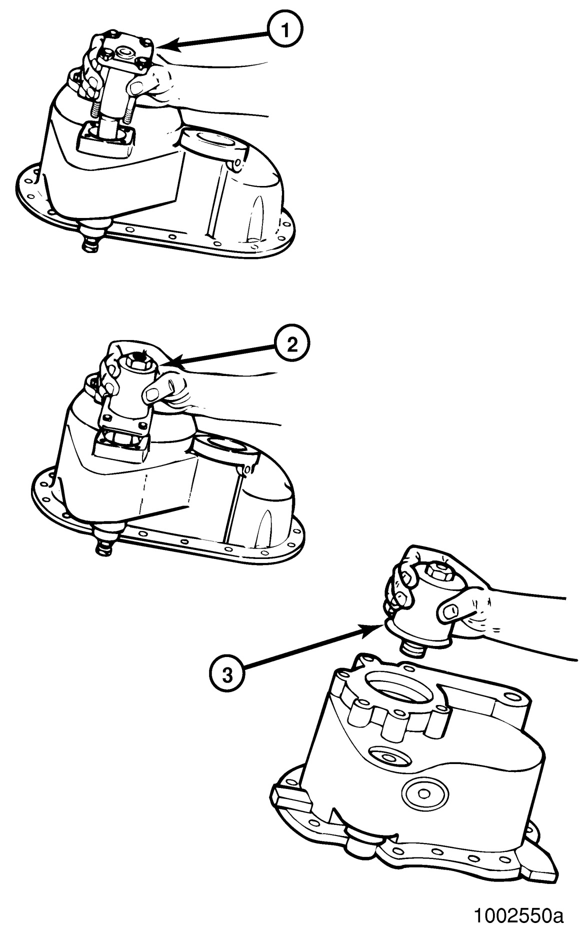
Figure 4.86



1 FORK—BOSS TOWARD REAR OF HELICAL GEAR COVER
2 ROLL PIN
3 SPRING

8. Use a plastic or leather hammer to tap the shift shaft into position in the helical gear cover. Make sure the roll-pin hole in the shaft is aligned with the roll-pin hole in the fork.
9. Use a hammer and a small drift to install the roll pin in the hole in the fork and the shaft.
10. Install the shift unit over the shift shaft and onto the helical gear cover.
11. On units that have Allen-head capscrews, install the four capscrews that fasten the shift unit to the helical gear cover. Tighten the capscrews from 7 to 11 lb-ft (10-14 N•m). **Figure 4.87**. T
12. On units that have long capscrews and tab retainers, use the following procedure: **Figure 4.87**.
   A. Loctite and install the four capscrews and the tab retainers that fasten the shift unit to the helical gear cover.
   B. Place the tab retainers so that two of the tabs are over the sides of the shift unit.
   C. Apply Loctite® to the capscrews and tighten from 7 to 11 lb-ft (10-14 N•m). T
   D. Bend the two tabs over the side of the shift unit against the top plate. Bend the third tab against the head of the capscrew.

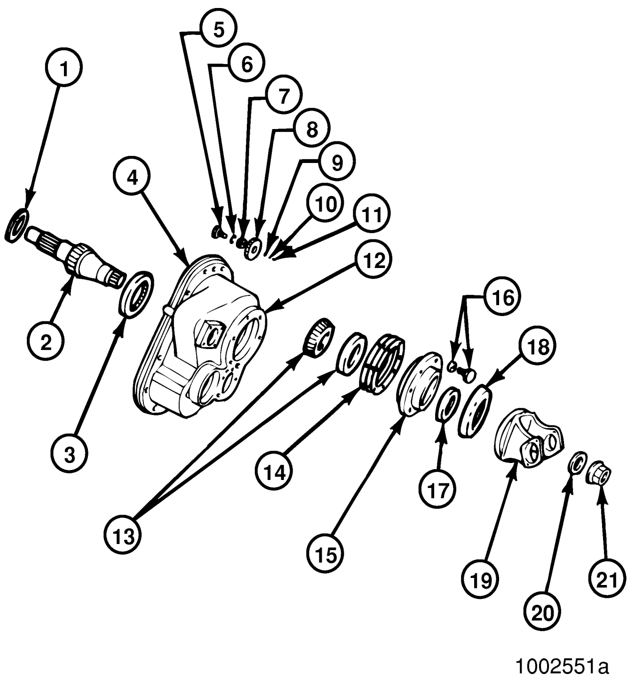
Figure 4.87



1 ORIGINAL BOLT-ON TYPE SHIFT UNIT (ORIGINAL DESIGN COVER)
2 MOST RECENT BOLT-ON TYPE SHIFT UNIT (ORIGINAL DESIGN COVER)
3 CURRENT SCREW-IN TYPE SHIFT UNIT CURRENT DESIGN HELICAL COVER

Installing the Input Shaft, the Clutch Collar and the Bearings in the Helical Gear Cover — Original Design

Figure 4.88



1	THRUST WASHER	12	IDLER SHAFT
2	INPUT SHAFT	13	INPUT FRONT BEARING CUP & CONE
3	CLUTCH COLLAR		
4	HELICAL GEAR COVER	14	SHIMS
5	IDLER GEAR SHAFT	15	BEARING CAGE
6	SNAP RING	16	CAPSCREW & WASHER
7	BEARING	17	OIL SEAL
8	PUMP IDLER GEAR	18	SLINGER
9	SPACER	19	YOKE
10	WASHER	20	WASHER
11	LOCK NUT	21	NUT

1. Engage the clutch collar on the shift fork.
2. Install the input shaft through the clutch collar. Rotate the input shaft to engage the splines in the clutch collar. At the same time, rotate the oil pump idler gear to engage the splines of the input shaft.

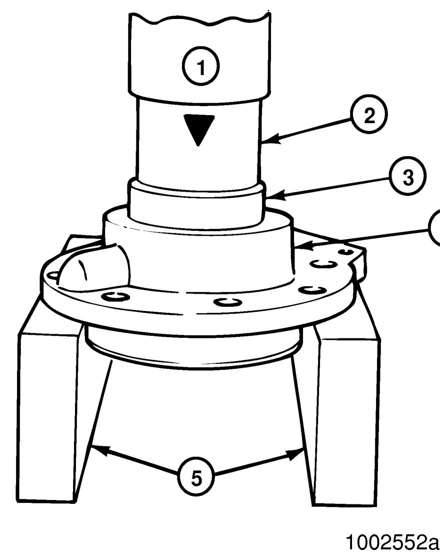
NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

3. Install the front bearing cone on the input shaft.

NOTE: If either the bearing cup or the cone need replacement, both parts must be replaced in a fully-matched set from the same manufacturer.

4. If the bearing cup was removed from the cage, install a new cup. Use a press and sleeve to install the cup in the cage. Make sure the cup touches the bottom of the bore in the cage. **Figure 4.89**.

Figure 4.89



1	PRESS
2	SLEEVE
3	BEARING CUP
4	CAGE
5	SUPPORTS

CAUTION

Do not use a sharp instrument like a drift or a punch to install the oil seal. Using these tools damages the lip of the seal retainer and causes the seal to leak. Do not apply pressure to the seal after the seal touches the bottom of the bore or the seal will be damaged.

5. If the oil seal was removed, a new seal must be installed. Refer to the following procedures for the seal used on the axle.

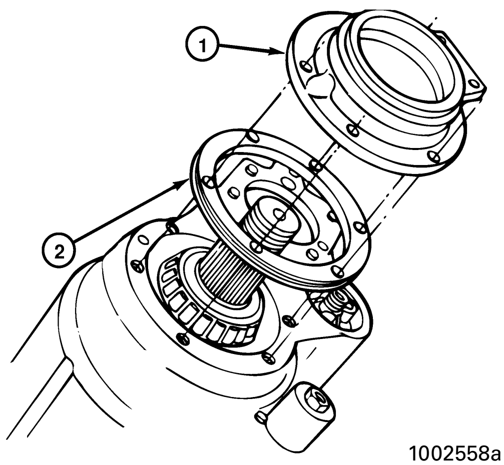
6. If the original input shaft, bearing cup and cone assemblies and rear side gear are installed, refer to the following procedure:

   A. Place the shim pack and the bearing cage assembly on the helical gear cover. **Figure 4.90**.

   B. Install the capscrews and the washers that fasten the cage to the cover. Tighten the capscrews from 85 to 115 lb-ft (116-155 N•m).

   C. Inspect the bearing end play according to "Inspecting and Adjusting the End Play of the Input Bearing — Original Design" in this section.

Figure 4.90



1 INPUT BEARING CAGE
2 SHIM PACK

7. If a new input shaft, bearing cup and cone assemblies (front and rear) or rear side gear is installed, refer to the following procedure:

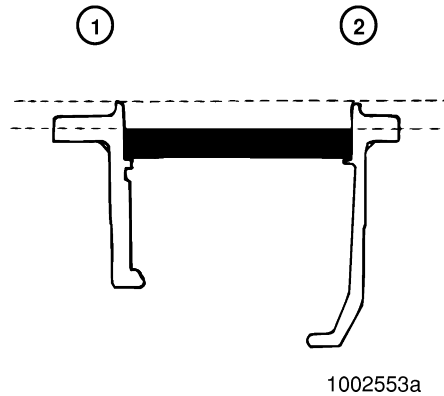
   A. Place the bearing cage assembly on the helical gear cover. Do not install the shim pack.

   B. Install the capscrews and the washers that fasten the cage to the cover. Tighten the capscrews by hand while rotating the input shaft to make sure the bearing cups and cones are correctly installed.

   C. Inspect the bearing end play according to "Inspecting and Adjusting the End Play of the Input Bearing — Original Design" in this section.

One-Piece Oil Seal

Figure 4.91



1 ONE-PIECE OIL SEAL
2 PRESS SEAL 0.515-0.545 INCH (13.081-13.843 MM) FROM TOP OF CAGE

A. Apply Lubriplate or equivalent to the lip of the seal.

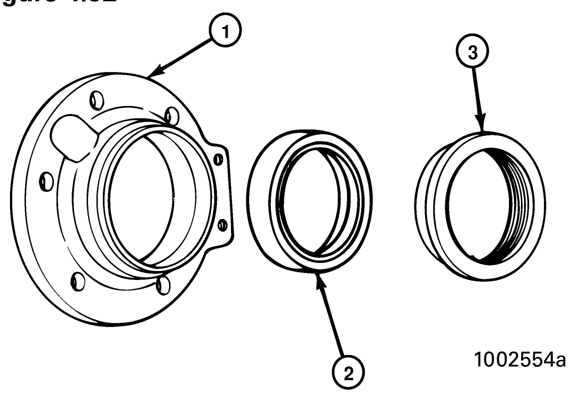
B. Apply a non-hardening sealant such as Permatex or equivalent to the outer diameter of the bearing cage.

C. Use a press and the correct seal driver to install the seal in the cage. If a press is not available, use a hammer and the correct seal driver. The seal driver must be smaller than the outer diameter of the seal. The driver touches the retainer (metal part) of the seal.

D. Press the seal in the bore to depth of 0.515- to 0.545-inch (13.081-13.843 mm) from the top of the bearing cage.

Cast-Iron Outer Protector and One-Piece Inner Oil Seal

Figure 4.92



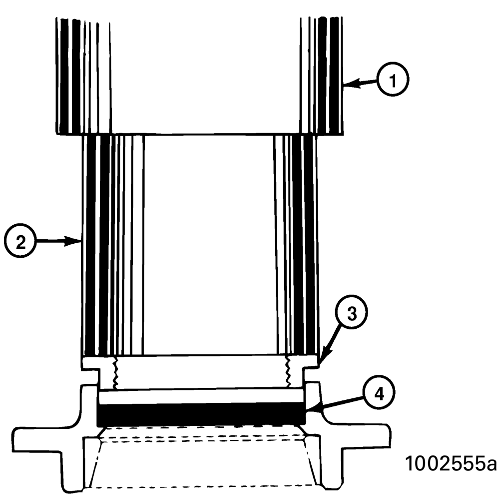
1 INPUT BEARING CAGE
2 ONE-PIECE INNER OIL SEAL
3 CAST-IRON OUTER PROTECTOR

A. Install the inner seal according to Steps A through D of the "One-Piece Oil Seal" installation procedure in this section.

B. Place the cast-iron outer protector in the bore of the bearing cage.

C. Use a press and a sleeve to install the protector in the cage. Make sure the flange on the protector touches the outer surface of the cage at all areas. **Figure 4.93.**

Figure 4.93



1 PRESS
2 SLEEVE
3 CAST-IRON OUTER PROTECTOR
4 INNER OIL SEAL

Triple-Lip (Main) Oil Seal

WARNING

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 and cause serious personal injury.

NOTE: If a press is not available, use a mallet and the sleeve or the driver to install the seal.

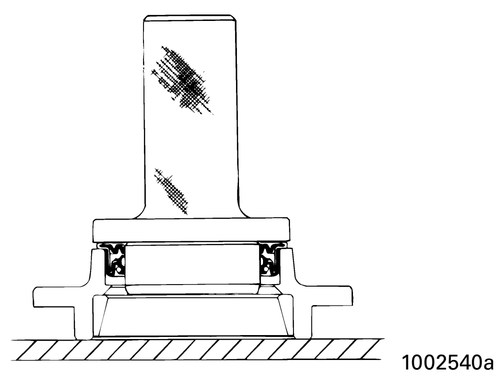
A. Apply Lubriplate or equivalent, or the grease for the wheel bearings, to the seal lips and the cavities between the lips. The Meritor specification for the grease is 0-617-A, 0-617-B or equivalent.

B. Apply axle lubricant to the seal bore of the bearing cage. Use the same type of lubricant that is used in the axle housing.

C. Place the drive pinion and cage assembly in a press so that the seal bore in the cage is toward the top.

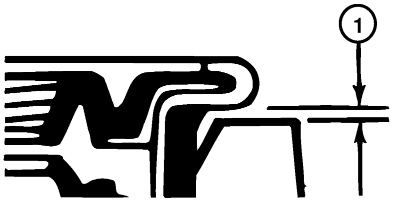
D. Press the seal into the bearing cage until the flange of the seal is flat against the top of the bearing cage. Use a sleeve or a seal driver of the correct size that fits against the metal flange of the seal. The diameter of the sleeve or the driver must be larger than the diameter of the flange. **Figure 4.94.**

Figure 4.94



E. After the seal is installed, a gap of 0.015- to 0.030-inch (0.380-0.760 mm) between the flange and the bearing cage is normal. Inspect the gap with a feeler gauge at several points around the seal. The difference between the largest and smallest gap measurement must not be more than 0.100-inch (0.254 mm). **Figure 4.95.**

Figure 4.95



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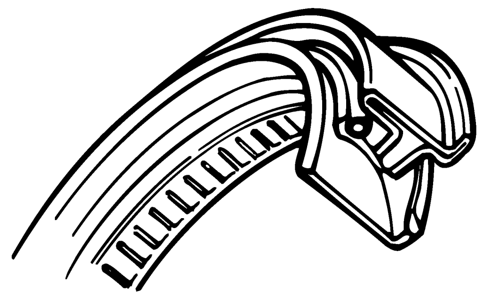
1 0.015-0.030 INCH (0.38-0.76 MM)

Figure 4.96



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UNITIZED SEAL

Unitized Pinion Seal (UPS)

A. Remove the replacement unitized seal from the package. Avoid particle contamination to the seal surfaces. Handle the seal by the outside edges only. Take care and avoid touching the inside area of the seal. **Figure 4.96**.

B. Select the proper seal driver for seal installation from the table below. Each driver is designed to properly install a specific diameter seal. To determine yoke seal diameter, measure the yoke journal. Refer to the table below.

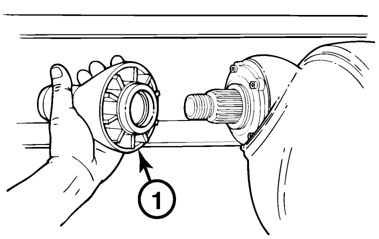
Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145 RS-19-145 RS-21-145 RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A RS-23-186 RS-26-185 RS-30-185	RT-34-144 /P RT-34-145 /P RT-40-145 /A /P RT-40-149 /A /P RT-44-145 /P RT-40-160 /A /P RT-40-169 /A /P RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	A-1205-R-2592	Tandem Forward Input (145 models from 11-93 to present)	R4422402	3.250 3.255
		A-1205-P-2590	Tandem Forward Output (Tandem Forward Input 145 models before 11-93 with seal A-1205-F-2424)	R4422401	3.000 3.005
		A-1205-N-2588	Tandem and Single Rear Input (145 models)	R4422401	3.000 3.005
		A-1205-Q-2591	Tandem and Single Rear Input (160/164/185 models)	R4422402	3.250 3.255
To obtain Meritor seal driver KIT 4454, call 888-725-9355.					

* Forward and rear input only.

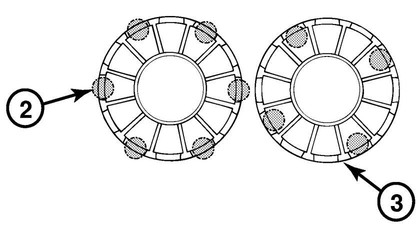
C. Position the driver and seal on the bearing cage seat. Refer to **Figure 4.97**.

NOTE: On the forward tandem axle output position the R4422401 driver tool outer spokes or fins MUST fit between the bearing cage bolts. Be sure that the bolts on the bottom of the bearing cage are not in the path of the driver spokes. If the driver spokes contact the bearing cage bolts, the driver will not properly install the seal into the bearing cage seat and will also result in damage to driver tool. The reference mark on the driver tool should be in the 12 o'clock or the 6 o'clock positions when installing the new seal.

Figure 4.97



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



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1 SEAL DRIVER
2 FASTENER HEADS
3 SEAL DRIVER R4422401

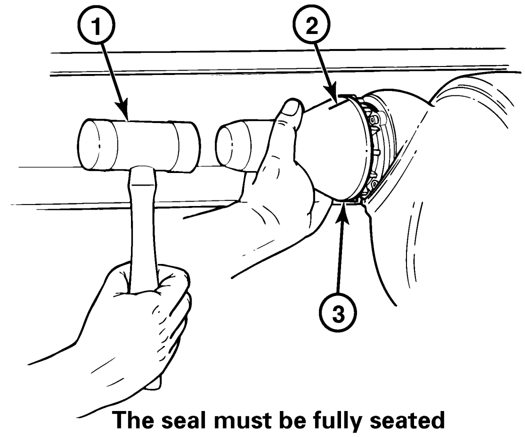
SEAL DRIVER

CAUTION

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 and cause serious personal injury.

D. Drive the seal into the bearing cage using a soft head mallet to seat the seal into the bearing cage. The seal must be fully seated into or against the bearing cage. **Figure 4.98**.

Figure 4.98



The seal must be fully seated into or against the bearing cage.

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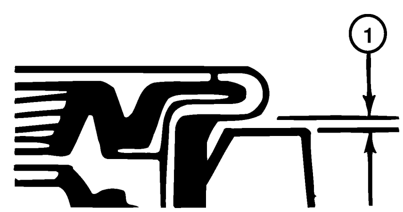
1 SOFT HEAD MALLET
2 REFERENCE MARK
3 SEAL DRIVER R4422401

SEATING SEAL

E. Use a .010-inch shim to feel for a gap between the flange of the seal and the bearing cage. If the .010-inch shim slides into a gap between the seal flange and bearing cage, this indicates that the seal is not fully seated into the bearing bore. Reinstall the seal driver and seat the seal into the bore until a .010-inch shim can not slide into a gap between the seal flange and the bearing cage. **Figure 4.99**.

Figure 4.99



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1 0.015- TO 0.030-INCH (0.380-0.760 MM)

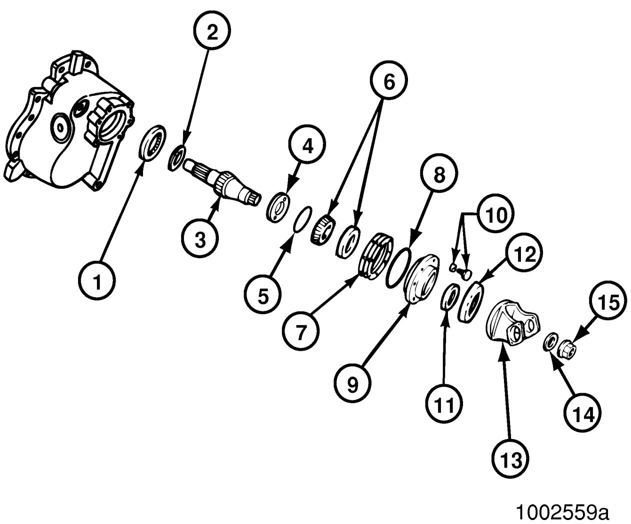
MEASURING SEAL GAP

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.

Installing the Input Shaft and the Clutch Collar in the Helical Gear Cover — Current Design

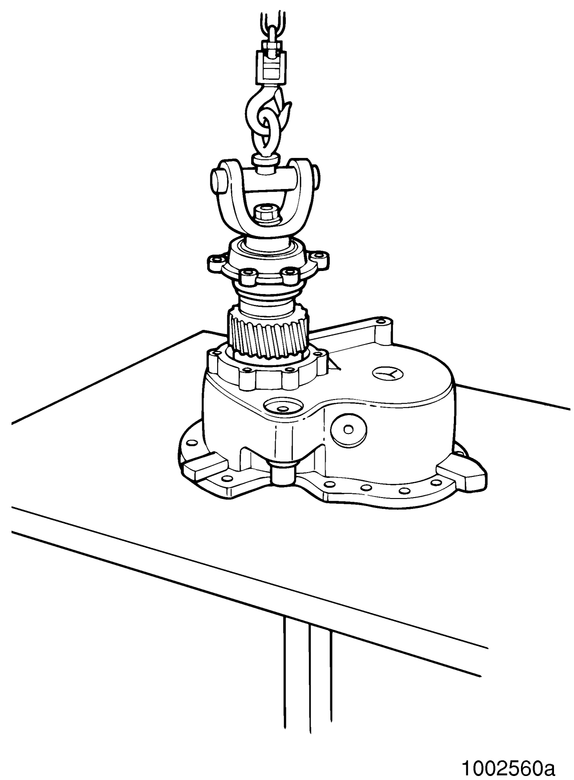
Figure 4.100



1 CLUTCH COLLAR
2 THRUST WASHER
3 INPUT SHAFT
4 OIL PUMP
5 O-RING
6 FORWARD INPUT SHAFT BEARING CUP & CONE
7 SHIMS
8 O-RING
9 BEARING CAGE
10 CAPSCREW & WASHER
11 OIL SEAL
12 SLINGER
13 YOKE
14 WASHER
15 NUT

1. Engage the clutch collar on the shaft fork.
2. Install the input shaft assembly in the helical gear cover according to the following procedure: **Figure 4.101**.
   A. Connect the lifting device to the input yoke. Lift the input shaft assembly over the bore in the helical gear cover.
   B. Lubricate the O-rings with axle oil.
   C. Lower the input shaft assembly into the differential carrier. **Figure 4.101**.

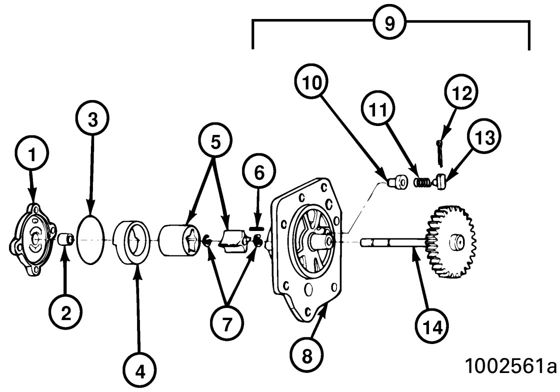
Figure 4.101



Assembling the Oil Pump — Original Design

Assembling the Oil Pump with a Rotor Pumping System

Figure 4.102



1	CAP	9	RELIEF VALVE ASSEMBLY
2	BUSHING	10	POPPET
3	O-RING	11	SPRING
4	REVERSING RING	12	COTTER PIN
5	2–PIECE ROTOR SET	13	CAP
6	KEY	14	GEAR AND SHAFT ASSEMBLY
7	SNAP RINGS		
8	PUMP BODY		

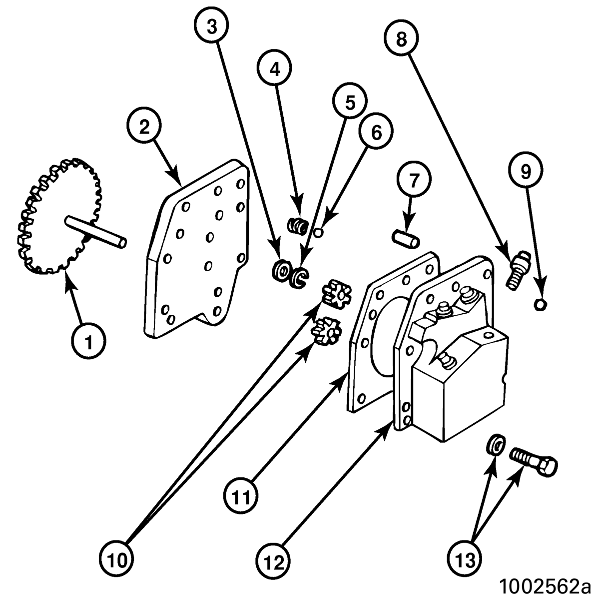
1. Clean the pump shaft bore and the lubrication passages in the pump cap and the pump body.
2. Assemble the relief valve into the bore in the pump body as follows:
   A. Install the small diameter end of the poppet into its seat inside the bore.
   B. Push the coil spring into the hole in the poppet.
   C. Install the relief valve cap into the spring and fasten the assembly in its bore with the cotter pin.
3. Install the shaft of the pump gear and shaft assembly through the back of the pump body.
4. Install a snap ring in the pump shaft groove next to the pump body.
5. Place the key in the slot in the pump shaft. Align the keyway on the inner part of the rotor and the key in the pump shaft. Slide the inner part of the rotor set over the shaft and the key until the rotor is against the snap ring.
6. Install the second snap ring in the groove in the pump shaft.
7. Assemble the outer part of the rotor set over the inner part of the set.
8. Place the reversing ring in position in the pump body. Make sure that the notch in the reversing ring is toward the front of the axle.
9. Install a new O-ring seal in the pump cap.

NOTE: Apply axle lubricant to the faces of the rotor and to the end of the pump shaft. Use the same type of axle lubricant that is used in the housing.

10. Install the pump cap with the pump shaft in the bore in the cap. Make sure that the pin in the cap fits into the notch in the reversing ring.

Disassembling the Oil Pump with a Gear Pumping System

Figure 4.103



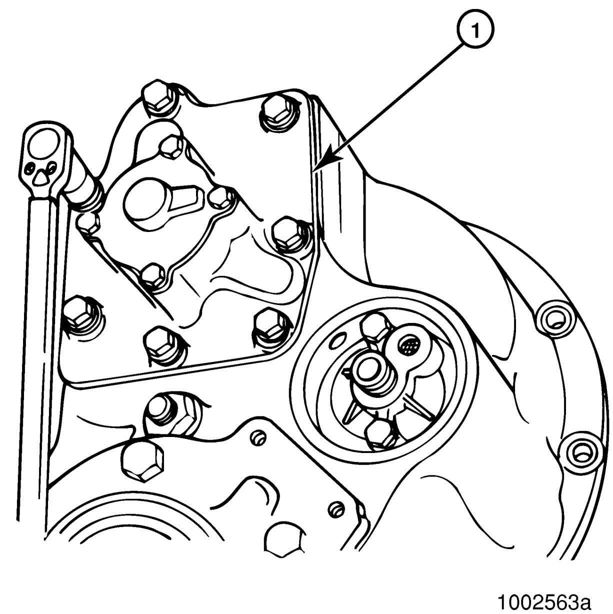
1	PUMP DRIVEN GEAR AND SHAFT
2	PUMP PLATE
3	WASHER
4	SPRING
5	SNAP RING
6	BALL
7	DOWEL
8	PLUG ASSEMBLY (4 TOTAL) 2 SMALL/2 LARGE
9	BALL (4 TOTAL) 2 SMALL/2 LARGE
10	PUMP GEARS
11	GASKET
12	BALL (4 TOTAL) 2 SMALL/2 LARGE
13	ATTACHING CAPSCREWS & WASHERS (7 TOTAL)

1. Clean the pump shaft bore and the lubrication passages in the pump cap and the pump body.
2. Inspect the bushing for the pump shaft in the pump plate. If necessary, use a press and a sleeve to remove and replace the bushing in the plate.
3. Inspect the pump gear shaft on the suction (lower) side of the pump. To replace the shaft:
   A. Support the pump plate so that the shaft is away from you.
   B. Use a brass drift and a hammer to drive the shaft from the plate.
   C. Turn the pump plate over so that the rear of the plate is away from you.
   D. Use a press and a disc to install the shaft in the pump plate.
4. Install the pump driven gear and driveshaft assembly in the pump plate. Install the washer and snap ring that fasten the shaft to the plate.
5. Place a gear on the gear shaft of the pump and the gear shaft of the pump driven gear.
6. Place the spring for the relief valve into the bore in the pump plate. The large end of the spring must be installed in the bottom of the bore.
7. Place a new gasket and the two dowels on the pump plate. Install the pump cover on the pump plate.
8. Install the two large check valve balls and two large pipe plugs in the correct bores on the cover. Install the two small check valve balls and the two small pipe plugs in the correct bores. Refer to **Figure 4.106** for the correct identification of the bores for the check valve balls and pipe plugs.

Installing the Oil Pump — Original Design

1. Make sure all oil passages in the pump and the helical gear cover are lean and free of obstructions.
2. Install a new gasket between the oil pump and the helical gear cover.
3. Install the oil pump into the helical gear cover. Make sure the teeth of the driven gear on the oil pump engage the teeth of the idler gear. **Figure 4.104**.
4. Install the capscrews that fasten the oil pump to the helical gear cover. Tighten the capscrews from 35 to 50 lb-ft (48-67 N•m). T

Figure 4.104

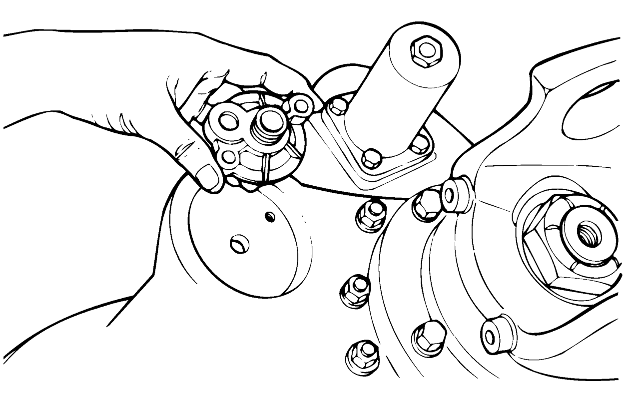


1 OIL PUMP

Installing the Adapter and the Oil Filter — Original Design

1. If removed and undamaged, install the adapter for the oil filter in the bore of the helical gear cover. Install the capscrews and washers that fasten the adapter to the cover. Tighten the capscrews from 20 to 30 lb-ft (28-40 N•m). **Figure 4.105**. T

Figure 4.105



CAUTION

Use of a Meritor filter is highly recommended to ensure a filter with a drain back design. Lubrication drain back is required to maintain correct equipment operation.

NOTE: Install a new-style filter, lubricate the gear cavity and the pump passages to prevent damaging the axle during start-up. The replacement filter should have a peroxide-cured seal for synthetic lubrication compatibility and **should not** have an anti drain-back design.

2. On oil pumps with a gear pumping system, remove the two large pipe plugs from the oil pump. Lubricate the oil passages sealed by the large pipe plugs with the lubricant used in the axle housing. Install the two large pipe plugs in the oil pump. **Figure 4.106**.

CAUTION

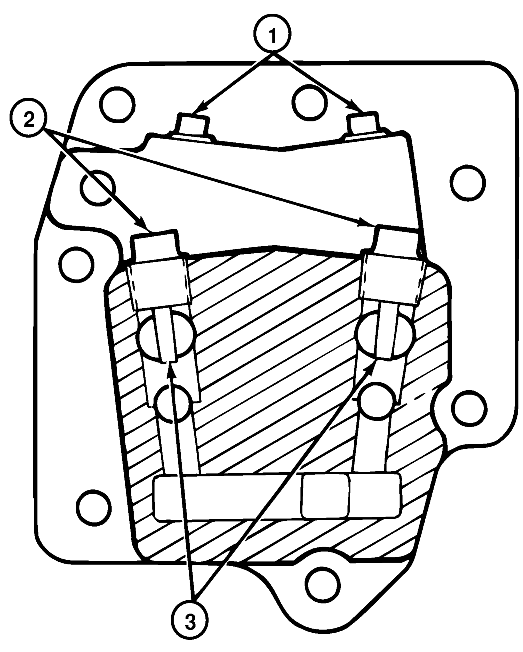
If the filter is tightened more than one complete turn after it touches the gasket, the oil filter will be damaged and leak fluid.

3. Lubricate the gasket of the new oil filter with the lubricant that is used in the axle housing. Install the oil filter on the adapter. Tighten the oil filter one turn after the gasket on the filter touches the adapter. Do not overtighten. If necessary, use an oil filter wrench to tighten the filter. **Figure 4.107**.

NOTE: If a steel cover for the oil filter is replacing a plastic cover for the oil filter, refer to Section 5 in this manual. This section describes the modifications that are necessary to replace the plastic cover with the steel cover for the oil filter.

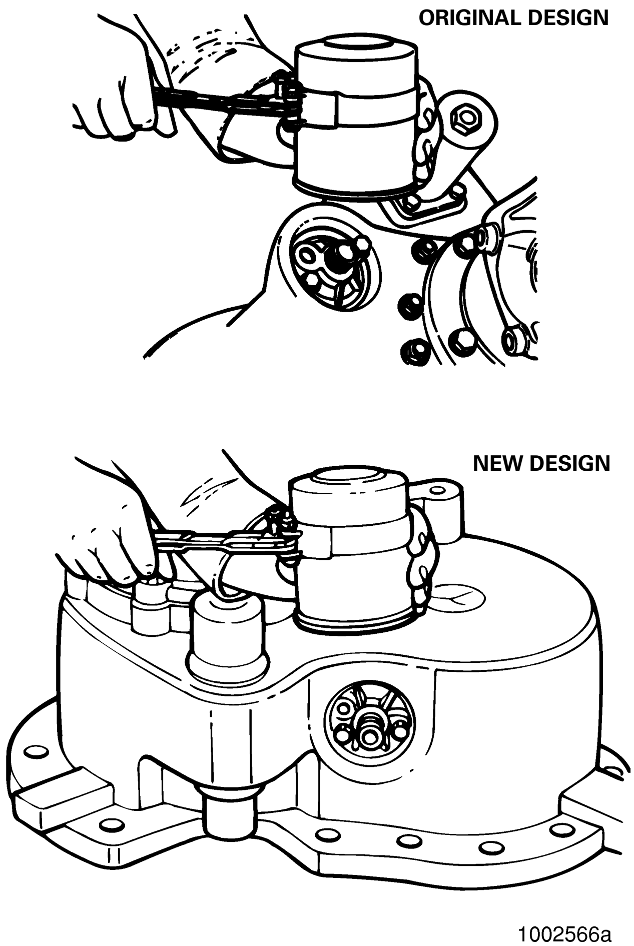
4. Place the cover over the oil filter. Install the washers, apply Loctite® to the capscrews. Tighten the capscrews from 35 to 50 lb-ft (48-67 N•m). T

Figure 4.106



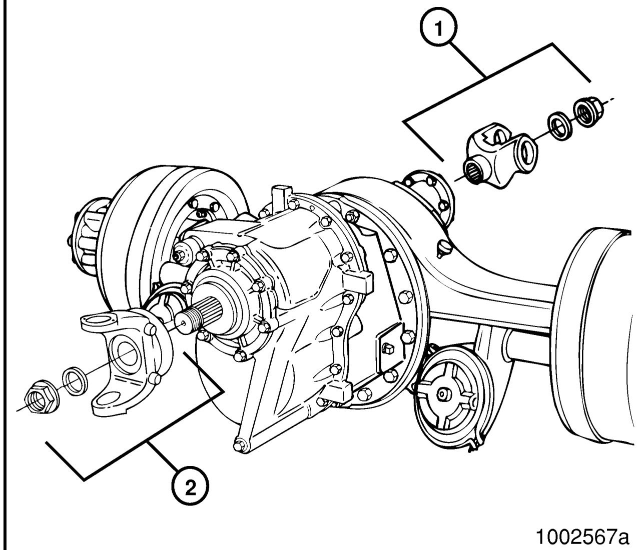
1 SMALL PIPE PLUGS
2 LARGE PIPE PLUGS
3 FILL PASSAGES WITH LUBRICANT

Figure 4.107



Installing the Yoke

Figure 4.108



1 OUTPUT YOKES ASSEMBLY
2 INPUT YOKES ASSEMBLY

Three types of yokes are used: a slip-fit, a tight-fit and a loose-fit. Refer to the procedure for the yoke that is used on the carrier.

- The **input** yoke is installed before the helical gear cover is installed on the differential carrier.
- The **output** yoke is installed after the end play of the output bearing is inspected and adjusted.

⚠ CAUTION

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.

Slip-Fit Yoke

1. Apply the axle lubricant that is used in the housing to the oil seal.
2. Inspect all surfaces of the yoke hub for damage. Replace with new yoke assembly, if required.
3. On the input shaft, install the oil slinger over the input shaft in the helical gear cover. On the thru-shaft (output shaft) yoke, install the wiper sleeve over the thru-shaft.

⚠ CAUTION

Do not use a hammer or a mallet to install the yoke. Using a hammer or mallet will damage the yoke and result in driveline misalignment.

4. Align the yoke with the splines on the shaft and install the yoke.
5. Install the washer and the nut that fasten the yoke to the shaft. Tighten the nut so that there is not any end play between the yoke and the bearing. If the bearing end play adjustment is not required, place a holding tool on the yoke and tighten the nut to the correct torque. Refer to **Table H** in Section 7. T

Tight-Fit Yokes

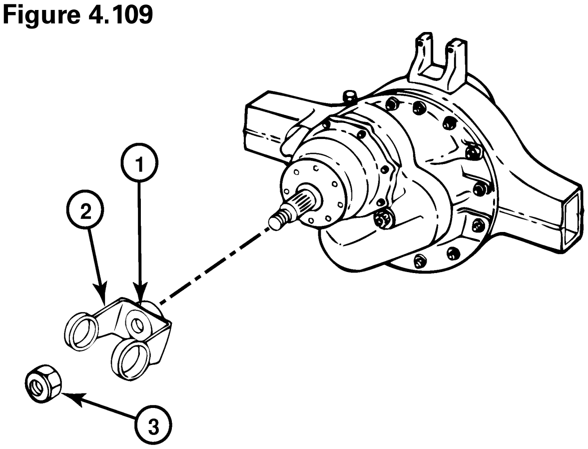
1. Apply the axle lubricant that is used in the housing to the oil seal.
2. Inspect all surfaces of the yoke hub for damage. Replace with new yoke assembly if required. **Figure 4.109**.
3. Align the yoke splines with the shaft splines and slide the yoke over the shaft spline.

⚠ 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 and result in driveline misalignment.

4. 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. A yoke installation tool is required to fully seat the yoke against the output bearing.

Figure 4.109



1 **INSPECT YOKE HUB SURFACES**
2 **YOKE**
3 **NUT**

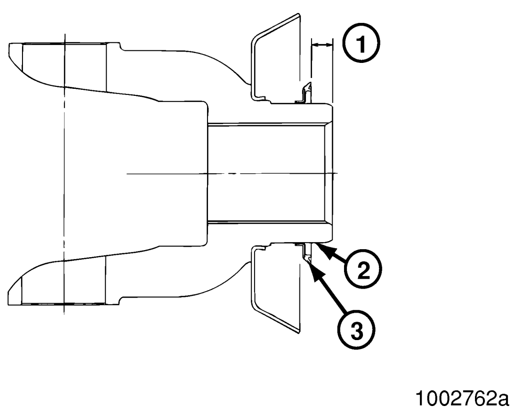
5. On the input shaft, install the slinger over the yoke hub. On the thru-shaft (output shaft) yoke, install the wiper sleeve over the yoke hub.
6. Install the nut (and washer if required) that fasten the yoke to the shaft. Tighten the nut to remove any end play between the yoke and the bearing. If the bearing end play adjustment is not required, place a holding tool on the yoke and tighten the nut to the correct torque. Refer to **Table H** in Section 7. T

NOTE: Anytime the yoke is removed or partially removed the unitized pinion seal (UPS) must be replaced. This includes yokes removed for driveline phasing adjustments or any other reason for yoke removal.

Installing Tight-Fit Yokes with POSE™ Seal

1. Apply the same lubricant used in axle housing to the hub of the yoke or flange.
2. Inspect and make sure the lips of the POSE™ seal and the outer retainer of the triple-lip seal (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 (opposite shoulder). Slide the POSE™ seal on the hub until the lips are from 0.25-inch to 0.50-inch (6.4 mm-12.7 mm) from the end of the hub. DO NOT INSTALL THE POSE™ SEAL AGAINST THE SHOULDER. **Figure 4.110**.

Figure 4.110



1 0.25"-0.50" (6.4 MM-12.7 MM)
2 YOKE HUB
3 FACE SEAL ASSEMBLY (POSE™ SEAL ELEMENT)

FACE SEAL INSTALLATION

NOTE: 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, again apply the same lubricant used in the axle housing to the hub.
5. Install the yoke or flange using the correct procedure.

NOTE: The yoke must be completely seated before tightening pinion nut to the input shaft.

When Installing Any Type Yoke with 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.

Loose-Fit Yoke

1. Apply the axle lubricant that is used in the housing to the oil seal. Do not apply lubricant to input shaft threads.
2. Inspect all surfaces of the yoke hub for damage. Replace with new yoke assembly if required.
3. On the input shaft, install the oil slinger over the input shaft in the helical gear cover. On the thru-shaft (output shaft) yoke, install the wiper sleeve over the thru-shaft.
4. Align the yoke splines with the shaft splines and slide the yoke over the shaft.

CAUTION

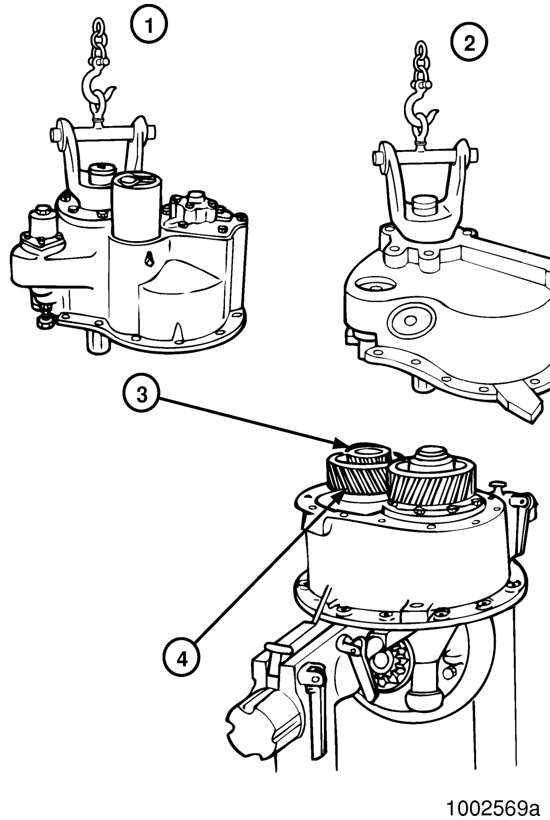
Do not use a hammer or mallet to install the yoke. Using a hammer or mallet will damage the yoke and result in driveline misalignment.

5. Apply Loctite® No. 277 to the input shaft threads of all forward carriers, prior to installation of the nut.
6. Install the washer and nut that fasten the yoke to the shaft. Tighten the nut so that there is not any end play between the yoke and the bearing. If the bearing end play adjustment is not required, place a holding tool on the yoke and tighten the nut to the correct torque. Refer to **Table H**.

NOTE: Loose fit yokes can be used with any of the three seal types: triple lip, triple lip plus POSE™ and unitized pinion seals (UPS).

Installing the Helical Gear Cover on the Differential Carrier

Figure 4.111



1 ORIGINAL DESIGN HELICAL COVER
2 CURRENT DESIGN HELICAL COVER
3 THRUST WASHER
4 HELICAL DRIVE GEAR

NOTE: If the end play on the input bearing is inspected and adjusted, remove the forward side gear, the helical drive gear and the inter-axle differential.

1. Place the differential carrier in a repair stand so that the helical drive gear and the driven gear are toward you.
2. Use petroleum jelly or equivalent to hold the thrust washer on the forward side gear that is inside the helical drive gear. The lubricant holds the thrust washer in position when the input shaft is installed.
3. Apply RTV gasket material to the cover mounting surface on the differential case. Refer to "Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential" in Section 3. Do not apply RTV gasket material if the end play of the input bearing is being inspected and adjusted.
4. Install the helical gear cover on the differential case as follows:
   A. Use a lifting device to lift the helical gear cover assembly by the input yoke.
   B. Lower the helical gear cover onto the differential case and align the input shaft with the bore in the inter-axle differential. When the input shaft enters the differential, rotate the input shaft so that the splines on the shaft and the spider are aligned.
   C. Remove the lifting device from the input yoke.
5. Install the capscrews and the washers that fasten the cover to the carrier. Tighten the capscrews from 85 to 115 lb-ft (116-155 N•m). T

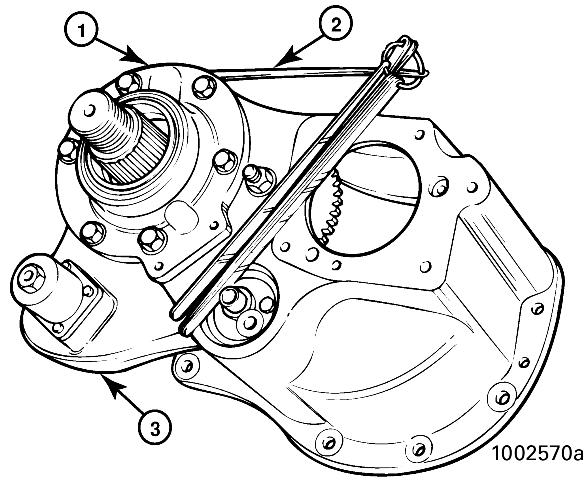
Inspecting and Adjusting the End Play of the Input Bearing — Original Design

Specification:

- End Play of the Input Bearing: 0.002- to 0.008-Inch (0.0508-0.2032 mm)

1. The end play of the input bearing is adjusted with the carrier in the horizontal position or the vertical position.
2. Before the end play is inspected, make sure of the following:
   A. The forward side gear, helical drive gear and the inter-axle differential assembly are removed from the differential case.
   B. The shim pack between the bearing cage and the helical gear cover is removed.
   C. The capscrews that fasten the bearing cage to the helical gear cover are hand-tight.
3. Use a feeler gauge to measure the gap between the bearing cage and the helical gear cover. Record the measurement of the gap. **Figure 4.112**.

Figure 4.112



1 INPUT BEARING CAGE
2 FEELER GAUGE
3 ORIGINAL DESIGN HELICAL GEAR COVER

4. Add 0.005-inch (0.127 mm) to the measurement of the gap between the bearing cage and the helical gear cover. Add this number to the original shim pack and make a new shim pack. Use a minimum of three shims for the shim pack. The thinnest shims must be installed on each side of the shim pack.
5. Remove the input yoke. Refer to "Removing the Input Shaft, the Forward Bearing and the Clutch Collar — Original Design Helical Cover" in Section 2.
6. Remove the capscrews and the washers that fasten the bearing cage to the helical gear cover. Remove the cage and install the new shim pack. Place the cover on the cage and install the washers and the capscrews. Tighten the capscrews from 60 to 75 lb-ft (82-101 N•m). T
7. Use a dial indicator with a base to inspect the end play of the input bearing. Make sure the pointer of the dial indicator is against the top of the input shaft. **Figure 4.113**.
8. Push the yoke against the input bearing and turn the yoke from side to side to make sure the cup is installed in the cone. Adjust the dial indicator to zero (0).
9. Pull the yoke out and rotate the yoke from side to side. Read the dial indicator. The end play measurement must be 0.0020 to 0.0080-inch (0.0508-0.2032 mm).

NOTE: Use a minimum of three shims to make the shim pack.

10. If the end play measurement is not 0.002- to 0.008-inch (0.0508-0.2032 mm), add or remove shims from the shim pack. Remove the capscrews and washers and remove the bearing cage and the shim pack. Add shims to the shim pack to increase the end play. Remove shims from the shim pack to decrease the end play. Repeat Steps 6-9 of this procedure. **Figure 4.114**.

Figure 4.113

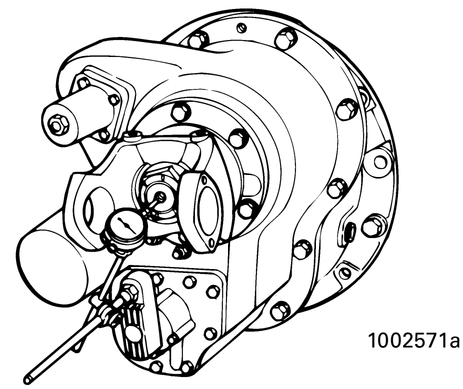
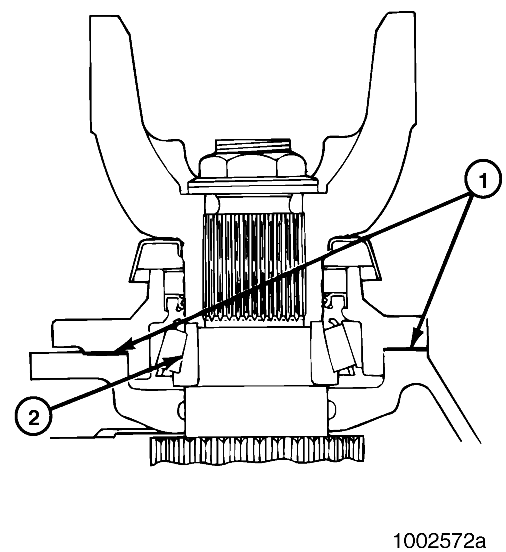


Figure 4.114 INPUT BEARING END PLAY



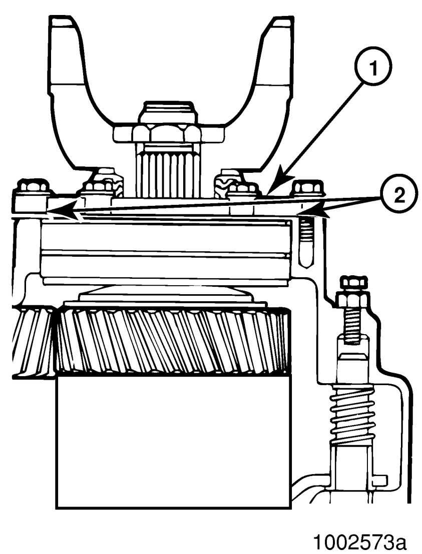
1 SHIM PACK
2 INPUT BEARING
ADD SHIMS TO INCREASE END PLAY
REMOVE SHIMS TO DECREASE END PLAY

NOTE: USE A MINIMUM OF THREE SHIMS FOR THE SHIM PACK

11. Install the inter-axle differential assembly, the helical drive gear and the forward side gear. Refer to the procedure under "Assembling the Inter-Axle Differential" in this section.
12. Install the yoke. Refer to the procedure under "Installing the Yoke" in this section.
13. Install the helical gear cover on the differential case. Refer to the procedure under "Installing the Helical Gear Cover on the Differential Carrier" in this section.

Inspecting and Adjusting the End Play of the Input Bearing — Current Design

Figure 4.115



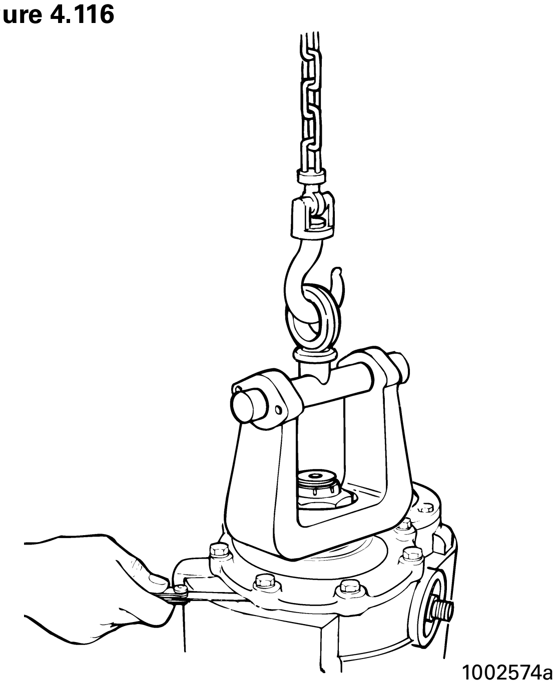
1 INPUT BEARING CAGE
2 SHIM PACK CONTROLS END PLAY OF INPUT BEARING

Specification:

- End Play of the Input Shaft: 0.002- to 0.008-inch (0.050-0.200 mm)

1. Install capscrews, but not the washers, that fasten the input bearing cage to the carrier. Rotate the input shaft in each direction to make sure the bearings are correctly installed while hand tightening the capscrews. **Do not tighten the capscrews to the specified torque value at this time.**
2. Use a feeler gauge to measure the gap between the input bearing cage and the helical gear cover. Inspect the gap at four equally spaced locations on the cage. **Figure 4.116**.
3. Add up the four measurements and determine the average gap between the cage and the carrier. Add 0.005-inch (0.130 mm) to the average gap measurement to determine the size of the shim pack between the cage and the carrier.
4. Use at least three shims when building a shim pack. Always place the thickest shims in the middle of the shim pack.
5. Remove the capscrews (from Step 1) that fasten the input bearing cage to the carrier.
6. Install the shim pack according to the following procedure:
   A. Connect a lifting device to the input yoke. Lift the input shaft assembly until there is a distance of 1/4 to 1/2-inch (6-12 mm) between the cage and carrier mounting surface.

Figure 4.116



CAUTION

If pinion cage has an O-ring-type seal, do not use any type of sealant (Loctite®, etc.). Sealant may be used except in cases where an O-ring exists between the pinion bearing cage and the carrier bore.

B. Install the shim pack under the bearing cage. Make sure that the hole pattern of the shim pack matches the hole pattern of the cage. **Figure 4.117**.

C. Place the shield for the oil filter in position on the bearing cage.

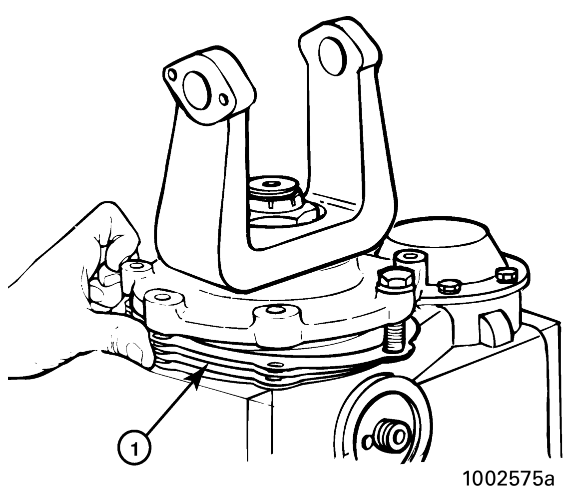
D. Install the capscrews and washers into the carrier cage. Make sure that the capscrews are aligned with the holes in the shim pack. Tighten the capscrews without stripping the threaded bores. Make sure that the capscrew threads turn into the original holes in the carrier.

E. Lower the input shaft assembly so that the cage and the shim pack are installed against the carrier. Remove the lifting device from the yoke or flange.

F. Tighten the capscrews from 75 to 95 lb-ft (100-127 N•m) while rotating the input shaft in each direction to make sure that the bearings are correctly installed. T

7. Place a holding tool on the input yoke or flange and tighten the nut to the specified torque. Refer to **Table H**. T

Figure 4.117



1 SHIMS

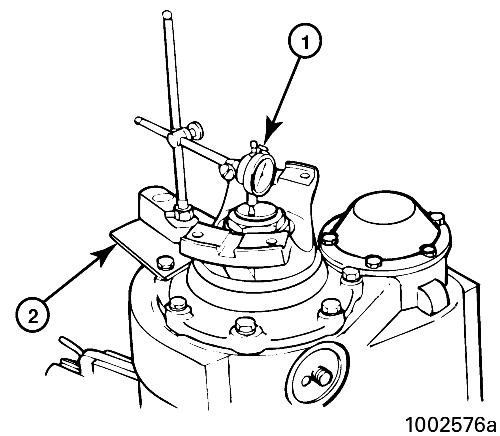
8. Inspect the end play of the input shaft according to the following procedure:

   A. Rotate the input shaft in each direction and push the yoke or flange toward the bearing cage. This makes sure that the input shaft assembly is at the bottom of its travel.

   B. Use a dial indicator with a magnetic base or a C-clamp base to inspect the end play of the input bearing. Make sure the pointer of the dial indicator is against the top of the input shaft. Set the dial indicator to zero (0). **Figure 4.118**.

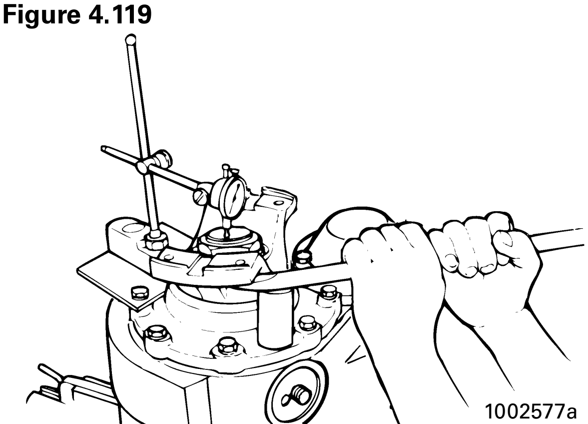
   C. Use a pry bar and a support to push the yoke or the flange away from the carrier. Read the dial indicator. The reading must be in the 0.002- to 0.008-inch range (0.050-0.200 mm). **Figure 4.119**.

Figure 4.118



1 DIAL INDICATOR
2 PLATE

Figure 4.119



9. If the end play of the input bearing is not within the 0.002- to 0.008-inch range (0.050-0.200 mm), add or remove shims from the shim pack. Repeat Steps 4-8 of this procedure.

Installing the Differential Carrier in the Axle Housing

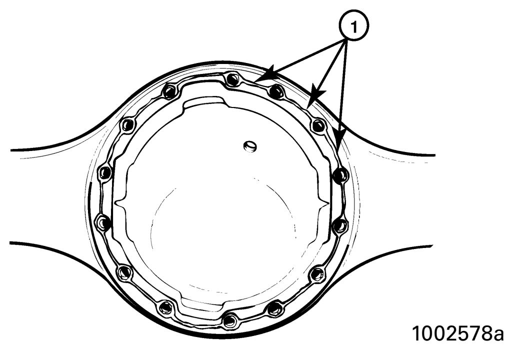
WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the inside of the axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also refer to "Cleaning the Axle Assembly" in Section 3.
2. Inspect the axle housing for damage. Repair or replace the axle housing. Also refer to "Repairing or Replacing Axle Components" in Section 3.
3. Is used, inspect for loose studs in the mounting surface of the housing where the carrier fastens. Remove and clean the studs that are loose.
4. If studs are used, apply liquid adhesive to the threaded holes. Install the studs in the axle housing. Refer to "Installing Fasteners with Pre-applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent" in Section 3. Tighten the studs to the correct torque value. Refer to **Table H**.
5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material" in Section 3. **Figure 4.120**.

Figure 4.120



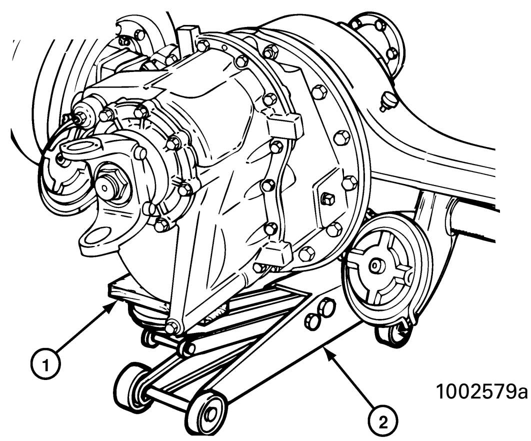
1 CONTINUOUS SILICONE BEAD

CAUTION

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 and cause serious personal injury.

6. Install the carrier into the axle housing. Use a hydraulic roller jack or a listing tool. **Figure 4.121**.

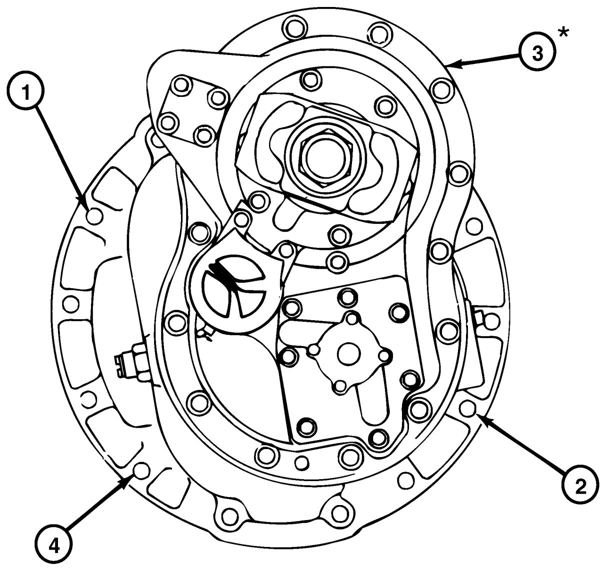
Figure 4.121



1 WOOD BLOCK
2 ROLLER JACK

7. Install the nuts and the washers or the capscrews and the washers in the four corner locations around the carrier and the axle housing. Tighten the fasteners by hand. **Do not tighten to the specified torque. Figure 4.122**.

Figure 4.122



*** (UNDER HELICAL GEAR COVER)**

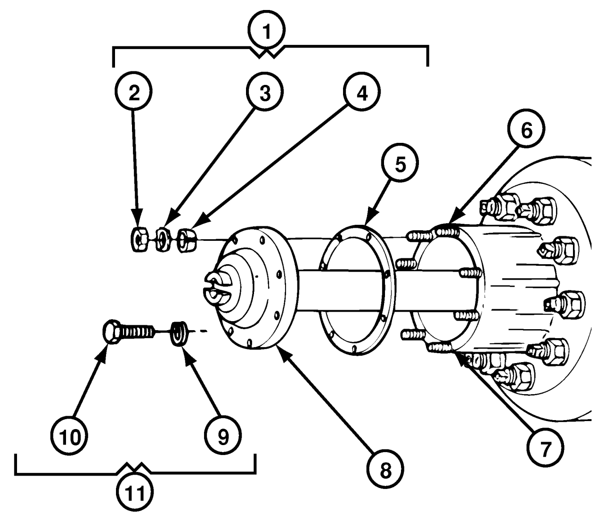
8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other.
9. Repeat Step 8 until the four fasteners are tightened to the correct torque value. Refer to **Table H**.
10. Install the other fasteners and the washers that hold the carrier in the axle housing. Tighten the fasteners to the correct torque value. Refer to **Table H**.
11. Connect the driveshaft to the input yoke on the carrier.

WARNING

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 and cause serious personal injury.

12. Clean the mating surfaces of the axle shaft and the wheel hub.
13. If silicone gasket material is used, apply a 1/8-inch-diameter bead of the silicone gasket material around the mating surface of the hub and around the edge of each fastener hole in the surface.
14. If a gasket is used, install the gasket and the axle shaft into the housing. The gasket and flange of the axle shaft MUST fit flat against the wheel hub. Refer to **Figure 4.123**.

Figure 4.123



1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET-RTV
6 STUD
7 SHAFT HUB AXLE
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

15. 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. If split tapered dowels were used originally, replace with solid tapered dowels.
16. Install the Grade 8 nuts and hardened washers on the stud. (Lock washers are an acceptable alternative.) Tighten the stud nuts or bolts to the torque specified in **Table B**.

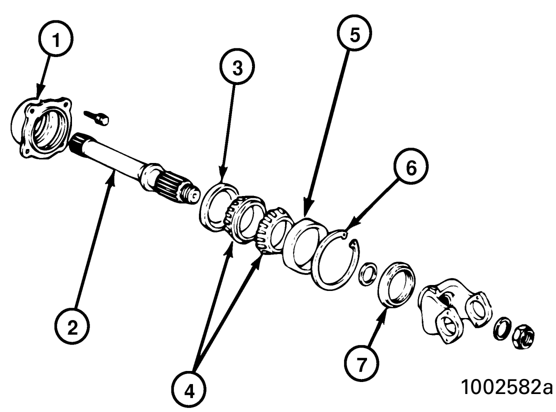
Table B: Torque Fastener Chart

Fastener	Thread Size	Torque Value — Grade 8 Nuts lb-ft (N•m)	
		Plain Nut	**Lock Nut**
Stud Nut (Axle Shaft)	0.44-20	50 to 75 (68-102)	40 to 65 (54-88)
	0.50-20	75 to 115 (102-156)	65 to 100 (88-136)
	0.56-18	110 to 165 (150-224)	100 to 145 (136-197)
	0.62-18	150 to 230 (204-312)	130 to 190 (176-258)
Studs	All	Install the course thread end of stud into hub and tighten to last thread.	

17. Install the bearing cage, the thru-shaft and the bearing assembly in the housing and adjust the end play of the output bearing. Refer to the following procedures.

Assembling the Output Bearings, the Thru-Shaft and the Oil Seal

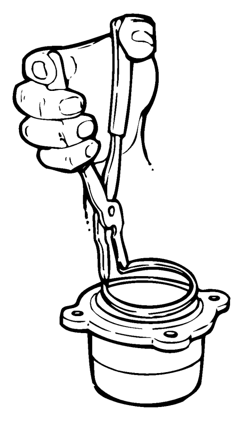
Figure 4.124



1	OUTPUT BEARING CAGE	4	BEARING CONES
2	THRU-SHAFT	5	OUTER BEARING CUP
3	INNER BEARING CUP	6	SNAP RING
		7	OIL SEAL

1. Lubricate the bearing cups and cones with the lubricant that is used in the axle housing.
2. If the bearing cones were removed from the thru-shaft, install new bearing cones. When a bearing cone is replaced, always replace the cup. Replace the cup and the cone in a matched set from the same manufacturer. Place both cones back to back on the thru-shaft. Use a press and a sleeve to install both cones. Apply pressure until the inner cone touches the shoulder of the thru-shaft.
3. Place the output bearing cage in a vise. Make sure the jaws of the vise are covered with soft metal shields to prevent damage to the cage.
4. Place the inner bearing cup in the cage. Place the thru-shaft and bearing assembly in the cage.
5. Place the outer bearing cup into the cage over the thru-shaft.
6. Install the snap ring that fastens the outer cone in the cage. The snap ring controls the end play of the output bearing. **Figure 4.125**.
7. Inspect and adjust the end play of the output bearing. Refer to the following procedure.

Figure 4.125



Inspecting and Adjusting the End Play of the Output Bearing

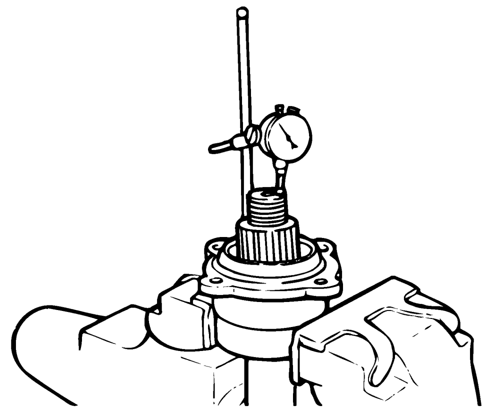
Specification:

- 10 lb-in (1.13 N•m) preload to 0.003-inch (0.076 mm) bearing end play. T

The end play of the output bearing is controlled by the size of the snap ring that holds the bearings in the output cage. The snap rings are available in a range of 0.088- to 0.112-inch (2.235-2.844 mm) in sizes of 0.003-inch (0.076 mm). Install the correct snap ring to get an end play from 0.001- to 0.0030-inch (0.0025-0.0762 mm).

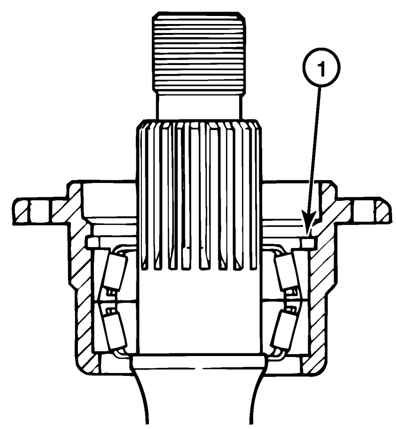
1. Place the thru-shaft and the bearing cage assembly in a vise.
2. Pull on the differential end of the thru-shaft and turn the shaft from side to side to make sure the cones are installed in the cups.
3. Install a dial indicator so that the base of the indicator is on the flange of the cage and the pointer of the indicator touches the yoke end of the thru-shaft. Adjust the dial indicator to the zero (0) setting. **Figure 4.126**.
4. Push on the differential end of the thru-shaft while turning the shaft from side to side. Record the reading on the dial indicator. The reading should be 0.003-inch (0.076 mm). This reading is the measurement of the end play on the output bearing.
5. If the end play reading is more than 0.003-inch (0.076 mm), remove and replace the snap ring that fastens the bearings in the cage. Install a thinner snap ring to increase end play. Install a thicker snap ring to decrease end play. **Figure 4.127**.

Figure 4.126



1002584a

Figure 4.127 OUTPUT BEARING END PLAY



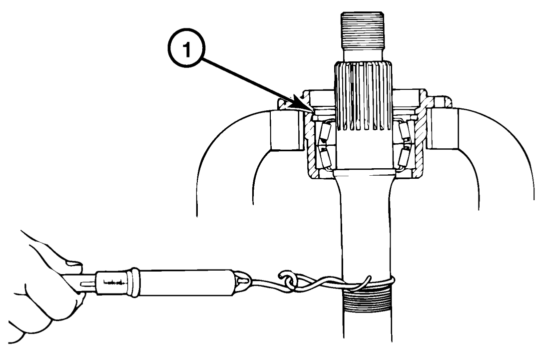
To increase end play, install a thinner snap ring.
To decrease end play, install a thicker snap ring.

1002585a

1 SNAP RING

6. If the end play reading is zero (0), measure the preload of the output bearings. Wind a wire around the output shaft. Attach a spring scale to the end of the wire. Pull the scale to rotate the output shaft and record the reading. If the rotating force is more than 10 lb-in (1.13 N•m), remove and replace the snap ring that fastens the bearings in the cage. Install a thinner snap ring to decrease output bearing preload. Install a thicker snap ring to increase output bearing preload. **Figure 4.128**.

Figure 4.128 OUTPUT BEARING PRELOAD



To increase preload, install a thicker snap ring.
To decrease preload, install a thinner snap ring.

1002586a

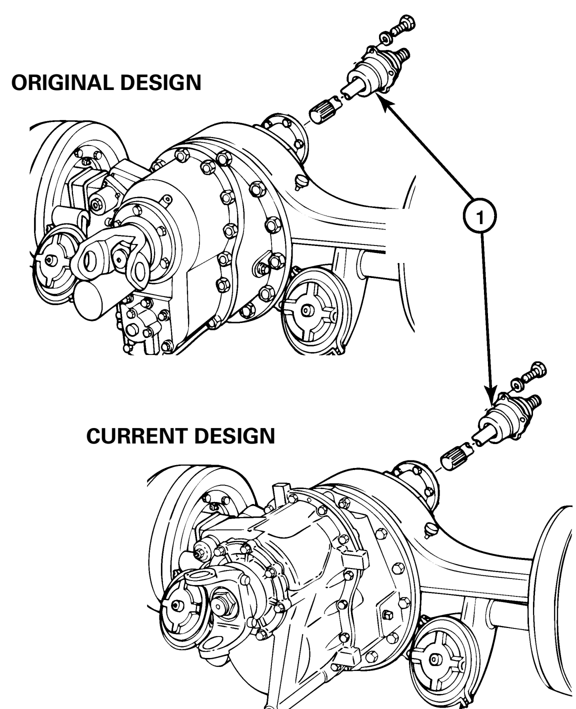
1 SNAP RING

7. Install the output yoke and spacer on the thru-shaft. Refer to "Installing the Yoke" in this section. Do not install the oil seal at this time.
8. Install the nut that fastens the output yoke on the thru-shaft. Place a holding tool on the yoke and tighten the nut to the specified torque. Refer to **Table H**.
9. Inspect the end play of the output bearing with the yoke installed. Refer to Steps 1-6 of this procedure.
10. Remove the yoke and the spacer from the thru-shaft. Refer to "Removing the Carrier from the Axle Housing" in Section 2.

Installing the Oil Seal, the Yoke, the Thru-Shaft and the Bearing Cage

1. Install the oil seal in the bearing cage. Refer to the procedure under "Installing the Input Shaft, the Clutch Collar and the Bearings in the Helical Gear Cover — Original Design" in this section.
2. Squirt axle lubricant through the inner and outer openings of the bearing cage to lubricate the bearings.
3. After the bearings are oiled, pack the inner and outer bearings with Meritor Specification 0-622 grease or equivalent. Use a grease gun with a flexible nozzle to pack the bearing cavities through the inner and outer openings of the bearing cage.
4. Install the gasket between the bearing cage and the axle housing.
5. Place the thru-shaft and bearing cage assembly in the axle housing. Rotate the thru-shaft to align the splines of the thru-shaft with the splines of the rear side gear. **Figure 4.129**.

Figure 4.129

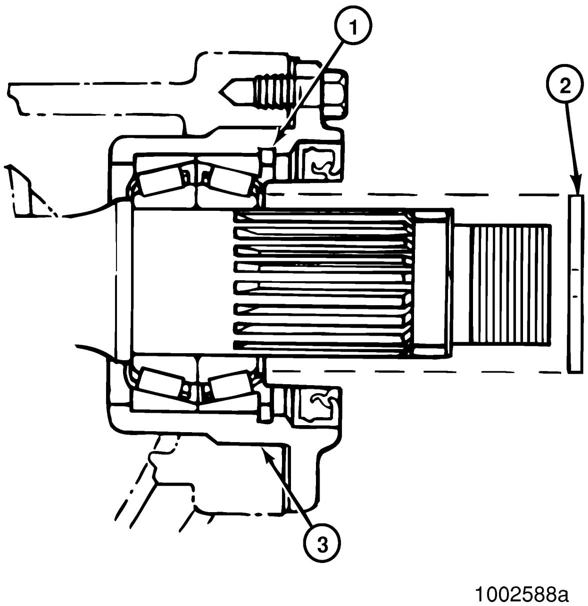


1002576a

1 THRU-SHAFT AND BEARING CAGE ASSEMBLY

6. Install the washers and the capscrews that fasten the output bearing cage to the axle housing. Tighten the capscrews from 35 to 50 lb-ft (48-67 N•m). T
7. Install the spacer on the thru-shaft. **Figure 4.130**.
8. Install the output yoke on the thru-shaft. Refer to the procedure under "Installing the Yoke" in this section.

Figure 4.130



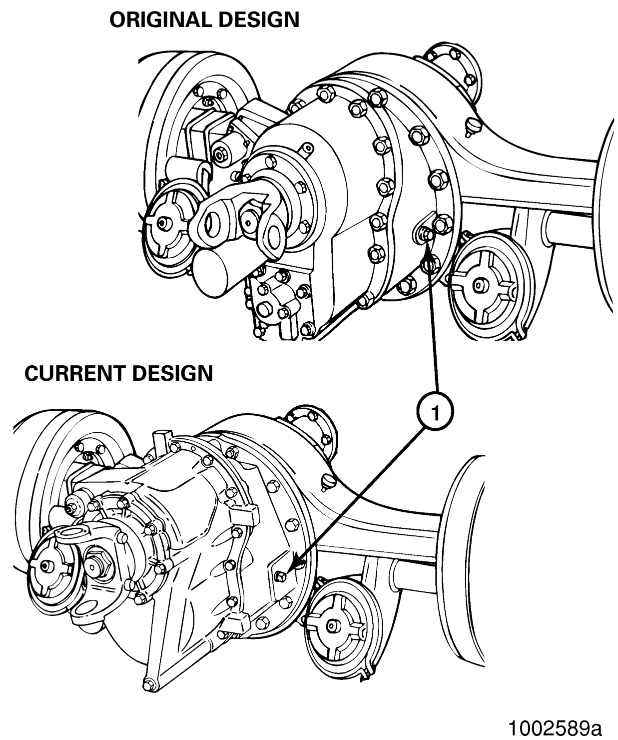
1 SNAP RING
2 SPACER
3 BEARING CAGE

Filling the Axle with Lubricant — On-Highway Axles

NOTE: For additional lubrication information, refer to Maintenance Manual 1, *Lubrication*.

1. Make sure the vehicle is parked on a level surface. The drive pinion must be in the horizontal position. When the angle of the drive pinion changes, the lubricant capacity of the axle will change.
2. Remove the fill plug from the side of the differential carrier. **Figure 4.131**.
3. Place the specified axle lubricant in through the fill plug hole. Fill the axle with lubricant until the lubricant level is to the bottom of the fill plug hole. Refer to **Table C** for the specified axle lubricant.
4. Install the fill plug and tighten to a minimum torque of 35 lb-ft (47 N•m). When correctly installed, one complete thread of the fill plug is visible. T
5. On axles with an inter-axle differential, remove the plug on the top of the axle housing. Place two U.S. pints (0.946 liters) of the specified lubricant in the axle housing. Refer to **Table C** for the specified lubricant.
6. Drive the vehicle in an unloaded condition for 1 to 2 miles (1.6-3.2 km) at speeds not more than 25 mph (40 km/h). Operating the vehicle makes sure that the lubricant flows through the complete axle assembly.

Figure 4.131

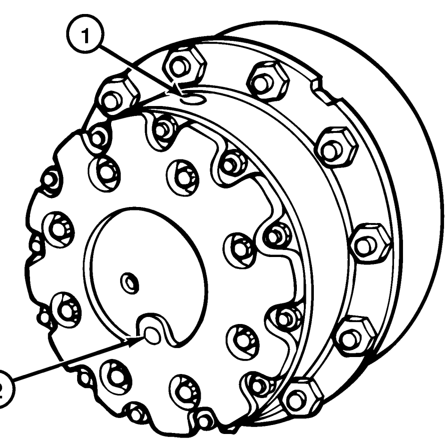


1 DIFFERENTIAL FILL PLUG

Filling the Axle with Lubricant — Off-Highway Axles

1. Rotate each wheel end so that the lubricant level hole is even with the horizontal position of the drive pinion.
2. On wheel ends with a bolted cover, remove the **fill/drain** plug from the top of the wheel hub and **oil level** plug from cover on the wheel end. **Figure 4.132**.

Figure 4.132



1 FILL PLUG
2 OIL LEVEL PLUG

3. For SPR-570 and SPRC-4806 axles, remove the **fill/level** plug from the axle housing bowl. **Figure 4.133**.

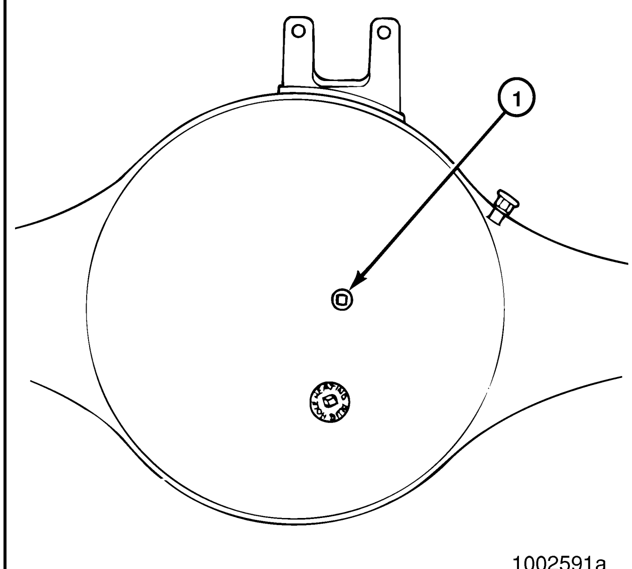
   For SPRC-1927 axles, remove the **fill/level** plug from the side of the differential carrier.

NOTE: For SPR-570 and SPRC-4806 axles, the axle and the wheel ends have the same lubricant level because an axle shaft seal is not used. For SPRC-1927 axles, each wheel end and the axle housing have different lubricant levels because an axle shaft seal is used.

4. For SPR-570 and SPRC-4806 axles, do the following:
   A. Remove the **fill** plug from the axle housing bowl.
   B. Add lubricant through the **fill** plug hole and the **fill/drain** plug hole in each wheel end.
   C. Give enough time for the lubricant to flow through the complete axle assembly.
   D. Continue to add lubricant until the lubricant flows from the bottom of the **oil level** hole in each wheel end and the bottom of the **fill** hole in the axle housing.

   For SPRC-1927 axles, do the following:
   - Add lubricant through the **fill** plug holes in each wheel end and the side of the differential carrier.
   - Continue to add lubricant until lubricant flows from the bottom of the fill plug holes.
5. Install and tighten all the plugs. Refer to **Table H**. T

Figure 4.133



1 FILL PLUG

NOTE: This section describes the necessary requirements to install components of a recent design on older carriers.

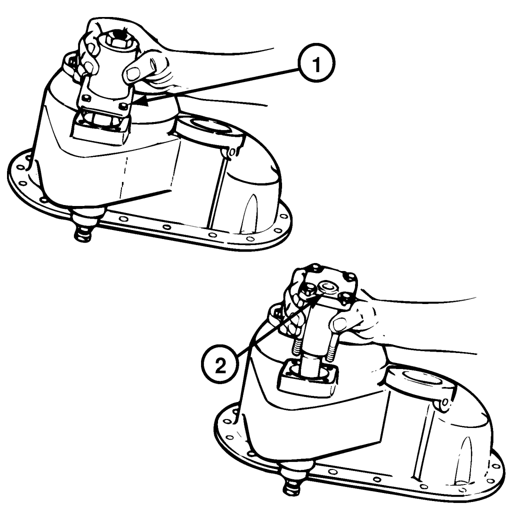
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Shift Unit

Shift units with Allen-head capscrew retainers are installed on carriers that have shift units with long capscrew and retainers without changing the helical gear cover. **Figure 5.1**.

Figure 5.1

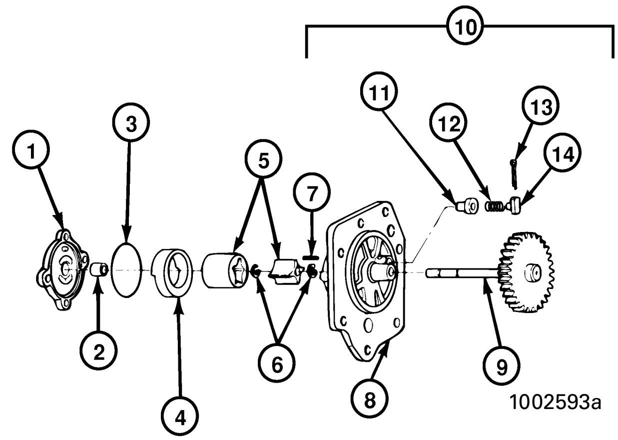


1 ALLEN-HEAD CAPSCREW RETAINER SHIFT UNIT
2 LONG CAPSCREW AND RETAINER SHIFT UNIT

Rotor-Type Oil Pump

If a rotor-type oil pump is installed on a helical gear cover that uses the gear-type oil pump, the helical gear cover and the idler gear assembly must be replaced. **Figure 5.2**.

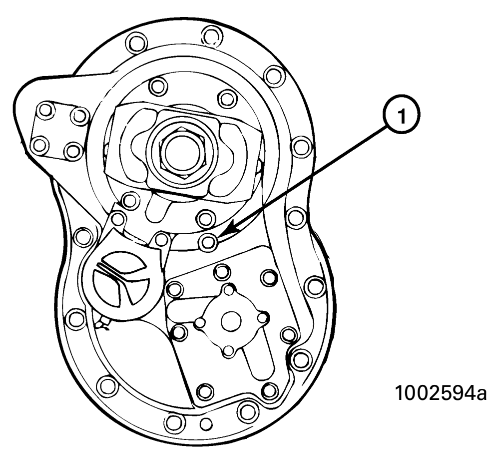
Figure 5.2



1 CAP
2 BUSHING
3 O-RING
4 REVERSING RING
5 2–PIECE ROTOR SET
6 SNAP RINGS
7 KEY
8 PUMP BODY
9 GEAR AND SHAFT ASSEMBLY
10 RELIEF VALVE ASSEMBLY
11 POPPET
12 SPRING
13 COTTER PIN
14 CAP

NOTE: The helical gear cover (Part Number A-3266-W-881) that uses a hollow sleeve for the idler gear of the oil pump can use a solid shaft (Part Number A-3266-N-1080) for the idler gear. Drill the 0.531-inch (13.487 mm) hole to a larger diameter of 0.656-inch (16.662 mm). The bore does not have to be made larger if Kit 3301-A is used on the A-3266-W-881 carrier. **Figure 5.3**.

Figure 5.3

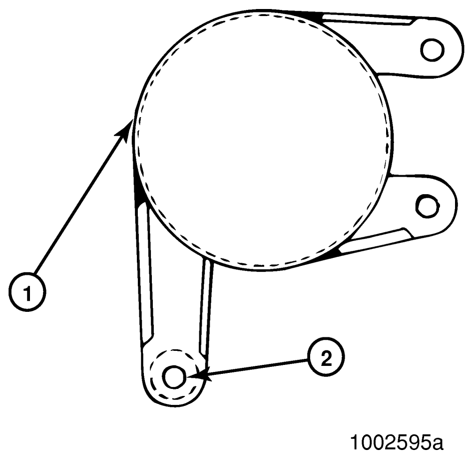


1 ENLARGE IDLER SHAFT HOLE FROM 0.531 INCH (13.487 mm) TO 0.656 INCH (16.662 mm) (NOT REQUIRED IF KIT 3301-A IS USED)

Steel Oil-Filter Cover

If a steel oil-filter cover is installed on a helical gear cover that uses a plastic oil-filter cover, a 2.0-inch capscrew (Part Number S-2616-1 or equivalent) is necessary. Place the steel cover over the existing studs. Install the new capscrew through the long arm of the cover, the pump assembly and into the helical gear cover. **Figure 5.4**.

Figure 5.4



1 STEEL OIL-FILTER COVER
2 INSTALL LONG CAPSCREW HERE

Two-Piece (Separable Race) Spigot Bearing — 280/380 Series Only

To install a two-piece (separable race) spigot bearing in a carrier that uses the one-piece spigot bearing, some parts are replaced and the carrier must be matched. **Figure 5.5**.

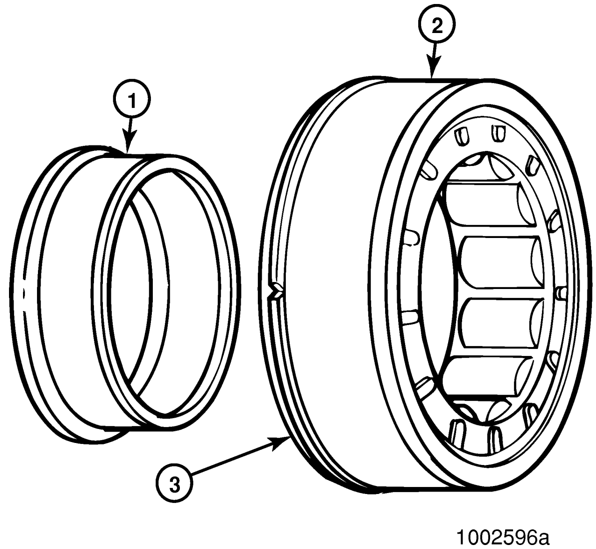
The parts that must be replaced are:

- Differential Case Halves
- Differential Case Fasteners (Bolts, Washers and Lock Nuts)
- Spigot Bearing Snap Ring
- Ring Gear
- Drive Pinion
- Ring Gear-to-Differential Case Fasteners (Bolts, Washers and Lock Nuts)

The bore in the differential carrier for the snap ring of the spigot bearing is machined to a diameter of 4.380-inch (11.124 cm) at a depth of 0.030-inch (0.762 mm). **Figure 5.6**.

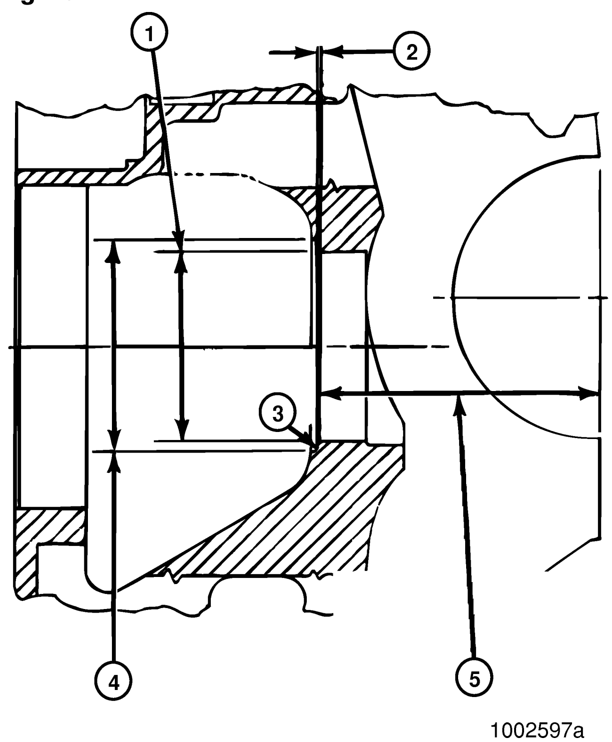
The bore depth is important because there must be a distance of 5.738- to 5.748-inch (14.574-14.599 mm) from the bottom of the bore for the snap ring to the mounting surface of the bearing caps on the carrier. The bottom of the snap ring bore must be perpendicular within 0.003-inch (0.076 mm) to the 3.9370- to 3.9384-inch (9.9999-10.0035 cm) bore diameter for the spigot bearing in the carrier.

Figure 5.5



1 INNER RACE PRESSED ON DRIVE PINION
2 OUTER RACE INSTALLED IN CARRIER
3 SNAP RING

Figure 5.6



1 SPIGOT BEARING BORE: 3.9370-3.9384 INCH (9.9999-1035 mm)
2 0.060 INCH (0.762 mm) COUNTERSINK
3 0.060 INCH (1.524 mm) RADIUS
4 SNAP RING BORE DIAMETER: 4.38 INCH (11.125 mm)
5 BOTTOM OF SNAP RING BORE TO BEARING CAP MOUNTING SURFACE: 5.738-5.748 INCH (14.574-14.599 mm)

Triple-Lip (Main) Oil Seal

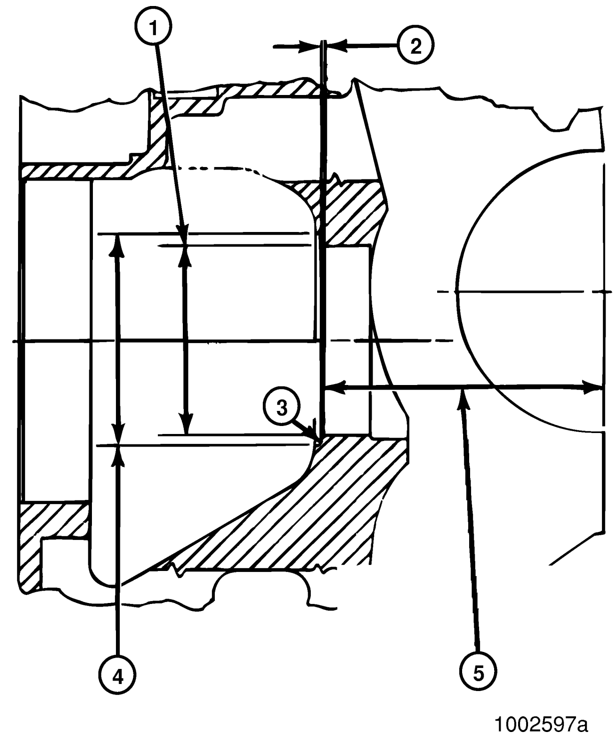
Input Shaft on Forward-Rear Differential Carriers

A triple-lip (main) oil seal can be installed in bearing cages that are used in one-piece oil seals if the chamfer of the bearing cage is changed. The 45° chamfer angle in the cage must be grounded to a 30° angle. Changing the chamfer angle permits the triple-lip (main) oil seal to be installed correctly in an input bearing cage that uses the one-piece oil seal.

To change the chamfer angle from 45° to 30°:

- Remove the input bearing cage from the helical gear cover.
- Remove and discard the one-piece oil seal. Make sure that the outer face and the inner diameter of the bearing cage are not damaged.
- Remove the bearing cones from the cages.
- Grind the chamfer of the bearing cage from the 45° angle to the 30° angle. **Figure 5.7**.
- Clean the bearing cage and cup assembly. Make sure all metal particles are removed from the assembly.
- Install the triple-lip (main) oil seal as described under "Triple-Lip (Main) Oil Seal" in Section 4.
- Place the bearing cones in the cage. Install the cage on the helical gear cover as described under "Triple-Lip (Main) Oil Seal" in Section 4.

Figure 5.7



1 SPIGOT BEARING BORE: 3.9370-3.9384 INCH (9.9999-1035 mm)
2 0.060 INCH (0.762 mm) COUNTERSINK
3 0.060 INCH (1.524 mm) RADIUS
4 SNAP RING BORE DIAMETER: 4.38 INCH (11.125 mm)
5 BOTTOM OF SNAP RING BORE TO BEARING CAP MOUNTING SURFACE: 5.738-5.748 INCH (14.574-14.599 mm)

Output Shaft on Forward-Rear Differential Carriers

The triple-lip (main) oil seal cannot be installed in a bearing cage that uses the one-piece oil seal. The bearing cage must be replaced with a cage that uses the triple-lip (main) oil seal.

Input Shaft on Rear-Rear Differential Carriers

The triple-lip (main) oil seal cannot be installed in a bearing cage that uses the one-piece oil seal. The bearing cage must be replaced with a cage of the design that uses the triple-lip (main) oil seal. On 270-280 series carriers, the oil deflector and the bearing cage are replaced when a triple-lip (main) oil seal is used to replace a one-piece oil seal.

NOTE: For complete information on lubricating drive axles and carriers, refer to Maintenance Manual 1, *Lubrication*.

NOTE: Refer to the following tables for standard information on lubricants, schedules and capacities.

Table C: Lubricant Cross Reference (Viscosity) and Temperature Chart

Meritor Lubricant Specification	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	–12.2°C (+10°F)	- - -*
0-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	–26.1°C (–15°F)	- - -*
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	–26.1°C (–15°F)	- - -*
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	–40°C (–40°F)	- - -*
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	–40°C (–40°F)	+ 1.6°C (+ 35°F)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	–40°C (–40°F)	- - -*

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

Table D: Oil Change Intervals and Specifications for All Rear Drive Axles ①

Vocation or Vehicle Operation	Linehaul Motorhome Intercity Coach	City Delivery School Bus Fire Truck	Construction Transit Bus Refuse Yard Tractor Logging Heavy Haul Mining Oil Field Rescue
Initial Oil Change	No longer required as of January 1, 1993		
Check Oil Level	Every 25,000 miles (40 000 km) or the fleet maintenance interval (whichever comes first)	Every 10,000 miles (16 000 km), once a month or the fleet maintenance interval (whichever comes first)	Every 5,000 miles (8000 km), once a month or the fleet maintenance interval (whichever comes first) ②
Petroleum based oil change on axle WITH or WITHOUT pump and filter system	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first	Every 25,000 miles (40 000 km) or annually, whichever comes first
Synthetic oil change on axle WITHOUT pump and filter system ③	Every 250,000 miles (400 000 km) or annually, whichever comes first	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first
Synthetic oil change on axle WITH pump and filter system ③	Every 500,000 miles (800 000 km)	Every 250,000 miles (400 000 km)	Every 100,000 miles (160 000 km)
Filter change on axle WITH pump and filter system	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)

① 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).

② 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.

③ 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*. To order this publication, call ArvinMeritor's Customer Service Center at 800-535-5560.

Table E: Lubricant Specifications

	Gear Oil Type	A.P.I. Specification	SAE Grade	Meritor Specification	Military Specification	Outside Temperature
Non-Extended Drain Lubricants	Petroleum With EP Additives	GL-5	85W/140	O-76A	MIL-L-2105D or MIL-PRF-2105E	Above +10°F (–12°C)
			80W/90	O-76D		Above –15°F (–26°C)
			75W/90	O-76E		Above –40°F (–40°C)
			75W	O-76J		From –40°F (–40°C) to 35°F (2°C)
			75W/140	O-76L		Above –40°F (–40°C)
Extended Drain Lubricants	Petroleum With Extended Drain Additives	GL-5	80W/90	—	MIL-L-2105D or MIL-PRF-2105E	Above –15°F (–26°C)
	Semi-Synthetic					Above –15°F (–26°C)
	Full Synthetic		75W/140	O-76M		Above –40°F (–40°C)
			75W/90	O-76N		Above –40°F (–40°C)

Table F: Lubricant Capacities — On-Highway Axles

Model	Carrier	Capacity	
		U.S. Pints	Liters
SR-170, RT-, RP-48-180	Forward	55.0	26.0
	Rear	43.0	23.3
SR-270/280 RT-, RP-48-380	Forward	55.0	26.0
	Rear	55.0	26.0
ST-170, RT-, RP-52-180	Forward	55.0	26.0
	Rear	43.0	23.3
ST-270/280 RT, RP-52-380	Forward	55.0	26.0
	Rear	55.0	26.0
SU-170 RT-, RP-52-180	Forward	55.0	26.0
	Rear	43.0	23.3
SU-270/280, RT-, RP-58-380	Forward	55.0	26.0
	Rear	55.0	26.0
SW-170	Forward	55.0	26.0
	Rear	43.0	23.0
SW-270/280, RT, RP-70-380	Forward	55.0	26.0
	Rear	55.0	26.0

Table G: Lubricant Capacities — Off-Highway Axles ①

		Capacity			
		Wheel Ends		Axle Housing Bowl	
Model	Carrier	U.S. Pints per Wheel End	Liters per Wheel End	U.S. Pints	Liters
SPR-570	Forward	32.0	15.0	72.0	34.0
	Rear	32.0	15.0	72.0	34.0
SPRC-4806	Forward	32.0	15.0	72.0	34.0
	Rear	32.0	15.0	72.0	34.0

① For correct lubrication, each wheel end and the axle housing bowl must be filled with the specified amount of lubricant. **Do not fill the axle only through the wheel ends or the axle housing bowl.**

Torque Values for Fasteners

General Information

1. The torque values in **Table H** are for fasteners that have a light application of oil on the threads.
2. If the fasteners are dry, increase the torque values by ten percent (10%).
3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by ten percent (10%).
4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

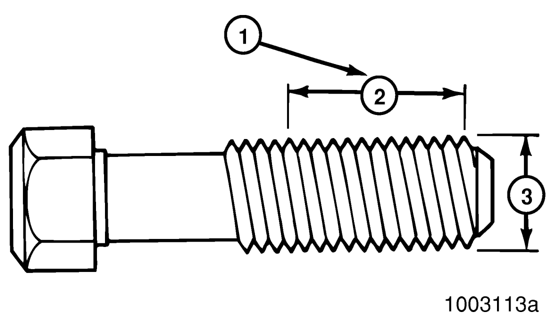
A. Measure the diameter of the threads in inches, dimension X. **Figure 7.1**.

B. Count the amount of threads there are in one-inch (1.0-inch). **Figure 7.1**.

Example:

- American Standard size fastener is 0.50-13.00.
  - — 0.50 is the diameter of the fastener in inches or dimension X.
  - — 13.00 is the amount of threads in one-inch (1.0-inch).

Figure 7.1



1 AMOUNT OF THREADS IN ONE INCH
2 1″
3 X

X DIMENSION = (EXAMPLE 1/2″)

Metric Fasteners

A. Measure the diameter of the threads in millimeters (mm), dimension X. **Figure 7.2**.

B. Measure the distance of ten (10) threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y. **Figure 7.2**.

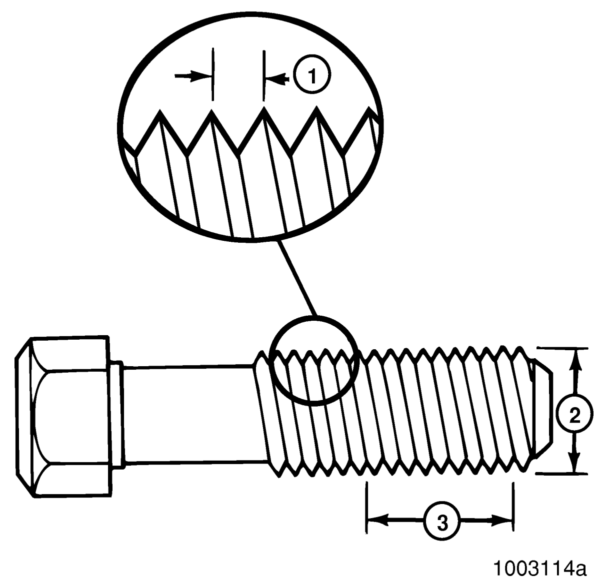
C. Divide dimension Y by ten (10). The result will be the distance between two threads or pitch.

Example:

- Metric size fastener is M8 x 1.25.
  - — M8 is the diameter of the fastener in millimeters (mm) or dimension X.
  - — 1.25 is the distance between two threads or pitch.

5. Compare the size of fastener measured in Step 4 to the list of fasteners in **Table H** to find the correct torque value.

Figure 7.2



1 PITCH
2 X
3 Y

X DIMENSION = (EXAMPLE M8 OR 8 MM)

Y DIMENSION = DISTANCE OF 10 THREADS

Figure 7.3

TORQUE LOCATIONS

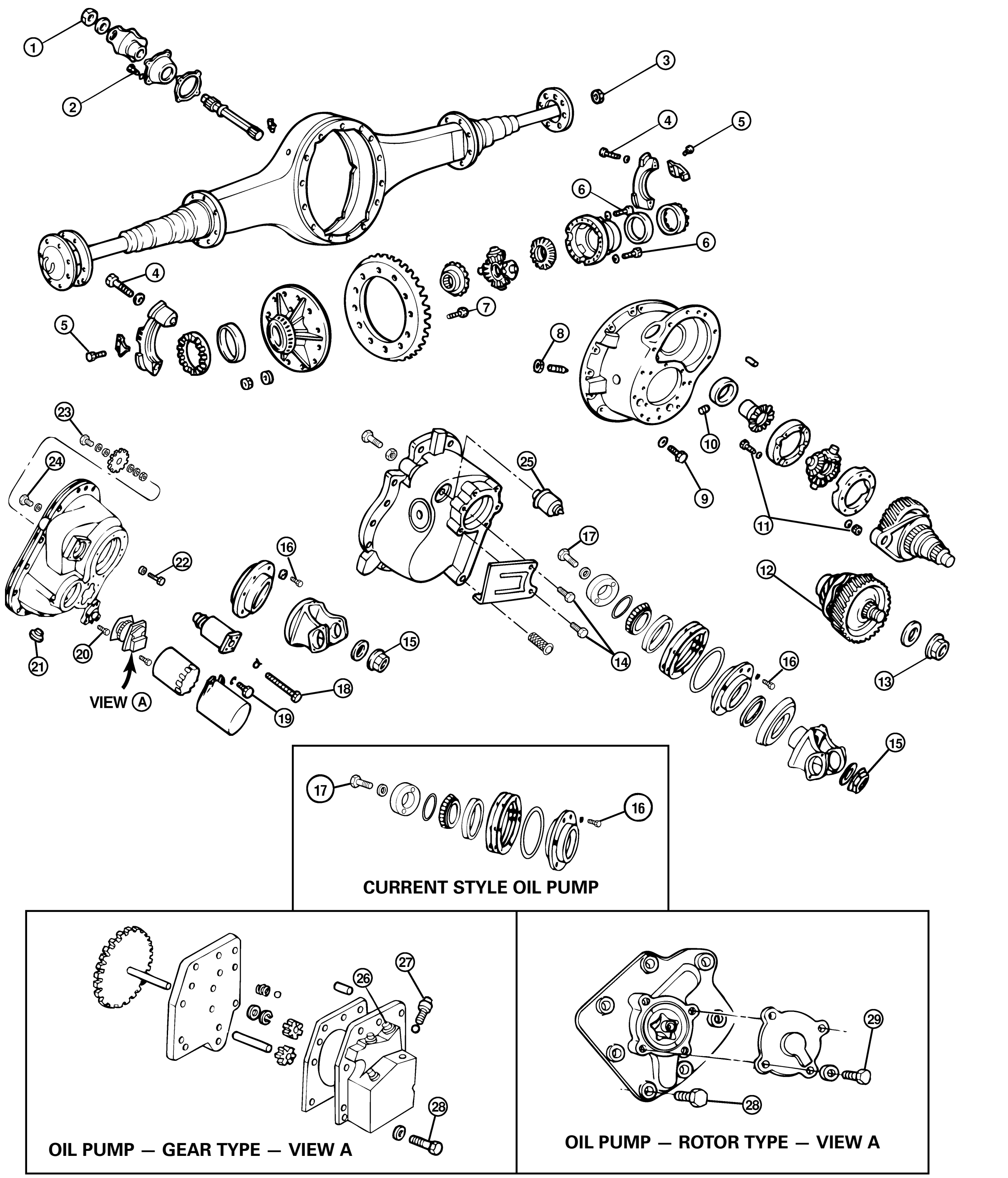


Table H: Torque Specifications

Position	Description	Thread Size	Torque Value	
			Lb-Ft	N•m
1	Output Yoke-to-Thru-Shaft Nut	1-1/2"-12	450-650	610-881
2	Output Bearing Cage-to-Axle Housing Capscrew	7/16"-14	60-75	82-101
		3/8"-16 x 1-1/4"	35-50	48-67
3	Wheel Hub-to-Axle Shaft Flange Nut ④	5/8"-18	150-230	203-312
4	Bearing Cap-to-Axle Housing Capscrew	3/4"-10 x 4-3/4"	290-350	394-474
		7/8"-14	375-435	509-589
5	Adjusting Ring Lock-to-Bearing Cap Capscrew	5/16"-18	20-30	28-40
5A	Differential Case Halves Bolts	5/8"-11	180-230	245-311
		1/2"-13	40-55	55-75
6	Differential Case Halves Thru-Bolts	5/8"-18	210-250	285-340
7	Ring Gear-to-Differential Case Nut and Bolt	5/8"-18	180-230	245-311
		7/8"-14	600-700	810-950
8	Thrust Screw Jam Nut	1-/18"-16	150-190	204-257
		7/8"-14	150-190	204-257
9	Differential Carrier-to-Axle Housing Capscrew or Nut	5/8"-11 x 1"	180-230	245-311
10	Fill Plug ①	3/4"-14	35 Min.	48 Min.
11	Inter-Axle Differential Case Halves Nut and Bolt	3/8"-16	30-40	41-54
		3/8"-16 x 2-7/8"	35-50	48-67
12	Drive Pinion Bearing Cage-to-Differential Carrier Capscrew	1/2"-13	85-115	116-155
		5/8"-11 x 1-1/2"	180-230	245-311
13	Helical Driven Gear-to-Drive Pinion Nut	2"-12	1200-1500	1627-2033
14	Oil Shield Bolt			
15	Input Yoke-to-Input Shaft Nut	Refer to **Table I**.		
16	Input Bearing Cage-to-Differential Carrier Capscrew	1/2"-13	85-115	116-155
17	Oil Pump to Bearing Cage Capscrew — New Designs			
18	Air Shift Unit-to-Helical Gear Cover Long Capscrew and Allen-head Capscrew	1/4"-20	7-10 ②	10-14
19	Oil Filter Cover-to-Helical Gear Cover Capscrew ③	5/16"-18	15	20
20	Oil Filter Adapter-to-Helical Gear Cover Capscrew	5/16"-18 x 1	20-30	28-40
21	Drain Plug ①	3/4"-14	35 Min.	48 Min.
22	Helical Gear Cover-to-Differential Carrier Capscrew	1/2"-13	85-115	116-155
23	Oil Pump Idler Gear-to-Helical Gear Cover Nut	1/2"-13 — Lock Nut	75-100	102-135
		1/2"-13, Gr. 8 — Plain Nut	85-115	116-155
		1/2"-13, Gr. 5 — Plain Nut	65-85	88-115
		5/8"-11 — Plain Nut	110-145	145-197
24	Shift Fork Adjusting Screw Jam Nut	1/2"-13	40-55	55-74
25	Oil Pump to Helical Cover Capscrew — Rotor Type			
26	Oil Pump Pipe Plug — Small ①	1/4"-18	15 Min.	20 Min.
27	Oil Pump Pipe Plug — Large ①	1/2"-14	25 Min.	33 Min.
28	Oil Pump-to-Helical Cover Capscrew — Gear and Rotor Types	3/8"-16	35-50	48-67
29	Cap-to-Oil Pump Capscrew (Rotor-Type Pump Only)	5/16"-18	15-20	21-27

① Minimum torque. Tighten until one thread is visible.

② 75-100 lb-in.

③ On steel oil filter covers, tighten the capscrew that fastens lower, longer leg of the cover to 30 lb-ft (41 N•m).

④ To install the stud, place the coarse end of the stud into the hub. Tighten the stud to the last thread.

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Table I: Input and Output Yoke Pinion Nut Fastener Torque Specifications

Single Axles

Pinion Nut Location \ Axle Model	RS-120, RS-125, RS-140	RS-145	RS-160, RS-161, RS-185, RS-186	RS-210, RS-220, RS-230	RS-240	RS-380
Carrier Input Yoke	740-920 lb-ft (1000-1245 N•m) Fastener Size: M32 X 1.5	920-1130 lb-ft (1250-1535 N•m) Fastener Size: M39 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	740-920 lb-ft (1000-1245 N•m) Fastener Size: M32 X 1.5	740-920 lb-ft (1000-1245 N•m) Fastener Size: M39 X 1.5	800-1100 lb-ft (1085-1496 N•m) Fastener Size: 1-1/2 - 12 UNF

Tandem Axles

Pinion Nut Location \ Axle Model	RT-140	RT-145, RT-149	RT-160, RT-164, RT-169	RT-185	RT-380 With IAD	RT-380 Without IAD
First Carrier Input Yoke	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: 1-3/4 - 12 UN	600-800 lb-ft (815-1085 N•m) Fastener Size: 1-3/4 - 12 UN	900-1200 lb-ft (1224-1632 N•m) Fastener Size: 1-3/4 - 12 UN
First Carrier Output Yoke	450-650 lb-ft (610-880 N•m) Fastener Size: M32 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 - 12 UNF	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 - 12 UNF	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 - 12 UNF
Second Carrier Input Yoke	740-920 lb-ft (1000-1245 N•m) Fastener Size: M32 X 1.5	920-1130 lb-ft (1250-1535 N•m) Fastener Size: M39 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	800-1100 lb-ft (1085-1496 N•m) Fastener Size: 1-1/2 - 12 UNF	800-1100 lb-ft (1085-1496 N•m) Fastener Size: 1-1/2 - 12 UNF

Tridem Axles

Pinion Nut Location \ Axle Model	RZ-164	RZ-166	RZ-186	RZ-188
First Carrier Input Yoke	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: 1-3/4 - 12 UN	600-800 lb-ft (815-1085 N•m) Fastener Size: 1-3/4 - 12 UN
First Carrier Output Yoke	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 -12 UNF	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 - 12 UNF
Second Carrier Input Yoke	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: M45 X 1.5	600-800 lb-ft (815-1085 N•m) Fastener Size: 1-3/4 - 12 UN
Second Carrier Output Yoke	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: M39 X 1.5	450-650 lb-ft (610-880 N•m) Fastener Size: 1-1/2 - 12 UNF
Third Carrier Input Yoke	920-1130 lb-ft (1250-1535 N•m) Fastener Size: M39 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5

NOTE: Refer to Section 4 for further information.

Drive Pinion Bearings — Preload

Specification	New bearings — From 5 to 25 lb-in (0.56 to 2.82 N•m) torque T Used bearings in good condition — From 5 to 15 lb-in (0.56 to 1.69 N•m) torque T
Adjustment	Preload is controlled by the thickness of the spacer between bearings. — To increase preload, install a thinner spacer — To decrease preload, install a thicker spacer

Drive Pinion — Depth in Carrier

Specification	Install the correct amount of shims between the bearing cage and carrier. To calculate, use old shim pack thickness and new and old pinion cone number.
Adjustment	Change the thickness of the shim pack to get a good gear-tooth contact pattern.

Hypoid Gear Set — Tooth Contact Patterns (Hand Rolled)

Specification	Conventional gear set — Toward the toe of the gear tooth and in the center between the top and bottom of the tooth
Adjustment	Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash — To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage — To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage — To move the contact pattern toward the toe of the tooth, decrease backlash of the ring gear — To move the contact pattern toward the heel of the tooth, increase backlash of the ring gear

Input Bearing — End Play

Specification	0.002 to 0.008-inch (0.0508-0.2032 mm)
Adjustment	End play is controlled by the size of the shim pack. — To increase end play, add shims to the shim pack — To decrease end play, remove shims from the shim pack

Main Differentail Bearings — Preload

Specification	From 15 to 35 lb-in (1.7 to 3.9 N•m) torque T **or** Expansion between bearing caps — 0.006 to 0.013-inch (0.15 to 0.33 mm)
Adjustment	Preload is controlled by tightening both adjusting rings after zero end play is reached

Main Differential Gears — Rotating Resistance

Specification	50 lb-ft (68 N•m) torque applied to one side gear T

Output Bearing — End Play and Preload

Specification	10 lb-in (1.13 N•m) bearing preload to 0.0030-inch (0.0762 mm) bearing end play T
Adjustment	End play and preload are controlled by the size of the snap ring in the output bearing cage. — Increase end play and decrease preload by installing a thinner snap ring — Decrease end play and increase preload by installing a thicker snap ring

Ring Gear — Backlash

Specification	0.008 to 0.020-inch (0.020-0.510 mm) 0.014-inch (0.350 mm) for a new gear set
Adjustment	Backlash is controlled by the position of the ring gear. Change backlash within specifications to get a good tooth contact pattern. — To increase backlash, move the ring gear away from the drive pinion — To decrease backlash, move the ring gear toward the drive pinion

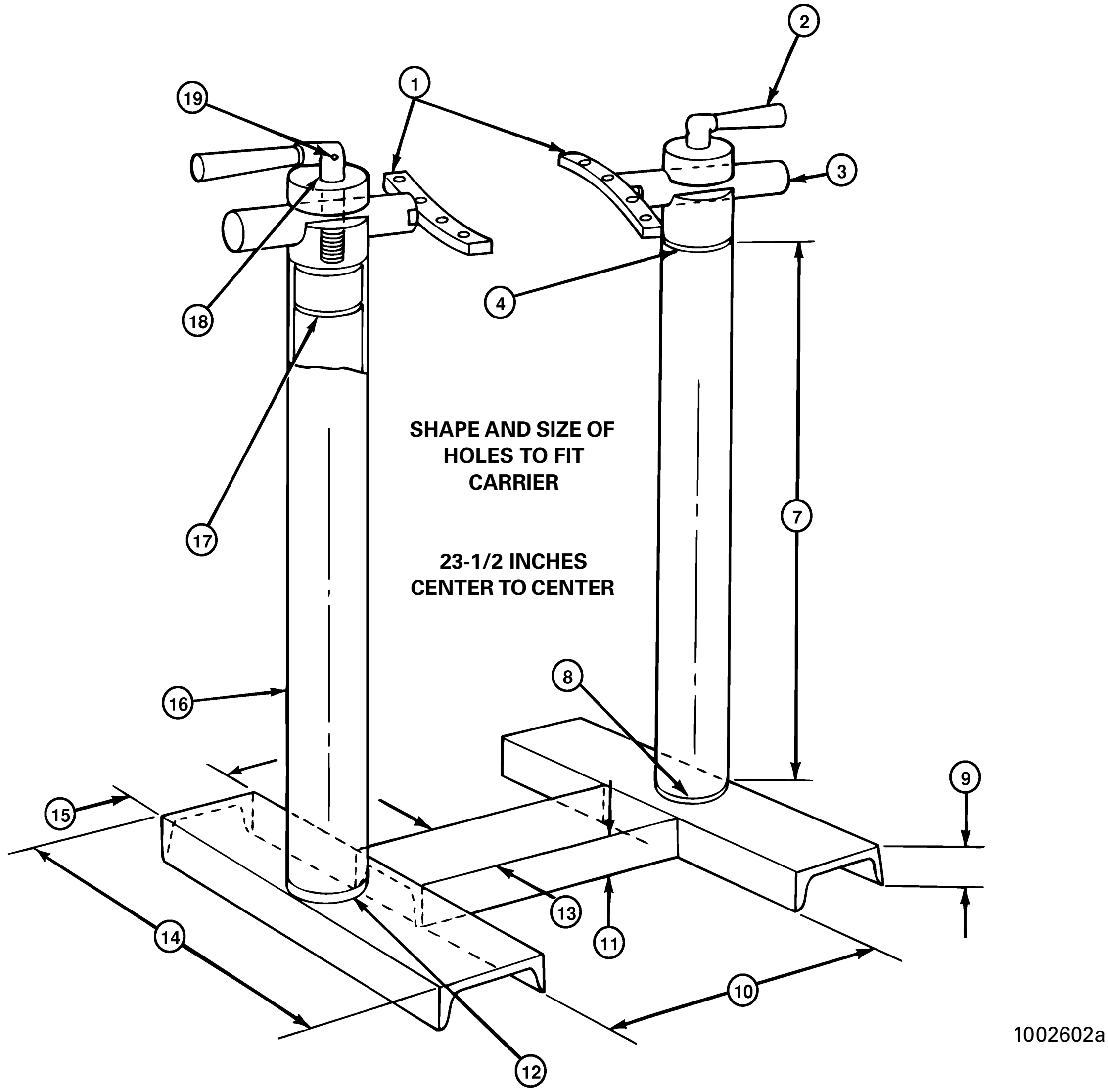
Ring Gear — Runout

Specification	0.008-inch (0.200 mm) maximum

Thrust Screw — Clearance

Specification	0.025 to 0.045-inch (0.65 to 1.14 mm) **or** Loosen the thrust screw 1/4 turn after tightening the thrust screw, hand tight, against the ring gear

CARRIER STAND



1 PLATES 8 INCHES LONG X 3/4 INCH THICK x 1-1/4 INCHES WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR.
2 HANDLE 7 INCHES LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW
3 BAR 2 INCHES DIAMETER x 9 INCHES LONG WITH ONE END SLOTTED TO FIT PLATE.
4 WELD ALL AROUND AFTER PRESSING PLUG IN PIPE.
7 29-1/4 INCHES
8 WELD
9 2-1/4 INCHES
10 16 INCHES
11 2-1/4 INCHES
12 CHAMFER END OF PIPE FOR WELDING.
13 6 INCHES
14 25-1/2 INCHES
15 6 INCHES
16 4 INCHES DIAMETER PIPE
17 PLUG 4 INCHES DIAMETER x 7 INCHES LONG WITH ONE END TURNED 3 INCHES LONG TO FIT PIPE. DRILL 2-INCH HOLE AND MILL 3/16-INCH WIDE SLOT 2 INCHES FROM TOP.
18 SCREW 3-1/2 INCHES LONG x 5/8-INCH DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2-INCH LENGTH OF THREAD ON OTHER END.
19 DRILL 3/8-INCH HOLE THROUGH HANDLE AND SCREW

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

SINGLE AXLE

With Driver Controlled Main Differential Lock (DCDL — Screw-In [threaded] shift assembly)

TANDEM AXLE

With Driver Controlled Main Differential Lock (DCDL — Screw-In [threaded] shift assembly) and with Inter-Axle Differential (IAD)

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

Before Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the DCDL and the IAD to the unlocked (disengaged) positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
4. Stop the engine.

Table J

Single Axles	Remove the left-hand (road side) axle shaft
Tandem Axles — **Forward Axle:**	Remove the right-hand (curb side) axle shaft
Tandem Axles — **Rear Axle:**	Remove the left-hand (road side) axle shaft

NOTE: Remove only the axle shaft(s), shown in **Table J** at this time, from the axle(s) that will remain on the road when the vehicle is transported. Continue with Step 5.

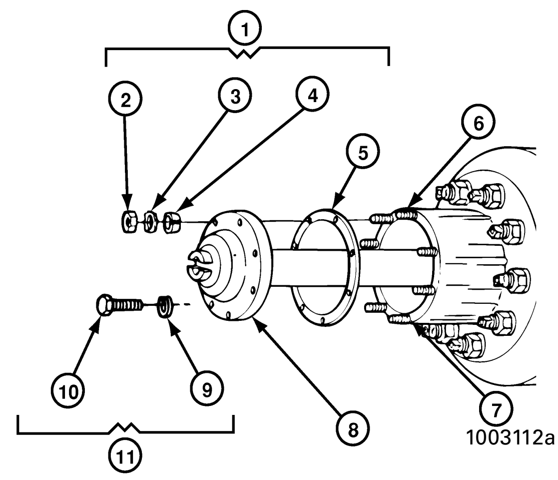
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 10.1**.

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/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.1**.

Figure 10.1



1	TAPERED DOWEL RETENTION	7	SHAFT HUB AXLE
2	STUD NUT	8	AXLE SHAFT (FLANGE)
3	WASHER	9	WASHER
4	TAPERED DOWEL	10	CAPSCREW
5	GASKET	11	NON-TAPERED DOWEL RETENTION
6	STUD		

Brass Drift Method:

WARNING

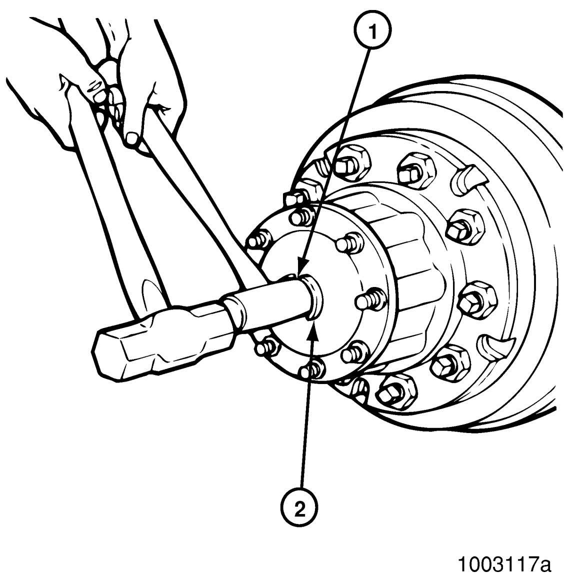
Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE: A 1.5-inch (38.1 mm) diameter brass hammer can be used as a drift.

A. Hold a 1.5-inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, **inside the round driving lugs. Figure 10.2**.

B. Hit the end of the drift with a large hammer (5 to 6 pounds, 2.3 to 2.7 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.2**.

Figure 10.2



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

Air Hammer Vibration Method:

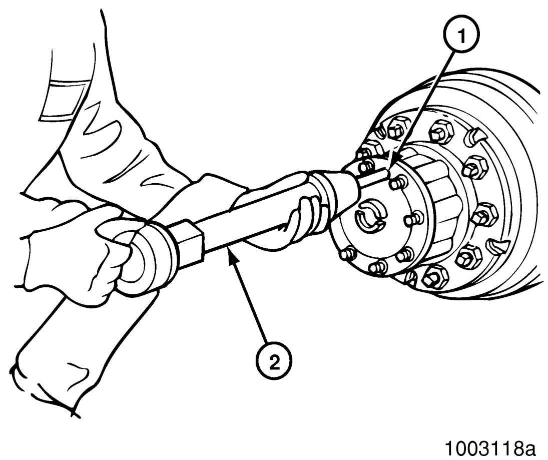
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

A. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

B. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.3**.

Figure 10.3



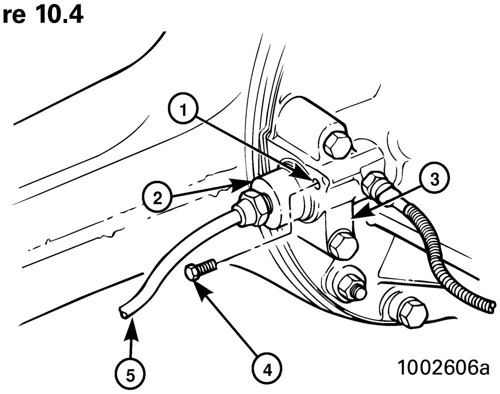
1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

7. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)

8. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.1**.

9. Disconnect the air hose from the shift cylinder. **Figure 10.4**.
10. Remove the manual engaging capscrew from the storage hole. The storage hole of threaded shift assemblies is located in the shift tower of the carrier, next to the cylinder. **Figure 10.4**.
11. Lock (engage) the main differential using the Manual Engaging Method.

Figure 10.4



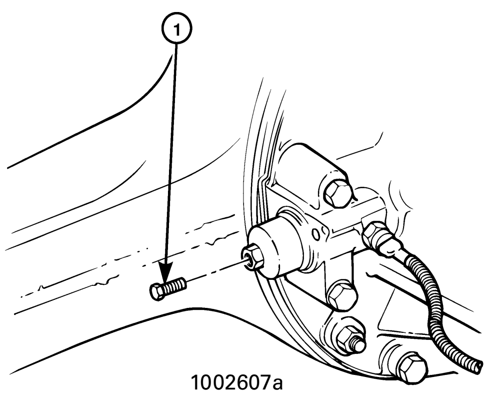
1	STORAGE HOLE	4	MANUAL ENGAGING CAPSCREW
2	CYLINDER		
3	SHIFT TOWER	5	AIR HOSE

THREADED SHIFT ASSEMBLY

Manual Engaging Method

A. Install the manual engaging capscrew into the threaded hole in the center of the cylinder. **Figure 10.5**.

Figure 10.5



1 MANUAL ENGAGING CAPSCREW

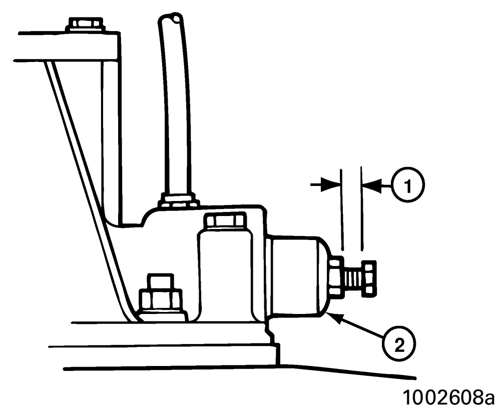
THREADED SHIFT ASSEMBLY

⚠ CAUTION

When you turn the capscrew in Step B and you feel a high resistance, STOP TURNING THE CAPSCREW. A high resistance against the capscrew indicates that the splines of the shift collar and differential case are not aligned. Damage to the threads of the cylinder and capscrew will result. To align the splines, continue with Steps C, D and E.

B. Turn the capscrew to the right until the head is approximately 0.25- to 0.50-inch (6.4-12.7 mm) from the cylinder. The capscrew is now in the service position and the main differential is locked (engaged). **Figure 10.6**. When turning the capscrew you will feel a small amount of resistance. This is normal. If you feel a high resistance before achieving the 0.25- to 0.50-inch distance between the capscrew head and cylinder, **stop turning the capscrew** and continue with Steps C, D and E.

Figure 10.6



1 0.25” TO 0.50” (6.4 TO 12.7 MM)
2 CYLINDER

C. Rotate the main driveline or the IAD a small amount by hand.

D. Turn the manual engaging capscrew again to the right. If you still feel a high resistance, **stop turning the capscrew**.

E. Repeat Steps C and D until you feel a low resistance on the capscrew. Continue with Step B.

12. Remove the remaining axle shaft(s) from the axle(s) that will remain on the road when the vehicle is transported. Follow Steps 5 through 8 found previously.
13. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Steps 14 and 15, otherwise continue with Step 16.

14. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 16.
15. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 16 is not required.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

16. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

Table K

Single Axles Install the right-hand (curb side) axle shaft
Tandem Axles **Forward Axle:** Install the left-hand (road side) axle shaft **Rear Axle:** Install the right-hand (curb side) axle shaft

NOTE: Install only the axle shaft(s) shown in **Table K** at this time. These axle shafts have a double row of splines that engage with splines of the side gear and shift collar in the main differential. **Figure 10.7**. Continue with Step 5.

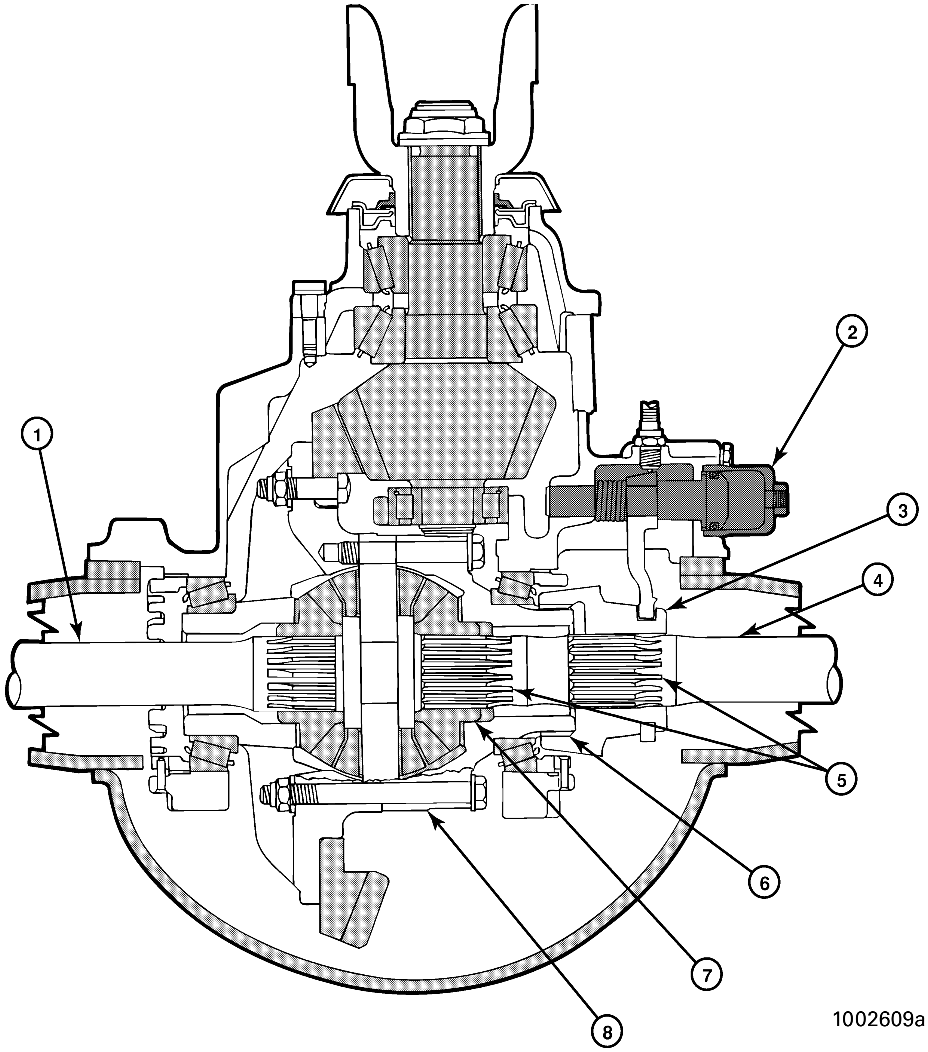
5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.1**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in **Table L** below.

Table L

	Thread Size	Torque Value lb-ft (N•m)
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts: (plain nuts)	0.44"-20	50-75 (68-102)
	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Unlock (disengage) the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of threaded shift assemblies is located in the shift tower of the carrier next to the cylinder. Tighten to 15 to 25 lb-ft (20-35 N•m). **Figure 10.4**. T
10. Connect the air hose to the shift cylinder. Tighten to 22 to 30 lb-ft (30-40 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier. Follow Steps 5 through 7 found previously.
12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to the Maintenance Manual 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

Figure 10.7



1 LEFT-HAND (ROAD SIDE) AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND (CURB SIDE) AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED (LOCKED)
7 SIDE GEAR
8 DIFFERENTIAL CASE

SINGLE AXLE OR REAR AXLE OF TANDEM:
Shown with Screw-In Shift Assembly and in the Locked (Engaged) Position

SINGLE AND TANDEM AXLE

With Driver Controlled Main Differential Lock (DCDL — Bolt-On shift assembly) and with Inter-Axle Differential (IAD)

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

Before Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the DCDL and the IAD to the unlocked (disengaged) positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
4. Stop the engine.

Table M

Single Axle	Remove the left-hand (road side) axle shaft
Tandem Axles — **Forward Axle:**	Remove the right-hand (curb side) axle shaft
Tandem Axles — **Rear Axle:**	Remove the left-hand (road side) axle shaft

NOTE: Remove only the axle shaft(s), shown in **Table M** at this time, from the axle(s) that will remain on the road when the vehicle is transported. Continue with Step 5.

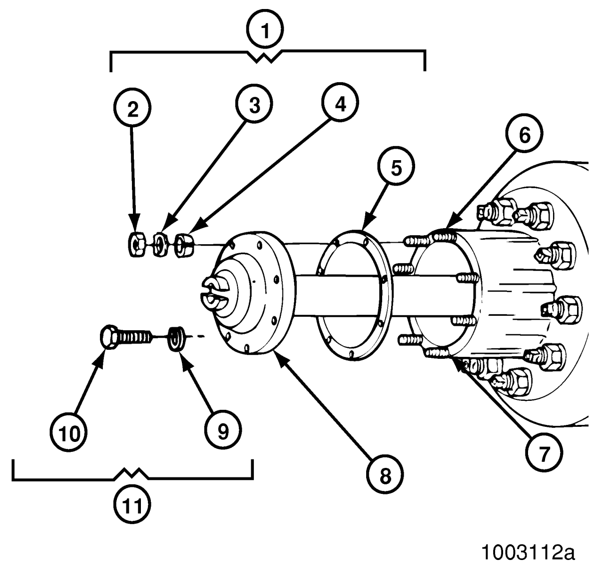
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft **Figure 10.8**.

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/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.8**.

Figure 10.8



1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET
6 STUD
7 SHAFT HUB AXLE
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

Brass Drift Method:

WARNING

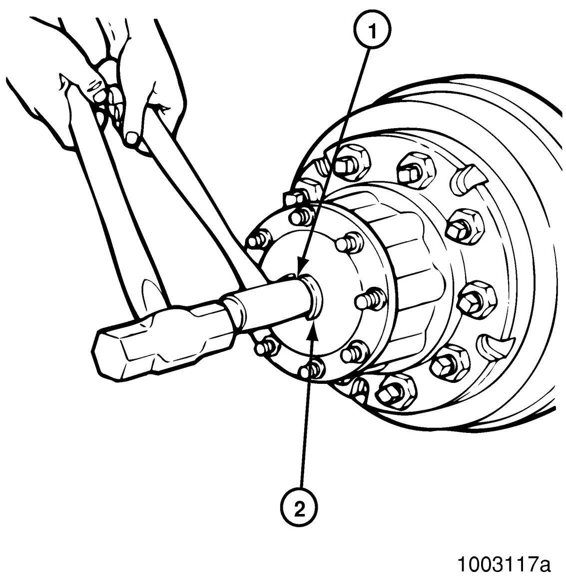
Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE: A 1.5-inch (38.1 mm) diameter brass hammer can be used as a drift.

A. Hold a 1.5-inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, **inside the round driving lugs**. **Figure 10.9**.

B. Hit the end of the drift with a large hammer (5 to 6 pounds, 2.3 to 2.7 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.9**.

Figure 10.9



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUGS

Air Hammer Method:

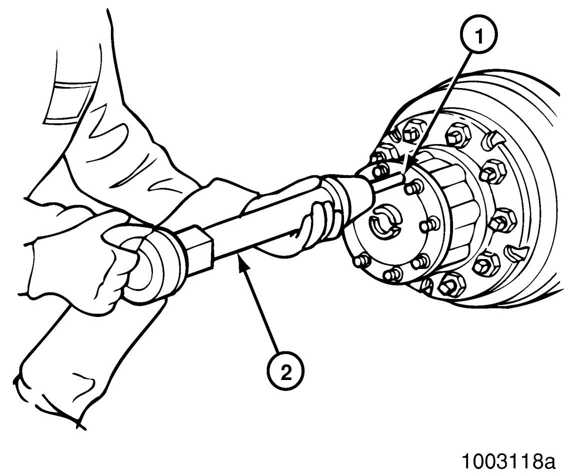
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

A. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

B. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.10**.

Figure 10.10

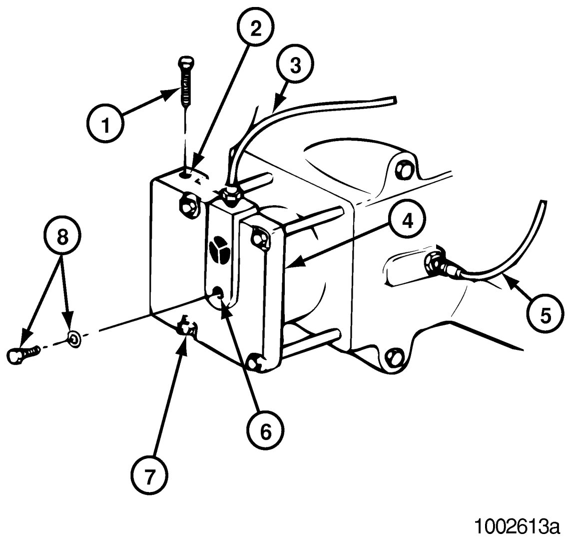


1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

7. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)
8. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.11**.

9. Remove the manual engaging capscrew from the storage hole. The storage hole of bolted-on shift assemblies is located in the top side of the shift cylinder cover. **Figure 10.11**.

Figure 10.11



1 MANUAL ENGAGING CAPSCREW
2 TOP STORAGE HOLE FOR MANUAL ENGAGING CAPSCREW
3 AIR LINE
4 CYLINDER COVER
5 WIRE
6 SERVICE POSITION CAPSCREW HOLE
7 BOTTOM STORAGE HOLE FOR PLUG AND GASKET
8 PLUG AND GASKET

BOLT-ON SHIFT ASSEMBLY

10. Remove the plug and gasket from the center of the shift cylinder cover. Install the plug and gasket into the bottom side storage hole of the shift cylinder cover (opposite end of the storage hole for the manual engaging capscrew). Tighten to 15 to 25 lb-ft (20-35 N•m) torque. **Figure 10.11**. T

11. Lock (engage) the main differential using one of the two following methods: Air Pressure Method or Manual Engaging Method.

Air Pressure Method:

A. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. Turn the capscrew to the right 3 to 5 turns. **Figure 10.12**.

B. Shift the transmission into neutral and start the vehicle's engine. Let the engine idle to increase the pressure in the air system. **Do not release the parking brakes**.

C. Shift the main differential to the locked (engaged) position using the switch inside the cab of the vehicle. When the differential is locked, the indicator light in the cab will go on. If the light does not go on it will be necessary to rotate the main driveline or the IAD by hand until the main differential is locked and the indicator light goes on.

NOTE: When the shift collar is completely engaged with the splines of the main differential case, the differential is locked and the driveline cannot be rotated. **Figure 10.14**.

D. While the differential is held in the locked position by air pressure, turn the manual engaging capscrew to the right until you feel resistance against the piston. **Stop turning the capscrew.**

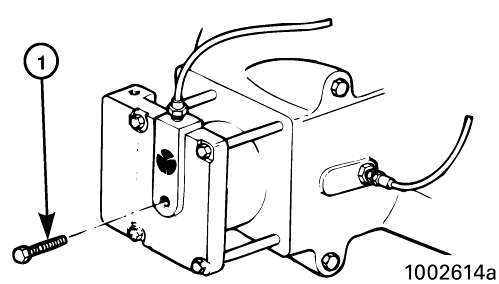
E. Place the main differential lock switch in the unlocked (disengaged) position.

F. Stop the engine. Continue with Step 12.

Manual Engaging Method:

A. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. **Figure 10.12**.

Figure 10.12



1 MANUAL ENGAGING CAPSCREW

BOLT-ON SHIFT ASSEMBLY

CAUTION

When you turn the capscrew in Step B and you feel a high resistance, STOP TURNING THE CAPSCREW. A high resistance against the capscrew indicates that the splines of the shift collar and differential case are not aligned. Damage to the threads of the cylinder cover and capscrew will result. To align the splines, continue with Steps C, D and E.

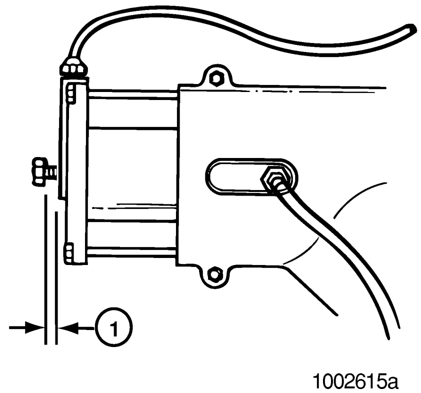
B. Turn the capscrew to the right until the head is approximately 0.25- to 0.50-inch (6.4-12.7 mm) from the cylinder cover. The capscrew is now in the service position and the main differential is locked (engaged). **Figure 10.13**. When turning the capscrew you will feel a small amount of resistance. This is normal.
If you feel a high resistance before achieving the 0.25- to 0.50-inch distance between the capscrew head and cylinder, **stop turning the capscrew** and continue with Steps C, D and E.

C. Rotate the main driveline or the IAD a small amount by hand.

D. Turn the manual engaging capscrew again to the right. If you still feel a high resistance, **stop turning the capscrew**.

E. Repeat Steps C and D until you feel a low resistance on the capscrew. Continue with Step B.

Figure 10.13



1 0.25" TO 0.50" (6.4-12.7 MM)

12. Remove the remaining axle shaft(s) from the axle(s) that will remain on the road when the vehicle is transported. Follow Steps 5 through 8 found previously.
13. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Steps 14 and 15, otherwise continue with Step 16.

14. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 16.
15. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 16 is not required.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

16. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

Table N

Single Axles
Install the right-hand (curb side) axle shaft
Tandem Axles
Forward Axle:
Install the left-hand (road side) axle shaft
Rear Axle:
Install the right-hand (curb side) axle shaft

NOTE: Install only the axle shaft(s) shown in **Table N** at this time. These axle shafts have a double row of splines that engage with splines of the side gear and shift collar in the main differential. Continue with Step 5. **Figure 10.14**.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.8**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in **Table O** below.

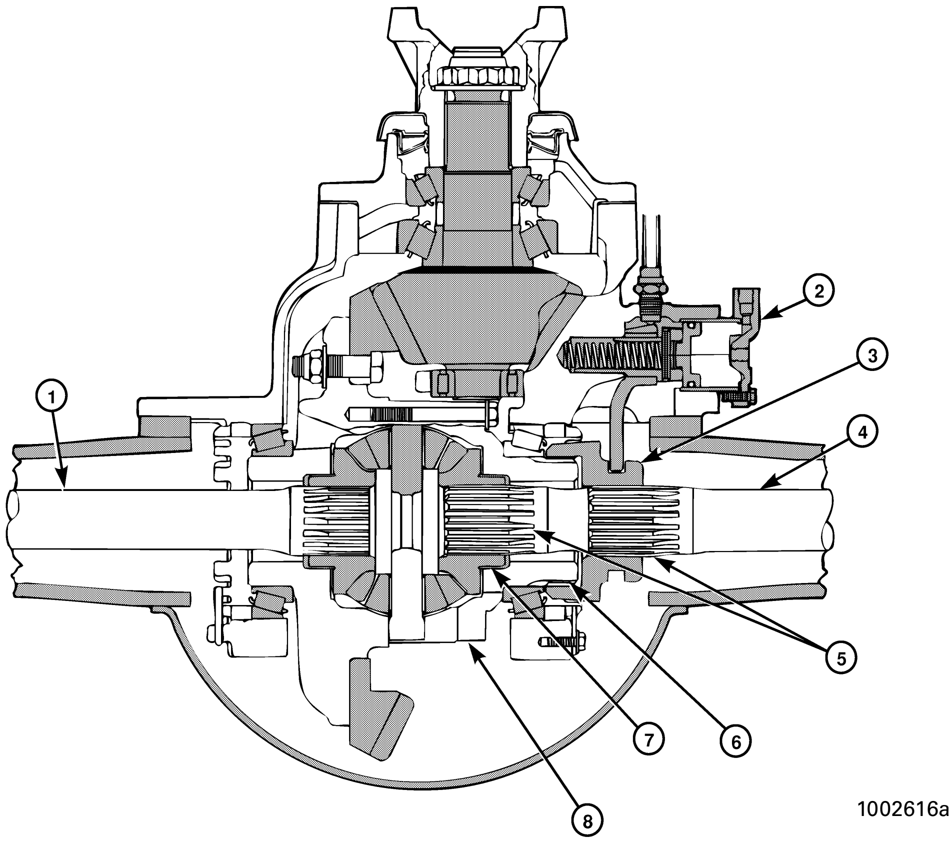
Table O

	Thread Size	Torque Value lb-ft (N•m)
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts:	0.44"-20	50-75 (68-102)
(plain nuts)	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Unlock (disengage) the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of bolted-on shift assemblies is located in the top side of the shift cylinder cover. Tighten to 15 to 25 lb-ft (20-35 N•m). **Figure 10.11**. T
10. Remove the plug and gasket from the storage hole. Install the plug and gasket into the threaded hole in the center of the shift cylinder cover. Tighten from 15 to 25 lb-ft (25-30 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier. Follow Steps 5 through 7.

12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to the Maintenance Manual 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

Figure 10.14



1 LEFT-HAND (ROAD SIDE) AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND (CURB SIDE) AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED (LOCKED)
7 SIDE GEAR
8 DIFFERENTIAL CASE

SINGLE AXLE OR REAR AXLE OF TANDEM:
Shown with Bolted On Shift Assembly and in the Locked (Engaged) Position

SINGLE AXLE

Without Driver Controlled Main Differential Lock (DCDL)

TANDEM AXLE

Without Driver Controlled Main Differential Lock (DCDL) and with Inter-Axle Differential (IAD)

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

Before Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.

NOTE: Single Axle continue with Step 5. Tandem Axle continue with Step 2.

2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the IAD to the unlocked (disengaged) position using the switch inside the cab of the vehicle. The indicator light in the cab will go off.
4. Stop the engine.

NOTE: Remove both axle shafts from the axle(s) that will remain on the road when the vehicle is transported. Continue with Step 5 for both axle shafts.

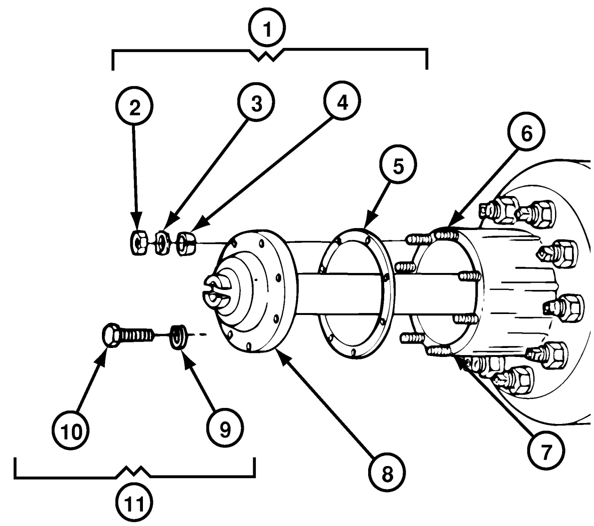
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 10.15**.

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/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.15**.

Figure 10.15



1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET
6 STUD
7 SHAFT HUB AXLE
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

Brass Drift Method:

WARNING

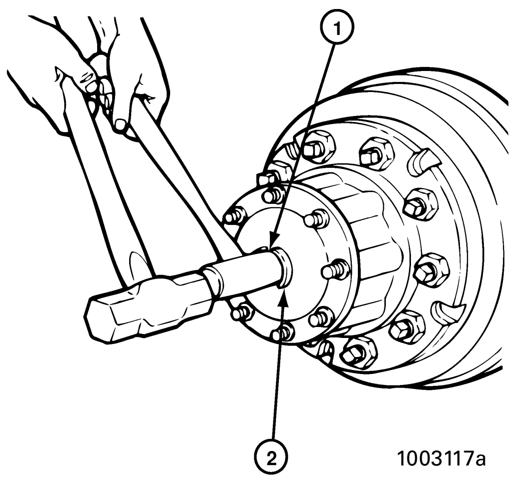
Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE: A 1.5-inch (38.1 mm) diameter brass hammer can be used as a drift.

A. Hold a 1.5-inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, **inside the round driving lugs. Figure 10.16**.

B. Hit the end of the drift with a large hammer (5 to 6 lbs, 2 to 3 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.16**.

Figure 10.16



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

Air Hammer Vibration Method:

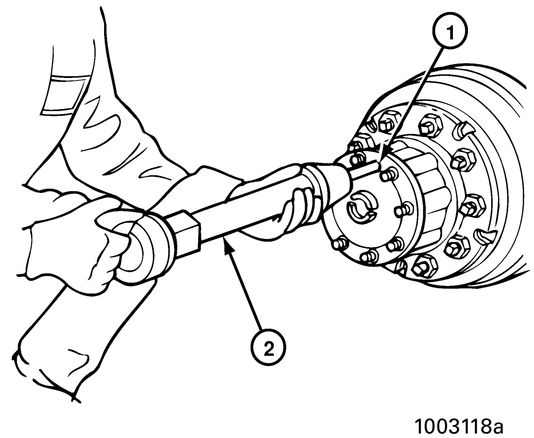
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

A. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

B. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.17**.

Figure 10.17



1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

7. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)
8. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.15**.
9. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Step 10 and 11, otherwise continue with Step 12.

10. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 12.

11. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 12 is not required.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

12. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

NOTE: Continue with Steps 5 through 7 to install all axle shafts.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.15**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in **Table P** below.

Table P

	Thread Size	Torque Value lb-ft (N•m)
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts: (plain nuts)	0.44"-20	50-75 (68-102)
	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. Refer to Maintenance Manual 1, *Lubrication*, for additional information.

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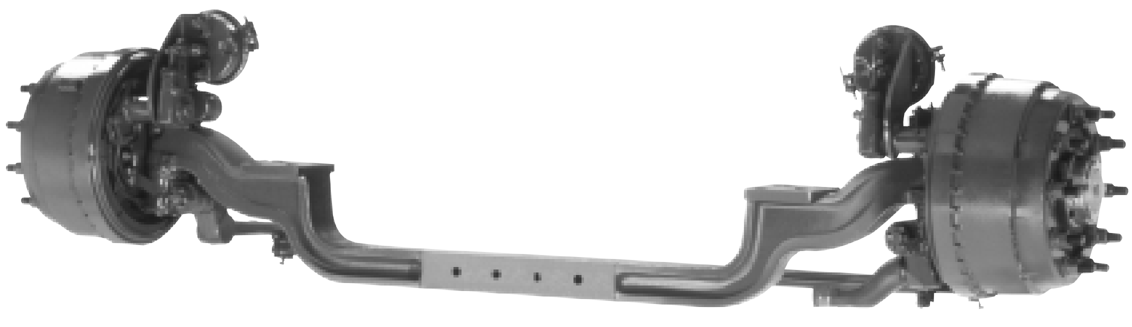
Bus and Coach
Front Axles

Maintenance Manual 23



17100	FH 941
17101	FH 945
17110	FH 946
17111	

Service Notes

Before You Begin

This manual provides maintenance procedures for ArvinMeritor's bus and coach front non-drive steer axles: 17100, 17101, 17110, 17111, FH 941, FH 945 and FH 946. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

WARNING	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
CAUTION	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious personal injury can also occur.
T	The torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE:	A Note provides information or suggestions that help you correctly service a component.

Access Information on ArvinMeritor's Web Site

Additional maintenance and service information for ArvinMeritor's commercial vehicle systems component lineup is also available on ArvinMeritor's web site at www.arvinmeritor.com.

To access information, click on Products & Services/Tech Library Icon/HVS Publications. The screen will display an index of publications by type.

Additional Information

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following publications.

- *Bus and Coach Rear Axles* Maintenance Manual 23A
- *Bus and Coach Brakes* Maintenance Manual 23B
- *Technical Electronic Library* on CD. Features product and service information on most Meritor, ZF Meritor and Meritor WABCO components. $20. Order TP-9853.

MERITOR™

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ASBESTOS FIBER WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

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.

NON-ASBESTOS FIBER WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a potential cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some medical experts believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposures levels may exceed OSHA or manufacturer's recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH of MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

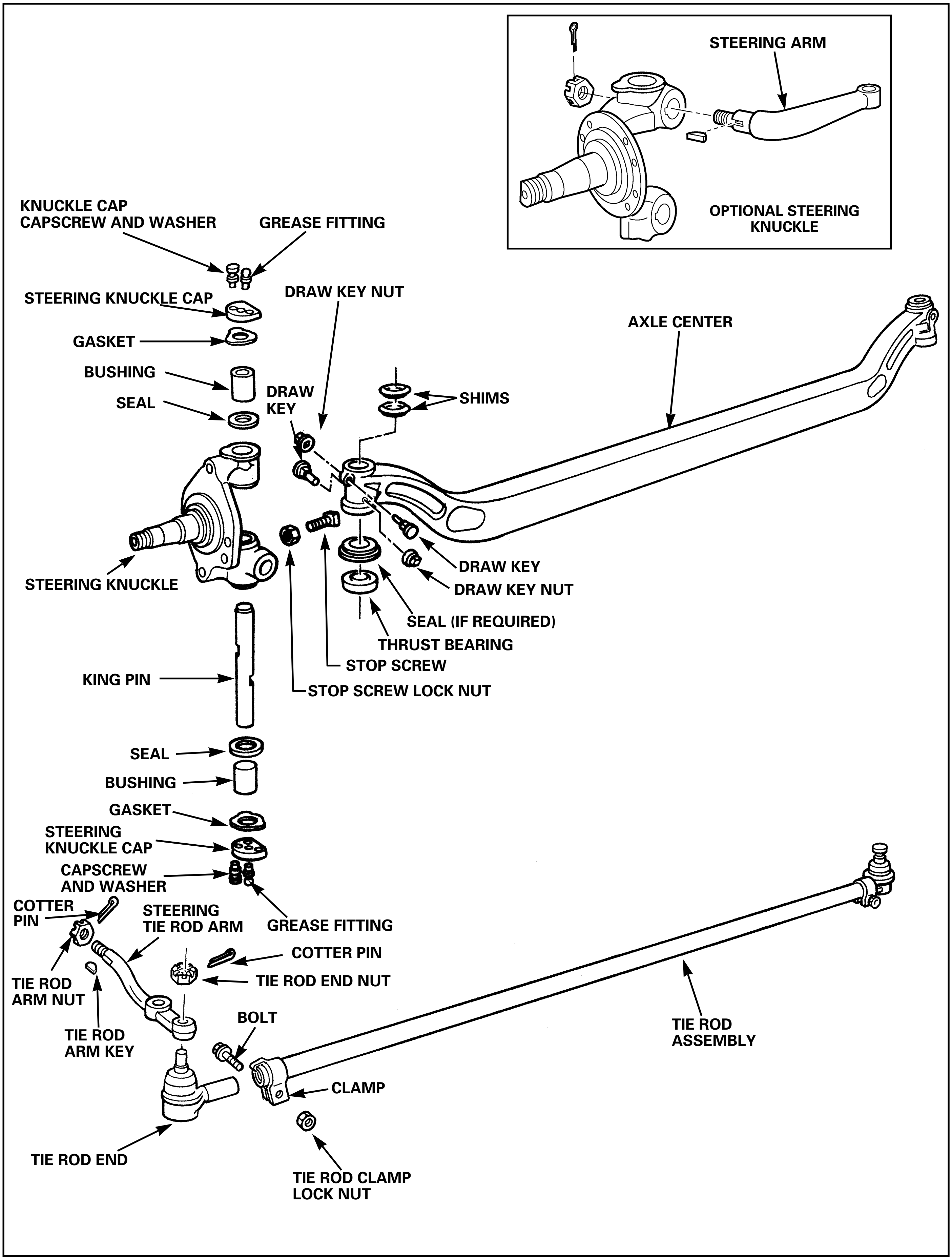
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

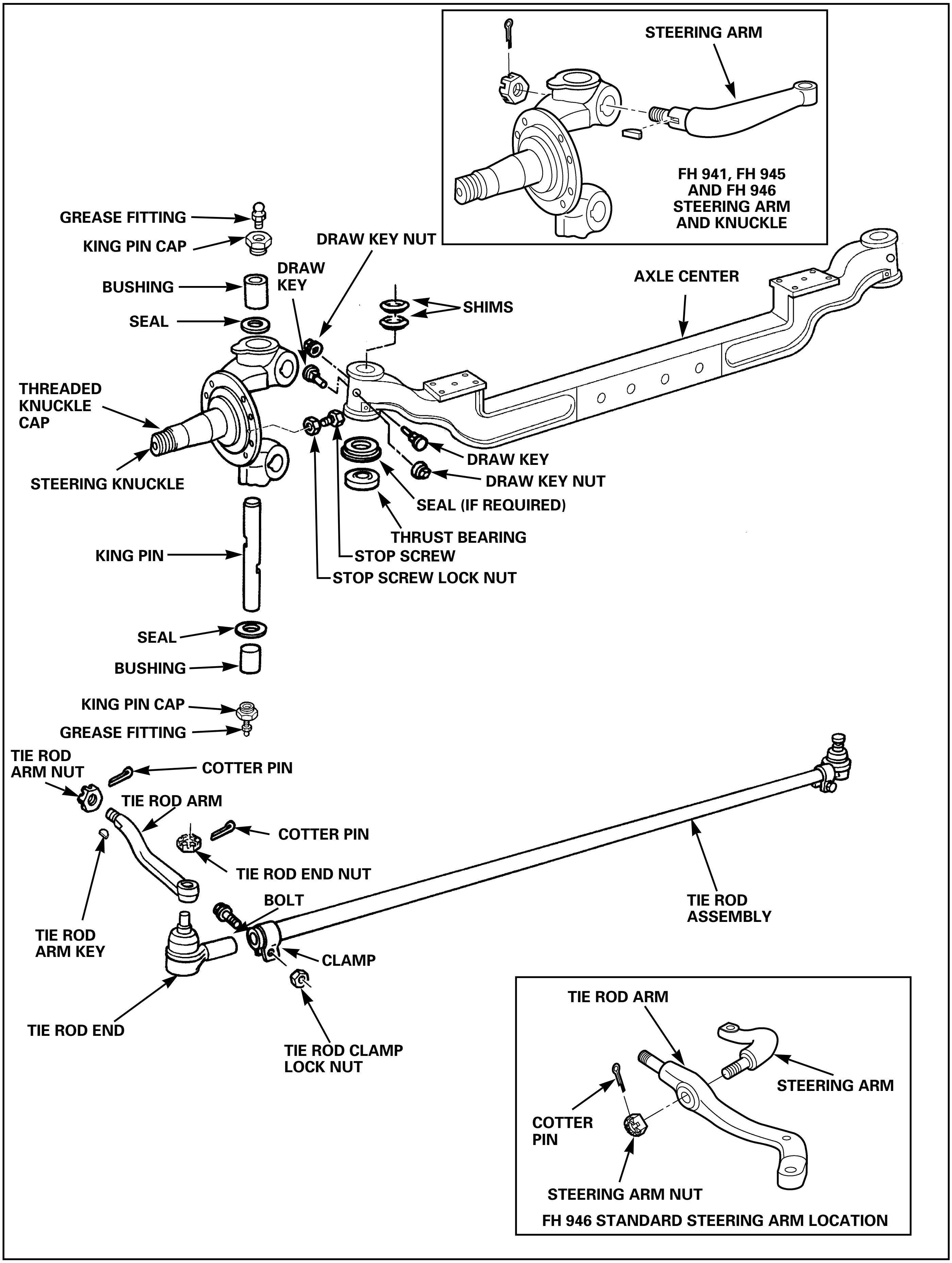
Regulatory Guidance

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.

17100, 17101, 17110, 17111 Axles



FH 941, FH 945 and FH 946 Axles



Section 1
Introduction

MERITOR™

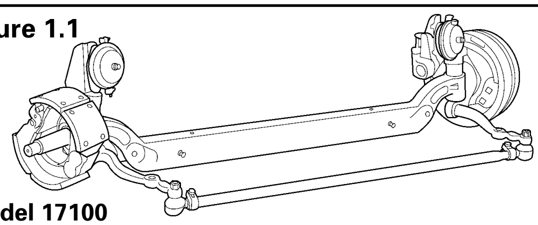
Description

Six Meritor front non-drive steer axle models are available for buses and coaches: 17100, 17101, 17110, 17111, FH 941 (not shown), FH 945 and FH 946. **Figures 1.1, 1.2 and 1.3.**

NOTE

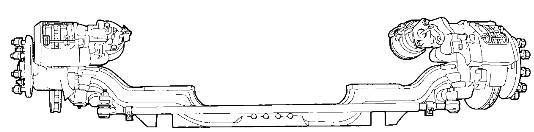
Model 17110 and 17111 have identical characteristics as model 17100 and 17101 except that they have an I-beam instead of a rectangular beam in the center. Model FH 941 has I-beam construction.

Figure 1.1



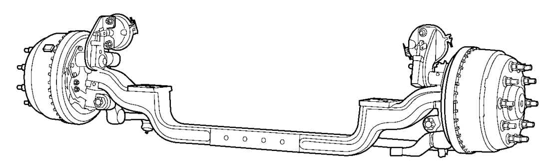
Model 17100

Figure 1.2



Model FH 945

Figure 1.3



Model FH 946

Model	Track inches (mm)	Length inches (mm)
17100	79.66 (2023.4)	95.44 (2424.2)
17101	85.66 (2175.8)	101.44 (2576.6)
17110	79.66 (2023.4)	95.44 (2424.2)
17111	85.66 (2175.8)	101.44 (2576.6)
FH 941	84.94 (2157.5)	101.82 (2586)
FH 945	84.94 (2157.5)	101.82 (2586)
FH 946	84.94 (2157.5)	101.82 (2586)

Identification

The axle model number identification plate is located on the axle center. Use the model number to order the correct parts from Meritor. **Figures 1.4 and 1.5.**

Figure 1.4

IDENTIFICATION NUMBER

17101-WX-69

FRONT AXLE IDENTIFICATION NUMBER

BRAKE USAGE

SPECIFICATION VARIATION

Figure 1.5

IDENTIFICATION NUMBER

FH 945 L X 3

FRONT AXLE IDENTIFICATION NUMBER

BRAKE USAGE

SPECIFICATION VARIATION

Remove the Tie Rod, Tie Rod Arms and Tie Rod Ends

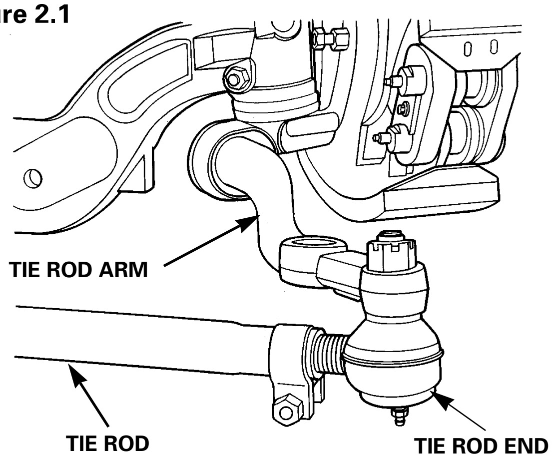
WARNINGS

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle that is supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels you will service are off the ground. Support the vehicle with safety stands.
4. Remove the cotter pins and nuts that fasten each tie rod end to the tie rod arms. **Figure 2.1.**

Figure 2.1



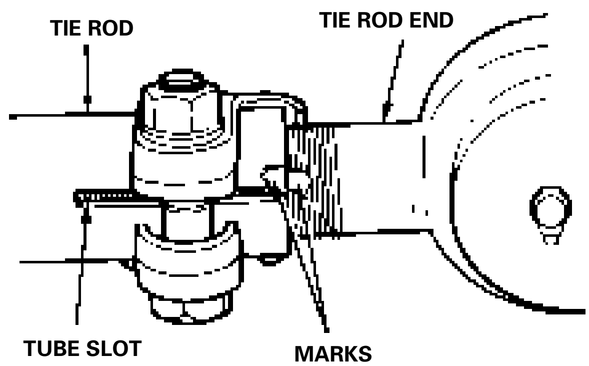
5. Disconnect the tie rod assembly from the tie rod arm. If necessary, use the removal tool to separate the tie rod end from the tie rod arm.
6. Disconnect any steering linkage attached to the tie rod arms.
7. Remove the cotter pin and nut that secures the tie rod arms in the knuckle.

WARNING

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 and cause serious personal injury.

8. Remove the tie rod arms from the knuckle. If necessary tap on the end of the arm with a leather or plastic mallet to separate the arm from the knuckle. Remove the key from the tie rod arm.
9. If necessary, remove the tie rod ends from the tie rod according to the following procedure: **Figure 2.2.**

Figure 2.2



   a. Mark the position where each tie rod end is installed in the tie rod. The position of the tie rod ends determines toe-in.
   b. Remove the bolts and nuts from the clamp on the tie rod.
   c. Remove the tie rod ends from the tie rod.

Remove the Knuckle

1. If you are using oil-lubricated hubs, drain the oil from the hubcap.
2. Remove the capscrews that fasten the cap to the hub. Remove the cap and gasket. **Figure 2.3.**

CAUTION

When wheel bearing adjusting nuts are tightened or loosened, always use the correct size socket to avoid damaging the adjusting nut.

3. Bend the tabs of the lock washer away from the jam nut. Remove the jam nut, jam nut lock washer, pierced lock ring and adjusting nut from the knuckle. **Figure 2.3 or 2.4.**

Figure 2.3 FOR MODELS 17100, 17101, 17110, 17111

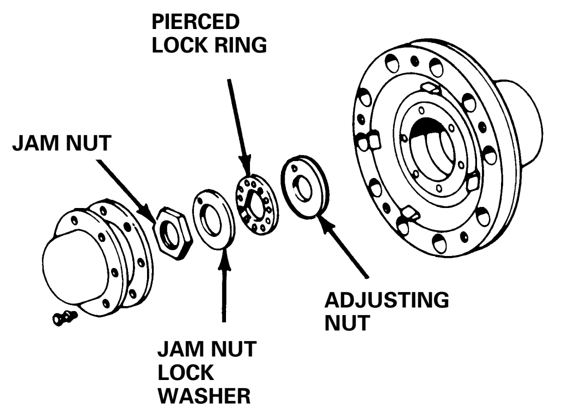
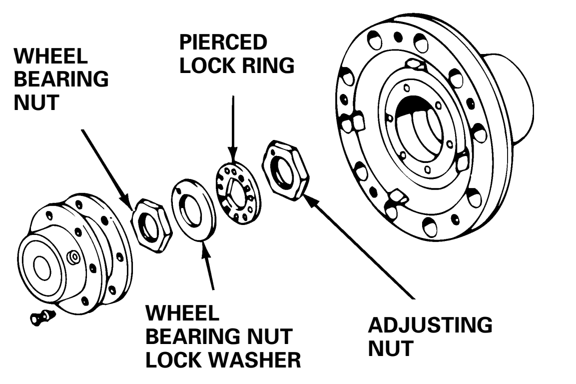


Figure 2.4 FOR MODELS FH 941, FH 945, FH 946



4. Remove the air from the brake system. Disconnect the air lines from the brakes.
5. If the vehicle is equipped with disc brakes, remove the caliper from the torque plate. Refer to brake manufacturer's procedure.
6. Remove the outer wheel bearing cone from the hub.
7. Remove the tire, hub and drum, or hub and disc as an assembly.
8. Remove the brake assembly or torque plate from the knuckle. Refer to Meritor Maintenance Manual No. 23B, "*Bus and Coach Brakes.*" To order this publication, call Meritor's Customer Service Center at 800-535-5560.
9. Remove the tie rod arms from the knuckle. Refer to procedure in this section.
10. On 17100, 17101, 17110 and 17111 models, remove the capscrews that fasten the caps to the top and bottom of the knuckle. Remove the caps and gaskets.
11. On FH 941, FH 945 and FH 946 models, unscrew the king pin caps from the top and bottom of the knuckle.
12. Remove the threaded draw keys from the beam according to the following procedure:

WARNING

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 and cause serious personal injury.

CAUTION

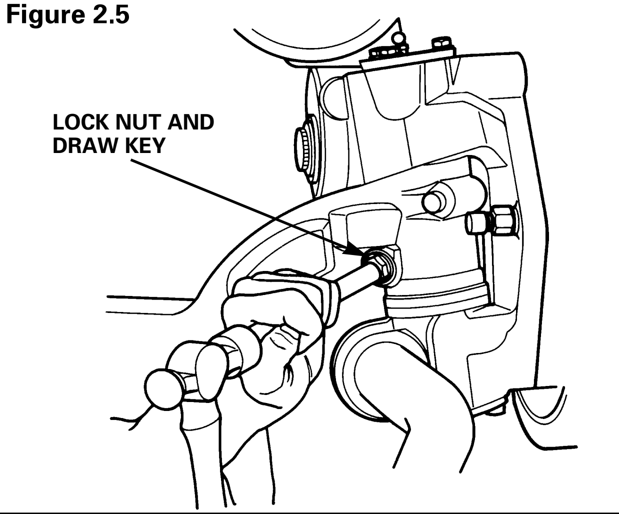
Apply force to bottom of nut and end of key. If force is not applied directly, draw key will be damaged.

a. Loosen the lock nut and move it to the end of the threads. Ensure the top of the lock nut is even with the end of the draw key.

b. Use a brass drift and hammer to hit the end of nut to loosen the draw key. **Figure 2.5.**

c. Remove the nuts and draw keys from each side of the beam.

Figure 2.5



NOTE

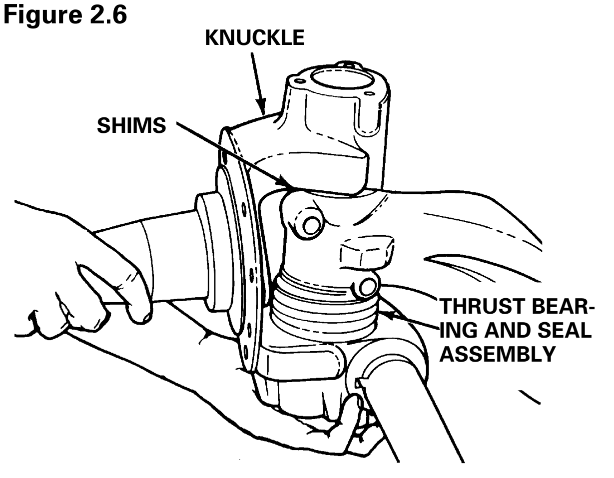
If the bushings are not to be replaced, use the following procedure to prevent damage to the bushings during king pin removal.

- ***Remove any flaring on the drift that touches the king pin.***
- ***Apply tape to 0.0625 inch (1.5 mm) thickness on end of drift.***

13. Use the brass drift and hammer to remove the king pins from the knuckle. If the king pin is difficult to remove, use a hydraulic king pin remover. Refer to Special Tools chart in Section 8.

14. Remove the knuckle from the axle center. Remove the shims, thrust bearing and seal from the knuckle. **Figure 2.6.**

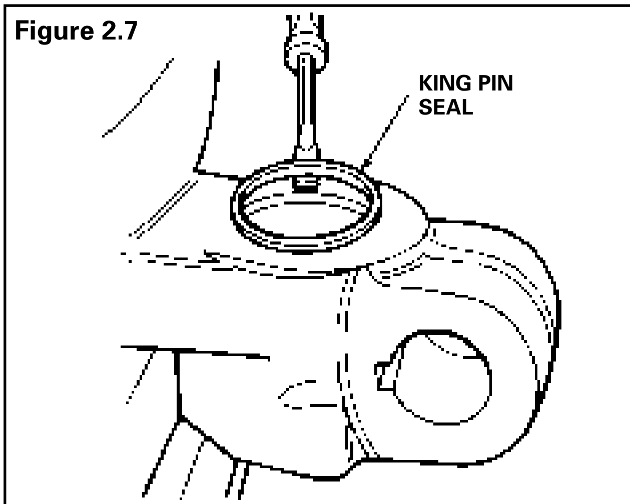
Figure 2.6



15. If the knuckle bushings are damaged, remove the bushings according to the following procedure.

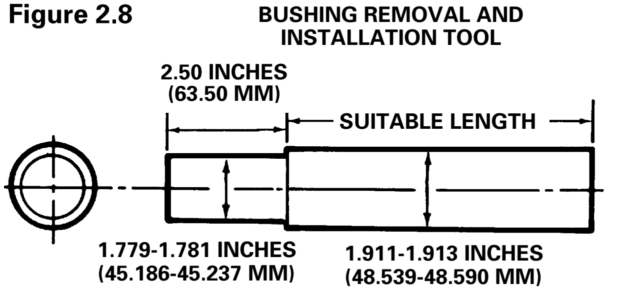
a. Remove and discard the upper and lower king pin seal. **Figure 2.7.**

Figure 2.7



b. Produce tool to remove bushings. Refer to **Figure 2.8** for tool dimensions.

Figure 2.8



WARNING

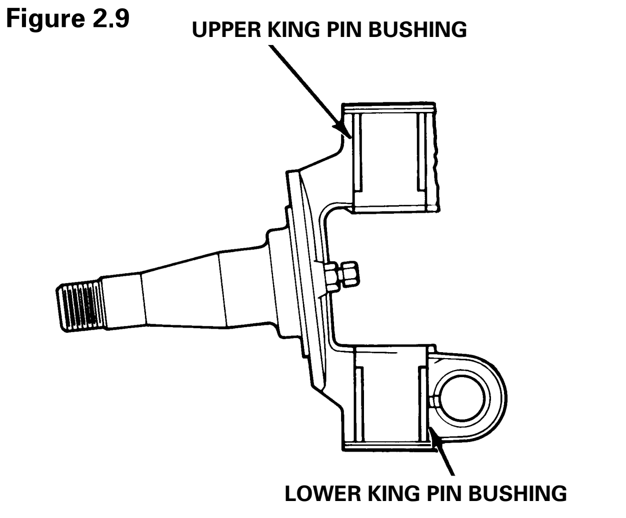
Observe all WARNINGS and CAUTIONS provided by the press manufacturer to avoid damage to components and serious personal injury.

c. Place the knuckle on a press with a 5 ton (4545 kg) capacity. The knuckle must not move when the bushings are removed.

d. Install the tool in the upper king pin bushing. Press the top bushing from the knuckle. **Figure 2.9.**

e. Install the tool in the lower king pin bushing. Press the bottom bushing from the knuckle. **Figure 2.9.**

Figure 2.9



Repair Parts

WARNINGS

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***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.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

CAUTION

The repair or reconditioning of front axle components is not allowed. Meritor recommends replacing damaged or out-of-specification components. All major components are heat treated and tempered. The components cannot be bent, welded, heated or repaired in any way without reducing the strength or life of the component.

The following operations are prohibited on front axle components.

- Welding of or to steering arms, tie rod arms, knuckles, king pins, axle centers, tie rod assemblies, hubs, drums or brakes.
- Hot or cold bending of knuckles, steering arms, tie rod arms, ball studs, axle centers or tie rod assemblies.
- Drilling out of holes in axle center for knuckle pins.
- Drilling out of draw key holes in axle center.
- Spray welding of bearing diameters on knuckles or in machined bores.
- Milling or machining of any component.

Clean Ground or Polished Parts

Use cleaning solvent to clean ground or polished parts and surfaces. Kerosene or diesel fuel can be used for this purpose. DO NOT USE GASOLINE.

Do NOT clean ground or polished parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of parts.

Clean Rough Parts

Rough parts can be cleaned with the ground or polished parts. Rough parts also can be cleaned in hot solution tanks with a weak alkaline solution. Parts must remain in hot solution tanks until they are completely cleaned and heated.

Dry Cleaned Parts

Parts must be dried immediately after cleaning. Dry parts with clean paper or rags, or compressed air. Do not dry bearings by spinning with compressed air.

Prevent Corrosion on Cleaned Parts

Apply light oil to cleaned and dried parts that are not damaged and are to be immediately assembled. Do NOT apply oil to brake linings or brake drums. If parts are to be stored, apply a good corrosion preventative to all surfaces. Do NOT apply material to brake linings or brake drums. Store parts inside special paper or other material that prevents corrosion.

NOTE

Make sure that all tapered joints are clean and dry with no lubricant or corrosion preventative applied to mating surfaces.

Inspect Parts

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Carefully inspect all disassembled parts before assembly. Inspect and replace any parts that are worn, cracked or damaged. Check for cracks with dye penetrant, magnetic flux or fluorescent particle testing methods.

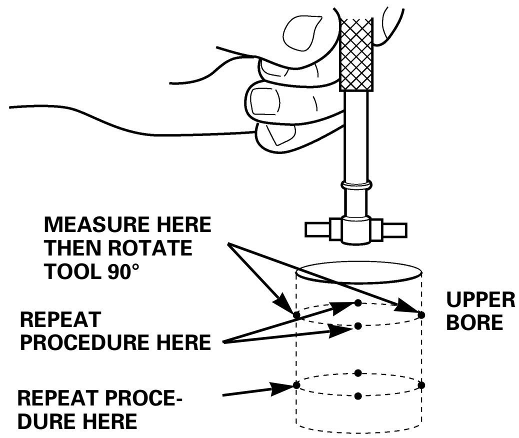
Inspect the Fasteners

1. Use a torque wrench to verify that all fasteners are tightened to the specified torque. As soon as the fastener starts to move, record the torque. Correct if necessary. T
2. Replace any worn or damaged fasteners.

Inspect the King Pin Bushing

1. Measure the king pin bushing inside diameter with a micrometer and a telescoping gauge. **Figure 3.1.**
2. If the average inside diameter measurement is greater than the king pin bushing maximum inner diameter in the Axle Wear Limits Specifications table on page 11, install new bushings.

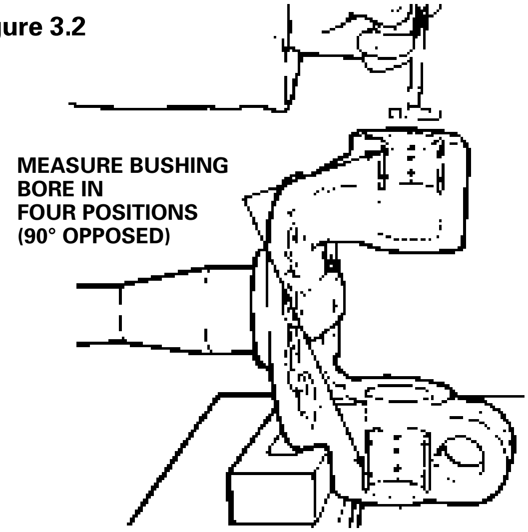
Figure 3.1 MEASUREMENT PROCEDURE



Inspect the Upper Knuckle Bore

1. Remove the old bushing from the knuckle.
2. Measure the upper knuckle bore inside diameter in four positions and at two locations. The two locations must be 90 degrees opposed from each other. Always use a micrometer and a telescoping gauge when measuring knuckle bore inside diameter. Rounding of the top and bottom bore edges is acceptable. **Figure 3.2.**
3. If the average measurement is more than the knuckle bore maximum diameter specifications in the Axle Wear Limits Specifications table on page 11, replace the knuckle.

Figure 3.2



Inspect the Lower Knuckle Bore

1. Repeat the preceding steps to measure the lower knuckle bore. Refer to the knuckle bore maximum diameter indicated in the Axle Wear Limits Specifications table on this page.
2. Verify that the average inside diameter bore dimension does not exceed the knuckle bore maximum diameter specifications. **Figure 3.2.**

If measurements taken at either the upper or lower knuckle bores exceed the maximum diameter in the Axle Wear Limits Specifications table, replace the knuckle.

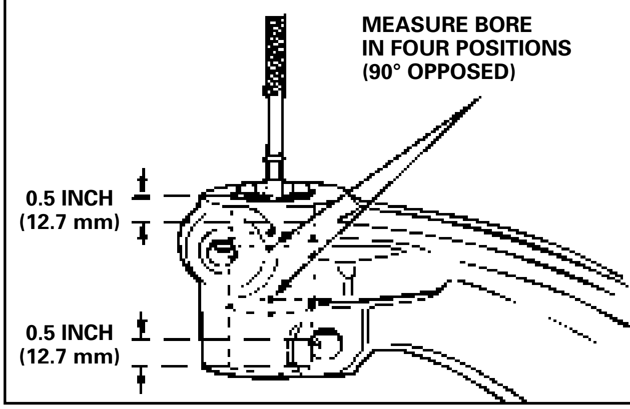
Inspect the New King Pin Bushing

1. Measure the inner diameter of the new king pin bushing after installation and reaming. Measure the inner diameter of the bushing in four positions and at two locations. The two locations must be 90 degrees opposed from each other. Refer to Section 4.
2. If the average measurement is more than the king pin bushing maximum inner diameter specification in the Axle Wear Limits Specifications table on this page, replace the bushing. **Figure 3.2.**

Inspect the Axle Beam

1. Measure the inner bore of the axle beam. Rounding at the top and bottom of the beam is acceptable.
2. Measure the axle beam bore at four positions and at two specific locations: 0.5 inch (12.7 mm) below the top of the bore and 0.5 inch (12.7 mm) above the bottom of the bore. **Figure 3.3.**

Figure 3.3 AXLE BEAM MEASUREMENT



3. If the average measurement is greater than the axle beam bore maximum diameter given in the Axle Wear Limits Specifications shown below, the entire axle beam requires replacement.

Table A

Axle Wear Limits Specifications			
Model Number	**Knuckle Bore Maximum Diameter inch (millimeter)**	**Beam Bore Maximum Diameter inch (millimeter)**	**Knuckle Bushing Maximum① Inner Diameter inch (millimeter)**
17100 17101 ①	1.922 (48.818)	1.7980 (45.6692)	1.7975 (45.6565)
17100 17101 ②	1.922 (48.818)	1.7980 (45.6692)	1.7960 (45.618) 1.7950 (45.610) ②
17110 17111 ①	1.922 (48.818)	1.7980 (45.6692)	1.7975 (45.6565)
17110 17111 ②	1.922 (48.818)	1.7980 (45.6692)	1.7960 (45.618) 1.7950 (45.610) ②
FH 945 FH 946 FH 941 ②	1.922 (48.818)	1.7980 (45.6692)	1.7960 (45.618) 1.7950 (45.610) ②

NOTES

① Knuckles with bronze bushings.
② Knuckles with "Easy Steer" bushings.

4. Inspect the taper on the tie rod arm for wear or damage. Inspect the hole for the taper in the knuckle. If the hole is worn or damaged, replace the knuckle and arm. If only the taper on the arm is damaged, replace the arm.
5. If the king pin has worn through the bushing and into the knuckle, replace the knuckle.

NOTE

If any part of the steering linkage is loose, check all the pivot points. Check the pivot points when the linkage is lubricated.

6. Make sure all pivot points in the steering linkage are tight.
7. Inspect the thrust bearing and seal for wear or damage. Replace parts that are worn or damaged.

Inspect the Tie Rod and Tie Rod End

1. Inspect the tie rod end for wear and damage. Replace if worn or damaged. Refer to Section 7, "Diagnostics."
2. If the seal is damaged on tie rod ends equipped with a grease fitting, replace the seal only.
3. If the seal is damaged on tie rod ends not equipped with a grease fitting, replace complete tie rod end.

Inspect the Wheel Bearings

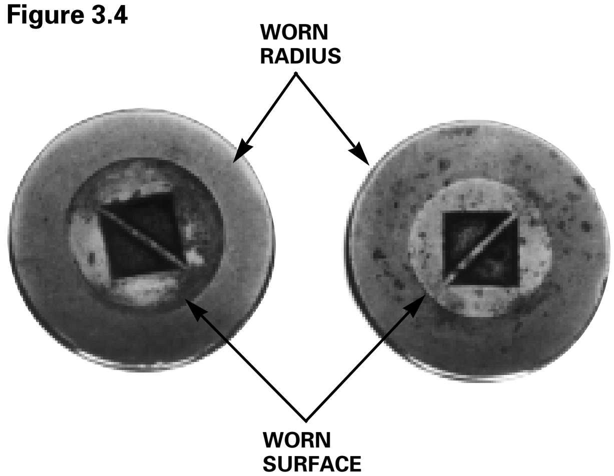
Inspect the wheel bearings when the knuckle is inspected or repaired.

Remove all lubricant from the bearings, knuckle, hub and hub cap.

Inspect the cup, the cone and the rollers and cage of all bearings. If any of the following conditions exist, the bearing **MUST** be replaced.

1. The center of the large diameter end of the rollers is worn level or below the outer surface. **Figure 3.4.**
2. The radius at the large diameter end of the rollers is worn to a sharp edge. **Figure 3.4.**

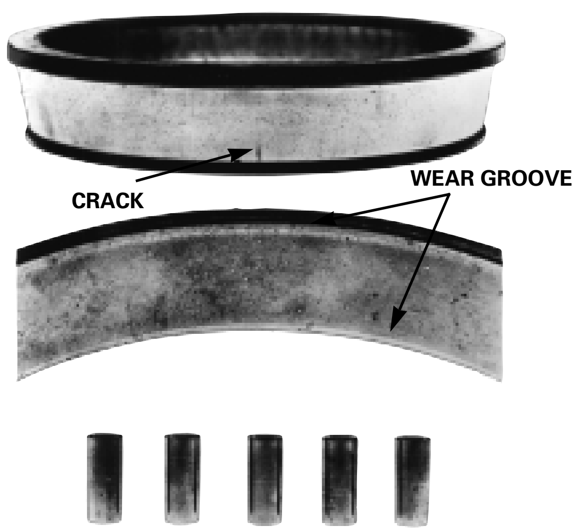
Figure 3.4



3. A visible roller groove in the cup or the cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts. **Figure 3.5.**

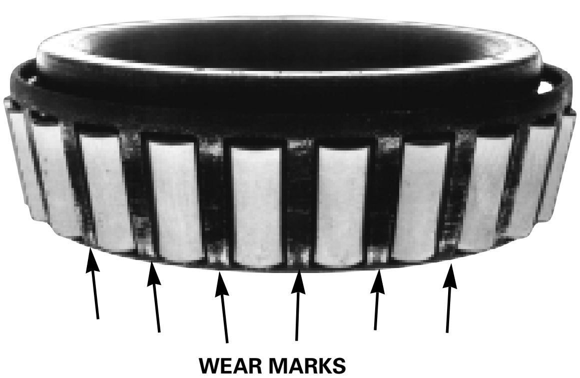
4. Deep cracks or breaks in the cup, the cone inner race or the roller surfaces. **Figure 3.5.**

Figure 3.5



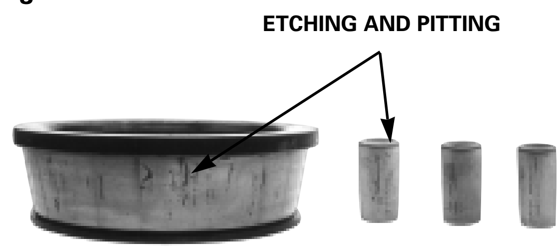
5. Bright wear marks on the outer surface of the roller cage. **Figure 3.6.**

Figure 3.6



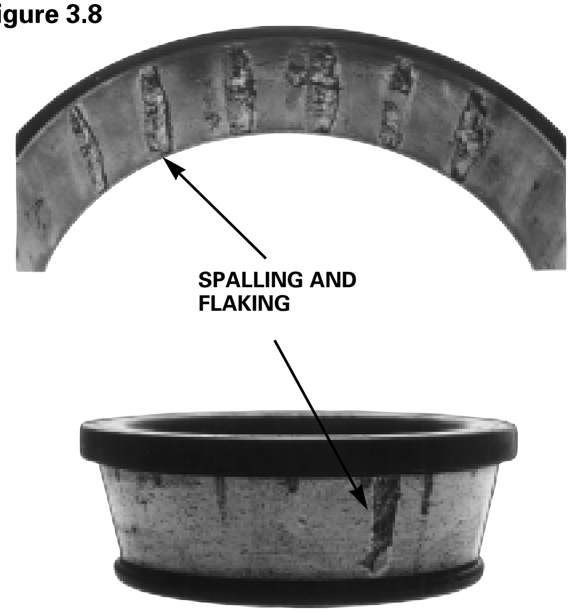
6. Damage on the rollers and on the surfaces of the cup and the cone inner race that touch the rollers. **Figure 3.7.**

Figure 3.7



7. Damage on the cup and the cup and the cone inner surfaces that touch the rollers. **Figure 3.8.**

Figure 3.8



Inspect the Disc Brake Caliper/Brake Pads

- Refer to brake manufacturer's inspection instruction.

Inspect the Disc (Rotor)

NOTE

The following information on rotor thickness applies only to Meritor Air Disc Brake Model ADB-1560. For brakes from other manufacturers, refer to their instructions.

CAUTION

You must always replace a damaged disc.

When you inspect the brakes, also inspect both sides and the outer diameter of the disc. Inspect for:

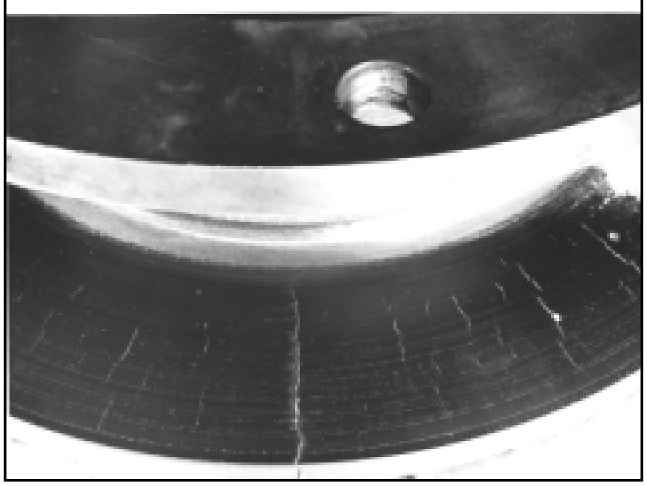
- cracks,
- heat checking,
- grooves or score, and
- blue marks or bands.

When you reline the brakes, you must measure the thickness of the disc.

Cracks

A crack can extend through a section of the disc and can cause the two sides of the crack to separate. If you find any cracks, **always replace the disc. Figure 3.9.**

Figure 3.9



Heat Checking

Heat checking produces cracks in the surface of the disc. Heat checking can be light or heavy.

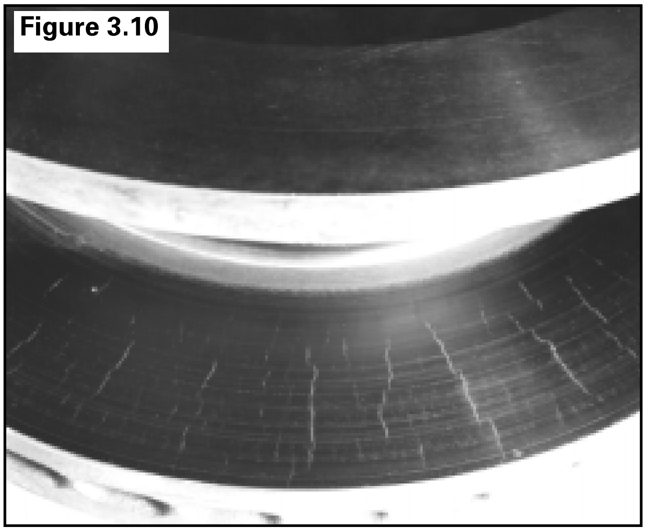
- **Light Heat Checking**

Light heat checking is very fine, tight, small cracks. Light heat checking is normal. You can continue to use a disc with light heat checking.

- **Heavy Heat Checking**

Heavy heat checking produces surface cracks that have width and depth. If you find heavy heat checking, **always replace the disc. Figure 3.10.**

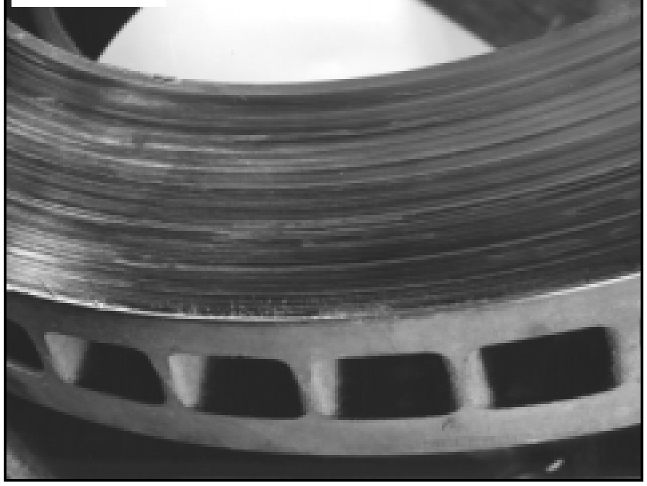
Figure 3.10



Grooves or Scores

Check both sides of the disc for deep grooves or scores. If the grooves or scores are deep, replace the disc. If the grooves or scores are not too deep, you can continue to use the disc. **Figure 3.11.**

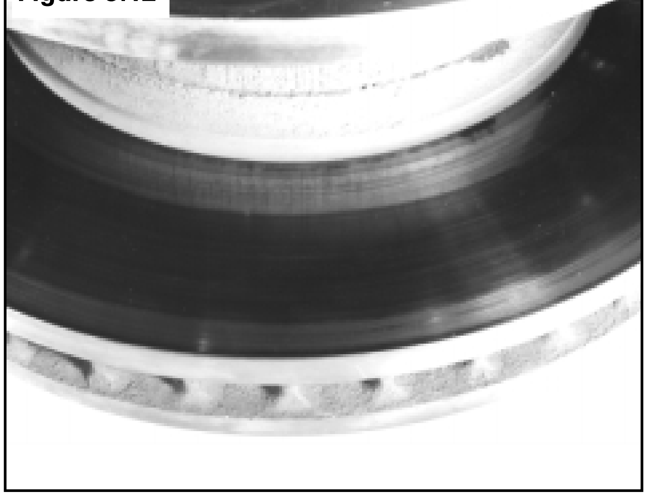
Figure 3.11



Blue Marks or Bands

Blue marks or bands indicate that the disc was very hot. If blue marks or bands are present, use the Diagnostics Guide to find and correct the cause of the problem. **Figure 3.12.**

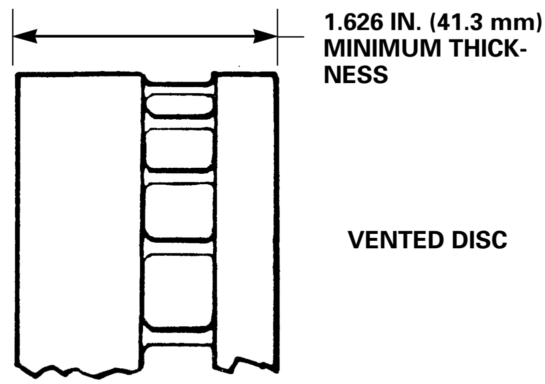
Figure 3.12



Measure Thickness of Disc

Measure the thickness of the disc when you reline the brakes. Discs with vents must be at least 1.626 inches (41.3 mm) thick. If the thickness of the disc is less than the specification, **always replace the disc. Figure 3.13.**

Figure 3.13



Install the Knuckle Bushings

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Install the Bronze Spindle Bushings

WARNING

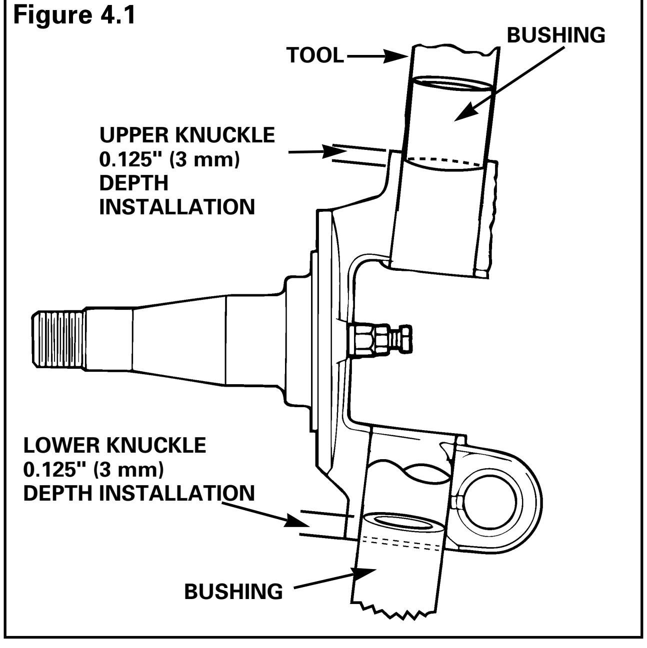
Observe all WARNINGS and CAUTIONS provided by the press manufacturer concerning press operation to avoid serious personal injury and possible damage to components.

NOTE

Bronze spindle bushings were installed only on past models of the 17100, 17101, 17110 and 17111 axle series. Bronze spindle bushings are not available on current models of this series.

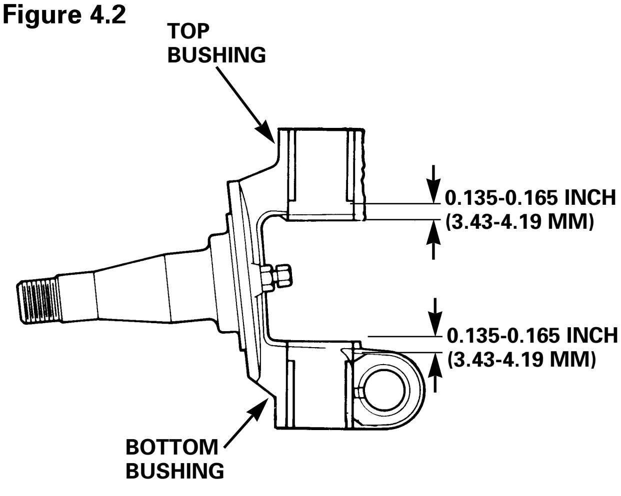
1. Install the top spindle bushing first.
2. Place the spindle in a press with minimum capacity of 5 tons (4545 kg) so that the bushing bores are straight with the top of the knuckle toward the top of press.
3. Place the bushing in the bore.

Figure 4.1



4. Use the installation tool shown in **Figure 2.9** to press the bushing 0.125 inch (3 mm) into the bore. Release the pressure on press. Make sure the bushing is pressed straight into the bore.**Figure 4.1.**
5. Press the bushing into the bore until the top of the bushing is even with the top of the knuckle. Make sure there is 0.135-0.165 inch (3.5-4.0 mm) clearance between the bottom of bushing and the bottom of the top knuckle bore. **Figure 4.2.**

Figure 4.2

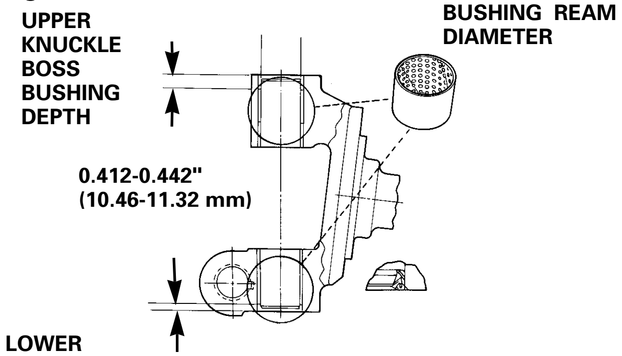


6. Turn the knuckle over so that the bottom of the knuckle is toward the top of the press. Make sure bushing bore is straight.
7. Place the bottom bushing in the bore.
8. Use the installation tool to press the bushing 0.125 inch (3 mm) into the bore. Release the pressure on the press. Make sure the bushing is pressed straight into the bore. **Figure 4.1.**
9. Press the bushing into the bore until the top of the bushing is even with the cap surface of the knuckle. Make sure there is 0.135-0.165 inch (3.5-4.0 mm) clearance between the end of the bushing and the top of the bottom knuckle bore.
10. Ream the bushings according to the procedure on page 18.

Install Easy Steer™ Bushings in 17100, 17101, 17110 and 17111 Models

1. Install the top knuckle bushing first.
2. Place the spindle in a press so that the bushing bores are straight. The upper knuckle boss must be toward top of press.
3. Place the bushing in the bore.
4. Use the installation tool shown in **Figure 2.9** and press the bushing 0.125 inch (3 mm) into the bore. Release the pressure on press. Make sure the bushing is pressed straight into the bore. **Figure 4.1.**
5. Press the bushing into the bore until the top of the bushing is 0.412-0.442 inch (10.46-11.32 mm) below the top of the knuckle. **Figure 4.3.**

Figure 4.3

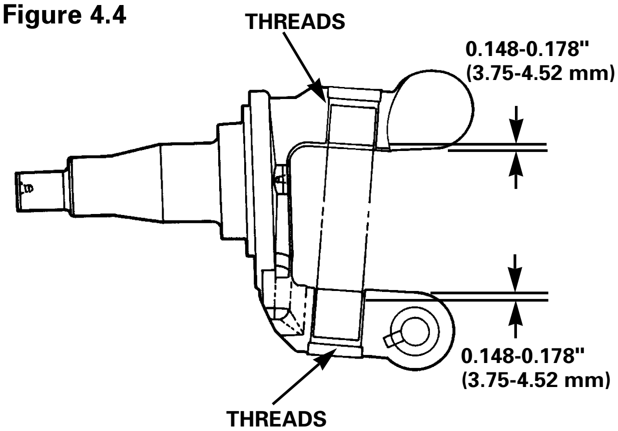


6. Turn the knuckle over so that the bottom of the knuckle is toward the top of the press. Make sure the bushing bore is straight.
7. Put the bottom bushing in the bore.
8. Use the installation tool to press the bushing 0.125 inch (3 mm) into the bore. Release the pressure on the press. Make sure the bushing is pressed straight into the bore. **Figure 4.1.**
9. Press the bushing into the bore until the top of the bushing is 0.412-0.442 inch (10.46-11.32 mm) below the cap surface of the knuckle.
10. Ream the bushings according to the procedure in this section.

Install Easy Steer™ Bushings in FH 941, FH 945 and FH 946 Models

1. Install the top knuckle bushing first.
2. Place the spindle in a press so that the bushing bores are straight. The upper knuckle boss must be toward the top of the press.
3. Place the bushing in the bore.
4. Use the installation tool and press the bushing 0.125 inch (3 mm) into bore. Release the pressure on the press. Make sure the bushing is pressed straight into the bore. Refer to **Figure 4.1.**
5. Press the bushing into the bore until the bottom of the bushing is 0.148-0.178 inch (3.75-4.52 mm) above the bottom of the knuckle bore. **Figure 4.4.**

Figure 4.4



6. Turn the knuckle over so that the bottom of the knuckle is toward the top of the press. Make sure the bushing bore is straight.
7. Place the bottom bushing in the bore.
8. Use the installation tool and press the bushing 0.125 inch (3 mm) into bore. Release the pressure on the press. Make sure the bushing is pressed straight into the bore. **Figure 4.1.**
9. Press the bushing into the bore until the bottom of the bushing is 0.148-0.178 (3.75-4.52 mm) above the bottom of the knuckle bore. **Figure 4.4.**
10. Ream the bushing according to the procedure in this section.

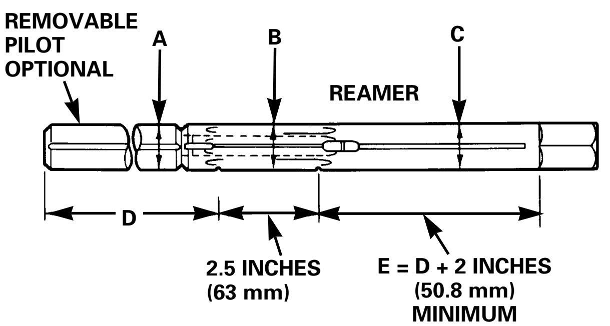
Ream Bronze and Easy Steer™ Knuckle Bushings

⚠ *CAUTION*

Reaming with a fixed reamer is the only recommended procedure. Do not hone or burnish the bushings. The bushings will be damaged by honing or burnishing.

1. Place the spindle in the vise with brass jaws.
2. Make a reamer tool. Refer to **Figure 4.5** for tool dimensions.

Figure 4.5 **BUSHING REAMER DIMENSIONS (See Chart)**



General Reamer Specifications

Material used: High speed steel
Blades used: 10-14
Blade cut: Right-hand cut, left-hand flute
Blade length: 2.50 inches (63.5 mm)

Bushing Reamer Dimensions

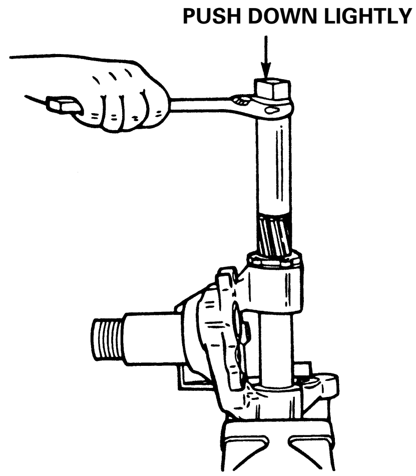
Axle Model	Lower Pilot Diameter Dimen. "A" (±0.001 in or ±0.0245 mm)		Blade Diameter Dimen. "B" (±0.0005 in or ±0.0127 mm)		Upper Pilot Diameter Dimen. "C" (±0.001 in or ±0.0245 mm)		Lower Pilot Length Dimen. "D"		Upper Pilot Length Minimum Dimen. "E"	
	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
17100 17101 ①	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
17100 17101 ②	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
17110 17111 ①	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
17110 17111 ②	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FH 941 FH 945 FH 946 ①	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15

NOTES

① Knuckles with "Easy Steer" bushing.
② Knuckles with bronze bushing.

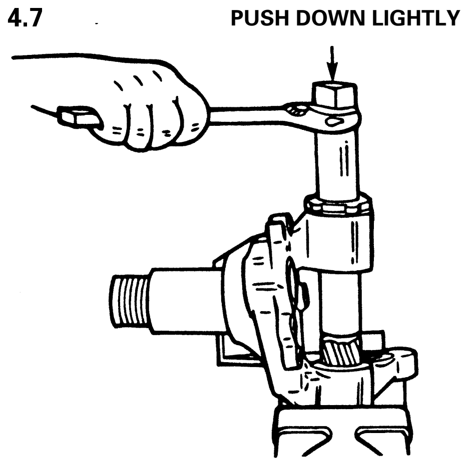
3. Slide the pilot of the reamer tool through the top bushing in the knuckle until the blades of the reamer tool touch the bushing. **Figure 4.6.**

Figure 4.6



4. Rotate the reamer tool with light downward pressure. Do not apply too much force. Rotate the reamer tool smoothly.
5. After the reamer cuts most of the top bushing, support the tool so it does not drop to the bottom bushing.
6. After cutting the top bushing, guide the reamer tool into the bottom bushing. Repeat steps 3-5. **Figure 4.7.**

Figure 4.7

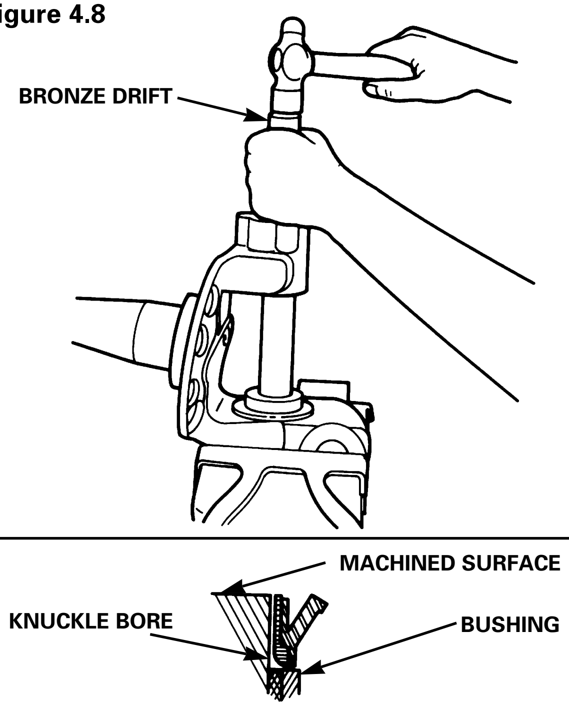


7. Slide the reamer tool out of the bottom of the bottom bushing. If the reamer must be removed through the top bushing, rotate the tool in the opposite direction as the tool is removed.
8. Clean all material from bushings, knuckle and king pin cap threads of the FH 941, FH 945 and FH 946 knuckles.

Install the Inner Knuckle Bushing Seal

1. Place the knuckle in vise with brass jaws so that the jaws of the vise hold the top of the knuckle. Bottom of the knuckle must be toward you.
2. Place the seal in the bottom of the top knuckle bore. Make sure the lip of the seal is away from the bore. **Figure 4.8.**

Figure 4.8



⚠ *WARNING*

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 and cause serious personal injury.

3. Use a brass drift, hammer and correct size driver or socket to install the seal.
   - On knuckles with bronze bushings, install the seal until the bottom of the seal touches the bushing.
   - On knuckles with Easy-Steer™ bushings, install the seal until the top of the seal is even with the machined surface of the knuckle. **Figure 4.8.**
   - Both bushing types should press the seal until the seal is flush or slightly below the machined yoke face.
4. Turn the knuckle over in the vise. The jaws of the vise must hold the bottom of the knuckle. The top of the knuckle must be toward you.
5. Place the seal in the top of the bottom knuckle bore. Make sure the lip of the seal is away from the bore.
6. Repeat step 3 of this procedure.

Install the Knuckle

1. Clean the knuckle bores and axle center.
2. Place the knuckle on the axle center.

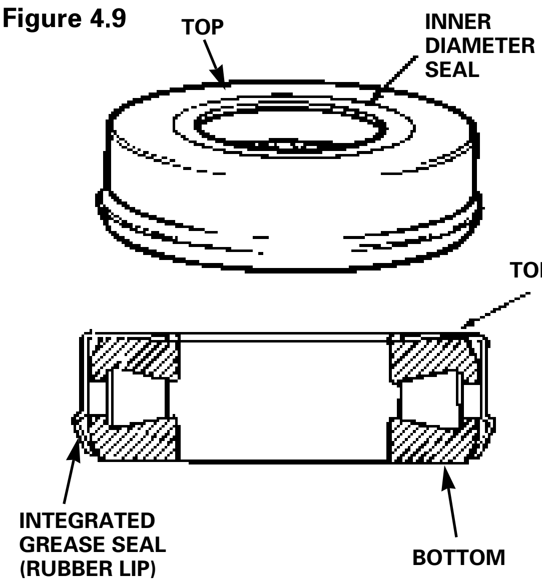
NOTE

Some newer thrust bearings have the seal integrated with the bearing assembly. **Figure 4.9.**

The one-piece thrust bearing with an integrated grease seal is completely interchangeable with the two-piece design. It has a specified top and bottom orientation:

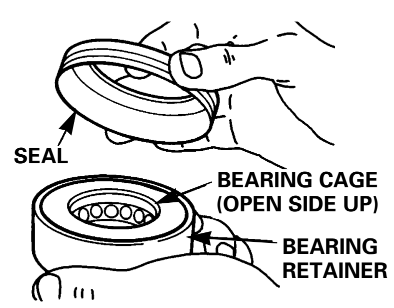
- The surface with the inner diameter seal must be on top.
- The surface with the outer diameter seal must be on the bottom. **Figure 4.9.**

Figure 4.9



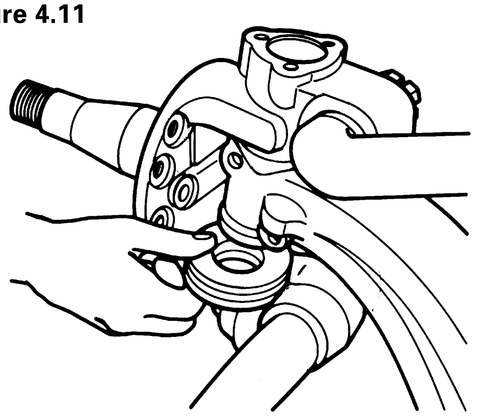
3. On cover-type seals, install the cover seal over the open part of the thrust bearing. **Figure 4.10.**

Figure 4.10



4. Slide the seal and thrust bearing assembly between the bottom of the axle center and knuckle. Make sure the seal is toward the axle center and over the thrust bearing. **Figure 4.11.**

Figure 4.11



WARNING

Wear gloves when holding shims. Shims have sharp edges and can cause serious personal injury.

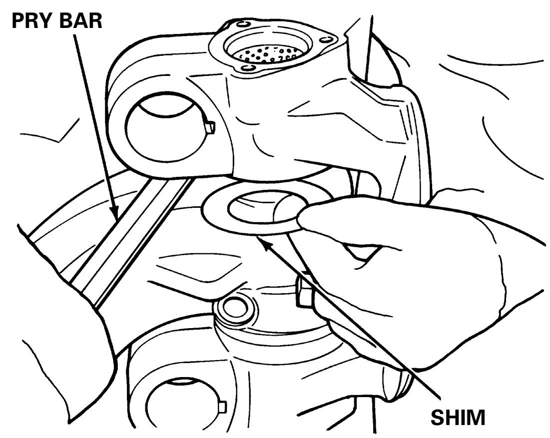
5. Install the shims according to following procedure:

   a. Inspect the shims. Replace any damaged shims.

   b. If a new shim pack must be determined, select amount of shims that will give the least end play: 0.001 inch minimum to 0.025 inch maximum. (0.025 mm to 0.635 mm).

   c. Place a pry bar between the steering arm boss and the axle beam. Lift the knuckle and slide the shim pack between the top of the axle center and the knuckle. **Figure 4.12.**

Figure 4.12

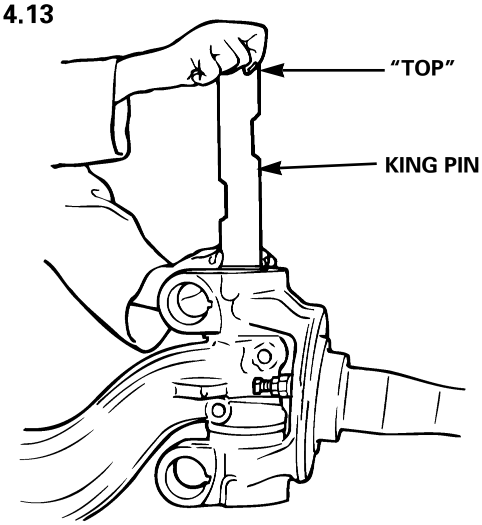


   d. Make sure the bores of the knuckle, axle center, shims, seals and thrust bearing are aligned. If these parts are not aligned, parts will be damaged when the king pin is installed.

   e. Remove the pry bar.

6. Install the king pin according to the following procedure: **Figure 4.13.**

Figure 4.13



   a. Apply a specified lubricant to the bottom half of the king pin.

   b. Install the king pin in the top of the knuckle. Make sure the word 'TOP' that is stamped on king pin is toward you.

c. Rotate the king pin so that the draw key slots in the pin are aligned with the holes in the axle center.

CAUTION

Do not force the pin through the top bushing. Shims will be damaged.

d. Push the king pin through the top bushing, bushing seal and shim pack. If the king pin is difficult to install, make sure all the parts are aligned.

e. After the king pin is through the shim pack, push the king pin into bottom bushing. If necessary, use a brass hammer to drive the king pin into the bushing. Make sure the axle center, spindle and thrust bearing and bushing seal are aligned.

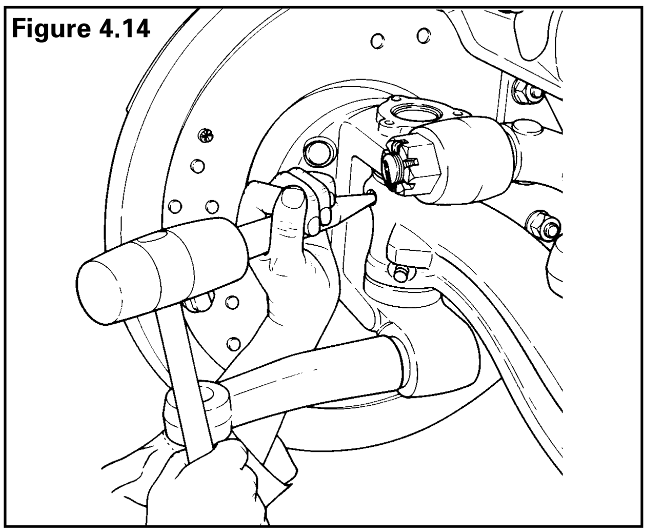
f. Make sure the draw key slots in the pin are aligned with the holes in the axle center.

NOTE

Do not drive the draw keys into the knuckle until after the end play is checked and adjusted.

7. Install the top draw key in front of the axle center. Install the bottom draw key in back of the axle center. Make sure the key goes through the slot in the pin. Lightly tap the draw keys into the axle center. **Figure 4.14.**

Figure 4.14



8. Check end play of knuckle according to following procedure.

• Check the Knuckle End Play with the

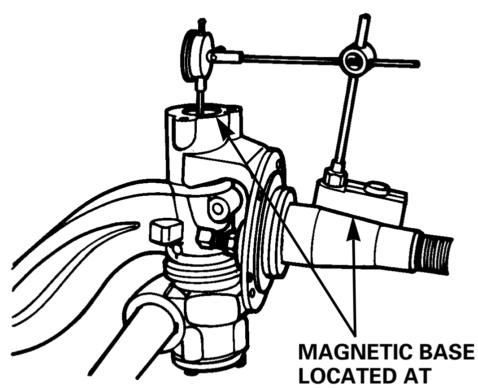
Wheel Not Removed from the Spindle

a. Hit the top boss of the knuckle with a rubber mallet to move all parts in position.

b. Turn the knuckle to straight (forward) position.

c. Attach a dial indicator. Place the base of the indicator on the knuckle assembly. Place the tip of the indicator on the center of the king pin. Place the dial indicator on zero position. **Figure 4.15.**

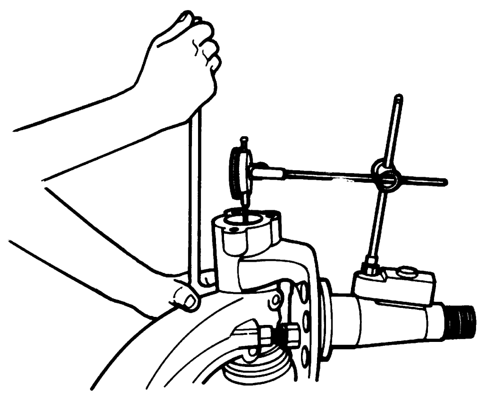
Figure 4.15



d. Use one of the following procedures to measure end play:

- Place the pry bar between the knuckle and the top of the axle center. Pull the knuckle upward and measure the end play. **Figure 4.16.**

Figure 4.16

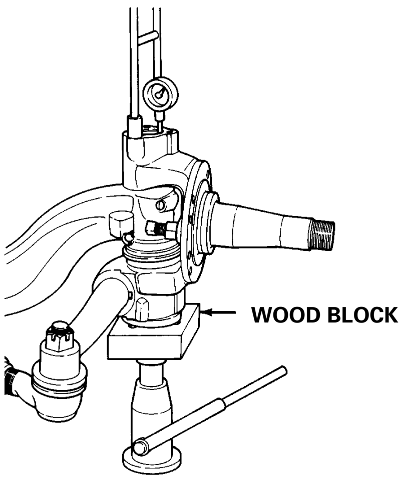


WARNING

If a hydraulic jack is used to measure end play, use safety stands to support the axle. If safety stands are not used, the axle can fall and cause serious personal injury.

- Place a block of wood and hydraulic jack under the bottom of the knuckle. Raise the knuckle until the pointer on the dial indicator stops. **Figure 4.17.**

Figure 4.17



e. Repeat steps C and D with the axle in full right turn and full left turn positions.

f. End play must measure 0.001-0.025 inch (0.025-0.635 mm) in all axle positions.

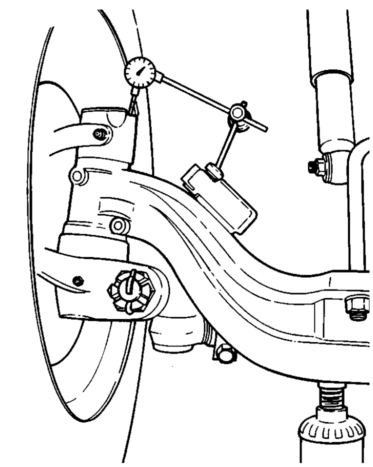
If the knuckle binds or zero end play is measured, remove the shims from the shim pack.

If more than 0.025 inch (0.635 mm) end play is measured, add shims to the shim pack.

• Check the Knuckle End Play with the Wheel Installed on the Spindle

a. Install a dial indicator. Make sure the base of indicator is on the axle center. Make sure the tip of the indicator is on the center of the knuckle cap. The tip of the indicator can also be put on the knuckle. **Figure 4.18.**

Figure 4.18



b. Use a lever to lift the knuckle to measure the end play.

c. End play should measure 0.001-0.025 inch (0.025-0.635 mm) on both knuckles.

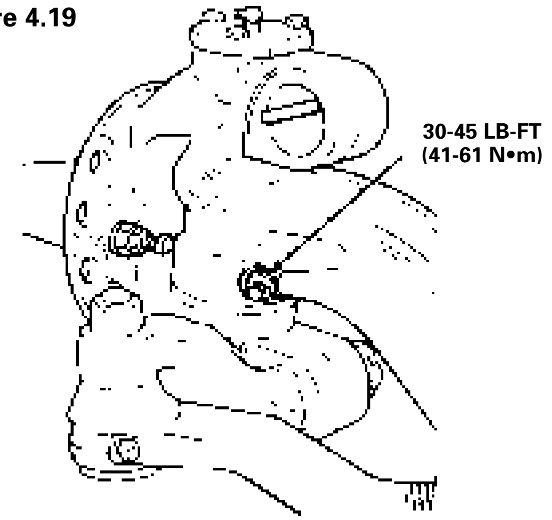
- If knuckle is binding or zero end play is measured, remove shims from the shim pack.
- If more than 0.025 inch (0.635 mm) end play is measured, add shims to the shim pack.

CAUTION

Make sure the draw key is installed completely and the locknut is tightened to the specified torque. If the draw key is not installed correctly, the king pin and the axle center will be damaged.

9. Install the lock nut on the threaded draw keys and tighten to 30-45 lb-ft (41-54 N•m). **Figure 4.19.** T

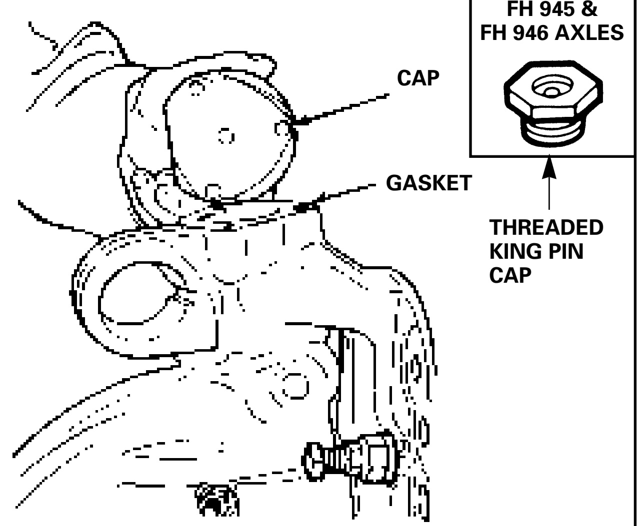
Figure 4.19



10. For 17100, 17101, 17110 and 17111 axles, install new gaskets and caps on top and bottom of knuckle. Install capscrews and washers and tighten to 20-30 lb-ft (28-40 N•m). **Figure 4.20.**

    For FH 941, FH 945 and FH 946 axles apply sealant 360° around the first thread of the king pin cap and install the top and bottom threaded king pin caps. Tighten to 100-120 lb-ft (135-160 N•m) **Figure 4.20.** T

Figure 4.20



11. Connect the tie rod arm to the knuckle. See procedure in this section.
12. Install the brake assembly or torque plate on the knuckle. Refer to Meritor Maintenance Manual No. 23B, *"Bus and Coach Brakes."* To order this publication, call Meritor's Customer Service Center at 800-535-5560.
13. For grease-lubed wheel ends, lubricate the wheel bearings. Refer to Section 6, Lubrication.
14. Install the hub, drum, wheel and tire assembly on the knuckle.
15. Install the outer wheel bearing cone in the hub.
16. Adjust the wheel bearings. Refer to Section 5, Adjustments.
17. Install the hub cap and gasket on the knuckle. Install the capscrews and tighten to 20-30 lb-ft (27-41 N•m). **Tighten plastic hubcaps to 15-18 lb-ft (20-24 N•m).** T
18. For oil-lubricated wheel ends, provide the proper lubricant level. Refer to Section 6, Lubrication.
19. Lower the vehicle to the ground. Check brake operation.
20. Check and adjust toe-in. Refer to Section 5, Adjustments.

Install the Tie Rod Arms and Steering Arms

1. Install the key in the slot at the tapered end of the arm. Press the key into slot. Do not mix the arm key and slot types.
   a. **Square Key**: Position flush to shoulder of arm taper.
   b. **Woodruff Key**: Position in slot provided.
2. Install the tie rod arm in the knuckle.

CAUTION

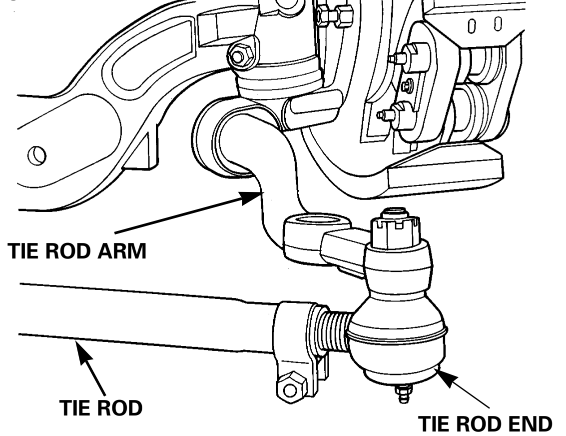
Tighten nuts of tie rod arm to specified torque. If nuts are not tightened to specified torque, tie rod arm, Pitman arm or knuckle will be damaged.

3. Install the nut that fastens the tie rod arm to the knuckle.
   - For 1.125"-12 thread, tighten nut to 550-1025 lb-ft (745-1388 N•m). T
   - For 1.250"-12 thread, tighten nut to 775-1450 lb-ft (1051-1965 N•m). T
4. Install the cotter pins. If the holes are not aligned, tighten the nut to the next hole in the nut. Do not loosen the nut to install the cotter pin.
5. Check and, if necessary, adjust toe-in. Refer to Section 5, Adjustments.

Install the Tie Rod Assembly and Tie Rod Ends

(Figure 4.21)

Figure 4.21



NOTE

The tie rod has right-hand threads on one end and left-hand threads on other end. Make sure correct tie rod ends are installed on tie rod.

1. If removed, install the tie rod ends on the tie rod. Install the tie rod ends to the position marked during removal.

   If new tie rod ends are installed, thread the tie rod ends equally on each side of the tie rod to the overall required length.
2. Install the nuts and bolts in the clamps on the tie rod. Tighten nuts and bolts:
   - 0.625"-11 clamp bolt: 40-60 lb-ft (55-81 N•m). T
   - 0.750"-10 clamp bolt: 155-175 lb-ft (210-237 N•m). T
3. Clean and dry the tie rod end taper and the tie rod arm tapered hole.
4. Connect the tie rod ends into the tie rod arms on the knuckle.

CAUTION

- ***Some axles are equipped with "deep drop" tie rods. The nuts on "deep drop" tie rod ends require a higher installation torque than the torque on a standard tie rod to prevent loosening during service.***
- ***After several hours, some torque relaxation will occur in the "deep drop" tie rod nuts. To avoid loosening, the nut torque must not drop below 150 lb-ft (200 N•m).***

5. Install the nuts that fasten the tie rod ends to the tie rod arms. Use the following torque values:

   Standard tie rod: Tighten nuts to 160-300 lb-ft (217-406 N•m). T

   "Deep drop" tie rod: Tighten nuts to 200-340 lb-ft (270-460 N•m). T
6. Install the cotter pins. If the holes are not aligned, tighten the nut to the next hole in the nut. Do not loosen the nut to install the cotter pin.
7. Check and, if necessary, adjust toe-in. Refer to Section 5, Adjustments.

Check and Adjust the Wheel Bearings

WARNINGS

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury can result.

1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.

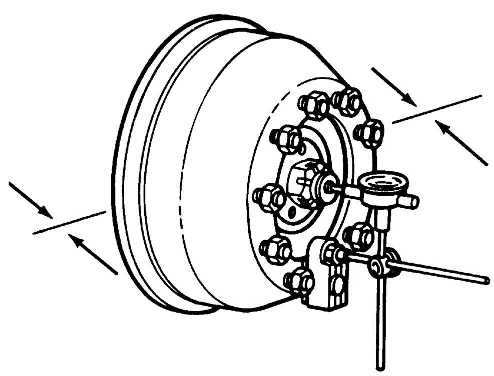
NOTE

If using oil lube hubs, drain oil from the hubcap.

4. Remove the wheel and tire assembly from the hub.
5. Remove the capscrews that fasten the cap to the hub. Remove the gasket and cap.
6. If the drum is retained, make sure that it is firmly attached to the hub by the wheel nuts.
7. Attach a dial indicator with the magnetic base at the bottom of the hub or the brake drum.

   Adjust the dial indicator so that the pointer is against the center of the knuckle. Set the dial indicator on zero. **Figure 5.1.**

Figure 5.1



NOTE

Do not push/pull at the top and the bottom of the hub or drum. Pushing or pulling at the top and the bottom will not give a true reading of the end play.

8. Measure the end play by pushing/pulling on each **side** of the hub or drum while looking at the dial indicator. The end play is the total travel observed. If the end play is not within 0.001-0.005 inch (0.025-0.127 mm), adjust the wheel bearings.
9. If necessary, adjust the wheel bearings according to the procedure in Step 13.
10. Bend the lock washer off the flats of the jam nut. Remove the jam nut, jam nut washer and pierced lock ring.

WARNING

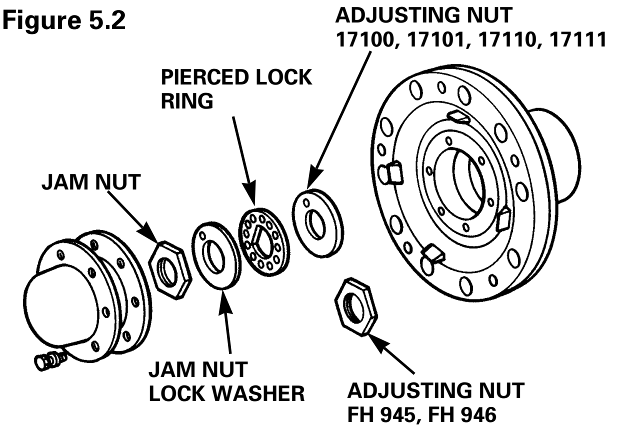
When performing a wheel bearing adjustment:

- ***Always use the correct size wrench socket.***
- ***Always use a torque wrench to tighten the adjusting nuts to their correct adjusting torques.***
- ***Never attempt to tighten or loosen the adjusting nuts by either hitting them directly with a hammer or by hitting a chisel or a drift placed against them with a hammer. Failure to do this can damage the nuts, prevent a proper wheel bearing adjustment from being achieved, and cause possible loss of vehicle wheel-end equipment and serious personal injury.***

11. Use the torque wrench to tighten the adjusting nut to 100 lb-ft (136 N•m) while rotating the brake drum or hub in both directions. T
12. Loosen the nut completely and then tighten the nut to 20 lb-ft (27 N•m) while rotating the brake drum or hub. T

13. Adjust the wheel bearings according to the following procedure. **Figure 5.2.**

Figure 5.2



   a. Back off the adjusting nut 1/3 turn.
   b. Install the pierced lock ring, lock washer and jam nut.
   c. Tighten a 1-1/8 - 2-5/8 inch threaded jam nut to 200-300 lb-ft (271-407 N•m).
   d. Measure the wheel end play to make sure end play is 0.001-0.005 inch (0.025-0.127 mm) or Steps "a"-"c" must be repeated. If end play exceeds 0.005 inch (0.127 mm), reduce the amount the adjusting nut is backed off in Step "a" to 1/4 turn.
   e. When the proper end play is achieved, lock the jam nut in place by bending the edge of the jam nut lock washer over one flat of the jam nut.

14. Measure the end play by pushing/pulling on the horizontal axis of the hub or drum while looking at the dial indicator. The end play is the total travel observed. If the end play is not within specifications, adjust the wheel bearings.
15. Install the gasket and cap on the hub. Install capscrews and tighten to 20-30 lb-ft (27-41 N•m). **Tighten plastic hub capscrews to 15-18 lb-ft (20-24 N•m).**
16. Install the tire and wheel assembly.
17. Lower the vehicle to ground. Check the brake operation.
18. Refill the oil lube hub reservoir. Refer to Section 6, Lubrication.
19. Tighten Zytel filler plug to 15-25 lb-in (1.7-2.8 N•m).

Adjust the Steering Stop

The steering stop adjustment controls the maximum turn angle of the vehicle.

CAUTION

If the stop bolt is missing, bent or broken, the system requires adjustment. Refer to "Mechanical Stop" in this section.

NOTE

- ***If the steering system is out of adjustment, inspect the steering arm and tie rod arms for damage. Use a magnetic particle or liquid dye penetrate inspection procedure to inspect the steering arm. Pay particular attention to the bend, the taper and the area near the ball stud. Refer to the vehicle manufacturer's manual for additional inspection procedures.***
- ***Do not increase specified maximum turn angle of vehicle. If the angle is increased, the steering arm, tie rod and tie rod ends will be damaged.***
- ***Adjust the maximum turn angle only if the manufacturer of the vehicle specifies adjustment. See specifications of the vehicle manufacturer for maximum turn angle.***
- ***Meritor does not recommend any power steering system that does not have mechanical stops or pressure relief before the maximum turn angle is obtained.***

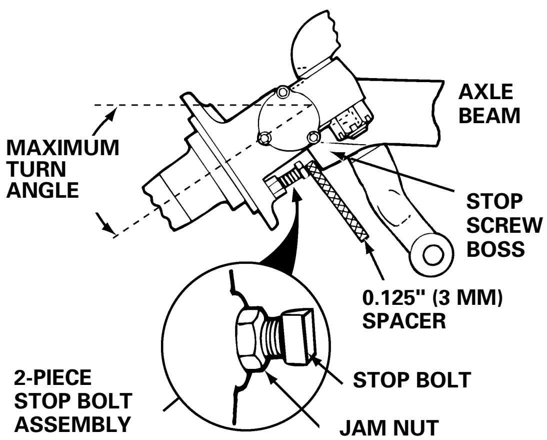
CAUTION

In power steering systems, the hydraulic pressure should relieve or "drop off" at the end of the steering stroke (with 0.125 inch or 3 mm minimum clearance at the stop bolt). If the pressure does not relieve, the components of the front axle will be damaged.

NOTE

***For power steering systems, the stop bolt must NOT touch the beam. The stop bolt must always have a minimum clearance of 0.125 inch (3 mm) as shown in* Figure 5.3.**

Figure 5.3 Two-piece steering stop bolt



NOTE

***For manual steering systems, Meritor recommends a stop bolt clearance of 0.125 inch (3 mm). Stop bolt contact is acceptable if no other stops are used for the maximum turn angle of the steering knuckle.* Figure 5.3.**

1. Place a 0.125 inch (3 mm) spacer between the stop bolt and the boss on the axle beam.
2. Turn the steering wheel until the boss on the axle beam touches the spacer in front of the stop bolt. Measure the turn angle. **Figure 5.3.**
3. If the maximum turn angle does not meet vehicle manufacturer's specifications, correct the maximum angle. In a power steering system, adjust the pressure relief. In a manual steering system, follow guidelines and specifications from the vehicle manufacturer.
4. When the maximum turn angle is correct:
   a. Loosen the stop bolt jam nut. **Figure 5.3.**
   b. Insert a 0.125 inch (3 mm) spacer and adjust the stop bolt.
   c. Tighten the jam nut to 65-85 lb-ft (68-101 N•m). T

Adjust the Pressure Relief in the Power Steering System (Setting Maximum Turn Angle)

The pressure relief in the power steering system stops or reduces forces applied to the axle when the wheel is moved in the full turn position.

Check the pressure relief if the steering arm is damaged or the power steering gear is serviced.

Two types of systems are used to adjust the pressure relief.

- Mechanical stop on the Pitman Arm or in the assist cylinder.
- Hydraulic pressure relief in the power steering gear.

Mechanical Stop

Use the mechanical stop in the steering system to adjust the pressure relief. Do not use the stop bolt on the knuckle alone to adjust the poppet valve pressure relief.

NOTE

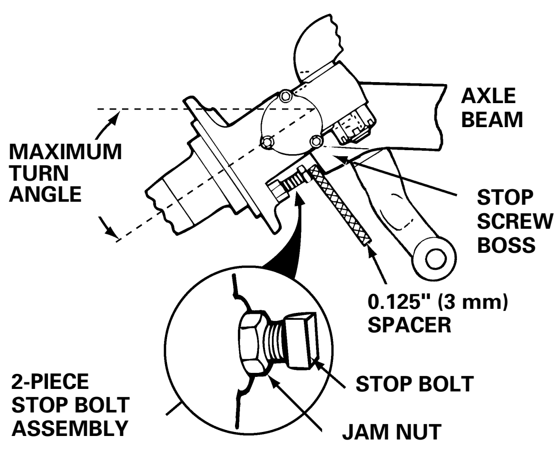
Refer to the specified procedures from the vehicle manufacturer.

CAUTION

Use a pressure gauge to verify that the pressure drops from the maximum system delivery pressure to a maximum of 700-1000 psi (48.3-69.0 bar) BEFORE the full turning angle is achieved.

Steering systems with mechanical stops are adjusted when the wheels are turned to the full right and full left turn positions. The stop travel is set at 0.125 inch (3 mm) before the stop bolt contacts the axle beam boss. **Figure 5.4.**

Figure 5.4 **Two-piece steering stop bolt**



Hydraulic Pressure Relief in the Steering Gear

NOTE

Refer to the specified procedure from the vehicle manufacturer.

NOTE

The stop bolt should always have a minimum clearance of 0.125 inch (3 mm) between the stop bolt and the axle beam boss.

Hydraulic steering gears with poppet valves are adjusted with a spacer between the stop bolt in the knuckle and the boss on the axle beam. The poppet valves are adjusted to stop or reduce steering forces from the 0.125 inch (3 mm) specified distance between the beam boss and the spacer. **Figure 5.4.**

Adjust Toe-In

Specification:

- **Unloaded:** 1/16" ± 1/32" (1.587 mm ± 0.0312 mm)
- **Loaded:** 1/32" ± 1/32" (0.794 mm ± 0.794 mm)

CAUTION

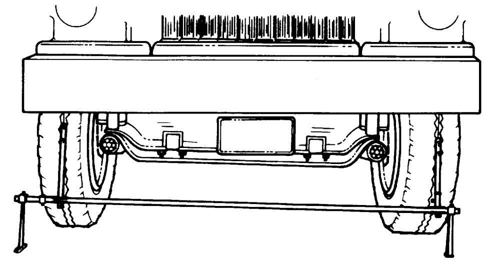
Most tire wear is caused by incorrect toe settings. Do not change camber or caster settings to correct tire wear problems. If the axle assembly is bent to change caster or camber, the strength of the axle is reduced and the warranty is voided. An axle damaged by bending can cause a vehicle accident and result in serious personal injury.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

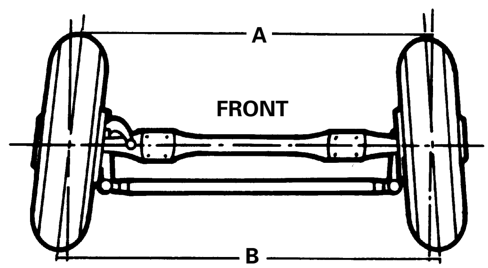
1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
4. Use paint or chalk to mark center area of both front tires around the complete outer surface of the tire.
5. Put the pointers of the trammel bar on the marks of each tire. Rotate tires. Make sure the straight line is marked on the outer surface of tire.
6. Lower the vehicle to the floor. Move the vehicle forward and backward 10 feet (3 meters).
7. Place a trammel bar at back of tires. Align the pointers with the marks on the tires. Raise the pointers so that they are even with the spindles. Measure and record the distance between pointers.
8. Place a trammel bar at the front of the tires. Align the pointers with the marks on tires. Raise the pointers so they are even with the spindles. Measure and record the distance between the pointers. **Figure 5.6.**

Figure 5.6



9. To get toe-in measurement, subtract the reading of the front of the tires from the reading at the back of the tires. **Figure 5.7.**

Figure 5.7



B MINUS A EQUALS TOE-IN

10. If the toe-in measurement is not at the specified distance, use following procedure:
    a. Loosen the nut and bolt on each end of the tie rod clamps.
    b. Turn the tie rod until the specified toe-in distance is obtained.
    c. Tighten the nut and bolt on each end of the tie rod clamp:
       - 0.625"-11 clamp bolt: 40-60 lb-ft (55-81 N•m). T
       - 0.750"-10 clamp bolt: 155-175 lb-ft (210-237 N•m). T
11. Repeat Steps 1-9 to check toe-in dimension.

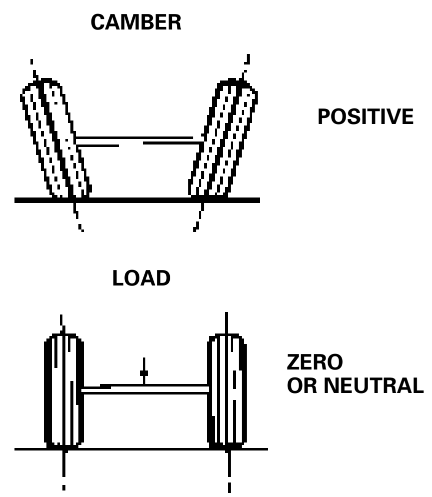
Camber Angle

WARNING

The camber angle is not adjustable. Meritor does not recommend changing the camber angle or bending the axle beam. If the axle beam is bent to change the camber angle, the strength of the axle is reduced and the warranty is voided. The axle may be damaged if bent. An axle damaged by bending may cause a vehicle accident and result in serious personal injury.

Camber is the angle of the tire in relation to the ground. **Positive camber** occurs when the distance between the top of the wheels is greater than the distance between the bottom of the wheels at ground level. A small amount of positive camber is built into the knuckle because camber changes with load. This results in a **zero or neutral camber angle** when the vehicle is operated at the normal load. **Figure 5.8.**

Figure 5.8



If camber is out of specification by more than 1-1/2 degrees, rapid or uneven tire wear will occur.

- Bias ply tires will show excess camber easily.
- Radial tires will not show excess camber easily.

The camber angle is not adjustable. It is machined into both the axle beam and the knuckle. If the camber angle is not at the specified angle, check the axle beam and the steering knuckle for damage. Service as necessary.

Camber Angle Specifications

Axle removed from the vehicle without hubs and without load:

- Left side (driver's) and right side (passenger's):
  +1/4 degree nominal

Axle installed on the vehicle without load:

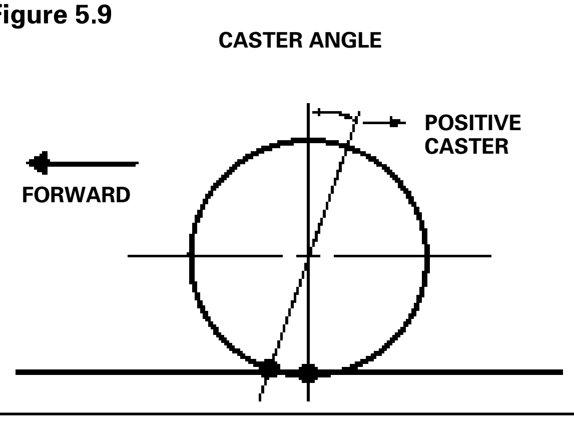
- Left side (driver's) and right side (passenger's):
  +1/4 degree ± 7/16 degree (–3/16° to 11/16 degree) final reading.

Caster Angle

Caster is the forward tilt of the king pin center line when viewed from the side of the vehicle.

The **caster angle** is the angle from the vertical position to the center line of the king pin. If the top of the king pin axis is toward the rear of the vehicle, the caster is **positive.** A slight positive caster creates a self-aligning action that helps to stabilize the vehicle after turning and stabilizes it for driving straight ahead. **Figure 5.9.**

Figure 5.9



Too much caster will increase steering effort or may amplify a shimmy condition.

Adjust caster according to vehicle manufacturer's procedure. Refer to vehicle manufacturer's specifications for caster angle.

The coach axle beams have a +3 degree caster angle machined into the beam.

Dual Barrel Spider Mounted Wheel Speed Pencil Sensor

NOTE

The sensor must be reset each time the wheel end is removed to obtain the proper sensor-to-rotor gap.

Reset the Sensor

1. Remove the wheel assembly from the vehicle. Refer to Section 2.
2. Examine the sensor face. If the white bobbins are exposed, replace the sensor.
3. With your fingers, push the sensor **outward** from the rear of the sensor housing. If the sensor cannot be moved with finger pressure only, use the following procedure:
   a. Remove the brake shoe return springs and raise the upper brake shoe for access to the sensor locking bolt.
   b. Loosen the locking bolt only enough to relieve the internal spring load (approximately two turns) and push the sensor **outward** until the internal stop is felt.
   c. Seat the retaining plate against the back of the sensor housing and tighten the locking capscrews to 25-35 lb-ft (34-47 N•m). T

Replace the Sensor

1. Remove the wheel assembly from the vehicle. Refer to Section 2.
2. If used, remove the in-line connector clip. Unplug the sensor lead from the sensor in-line connector.
3. Cut the tires which hold the sensor lead to the air delivery hose. Remove all the bracket wire clips.
4. Loosen and remove the sensor housing mounting bolts.
5. Slide the sensor lead and connector through the hole in the spider and/or the dust shield. Remove the sensor lead and connector.
6. Loosen the sensor housing locking bolts or capscrews only enough to relieve the internal spring load (approximately two turns). Remove and discard the sensor from the rear of the housing.
7. Insert the new pencil sensor through the retainer and align the flattened portion with the squared edge in the front of the sensor housing. Push the sensor outward until the internal stop is felt. Seat the retaining plate against the back of the housing. Tighten the locking bolt to 25-35 lb-ft (34-47 N•m). T
8. Mount the sensor assembly to the spider mounted bracket. Tighten the mounting bolts to 25-35 lb-ft (34-47 N•m). T
9. Insert the connector through the hole in the brake spider or dust shield. Use a grommet in the hole for proper sealing and cable strain relief.

CAUTION

The cable routing must not interfere with any of the moving brake components.

10. Route the sensor lead along the air delivery hose to the sensor cable. Reconnect the sensor in-line connector. Place the in-line connector clip over the in-line connector. Snap the clip securely.

NOTE

When attaching bracket wire clips, avoid undue strain on the sensor cable. Provide a generous cable loop radius at the rear of the sensor.

11. Tie the cable to the air hose at 8 inch (203 mm) intervals without any excess stretching or pulling of the sensor lead. Install the bracket wire clips.

NOTE

Do not tilt or rock the wheel assembly during mounting to prevent premature adjustment of the sensor assembly.

12. Install the wheel assembly on the axle spindle only enough to start the proper turning of the bearing adjusting nut.
13. Draw the wheel assembly on with the adjusting nut to ensure proper sensor gap setting.

14. Adjust the wheel bearing to the correct specifications. Install the lock ring and jam nut.
15. Check the sensor operation with the Service Aid Tester for proper wheel speed signals.

Replace the Sensor Housing and/or Bracket

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury can result.

1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
4. Remove the wheel (hub, drum and tire). Refer to Section 2.

CAUTION

Do not twist the connector. This will damage the pins and sockets.

NOTE

It is not necessary to disconnect the long sensor cable (in-line connector to the computer) or to remove the nylon ties. If only the sensor assembly and housing is to be removed (bracket left on brake spider), proceed to Step 8.

5. If used, remove the in-line connector clip and disconnect the sensor cable.
6. Cut the nylon ties that hold the sensor cable to the air delivery hose.
7. Disassemble the complete sensor assembly, housing and bracket from the brake spider by removing two bracket-to-brake spider capscrews and washers. Pull the cable through the hole in the spider and/or dust shield.
8. Disassemble the sensor assembly with the housing from the bracket by removing the two housing-to-bracket bolts, nuts and washers.
9. If the sensor bracket is to be replaced, secure the bracket to the brake spider with two housing-to-bracket bolts, nuts and washers. Tighten to 30-45 lb-ft (41-61 N•m). T

NOTE

To avoid clearance problems, install the bolts from the top and install the nuts and washers from the bottom.

10. Assemble the sensor assembly with the housing to the sensor bracket with two bolts, nuts and washers. Tighten to 30-40 lb-ft (41-54 N•m). T
11. Insert the connector of the sensor through the hole in the brake spider and/or dust shield. Use a grommet in the hole for proper sealing and cable strain relief.
12. Route the sensor lead along the air delivery hose to the sensor cable and reconnect the sensor in-line connector and, if used, install the in-line connector clip.

Lubricant Specifications - Front Axle

Description	Lubricant Specification
King Pins, Bushings, Ends of Tie Rods, Ball Studs of Drag Link, Wheel Bearings	• Multi-Purpose Chassis Grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade #1, Meritor Specification, 0-617-A, or equivalent. • Multi-Purpose Chassis Grease 8% 12-hydroxy lithium stearate grease, NLGI Grade #2, Meritor Specification 0-617-B, or equivalent.

Wheel End Oil Change Intervals and Specifications

On-Highway Operation Intervals					Outside Temperature			
					°F		°C	
Check Oil Level	Petroleum Oil Change	Meritor Specification	Military Specification	Oil Description	Min.	Max.	Min.	Max.
1,000 miles (1,600 kilometers)	Whichever comes first: Seals replaced. Brakes relined. 30,000 miles (50,000 kilometers). Twice a year.	0-76A, Gear Oil	MIL-L-2105-D	GL-5, SAE 85W/140	10	None	12	None
		0-76D, Gear Oil	MIL-L-2105-D	GL-5, SAE 80W/90	–15	None	–26	None
		0-76E, Gear Oil	MIL-L-2105-D	GL-5, SAE 75W/90	–40	None	–40	None
		0-76J, Gear Oil	MIL-L-2105-D	GL-5, SAE 75W	–40	36	–40	2
		Heavy Duty Engine Oil	MIL-L-2104-B -C, -D or -E	API -CD, -CE -SF or -SG SAE 40 or 50 ①	10	None	12	None
		Heavy Duty Engine Oil	MIL-L-2104-B -C, -D or -E	API -CD, -CE, -SF or -SG SAE 30 ②	–15	None	–26	None

① Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 40 or 50.
② Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 30.

MERITOR™

Conventional Front Non-Drive Axle Greasing Intervals and Specifications

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Classification	Outside Temperature
King Pins and Bushings	50,000 miles (80,000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Ball Studs on Steering Arm Tie Rod Arm Ends and Drag Link ①			O-617-B	2		

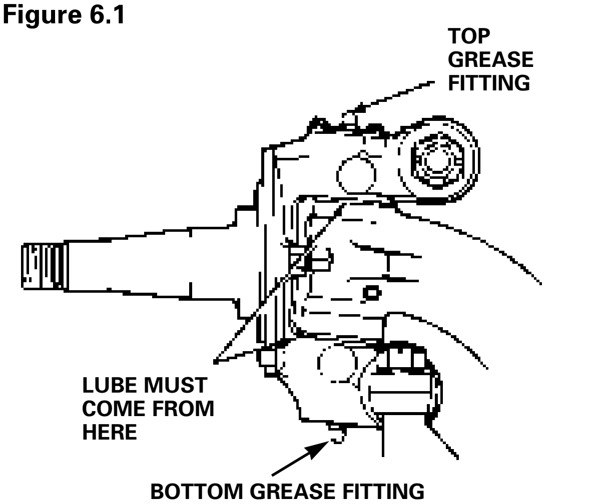
① Applies to ball studs on conventional and Easy Steer axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154,000 km) for wear and damage. Service as necessary.

Lubrication Procedure

King Pins

1. Make sure the tires touch the ground. DO NOT RAISE THE VEHICLE.
2. Clean off all grease fittings prior to lubrication.
3. Lubricate the pins through the grease fittings on the top and bottom of the knuckle. **Figure 6.1.**
4. Apply lubricant until new lubricant comes from the thrust bearing seal and the upper shim pack.

Figure 6.1

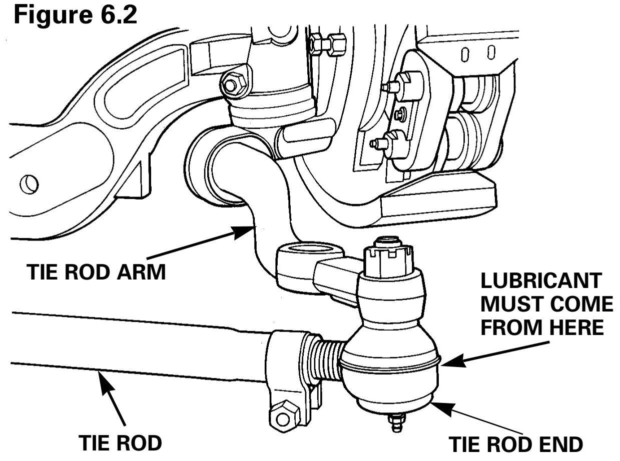


Tie Rod

Lubricate the ends of the tie rod according to the following procedure:

1. Make sure the tires touch the ground.
2. Use a grease gun to lubricate the assembly. Apply the lubricant through grease fittings on assembly. **Figure 6.2.**
3. Apply the lubricant until new lubricant comes from the boot. **Figure 6.2.**

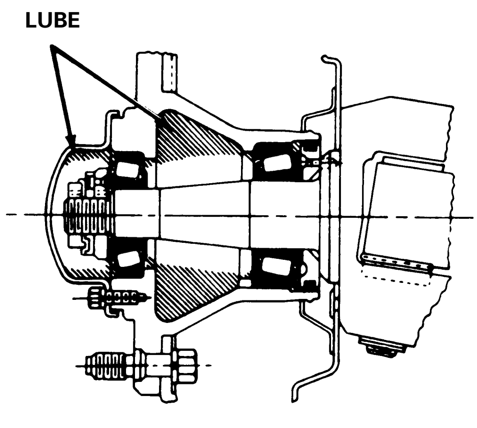
Figure 6.2



Grease Lubricated Wheel Bearings

1. Remove the tire and wheel assembly. Remove and disassemble the hub. Refer to “Removing Knuckle” in Section 2.
2. Remove the old lubricant from all parts. Discard the seals. Inspect the wheel bearings for wear or damage. Replace worn or damaged bearings. Refer to Section 3, “Prepare Parts for Assembly.”
3. Force the specified lubricant from the large end of the cones into the cavities between the rollers and cage. Pack the hub between the bearing cups with lubricant to the level of the smallest diameter of the cups. **Figure 6.3.**

Figure 6.3

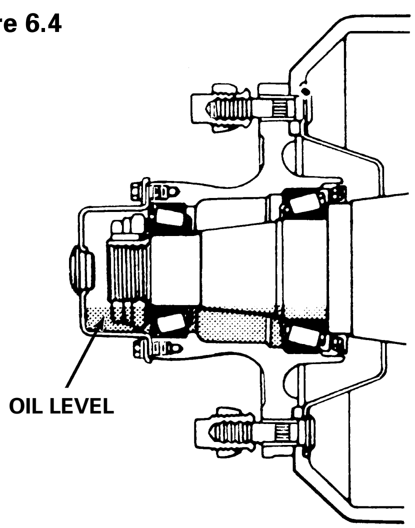


4. Install the inner and outer bearing cones into the cups in the hubs. The bearing cups must be pressed tight against the shoulder in the hubs.
5. Install new wheel seals in the hubs.
6. Install the hub and the wheel and tire assembly. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
7. Adjust the wheel bearings. Refer to "Check and Adjust the Wheel Bearings" in Section 5.

Oil Lubricated Wheel Bearings

Check the level on the cap. If the oil level is not at the specified level on the cap, remove the fill plug. Add the specified oil until the oil is at the correct level. **Figure 6.4.**

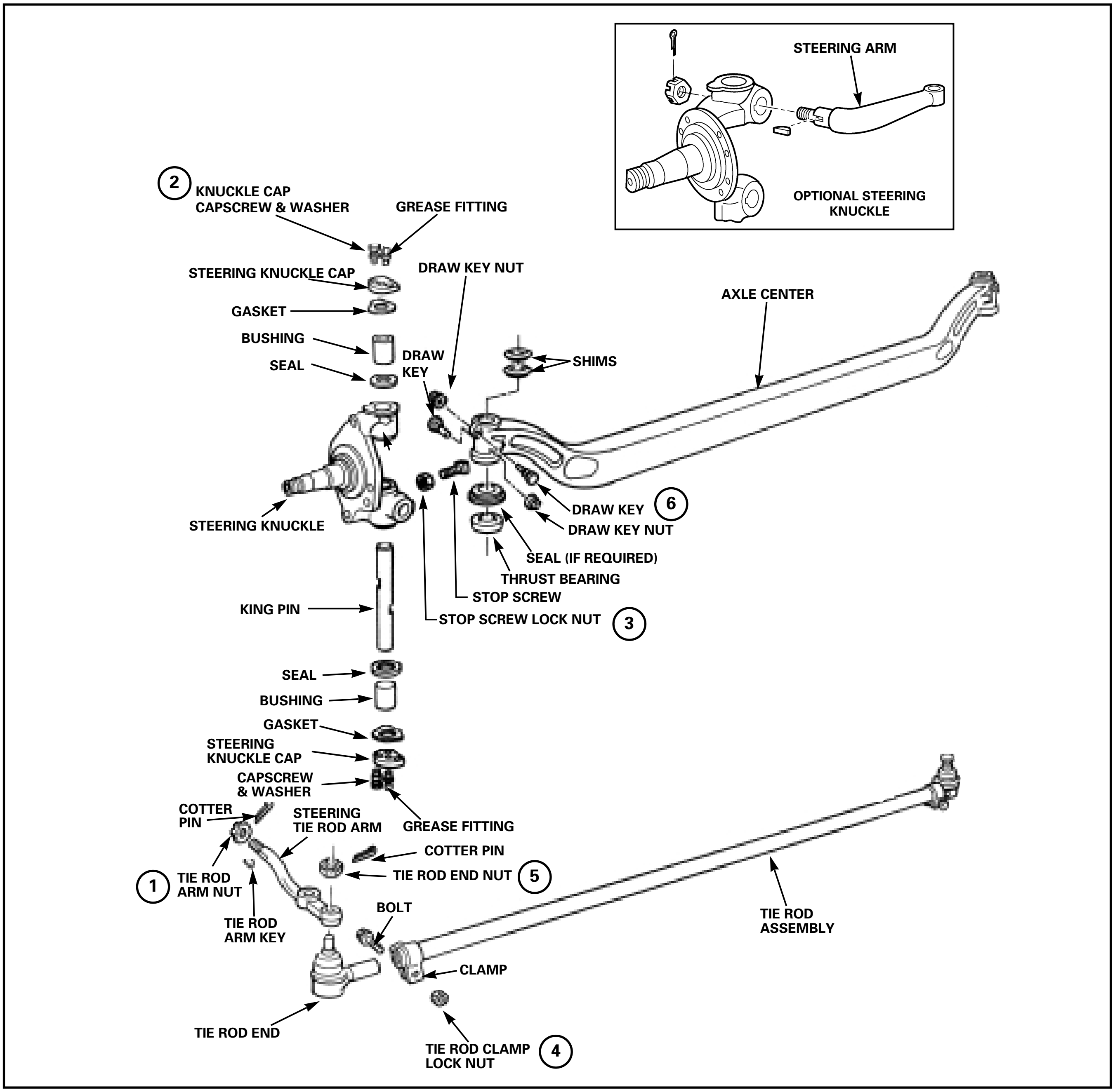
Figure 6.4



The following chart is for diagnosing axle conditions.

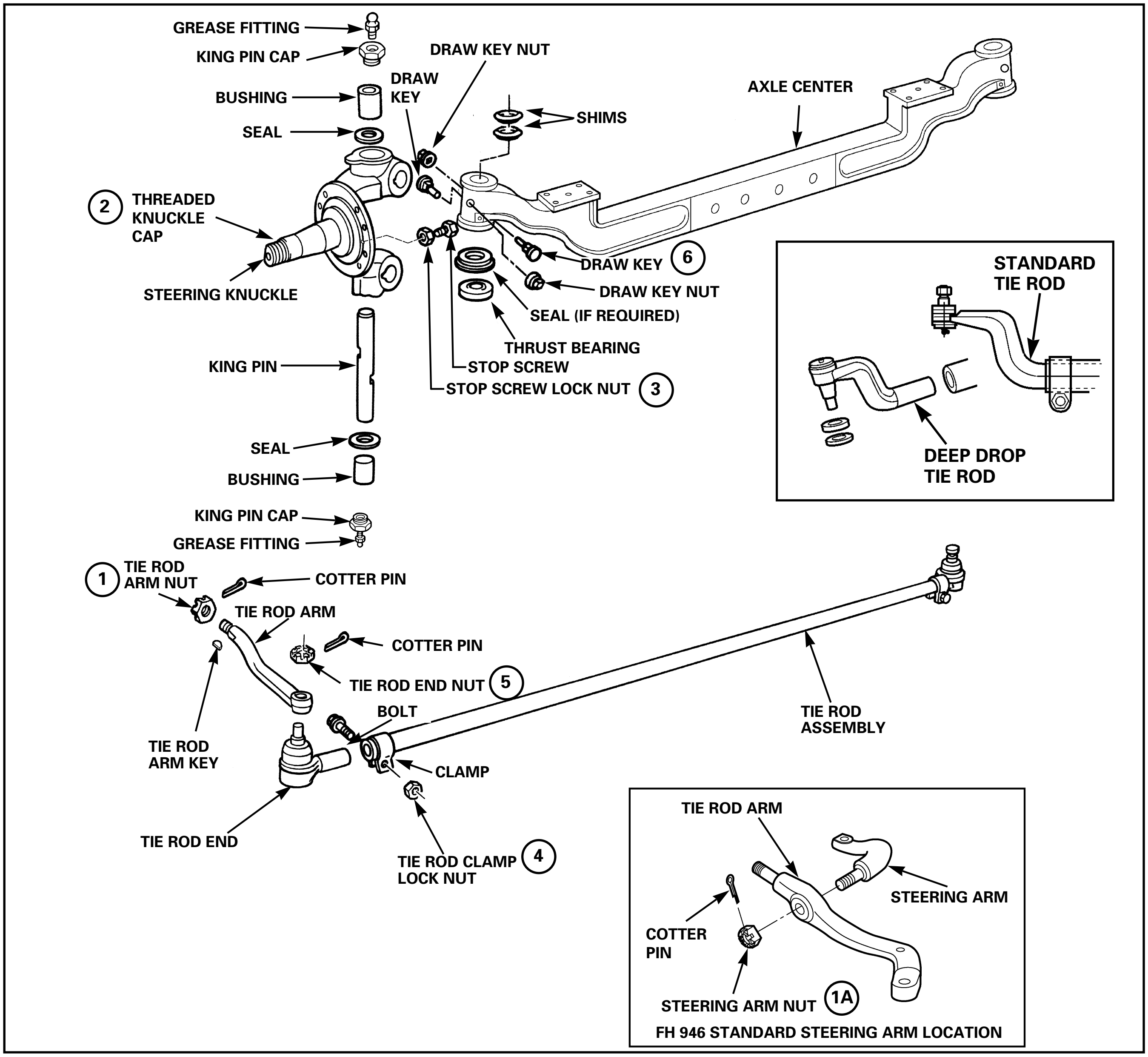
Condition	Cause	Correction
Tires wear out quickly or tires have uneven tire wear	1. Tires have incorrect air pressure 2. Tires out-of-balance 3. Incorrect tandem axle alignment 4. Incorrect toe-in setting 5. Incorrect steering arm geometry 6. Excessive wheel end play exists	1. Place specified air pressure in tires. 2. Balance or replace tires. 3. Align tandem axles. 4. Adjust toe-in specified setting. 5. Service steering system as necessary. 6. Readjust wheel bearings.
Vehicle is hard to steer	1. Low pressure in the power steering system 2. Steering gear not assembled correctly 3. Steering linkage needs lubrication 4. King pins binding 5. Incorrect steering arm geometry 6. Caster out-of-adjustment 7. Tie rod ends hard to move 8. Worn thrust bearing	1. Repair power steering system. 2. Assemble steering gear correctly. 3. Lubricate steering linkage. 4. Replace king pins. 5. Service steering system as necessary. 6. Adjust caster as necessary. 7. Replace tie rod ends. 8. Replace thrust bearing.
Ends of the tie rod are worn	1. Ends of the tie rod need lubrication 2. Severe operating conditions 3. Damaged boot on end of tie rod 4. Add-on type of power steering cylinders not installed correctly	1. Lubricate ends of tie rod. Make sure lubrication schedule is followed. 2. Operate vehicle correctly. 3. Replace boot. 4. Install power steering cylinders correctly.
Bent or broken tie rod, ball stud, steering arm or cross tube arm	1. Too much pressure in the power steering system 2. Cut-off pressure of the power steering system out-of-adjustment 3. Vehicle not operated correctly 4. Add-on type of power steering system not installed correctly	1. Adjust power steering system to specified pressure. 2. Adjust power steering system to specified pressure. 3. Make sure vehicle is operated correctly. 4. Correctly install add-on power steering system.
Worn or broken steering ball stud	1. Drag link fasteners tightened past specified torque 2. Lack of lubrication or incorrect lubricant 3. Power steering stops out-of-adjustment	1. Tighten drag link fasteners to specified torque. 2. Lubricate linkage with specified lubricant. 3. Adjust stops to specified dimension.
Worn king pins and bushings	1. Worn or missing seals and gaskets 2. Incorrect lubricant 3. Axle not lubricated at scheduled frequency 4. Incorrect lubrication procedures 5. Lubrication schedule does not match operating conditions	1. Replace seals and gaskets. 2. Lubricate axle with specified lubricant. 3. Lubricate axle at scheduled frequency. 4. Use correct lubrication procedures. 5. Change lubrication schedule to match operating conditions.
Vibration or shimmy of front axle during operation	1. Caster out of adjustment 2. Wheels and/or tires out-of-balance 3. Worn shock absorbers	1. Adjust caster. 2. Balance or replace wheels and/or tires. 3. Replace shock absorbers.

Fastener Torque Chart: 17100, 17101, 17110 & 17111 Axles



Item	Description	Size	Torque Range Lb-Ft	N•m
1	Tie Rod Arm Nut	1.125"-12	550-740	745-1003
2	Knuckle Cap Capscrew	0.312"-18	20-30	28-40
3	Stop Screw Lock Nut	0.500"-20	50-65	68-88
4	Tie Rod Clamp Lock Nut	0.625"-11	40-60	55-82
5	Tie Rod End Nut	0.875"-14	160-300	217-407
6	Draw Key	0.438"-20	30-45	41-61

Fastener Torque Chart: FH 941, FH 945 and FH 946 Axles



Item	Description	Size	Torque Range Lb-Ft	N•m
1	Tie Rod Arm Nut	1.125"-12	550-1025	745-1003
1A	Steering Arm Nut	1.25"-12	775-1450	1051-1965
2	Threaded Knuckle Cap	2.00"	100-120	135-160
3	Stop Screw Lock Nut	0.500"-20	50-65	68-88
4	Tie Rod Clamp Lock Nut	0.625"-11	40-60	55-82
		0.750"-10	155-175	210-237
5	Standard Tie Rod End Nut	0.875"-14	160-300	217-407
5A	“Deep Drop” Tie Rod End Nut	0.875"-14	200-340	270-460
6	Draw Key	0.4375"-20	30-45	41-61

Special Tools

Description	Kent-Moore Tool Number ①	Owatonna Tool Number ②	Snap-On® Tool Number ③
King Pin Remover	J 36136	4240	20 Ton: CG430HYB 35 Ton: CG730HY
King Pin Bushing Service Kit King Pin Reamer Kit Basic Service Kit FH Series 171XX Series	④ PT 4375-A	 —	 —

NOTES

① Order Kent-Moore tools from: Kent-Moore Heavy Duty Division, 29874 Little Mack, Roseville, MI 48066-2298.
② Order Owatonna tools from OTC Toll and Equipment Division, 655 Eisenhower Drive, Owatonna, MN 55060.
③ See your local Snap-On® dealer.
④ Use Basic Service Kit along with the correct axle series kit.

Drivetrain Plus™ by ArvinMeritor

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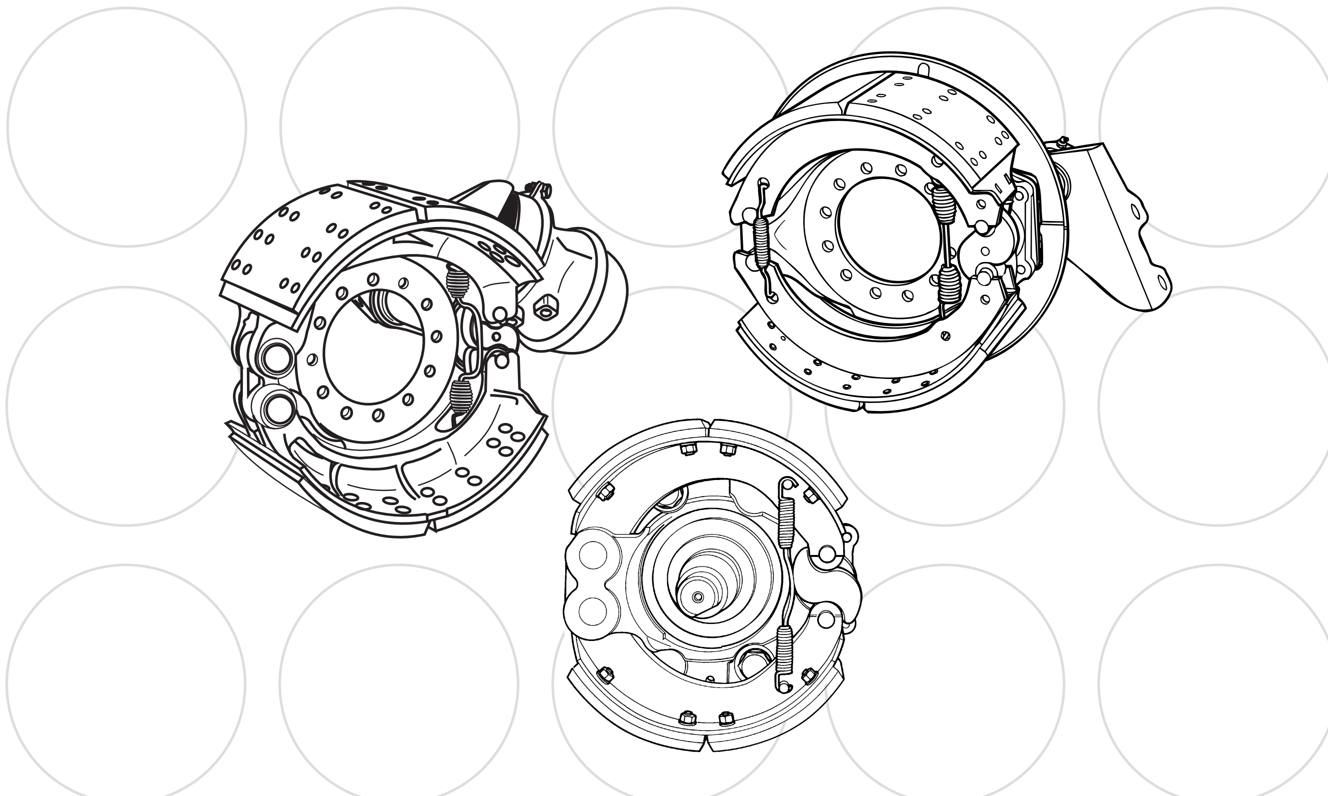
MERITOR®

an ArvinMeritor brand

Maintenance Manual 23B

Bus and Coach Cam Brakes

Revised 07-04



About This Manual

This manual provides maintenance and service information for the Meritor bus and coach Q Series, Q Plus™, Cast Plus™ and W Series cam brakes.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit the DriveTrain Plus™ by ArvinMeritor Tech Library at arvinmeritor.com to easily access product and service information. The Library also offers an interactive and printable Literature Order Form.

ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. $20. Specify TP-9853.

How to Obtain Tools, Supplies and Brake Conversion Kits Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies. Lined shoe kits and brake hardware kits are available. You also can obtain the following conversion kit.

- A kit to convert standard 16.5-inch Q Series cam brakes to Q Plus™ cam brakes

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ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up**.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

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.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

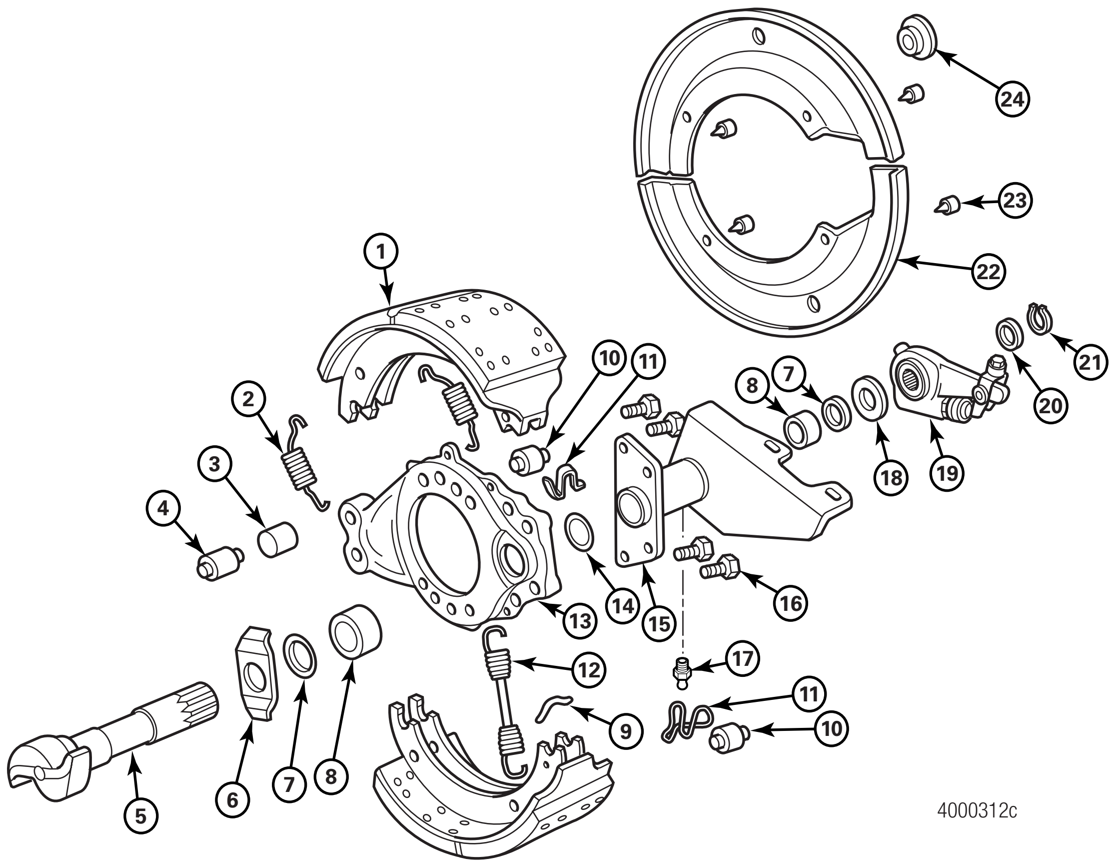
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal**.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

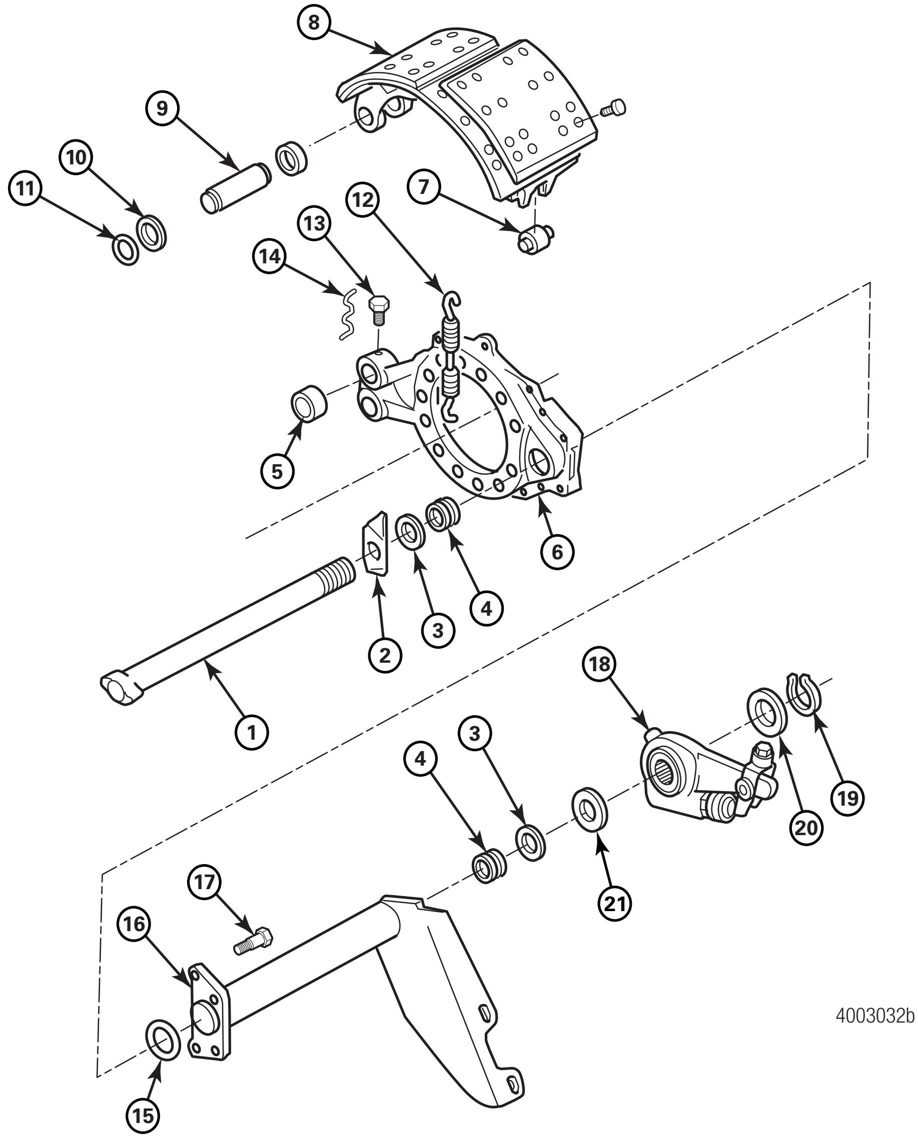
References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them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

15-Inch and 16.5-Inch Q Plus™ and Q Series Cam Brakes with Cast Spiders



Item	Description	Item	Description
1	Shoe and Lining Assembly	13	Cast Brake Spider
2	Shoe Retaining Spring	14	Chamber Bracket Seal
3	Anchor Pin Bushing	15	Chamber Bracket
4	Brake Shoe Anchor Pin	16	Chamber Bracket Capscrew
5	“S” Head Camshaft	17	Grease Fitting
6	Cam Head Washer	18	Thick Camshaft Washer
7	Camshaft Grease Seal	19	Automatic Slack Adjuster
8	Camshaft Bushing	20	Spacing Washer
9	Return Spring Pin	21	Camshaft Snap Ring
10	Brake Shoe Roller	22	Dust Shield
11	Shoe Roller Retainer	23	Dust Shield Capscrew
12	Brake Shoe Return Spring	24	Plug

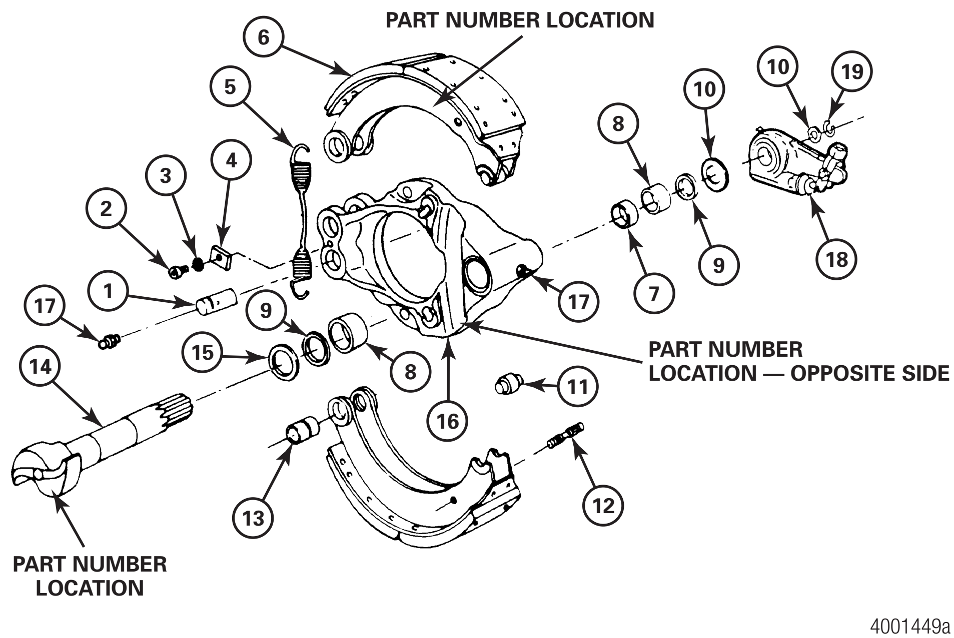
16.5-Inch Cast Plus™ Cam Brake



Item	Description	Item	Description
1	Camshaft	12	Brake Shoe Return Spring
2	Cam Head Washer	13	Anchor Pin Set Screw
3	Camshaft Seal	14	Anchor Pin Set Screw Lock Wire
4	Camshaft Bushing	15	Chamber Bracket Seal
5	Anchor Pin Bushing	16	Chamber Bracket
6	Brake Spider	17	Chamber Bracket Capscrew
7	Brake Shoe Roller	18	Automatic Slack Adjuster
8	Brake Shoe and Lining Assembly	19	Snap Ring
9	Anchor Pin	20	Camshaft Spacing Washers
10	Anchor Pin Washer	21	Thick Camshaft Washer
11	Anchor Pin Snap Ring		

14.5-Inch W Series Brakes

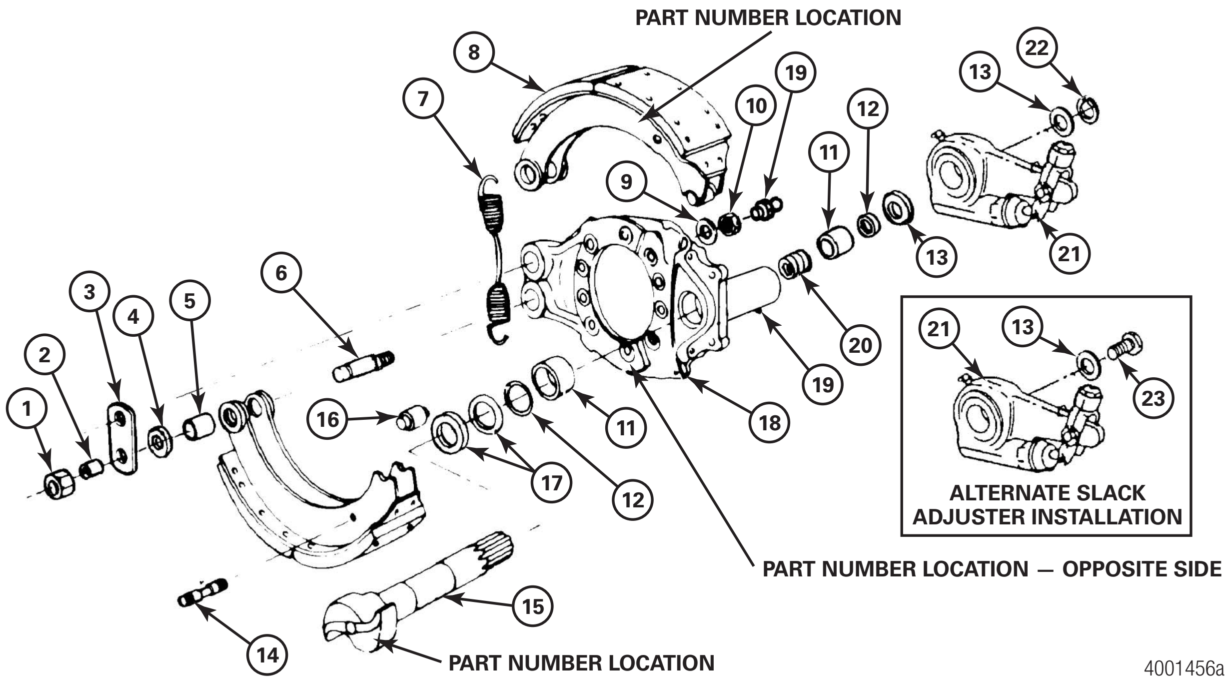
14.5 x 5-Inch and 14.5 x 6-Inch



Item	Description
1	Brake Shoe Anchor Pin
2	Anchor Pin Lock Capscrew
3	Lock Washer
4	Strap
5	Brake Shoe Return Spring
6	Brake Shoe and Lining Assembly
7	Spider Bushing Spacer
8	Spider Camshaft Bushing
9	Camshaft Seal
10	Spacing Washer
11	Brake Shoe Roller
12	Brake Shoe Return Spring Pin
13	Brake Shoe Bushing
14	Camshaft
15	Cam Head Washer
16	Brake Spider
17	Grease Fitting
18	Automatic Slack Adjuster
19	Lock Ring

14.5-Inch W Series Brakes

14.5 x 8-Inch and 14.5 x 10-Inch Type I, Tapered Seat Anchor Pin and Integral Cam Bracket

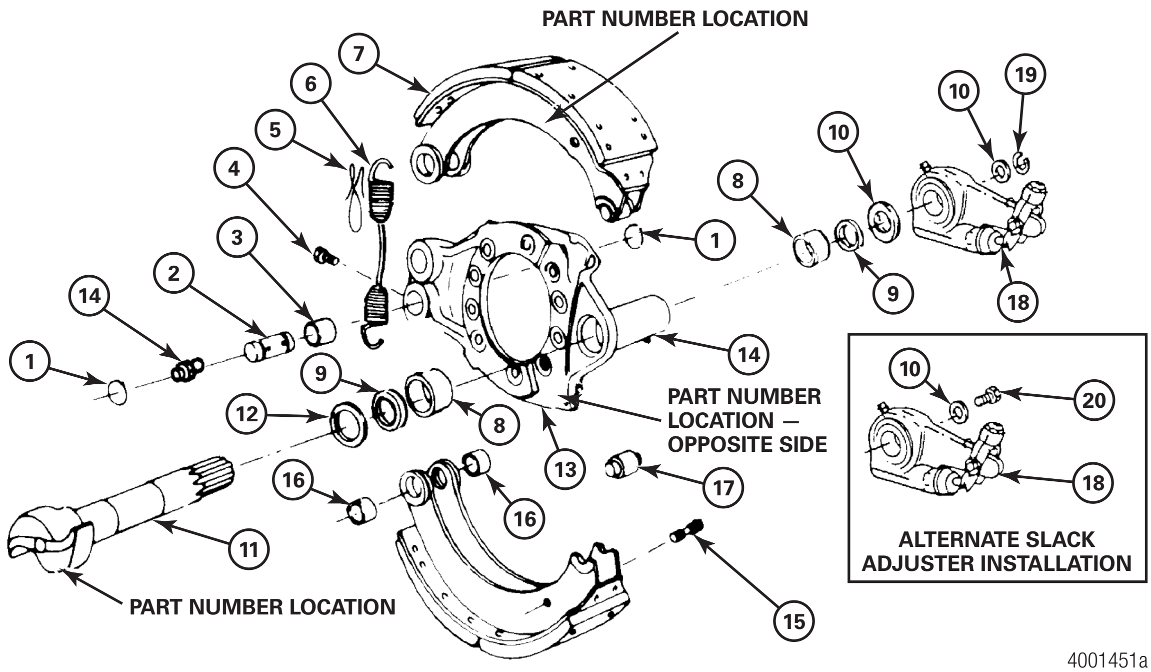


Item	Description
1	Shoe Retaining Nut
2	Dowel
3	Strap
4	Shim
5	Brake Shoe Bushing
6	Brake Shoe Anchor Pin
7	Brake Shoe Return Spring
8	Brake Shoe and Lining Assembly
9	Flat Washer
10	Anchor Pin Nut
11	Camshaft Spider Bushing
12	Camshaft Seal
13	Spacing Washer
14	Brake Shoe Return Spring Pin
15	Camshaft

Item	Description
16	Brake Shoe Roller
17	Spacing Washer
18	Brake Spider
19	Grease Fitting
20	Spider Bushing Spacer
21	Automatic Slack Adjuster
22	Lock Ring
23	Capscrew

14.5-Inch W Series Brakes

14.5 x 10-Inch Type II, Straight Anchor Pin and Integral Cam Bracket

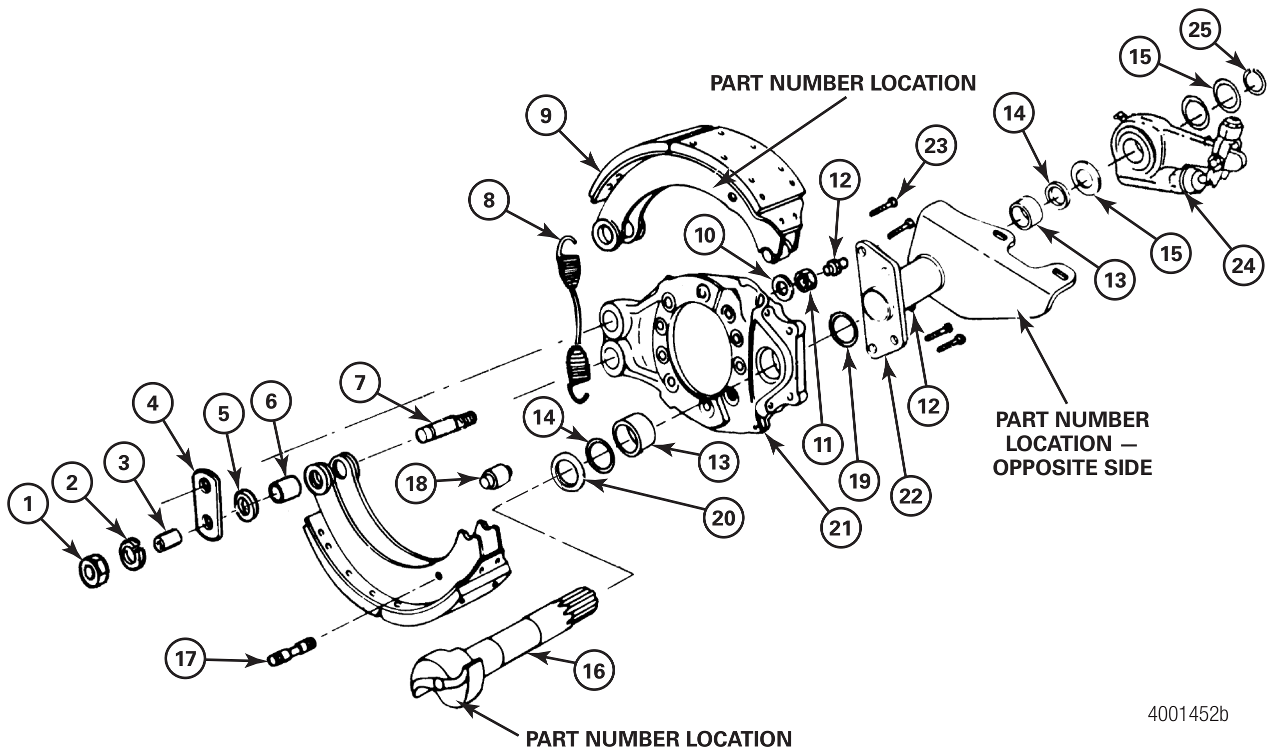


Item	Description
1	Anchor Pin Lock Ring
2	Brake Shoe Anchor Pin
3	Anchor Pin Bushing
4	Anchor Pin Set Screw
5	Anchor Pin Lock Wire
6	Brake Shoe Return Spring
7	Brake Shoe and Lining Assembly
8	Camshaft Spider Bushing
9	Camshaft Seal
10	Spacing Washer
11	Camshaft
12	Cam Head Washer
13	Brake Spider
14	Grease Fitting
15	Brake Shoe Return Spring Pin

Item	Description
16	Brake Shoe Bushing
17	Brake Shoe Roller
18	Automatic Slack Adjuster
19	Lock Ring
20	Capscrew

14.5-Inch W Series Brakes

14.5 x 10-Inch Type III, Tapered Seat Anchor Pin and Standard Cam and Chamber Bracket



Item	Description
1	Shoe Retaining Nut
2	Lock Washer
3	Dowel
4	Strap
5	Shim
6	Brake Shoe Bushing
7	Brake Shoe Anchor Pin
8	Brake Shoe Return Spring
9	Brake Shoe and Lining Assembly
10	Flat Washer
11	Anchor Pin Nut
12	Grease Fitting
13	Camshaft Bushing
14	Camshaft Seal

Item	Description
15	Spacing Washer
16	Camshaft
17	Brake Shoe Return Spring Pin
18	Brake Shoe Roller
19	Bracket O-Ring Seal
20	Flat Washer
21	Brake Spider
22	Chamber Bracket
23	Bracket Capscrew
24	Automatic Slack Adjuster
25	Lock Ring

Description

Cam Brakes

The Meritor cam brakes are air-actuated, cam-operated, double shoe brakes with each shoe mounted on a separate anchor pin. The brakes are available with automatic adjustment and can be assembled with auxiliary spring brakes.

There are three types of cam brakes for buses and coaches: Q Series and Q Plus™, Cast Plus™ and W Series.

Q Series and Q Plus™

The Q Series and Q Plus™ brake shoe has an open end on the anchor pin ends for "quick change" service. An anchor pin fastens each brake shoe to the spider. The linings are fastened to the brake shoes with rivets. Two retaining springs and one return spring hold the shoes together on the spider. Figure 2.1.

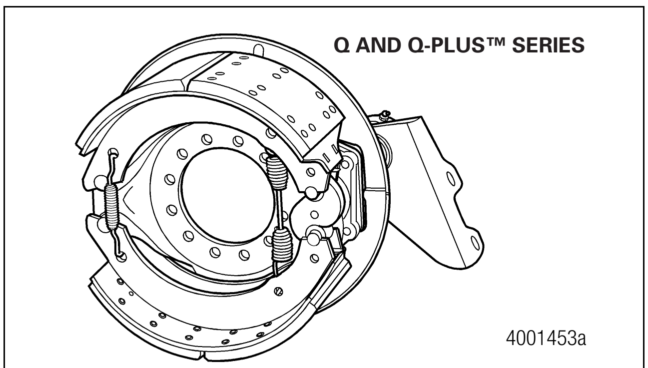


Figure 2.1

Q Series brakes are available in 16.5-inch diameter with a 10-inch width and 0.75-inch tapered brake lining.

Q Plus™ brakes are available in 15-inch and 16.5-inch (419 mm) diameter with 5-, 6-, 7- and 8.625-inch (127, 152, 178 and 219 mm) widths. The tapered brake linings are 0.73-inch (18.54 mm) thick on 15-inch brakes and 0.84-inch (21.34 mm) thick on 16.5-inch brakes.

Cast Plus™

The Cast Plus™ brake is designed for heavy-duty, off-highway and people-mover applications. A redesigned S-cam and heavy-duty shoe return spring allow additional shoe travel. An improved camshaft bushing contributes to longer service life. The Cast Plus™ brake uses Q Plus™ brake linings and the P Series brake shoe design. For more information on the P Series brake, refer to Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual. The brake linings are fastened to the brake shoes with rivets or bolts. Figure 2.2.

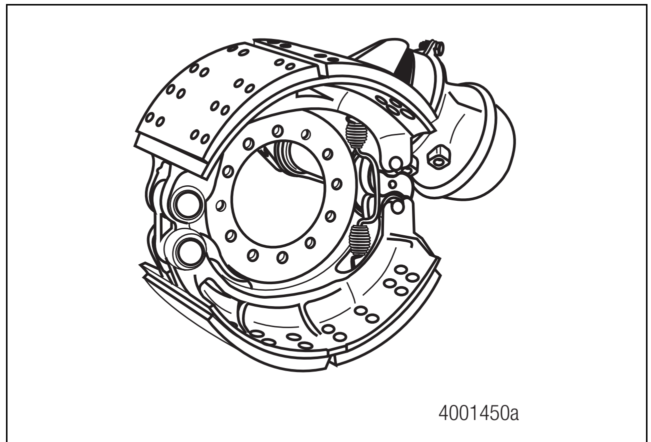


Figure 2.2

Cast Plus™ brakes are available in 16.5-inch (419 mm) diameter with 6- and 8.625-inch (152 and 219 mm) widths.

W Series

The W Series brake has anchor pins that fasten the brake shoe to the spider. The anchor pins can have a straight or tapered design. The spider can have an integral or separate cam bracket. The brake shoes are fastened to the linings with bolts. Figure 2.3.

W Series brakes are available in 14.5-inch (368 mm) diameter with 5-, 6-, 8- and 10-inch (127, 152, 203 and 254 mm) widths.

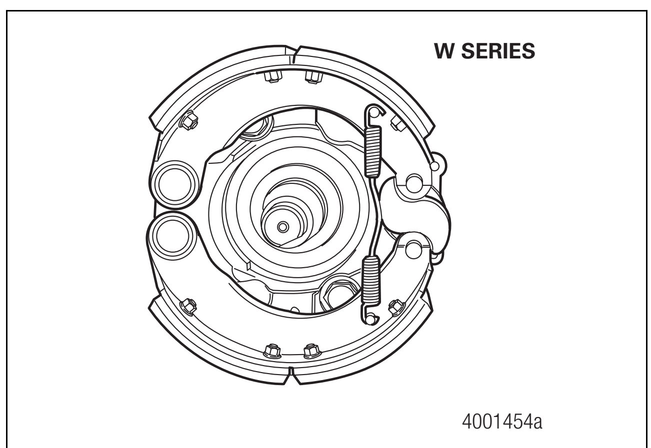


Figure 2.3

Identification

An identification tag is located on the axle housing or the differential carrier. Use the model number and the ratio number marked on the tag to order replacement parts. Figure 2.4.

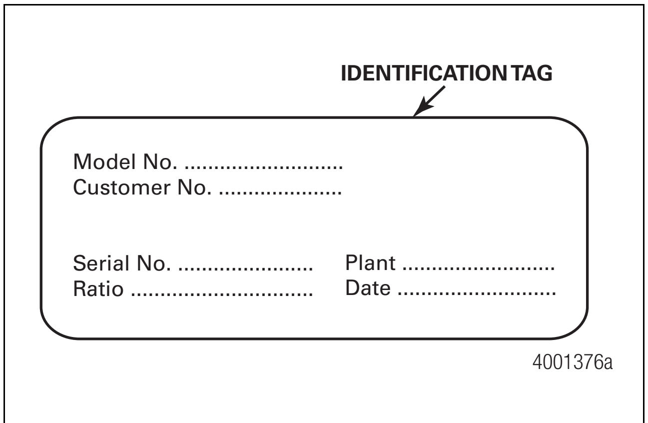


Figure 2.4

The model number designation for the 59000, 61000 and 71000 Series axles are identified in Figure 2.5 and Figure 2.6.

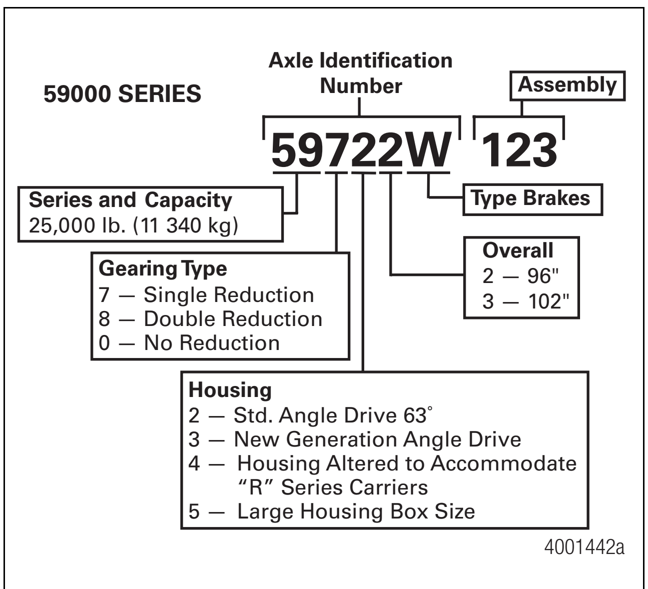


Figure 2.5

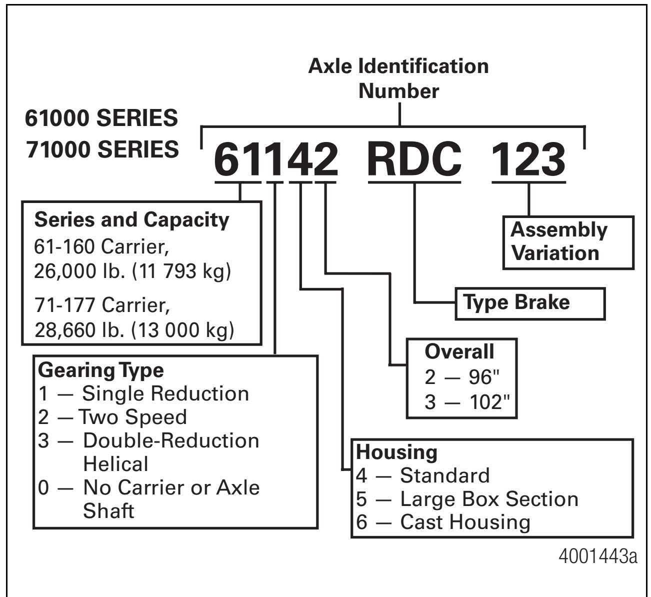


Figure 2.6

The RC-23-160 coach rear axle is identified by a letter and number system that provides information about the specific axle model. The first seven positions of the designation identify a basic axle model. The second group of letters and numbers identify complete axle specifications. Figure 2.7.

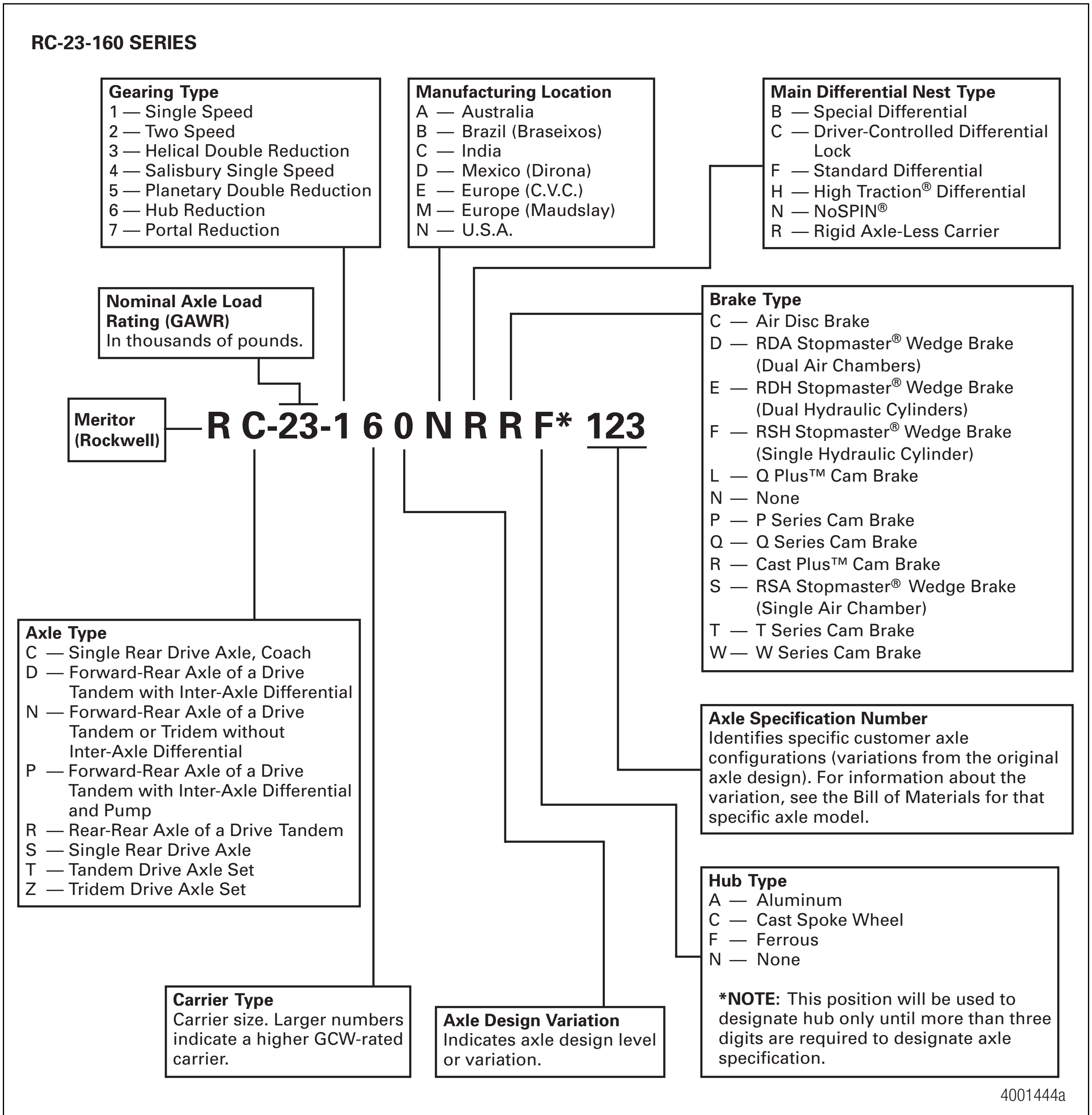


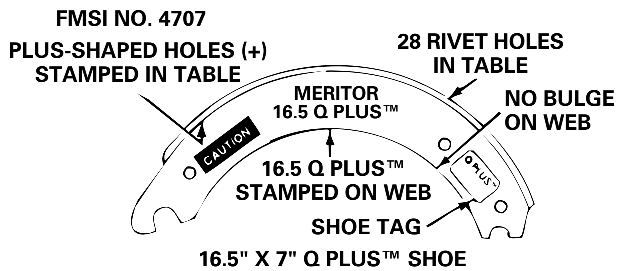
Figure 2.7

When parts are replaced, the correct parts must be used. Part numbers are found on the camshaft, on the brake spider, on the brake shoes and on the air chamber bracket.

Description

Differences Between Q Plus™ and Q Series Cam Brakes

Q Plus™ Components



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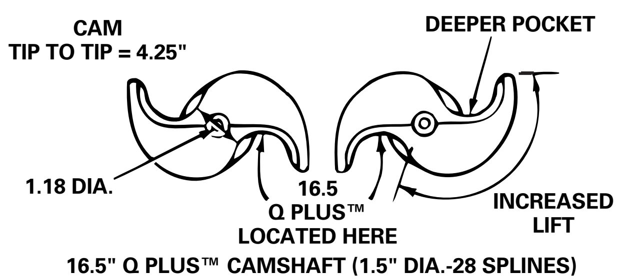

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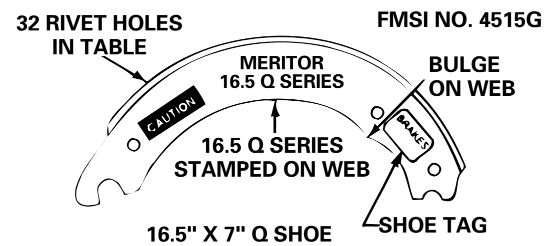
Q Series Components



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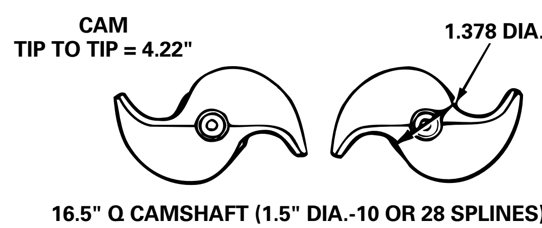

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Camshafts	Shoes	Return Springs
Q Plus™	Q Plus™	Heavy-duty (blue)
Q Plus™	Q Series	Standard
Q Series	Q Series	Standard

Removal

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Wheel Components

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. Remove the wheel nuts, and tire and rim assemblies.

WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.
5. Release the automatic slack adjuster to retract the shoes so the drum can clear the lining. Refer to Section 7 for Meritor automatic slack adjusters. For non-Meritor automatic slack adjusters, refer to the slack adjuster manufacturer's instructions.

Brake Drums

1. If equipped, remove the screws that secure the brake drum to the hub.

WARNING

To avoid serious personal injury and damage to components, take care when using lifting devices during service and maintenance procedures. Inspect a lifting strap to ensure that it is not damaged. Do not subject lifting straps to shocks or drop loading. The lifting bolt threads must be fully engaged.

2. Use a lifting device to remove the brake drum.
   - **If the drum is difficult to remove and is equipped with push holes:** Install the bolts into the push holes. Tighten the bolts sequentially until the drum separates from the hub.

Brake Shoes

1. Push DOWN on the bottom brake shoe. Pull on the brake shoe roller retainer clip to remove the bottom roller. Figure 3.1.

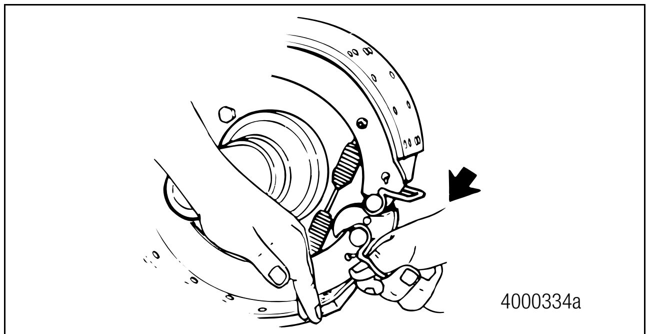


Figure 3.1

2. Lift the top brake shoe and pull on the brake shoe roller retainer clip to remove the top roller.
3. Lift the bottom shoe to release the tension on the brake shoe return spring. Figure 3.2.

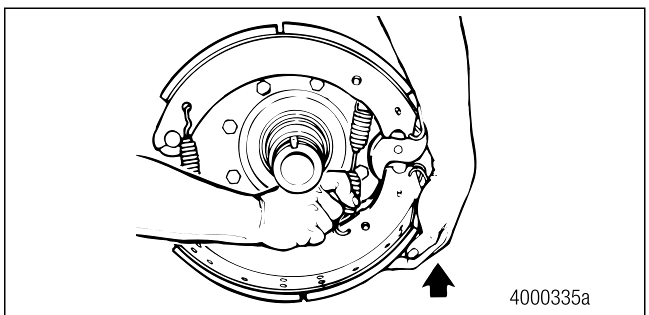


Figure 3.2

4. Rotate the bottom shoe to release the tension on the brake shoe retainer springs. Figure 3.3.

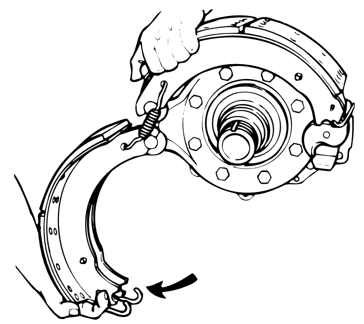


Figure 3.3

5. Remove the shoe retainer springs and the brake shoes.

Check Cam-to-Bushing Radial Free Play

Meritor recommends that you replace the camshaft bushings if the S-cam is replaced, if the radial movement exceeds 0.030-inch (0.762 mm), and at every brake shoe reline. Always replace the S-cam seals when you replace the S-cam bushings.

Before you remove the automatic slack adjuster and camshaft, move the camshaft as shown in Figure 3.4. Use a dial indicator to verify that the cam-to-bushing radial free play is within specification.

- **If radial free play movement exceeds 0.030-inch (0.76 mm):** Replace the bushings and seals.

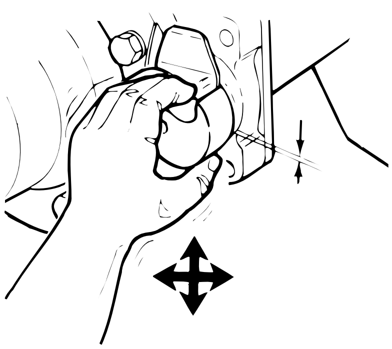


Figure 3.4

Automatic Slack Adjuster and Camshaft

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Section 7 and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

1. Remove the automatic slack adjuster from the camshaft.
2. If equipped, remove the spacer washers from the camshaft on the inboard side of the spider.
3. If necessary, remove the hub from the axle. Refer to the appropriate axle maintenance manual for hub removal procedures.
4. Remove the camshaft from the spider and bracket.
5. Use the correct size driver to remove the bushings and seals from the spider and bracket. On some brakes, a spacer is installed between the camshaft bushings.
6. Remove the capscrews that fasten the bracket to the spider. Remove the bracket and the seal.
7. If the spider must be removed, mark the position of the spider on the axle flange. Remove the capscrews that fasten the spider to the flange. Remove the spider. Inspect the axle flange for damage.

Prepare Parts for Assembly

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Clean and Dry Parts

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.**
- **You must 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

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.

Use soap and water to clean non-metal parts. Dry parts immediately after cleaning with soft, clean paper or cloth, or compressed air.

Corrosion Protection

1. If you assemble parts immediately after you clean them, lubricate parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them. Do not apply grease to the brake linings or the brake drums.
2. If you store parts after you clean them, apply a corrosion-preventive material. Do not apply the material to the brake linings or the brake drums. Store parts in a special paper or other material that prevents corrosion.

Inspect Parts

Meritor recommends that you replace the following parts at each reline.

- Brake Shoe Springs
- Clevis Pin Clips
- Rollers
- Camshaft Seals and Bushings
- Anchor Pins

1. Check the inside diameter of the anchor pin bushings. Figure 3.5. The inside diameter of the bushing must not exceed 1.259-inches (31.98 mm). Replace worn bushings.

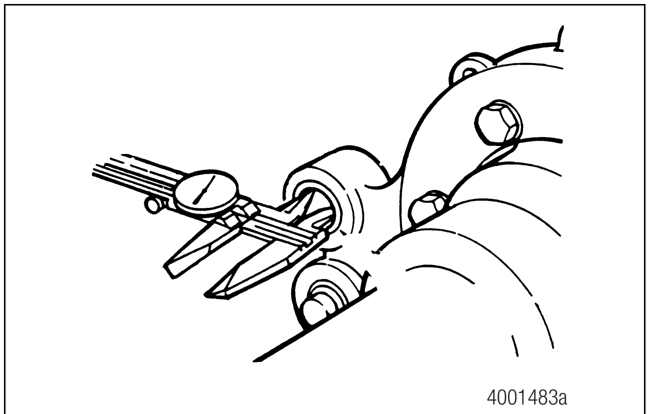


Figure 3.5

2. Check the spider for worn anchor pin holes or cracks. Replace damaged spiders. Tighten the spider mounting bolts to the vehicle manufacturer's specifications.
3. Check the camshaft bracket for broken welds, cracks and correct alignment. Replace damaged brackets.
4. Check the anchor pins for corrosion and wear. Replace worn or damaged anchor pins.
    - The anchor pin body diameter should be 1.244-1.248-inches (31.598-31.699 mm).
    - The anchor pin journal diameter should be 0.9985 ± 0.0015-inches (25.3619 ± 0.0381 mm).
5. Check the brake shoe lining thickness. Reline the brake when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point, usually at the crown.
6. Check the brake shoes for worn anchor pin slots, rust, expanded rivet holes, broken welds and correct alignment. The rivet holes must not exceed 0.257-0.263-inch (6.52-6.68 mm). Replace brake shoes as necessary.
7. For 16.5-inch brake shoes, the anchor pin slots must not exceed 1.009-inches (25.63 mm) in diameter. Replace any brake shoes that do not meet measurement specifications.

8. With the roller and anchor pin installed, measure the distance from the center of the anchor pin slot to the center of the roller slot. Figure 3.6. The distance must not exceed 12.75-inches (323.85 mm). Replace any brake shoes that do not meet measurement specifications.

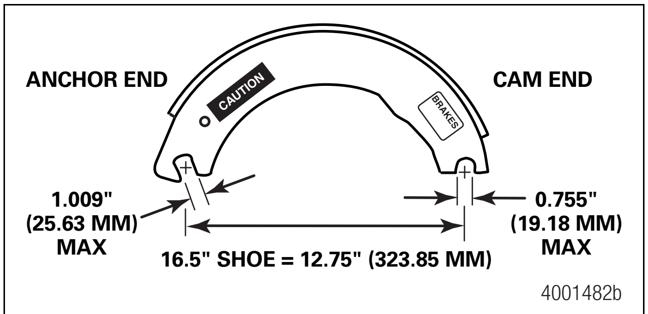


Figure 3.6

9. Measure the distance between the webs on the brake shoes at both ends. The web spacing should be 1.490-1.550-inches (37.85-39.37 mm) measured 1.0-inch (25.4 mm) from the edge of the slots. Replace the shoe if the web spacing is not within specification. Figure 3.7.

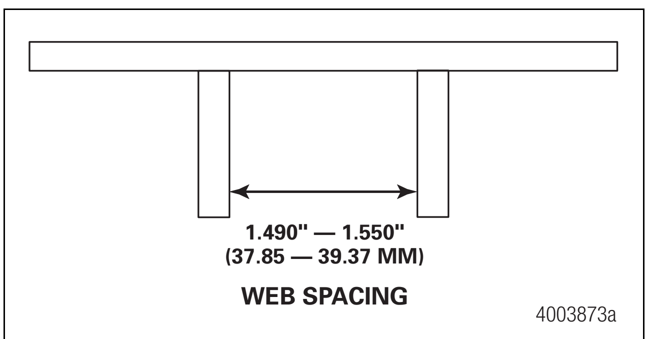


Figure 3.7

10. Check the camshaft for cracks, wear and corrosion. Check the cam head, bearing journals and splines. Replace worn or damaged camshafts.

⚠ CAUTION

Always replace used clevis pin retainer clips with new ones when you service an automatic slack adjuster or chamber. Do not reuse retainer clips. Discard used clips. When you remove a retainer clip, it can bend or "gap apart" and lose retention. Damage to components can result.

11. If you remove cotter pins from a slack adjuster during maintenance and service procedures, Meritor recommends that you install new clevis pin retainer clips at assembly. Always replace used clevis pin retainer clips with new ones. Do not reuse clevis pin retainer clips. Discard used clips.
12. Inspect the large and small clevis pins for wear or damage. Replace worn or damaged parts.

⚠ WARNING

Do not operate the vehicle with the brake drum worn or machined beyond the discard dimension indicated on the drum. The brake system may not operate correctly. Damage to components and serious personal injury can result.

⚠ CAUTION

Replace the brake drum if it is out-of-round. Do not turn or rebore a brake drum, which decreases the strength and capacity of the drum. Damage to components can result.

13. Use the following procedure to inspect the brake drums.
    A. Check the brake drums for cracks, severe heat checking, heat spotting, scoring, pitting and distortion. Replace drums as required. Do not turn or rebore brake drums, which decreases the strength and heat capacity of the drum.
    B. Measure the inside diameter of the drum in several locations with a drum caliper or internal micrometer. Figure 3.8.
        - **If the diameter exceeds the specifications supplied by the drum manufacturer or is close enough that the drum will wear past the specification before the next inspection:** Replace the drum.

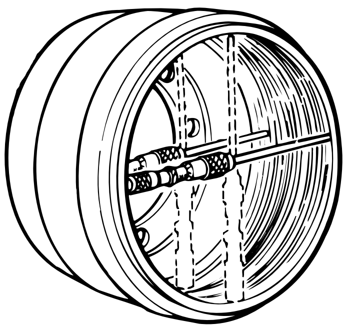


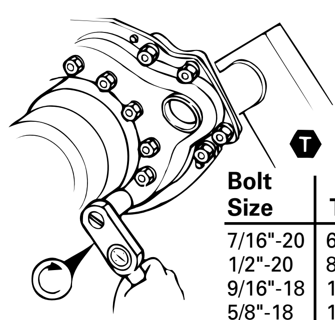
Figure 3.8

14. Check the dust shields for wear and damage. Repair or replace worn or damaged parts as necessary.
15. Check the automatic slack adjuster. For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
    - **If the slack adjuster is not a Meritor automatic slack adjuster:** Refer to the manufacturer's literature for the correct service procedures.

Camshaft

Meritor recommends that you replace the brake shoe springs, rollers, anchor pins, cam bushings and seals at each reline.

1. Tighten all spider bolts to the correct torque. Figure 3.9. T



T

Bolt Size	Torque	
7/16"-20	60-75 lb-ft	81-102 N•m
1/2"-20	85-115 lb-ft	115-156 N•m
9/16"-18	130-165 lb-ft	176-224 N•m
5/8"-18	180-230 lb-ft	244-312 N•m
7/8"-9	440-580 lb-ft	598-789 N•m

4000345a

Figure 3.9

2. Use a seal driver to install new camshaft bushings and new seals into the cast spider and camshaft bracket. Figure 3.10. The lips of the seals must face the slack adjuster. Figure 3.11.

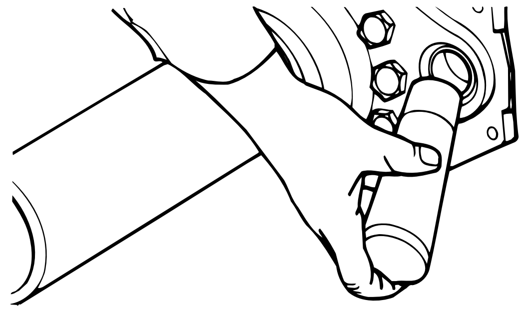


Figure 3.10

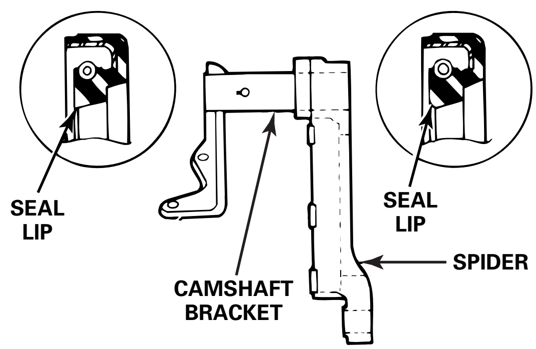


Figure 3.11

3. If the camshaft bracket has been removed, install the chamber bracket seal and bracket onto the spider. Tighten the capscrews to the correct torque. Figure 3.9. T

Installation

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

CAUTION

Only install a Q Plus™ camshaft in a Q Plus™ brake. A Q Series hammerclaw camshaft will not provide enough clearance between the brake shoe and the brake drum. Brake drag and damage to components can result.

To install a new brake drum so that it fits correctly over a Q Plus™ brake shoe, you must install a Q Plus™ camshaft to prevent damage to components.

Camshaft

1. Install the cam head thrust washer onto the camshaft. Apply Meritor specification O-617-A or O-617-B grease to the camshaft bushings and journals.
2. Install the camshaft through the spider and bracket so that the camshaft turns freely by hand. Figure 3.12.

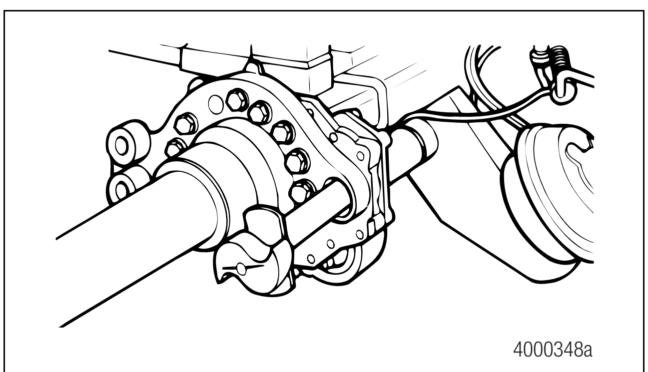


Figure 3.12

Replace a Hammerclaw Camshaft with a Standard Q Plus™ Camshaft

For front axles only, a standard Q Plus™ camshaft and shoe return spring with an offset center bar replaces the hammerclaw Q Series camshaft and shoe return spring with a straight center bar on the 16.5 x 5-inch and 6-inch Q Series cam brake. Figure 3.13 and Figure 3.14.

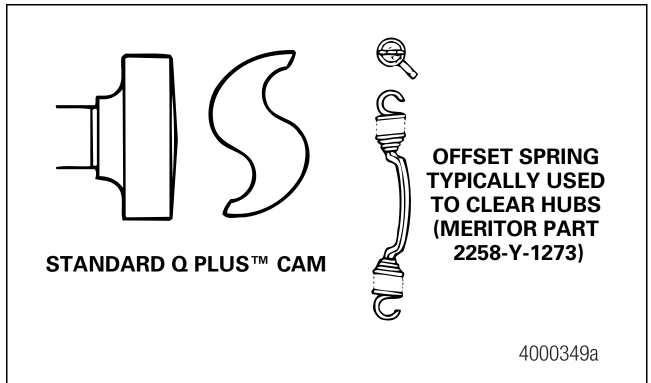


Figure 3.13

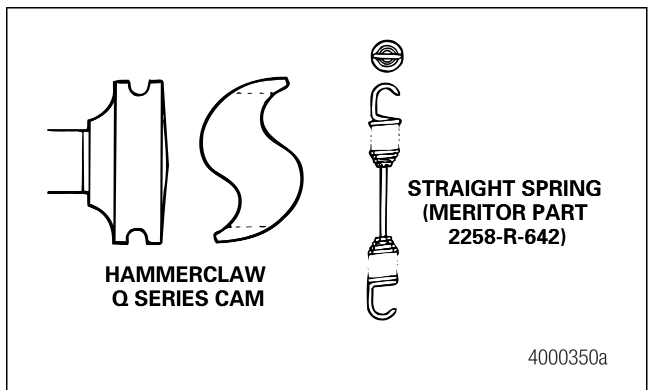


Figure 3.14

A Q Plus™ camshaft has deeper roller pockets than a Q Series camshaft and has “Q Plus” forged into one of the pockets. You may notice a larger gap between the brake lining and the drum after you assemble the brake shoe and shoe return spring with an offset center bar. Figure 3.15. The excess gap will be eliminated when you correctly adjust the brake.

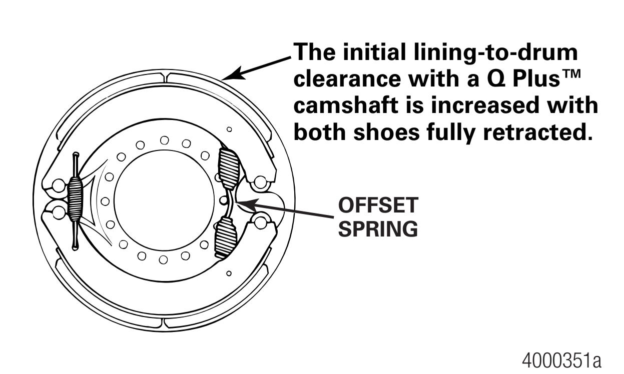


Figure 3.15

Follow the procedure in this section to replace a Q Series hammerclaw camshaft with a standard Q Plus™ camshaft.

Offset Shoe Return Spring

Install the new offset shoe return spring with the open end of the spring hooks TOWARD the camshaft. Figure 3.16.

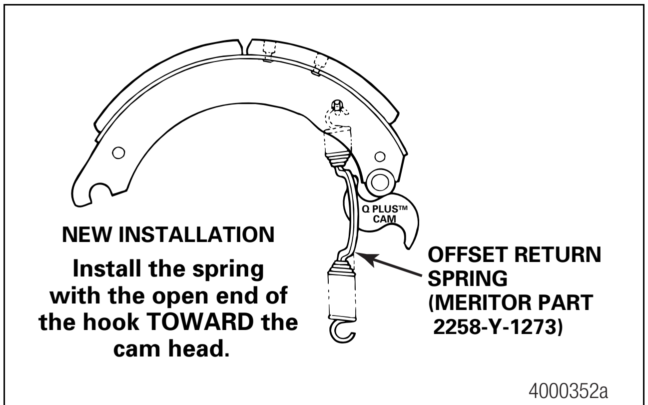


Figure 3.16

Brake Shoes, Rollers and Anchor Pins

Meritor recommends that you replace the brake shoe springs, rollers, anchor pins, cam bushings and seals, and clevis pin retainers at each reline.

When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers where these parts touch the brake shoes.

Do not allow grease to contact the area of the camshaft roller that touches the camshaft head.

1. Use Meritor specification O-617-A or O-617-B grease to lubricate the brake shoe roller and anchor pin. Figure 3.17.

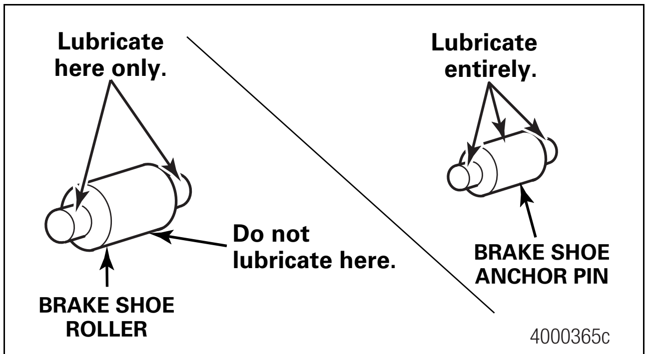


Figure 3.17

2. Install the lubricated anchor pins.
3. Place the upper brake shoe into position on the top anchor pin. Hold the lower brake shoe on the bottom anchor pin. Install two new brake shoe retaining springs. Figure 3.18.

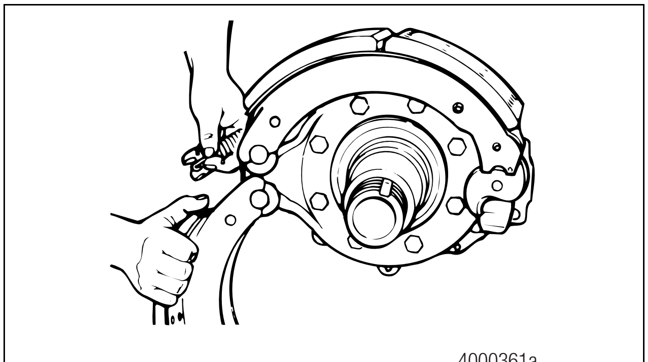


Figure 3.18

4. Rotate the lower brake shoe forward. Install a new brake shoe return spring with the open end of the spring hooks toward the camshaft. Figure 3.19.

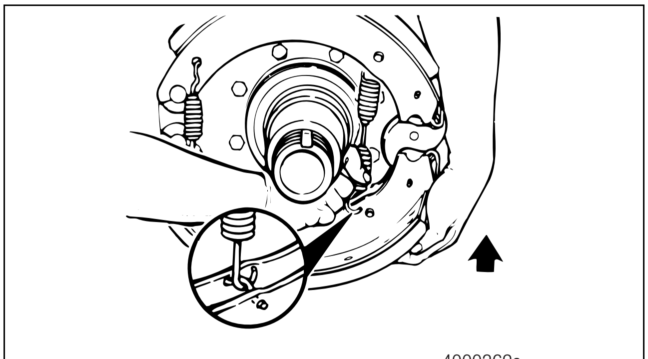


Figure 3.19

5. Pull each brake shoe away from the camshaft to enable you to install the brake shoe roller and roller retainer. Press the retainer ears to fit into the retainer between the brake shoe webs. Figure 3.20.

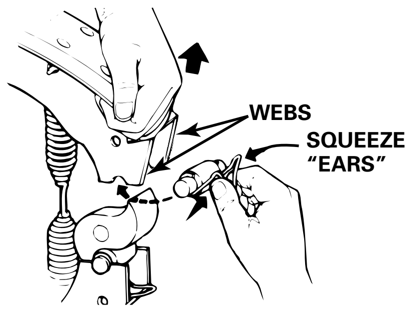


Figure 3.20

6. Push the brake shoe roller retainer into the brake shoe until the ears lock into the shoe web holes. Figure 3.21.

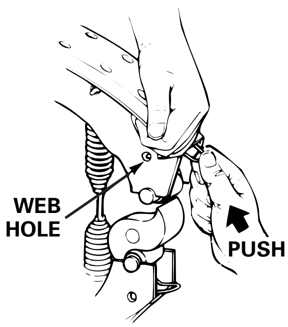


Figure 3.21

7. Use a lifting device to install the brake drum.
8. Connect the slack adjuster to the air chamber push rod. For complete instructions on the Meritor automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.
   - **If the slack adjuster is not a Meritor automatic slack adjuster:** Refer to the manufacturer's literature for the correct service procedures.

Burnish the Brakes

1. Adjust the brake manually. Refer to Section 7.
2. While driving the vehicle at 20 mph (32 km/h), apply the brakes to reduce speed, approximately 10 feet (3.05 m) per second, to five mph (8 km/h). Perform this operation 10 times at regular intervals of 500 feet or 0.1 mile (150 m or 0.16 km) without stopping the vehicle.
3. After 10 brake applications, make one complete stop from 20 to 0 mph (32 to 0 km/h).
4. Check the drum temperatures immediately after burnishing. Any drums that are cooler, approximately 50°F (10°C) side-to-side, 100°F (38°C) front-to-rear, than the others indicate a possible lack of braking effort on those wheels.

   A temperature difference greater than stated above is a possible indication of brake imbalance. Check for correct brake assembly and automatic slack adjuster setup. Refer to the appropriate section of this manual. In addition, check the vehicle manufacturer's specifications for correct air system setup. After the imbalance is repaired, reburnish the brakes.
5. Allow the brakes to cool to the ambient temperature. Readjust all the brakes manually.

Q Series and Q Plus™ Cam Brake Conversion Kits

Convert standard 16.5-inch Q Series brakes to Q Plus™ brakes. A kit includes all the hardware.

To obtain the brake conversion kit, refer to the Service Notes page on the front inside cover of this manual.

Removal

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Wheel Components

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. Remove the wheel nuts, and tire and rim assemblies.

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.
5. Release the automatic slack adjuster to retract the shoes so the drum can clear the lining. Refer to Section 7 for Meritor automatic slack adjusters. For non-Meritor automatic slack adjusters, refer to the slack adjuster manufacturer's instructions.

Brake Shoes

⚠ CAUTION

Do not overstress and deform the brake return spring when removing the brake shoes.

1. Use an appropriate tool to remove the brake shoe return spring. Insert the tool through the opening in the shoe. Figure 4.1.
   - You can use a return spring remover and assembler tool or a thin plate with a 0.25-inch (6.35 mm) slot to remove the brake shoe return spring. Refer to Section 14, Figure 14.3, for a tool production drawing.

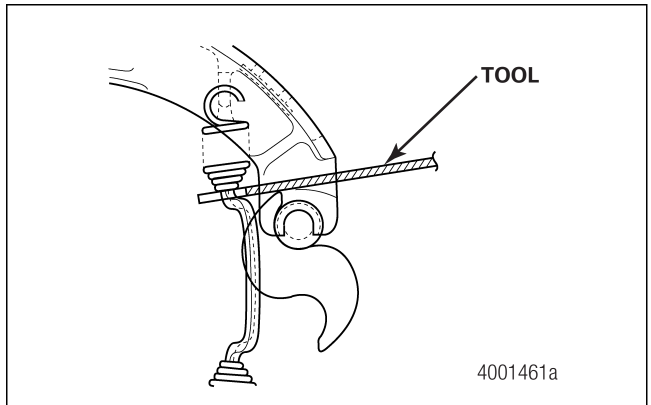


Figure 4.1

2. Remove the anchor pin snap rings, washers, set screws and lock wire. Figure 4.2.

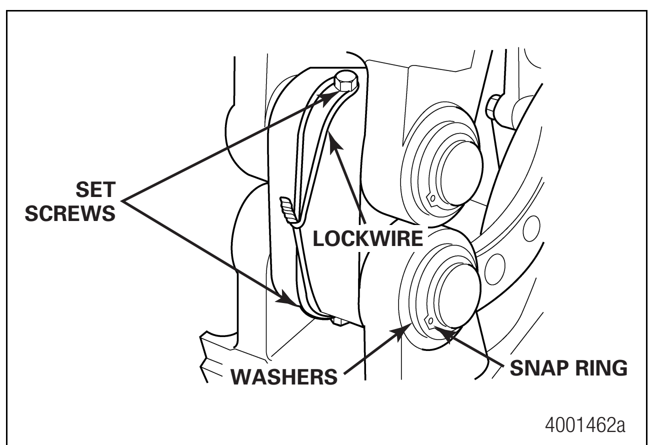


Figure 4.2

⚠ **WARNING**

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

3. Use a brass drift to remove the anchor pins. Figure 4.3.

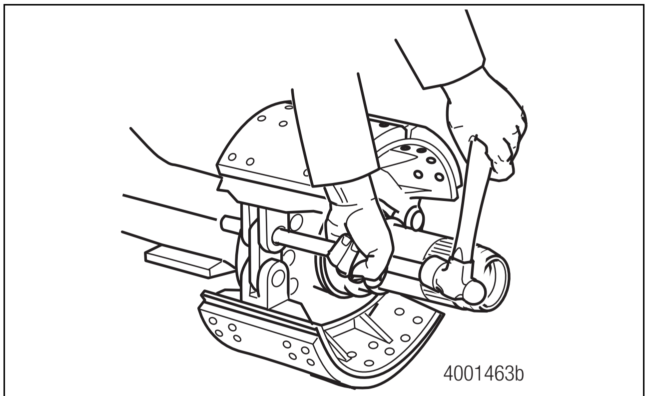


Figure 4.3

4. Remove the brake shoes. Figure 4.4. If necessary, remove the rollers. Figure 4.5.

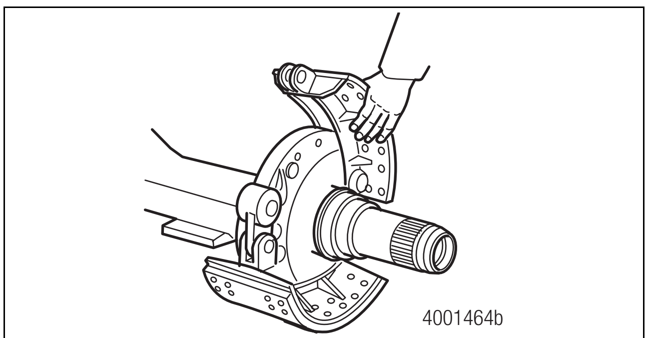


Figure 4.4

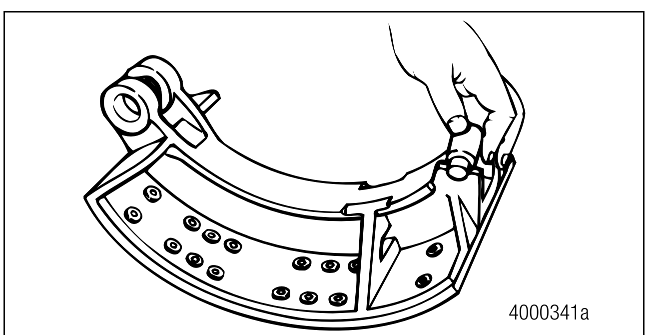


Figure 4.5

Automatic Slack Adjuster and Camshaft

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

To remove axle wheel-end components to access the camshaft for removal, refer to the appropriate maintenance manual. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

- Maintenance Manual 23, Bus and Coach Front Axles
- Maintenance Manual 23A, Bus and Coach Rear Axles
- Maintenance Manual 23D, Bus and Coach Inverted Portal Drive Axle
- Maintenance Manual 23E, Bus and Coach Planetary Drive Axle

Meritor recommends that you replace the camshaft bushings if the S-cam is replaced, if the radial movement exceeds 0.030-inch (0.762 mm), and at every brake shoe reline. Always replace the S-cam seals when you replace the S-cam bushings.

1. Move the camshaft as shown in Figure 4.6. Use a dial indicator to verify that the cam-to-bushing radial free play is within specification.
   - **If the radial free play movement exceeds 0.030-inch (0.76 mm):** Replace the bushings and seals.

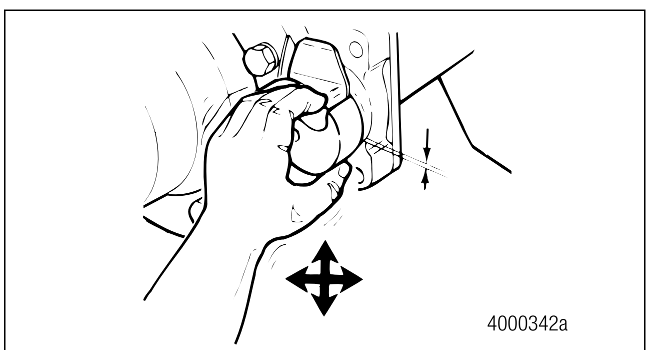


Figure 4.6

2. Remove the snap rings, washers and spacers from the camshaft.
3. Remove the two clevis pins from the clevis on the air chamber push rod. Remove the slack adjuster from the camshaft.

4. Remove the camshaft from the spider and bracket.
5. Use the correct size driver to remove the bushings from the spider and bracket.

Prepare Parts for Assembly

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Clean and Dry Parts

⚠ 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.**
- **You must 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

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.

Use soap and water to clean non-metal parts. Dry parts immediately after cleaning with soft, clean paper or cloth, or compressed air.

Corrosion Protection

1. If you assemble the parts immediately after you clean them, lubricate the parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them. Do not apply grease to the brake linings or the brake drums.
2. If you store the parts after you clean them, apply a corrosion-preventive material. Do not apply the material to the brake linings or the brake drums. Store the parts in a special paper or other material that prevents corrosion.

Inspect Parts

Meritor recommends that you replace the following parts at each reline.

- Brake Shoe Springs
- Clevis Pin Clips
- Rollers
- Camshaft Seals and Bushings
- Anchor Pins

1. Check the inside diameter of the anchor pin bushings. Figure 4.7. The inside diameter of the bushing must not exceed 1.259-inches (31.98 mm). Replace worn bushings.

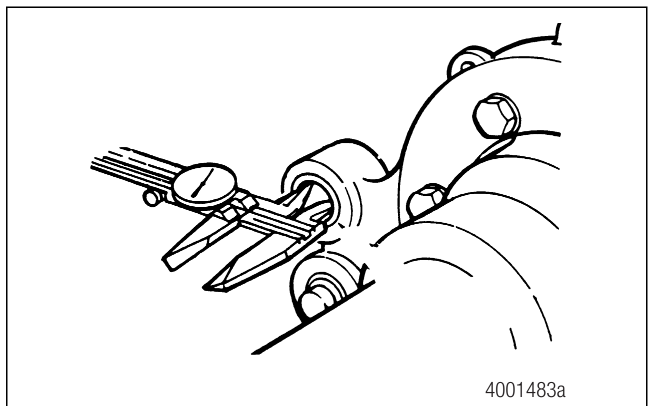


Figure 4.7

2. Check the spider for expanded anchor pin holes and for cracks. Replace damaged spiders. Tighten the spider mounting bolts to the vehicle manufacturer's specifications.
3. Check the camshaft bracket for broken welds, cracks and correct alignment. Replace damaged brackets.

4. Check the anchor pins for corrosion and wear. Replace worn or damaged anchor pins.
   - The anchor pin body diameter should be 1.246-1.252-inches (31.65-31.8 mm).
5. Check the brake shoe lining thickness at the thinnest spot. The minimum allowable lining thickness is 0.25-inch (6.35 mm). Discard and replace lining worn below this thickness.
6. Check the brake shoes for worn anchor pin holes, rust, expanded rivet holes, broken welds and correct alignment. The rivet holes must not exceed 0.257-0.263-inch (6.52-6.68 mm). Replace brake shoes as necessary.
7. The anchor pin holes must not exceed 1.009-inches (25.63 mm) in diameter. Replace any brake shoes that do not meet measurement specifications.
8. With the roller and anchor pin installed, measure the distance from the center of the anchor pin hole to the center of the roller slot. Figure 4.8. The distance must not exceed 12.75-inches (323.85 mm). Replace any brake shoes that do not meet measurement specifications.

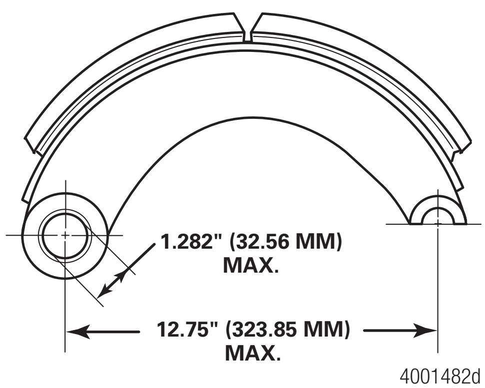


Figure 4.8

9. Check the camshaft for cracks, wear and corrosion. Check the cam head, bearing journals and splines. Replace worn or damaged camshafts.
10. Check the slack adjuster. Follow the vehicle manufacturer's recommendations. For Meritor slack adjusters, refer to Section 7 of this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

⚠ CAUTION

Always replace used clevis pin retainer clips with new ones when you service an automatic slack adjuster or chamber. Do not reuse retainer clips. Discard used clips. When you remove a retainer clip, it can bend or gap apart and lose retention. Damage to components can result.

11. If you remove cotter pins from a slack adjuster during maintenance and service procedures, Meritor recommends that you install new clevis pin retainer clips at assembly. Always replace used clevis pin retainer clips with new ones. Do not reuse clevis pin retainer clips. Discard used clips.
12. Inspect the large and small clevis pins for wear or damage. Replace worn or damaged parts.

⚠ WARNING

Do not operate the vehicle with the brake drum worn or machined beyond the discard dimension indicated on the drum. The brake system may not operate correctly. Damage to components and serious personal injury can result.

⚠ CAUTION

Replace the brake drum if it is out-of-round. Do not turn or rebore a brake drum, which decreases the strength and capacity of the drum. Damage to components can result.

13. Drums and shoes for Cast Plus™ brakes are also available in X, XX and XXX sizes. Refer to Technical Bulletin TP-0351, Lining Profile Change for Production Cast Plus™ Brake Service Kits, for information on servicing these drums and shoes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

    Use the following procedure to inspect the drum.

    A. Check the brake drum for cracks, severe heat checking, heat spotting, scoring, pitting and distortion. Replace the drum as required.

    B. Measure the inside diameter of the drum in several locations with a drum caliper or internal micrometer. Figure 4.9.

    - **If the diameter exceeds the specifications supplied by the drum manufacturer or is close enough that the drum will wear past the specification before the next inspection:** Replace the drum.

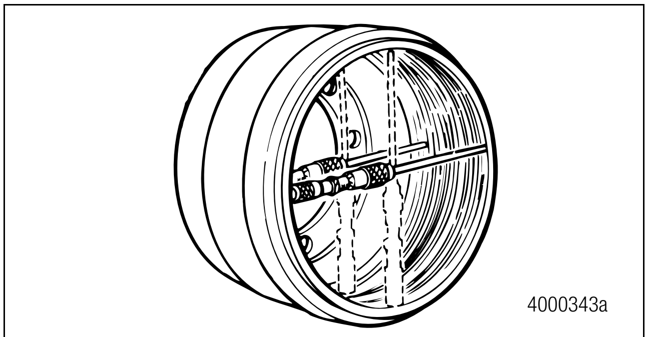


Figure 4.9

Installation

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

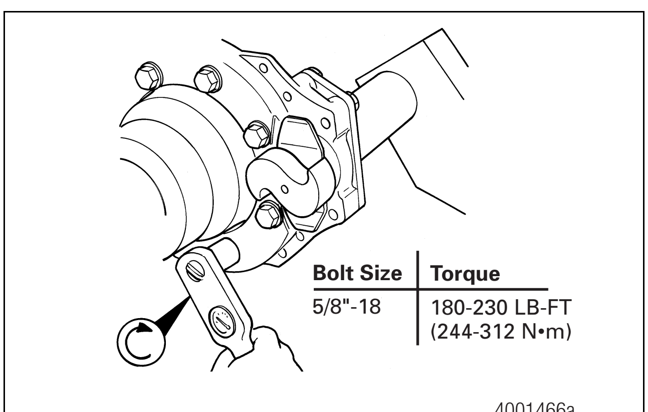
ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Camshaft

Meritor recommends that you replace the brake shoe springs, rollers, anchor pins, cam bushings and seals, and clevis pin clips at each reline.

1. Tighten all the spider bolts to the correct torque. Figure 4.10.



Bolt Size	Torque
5/8"-18	180-230 LB-FT (244-312 N•m)

Figure 4.10

2. If removed, use a seal driver to install the new camshaft seals and new bushings into the spider and camshaft bracket. Figure 4.11.

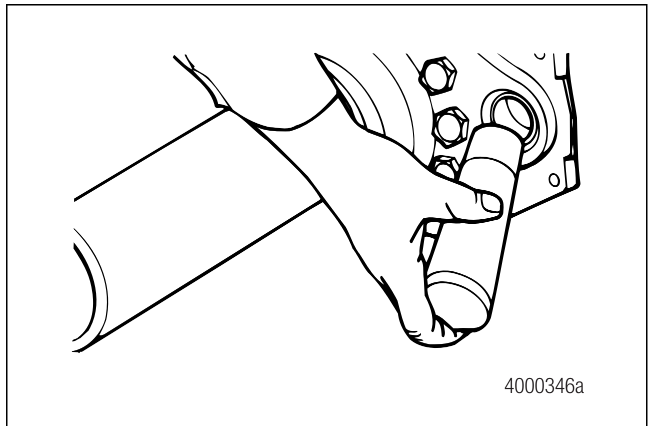


Figure 4.11

3. Install the seals with their lips toward the slack adjuster. Figure 4.12.

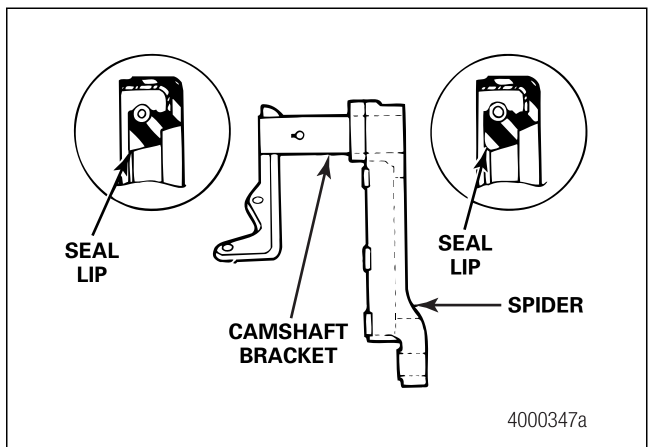


Figure 4.12

4. If the camshaft bracket was removed, install the gasket and bracket onto the spider. Tighten the capscrews to 44-55 lb-ft (60-75 N•m).

5. Place the cam head washer onto the camshaft. Apply Meritor specification O-617-A or O-617-B chassis grease to the camshaft bushings and journals. Install the camshaft through the spider and bracket. The camshaft should turn freely by hand. Figure 4.13.

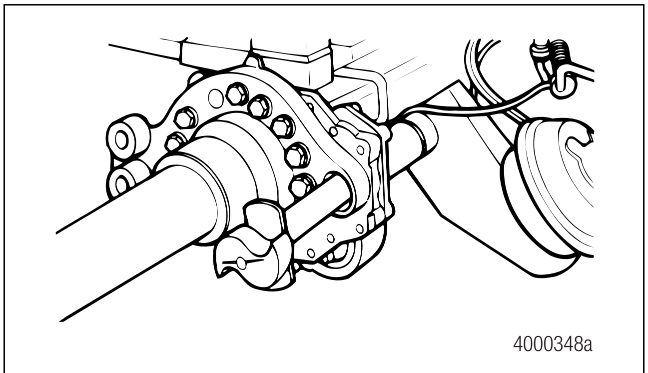


Figure 4.13

Brake Shoes, Rollers and Anchor Pins

Meritor recommends that you replace the brake shoe springs, rollers, anchor pins, cam bushings and seals, and clevis pin clips at each reline.

When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers. Figure 4.14 and Figure 4.15.

Do not allow grease to contact the area of the camshaft roller that touches the camshaft head.

Use Meritor specification O-617-A or O-617-B grease to lubricate the brake shoe rollers and Meritor specification O-637 anti-seize compound to lubricate the anchor pin. Figure 4.14.

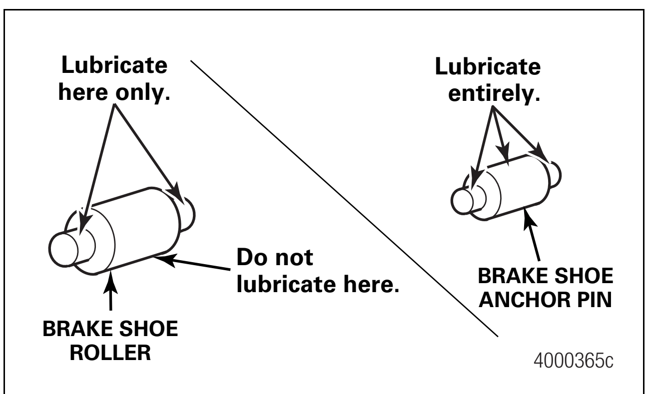


Figure 4.14

1. Install the anchor pin bushings. Align the holes in the bushings with the set screw holes in the spider.
2. Install the new brake shoe rollers. Place the brake shoes into position on the spider. Figure 4.15.

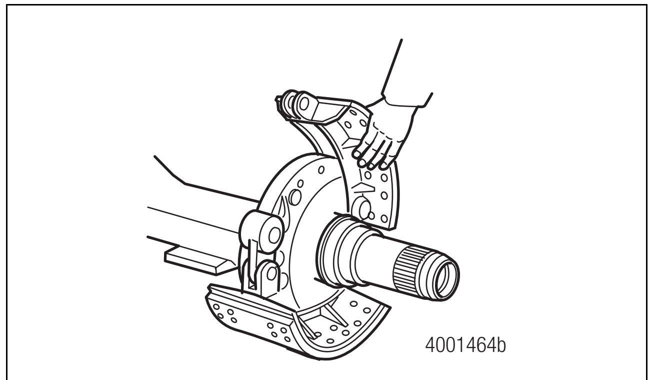


Figure 4.15

⚠ WARNING

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

3. Use a brass drift to install the anchor pins. Align the flat or groove on the pin with the holes in the spider and bushing.
4. Install the anchor pin washers, seals and snap rings.
5. Install the anchor pin set screws. Tighten the screws to 10-15 lb-ft (13.6-20.3 N•m).
6. Install a lock wire through both anchor pin set screws.

⚠ CAUTION

Do not overstress and deform the brake return spring when installing the brake shoes.

7. Use a brake spring tool to install the shoe return spring on the brake shoes. Figure 4.16.

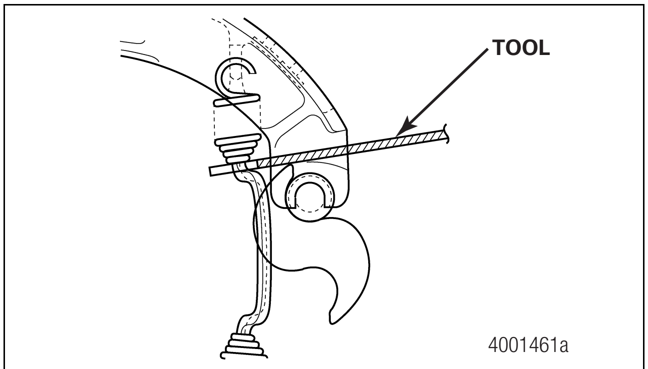


Figure 4.16

8. Use a lifting device to install the brake drum.

Automatic Slack Adjuster

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

For complete instructions on the Meritor automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the inside front cover of this manual.

Burnish the Brakes

1. Adjust the brake manually. Refer to Section 7.
2. While driving the vehicle at 20 mph (32 km/h), apply the brakes to reduce speed, approximately 10 feet (3.05 m) per second, to five mph (8 km/h). Perform this operation 10 times at regular intervals of 500 feet or 0.1 mile (150 m or 0.16 km) without stopping the vehicle.
3. After 10 brake applications, make one complete stop from 20 to 0 mph (32 to 0 km/h).
4. Check the drum temperatures immediately after burnishing. Any drums that are cooler, approximately 50°F (10°C) side-to-side, 100°F (38°C) front-to-rear, than the others indicate a possible lack of braking effort on those wheels.

   A temperature difference greater than stated above is a possible indication of brake imbalance. Check for correct brake assembly and automatic slack adjuster setup. Refer to the appropriate section of this manual. In addition, check the vehicle manufacturer's specifications for correct air system setup. After the imbalance is repaired, reburnish the brakes.
5. Allow the brakes to cool to the ambient temperature. Readjust all the brakes manually.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Removal

Wheel Components

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
3. Remove the wheel nuts, and tire and rim assemblies.

WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.
5. Release the automatic slack adjuster to retract the shoes so the drum can clear the lining. Refer to Section 7 for Meritor automatic slack adjusters. For non-Meritor automatic slack adjusters, refer to the slack adjuster manufacturer's instructions.

Automatic Slack Adjuster

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Brake Shoes

1. Place a pry bar between the bottom brake shoe and the cam. Push the shoe away from the cam and remove the brake shoe roller from the bottom shoe. Figure 5.1.

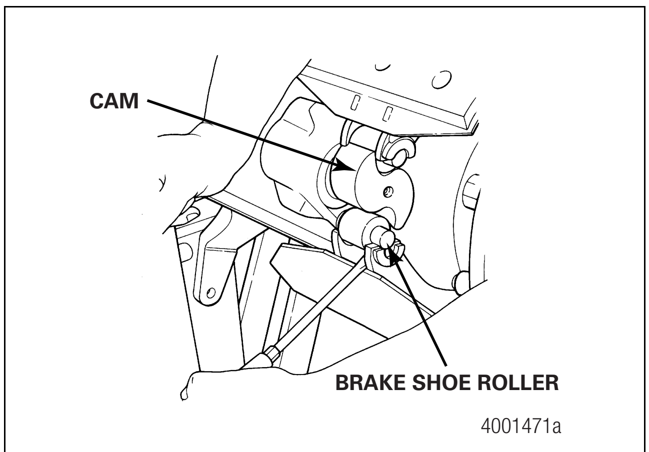


Figure 5.1

2. Place a pry bar between the top brake shoe and the cam. Push the shoe away from the cam and remove the brake shoe roller from the top shoe. Figure 5.1.
3. Mark each brake shoe so that the shoes can be installed in the same position if the same parts are used.

4. Remove the fasteners on the anchor pin. Use one of the following procedures that corresponds to the type of anchor pin and fastener used on the brake.

   A. **For a straight anchor pin with a strap**, remove the capscrew and washer that fasten the strap to the spider.

   B. Remove the strap. Figure 5.2.

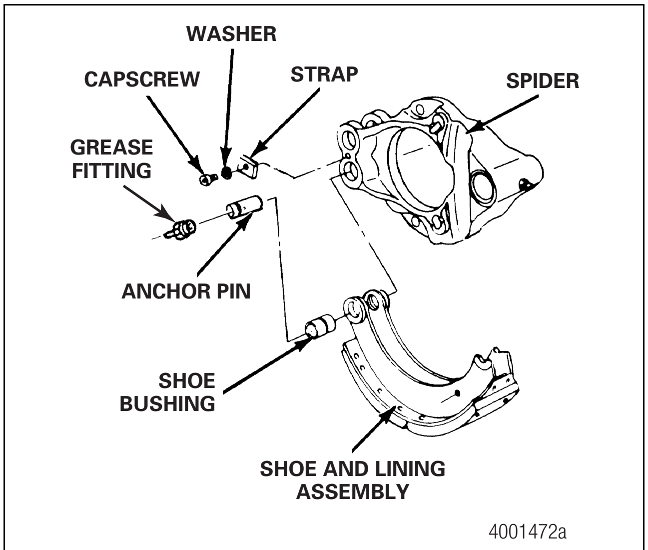


Figure 5.2

   A. **For a straight anchor pin with a lock ring and set screw**, remove the lock ring from the top of the anchor pin. Figure 5.3.

   B. Remove the set screw for the anchor pin from the side of the spider. Figure 5.3.

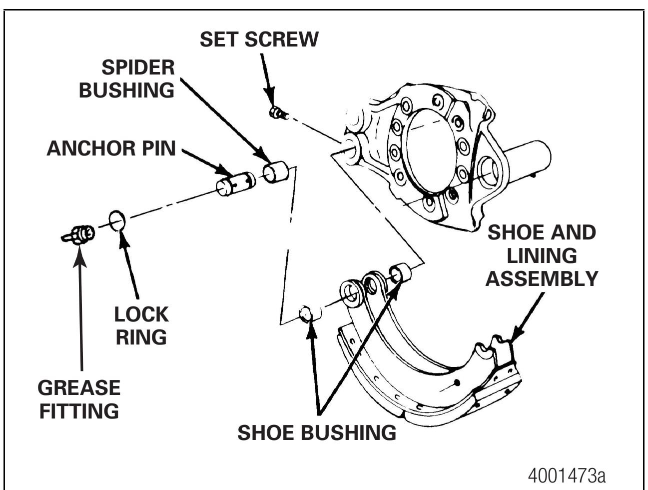


Figure 5.3

   A. **For a straight anchor pin with threads**, remove the grease fitting from the end of the anchor pin.

   B. From the inboard side of the spider, remove the nut and washer that hold the anchor pin in the spider. Figure 5.4.

   C. From the shoe side of the spider, remove the lock ring from the end of each anchor pin. Figure 5.4.

   D. Remove the strap from the anchor pins. Figure 5.4.

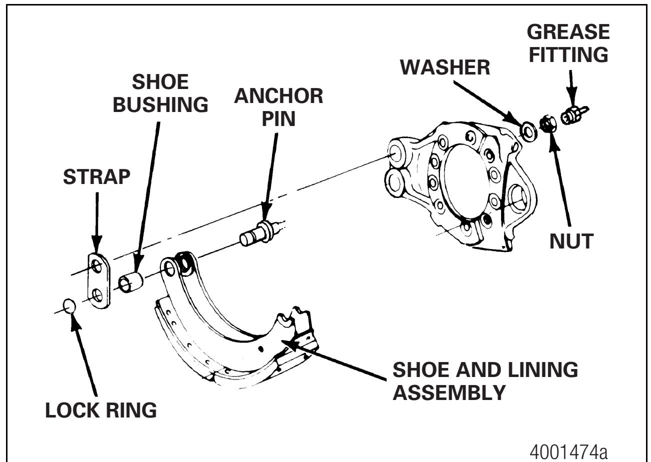


Figure 5.4

   A. **For a tapered anchor pin**, from the inboard side of the spider, remove the nut and washer that hold the anchor pin in the spider.

   B. From the shoe side of the spider, remove the nuts, lock washers if equipped, and dowels from the anchor pins. Figure 5.5.

   C. Remove the strap and washers, if equipped, from the anchor pins.

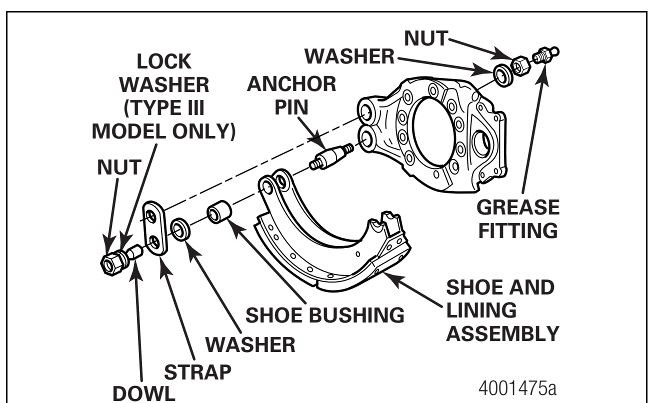


Figure 5.5

⚠ WARNING

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

5. From the inboard side of the spider, use a hammer and a brass drift to remove the anchor pin from the spider and the shoes. Figure 5.6.

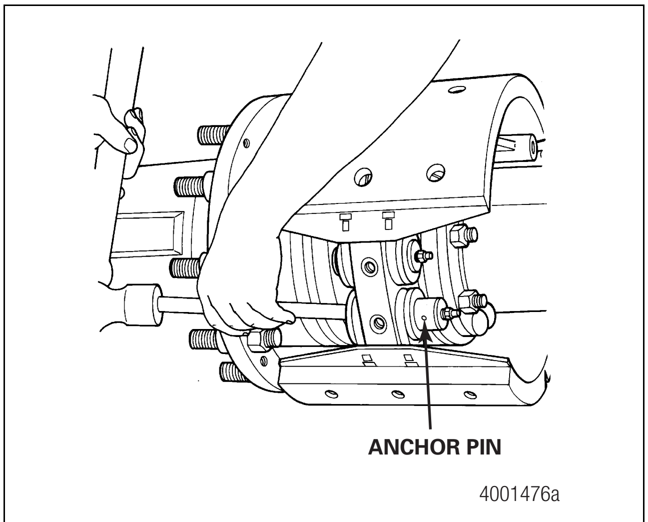


Figure 5.6

6. Remove the bushings from the anchor pins or the shoes.
7. Remove the brake shoe assemblies from the spider. Disconnect the spring from the shoes.

Slack Adjuster, Camshaft and Spider

For complete maintenance instructions on the Meritor automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

Meritor recommends that you replace the camshaft bushings if the S-cam is replaced, if the radial movement exceeds 0.030-inch (0.762 mm) and at every brake shoe reline. Always replace the S-cam seals when you replace the S-cam bushings.

1. Move the camshaft as shown in Figure 5.7. Use a dial indicator to verify that the cam-to-bushing radial free play is within specification.
   - **If the radial free play movement exceeds 0.030-inch (0.762 mm):** Replace the bushings and seals.

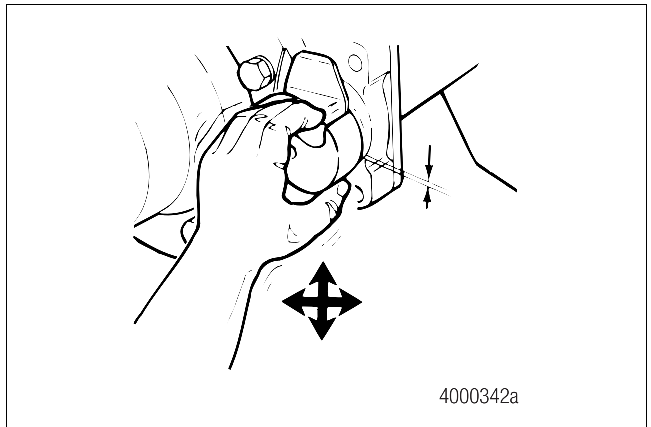


Figure 5.7

2. Disassemble the air chamber from the slack adjuster. Remove the slack adjuster from the camshaft.
3. Remove the lock ring or the capscrew and washer from the end of the camshaft.
4. Remove the spacer washers from the camshaft on the inboard side of the spider.
5. Remove the camshaft from the spider and bracket. Figure 5.8.

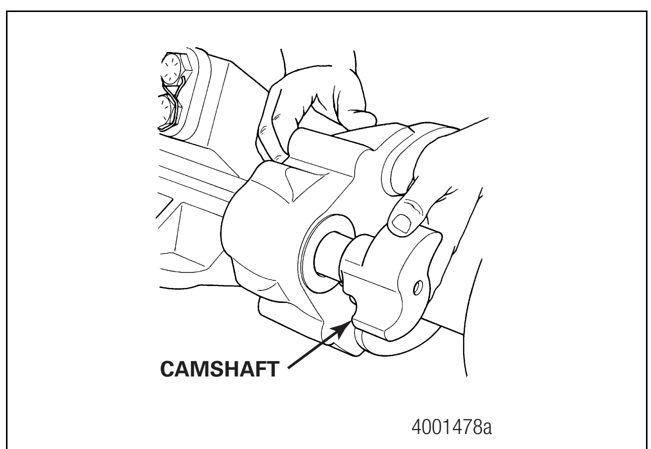


Figure 5.8

6. Remove the seals and the bushings. Use a mallet and the correct size driver to remove the bushings and seals from the spider and the bracket. On some brakes, a spacer is installed between the camshaft bushings. Meritor recommends that you replace the camshaft bushings and seals at each reline.
7. Remove the capscrews that fasten the bracket to the spider. Remove the bracket and the seal.
8. If the spider must be removed, mark the position of the spider on the axle flange. Remove the capscrews that fasten the spider to the axle flange. Remove the spider. Inspect the flange for damage.

Prepare Parts for Assembly

Clean and Dry Parts

⚠ 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.**
- **You must 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

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.

Use soap and water to clean non-metal parts. Dry parts immediately after cleaning with soft, clean paper or cloth, or compressed air.

Corrosion Protection

1. If you assemble parts immediately after you clean them, lubricate parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them. Do not apply grease to the brake linings or the brake drums.
2. If you store parts after you clean them, apply a corrosion-preventive material. Do not apply the material to the brake linings or the brake drums. Store parts in a special paper or other material that prevents corrosion.

Inspect Parts

Meritor recommends that you replace the following parts at each reline.

- Brake Shoe Springs
- Clevis Pin Clips
- Rollers
- Camshaft Seals and Bushings
- Anchor Pins

1. Check the brake lining. Figure 5.9. Brake lining thickness must be the same on both brake shoes and on both axle brakes.
    - **If the linings are worn to less than 0.3125-inch (7.9 mm) thick at the thinnest point:** Replace the lining on both brake shoes and both axle brakes. Refer to the vehicle manufacturer's recommendations for replacement linings.

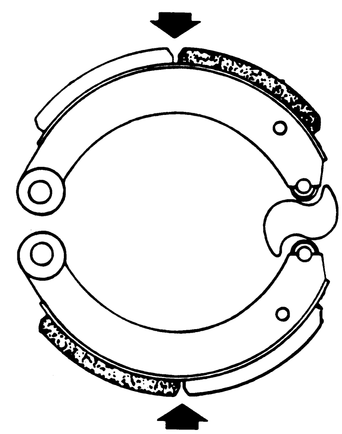


Figure 5.9

2. Check the brake shoes for excessive rust, expanded rivet holes, broken welds and correct alignment. The rivet holes must not exceed 0.39-0.40-inch (9.90-10.16 mm). Replace brake shoes as necessary.

3. The anchor pin holes must not exceed 1.282-inches (32.56 mm) in diameter. Figure 5.10.
4. With the roller and anchor pin installed, measure the distance from the center of the anchor pin hole to the center of the roller slot. Figure 5.10. The distance must not exceed 10.25-inches (260.35 mm). Replace any brake shoes that do not meet measurement specifications.
5. The distance between the webs of the shoe and the distance between the outside of the spacers at the anchor pin end must not exceed the specified dimension. Refer to Figure 5.11 and Table A for the specified distance on each end of the shoe. Replace shoes that exceed the distance.

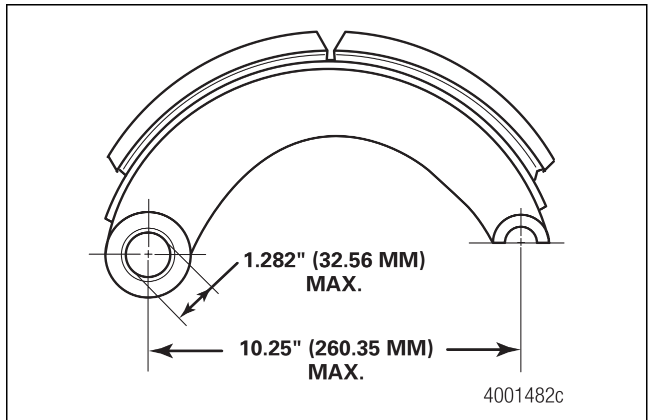


Figure 5.10

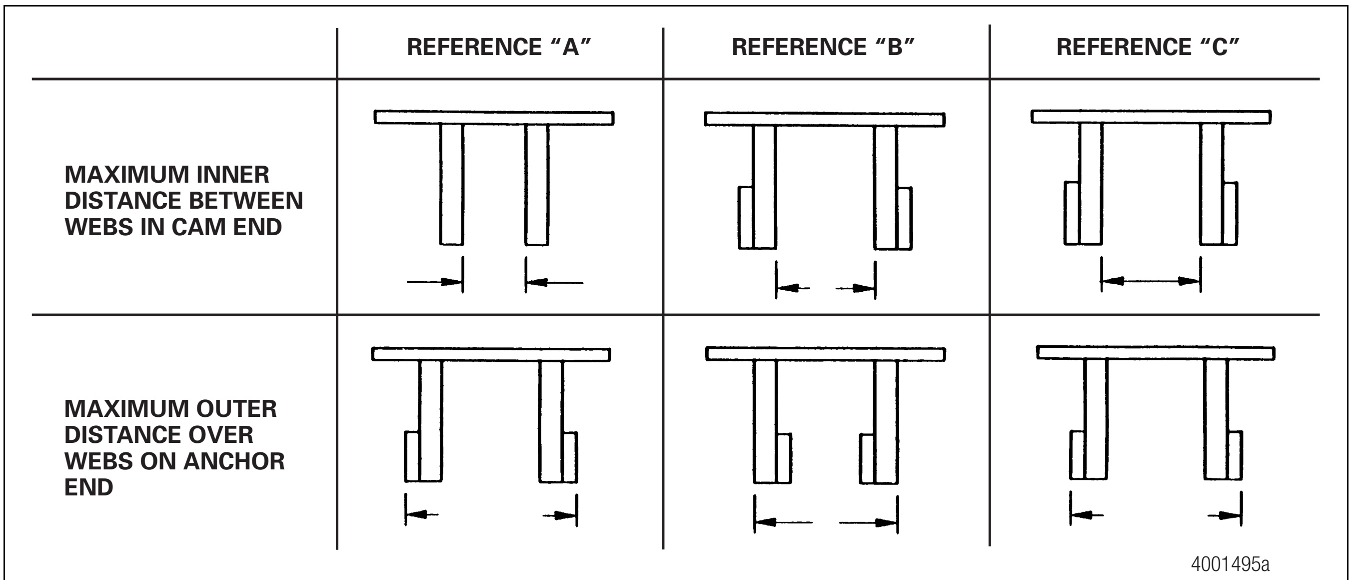


Figure 5.11

Table A: Maximum Inner and Outer Dimensions

Brake Size, Inch (mm)	Ref.	Maximum Inner Distance Between Webs on Cam End, Inch (mm)	Maximum Outer Distance Over Webs on Anchor End, Inch (mm)
14.5 x 4 (368 x 102)	A	0.855 (21.7)	1.970 (50)
14.5 x 5 (368 x 127)	A	0.855 (21.7)	1.970 (50)
14.5 x 6 (368 x 152)	A	0.855 (21.7)	1.970 (50)
14.5 x 8 (368 x 203)	B	1.355 (34.4)	1.994 (50.6)
14.5 x 10 (368 x 254) — Type I	B	1.395 (35.4)	2.167 (55)
14.5 x 10 (368 x 254) — Type III	B	1.395 (35.4)	2.167 (55)
14.5 x 10 (368 x 254) — Type II	C	1.520 (38.6)	2.914 (74)

6. The anchor pin diameter must be greater than 1.245-inches (31.62 mm).
7. Check the camshaft bracket for broken welds, cracks and correct alignment. Replace damaged brackets.
8. Check the camshaft for cracks, wear and corrosion. Check the cam head, bearing journal and splines. Replace damaged camshafts.
9. Determine if the camshaft bushings need replacement by using a dial indicator to check the radial movement of the camshaft. Figure 5.12.
   - **If the radial movement is more than 0.030-inch (0.76 mm):** Remove the camshaft. Replace the bushings and seals after the camshaft is removed.

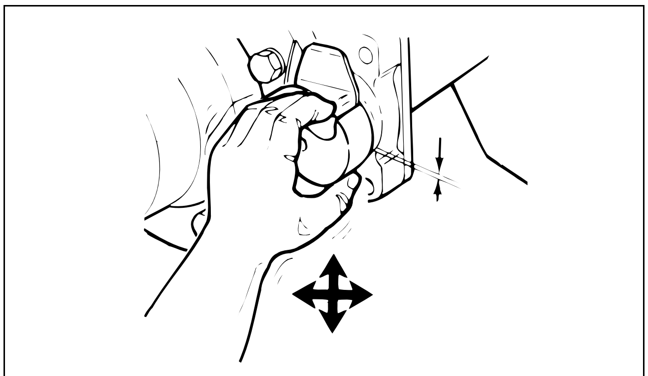


Figure 5.12

10. Check the camshaft seals for leakage. Replace damaged seals.
11. Check the spider for an expanded anchor pin hole and for cracks.
    A. Check the inside diameter of the anchor pin holes or the anchor pin bushings, if used.
       - On brake models without bushings, the diameter of the anchor pin holes must not exceed 1.252-inches (31.8 mm).
       - On brakes with anchor pin bushings, the inside diameter of the bushing must not exceed 1.023-inches (26 mm). Figure 5.13.

    B. Replace damaged or worn spiders, anchor pin bushings and anchor pins. Tighten the spider mounting bolts to the vehicle manufacturer's specifications.

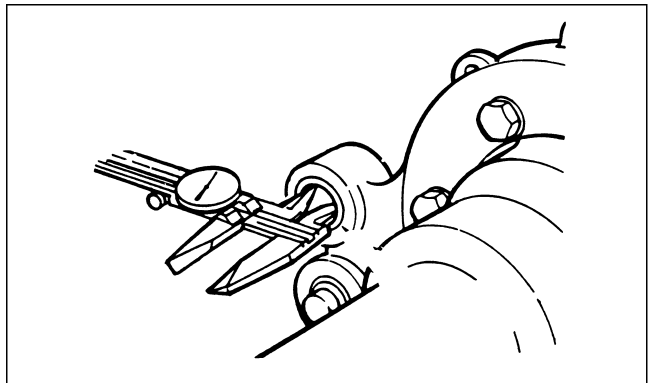


Figure 5.13

12. Check the slack adjuster. Follow the vehicle manufacturer's recommendations. For Meritor slack adjusters, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

⚠ WARNING

Do not operate the vehicle with the brake drum worn or machined beyond the discard dimension indicated on the drum. The brake system may not operate correctly. Damage to components and serious personal injury can result.

13. Drums and shoes for W Series brakes are also available in X, XX and XXX sizes. Refer to Parts Book PB-8857, Brake, Trailer Axle and Wheel Attaching Parts, for information on servicing these drums and shoes. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

    Check the brake drums.

    A. Check the drums for cracks, severe heat checking, heat spotting, scoring, pitting or distortion. Replace damaged drums.
    B. Measure the inside diameter of the drum in several locations with a drum caliper or inside micrometer. Figure 5.14.
       - **If the drum is out-of-round due to wear:** You can turn the drum if the diameter does not exceed the specifications.
       - **If the diameter exceeds the specifications supplied by the drum manufacturer or is close enough that the drum will wear past the specification before the next inspection:** Replace the drum.

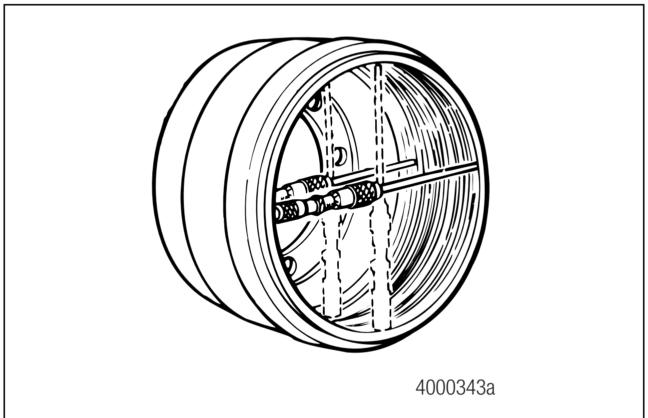
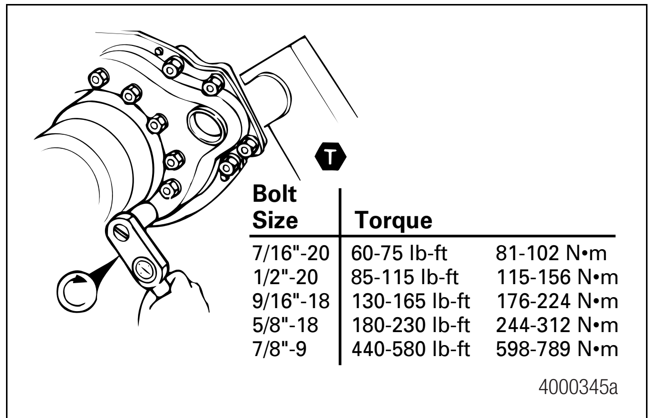


Figure 5.14



Bolt Size	Torque	
7/16"-20	60-75 lb-ft	81-102 N•m
1/2"-20	85-115 lb-ft	115-156 N•m
9/16"-18	130-165 lb-ft	176-224 N•m
5/8"-18	180-230 lb-ft	244-312 N•m
7/8"-9	440-580 lb-ft	598-789 N•m

Figure 5.15

14. Check the dust shields, if used, for rust and distortion. Repair or replace damaged shields as necessary.

Installation

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Camshaft Assembly

Some W Series brakes do not use a chamber bracket.

1. If removed, install the spider onto the axle housing flange. Align the marks you made on the spider and flange during removal. Install the spider-to-flange capscrews. Tighten the capscrews to the torque specified in Figure 5.15. T
2. If removed, install the seal and bracket onto the spider. Install the bracket fastener. Tighten the fastener to the torque specified in Figure 5.15. T
3. If the spider was not removed, check the torque of the spider-to-flange capscrews. Tighten the spider capscrews to the torque specified in Figure 5.15. T
4. If removed, install new bushings and seals into the spider and bracket.
   A. Lubricate the outside of the bushings and seals with Meritor specification O-617-A or O-617-B grease, or equivalent.
   B. Lubricate the bores in the spider and bracket with Meritor specification O-617-A or O-617-B grease, or equivalent.
   C. If used, install the bushing spacer into the bore.
   D. Place a bushing into the bore of the spider and bracket. Use the correct size driver to install the bushings into the bore. The bushings are correctly installed when the bottom of the bushing is even with the bottom of the seal bore. The bushing must not extend into the seal bore. Figure 5.16.

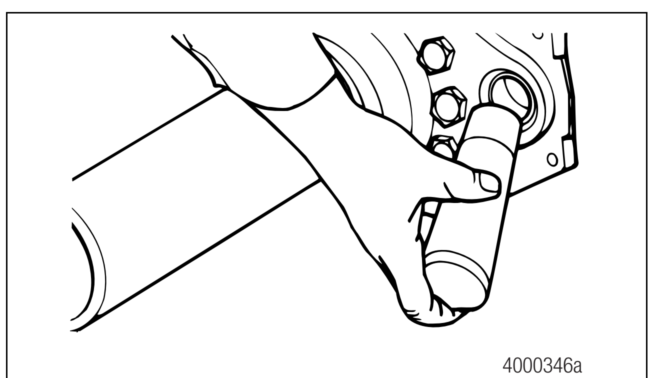


Figure 5.16

E. Place a seal into the bore of the spider and bracket. The lips of the seal must face the slack adjuster. Use the correct size driver to install the seals into the bore. The seal is correctly installed when the bottom of the seal touches the bottom of the bore. Figure 5.17.

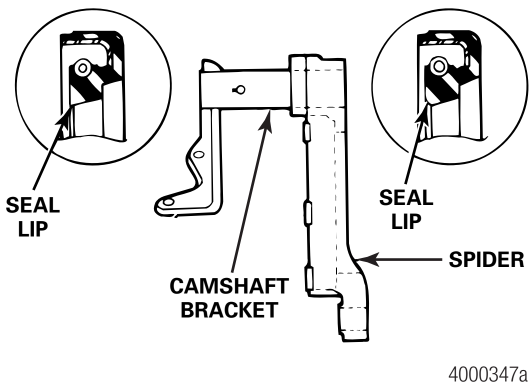


Figure 5.17

5. Place the cam head thrust washer onto the camshaft. Apply Meritor specification O-617-A or O-617-B grease to the camshaft bushings, camshaft journals and camshaft seal lips. Install the camshaft assembly through the spider and bracket. The camshaft should turn freely by hand. Figure 5.18.

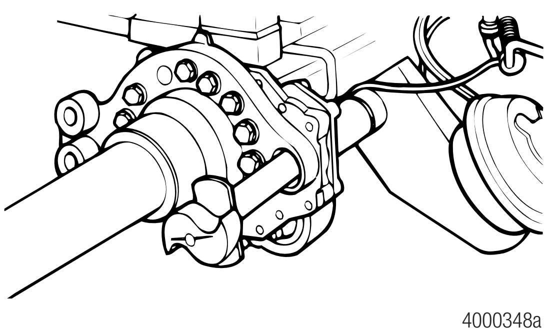


Figure 5.18

Lining with Bolts

1. Verify that the lining and shoe contact faces are clean.
2. Align the bolt holes in the lining with the bolt holes in the shoe.
3. Install the 0.375-inch diameter brass bolts into the bolt holes. The bolts must be the correct body diameter, head size and shape, and length and material. Follow the sequence shown in Figure 5.19 for 10-inch width brakes and Figure 5.20 for all other brake widths.
   - The maximum acceptable lining-to-shoe gap along the sides and ends of the assembly is 0.010-inch (0.25 mm). The maximum acceptable lining-to-shoe gap between webs is 0.025-inch (0.64 mm). Figure 5.21.
   - Use new lock washers.
   - Tighten the nuts to 18-23 lb-ft (24.8-31.6 N•m).

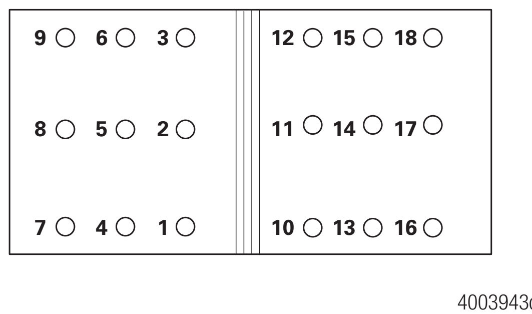


Figure 5.19

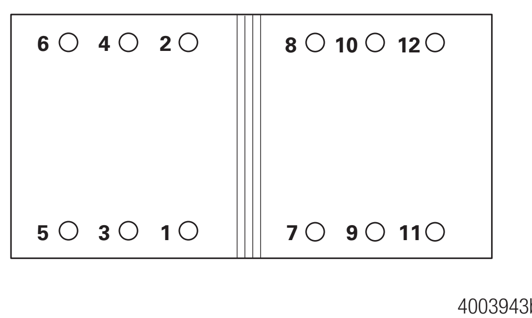


Figure 5.20

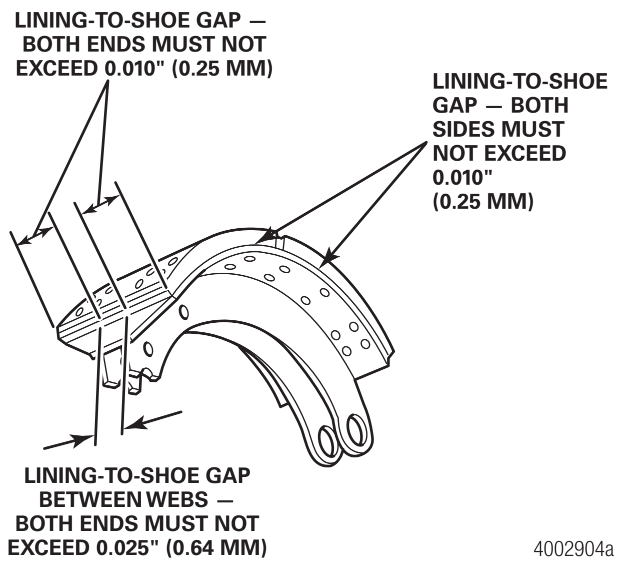


Figure 5.21

Brake Shoes

1. If removed, use a driver to install a new bushing into the brake shoe. The brake shoe may use a single or double bushing. When correctly installed, the top of the bushing is even with the outer surface of the shoe.
2. Connect the return spring to the brake shoes. Install the brake shoes onto the spider in the same position from which the shoes were removed. Figure 5.22.

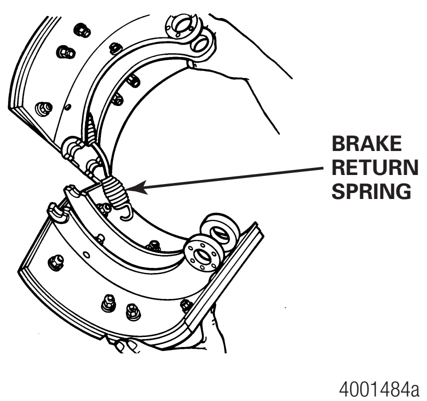


Figure 5.22

3. Lubricate the anchor pin and bushings with Meritor specification O-617-A or O-617-B grease, or equivalent.
4. Install the anchor pins through the brake shoes. Use one of the following procedures.

   A. **For a straight anchor pin with a strap**, place the anchor pin through the shoes and into the shoe side of the spider. The slot in the pin must be toward the bore for the strap fastener in the spider. Figure 5.23.

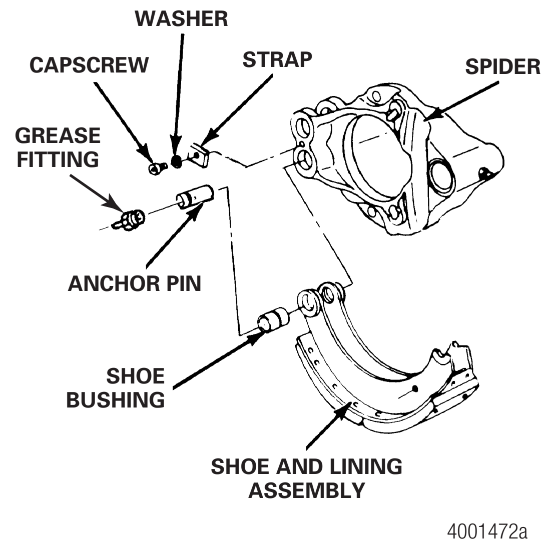


Figure 5.23

   B. Use a hammer and brass drift to install the anchor pin into the spider. The anchor pin is correctly installed when the bottom of the anchor pin is even with the end of the bore on the slack adjuster side of the spider.

   C. Install the strap into the slot on the anchor pin. Align the hole in the strap with the hole in the spider.

   D. Install the capscrew and washer that secure the strap to the spider. Tighten the capscrew to 15-20 lb-ft (20-27 N•m) for Grade 5, 22-28 lb-ft (30-38 N•m) for Grade 8.

   E. Install the grease fitting onto the outboard side of the anchor pin.

A. **For a straight anchor pin with a lock ring and set screw**, place the anchor pin through the shoes and into the shoe side of the spider. Align the hole in the pin with the set screw hole in the spider. Figure 5.24.

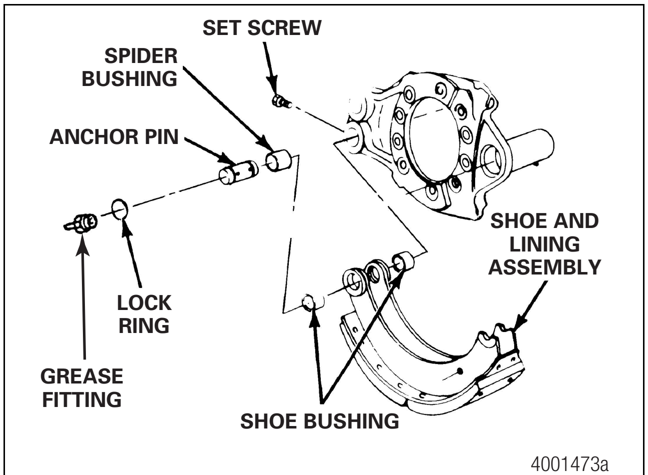


Figure 5.24

B. Install the anchor pin into the spider. Align the set screw hole in the spider with the anchor pin bore.

C. Install the set screw. Tighten the set screw to 10 lb-ft (14 N•m).

D. Install the lock ring onto each end of the anchor pin.

E. Install the grease fitting onto the outboard side of the anchor pin.

A. **For a straight anchor pin with threads**, place the anchor pin through the shoes and into the shoe side of the spider. The threads on the pin must be toward the slack adjuster. Figure 5.25.

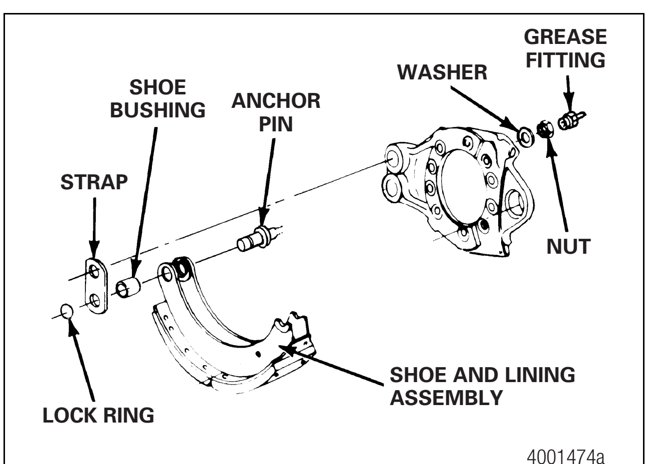


Figure 5.25

B. Use a hammer and brass drift to install the anchor pin into the spider. The anchor pin is correctly installed when the bottom of the anchor pin is even with the outer surface on the slack adjuster side of the spider.

C. Install the strap over both anchor pins.

D. Install the lock rings onto the anchor pins.

E. Install the grease fitting onto the slack adjuster side of the anchor pin.

A. **For a tapered anchor pin**, place the anchor pin through the shoes and into the shoe side of the spider. The tapered side of the pin must be toward the spider. Figure 5.26.

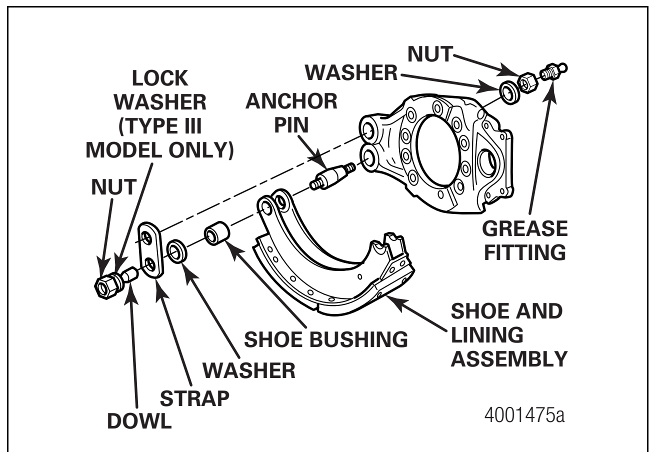


Figure 5.26

B. Use a hammer and brass drift to install the anchor pin into the spider. The taper on the pin must touch the bore.

C. Install one washer from shim pack S-1229-C-1563 onto each anchor pin. The required gap between the brake shoes and the strap is 0.030-0.060-inch (0.762-1.524 mm).

D. Install the strap over both pins on the shoe side of the spider.

E. Install the dowel over the pin threads on the shoe side of the spider.

F. Install the lock washer onto the pin.

G. Install the nut onto the pin. Tighten the nut to 210-270 lb-ft (286-367 N•m).

H. Check the gap between the brake shoes and strap. Figure 5.27.

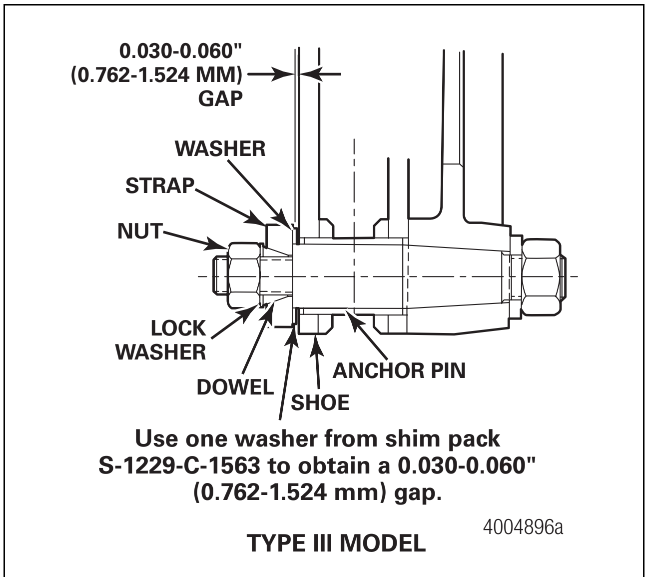


Figure 5.27

- **If the gap is not within 0.030-0.060-inch (0.762-1.524 mm):** Remove the nut, lock washer, dowel, strap and washer. Install a different size washer from shim pack S-1229-C-1563 to achieve the correct specification.

I. Install the washer and nut onto the anchor pin threads on the slack adjuster side of the spider. Tighten the nut to 150-180 lb-ft (203-244 N•m).

J. Install the grease fitting onto the slack adjuster side of the anchor pin.

5. Lubricate the shoe rollers with Meritor specification O-617-A or O-617-B grease, or equivalent. Lubricate the rollers where the parts touch the brake shoes. Do not allow grease to contact the area of the shoe roller that touches the camshaft head.

6. Place a pry bar between the shoe and the cam. Lift up the shoe. Install the shoe rollers onto the camshaft end of the shoes. The rollers must touch the ends of the shoes and camshaft. Figure 5.28.

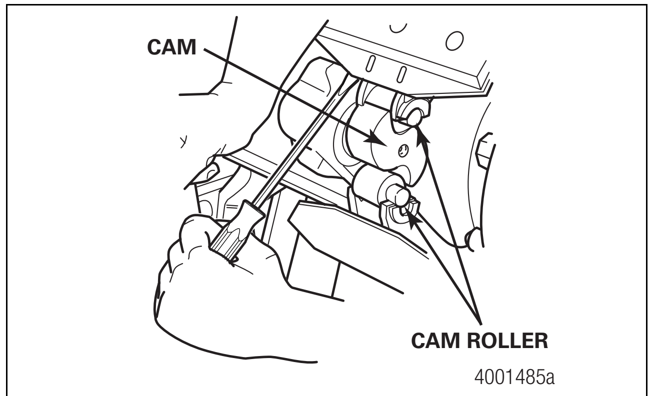


Figure 5.28

Slack Adjusters

If the slack adjuster is not a Meritor automatic slack adjuster, refer to the manufacturer's literature for the correct service procedures.

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Section 7 in this manual and Maintenance Manual 4, Cam Brakes and Automatic Slack Adjuster. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Burnish the Brakes

1. Adjust the brake manually. Refer to Section 7.
2. While driving the vehicle at 20 mph (32 km/h), apply the brakes to reduce speed, approximately 10 feet (3.05 m) per second, to five mph (8 km/h). Perform this operation 10 times at regular intervals of 500 feet or 0.1 mile (150 m or 0.16 km) without stopping the vehicle.
3. After 10 brake applications, make one complete stop from 20 to 0 mph (32 to 0 km/h).
4. Check the drum temperatures immediately after burnishing. Any drums that are cooler, approximately 50°F (10°C) side-to-side, 100°F (38°C) front-to-rear, than the others indicate a possible lack of braking effort on those wheels. Repeat the burnishing.

   A temperature difference greater than stated above is a possible indication of brake imbalance. Check for correct brake assembly and automatic slack adjuster setup. Refer to the appropriate section of this manual. In addition, check the vehicle manufacturer's specifications for correct air system setup. After the imbalance is repaired, reburnish the brakes.
5. Allow the brakes to cool to the ambient temperature. Readjust all the brakes manually.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Installation

Combination Friction Linings

Combination friction linings with different friction ratings on the primary and secondary shoes are frequently used. When you use combination friction linings, you must install the lining blocks to the correct locations on the brake shoes.

Always reline both wheels of a single axle and all four wheels of a tandem axle at the same time. Always install the same linings and drums onto both wheels of a single axle and all four wheels of a tandem axle. It is not necessary that the front and rear axles have the same linings and drums.

Determine the Location of the Primary and Secondary Brake Shoes

If the orientation of the brake shown does not match the brake you are servicing, rotate the figure to the correct orientation and wheel rotation.

The first brake shoe past the cam in the direction of the wheel rotation is the primary shoe. Figure 6.1. The primary shoe can be either at the TOP or BOTTOM position, depending on the location of the cam.

- **If the cam is BEHIND the axle:** The TOP shoe is the primary shoe.
- **If the cam is in FRONT of the axle:** The BOTTOM shoe is the primary shoe.

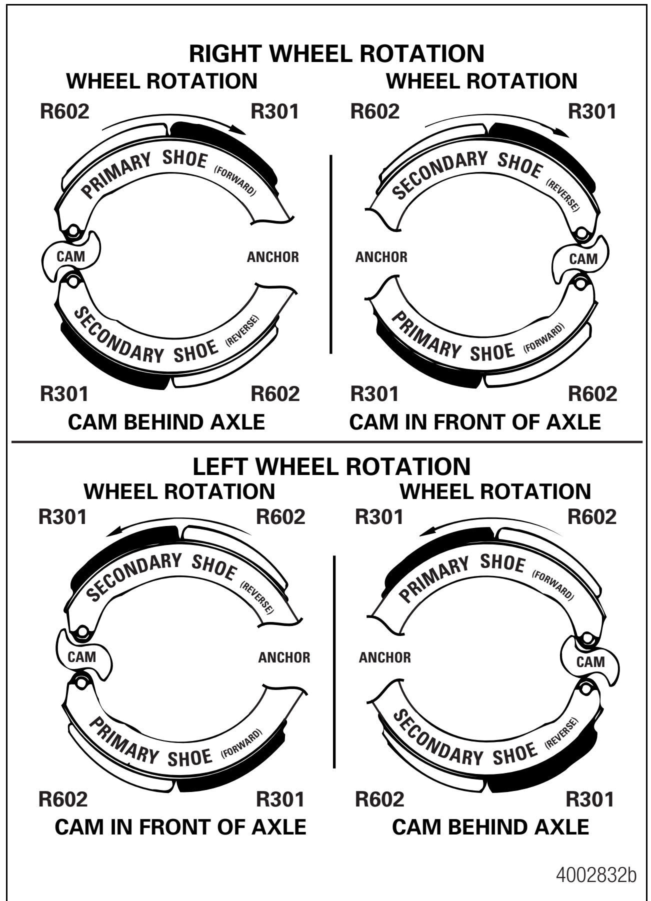


Figure 6.1

Install the Linings, Mount the Brake Shoes onto the Vehicle and Adjust the Brakes

To maintain uniform lining wear at each wheel end, Meritor recommends that you install matching lining sets onto both wheels of a single axle and all four wheels of a tandem axle.

1. Install the R301 linings onto the primary and secondary brake shoes.
2. Install the R602 linings onto the primary and secondary brake shoes.
3. Mount the brake shoes onto the vehicle.
4. Adjust the brakes. Refer to Section 7.

Hazard Alert Messages

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Overview

As of January 1993, some parts of the Meritor automatic slack adjuster are no longer serviceable and are not interchangeable with parts from earlier models.

Handed and Unhanded Slack Adjusters

There are two automatic slack adjuster designs: handed and unhanded. For most applications, install a handed automatic slack adjuster so that the pawl faces inboard on the vehicle.

The pawl can be on either side or on the front of the slack adjuster housing. Figure 7.1.

Pull Pawls

Pull pawls are spring-loaded. Pry the pull pawl at least 0.03-inch (0.78 mm) to disengage the teeth. Figure 7.1. When you remove the pry bar, the pull pawl will re-engage automatically.

Replace Conventional Pawls with Pull Pawls

When you service an automatic slack adjuster, replace a conventional pawl with a pull pawl. Figure 7.1. Install the slack adjuster so that you can remove the conventional pawl or disengage the pull pawl when you adjust the brake.

Clevis Types and Thread Sizes

Meritor's automatic slack adjusters and clevises are designed to be used as a system. Always replace original components with genuine Meritor replacement parts. Although parts from other manufacturers can look the same, significant differences can exist that can affect the brake system performance.

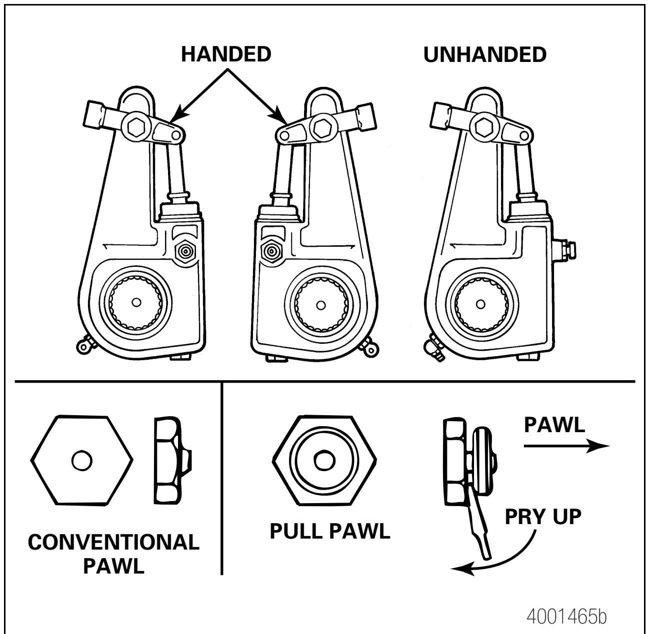


Figure 7.1

Removal

Automatic Slack Adjuster from the Camshaft

WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. If the brake has a spring brake, compress and lock the spring, so that the brake is released completely. Check that no air pressure remains in the service half of the air chamber.
3. If it is necessary to raise the vehicle, use a jack and support the vehicle with safety stands.

WARNING

When you remove a clevis pin that has a spring, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause serious personal injury.

4. Remove both clevis pins.
5. Remove a conventional pawl or disengage a pull pawl. Use a screwdriver or equivalent tool to lift the button of a pull pawl assembly at least 0.03125-inch (0.79375 mm) from the actuator.

CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

6. Use a wrench to turn the manual adjusting nut in the direction shown in Figure 7.2. Move the slack adjuster away from the clevis.

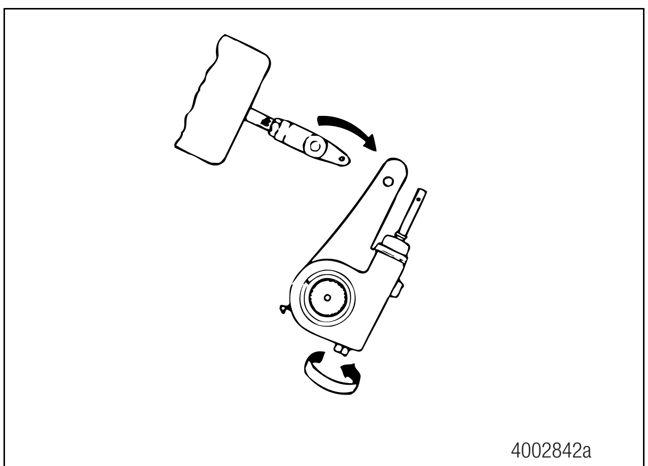


Figure 7.2

7. Remove the snap ring and washers from the camshaft. Remove the slack adjuster from the camshaft.

Installation

Automatic Slack Adjuster onto the Camshaft

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Check the camshaft, bushings and seals for wear and corrosion. Turn the camshaft by hand to check for smooth operation. Repair or replace parts as required.
3. Apply the service brake and spring brake several times. Check that the chamber return spring retracts the push rod quickly and completely. If necessary, replace the return spring or the air chamber.
4. Verify that the new automatic slack adjuster is the same length as the one you are replacing. Refer to Table B.

Table B: Chamber and Automatic Slack Adjuster Sizes

Length of Slack Adjuster (Inches)	Size of Chamber (Square Inches)
5	9, 12, 16, 20, 24, 30[1]
5-1/2	9, 12, 16, 20, 24, 30, 36[1]
6	24, 30, 36
6-1/2	30, 36

[1] Use an auxiliary spring on slack adjusters used with size 9 and 12 chambers. A size 9 or 12 chamber return spring cannot supply enough spring tension to completely retract the slack adjuster.

WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

5. If the vehicle has spring brakes, follow the chamber manufacturer's instructions to compress and lock the springs to completely release the brakes. Verify that no air pressure remains in the service chambers.

⚠ CAUTION

Most Meritor automatic slack adjusters manufactured after January 1990 have lubrication holes in the gear splines. Do not operate the actuator rod before you install the slack adjuster. Lubricant can pump through the holes and onto the splines. Damage to components can result.

6. Apply Meritor specification O-637, part number 2297-U-4571, anti-seize compound, or equivalent, to the slack adjuster and cam splines.
7. Install the slack adjuster onto the camshaft. Position the slack adjuster so that you can remove a conventional pawl or disengage a pull pawl when you adjust the brake.
8. Verify that the camshaft axial end play is 0.005-0.060-inch (0.127-1.52 mm).
   - **If the axial end play exceeds 0.060-inch (1.52 mm):** Remove the snap ring. Add an appropriate number of spacing washers to achieve the correct specification.
9. Install the clevis onto the push rod. Do not tighten the jam nut against the clevis.

⚠ CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

10. Disengage the pull pawl or remove a conventional pawl. Turn the manual adjusting nut to align the holes in the slack adjuster arm and clevis. Figure 7.3.
    - **If the slack adjuster has a welded clevis:** Apply anti-seize compound to the two clevis pins. Install the clevis pins through the clevis and the slack adjuster.
    - **If the slack adjuster has a threaded clevis:** Refer to the threaded clevis installation procedure in this section.

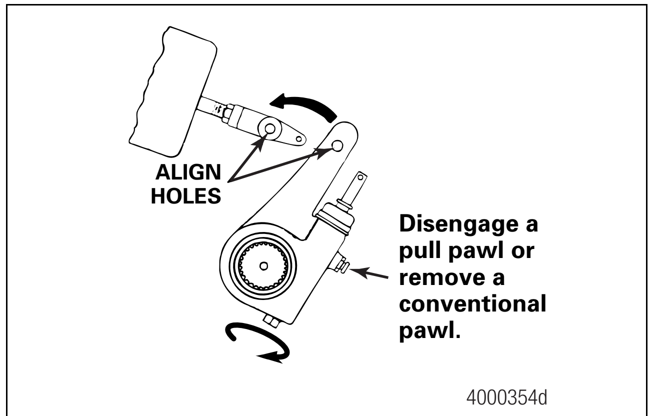


Figure 7.3

⚠ CAUTION

Always replace used clevis pin retainer clips with new ones when you service an automatic slack adjuster or chamber. Do not reuse retainer clips. Discard used clips. When you remove a retainer clip, it can bend or "gap apart" and lose retention. Damage to components can result.

11. Install new clevis pin retainer clips to secure the clevis pins. Figure 7.4.

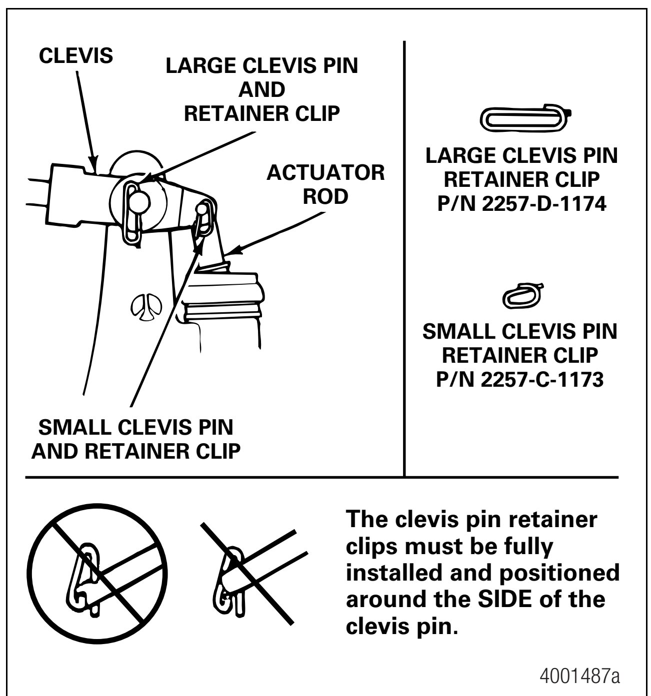


Figure 7.4

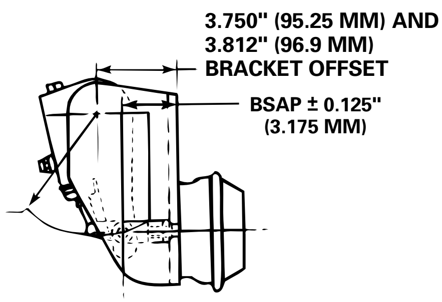
Check the Brake Chamber Push Rod Stroke and Adjust the Clevis Position

There are two methods you can use to adjust the clevis position on a chamber push rod that is equipped with a threaded clevis.

- The brake slack adjuster position (BSAP) method for standard and long stroke chambers.
- The Meritor automatic slack adjuster template method for standard stroke chambers only.

Brake Slack Adjuster Position (BSAP) Method

When you install the slack adjuster, verify that the BSAP chamber dimension matches the table in Figure 7.5.



Slack Length	BSAP
5.00" (127.0 mm)	2.75" (69.85 mm)
5.50" (139.7 mm)	2.75" (69.85 mm)
6.00" (152.4 mm)	2.75" (69.85 mm)
6.50" (165.1 mm)	2.62" (66.55 mm)

Correct positions of the slack adjuster are 3.750-inch (95.25 mm) and 3.812-inch (96.82 mm) offsets only. For other bracket offsets, refer to the vehicle manufacturer's specifications.

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Figure 7.5

Automatic Slack Adjuster Templates

⚠ CAUTION

There are five different installation templates for Meritor automatic slack adjusters. The templates are not interchangeable. You must use the correct template and you must adjust the clevis position as described below. If you use the wrong template and install the clevis in the wrong position, the slack adjuster will not adjust the brake correctly. If the slack adjuster under-adjusts, then stopping distances are increased. If the slack adjuster over-adjusts, then the linings may drag and damage the brake.

To obtain the correct automatic slack adjuster template, refer to the Service Notes page on the front inside cover of this manual. Figure 7.6.

Color of Template	Part Number	Use to Install Slack Adjusters On
Dark brown	TP-4786	Truck or tractor drum brake
Tan	TP-4787	Trailer drum brake
White	TP-4781	Coach drum brake
Green	TP-4788	Disc brake with offset clevis
Yellow	TP-4789	Disc brake with straight clevis

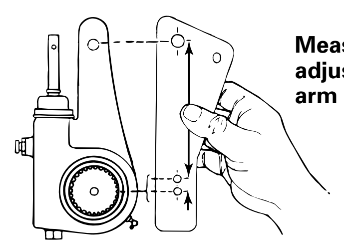

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Figure 7.6

Measure the Slack Adjuster

For long stroke chambers, use the BSAP method to measure the automatic slack adjuster.

Use the correct Meritor automatic slack adjuster template to measure the length of the slack adjuster. The marks by the holes in the small end of the template indicate the length of the slack adjuster. Figure 7.6.

Install a Threaded Clevis

1. Install the large clevis pin through the large holes in the template and the clevis.
2. Select the hole in the template that matches the length of the slack adjuster. Hold that hole on the center of the camshaft.
3. Look through the slot in the template to see if the small clevis hole completely aligns within the slot.
   - **If the small clevis hole doesn't align within the slot:** Adjust the clevis until you can see the small clevis pin hole within the slot. Figure 7.7.

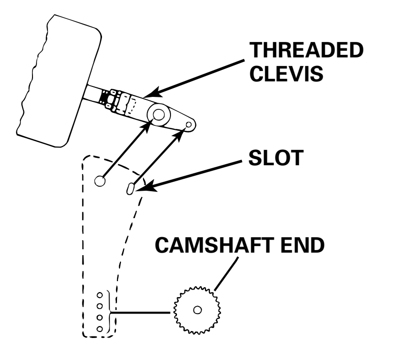


Figure 7.7

4. Verify that the thread engagement between the clevis and push rod is 0.5-0.625-inch (12.7-15.9 mm). Figure 7.8.

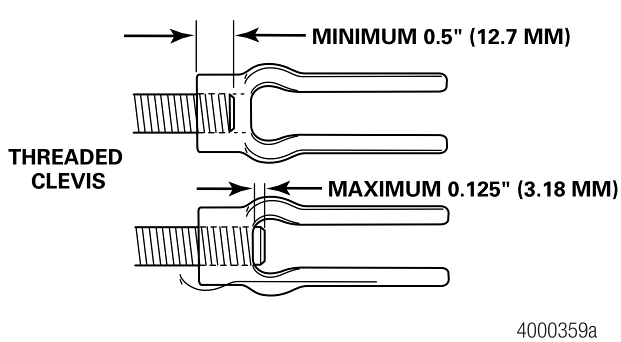


Figure 7.8

5. Verify that the push rod does not extend through the clevis more than 0.125-inch (3.18 mm).
   - **If the push rod extends through the clevis more than 0.125-inch (3.18 mm):** Cut the push rod or install a new air chamber and push rod.
6. Tighten the jam nut against the clevis to the torque specification in Table C.

Table C: Jam Nut Torque Specifications

Threads	Torque
1/2-20	20-30 lb-ft (27-41 N•m)
5/8-18	35-50 lb-ft (48-68 N•m)

Measure the Free Stroke

⚠ CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

During preventive maintenance on an in-service brake, check both the free stroke as described below and the adjusted chamber stroke. Refer to the procedure in this section.

On some applications, you may find the in-service free stroke to be slightly longer than specified below. This is acceptable if the adjusted chamber stroke is within the limits shown in the Commercial Vehicle Safety Alliance (CVSA) table in this section.

1. Disengage a pull pawl. Use a screwdriver or equivalent tool to pry the pull pawl at least 1/32-inch (0.8 mm) to disengage the teeth.
   - **If the slack adjuster has a conventional pawl:** Remove the pawl.
2. Use a wrench to turn the manual adjusting nut COUNTERCLOCKWISE until the brake linings contact the drum. Figure 7.9. Then back-off the adjusting nut 1/2 turn in the opposite direction.

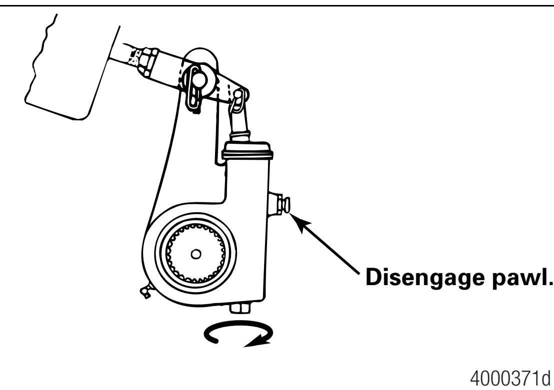


Figure 7.9

3. Measure the distance from the center of the large clevis pin to the bottom of the air chamber while the brake is released. The measurement you obtain is X in Figure 7.10.

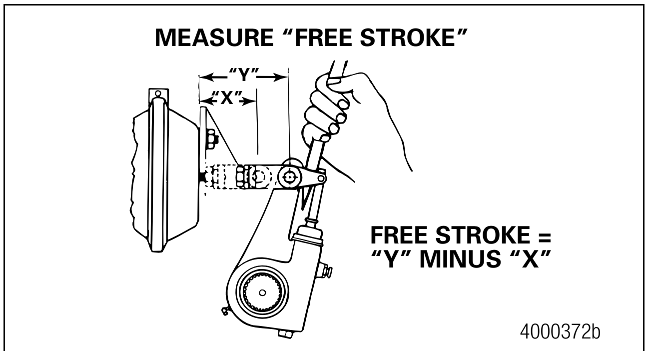


Figure 7.10

4. Use a pry bar to move the slack adjuster and position the linings against the drum with the brakes applied. Measure the same distance again while the brakes are applied. The measurement you obtain is Y in Figure 7.10.

⚠ CAUTION

Do not set the free stroke shorter than the specification. If the measurement is too short, the linings can drag. Damage to components can result.

5. Subtract X from Y to obtain the in-service free stroke. The measurement must be 0.5-0.625-inch (12.7-15.9 mm). Figure 7.10.
   - **If the free stroke measurement is not within specification:** Turn the adjusting nut COUNTERCLOCKWISE 1/8 turn to adjust the free stroke. Figure 7.11. Follow the steps above to check the free stroke again, until the measurement is within specification.

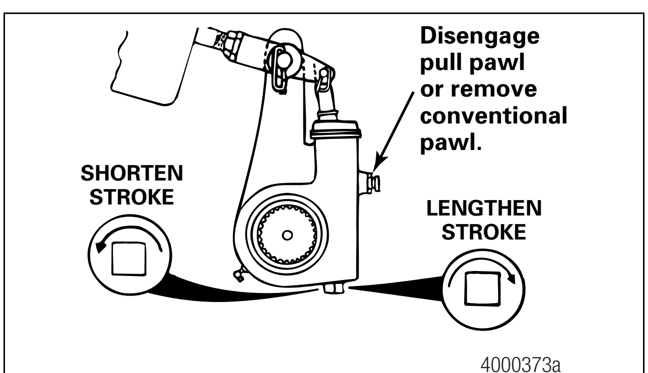


Figure 7.11

6. Re-engage the pull pawl by removing the screwdriver or equivalent tool. The pull pawl will re-engage automatically.
   - **If the slack adjuster has a conventional pawl:** Install the pawl assembly into the housing. Tighten the capscrew to 12-17 lb-ft (16-23 N•m). ⓣ

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

7. If the brakes have spring chambers, carefully release the springs. Test the vehicle before you return it to service.

Commercial Vehicle Safety Alliance (CVSA) Guidelines to Measure the Push Rod Travel or Adjusted Chamber Stroke

Use the following procedure to check the in-service push rod travel or adjusted chamber stroke on truck and tractor brakes with automatic slack adjusters.

Hold the ruler parallel to the push rod and measure as carefully as possible. A measurement error can affect CVSA re-adjustment limits. CVSA states that "any brake 1/4-inch or more past the re-adjustment limit, or any two brakes less than 1/4-inch beyond the re-adjustment limit, will be cause for rejection."

⚠ WARNING

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

1. The engine must be OFF. If the brake has a spring chamber, follow the manufacturer's instructions to release the spring. Verify that no air pressure remains in the service section of the chamber.
2. Verify that the pressure is between 90 and 100 psi (620-690 kPa) in the air tanks. Determine the size and type of brake chambers on the vehicle.

3. With the brakes released, mark the push rod where it exits the chamber. Measure and record the distance. Have another person apply and hold the brakes on full application. Figure 7.12.

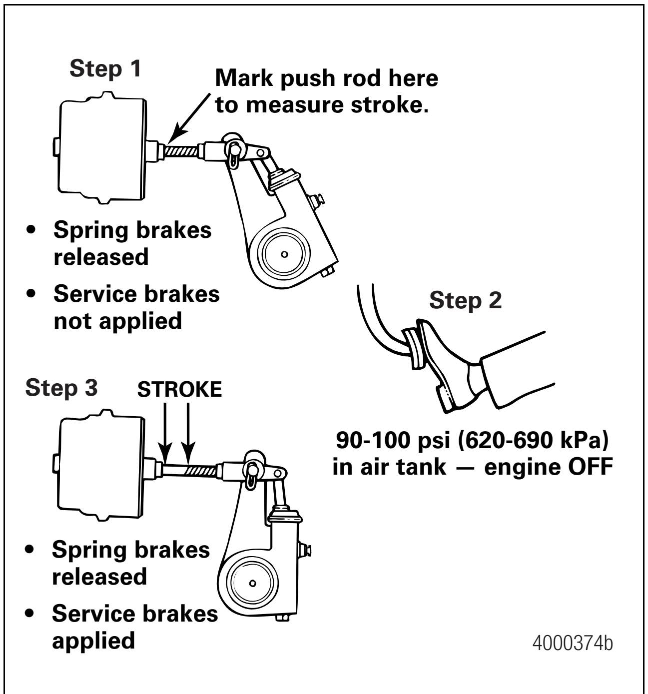


Figure 7.12

4. Measure the push rod travel or adjusted chamber stroke from where the push rod exits the brake chamber to your mark on the push rod. Measure and record the distance. Figure 7.12.
5. Subtract the measurement you recorded in Step 3 from the measurement you recorded in Step 4. The difference is the push rod travel or adjusted chamber stroke.
6. Refer to Table D or Table E to verify that the stroke length is correct for the size and type of air chambers on the vehicle.
   - **If the push rod travel or adjusted chamber stroke is greater than the maximum stroke shown in Table D or Table E:** Inspect the slack adjuster and replace it, if necessary.

Table D: Standard Stroke Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
6	4-1/2	1-1/4	Should be as short as possible without lining-to-drum contact
9	5-1/4	1-3/8	
12	5-4/16	1-3/8	
16	6-3/8	1-3/4	
20	6-25/32	1-3/4	
24	7-7/32	1-3/4	
30	8-3/32	2	
36	9	2-1/4	

Table E: Long Stroke Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
16	6-3/8	2.0	Should be as short as possible without lining-to-drum contact
20	6-25/32	2.0	
24	7-7/32	2.0	
24[1]	7-7/32	2.5	
30	8-3/32	2.5	

[1] For 3-inch maximum stroke, Type 24 chambers.

Alternate Method to Measure the Push Rod Travel or Adjusted Chamber Stroke

Use the CVSA procedure, except in Steps 3 and 4, measure the distance from the bottom of the air chamber to the center of the large clevis pin on each of the brakes.

CVSA North American Out-of-Service Criteria Reference Tables

A brake which is at the adjustment limit is not a violation.

Information contained in Table D and Table E is for reference only. Consult the CVSA's Out-of-Service Criteria Handbook for North American Standards, Appendix A. Visit their website to obtain the handbook.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform maintenance or service.

ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term affects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Inspection

Before riveting the linings, you must inspect the rivet machine components as detailed in this section. You must also verify that the gaps between the brake linings and shoes are correct before you rivet the linings onto Meritor Cast Plus™, Q Series and Q Plus™ cam brake shoes. Refer to the Meritor standards for inspecting rivets in this section.

Rivet Machine Components

Inspect the rivet machine components. Figure 8.1. You must adjust, repair or replace the rivet machine components when necessary to ensure that the machine presses the rivets into the correct position. For additional rivet machine service information, consult the manufacturer's instructions.

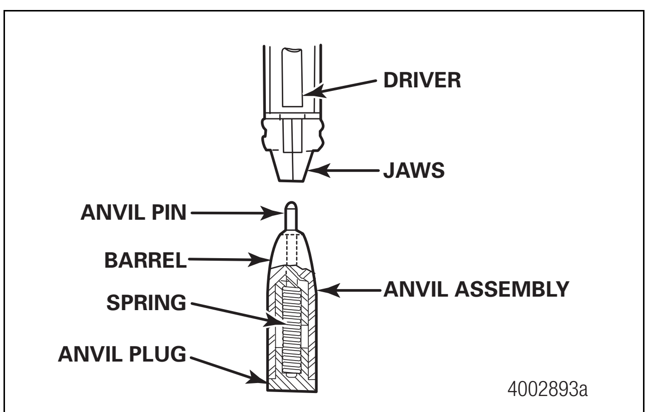


Figure 8.1

Rivet Machine Jaws

1. Remove the jaws from the rivet machine. Refer to the manufacturer's instructions.
2. Check the condition of the jaws. Carefully inspect the inner and outer surfaces for damage. Replace the damaged jaws.

Driver and Anvil Pin Alignment

The driver must align with the anvil pin. Use the following steps to check the driver and anvil pin alignment. Figure 8.2.

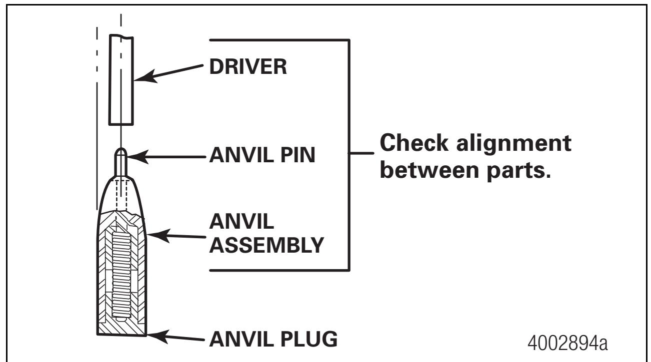


Figure 8.2

1. Use your hand to align the center of the driver with the anvil pin.
2. Adjust the alignment, if necessary.
3. If you cannot obtain the correct driver and anvil pin alignment, repair or replace the driver, anvil pin or anvil assembly. Refer to the manufacturer's instructions.

Anvil Pin Condition

1. Inspect the edge of the anvil pin. The corner must be sharp, not radial. Figure 8.3.

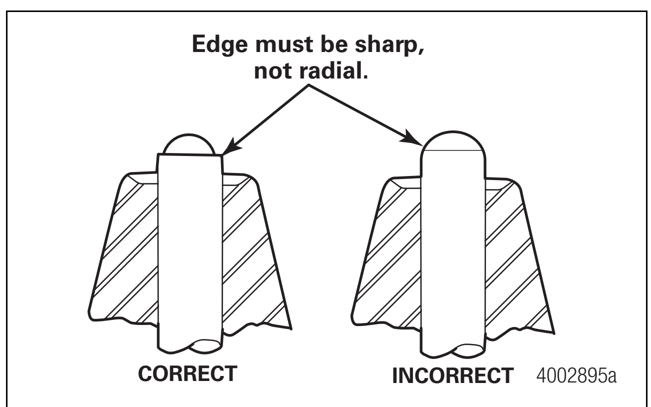


Figure 8.3

2. If the corner is not sharp, repair or replace the anvil pin. Refer to the manufacturer's instructions.
3. Use a micrometer to measure the diameter, Dimension A, of the anvil pin. Figure 8.4. Record the dimension.

Pin diameter must match the body diameter of the rivet being installed.

DIMENSION A Diameter of Anvil Pin
0.19" (4.83 mm)
0.25" (6.35 mm)
NOTE: Dimension A must match the body diameter of the rivet being installed.

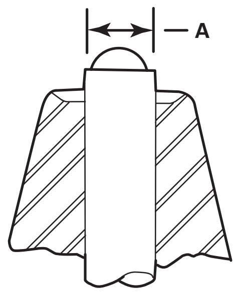


Figure 8.4

4. Push the anvil pin into the barrel of the anvil assembly until the base of the anvil pin contacts the top of the anvil assembly plug. Hold the anvil pin in this position.
5. Measure Dimension B from the sharp edge of the anvil pin to the bottom surface in the head of the barrel. Figure 8.5.
   - **If Dimension B exceeds the specification in Figure 8.5:** Use the following procedure to shorten the anvil pin.

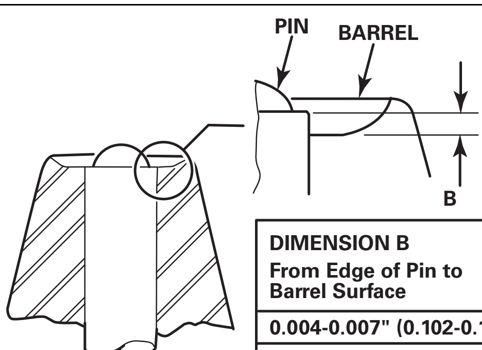
   A. Remove the anvil pin from the barrel.

   B. Grind the bottom of the anvil pin as needed. Figure 8.6.

   C. Assemble the anvil assembly.

   D. Repeat Step 4 and Step 5.

   E. Install the jaws onto the rivet machine.



DIMENSION B From Edge of Pin to Barrel Surface
0.004-0.007" (0.102-0.178 mm)
0.005-0.008" (0.127-0.203 mm)

4002897a

Figure 8.5

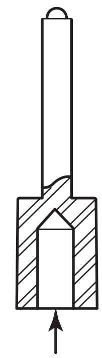


Figure 8.6

- **If Dimension B is less than the specification in Figure 8.5:** Use the following procedure to shorten the barrel.

A. Remove the plug, spring and anvil from the barrel.

B. Grind the bottom of the barrel as needed. Figure 8.7.

C. Assemble the anvil assembly.

D. Repeat Step 4 and Step 5.

E. Install the jaws onto the rivet machine.

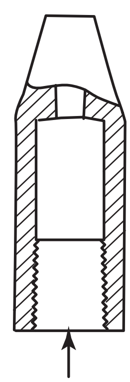


Figure 8.7

Meritor Standards for Inspecting Rivets

Refer to the following Meritor standards to inspect Meritor rivets and verify that the gaps between the Meritor linings and shoes are correct.

A rivet must fill the holes in the lining and shoe table. Figure 8.8.

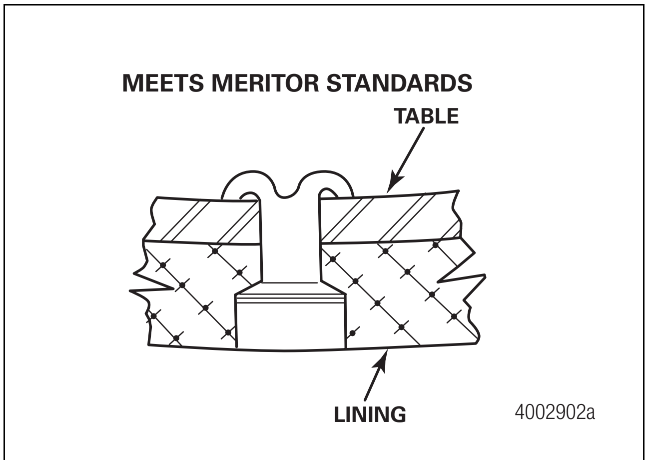


Figure 8.8

A rivet that does not fill the holes in the lining and shoe table does not meet Meritor standards. Figure 8.9.

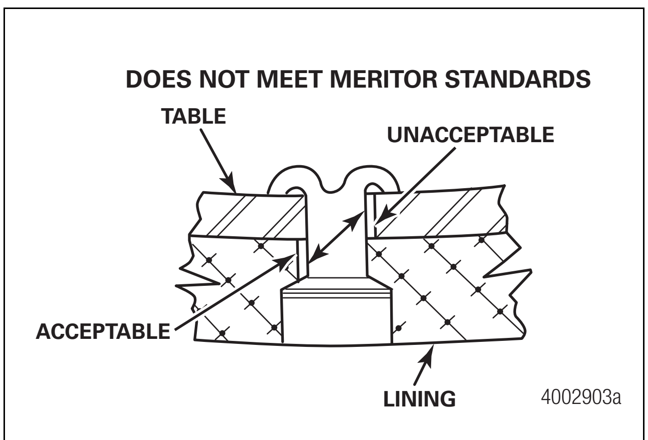


Figure 8.9

A rivet curl must completely contact the shoe table so that there's not a gap between the rivet curl and shoe. Figure 8.8. You must replace the rivet to correct the gap. Figure 8.10.

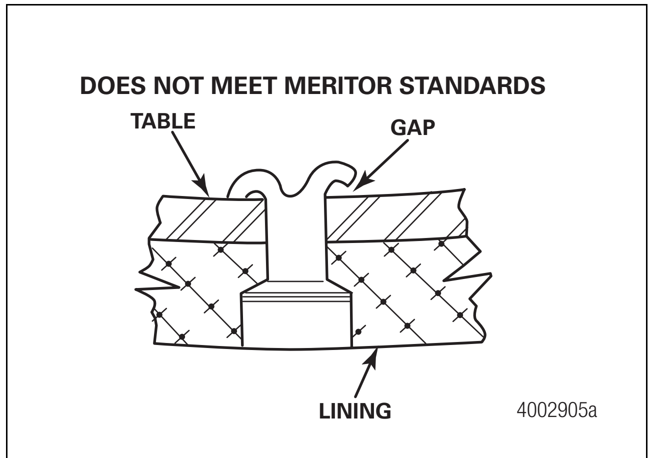


Figure 8.10

Meritor standards do not permit rivet movement. Use the following procedure to check for loose-rivet movement. Figure 8.11.

1. Use your hand to check for side-to-side and up-and-down rivet movement.
2. Place a punch on the driver side of the rivet. Gently tap the punch with a ball peen hammer. Check the roll side of the rivet with a 0.001-inch feeler gauge to ensure that the roll has not been lifted off the surface of the shoe.
   - **If rivet movement occurs during Step 1 or Step 2:** Remove the rivet and install another one.

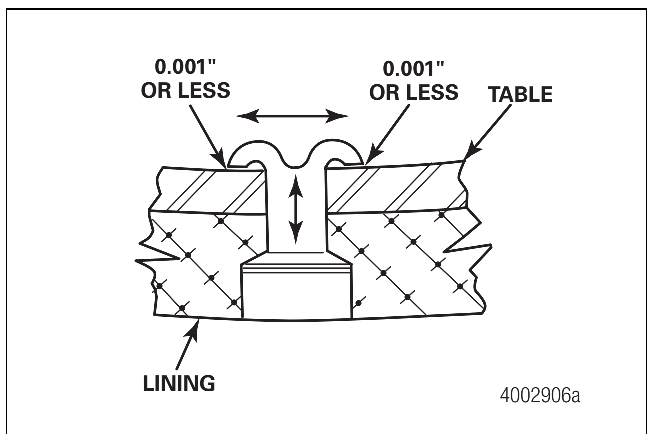


Figure 8.11

A rivet curl with more than one crack does not meet Meritor standards. Figure 8.12.

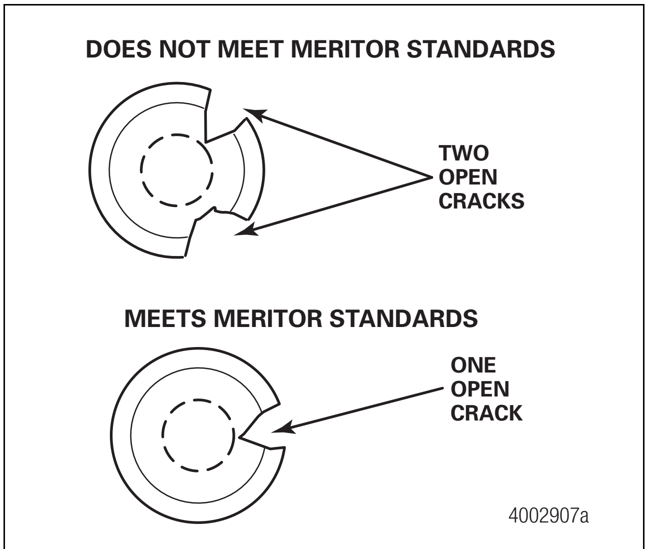


Figure 8.12

The maximum acceptable lining-to-shoe gap along the sides and ends of the assembly is 0.010-inch (0.25 mm). The maximum acceptable lining-to-shoe gap between webs is 0.025-inch (0.64 mm). Figure 8.13.

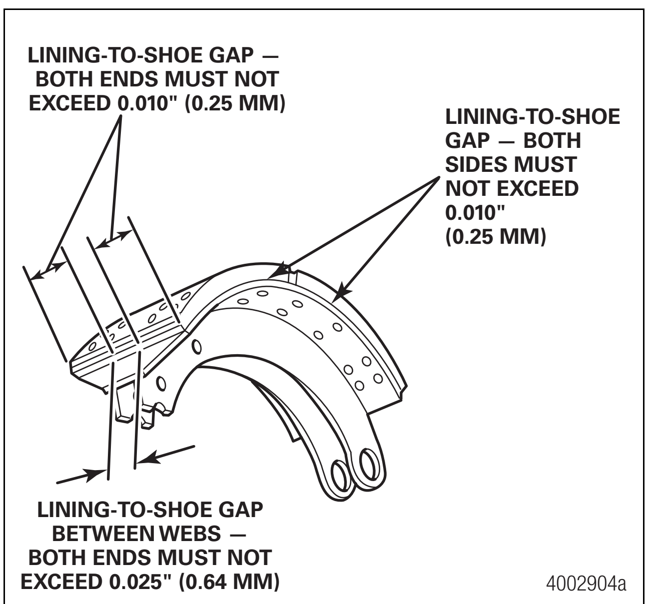


Figure 8.13

Installation

Lining with Rivets

1. Before riveting the linings, you must inspect the rivet machine components as detailed in the procedure in this section.
2. Verify that the gaps between the brake linings and shoes are correct before you rivet the linings onto Meritor Q Series, Q Plus™ and Cast Plus™ cam brake shoes. Refer to the procedure in this section.
3. Before you install the linings onto a shoe, check the compressed height of a rivet.
   A. Press a rivet into the machine.
   B. Measure distance A, which must be 0.460-0.475-inch (11.684-12.065 mm). Figure 8.14.

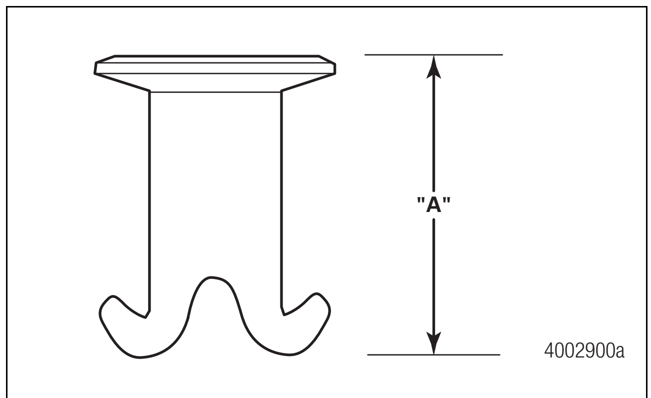


Figure 8.14

4. Verify that the lining and shoe contact faces are clean.
5. Align the rivet holes in the lining with the rivet holes in the shoe.
6. Before you cycle the rivet machine to fasten the linings to the brake shoe, check that the anvil pin extends through the table and lining assembly to ensure correct driver and anvil pin alignment. Figure 8.15.

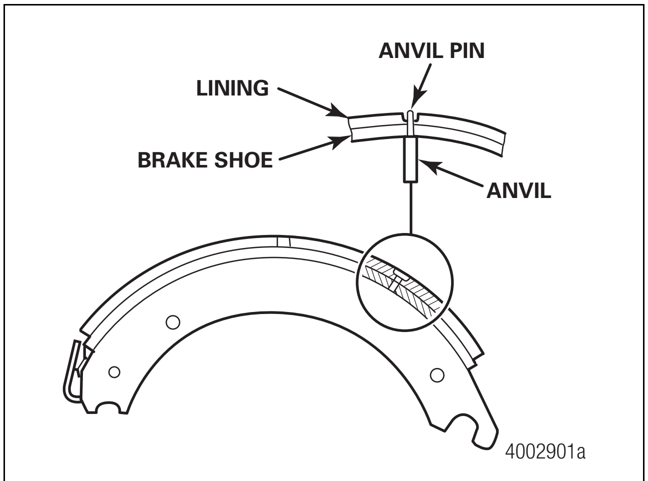


Figure 8.15

7. Install the rivets into the rivet holes following the sequence shown in Figure 8.16. For shoes with fewer rivet holes, start at the middle of the shoe and work toward the end. The rivets must be the correct body diameter, head size and shape, and length and material.

   A 0.010-inch (0.25 mm) maximum gap is acceptable between the shoe and linings along the sides and ends of the assembly, except between the double web. Between the webs, a 0.025-inch (0.64 mm) gap is acceptable.

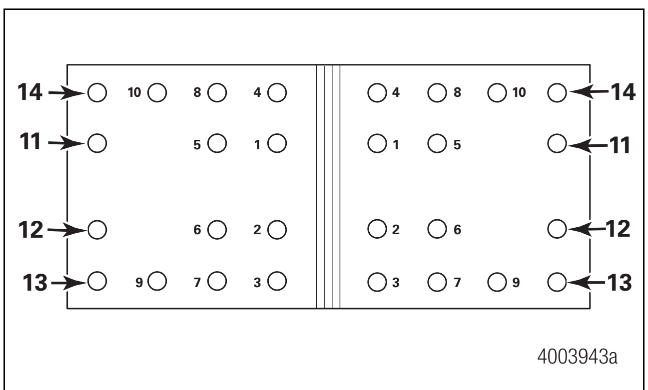


Figure 8.16

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ ASBESTOS AND NON-ASBESTOS FIBERS WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

Before You Install the Brake Drum

The internal machined brake drum pilot on Meritor 17000, 59000, 61000, 71000 and RC-26-700 Series bus and coach steer, center and drive axles fits over the machined flange of the hub. Figure 9.1. A correct drum-to-hub installation is essential to maintain the integrity of the wheel-end assembly.

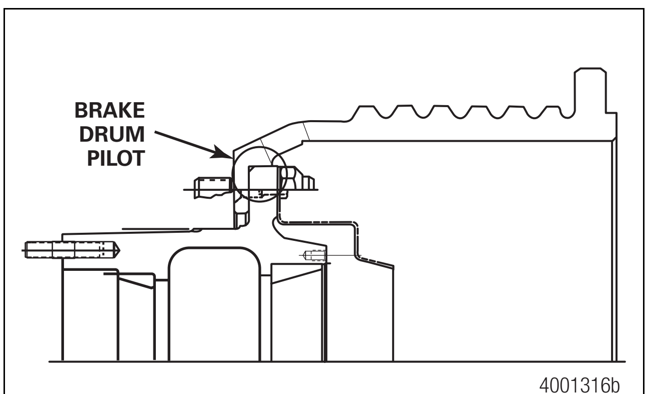


Figure 9.1

Replacing wheel studs can affect the fit of the drum onto the hub. If new wheel studs have been installed in the hub, there may be some localized swelling on the hub flange. The amount of swelling is usually small and localized. Figure 9.2.

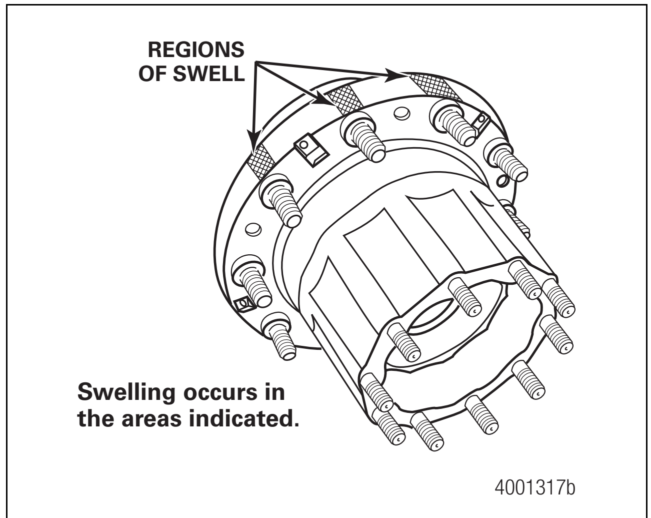


Figure 9.2

In a correct installation, the brake drum pilot should install easily over the machined flange of the hub. If it does not, perform the following procedures.

Installation

Brake Drum Procedure

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

You must carefully follow installation procedures when you install a brake drum onto a hub. An incorrect installation can cause the drum to fracture, which will affect braking performance. Loss of vehicle control, serious personal injury and damage to components can result.

⚠ CAUTION

When you install a brake drum and there's swelling on the hub flange, use a hand grinder to remove a small amount of material over each stud. Do not remove material from the flange area between the studs, which will weaken the drum mounting area. Damage to components can result.

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

2. Use a ring gauge measuring 12.7510-12.7520-inches (323.875-323.900 mm) to check the flange diameter.
   - **If the ring gauge fits over the flange:** Proceed to Step 3.
   - **If the ring gauge does not fit over the hub flange because of swelling:** Use one of the following methods to remove the swelling on the hub flange. Remove only enough material to allow for an easy ring gauge or drum fit. Do not remove material from the flange area between the studs, which will weaken the drum mounting area.

   A. Use a hand grinder to remove a small amount of material over each stud. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.

   B. Use a lathe to machine the hub flange and remove any swells. Locate the lathe on the bearing cups. Check the ring gauge or drum fit frequently to ensure that you're not removing too much material.
3. Use a wire brush to remove any rust, burrs and debris on both mating surfaces. Use a cloth dampened with water or a water-base solution to clean the brake drum pilot on both the brake drum and hub flange.

Check the Brake Drum Surface Total Indicator Runout (TIR)

A Hub Mounted on the Axle

1. Install the drum onto the hub. Carefully slide the drum onto the hub flange. Do not force the brake drum over the flange.
   - **If the brake drum does not install easily over the hub flange:** Use the procedure above to remove swelling on the hub flange.
2. Install the wheel nuts and suitable spacers to fasten the drum to the hub.
3. Attach the magnetic base of a dial indicator to the axle housing. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Install the drum. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide correct runout:** Replace the drum.

A Hub Not Mounted on the Axle

1. Assemble the hub, drum and wheel. Do not force the brake drum over the flange.
   - **If a brake drum does not install easily over the hub flange:** Use the procedure above to remove swelling on the hub flange.
2. Mount the hub, drum and wheel assembly onto a suitable spindle with the wheel bearings correctly adjusted.
3. Attach the magnetic base of a dial indicator to the spindle base. Measure brake drum total indicator runout (TIR) approximately one-inch (25 mm) from the open end of the drum. The runout should not exceed 0.015-inch (0.381 mm).
   - **If runout exceeds specifications:** Remove the drum from the hub. Rotate the drum and install it. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If you are unable to rotate the drum to provide the correct amount of runout:** Remove and turn the drum. The maximum diameter should be at least 0.1-inch (2.5 mm) less than the maximum dimension marked on the outer edge of the drum to maintain correct drum wear allowance. Install the drum. Verify that runout does not exceed 0.015-inch (0.381 mm).
   - **If turning the drum does not provide the correct amount of runout:** Replace the drum.
4. Mount the hub assembly onto the axle. Refer to the hub installation instructions in Maintenance Manual 23, Bus and Coach Front Axles; and Maintenance Manual 23A, Bus and Coach Rear Axles. To obtain these publications, refer to the Service Notes page on the front inside cover of this manual.

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Retention Screws

Meritor bus and coach steer, center and drive axles — 17000, 59000, 61000, 71000 and RC-26-700 Series — will be shipped without retention screws in the hub and drum assembly.

Purpose of Retention Screws in the Hub and Drum Assembly

On Meritor bus and coach axles, either three or five flat-head straight-slot or Phillips-head slot retention screws secure the drum to the hub. Retention screws make it easier to handle an axle during shipping and installation. Figure 10.1.

Retention screws do not provide integrity to the hub and drum assembly.

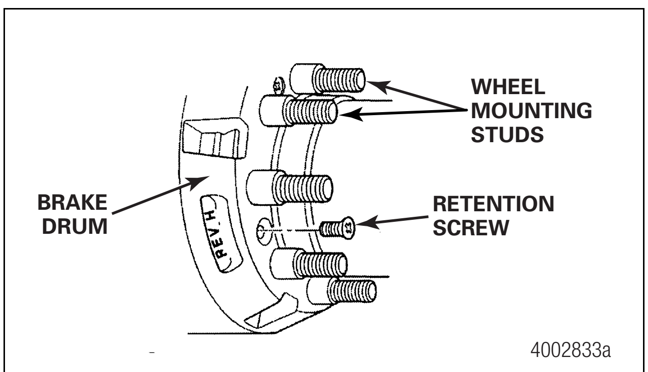

Figure 10.1

Retention Screws Can Loosen

WARNING

Retention screws can loosen, protrude beyond the brake drum and contact the inner back face. When you remove the wheels from a bus or coach, you must either tighten the retention screws to within the drum face or remove the retention screws from the hub and drum assembly.

Retention screws that are not recessed within the drum face or removed from the hub and drum assembly can prevent the wheel from seating when you mount it.

If this condition is not detected during vehicle inspection, wheel stud damage and wheel mounting nut loosening can cause the wheel to separate from the vehicle. Serious personal injury and damage to components can result.

Retention screws are recessed in the brake drum, which prevents screw heads from contacting the wheel. During normal vehicle operation, retention screws can loosen and unthread to the inner back face. You cannot detect this condition until you remove a wheel for maintenance or service.

Maintenance

Check Retention Screws During Maintenance or Whenever a Wheel is Removed from the Vehicle

During wheel assembly maintenance or service, or whenever you remove a wheel from the vehicle, you must complete one of the following procedures.

1. Tighten the retention screws to 15-30 lb-ft (20.3-41.0 N•m). The retention screws must be recessed within the drum face and the drum must be fully seated against its hub. Use the procedures and torque value recommended by the original equipment manufacturer to mount the wheels and tighten the wheel mounting nuts.
2. Remove all flat-head retention screws from the hub and drum assembly. Use the procedures and torque value recommended by the original equipment manufacturer to mount the wheels and tighten the wheel mounting nuts.

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Inspection

Brake System Visual Inspection

For safer operating conditions and longer component life, make these visual inspections before the vehicle is placed into service.

1. Check the complete air system for worn hoses and connectors. With the air pressure at 100 psi (689 kPa), the brakes released and the engine off, air pressure loss must not exceed two psi (13.8 kPa) per minute. Total loss must not exceed three psi (20.7 kPa) per minute.
2. Verify that the air compressor drive belt is tight. Air system pressure must rise to approximately 85-100 psi (620-690 kPa) in two minutes at full RPM.
3. The governor must be checked and set to the specifications supplied by the vehicle manufacturer.
4. Both wheel ends of each axle must have the same linings and drums. All four wheel ends of tandem axles also must have the same linings and drums. It is not necessary for the front axle brakes to be the same as the rear drive axle brakes. Figure 11.1.

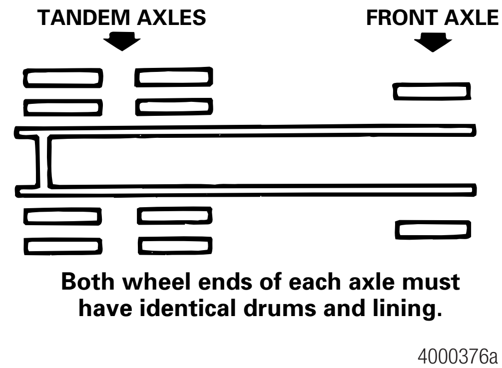

Figure 11.1

5. Always follow the specifications supplied by the vehicle manufacturer for the correct lining to be used. Vehicle brake systems must have the correct friction material. These requirements can change from vehicle to vehicle.
6. The return springs must retract the shoes completely when the brakes are released. Replace the return springs each time the brakes are relined. The spring brakes must retract completely when they are released.
7. The air chamber area multiplied by the length of the automatic slack adjuster is called the
AL factor. This number must be equal for both ends of a single axle and all four ends of a tandem axle. Figure 11.2. The push rod stroke length of all the brakes must be equal.

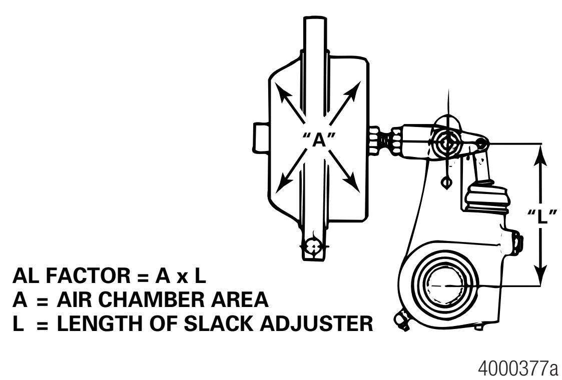

Figure 11.2

Intervals

Reline the Brakes

⚠ CAUTION
Reline the brakes when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point. The rivets or bolts must not touch the drum. Damage to components can result.

Meritor recommends that you replace the brake shoe springs, rollers, camshaft bushings and seals, anchor pins, and clevis pin clips at each reline.

Meritor recommends that you replace the camshaft bushings if the S-cam is replaced, if the radial movement exceeds 0.030-inch (0.762 mm) and at every brake shoe reline. Always replace the S-cam seals when you replace the S-cam bushings.

Reline the brake when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point.

Check the drum and perform a major inspection when you reline the brakes.

Important Information on Linings and Primary Shoe Locations

Use the Correct Lining Material

Use the lining material specified by the vehicle manufacturer. This will help to ensure that the brakes perform correctly and meet Department of Transportation (DOT) performance regulations.

Also note that the drums and linings on a front axle can be different than drums and linings on a rear axle. Figure 11.3.

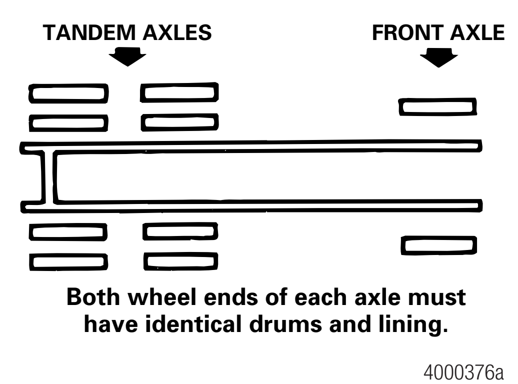

Figure 11.3

Single Axles

Always reline both wheels of a single axle at the same time.

Always install the same linings and drums onto both wheels of a single axle.

Tandem Axles

Always reline all four wheels of a tandem axle at the same time.

Always install the same linings and drums onto all four wheels of a tandem axle.

Overview

Cam Brake Tips

Air Chambers

To ensure correct brake balance, all brake chambers on the same axle must be the same size and type to help ensure a balanced brake system for maximum lining wear and drum life.

Brake Kits

Meritor brake shoes, rollers, camshafts and shoe return springs are designed to perform as a system. Always install the vehicle manufacturer's spec-level components during maintenance or when you upgrade from standard to long-life brakes to help ensure correct brake performance and maximum lining life.

Cam Heads

Cam heads can look the same, but that doesn't mean they will perform the same in your brake system. Two cam head profiles can appear to be identical, but very small differences in cams from different manufacturers can be significant enough to affect the performance of your brakes. To ensure a balanced brake system and optimum lining and drum life, always install the correct replacement cam.

Brake Shoe Rollers

To avoid flat spots, lubricate a brake shoe roller directly in the web roller pocket and not at the cam-to-roller contact area. Flat spots can affect brake adjustment and result in premature brake wear or reduced braking performance.

Drums

To help ensure balanced braking, even lining and drum wear, and correct function of the automatic slack adjuster, do not install a cast drum and a centrifuse drum on the same axle.

A cast drum and a centrifuse drum each absorbs and dissipates heat differently. When drum types and weights are mixed, different rates of heat absorption and dissipation occur that can affect the brake system.

Hardware

When you service cam brakes, replace all the brake shoe springs, anchor pins, bushings and seals, clevis pin clips and rollers — not just the shoe return springs — to help ensure maximum braking performance.

Linings

Insist on the same brand of quality vehicle manufacturer friction lining material to help ensure fewer relines and compatibility with your present system.

Replacement Parts

Always use the vehicle manufacturer's quality standard for replacement parts. Meritor brakes work as a system, and when you replace original parts with "will-fit" parts, you can compromise the performance of the entire system.

Return Springs

Replace cam brake return springs at every cam brake reline. The return spring is critical to alignment, accurate return of the brake away from the drum and correct automatic slack adjustment.

Automatic Slack Adjusters

Automatic doesn't mean maintenance-free. Correctly installed and lubricated automatic slack adjusters help to ensure maximum brake system performance.

Never mix automatic slack adjusters on the same axle. When you replace automatic slack adjusters, always use replacement parts that were originally designed for the brake system to help ensure even brake wear, balanced braking and maximum brake performance.

Lubrication

Cam Brakes

⚠ CAUTION
Do not permit grease to contact the brake drum or linings. Grease on the linings can cause poor brake performance. Contaminated linings must be replaced.

For lubrication information, refer to Table F, Table G and Figure 11.4, Figure 11.5 or Figure 11.6.

Table F: Grease Specifications

Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
O-616-A	1	Clay Base	Down to –40°F (–40°C)
O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
O-617-B	2		
O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
O-637[1]	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.

[1] Do not mix Meritor specification O-637 grease, part number 2297-U-4571, a calcium-base, rust-preventive grease, with other greases.

Table G: Grease Applications

Brake Component	Specification	Schedule	Procedure
Camshaft Bushings	Multi-Purpose Chassis Grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A, or equivalent Multi-Purpose Chassis Grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B, or equivalent	At each brake reline when the brake is disassembled. Every 100,000 miles (160,000 km). For severe duty, lubricate more often. Frequency is determined by monitoring the condition of the grease.	Through the fitting on the bracket or spider until new grease flows from the inboard seal.
Camshaft Splines	Metallic-base, temperature-resistant anti-seize compound, Meritor specification O-637, or equivalent	When necessary or when the brake is disassembled.	To all areas.
Anchor Pins	Anchor pin grease, non-melting grease with Bentone thickeners, NLGI Grade 1, Meritor specification O-616-A, O-617-B, or equivalent	When necessary or when the brake is disassembled.	Through the fittings and/or the entire surface of the anchor pin.
	Metallic-base, temperature-resistant anti-seize compound, Meritor specification O-637, or equivalent	Prior to assembly.	Coat exterior surface.
Brake Shoe Rollers	Multi-Purpose Chassis Grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade 1, Meritor specification O-617-A, or equivalent Multi-Purpose Chassis Grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade 2, Meritor specification O-617-B, or equivalent	When necessary or when the brake is disassembled.	To brake shoe rollers at areas where the rollers touch the brake shoes. Do not put lubricant on the part of the roller that touches the cam head.
ArvinMeritor Automatic Slack Adjuster[1]	Clay-base, non-melting grease with Bentone thickeners, NLGI Grade 1, Meritor specification O-616-A or equivalent Lithium-base, NLGI Grade 1 or 2, Meritor specification O-692 or equivalent synthetic oil, clay-base, NLGI Grade 2, Meritor specification O-645 or equivalent	Whichever of the following is the most frequent • Every 6 months • Four times during the life of the linings Always inspect and lubricate the automatic slack adjuster when the brakes are relined.	Through the fitting until new grease purges from around the inboard camshaft splines and from the pawl assembly.
Slack Adjuster Clevis Pins	Metallic-base, temperature-resistant anti-seize compound, Meritor specification O-637, or equivalent	Prior to assembly.	Coat pin surface.

[1] For non-Meritor automatic slack adjusters, refer to the vehicle manufacturer's instructions for maintenance intervals and specifications.

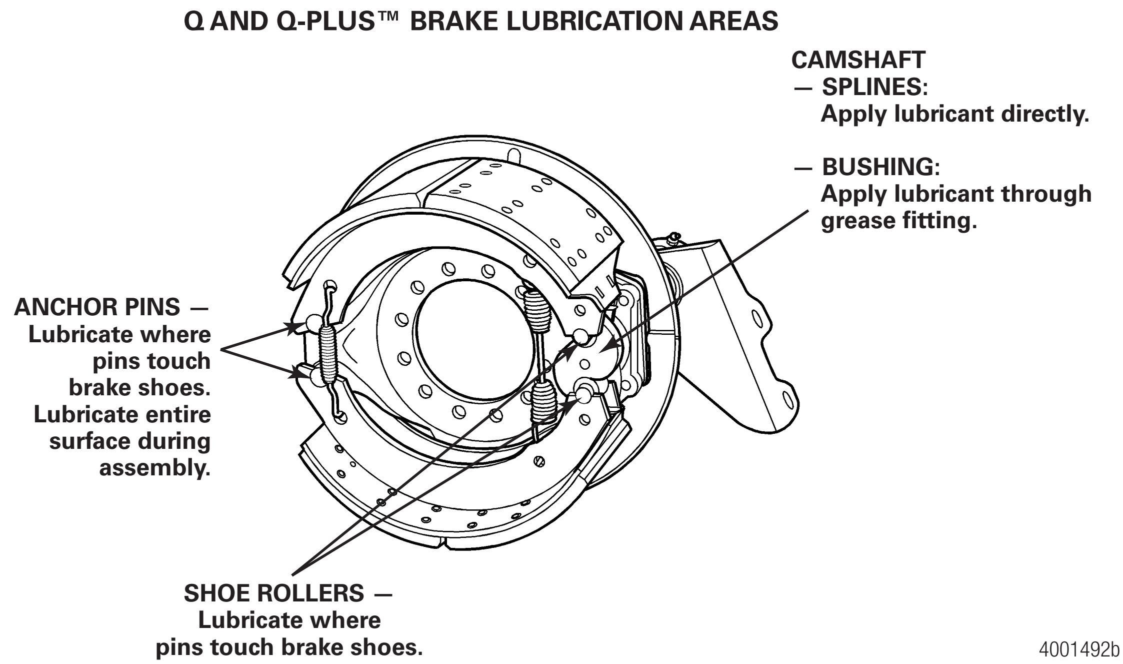

Figure 11.4

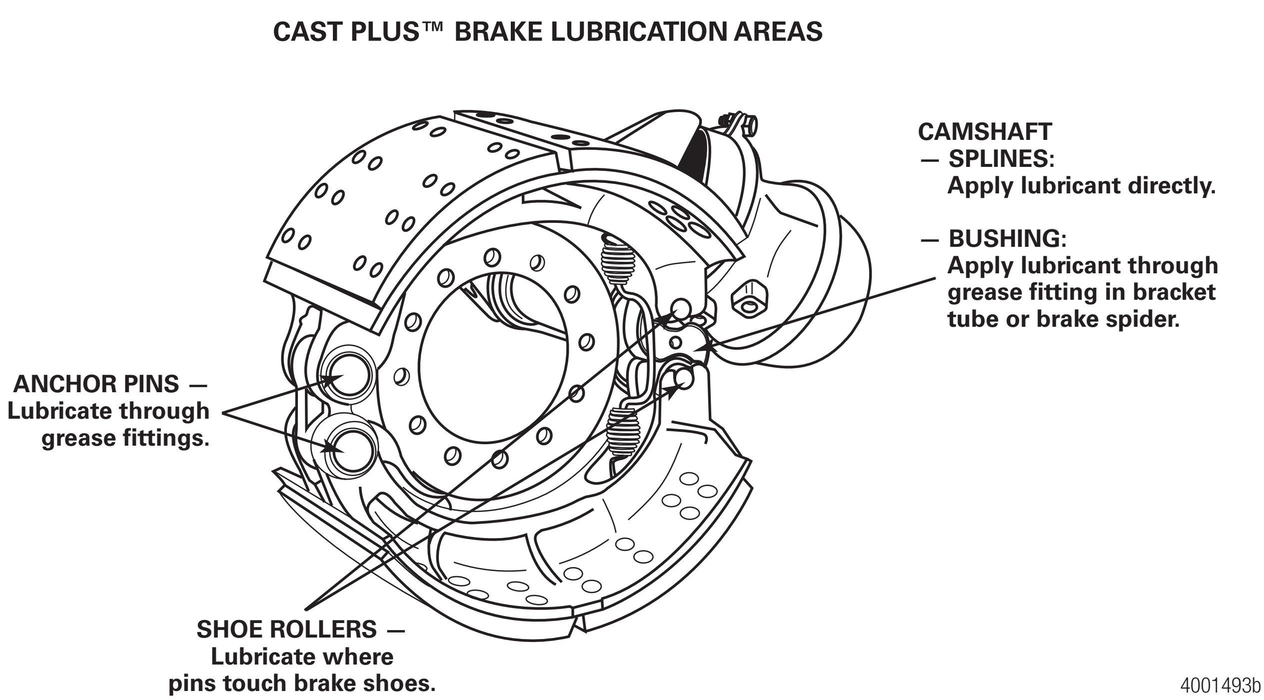

Figure 11.5

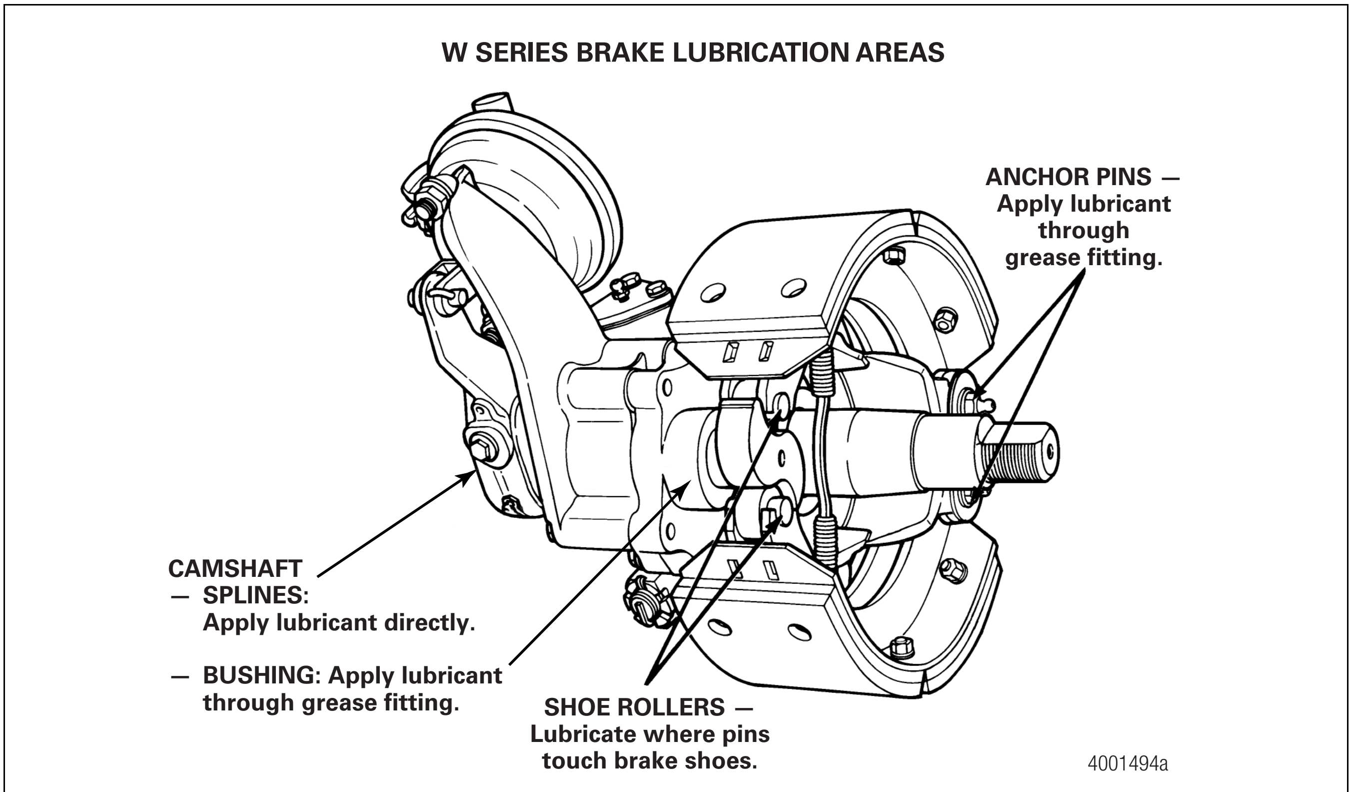
W SERIES BRAKE LUBRICATION AREAS
ANCHOR PINS — Apply lubricant through grease fitting.
CAMSHAFT
— SPLINES: Apply lubricant directly.
— BUSHING: Apply lubricant through grease fitting.
SHOE ROLLERS — Lubricate where pins touch brake shoes.
4001494a

Figure 11.6

Symptoms

Cam Brakes

Condition	Cause	Correction
Brakes do not apply or not enough braking force.	Worn or damaged camshaft.	Remove and replace the camshaft.
	Air chamber installed incorrectly.	Install correctly.
	Leak or restriction in air lines or valves.	Repair the air lines or valves.
	Air chamber air diaphragm damaged.	Repair or replace the air chamber.
	Brakes not adjusted correctly.	Adjust the brakes.
	Grease or other contamination on brake linings.	Replace the linings.
	Linings worn, damaged or missing.	Replace the linings.
Braking force not equal or lining wear not even.	Air chamber diaphragm damaged.	Repair or replace the air chamber.
	Damaged or worn camshaft.	Remove and replace the camshaft.
	Broken return springs.	Replace the return springs.
	Brakes not adjusted correctly.	Adjust the brakes.
	Grease or other contamination on brake linings.	Replace the linings.
	Brake linings installed backward.	Install the brake shoes correctly.
	Brake linings installed in wrong positions on shoes.	Install the linings in the correct positions.
	Drum has runout of more than 0.010-inch (0.25 mm).	Repair or replace the drum.
	Wheel bearings not adjusted correctly.	Adjust the wheel bearings.
	Incorrect linings are installed.	Replace with the specified linings.
Parking brake does not apply when air pressure is released.	Power spring in air chamber not fully released (spring is caged).	Release the power spring in the air chamber (uncage spring).
	Air pressure that holds springs in the compressed position is not fully released.	Repair the air system.
	Brakes not adjusted correctly.	Adjust the brakes.
	Power springs in air chamber weak or broken.	Replace the air chamber.
	Grease or other contamination on brake linings.	Replace the linings.
Brakes dragging.	Not enough air pressure to hold spring.	Repair the air system.
	Air lines connected to wrong ports.	Connect the lines to the correct ports.
	Leaks in air lines.	Repair or replace the air lines.
	Leaks in spring brake assembly.	Repair or replace the spring brake.
	Wheel bearings not adjusted correctly.	Adjust the wheel bearings.
	Drum has runout of more than 0.010-inch (0.25 mm).	Repair or replace the drums.
	Shoe return springs are weak, damaged or missing.	Replace the shoe return springs.
	Valve does not permit complete release of system pressure when brake is released.	Repair or replace the valves.
	Damaged camshaft.	Remove and replace the camshaft.
	Damaged rollers.	Remove and replace the rollers.

Torque Specifications

Cam Brakes

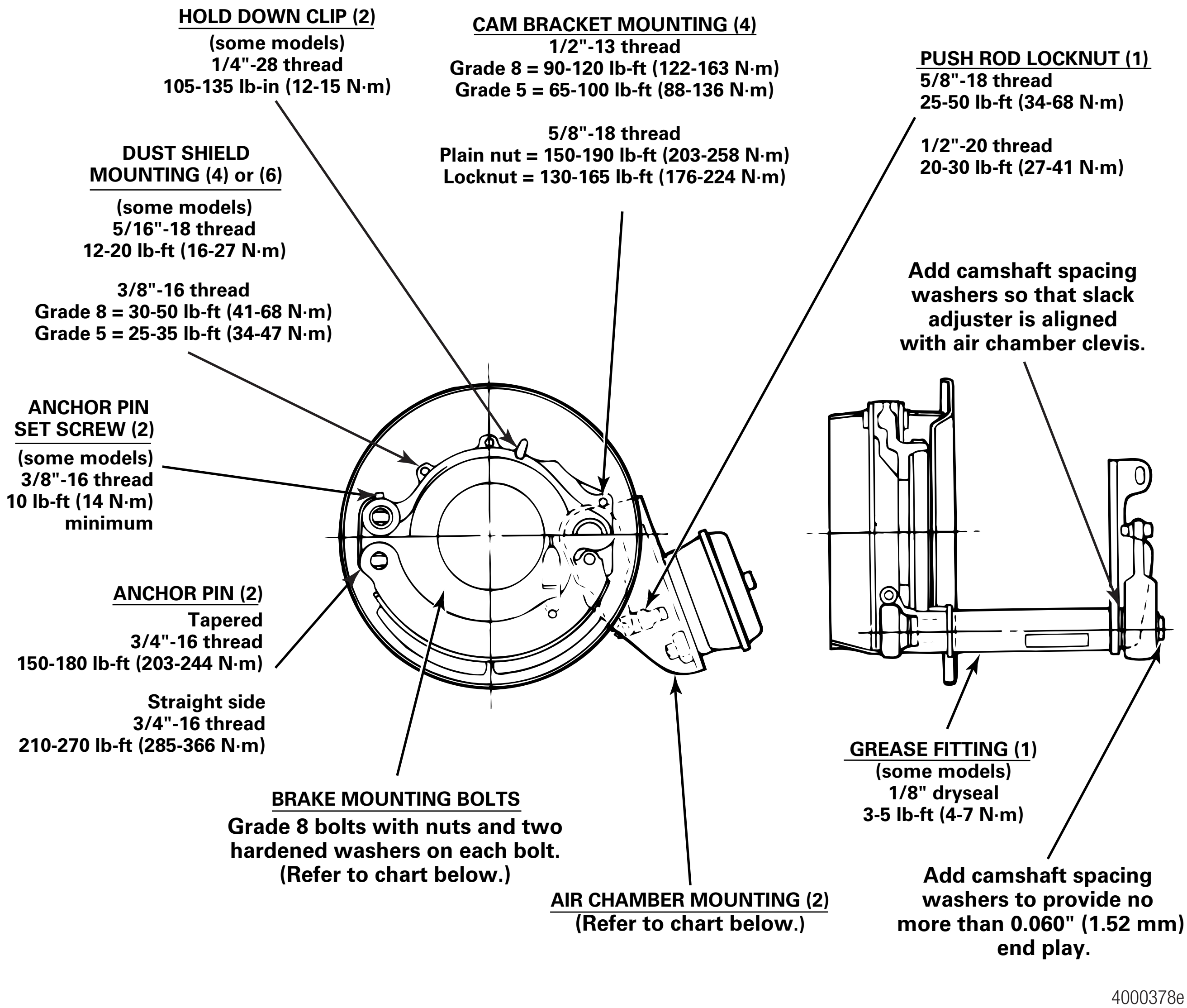

Table H: Brake Mounting Bolts

Bolt Size	Torque, lb-ft (N•m)
7/16″-20	60-75 (81-102)
1/2″-20	85-115 (115-156)
9/16″-18	130-165 (176-224)
5/8″-18	180-230 (244-312)
3/4″-16	350-450 (474-610)
3/4″-10	270-350 (366-474)

Table I: Air Chamber Mounting Bolts

Chamber Size	9	12	16	20	24	30	36	Spring Chamber
Bendix	20-30 lb-ft (27-41 N•m)		30-45 lb-ft (41-61 N•m)			45-65 lb-ft (61-88 N•m)		65-85 lb-ft (88-115 N•m)
Haldex	35-50 lb-ft (48-68 N•m)			70-100 lb-ft (95-136 N•m)				
MGM	35-40 lb-ft (48-54 N•m)			133-155 lb-ft (180-210 N•m)				
Anchorlok/Haldex	—			130-150 lb-ft (177-203 N•m)				

Tool Drawings

The following pages outline the machining and construction techniques for producing tools necessary to aid in servicing bus and coach cam brakes. Figure 14.1, Figure 14.2 and Figure 14.3.

All tools are within the capability of a reasonably equipped machine shop.

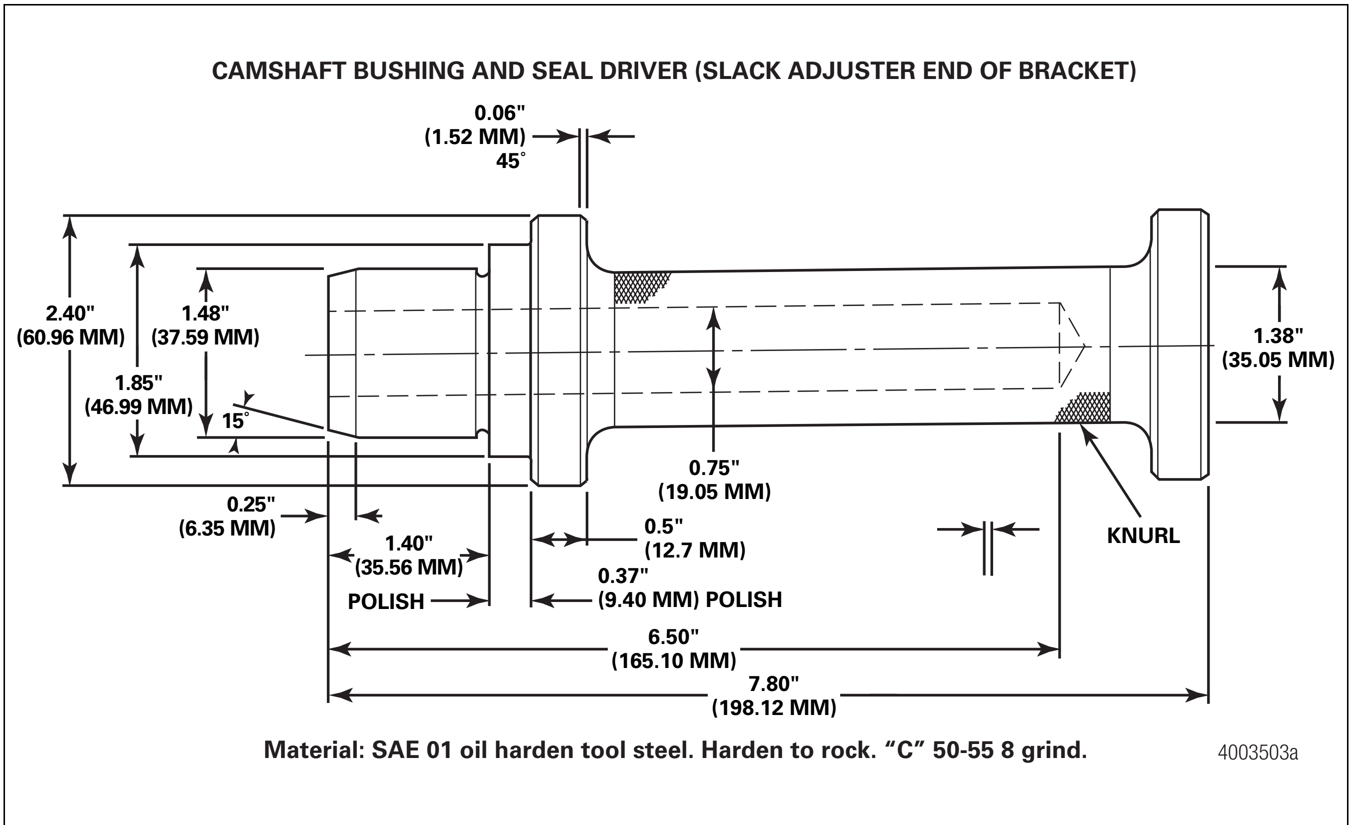

Figure 14.1

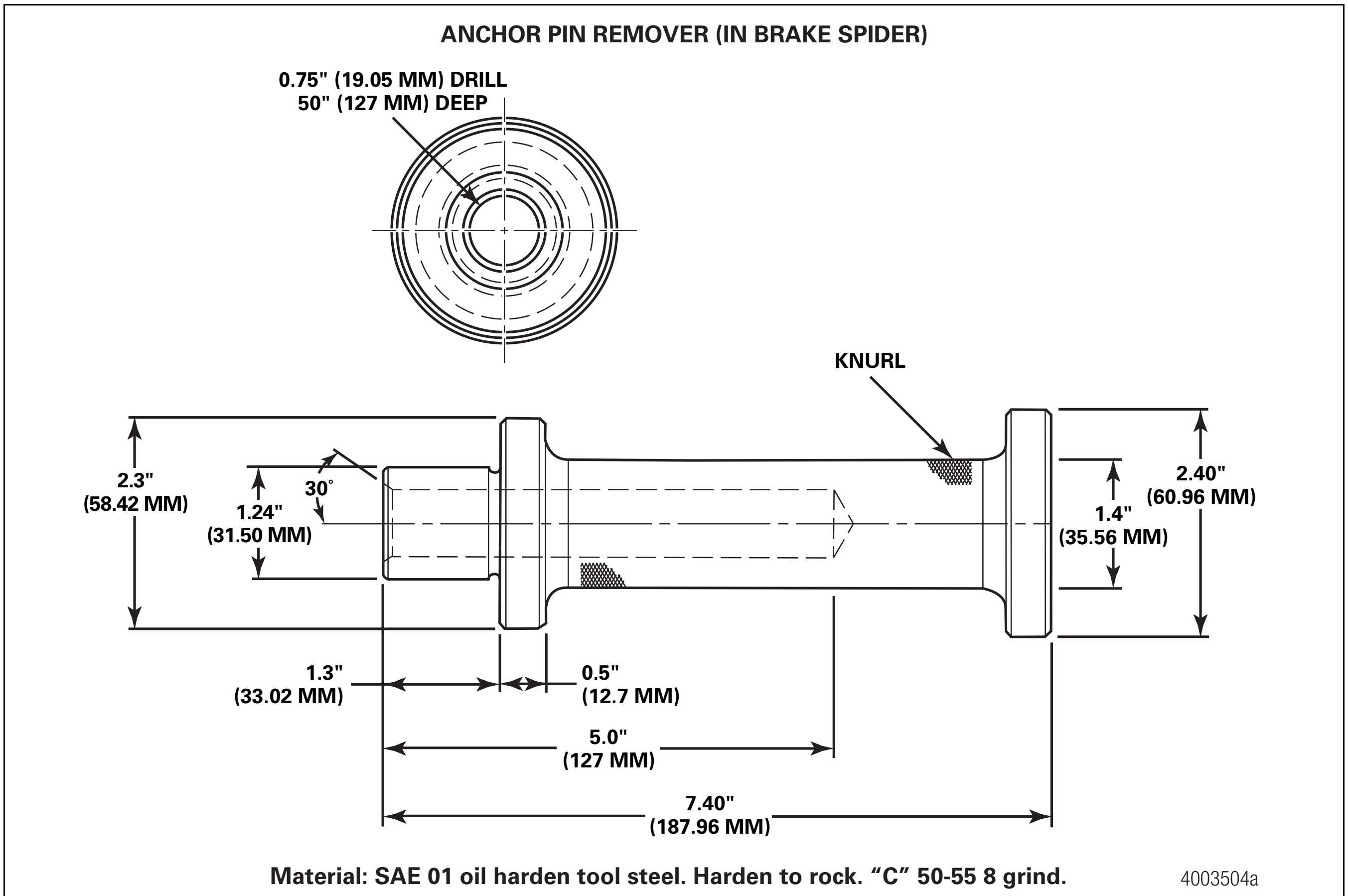

Figure 14.2

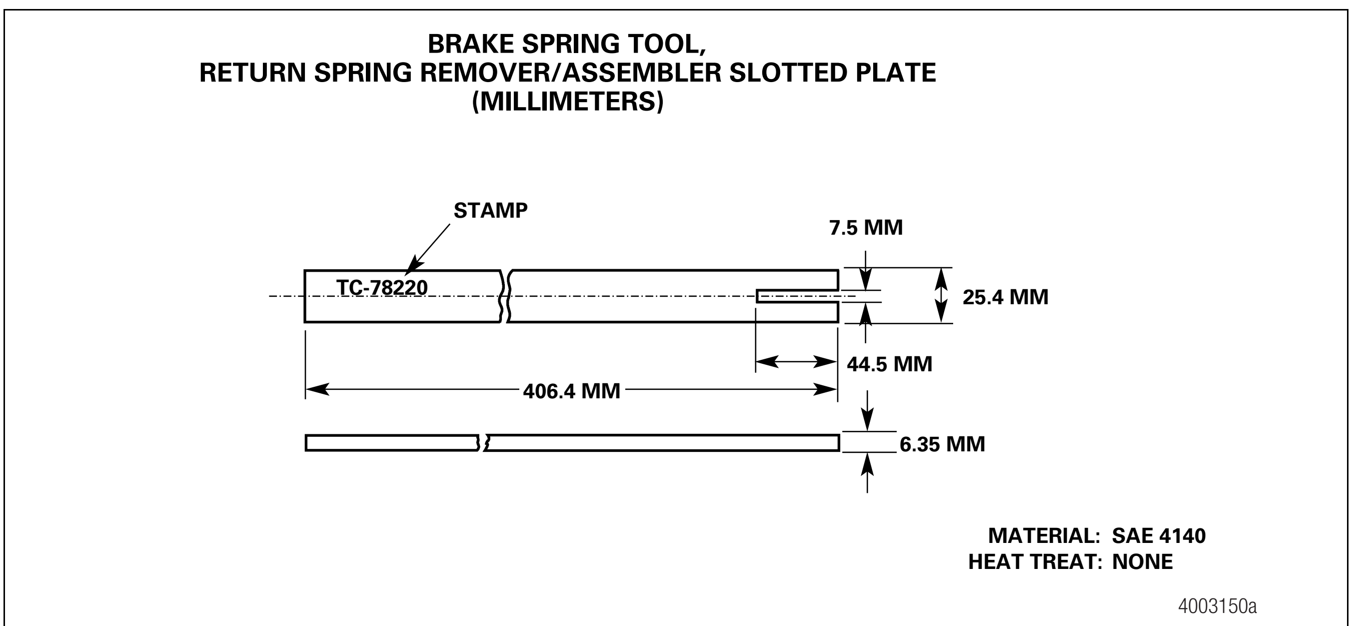

Figure 14.3

Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
arvinmeritor.com

Printed in USA

Revised 07-04
Maintenance Manual 23B (16579/24240)

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LRT-HP, LRT-SP

TK 52483-3-MM (Print Date: February 25, 2005)

The maintenance information in this manual covers unit model:	
LRT-HP 7.5 M (920401)	
LRT-SP 11 M (920280)	
Related Manuals:	
LRT HP Parts Manual	**TK 52671**
LRT SP Parts Manual	**TK 52672**
X426, X430 Compressor Overhaul for Bus Air Conditioning	**TK 6075**
Silver Brazing & Soft Soldering	**TK 7949**
Tool Catalog	**TK 5955**
IntelligAIRE II Diagnostic Manual	**TK 51535**
Electrostatic Discharge Training Guide	**TK 40282**
Thermo King Bus A/C Preventive Maintenance Forms	**TK 40809**
Diagnosing Thermo King Bus Air Conditioning Systems	**TK 51066**
The information in this manual is provided to assist owners, operators and service people in the proper upkeep and maintenance of Thermo King units. The above manuals may be purchased from your local Thermo King dealer.	

This manual is published for informational purposes only and the information so provided should not be considered as all-inclusive or covering all contingencies. If further information is required, Thermo King Corporation should be consulted.

Sale of product shown in this manual is subject to Thermo King's terms and conditions including, but not limited to, the Thermo King Limited Express Warranty. Such terms and conditions are available upon request. Thermo King's warranty will not apply to any equipment which has been "so repaired or altered outside the manufacturer's plants as, in the manufacturer's judgment, to effect its stability."

No warranties, express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, and descriptions contained herein. Manufacturer is not responsible and will not be held liable in contract or in tort (including negligence) for any special, indirect or consequential damages, including injury or damage caused to vehicles, contents or persons, by reason of the installation of any Thermo King product or its mechanical failure.

Recover Refrigerant

At Thermo King, we recognize the need to preserve the environment and limit the potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere.

We strictly adhere to a policy that promotes the recovery and limits the loss of refrigerant into the atmosphere.

In addition, service personnel must be aware of Federal and State regulations concerning the use of refrigerants and the certification of technicians. For additional information on regulations and technician certification programs, contact your local THERMO KING dealer.

R-134a/R-407C

WARNING: Use only Polyol Ester-based refrigeration compressor oil in R-134a/R-407C. See Thermo King Parts Manual for part number.

Do not mix Polyol Ester and standard synthetic compressor oils. Keep Polyol Ester compressor oil in tightly sealed containers. If Polyol Ester oil becomes contaminated with moisture or standard oils, dispose of properly–DO NOT USE.

When servicing Thermo King R-134a/R-407C unit, use only those service tools certified for and dedicated to R-134a/R-407C refrigerant and Polyol Ester compressor oils. Residual non-HFC refrigerants or oils will contaminate R-134a/R-407C systems.

About This Manual

Purpose

The purpose of this manual is to provide general maintenance information necessary to maintain the climate control unit at peak operating standards. This includes safety information, unit information such as bills of material and kit numbers, general unit information, maintenance procedures and related information (such as wiring and schematic diagrams), and some diagnostic and troubleshooting information.

NOTE: This manual may cover more than one unit. Therefore, it may contain information not applicable to your unit.

Contents

This manual is organized into the following chapters:

Chapter	Purpose
Safety Precautions	Provides detailed safety information. You should be familiar with the safety precautions before working on any unit.
Model Systems and Update Matrices or “About this Unit” (sometimes called “Model and Kit Numbers” or something similar)	These tables list the bills of material and kit options that make up your unit. Use them for the following purposes: 1. To determine if you have the right manual for your unit: the bill of material (B/M) number on your unit serial plate should match one of the bill of material numbers listed in this section. (If this is not the case, you may not necessarily have the wrong manual. Your unit may be a custom order or the manual may be outdated. If you cannot find your unit in the matrix, call TK Service for more information.) 2. To communicate with TK Service Department: If you need to call TK Service, you must know your model number(s) in order for the service representative to help you. 3. To order options and kits: Options and kits listed can be ordered using the bill of material number (sometimes called the system number) in the leftmost column of the charts. Call your Thermo King Service Representative for more information.
Specifications	Lists unit specifications.
General Description	Gives an overview description of your unit including standard and optional features, illustrations, and general a/c theory.
Unit Controls and Operation	Gives more detailed descriptions of the features specific to your unit.
Controller(s)	Provides description of controller, operating procedures, and circuit board maintenance procedures. (May be more than one chapter because some units have more than one controller option.)
Maintenance Inspection Schedule	Table of routine maintenance procedures.
Maintenance Chapters	Provides detailed maintenance procedures required for your unit. (Electrical, Refrigeration, Compressor[1], Structural, Clutch, Batteryless Alternator[1], Power Pack[1])
Air Conditioning Diagnosis and Analysis, Refrigeration Diagrams	Provides troubleshooting information for diagnosing problems.
Temperature-Pressure Charts	Provides general Temperature-Pressure information for refrigerants.
Wiring and Schematic Diagrams	Wiring and Schematic diagrams applicable to the unit.

[1] Optional. If your book does not have this chapter then this is not an option for your unit. Some OEM’s supply their own compressor. If so, this manual will not contain compressor information.

Contacting Thermo King Service

Before you call Thermo King Service, have the following information on hand:

- Bill of Material (usually located on the condenser/evaporator serial plates)
- Unit Type
- Bus Manufacturer

Who to call: Your Thermo King Service Representative.

Blank Pages

This manual may contain blank pages at the end of chapters. This is normal. There is no information missing from the manual.

Roadside/Curbside Terminology

Roadside/Curbside terminology: These terms can be confusing because of differences between North America and Europe. Please note:

Curbside:	The side of the bus to the driver’s right when the driver is in his seat and facing forward.
Roadside:	The side of the bus to the driver’s left when the driver is in his seat and facing forward.

Using the Model Tables in “Model Systems and Update Matrices”

The model tables in this section (called “About this Unit,” “Model Systems and Update Matrices,” or something similar) list important unit information that you will need to communicate with the Thermo King Service Department. See the table on the previous page for a description of how to use these tables.

Table of Contents

Refrigeration Maintenance (continued)

List of Figures

LRT-HP, LRT-SP Model Systems Matrix

NOTE: When calling the dealer or factory for information or parts please have the Bill of Material number for your particular unit handy.

LRT-HP

System #	Description	Cond/ Evap B/M	Comp Kit	Install Kit	Grille/ Filter Kit	Fan Motor	Control Voltage	Schem/Wiring Diagrams
920401	7.5 meter	099916/ 006541	720747	800009	720777	Spal	24 Vdc	1E11954/ 1E11955

LRT-SP

System #	Description	Cond/ Evap B/M	Comp Kit	Install Kit	Grille/ Filter Kit	Fan Motor	Control Voltage	Schem/Wiring Diagrams
920280	11 meter	006616/ 006615	720776	819990	720777	Spal	24 Vdc	1E11954/ 1E11955

Safety Precautions

NOTE: EPA Section 608 Certification is required to work on refrigeration systems.

Thermo King recommends that all services be performed by a Thermo King dealer. However, you should be aware of several general safety practices:

The ⚠ symbol appears next to a point that is particularly important.

DANGER: Denotes the possibility of serious injury or death.

WARNING: Denotes the possibility of serious equipment damage or serious personal injury.

CAUTION: Denotes the possibility of minor to severe equipment damage or personal injury.

General Practices

DANGER: Do not operate the compressor with the discharge valve closed. This condition increases internal pressure, which can cause an explosion.

DANGER: Never apply heat to a sealed refrigeration system or container. Heat increases internal pressure, which might cause an explosion.

DANGER: Refrigerant in the presence of an open flame, spark or electrical short produces toxic gases that are severe respiratory irritants.

DANGER: Keep your hands, clothing and tools clear of fans, pulleys, or belts when working on a unit that is running. Loose clothing might entangle moving fans, pulleys, or belts, causing serious injury or possible death.

DANGER: Do not inhale refrigerant. Use caution when working with refrigerant or a refrigeration system in any confined area with a limited air supply, such as a bus or garage. Refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death.

WARNING: Make sure your gauge manifold hoses are in good condition before using them. Never let them come in contact with moving belts, motors, engine pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury.

WARNING: Wear goggles or safety glasses when working around air conditioning systems or batteries. Refrigerant liquid, oil and battery acid can permanently damage your eyes.

WARNING: Use extreme caution when drilling holes in the unit. Holes might weaken structural components. Holes drilled into electrical wiring can cause a fire or explosion.

WARNING: Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils is best left to a certified Thermo King technician.

WARNING: Be careful when using ladders or scaffolding to install or service air conditioning systems. A work platform is recommended for servicing rooftop units. Follow the manufacture's instructions, safety labels and warnings.

CAUTION: Make sure all mounting bolts are tight and are the correct length for their applications. Improper torque and incorrect bolt lengths can damage equipment.

CAUTION: If soldering is required, use dry nitrogen to purge the system during any solder operations. Refer to “Using Pressurized Nitrogen” at the end of the Refrigeration Maintenance chapter.

Battery Removal Hazards

DANGER: Disconnect the negative terminal (-) first when removing a battery. Connect the positive terminal (+) first when installing a battery.

This order is important because the frame is grounded to the negative battery terminal. If the negative terminal is still connected, a complete circuit exists from the positive terminal of the battery to the frame. Metal objects contacting the positive side and the frame simultaneously will cause sparks or arcing. If there are sufficient hydrogen gases emitted from the battery, an explosion might occur, causing equipment damage, serious injury, even death.

CAUTION: Use recommended procedures when servicing equipment. Improper procedures might damage equipment.

Engine Coolant Hazards

CAUTION: Do not use coolant “boosters” or anti-corrosion additives in older Thermo King units (five to seven years old) as it will deteriorate the rubber/neoprene parts/hoses. Contact your local Thermo King dealer for additional information.

CAUTION: Use a mixture of 50 percent antifreeze and 50 percent water in Thermo King bus air conditioning and heating units manufactured with heating coils. This blend prevents coil freezing and assists in preventing corrosion buildup.

Electrical Hazards

WARNING: Control circuits used by bus air conditioners are low voltage (12 or 24 volts dc). This voltage is not dangerous, but the large amount of amperage available from the alternator can cause severe burns if accidentally shorted to ground with metal objects, such as tools.

WARNING: Do not wear jewelry, watches or rings because they increase the risk of shorting out electrical circuits and damaging equipment or causing severe burns.

WARNING: Use caution when working with electrical circuits that have capacitors. Some capacitors hold a significant charge that might cause burns or shocks if accidentally discharged. Make sure capacitors are discharged before working on electrical circuits.

CAUTION: When working with electrical circuits that contain microprocessors, always wear an ESD wrist strap (TK No. 204-622) and connect the opposite end to the chassis ground or CH terminal. This precaution will prevent electrostatic discharge from damaging circuits.

CAUTION: Certain service procedures on bus air conditioning equipment require that the system be de-energized. When this precaution is necessary, ensure the battery’s master switch or service switch is turned off. Confirm that power has been removed before servicing. Equipment that is connected to power is dangerous to service.

Refrigerant Hazards

DANGER: Do not use a Halide torch. When a flame comes in contact with refrigerant, toxic gases are produced that might cause suffocation, even death.

DANGER: Store refrigerant in proper containers, out of direct sunlight and away from intense heat. Heat increases pressure inside storage containers, which can cause them to burst.

DANGER: Do not use oxygen (O_2) or compressed air for leak testing systems. Oxygen mixed with refrigerant is combustible.

WARNING: Wear protective garments and goggles or safety glasses when working with refrigerant to prevent frostbite and eye injuries.

WARNING: Wear butyl lined gloves when handling refrigerant to help prevent frostbite.

CAUTION: All charging using the newer refrigerants (Azeotropic blends) must be done in liquid state. Failure to do this will decrease system operating efficiency. Refer to the charging procedures found in this manual for your unit.

CAUTION: When recovering or transferring refrigerant, use a process that prevents refrigerant from escaping into the atmosphere. Refrigerant damages the earth's upper ozone layer.

CAUTION: Refrigerant in a liquid state evaporates rapidly when exposed to the atmosphere, freezing anything it contacts. Be careful when handling refrigerant to protect your skin from frostbite.

Refrigerant Oil Hazards

WARNING: Protect your eyes from contact with refrigerant oil. The oil can cause serious eye injuries. Avoid prolonged or repeated contact with refrigerant oil. To prevent irritation, wash your hands and clothing thoroughly after handling the oil.

CAUTION: Do not mix refrigerant oils because that can cause system damage.

CAUTION: Use dedicated equipment to prevent contaminating the system with the wrong type of oil or refrigerant.

CAUTION: Thermo King uses a variety of compressor oils. Oil used in the system must be verified. Check ID label or Specification chapter in this manual for correct oil. Using incorrect oil will invalidate the warranty.

CAUTION: When servicing TK units, do not use equipment that might be contaminated with PAG oils.

CAUTION: Store refrigerant oil in an approved sealed container to avoid moisture contamination.

CAUTION: Do not expose refrigerant oil to the air any longer than necessary. The oil will absorb moisture, which results in much longer evacuation times and possible system contamination.

CAUTION: Wipe up spills immediately. Refrigerant oil can damage paints and rubber materials.

First Aid

Engine Coolant

Eyes: In case of eye contact, immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Ingestion: Do not induce vomiting. Immediately contact local poison control center or physician.

Refrigerant Oil

Eyes: Immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Ingestion: Do not induce vomiting. Immediately contact local poison control center or physician.

Refrigerant

In the event of frostbite, protect the frozen area from further injury, warm the area rapidly and maintain respiration.

Eyes: Immediately flush eyes with large amounts of water. CALL A PHYSICIAN.

Skin: Flush area with large amounts of warm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection. CALL A PHYSICIAN. Wash contaminated clothing before reuse.

Inhalation: Move victim to fresh air and use CPR (cardio pulmonary resuscitation) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrives.

Battery Acid

Eyes: Immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Specifications

Electrical Controls (all units)

Software Version (IntelligAIRE II)	P3.0
Software Application File Software Configuration File	2C40104H03 2C40105H28
Control Panel Relays	
Type Voltage: Maximum Vdc @ 85 C Voltage: Pull-In Resistance Coil Operating Current Contact Rating Restive: Normally Open (NO)	Double Pole Single Throw (DPST) 30.0 Vdc 14.4 Vdc 272 ± 10 ohms 88 mA 40 A @ 14 Vdc
Solenoid (Coolant) Valve	
Type Voltage Resistance	Normally closed 27 Vdc 38.4 ± 10 percent ohms @ 77 F (25 C)

Motors (all units)

Condenser Fan Motor Assemblies (3)	
Model Type Horsepower Voltage Current Draw–Full Load RPM–Full Load	Spal Axial VLL 0.273 hp 27 Vdc 10amps 3300
Evaporator Fan Motor Assemblies (3)	
Model Type Horsepower Voltage Current Draw–Full Load RPM–Full Load	Spal Centrifugal Blower Motor VLL 0.36 27 Vdc 10 amps 3800
Fresh Air Damper Motor (Units with Fresh Air option only)	
Voltage	27 Vdc

Refrigerant–LRT-HP

Type	R-22, R407C, R134a
Refrigerant Charge (System)	See unit charging procedures in the Refrigeration Maintenance chapter.

Refrigerant–LRT-SP

Type	R134a
Refrigerant Charge (System)	See unit charging procedures in the Refrigeration Maintenance chapter.

Refrigerant Controls for R-22 and R407C

Condenser Pressure Switch	
Opens	200 ± 20 psig (1379 ± 138 kPa)
Closes	300 +25/–0 psig (2068 + 172/–0 kPa)
Expansion Valve	
Type	External equalizer with Strainer
Superheat Setting	10 to 15 F (6 to 9 C)
Connection	Solder
Evaporator Pressure Regulator (EPR) (Orit 15)	
Type	Pilot operated—adjustable
Adjusted Minimum Pressure	50 ± 1 psig (345 ± 7 kPa)
High Pressure Relief Valve	
Opens	500 + 75/–15 psig (3447 + 517/–103 kPa)
Closes	400 psig (2758 kPa)

Refrigerant Controls for R134a Units

Condenser Pressure Switch	
Opens	160 ± 7 psig (1103 ± 48 kPa)
Closes	200 ± 7 psig (1379 ± 48 kPa)
Expansion Valve	
Type	External equalizer with Strainer
Superheat Setting	10 to 15 F (6 to 9 C)
Connection	Solder
Evaporator Pressure Regulator (EPR) (Orit 15)	
Type	Pilot operated—adjustable
Adjusted Minimum Pressure	24 ± 1 psig (166 ± 7 kPa)
High Pressure Relief Valve	
Opens	500 + 75/–15 psig (3447 + 517/–103 kPa)
Closes	400 psig (2758 kPa)

X430 Compressor, R-134a

Model	X430
Displacement	30 cid (492 cm^3)
Recommended Operating Range	800 to 3000 rpm
Oil Charge (Compressor)	119 oz (3.5 liters)
Oil Type: R-134a (Solest 35)[1 2]	Ester base
Oil Pump Operating Pressure Range	15 to 45 psig (103 to 310 kPa)
Weight (w/Clutch and Service Valves)	115 lb (52 kg)
CAUTION: Failure to use correct Thermo King recommended oil will invalidate your warranty.	
X430 Compressor Clutch: Type	Electromagnetic
Voltage	27 Vdc
Resistance[3]	12 ohms @ 100 F (38 C)
	11.6 ohms @ 75 F (24 C)
	11.2 ohms @ 50 F (10 C)
Air Gap	0.045 ± 0.005 in. (1.143 ± 1.127 mm)
Bearing Grease	Exxon Unirex N2[1]
Rotation	Clockwise
Pulley Diameter	7.75 OD
Pulley Groove	2–5V
Low Pressure Cutout Switch	
Opens	5-17 in. Hg vacuum
Closes	1-7 psig (7-48 kPa)
High Pressure Cutout Switch	
Opens	360 ± 10 psig (2482 ± 69 kPa)
Closes	240 ± 20 psig (1655 ± 138 kPa)

1 Consult the Thermo King Parts Catalog for part number.
2 Failure to use the correct Thermo King-recommended oil will invalidate your warranty.
3 For additional information, refer to the “Clutch Coil Electrical Check” in the Clutch Maintenance chapter in this manual.

X430 Compressor, R-22, R407C

Model	X430
Displacement	30 cid (492 cm^3)
Recommended Operating Range	800 to 3000 rpm
Oil Charge (Compressor)	119 oz (3.5 liters)
Oil Type for R22[1,2]	Alkylbenzene
Oil Type for R407C[1,2]	Ester base
Oil Pump Operating Pressure Range	15 to 45 psig (103 to 310 kPa)
Weight (w/Clutch and Service Valves)	115 lb (52 kg)
CAUTION: Failure to use correct Thermo King recommended oil will invalidate your warranty.	
X430 Compressor Clutch: Type	Electromagnetic
Voltage	27 Vdc
Resistance[3]	12 ohms @ 100 F (38 C)
	11.6 ohms @ 75 F (24 C)
	11.2 ohms @ 50 F (10 C)
Air Gap	0.045 ± 0.005 in. (1.143 ± 1.127 mm)
Bearing Grease	Exxon Unirex N2[1]
Rotation	Clockwise
Pulley Diameter	7.75 OD
Pulley Groove	2B
Low Pressure Cutout Switch	
Opens	5-17 in. Hg vacuum
Closes	1-7 psig (7-48 kPa)
High Pressure Cutout Switch	
Opens	470 ±7 psig (3241 ± 48 kPa)
Closes	375 ± 38 psig (2586 ± 262 kPa)

1 Consult the Thermo King Parts Catalog for part number.
2 Failure to use the correct Thermo King-recommended oil will invalidate your warranty.
3 For additional information, refer to the “Clutch Coil Electrical Check” in the Clutch Maintenance chapter in this manual.

Solder Applications

Components	Used for:	Details
Copper to copper or copper to brass	General refrigeration tubing connections	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 15% Silver TK No. 203-364 Use: Flux Type TK No. 203-365
Copper to stainless steel or brass to stainless steel	Refrigeration tubing connections of dissimilar metals	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

Components	Used for:	Details
Copper to copper or copper to brass	Hot water tubing connections	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 95% Tin and 5% antimony TK No. 204-167 Use: Flux Type TK No. 204-417
Copper to stainless steel or brass to stainless steel	Hot water tubing connections of dissimilar metals	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

NOTE: Some units may be equipped with an evaporator pressure regulating valve (EPR). To reduce the chance of overheating the EPR valve, 95-5 solder or equivalent may be used.

Use 95-5 TK No. 204-167

Use Flux TK No. 204-417

Physical Specifications

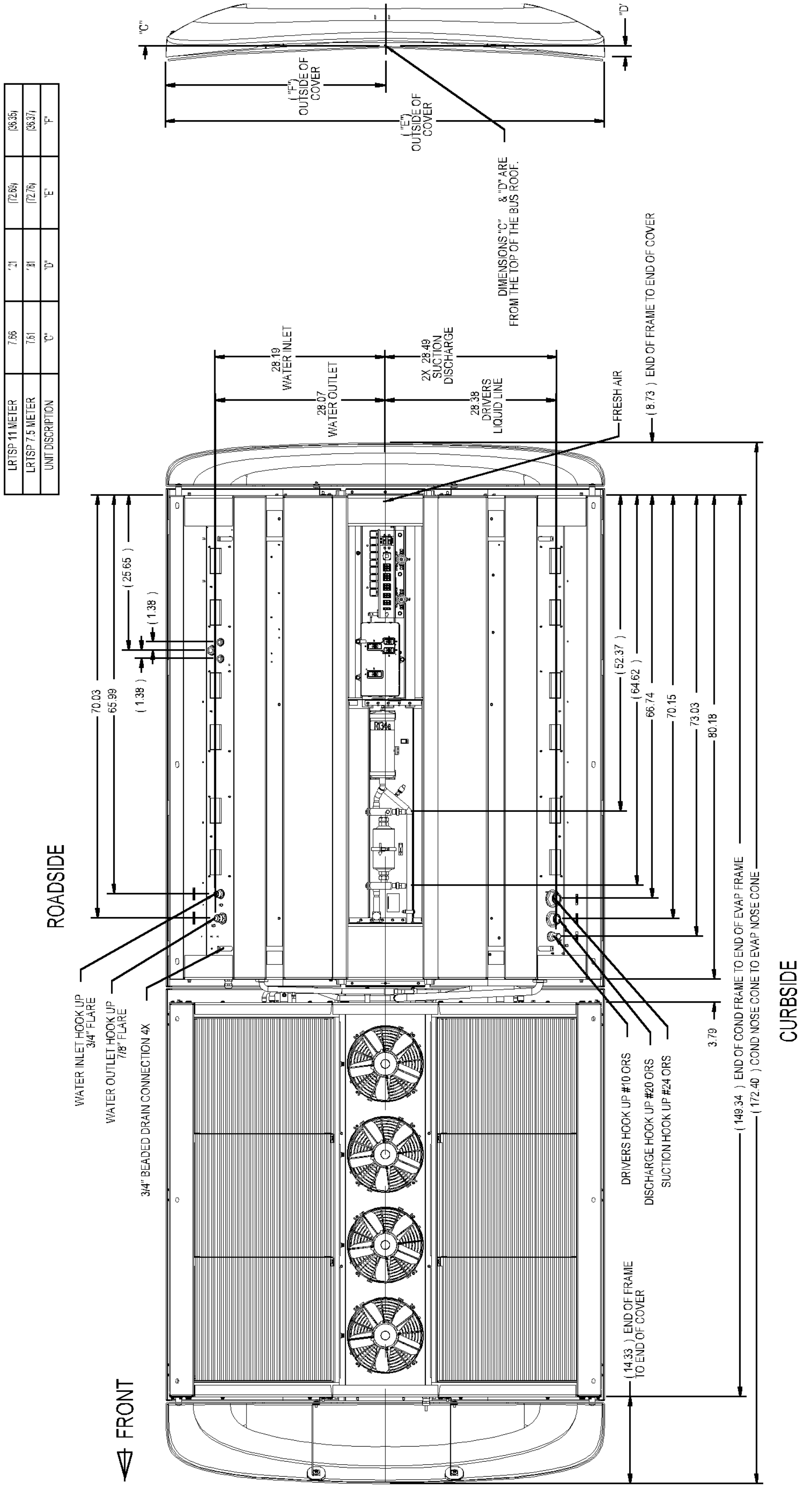
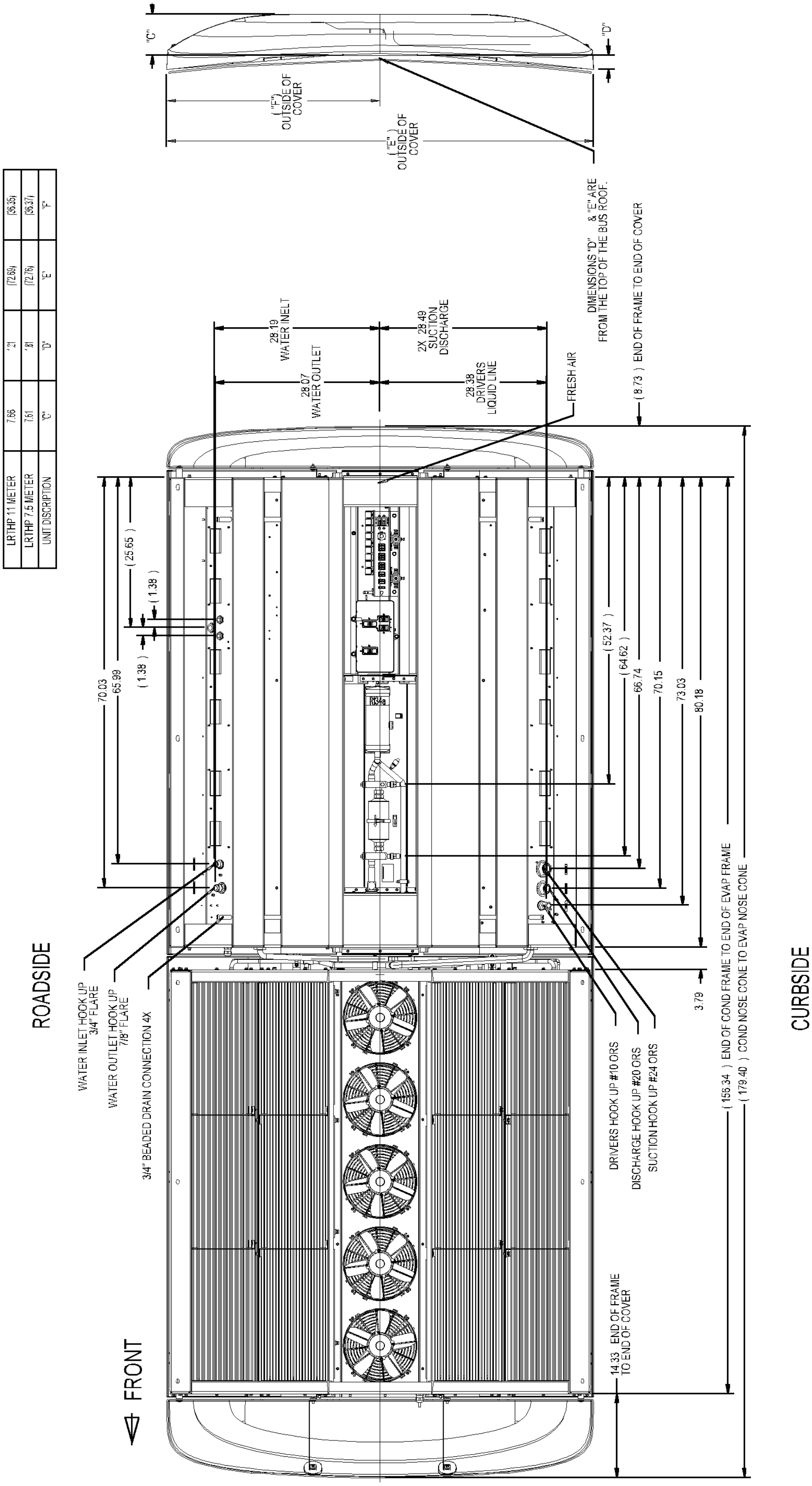


Figure 1: LRT-SP Dimensions



UNIT DISCRIPTION	"C"	"D"	"E"	"F"
LRTHP 11 METER	7.66	.21	(72.69)	(36.35)
LRTHP 7.5 METER	7.61	.81	(72.76)	(36.37)

Figure 2: LRT-HP Outline Dimensions

General Description

Unit Overview

The LRT-HP and LRT-SP are roof-mounted air conditioning units with a low, aerodynamic profiles designed for inner city and tour buses. Units are available in a 7.5 or 11 m radius base. The SP is a medium capacity unit, and the HP is a high capacity unit.

Thermo King IntelligAIRE II

The IntelligAIRE II™ microprocessor controls temperatures in up to three zones. It has a base module, an optional display module, and up to four expansion modules. It has an RS232 interface for downloading data to a PC. For more information, see the “ IntelligAIRE II” chapter in this manual.

X430 Compressor

The X430 is a 30 cid (491.6 cm^3), four-cylinder, V-type, reciprocating compressor. Maximum operating speed is 3000 rpm. The compressor is belt-driven by the bus engine through the electric clutch. Large grease cavities provide bearing lubrication. A grease fitting in the front seal allows lubrication without disassembly.

Cutout switches provide protection from high and low refrigerant pressures. Suction and discharge service valves with gauge manifold ports provide easy servicing.

Serial Number Locations

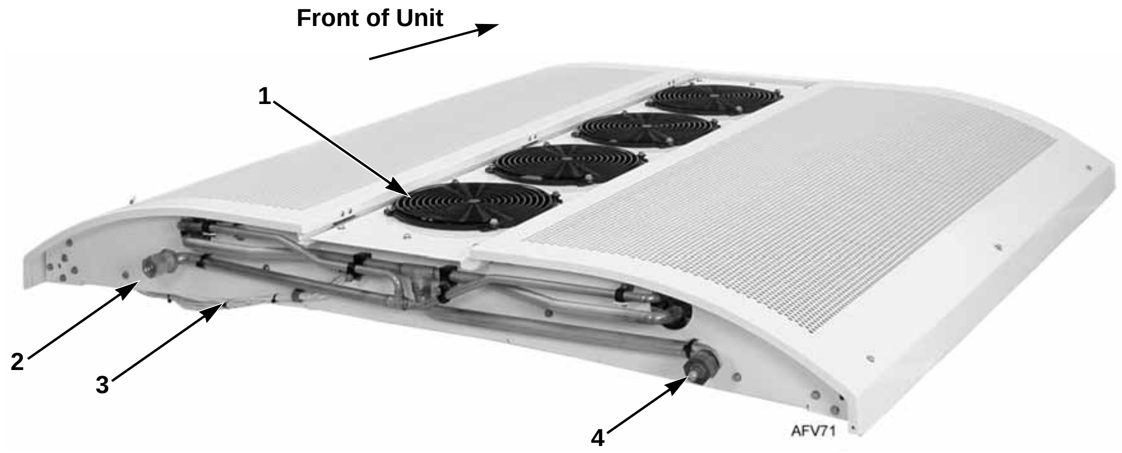
Motors: Located on back of motor housing assembly.

Compressor: Stamped on plate attached to compressor body above clutch.

Unit Evaporator: Nameplate is located inside of unit below the sight glass.

Unit Condenser: Nameplate is located on the curbside mounting channel under the cover.

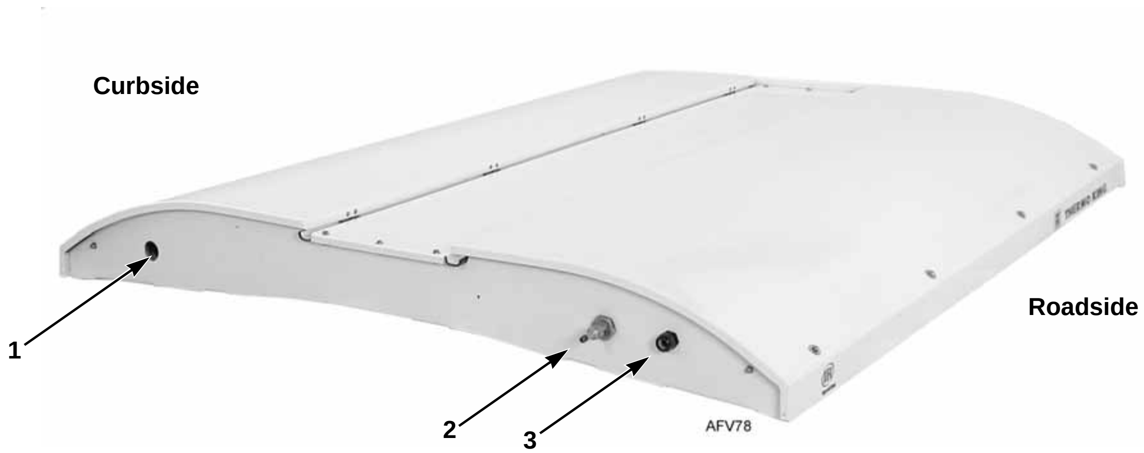
Photos and Illustrations



1.	Condenser Fan (4)	3.	Electrical Harness
2.	Liquid Line	4.	Discharge Line

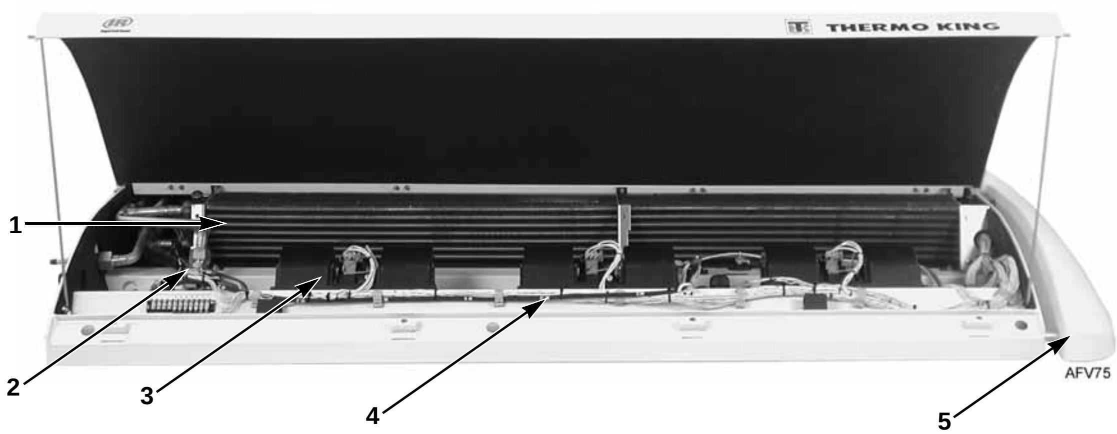
Figure 3: LRT-SP Condenser, Evaporator Connection Lines Shown

Figure 4: Condenser Coil



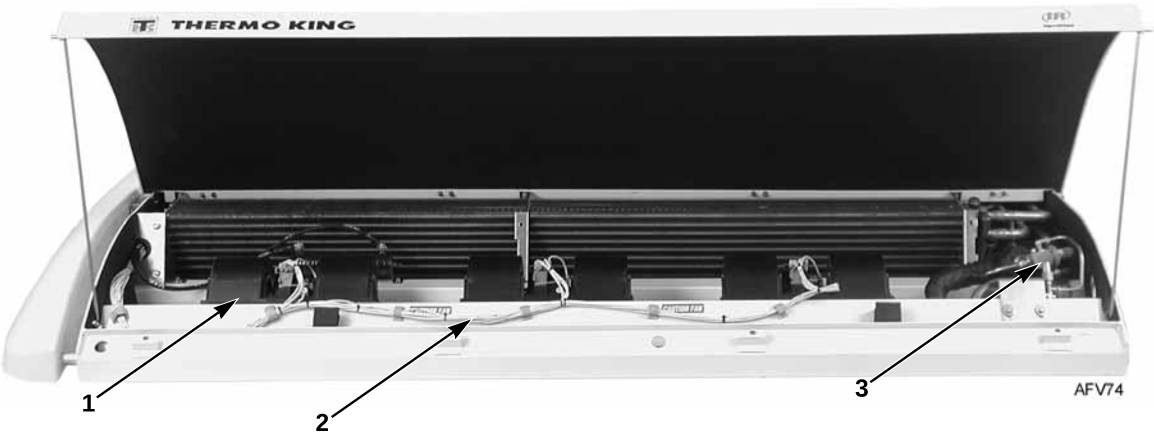
1.	Discharge Line	2.	Liquid Line
3.	Electrical Harness Connector (to Condenser)		

Figure 5: LRT Evaporator



1.	Evaporator Coil	2.	Coolant Valve
3.	Blower (3)	4.	Electrical Harness
5.	Rear Nose Cone		

Figure 6: LRT-SP Evaporator, Roadside View



1.	Blower (3)	2.	Electrical Harness
3.	EPR Valve and EPR Valve Shutoff Valve		

Figure 7: LRT-SP Evaporator, Curbside View

Unit Controls and Operation

Driver Controls

Mode Switch (MSW)

(Bus OEM Supplied)

When this switch is provided by the OEM, its function is to allow the driver to select the mode of operation for the HVAC system. Available modes include, Cool, Vent, Heat, and Automatic. When not provided, the IntelligAIRE control system will operate the HVAC system in the Automatic mode.

For buses equipped with the Programmable Logic Controller (PLC), the PLC uses the input from the mode switch and then energizes the appropriate circuit into the microprocessor controller system so the HVAC system will function in the desired mode.

NOTE: Refer to bus OEM maintenance manuals for information on PLC and associated control logic.

Driver Defrost Switch (DDS)

(OEM Supplied)

When heat is selected for the front defrost/heater unit, the DDS activates the boost pump (BP).

Fan Switch (FSW)

(OEM Supplied)

This switch controls blower speed in Heat or Vent mode. Two switch settings are provided, High speed and Low speed.

Unit Controls

IntelligAIRE II Control System

This unit uses the IntelligAIRE II microprocessor controller. The IntelligAIRE II interface allows you to easily download alarm codes for troubleshooting, and to easily upload programs for new configurations. It has a completely sealed control panel for maximum safety and durability, and can be used to control up to three temperature zones. See the microprocessor controller chapter in this manual for more information.

Ambient Temperature Sensor (ATS)

The ATS monitors outside air temperature and sends a signal to the controller, enabling the controller to select Cool or Heat mode, when running in Auto mode operation.

Return Air Temperature Sensor (RTS)

The RTS is located in the evaporator section. It monitors the return air temperature from inside the bus and sends a signal to the controller, regulating the compartment air temperature and humidity.

Coil Temperature Sensor (CTS)

The CTS monitors the evaporator coil temperature and sends a signal to the controller. If the coil temperature drops too low, the controller stops the compressor to prevent the evaporator coil from freezing. The controller starts the compressor after the coil temperature rises enough to keep the evaporator coil from freezing.

Water (Coolant) Temperature Sensor (WTS)

The WTS is a standard sensor on IntelligAIRE II systems that prevents the blowers from operating until the coolant is warm enough to heat the bus interior.

Condenser Pressure Switch (CPS)

The condenser pressure switch monitors the discharge (condenser) pressure. When the discharge pressure reaches the switch setpoint, it changes the condenser fan speed.

Evaporator Pressure Regulator (EPR)

The EPR valve is installed on the suction line and controls the pressure in the evaporator coil to prevent the coil from icing. See “Specifications” for the EPR pressure setting.

System Controlled Components

Coolant Valve

This coolant valve controls the flow of engine coolant to the evaporator heater coils.

Boost Pump

(OEM Supplied)

The boost pump increases the flow of engine coolant to the heating coil or driver defrost heater.

Evaporator Blower Motors

These motors turn the blower wheels that pull the compartment air through the filters and evaporator/heater coils to provide conditioned air to the passenger compartment.

Condenser Fan Motors

These motors turn the fans that draw air through the condenser coils. As this airflow passes through the condenser coils, it cools and condenses the refrigerant inside the condenser coils.

Compressor Clutch

The compressor clutch is an electromagnetic device that engages the belt-driven pulley to the engine belt-driven compressor.

Unit Indicators

Liquid Line Sight Glass

The liquid line sight glass shows the flow of liquid refrigerant leaving the drier. A clear sight glass with an occasional bubble indicates normal flow. A stream of bubbles indicates a low refrigerant charge, or an obstruction in the system.

The moisture indicator (dry eye) in the liquid line sight glass shows the level of moisture in the system by changing color. Check the color of the indicator against the color decal on the sight glass. The dry eye in the sight glass is GREEN when the system is dry and YELLOW when the system is wet (contains excessive moisture).

Compressor Oil Sight Glass

The compressor oil sight glass indicates the level of compressor oil in the compressor sump.

Unit Protection Devices

High Pressure Relief Valve

A high pressure relief valve is installed in the refrigerant tubing system to vent excessive pressure buildup if necessary.

Low Pressure Cutout Switch (LPCO)

The LPCO switch is a pressure sensitive switch located in the suction line or the suction manifold. If the suction pressure drops below the switch setpoint, the switch will open to stop the compressor. If the switch stays open for more than 60 seconds, the IntelligAIRE controller shuts down the compressor and logs Alarm Code 11.

High Pressure Cutout Switch (HPCO)

The HPCO switch is a pressure sensitive switch located in the compressor head or discharge manifold. If the discharge pressure exceeds the switch setpoint, the switch will open to stop the compressor. If the switch stays open for more than 2 seconds, the IntelligAIRE controller shuts down the compressor and logs Alarm Code 10.

Compressor Discharge Sensor (CDS)

The IntelligAIRE controller monitors the compressor discharge temperature through the CDS. If the compressor discharge temperature exceeds 300 F (149 C) for 30 minutes, the controller logs Alarm Code 08. If the compressor discharge temperature exceeds 320 F (160 C) for one minute, the controller shuts down the compressor and logs Alarm Code 12.

Circuit Breakers and Fuses

For more details, see the schematic diagram in this manual.

Fuse/CB	Amps	Protects
Fuse (not numbered)	150	Battery circuit (OEM Supplied)
CB 1	85	Evaporator Fan Motors
F1, F3, F5	30	Evaporator Fan Motors
F2, F4, F6	20	Evaporator Fan Motors
CB2	85	Condenser Fan Motors
F7-F11	15	Condenser Fan Motors
F12	10	Power Inputs to Clutch Circuit
F13	15	Power Inputs to Boost Pump Circuit
14	10	Power Inputs to Unit Control

Figure 8: Circuit Breakers and Fuses

IntelligAIRE II Controller

IntelligAIRE II Overview

The Thermo King IntelligAIRE™ II is a microprocessor-based controller for bus HVAC systems. It can have a standard display, a deluxe display, or no display, and can control temperatures in up to three zones.

IntelligAIRE II Features

IntelligAIRE II features include:

- Temperature setpoints for three zones (standard and deluxe display)
- Return air and ambient temperature display in three zones (standard and deluxe display)
- Cool, heat, and vent mode operation in three zones (deluxe display only)
- Internal air flow control in three zones (deluxe display only)
- Fresh air damper control in three zones (deluxe display only)
- Driver control of heat, cool, defrost, vent, and blower speed (deluxe display only).

IntelligAIRE II RS-232 PC Interface

The IntelligAIRE II has an RS-232 interface to a computer for use by service technicians. This diagnostic interface:

- Displays and saves alarm codes
- Stores, accesses, and tracks alarm code history
- Accesses hourmeter readings for the compressor, evaporator, and unit run hours
- Tests the system by manually or automatically cycling system outputs
- Displays and monitors system inputs
- Installs software upgrades by flash load rather than by changing a software EPROM.

IntelligAIRE II Components

The IntelligAIRE II is a component-based system that allows expansion of features and temperature control zones. The IntelligAIRE II consists of the following components:

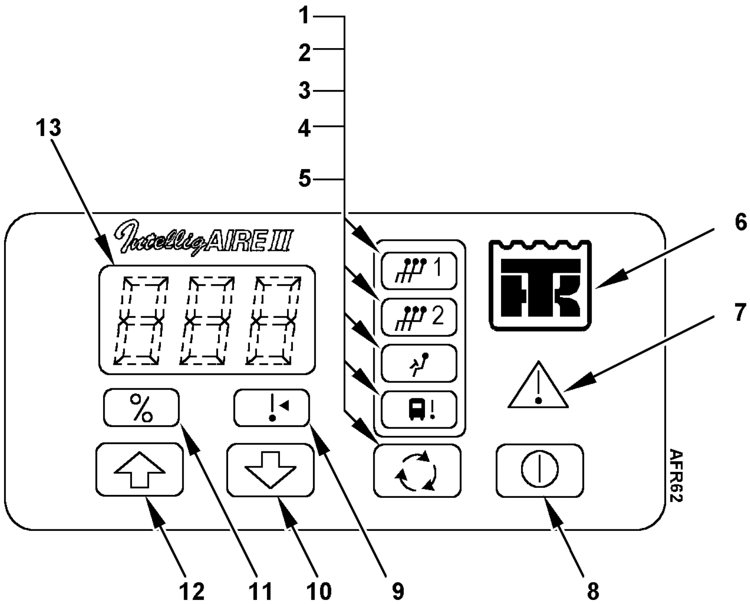
Base Module: The base module contains the main system controller. It communicates with the display module and expansion modules (if applicable) via an SAE J1939 CAN bus.

Expansion Modules: Based on application, a unit can have up to 4 expansion modules that can support additional passenger zones, floor heat zones, or provide expanded driver control.

Display Module (Optional): The display module provides a user interface. It is available in standard and deluxe versions. See the next section for the display panel description.

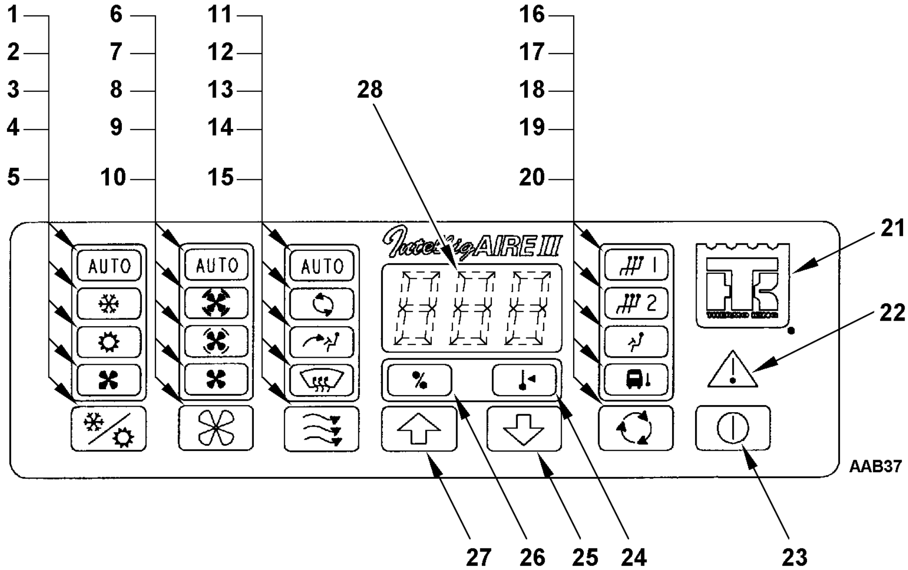
Display Module Description

Display modules are available in a standard version (shown in Figure 9 below) and a deluxe version (shown in Figure 10 on page 41). The display module consists of touch keys, an LED display, and display indicators. Keys and indicator lights are as follows:



1.	Passenger Zone 1 Return Air Temperature Indicator	8.	**ON/OFF** Key
2.	Passenger Zone 2 Return Air Temperature Indicator	9.	Setpoint Indicator
3.	Driver's Zone Return Air Temperature Indicator	10.	**DOWN ARROW** Key
4.	Ambient Air Temperature Indicator	11.	Percent Indicator
5.	**DISPLAY SELECT** Key	12.	**UP ARROW KEY**
6.	**THERMO KING LOGO** Key	13.	LED Display
7.	Warning Indicator		

Figure 9: Standard Display Module



1.	Auto Mode Indicator	15.	**DAMPER SELECT** Key
2.	Cool Mode Indicator	16.	Passenger Zone 1 Return Air Temperature Indicator
3.	Heat Mode Indicator	17.	Passenger Zone 2 Return Air Temperature Indicator
4.	Vent Mode Indicator	18.	Driver's Zone Return Air Temperature Indicator
5.	**OPERATING MODE SELECT** Key	19.	Ambient Air Indicator
6.	Auto Fan Speed Indicator	20.	**DISPLAY SELECT** Key
7.	High Fan Speed Indicator	21.	**THERMO KING LOGO** Key
8.	Medium Fan Speed Indicator	22.	Warning Indicator
9.	Low Fan Speed Indicator	23.	**ON/OFF** Key
10.	**FAN SPEED SELECT** Key	24.	Setpoint Indicator
11.	Auto Damper Indicator	25.	**DOWN ARROW** Key
12.	Recirculate Mode Indicator	26.	Percent Indicator
13.	Driver's Panel Air Indicator	27.	**UP ARROW** Key
14.	Defrost Indicator	28.	LED Display

Figure 10: Deluxe Display Module

On/Off Key: Turns the controller on and off. (If the bus has an OEM-supplied switch, this button is ignored.)

NOTE: The controller does a self-check when turned on. Display functions are not available until after the engine is running.

Operating Mode Select Key: On a deluxe display module, selects operating mode: Auto, Cool, Heat, or Vent. The default mode is Auto. Press this key to select other modes. On a standard display module, the bus OEM may provide a mode selection switch.

Fan Speed Select Key: Selects evaporator fan speed: Auto, High, Medium, or Low. The default mode is Auto. Press this key to select other fan speeds. Available speeds depend on configuration.

Damper Select Key: Selects damper position. The default mode is Auto. In Auto mode, the passenger zone damper opens when the inside temperature is within a few degrees of setpoint. The passenger zone damper has two modes: Auto and Recirculate. The driver zone has up to four modes, depending on the number of damper actuators installed. Select the following modes with the **Damper Select** key:

Auto: Fresh air damper is controlled automatically. Panel air and defrost dampers are closed.

Recirculate: Fresh air damper, panel air damper, and defrost damper are closed.

Panel: Fresh air damper and panel air damper are opened. Defrost damper is closed.

Defrost: Fresh air damper and defrost damper are opened. Panel air damper is closed.

Display Select Key: Selects the display temperature shown on the display: Passenger Zone 1 Return Air Temperature, Passenger Zone 2 Return Air Temperature, Driver Zone Return Air Temperature, or ambient air temperature. The standard default display is Passenger Zone 1 Return Air Temperature. Press the **Display Select** key to view other temperatures.

NOTE: The ambient temperature can alert the driver to possible icing on some road surfaces.

Up and Down Arrow Keys: Increase and decrease the setpoint temperature for the selected zone. In the Standard Display of return air temperature, pressing the **Up** or **Down** key displays the setpoint for the selected zone. Subsequent key presses increase or decrease the setpoint.

Warning Indicator Display: If a warning light stays on after the system has powered up, there is a malfunction occurring. A yellow warning indicates a Check or Log alarm. The system is operable, but should be investigated. A red warning indicates a Shutdown alarm. The unit will not run and should be checked immediately. See “Alarm Code Display Mode” on page 47 for more information.

Modes of Operation

Auto Mode

NOTE: For more information on the thermostat sequence, see the schematic diagram at the end of this manual

In Auto mode, the controller selects Cool or Heat mode based on the ambient temperature, return air temperature, and setpoint.

If the ambient temperature is below 55 F (12.7 C), the unit operates in Heat Mode. The unit stays in Heat Mode as long as the return air temperature is between 4.5 F (2.5 C) degrees above setpoint and 2.5 F (1.4 C) degrees below setpoint. If the return air temperature goes 4.5 F (2.5 C) degrees above the setpoint for more than ten minutes, the unit switches to Cool Mode.

If the ambient temperature is above 60 F (15.6 C), the unit operates in Cool Mode. The unit stays in Cool Mode if the return air temperature is between 2.5 F (1.4 C) above setpoint and 4.0 F (2.2 C) below setpoint. If the return air temperature goes below 4.0 F (2.2 C) for more than ten minutes, the unit switches to Heat Mode.

Cool Mode (Reheat)

In Cool mode with Reheat, the compressor runs continuously. Setpoint is maintained by passing hot engine coolant through the heater coil. The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Cool Mode (Cycling Clutch)

In Cool mode with Cycling Clutch, the compressor cycles on and off to maintain setpoint. A timer prevents the compressor from rapid cycling by setting a minimum off time (60 seconds). The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Vent Mode

In Vent mode, the evaporator blowers run at the speed determined automatically by the microprocessor or manually by the driver. The compressor, boost pump, and coolant valve are off.

Heat Mode

In Heat mode, setpoint is maintained by passing hot engine coolant through the heater coil. The evaporator blowers remain off until the engine coolant temperature rises to 105 F (41 C), as measured by the WTS (water temperature sensor) located on the inlet coolant tube. The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Operating Procedures

Selecting Displays

The Standard Display of Passenger Zone 1 Return Air Temperature displays when the unit is turned on.

To select other displays:

- Press the **DISPLAY SELECT** key. The indicator above the **DISPLAY SELECT** key lights, indicating which temperature is displayed: Passenger Zone 1, Passenger Zone 2, Driver Zone, or Ambient.

Viewing and Changing Setpoints

To view and change setpoints:

1. Press the **DISPLAY SELECT** key to select the desired zone. The indicator above the **DISPLAY SELECT** key lights, indicating which temperature is displayed: Passenger Zone 1, Passenger Zone 2, Driver Zone, or Ambient.
2. To view the setpoint for the selected zone, press the **UP** or **DOWN ARROW** key once. The setpoint indicator flashes, indicating that setpoint is displayed.
3. Press the **UP** key to raise the setpoint. Press the **DOWN** key to lower the setpoint. When the desired setpoint displays, wait approximately 5 seconds. The display returns to the temperature for the selected zone, indicating that the setpoint has changed.

Selecting Operating Modes (Deluxe Display Module Only)

The default operating mode is Auto. To select a different mode, press the **OPERATING MODE SELECT** key. The indicator above the **OPERATING MODE SELECT** key lights, indicating which mode is selected: Auto, Cool, Heat, or Vent.

Selecting Fan Speed (Deluxe Display Module Only)

The default fan speed is Auto. To select a different fan speed, press the **FAN SPEED SELECT** key. The indicator above the **FAN SPEED SELECT** key lights, indicating which mode is selected: Auto, High, Medium, or Low.

Selecting Damper Settings (Deluxe Display Module Only)

The default damper setting is Auto for the passenger zones and Fresh Air for the driver zone. To select a different damper setting, press the **DAMPER SELECT** key. The indicators above the **DAMPER SELECT** key indicate which modes are selected. Auto and Recirculate are available for the passenger zones. Fresh Air, Recirculate, Panel Air, Defrost, and Normal are available for the driver zone.

IntelligAIRE II Diagnostics

Setup Mode

When accessed through the display module, Setup mode is view-only. To change settings, you must use a PC with SMART-Pac™ software.

1. To enter the Setup Mode, press and hold both the **UP** and **DOWN ARROW** keys down for approximately 5 seconds. [Un] appears, indicating the unit is in Setup Mode. Normal operation stops when the unit is in Setup Mode.
2. To scroll through the Setup Mode features, press the **DISPLAY SELECT** key. The features appear in the order shown here:

Programmable Features (Setup Mode)

Display	Programmable Feature
Un	Units of Measure (F = Fahrenheit or C = Celsius)
CC	Clutch Control (rh or Cy)
HC	High Cool Setpoint Limit
LC	Low Cool Setpoint Limit
HH	High Heat Setpoint Limit
LH	Low Heat Setpoint Limit
HA	High Auto Mode Setpoint Limit
LA	Low Auto Mode Setpoint Limit

3. When the desired feature displays, press the **UP** or **DOWN ARROW** key to display the current value.
4. To return to Standard Display mode, press the **TK LOGO** key.

Calibration Mode

When accessed through the display panel, the Calibrate Mode is view-only. To change settings, you must use a PC with SMART-Pac™ software. Consult the unit schematic diagram to determine which input is being displayed. For example, on the schematic diagram, Analog Input 13 is the ATS. When [A13] is displayed in Calibration mode, it is the current reading of the ATS.

1. To enter Calibration Mode, press and hold the **UP ARROW** key and the **TK LOGO** key for approximately 5 seconds. [Axx] appears, indicating the unit is in Calibration Mode. Normal unit operation stops when the unit is in Calibration Mode.
2. To scroll through the Calibration Mode features, press the **DISPLAY SELECT** key. The display shows [Axx] for analog inputs, [Uxx] for analog outputs, and [Pxx] for potentiometers on the servo actuators.
3. When the desired feature displays, press the **UP** or **DOWN ARROW** key to view its value.

   The analog input reading on the display is converted to the units associated with the analog input. If an input is not adjustable, it will display “---”.

   The analog output reading on the display is the percentage of full-scale output voltage 0.0 to 5.0 Vdc. You can measure output voltage with a voltmeter.
4. To return to Standard Display mode, press the **TK LOGO** key.

Service Test Mode

Service test mode allows a service technician to verify the operation of relays, contactors, motor controllers, coolant valves, and modulating valves.

1. To enter Service Test Mode, press and hold the **DOWN ARROW** key and the **DISPLAY SELECT** key for approximately 5 seconds. [Pt] appears, indicating the unit is in Service Test Mode. Normal unit operation stops when the unit is in Service Test Mode.
2. To scroll through the Service Test Mode options, press the **DISPLAY SELECT** key. The test options appear in the order shown below.
3. When the desired test displays, press the **UP** or **DOWN ARROW** key to select the test.

   If an output or function is not enabled in the configuration, the test for that feature is skipped.
4. To exit Service Test Mode and return to the Standard Display, press the **TK LOGO** key.

Service Tests (Service Test Mode)

Display	Service Tests
Pt	Pretrip Test
rt	Relay Test
Ft	Functional Test
EFx	Variable Evaporator x Fan Speed Control Test
CF	Variable Condenser Fan Speed Control Test
CUx	Variable Coolant Valve x Control Test
dPx	Variable Damper Position x Control Test

Pretrip Test

To initiate the Pretrip Test, press either the **Up** or **Down Arrow** key when [Pt] is shown in the display. The test stops if any alarm codes are generated. At the end of the test, the display shows [PAS] (pass) or [FAL] (fail). Pretrip tests are as follows:

1. Relay Test: Sequentially cycles each enabled output on for 5 seconds.
2. Variable Output Tests (CF, EFx, CUx, dPx): Sequentially increment each enabled output from 0 to 100 percent in 10 seconds.

   If the compressor has not been enabled in the configuration, the test will jump to step 4.
3. Cool High Test: The temperature delta for each enabled zone must be at least a preset amount in a preset time period. If discharge air temperature sensors are not installed, the return air temperature for each enabled zone drops at least a preset amount in a preset time period.

   If the boost pump is not enabled in the configuration, the test jumps to step 5.
4. Heat High Test: The temperature delta for each enabled zone must be at least a preset amount in a preset time period. If discharge air temperature sensors are not installed, the return air temperature for each enabled zone rises at least a preset amount in a preset time period.
5. Test Complete: The display shows [PAS] (pass) or [FAL] (fail).
6. To return to Standard Display mode, press the **TK Logo** key.

Relay Test

The Relay Test manually energizes each relay output one at a time, allowing relays to be latched on for diagnosis by a technician.

1. To initiate the Relay Test, press either the **Up** or **Down Arrow** key when [rt] appears in the display. When initiated, the Relay Test turns on the first relay.
2. To scroll through the relay tests, press either the **Up** or **Down Arrow** key. The output on the digital display is turned on and all other outputs are turned off. Consult the unit schematic diagram to determine what component is controlled by each output. The controller has time limits for outputs that can cause damage if left on too long.
3. To exit the Relay Test at any time, press the **Display Select** key.

Functional Test

These tests allow the technician to force the unit into a particular operating mode, regardless of setpoint or return air temperature sensor readings.

1. To initiate the Functional Test, press either the **Up** or **Down Arrow** key when [Ft] appears in the display.
2. To scroll through the Functional tests, press either the **Up** and **Down Arrow** key. The Functional Test Features appear in the order shown in the table below.
3. To exit the Functional Test at any time, press the **Display Select** key.

Functional Test Features

Display	Auto Test Feature
CH	Cool High
Cn	Cool Medium
CL	Cool Low
HH	Heat High
Hn	Heat Medium
HL	Heat Low
UH	Vent High
Un	Vent Medium
UL	Vent Low

Variable Output Tests

The Variable Output test energizes the device connected to the selected output with a 0 percent drive signal or position signal. [00] appears in the display.

1. To initiate the Variable Output Test, press either the **Up** or **Down Arrow** key when [EFx], [CF], [Cux], or [dPx] appears in the display.
2. Press the **Up** or **Down Arrow** keys to increase or decrease the drive signal or position signal for the selected output. Each key press changes the signal and the reading in the display by 1 percent.
3. To exit the Variable Output Test at any time. press the **Display Select** key.

Hourmeter and Real Time Clock Display Mode

1. To enter Hourmeter Display Mode, press and hold the **Display Select** key for approximately 5 seconds. [Un] appears, indicating the unit has entered the Hourmeter Display Mode. Normal unit operation stops when the unit is in Hourmeter Display Mode.
2. Release the **Display Select** key to view the hourmeter readings. The controller automatically scrolls through the displays.

   Each record is displayed in several parts, with each part being displayed for 1 second. Each part is described below.

Total Unit Hour Format

Un	Hr	XX	YY	ZZ

Evaporator Hour Format

EP1	Hr	XX	YY	ZZ
EP2	Hr	XX	YY	ZZ
EP3	Hr	XX	YY	ZZ

Compressor Hour Format

CP	Hr	XX	YY	ZZ

The underlined symbols display as shown. The non-underlined symbols are replaced with numbers according to the following legend:

Digit Legend

XX	=	Most significant two digits of hour total
YY	=	Middle two digits of hour total
ZZ	=	Least significant two digits of hour total

For example, a Total Unit Hours reading of 187 hours would appear as:

Example of 187 Total Unit Hours

Un	Hr	00	01	87

When all hourmeters have displayed, the Display Module scrolls through the time and date for the real time clock:

Real Time Clock Format

rtc		
Hr	XX	Hour–24 Hour Format
UtE	XX	Minute
nth	XX	Month
dAy	XX	Day of Month
yr	XX	Year

3. To modify time or date parameters:
   a. Press the **Up** or **Down Arrow** key while the parameters are displayed. The display blinks, indicating the Modify mode.
   b. Press the **Display Select** key to scroll through each selection for the clock.
   c. To modify the displayed selection, press the **Up** or **Down Arrow** key. After scrolling through all the parameters, the system will

return to Standard Display Mode. If more than 5 seconds pass between key presses during the modify mode, the system returns to Standard Display Mode and the real time clock settings will not change.

4. To exit the Hourmeter Display Mode, press the **TK Logo** key.

Alarm Code Display Mode

Displaying Alarm Codes

1. To enter the Alarm Code Display Mode, press and hold the **Thermo King Logo** key for 5 seconds. The display changes to the most recent alarm code.
2. To scroll through the alarm codes, press the **Display Select** key.
3. To clear the displayed alarm code, press the **Up** or **Down Arrow** key. Two dashes (- -) display, indicating the alarm is cleared. See the table “Alarm Codes” on page 48 for alarm code descriptions.
4. To exit Alarm Code Display Mode, press the **TK Logo** key.

Types of Alarm Codes

Log: Indicates a service timer has expired. The alarm code reappears until the timer is reset.

Check: Indicates a system fault that requires attention but is not serious enough to shut the unit down. You can clear a Check Alarm only after the alarm condition no longer exists.

Shutdown: Indicates a serious system fault that causes the unit to shut down. You can clear a Shutdown Alarm at any time, but the alarm will re-occur if the alarm condition is not corrected.

Alarm Codes

Code	Type	Description
00		No Alarm Codes Present
01	Check	Coolant Temperature Sensor (WTS) - reading out-of-range
02	Check	Evaporator Coil Temperature Sensor (CTS) - reading out-of-range
03	Check	Return Air Temperature Sensor (RTS) - reading out-of-range
04	Check	Discharge Air Temperature Sensor (DTS) - reading out-of-range
05	Check	Ambient Air Temperature Sensor (ATS) - reading out-of-range
06	Check	Compressor Discharge Temperature Sensor (CDS) - reading out-of-range
07	Check	Low Heating Capacity
08	Check	Compressor Discharge Temperature Warning
09	Check	Low Cooling Capacity
10	Shutdown	High Pressure Shutdown
11	Shutdown	Low Pressure Shutdown
12	Shutdown	Compressor Discharge Temperature Shutdown
13	Shutdown	Condenser Fan Motor Drive - drive fault
14	Shutdown	Evaporator Fan Motor Drive - drive fault
15	Check	Compressor Clutch - output fault
16	Check	Boost Pump (BP) - output fault
17	Check	Condenser High Speed - output fault
18	Check	Condenser Low Speed - output fault
19	Check	Condenser Variable Speed - output fault
20	Check	Loader/Unloader Solenoid 1 (LV1/US1) - output fault
21	Check	Loader/Unloader Solenoid 2 (LV2/US2) - output fault
22	Check	Condenser Pressure Transducer (CPT) - reading out-of-range
25	Check	Evaporator High Speed - output fault
26	Check	Evaporator Medium Speed - output fault
27	Check	Evaporator Low Speed - output fault
28	Check	Evaporator Variable Speed - output fault
29	Check	Liquid Valve (LLV)- output fault
30	Check	Modulating Liquid Valve (MLV) - output fault
31	Check	Coolant Valve (CV) - output fault
32	Check	Variable Coolant Valve - feedback fault
33	Check	Floor Coolant Valve - output fault
34	Check	Floor Variable Coolant Valve - feedback fault
35	Check	Fresh Air Damper - output fault
36	Check	Variable Fresh Air Damper - feedback fault
40	Check	Base Module (ECM) - internal fault
41	Check	Base Module (ECM) Battery Power - input fault
42	Check	Base Module (ECM) Control Power - input fault
43	Check	Base Module Compressor Power - input fault
44	Check	Base Module Boost Pump (BP) Power - input fault
50	Check	Expansion Module 1 (EPM) - internal fault
51	Check	Expansion Module 1 (EPM) Battery Power - input fault

Alarm Codes (Continued)

Code	Type	Description
52	Check	Expansion Module 1 (EPM) Control Power - input fault
60	Check	Expansion Module 2 (EPM) - internal fault
61	Check	Expansion Module 2 (EPM) Battery Power - input fault
62	Check	Expansion Module 2 (EPM) Control Power - input fault
70	Check	Expansion Module 3 (EPM) - internal fault
71	Check	Expansion Module 3 (EPM) Battery Power - input fault
72	Check	Expansion Module 3 (EPM) Control Power - input fault
80	Check	Expansion Module 4 (EPM) - internal fault
81	Check	Expansion Module 4 (EPM) Battery Power - input fault
82	Check	Expansion Module 4 (EPM) Control Power - input fault
90	Log	Condenser/Compressor Service Timer - has expired
91	Log	Evaporator 1 Service Timer - has expired
92	Log	Evaporator 2 Service Timer - has expired
93	Log	Evaporator 3 Service Timer - has expired
95	Check	Display Module (DDM) - not responding
96	Check	Expansion Module 1 (EPM) - not responding
97	Check	Expansion Module 2 (EPM) - not responding
98	Check	Expansion Module 3 (EPM) - not responding
99	Check	Expansion Module 4 (EPM) - not responding
102	Check	Passenger Zone 1 Evaporator Coil Temperature Sensor (CTS1) - reading out-of-range
103	Check	Passenger Zone 1 Return Air Temperature Sensor (RTS1) - reading out-of-range
104	Check	Passenger Zone 1 Discharge Air Temperature Sensor (DTS1) - reading out-of-range
107	Check	Passenger Zone 1 Low Heating Capacity
109	Check	Passenger Zone 1 Low Cooling Capacity
114	Check	Passenger Zone 1 Evaporator Inverter - drive fault
125	Check	Passenger Zone 1 Evaporator High Speed - output fault
126	Check	Passenger Zone 1 Evaporator Medium Speed - output fault
127	Check	Passenger Zone 1 Evaporator Low Speed - output fault
128	Check	Passenger Zone 1 Evaporator Variable Speed - output fault
129	Check	Passenger Zone 1 Liquid Valve (LLV1) - output fault
130	Check	Passenger Zone 1 Modulating Liquid Valve (MLV1) - output fault
131	Check	Passenger Zone 1 Coolant Valve - output fault
132	Check	Passenger Zone 1 Variable Coolant Valve - feedback fault
133	Check	Passenger Zone 1 Floor Coolant Valve - output fault
134	Check	Passenger Zone 1 Floor Variable Coolant Valve - feedback fault
135	Check	Passenger Zone 1 Fresh Air Damper - output fault
136	Check	Passenger Zone 1 Variable Fresh Air Damper - feedback fault
202	Check	Passenger Zone 2 Evaporator Coil Temperature Sensor (CTS2) - reading out-of-range
203	Check	Passenger Zone 2 Return Air Temperature Sensor (RTS2) - reading out-of-range
204	Check	Passenger Zone 2 Discharge Air Temperature Sensor (DTS2) - reading out-of-range
207	Check	Passenger Zone 2 Low Heating Capacity
209	Check	Passenger Zone 2 Low Cooling Capacity

Alarm Codes (Continued)

Code	Type	Description
214	Check	Passenger Zone 2 Evaporator Inverter - drive fault
225	Check	Passenger Zone 2 Evaporator High Speed - output fault
226	Check	Passenger Zone 2 Evaporator Medium Speed - output fault
227	Check	Passenger Zone 2 Evaporator Low Speed - output fault
228	Check	Passenger Zone 2 Evaporator Variable Speed - output fault
229	Check	Passenger Zone 2 Liquid Valve (LLV2) - output fault
230	Check	Passenger Zone 2 Modulating Liquid Valve (MLV2) - output fault
231	Check	Passenger Zone 2 Coolant Valve - output fault
232	Check	Passenger Zone 2 Variable Coolant Valve - feedback fault
233	Check	Passenger Zone 2 Floor Coolant Valve - output fault
234	Check	Passenger Zone 2 Floor Variable Coolant Valve - feedback fault
235	Check	Passenger Zone 2 Fresh Air Damper - output fault
236	Check	Passenger Zone 2 Variable Fresh Air Damper - feedback fault
302	Check	Driver Zone Evaporator Coil Temperature Sensor (CTS3) - reading out-of-range
303	Check	Driver Zone Return Air Temperature Sensor (RTS3) - reading out-of-range
304	Check	Driver Zone Discharge Air Temperature Sensor (DTS3) - reading out-of-range
307	Check	Driver Zone Low Heating Capacity
309	Check	Driver Zone Low Cooling Capacity
314	Check	Driver Zone Evaporator Inverter - drive fault
325	Check	Driver Zone Evaporator High Speed - output fault
326	Check	Driver Zone Evaporator Medium Speed - output fault
327	Check	Driver Zone Evaporator Low Speed - output fault
328	Check	Driver Zone Evaporator Variable Speed - output fault
329	Check	Driver Zone Liquid Valve (LLV3) - output fault
331	Check	Driver Zone Coolant Valve - output fault
332	Check	Driver Zone Variable Coolant Valve - feedback fault
333	Check	Driver Zone Floor Coolant Valve - output fault
334	Check	Driver Zone Floor Variable Coolant Valve -feedback fault
335.	Check	Driver Zone Fresh Air Damper - output fault
336	Check	Driver Zone Variable Fresh Air Damper - feedback fault
337	Check	Driver Zone Panel Air Damper - output fault
338	Check	Driver Zone Variable Panel Air Damper - feedback fault
339	Check	Driver Zone Defrost Air Damper - output fault
340	Check	Driver Zone Variable Defrost Air Damper - feedback fault

Maintenance Inspection Schedule

Coordinate the maintenance inspection schedule with the Bus Preventive Maintenance Schedule. See Thermo King Bus A/C Preventive Maintenance forms TK 40809 for more information.

NOTE: Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.

NOTE: See the appropriate chapter in this maintenance manual for instructions on how to correctly perform required maintenance.

Off Season Operation Of Bus Air Conditioning System

In order for the A/C system to be ready for operation, normal preventive maintenance is necessary. Operate all systems periodically, especially during the off season. By operating the system weekly for short intervals (5 to 10 minutes) year round, the internal parts of the compressor will remain lubricated. Off-season operation also helps reduce compressor shaft seal leakage and allows early detection of refrigerant loss.

Prior to operating the compressor during winter months, you must warm up the coach interior to normal operating temperature (60 to 76 F [15 to 21 C]). Unless this precaution is taken, liquid refrigerant might be forced into the compressor, causing severe damage.

Electrical

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
	Semi-annually		Check evaporator blower motors speed, voltage and amperes (all motors).
	Semi-annually		Check condenser fan motor speed, voltage and amperes (all motors).
		•	Check thermostat cycle sequence on all modes (e.g., cool/reheat, vent/heat).
		•	Visually inspect alternator drive belts for excessive wear, tension and alignment.
		•	Clean alternator, check for signs of corrosion, and check wire connections.
		•	Clean control panel area and return air sensor with compressed air. ***NOTE: These may need to be cleaned more frequently.***
		•	Check boost pump (OEM supplied) motor operation, and inspect brushes (when equipped).
		•	Inspect wires and terminals for damage or corrosion. If corrosion is present, clean terminals with electrical contact cleaner.
		•	Check condenser pressure switch/condenser motor high and low speed operation.
		•	Check high pressure cutout and low pressure cutout switches.

Refrigeration/Heating

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•	•	Check refrigerant charge. Make sure discharge pressure is 250 psig (1724 kPa) on R-22 and R-407C systems and 150 psig (1034 kPa) on R-134a systems. The ball in the top receiver tank sight glass should be floating and the liquid line sight glass (if equipped) should be full and clear—no bubbles. Charge: OK _______, Needs charging _______ ***NOTE: This should be done twice monthly during air conditioning season.***
•	•	•	Inspect condition of refrigerant hoses and tubing.
•	•	•	Inspect for leaks of refrigerant and oil.
•	•	•	Check dry eye in the liquid line sight glass for moisture content.
•	•	•	Check compressor oil level and color (1/4 to 3/4 way up on the sight glass after 15 minutes of operation—X430 compressor).
	•	•	Install service gauge manifold set and check system operating pressures, temperatures and suction line conditions.
		•	Check compressor oil for acidity.
		•	Check compressor efficiency.
		•	Check compressor oil pump pressure.
		•	Check evaporator pressure regulator (EPR) valve operation.
		•	Replace filter-drier (liquid line dehydrator). ***NOTE: The filter-drier should be changed anytime the system is opened.***
		•	Check hot water control valve operation.

Structural

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•		Inspect condenser coil for cleanliness.
•	•		Inspect evaporator coil for cleanliness.
•	•	•	Visually inspect unit for loose, damaged, or broken parts.
•	•	•	Clean or replace return air filter (more frequently if necessary).
	Semi-annually		Lubricate evaporator fanshaft bearings (Shell Alvania EP2).
		•	Clean condenser and evaporator drains. Make sure the evaporator drain hose check valves (kazoos) are in place and in good condition.
		•	Visually inspect engine coolant hose and hose clamp condition on heater coil system.
		•	Clean condenser and evaporator coils.
		•	Check engine coolant for antifreeze protection down to –30 F (–34 C) to prevent heater coil freeze up.
		•	Tighten compressor, unit, and fan motor mounting bolts and brackets (more frequently if necessary).
		•	Check condenser air seals.

X430 Compressor Clutch

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•	•	Inspect clutch armature for wear and overheating caused by slippage.
•	•	•	Inspect compressor drive belts for excessive wear, tension and alignment (refer to bus manufacturer and/or belt supplier for proper tension).
	•	•	Check clutch air gap 0.045 ± 0.005 in. (1.143 ± 0.127 mm) and surface flatness—X430 compressor.
		•	Steam clean compressor and clutch.
		•	Check clutch coil resistance and voltage.
		•	Lubricate X430 compressor clutch bearing (Exxon Unirex N2).

Electrical Maintenance

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Inspect evaporator blower motor bearings, speed, voltage, and amperage. See “Specifications” chapter for normal readings. Bearings: OK _______, Replace ______ Speed _______ rpm, Voltage _______ Vdc, Amperage _______ amps		Semi-Annually	
Inspect condenser fan motor bearings, speed, voltage, and amperes. See “Specifications” chapter for normal readings. Bearings: OK _______, Replace ______ Speed _______ rpm, Voltage _______ Vdc, Amperage _______ amps		Semi-Annually	
Check thermostat cycle sequence on all modes (e.g., cool/vent, cool/reheat, and vent/heat). OK _______ Diagnose thermostat/unit_______			•
Visually check alternator belt wear, alignment and tension. Condition: OK _______, Replace ______ Alignment: OK _______, Adjusted ______ Tension: OK _______, Adjusted ______			•
Clean alternator, check for signs of corrosion, and check wire connections.			•
Clean control panel area and return air sensor.			•
Check boost pump motor (OEM supplied) operation, voltage, and inspect brushes. Voltage _______Vdc Brushes: OK _______, Replace ______ Operation: OK _______, Replace motor______			•
Inspect all wires and terminals for damage or corrosion.			•
Check condenser pressure switch (CPS)/condenser fan motor high and low speed operation. See “Specifications” chapter for normal readings. CPS opens at _______ psig CPS closes at _______ psig			•

WARNING: Take precautions to ensure the unit and the bus will not accidentally start while you are servicing the system.

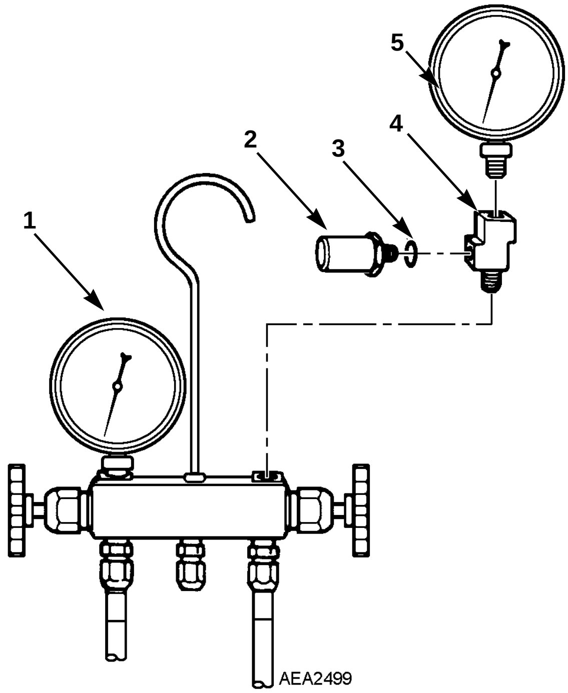
Wiring and Harness Inspection

Inspect the unit wiring and wire harness during scheduled maintenance intervals as follows:

1. Monitor the voltage available and test for voltage drops. More than a 0.2 volt drop across any of the wiring or connections indicates a problem. Repair or replace the component.
2. Spray contacts and terminals with an electrical cleaner. A good grade of cleaner also provides waterproofing that helps prevent voltage leaks.

High Pressure Cutout Switch (HPCO)

The high pressure cutout (HPCO) switch located on the compressor cylinder head or discharge manifold. If the discharge pressure rises above switch setpoint, the switch opens the clutch circuit, stopping the compressor. When the discharge pressure drops below switch setpoint, the switch closes. To test the switch, rework a gauge manifold per Figure 11.



1.	Suction Gauge
2.	Relief Valve
3.	O-ring
4.	Adapter Tee (Edelmann PN 22-7200)
5.	Discharge Gauge

Figure 11: High Pressure Cutout Manifold

HPCO Test Procedure

Refer to the “Specifications” chapter for the HPCO specifications.

1. Connect the modified gauge set as seen in Figure 11 to the compressor discharge service valve with a heavy duty, black-jacketed, thick wall #HCA 144 hose with a 900 psig (6205 kPa) working pressure rating.
2. Adjust the temperature setpoint well below the ambient temperature so that the unit will go into the Cool mode.
3. Start the unit and let it run for a few minutes.
4. Raise the discharge pressure by blocking the condenser coil air inlet. Observe the discharge pressure reading on the gauge the instant the compressor stops. If the gauge reading exceeds the switch specification (see Specifications chapter), replace the switch.

WARNING: If the HPCO fails to stop the compressor when pressure reaches the switch specification, immediately stop the unit. Pressure in excess of this amount can damage the unit.

CAUTION: If the HPCO fails, excess pressure may build up, causing the high pressure relief valve to open.

5. To investigate the failure of the HPCO to stop compressor operation, first check the control circuit operation, then replace the HPCO switch. To check the control circuit operation, disconnect the electrical leads to the HPCO switch. The compressor should immediately stop, indicating the HPCO switch is defective and must be replaced.

HPCO Removal and Installation

Removal

1. Jumper the low pressure cutout (LPCO) switch to prevent automatic unit shutdown.
2. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
3. Run the unit and close the suction service valve to pump the compressor down to a 15 in. vacuum (–51 kPa).
4. Stop the unit.
5. If the compound gauge rises out of the 15 in. vacuum (–51 kPa), run the unit again. Repeat this process until the reading remains at a 15 in. vacuum (–51 kPa).
6. With the unit stopped and the compound gauge reading remaining at a 15 in. vacuum (-51 kPa), close (i.e., front seat) the discharge service valve.

CAUTION: Whenever the discharge service valve is front seated, secure the unit and the bus so they cannot run.

7. Have a new switch ready to install. Apply refrigeration Loctite™ to the threads of the new switch.

CAUTION: Refrigerant pressure in the manifold is high.

8. Bleed the refrigerant from high side to low side through the gauge manifold. Reclaim any refrigerant left in the high side.
9. Disconnect the wires and remove the switch

Installation

NOTE: Install the new switch immediately to minimize the amount of air entering the system.

1. Install the new switch and connect the wires.
2. Pressurize the compressor and test for leaks.
3. If no leaks are found, evacuate the compressor. Then open the suction and discharge service valves and place the unit in operation.

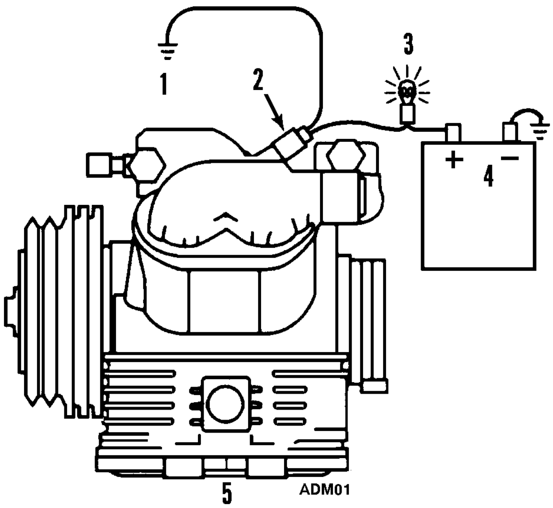
Low Pressure Cutout Switch (LPCO)

The low pressure cutout (LPCO) switch is located on the suction manifold of the compressor. If the suction pressure drops below the switch setpoint, the switch opens the clutch circuit, stopping the compressor.

LPCO Test Procedure

Refer to the “Specifications” chapter for the LPCO specifications.

1. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Adjust the thermostat setpoint well below the ambient temperature so the unit goes into Cool mode.
3. Start the unit and let it run for a few minutes.
4. Close the receiver tank outlet valve or liquid line shutoff valve to pump down the low side. Observe the suction pressure reading on the compound gauge at the instant the compressor stops. The switch should open to stop the compressor within the switch specifications.
5. To test switch closing, connect the switch to a test light using the following procedure:
   a. Disconnect the switch leads.
   b. Jumper one side of the switch to ground.
   c. Connect the other side of the switch to a test light, as shown in Figure 12.



1.	Ground
2.	LPCO Switch
3.	Test Light
4.	Voltage Source (12 or 24 V)
5.	Compressor

Figure 12: Test Light Connections

   d. Connect the other end of the test light to a voltage source (12 or 24 volts).
   e. Slowly open the tank outlet valve or liquid line shutoff valve to allow the suction pressure to rise. Observe the suction pressure reading on the compound gauge at the instant the test light comes on. The reading should be within the switch specifications.
6. To investigate the failure of the LPCO to stop the compressor, first check the control circuit operation, then replace the LPCO. To check control circuit operation, disconnect the

electrical leads to the LPCO. The compressor should immediately stop, indicating the LPCO switch is defective and must be replaced.

LPCO Removal and Installation

Removal

1. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Jumper the low pressure cutout (LPCO) switch to prevent automatic unit shutdown.
3. Start the unit and let it run for a few minutes.
4. Pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown”).
5. Have new switch ready to install onto the 1/4 in. MFL fitting. Before installing, check the switch. The Schrader valve depressor must be functional. Ensure depressor is not bent or plugged with dirt.
6. Disconnect the wires and remove the switch.

Installation

NOTE: Install the new switch immediately to minimize the amount of air entering the system.

1. Install the new switch and connect the wires.
2. Pressurize the low side and check for leaks.
3. If no leaks are found, evacuate the low side. Open the receiver tank outlet valve or liquid line shutoff valve and place the unit in operation.

Condenser Pressure Switch (CPS)

This pressure sensitive switch is located in a fitting on the high pressure inlet line to the receiver tank in the evaporator section. The CPS monitors the discharge pressure. When pressure reaches the switch setpoint, it changes the condenser fan speed.

CPS Test Procedure

Refer to the “Specifications” chapter for the CPS specifications.

1. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Adjust thermostat setpoint well below the ambient temperature so that the unit will be in Cool mode.
3. Start the unit and let it run for a few minutes.
4. Raise the discharge pressure by covering the condenser coil air inlets. Observe the discharge pressure reading on gauge when the condenser fans go from low speed to high speed.
5. Lower the discharge pressure by removing the covers from the condenser coil air inlets. Observe the discharge pressure reading on gauge when the condenser fans go from high speed to low speed.
6. Failure of the CPS to change the condenser fan speeds should be investigated first by checking the control circuit operation, and secondly by replacing the CPS switch. To check control circuit operation, disconnect the electrical connector to the CPS switch. The condenser fans should run in high speed. Place a jumper between the CPS and CH circuits in the evaporator control harness. The condenser fans should go to low speed. If the condenser fans go from high speed to low speed when the jumper is placed between the CPS and CH circuits, the CPS switch is defective and must be replaced.

CPS Removal and Installation

Removal

1. Recover the refrigerant charge.
2. Disconnect the wires and remove the switch.

Installation

1. Before installing the new switch, apply a refrigerant loctite to the threads of the new switch.
2. Install and tighten the new switch.
3. Pressurize the system and leak test the system.
4. If no leaks are found, evacuate the system.

5. Recharge the unit with the proper refrigerant and check the compressor oil.

Boost Pump

(OEM Supplied)

Consult the bus OEM manual for information concerning diagnosis and repair procedures.

Coolant Valve

The coolant valve controls the flow of engine coolant to the heater coil. The coolant valve requires no maintenance. However, deposits of dirt, scale, or sludge can accumulate in the valve, causing the valve coil to hum. You can eliminate this by cleaning or flushing the valve and engine coolant system. To assist in preventing corrosion buildup and freezing, Thermo King specifies that all heating coils be operated with a mixture of 50 percent ethylene glycol and 50 percent water.

Service of the valve includes replacement of the coil; the diaphragm, plunger, and seal; or the entire valve.

There are three possible valve malfunctions: coil burnout, failure to open and failure to close. Each is described below.

Coil Burnout

Coil burnout is caused by:

- Improper voltage
- Continuous over-voltage of more than 10%
- Incomplete magnetic circuit due to the omission of parts such as coil housing or plunger
- Mechanical interference with movement of plunger which can be caused by a deformed enclosing tube.

Failure to Open (Normally Closed Types)

Failure to open on normally closed coolant valves is caused by:

- Coil burned out or an open circuit to coil connections
- Improper voltage
- Deformed valve body or enclosing tube

Failure to Close

Failure to close is caused by:

- Torn diaphragm
- Deformed valve body or enclosing tube
- Foreign material (dirt, scale, etc.) in seat.

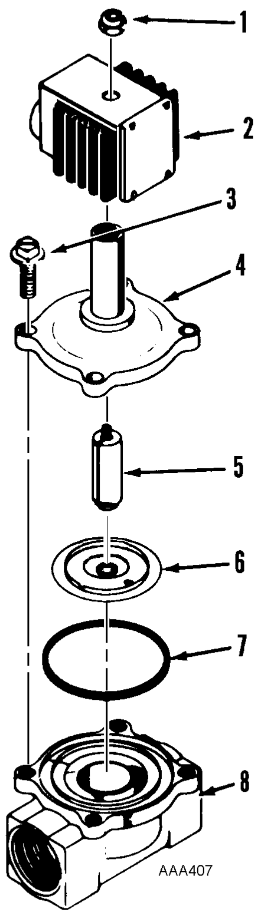
Coolant Valve Repair

1. Turn the power switch off. Disconnect the electrical connections to the coolant valve.
2. Close the engine coolant return shutoff valve above the engine. Remove the heater coil inlet hose connection. Drain the coolant.
3. Disconnect the lead wires.
4. Remove the locknut on the coolant valve coil and remove the coil.

   NOTE: In most cases, only the coil needs replacement.
5. Sporlan valve disassembly and assembly.
   a. Remove the four enclosing tube mounting bolts. Disassemble the enclosing tube and the internal valve parts.
   b. Assemble the new diaphragm, plunger and gasket seal on the valve base. Install the enclosing tube and the mounting bolts.
6. Install the coil assembly and tighten the locknut.
7. Connect the coolant lines. Fill the heating system with coolant and bleed air from the system.
8. Connect the electrical connections to the coolant valve and place the unit back in service.

   NOTE: When installing the valve, observe the In and Outlet positions stamped on the valve for proper connections. Failure to connect the valve properly will cause a malfunction.
9. When replacing the entire coolant valve, remove the coolant connections and fittings from the valve body. You can install the new

valve without disassembly. Carefully apply pipe sealing compound to the threads of the fittings to avoid deposits that might interfere with the operation of the valve.



1.	Locknut	5.	Plunger
2.	Coil	6.	Diaphragm
3.	Mounting Bolt (4)	7.	Gasket
4.	Enclosing Tube	8.	Body

Figure 13: Sporlan Coolant Valve

Condenser Axial Fan Motors

The axial fan motor is a non-repairable motor. If this motor malfunctions, it must be replaced.

Motor Test Procedure

Refer to the “Specifications” chapter for fan motor specifications.

To test the motor:

1. Disconnect the motor power plug from the unit wire harness.
2. Apply 24 Vdc to the red wire and ground to the black wire. The motor should run at full speed. If it does not, then the motor is not operable and must be replaced.
3. Disconnect the black wire from ground and the motor should stop. If the motor fails this test, it must be replaced.

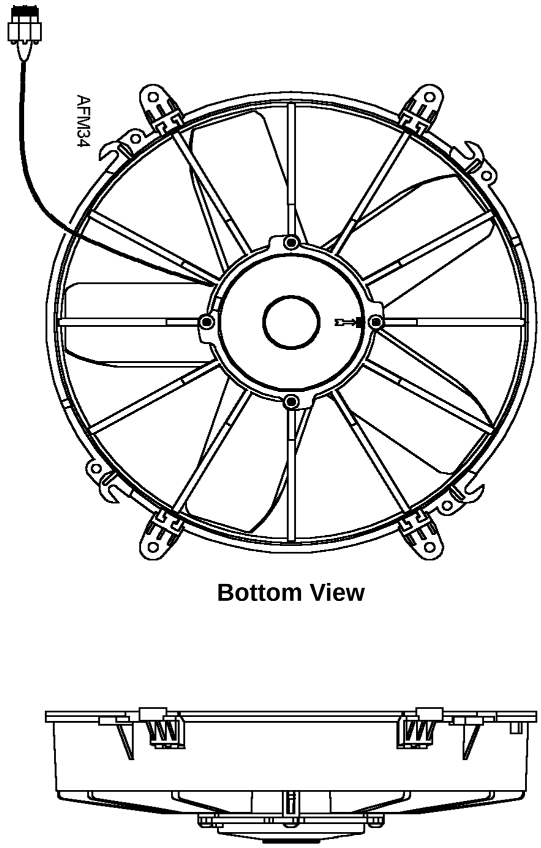


Figure 14: Axial Fan Motor Assembly

Motor Removal and Installation

Removal

1. Disconnect power to the unit. Make sure you cannot start the unit or serious injury could result.
2. Remove the bolts that attach the center condenser orifice panel to the condenser.

   NOTE: The motors are attached to the orifice access panel frame.

3. Lift the panel and disconnect the motor power plug from the unit wire harness.
4. Remove the four (4) mounting bolts that attach the axial fan motor assembly and the fan guard to the orifice panel.
5. Remove the axial fan motor assembly from the unit.

Installation

1. Attach the axial fan motor assembly and the fan guard to the orifice panel. Securely tighten the mounting bolts.
2. Reconnect the power plug.
3. Replace the condenser fan orifice panel and securely tighten the mounting bolts.
4. Start the unit and check the fan motor operation.
5. If the unit is operating properly, return the bus to service.

Evaporator Blower Motor

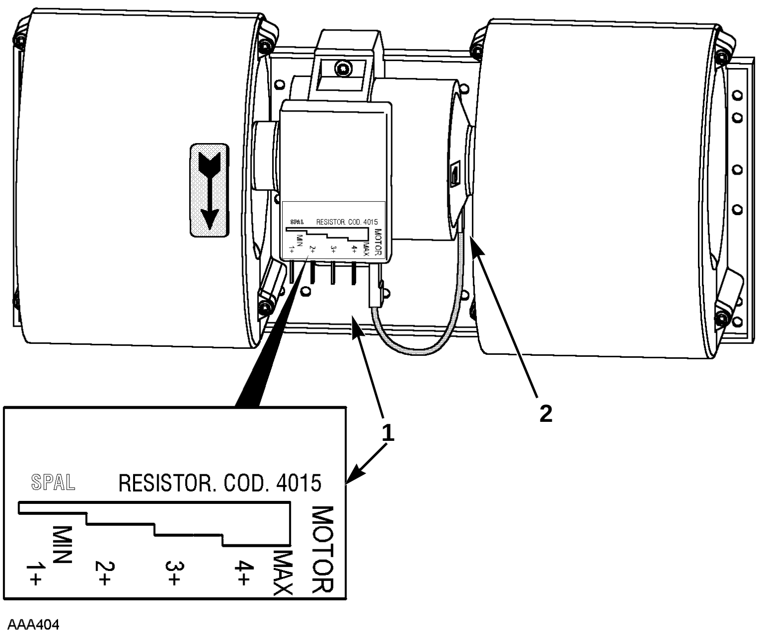
Motor Test Procedure

NOTE: Refer to the "Specifications" chapter for fan motor specifications.

To test the motor:

1. If the unit does not have a battery, start the bus. (The unit does not have to be running, but must have power to the motors.)
2. Disconnect the wires from the 2+, 3+, and 4+ terminals on the resistor block. Note which wires go to which terminals.
3. Use a jumper wire to apply +24 V to the terminals on the resistor block.
   a. Apply +24 V to the 2+ terminal. The motor should run at low speed.
   b. Apply +24 V to the 3+ terminal. The motor should run at medium speed.
   c. Apply +24 V to the 4+ terminal. The motor should run at high speed.

   If the motor fails to run at any of the test points, replace it.



1.	Resistor Block Terminals. *Note which wires go to which terminals.*	2.	Orange Wire Connected to Positive (+) Motor Terminal

Figure 15: Test Terminals on Resistor Block and Motor

Evaporator Blower Motor Removal and Installation

Removal

NOTE: The motor and housing are replaced as a unit. No repair is possible to the motor itself. Motor assembly removal and installation is the same for each unit.

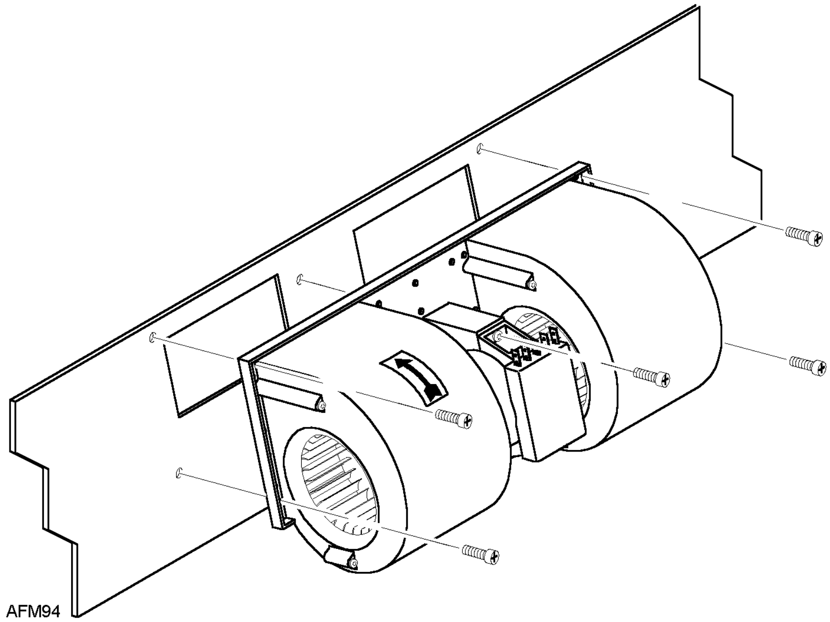
1. Turn the unit off.
2. Unfasten and carefully remove the evaporator cover from the unit.
3. Remove evaporator drain pan.
4. Disconnect the power plug from the motor(s).

IMPORTANT: Verify that the rotation of the motor/blower wheel is correct.

5. Unscrew the five (5) screws attaching the motor housing to the evaporator frame and remove the housing from the unit.

Installation

1. Install the motor assembly into the frame.
2. Align and replace the motor assembly mounting screws in the frame. Securely tighten all the mounting screws.
3. Connect the power plug to the motor.
4. Return power to the unit and run the motor(s).
5. If the unit runs properly, replace the evaporator cover and secure fasteners.
6. Reinstall evaporator drain pan.
7. Restore the unit to service.

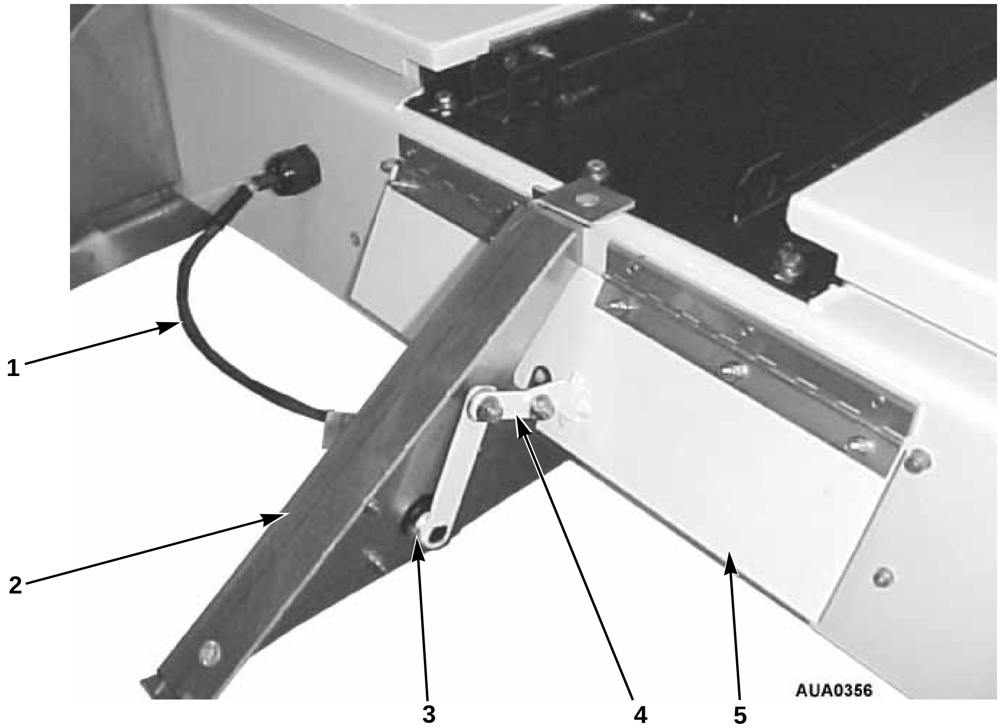


1.	Mounting Screws

Figure 16: Evaporator Blower Motor Assembly

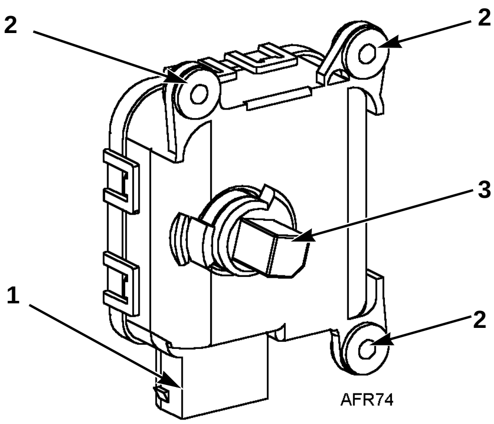
Fresh Air Damper Actuator

NOTE: The front fresh air damper is located underneath the front nose cone. Remove the nose cone to access the actuator.



1.	Actuator Power Cable
2.	Actuator Mounting Bracket
3.	Screw; HH 8-32 SS Mounted On Shaft Flats
4.	Actuator/Damper Door Linkage
5.	Fresh Air Damper Door

Figure 17: Actuator Motor Assembly Mounted Underneath Nose Cone



1.	Connector Plug
2.	Mounting Screw Locations (3)
3.	Actuator Shaft

Figure 18: Actuator Motor

CAUTION: Ensure the unit and bus can not be run while you are servicing the system.

Fresh Air Damper Operation Test

The following test uses the Service Test Mode feature in IntelligAIRE™ II Diagnostics. For additional information refer to the Service Test Mode procedure in the IntelligAIRE™ II Diagnostics chapter in this manual.

1. Press and hold both the **DOWN ARROW** key and the **ZONE SELECT** key for at least 5 seconds. This places the unit into the Service Test Mode. After these keys have been held for this period, the digital readout shall display “Pt” to indicate the unit has entered Service Test Mode.

   NOTE: Normal unit operation will cease when the Display Module is in Service Test Mode.

2. Press the **ZONE SELECT** key to scroll through the test options. The test options shall appear in the order shown in the following table.

Service Tests (Service Test Mode)

Digital Display	Service Tests
Pt	Pretrip Test
rt	Relay Test
Ft	Functional Test
EFx	Variable Evaporator x Fan Speed Control Test
CF	Variable Condenser Fan Speed Control Test
CUx	Variable Coolant Valve x Control Test
dPx	Variable Damper Position x Control Test

3. Select dP1, which is a Variable Output Test.

4. After dP1 is selected, press the **UP** or **DOWN ARROW** key. This initiates the Variable Output Test.

   When initiated, the Variable Output Test energizes the device connected to the selected output with a 0 percent drive signal or position signal, and the digital display reads “00”.

5. Press either the **UP** or **DOWN ARROW** key.

   For each press of the **UP** or **DOWN ARROW** key, the drive signal or position signal for the output and the digital display is incremented or decremented by 1 percent.

6. If fresh air damper does not operate properly, repair as required.

7. After the fresh air damper has been tested, exit the Variable Output Test by pressing the **ZONE SELECT** key.

8. Press the **TK LOGO** (hidden key) to return to the standard display mode.

Actuator Motor Tests

The following testing procedures refer to Figure 19 below. For additional information, refer to drawing 2C36452.

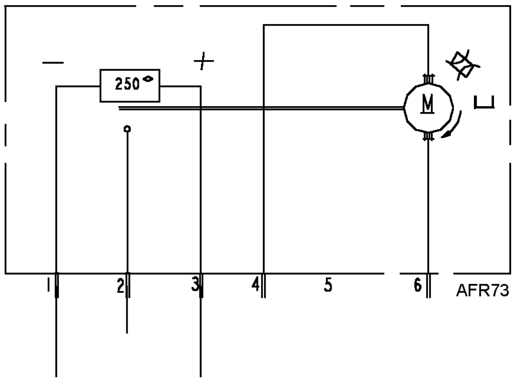


Figure 19: Actuator Connector Plug Wiring Diagram

Test Voltages

CW	CCW
+ON 4	+ON 6
- ON 6	- ON 4

Rotation Test

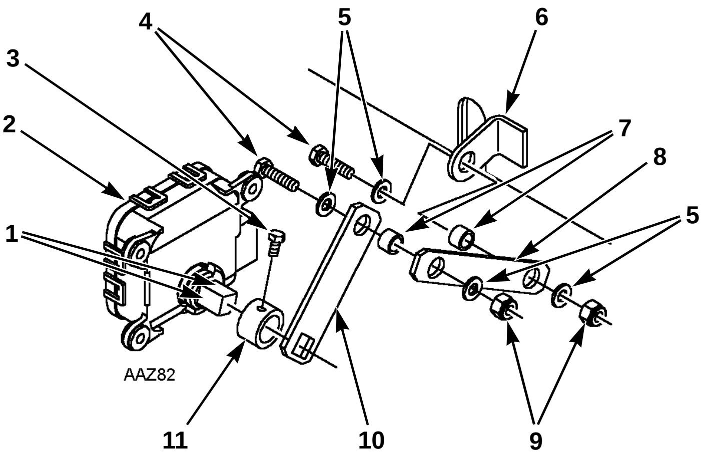
1. Apply + 26 Vdc on Pin 6 and ground Pin 4. The actuator shaft should turn counter clockwise.
2. Apply + 26 Vdc on Pin 4 and ground Pin 6. The actuator shaft should turn clockwise.

Ohmmeter Test

1. Place an ohmmeter between pins 1 and 3.
2. The ohmmeter should read 4.7 K ohms ± 20 percent.
3. Place ohmmeter test leads between pins 1 and 2. Apply + 26 Vdc on Pin 6 and ground Pin 4. The actuator shaft should turn counter clockwise.
4. The ohmmeter should read less than 1 K ohms.
5. Apply + 26 Vdc on Pin 4 and ground Pin 6. The actuator shaft should turn clockwise.
6. The ohmmeter should read greater than 3 K ohms.
7. If the actuator fails these tests, it must be replaced.

Actuator Motor Removal

1. Remove the front nose cone.
2. Disconnect the power connector.



1.	Shaft Flats	7.	Spacers (2)
2.	Motor Actuator	8	Actuator/Damper Door Linkage
3	Screw; HH 8-32 SS - Mounted On Shaft Flats	9.	Nut HH Nylock 10-32-SS (2)
4.	Screw -HH 10-32 (2)	10.	Actuator Plate
5.	Flatwashers (4)	11.	Actuator Plate Collar (Welded to Actuator Plate)
6.	Bracket Support		

Figure 20: Actuator Motor and Linkage Assembly

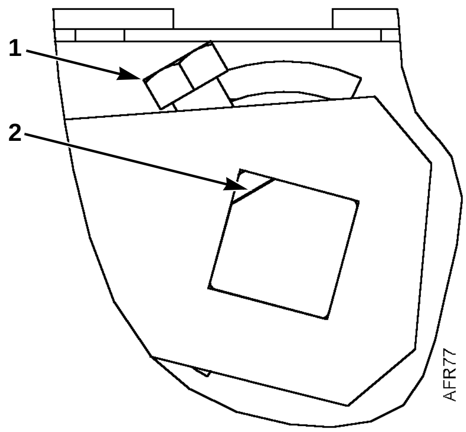
3. Loosen the mounting screw (Figure 20 item 3) from the actuator plate collar.
4. Remove the three (3) actuator motor mounting screws from actuator mounting bracket.
5. Remove and discard the old actuator motor, if required.

Actuator Motor Installation

1. Install the new actuator motor and secure it with the mounting screws and nuts.
2. Before installing the plate assembly, apply Loctite™ to threads of the mounting screw (Figure 20 item 3).
3. Install the plate assembly (Figure 20 items 10 and 11). It should be flush with the end of the actuator shaft.
4. Tighten the mounting screw in actuator plate collar (with Loctite™) until it contacts the shaft flat.

   NOTE: If necessary, apply voltage to rotate shaft so that set screw is aligned with flat on shaft.

   Then turn screw an additional 1/4 turn. See Figure 21 below.



1.	Screw; HH 8-32 SS
2.	Screw Goes to Flat on Actuator Shaft

Figure 21: Plate Assembly on Actuator Shaft

5. Install the power connector.
6. Restore power to the unit.
7. Calibrate damper using PC with SMART-PAC software.

8. Test the fresh air damper to ensure proper operation. See “Fresh Air Damper Operation Test” on page 64.

   a. Run damper to the fully closed position. Inspect it to ensure that the damper seals tightly and the linkage does not bind.

   b. Run the damper to the fully open position. Ensure the linkage does not bind.

   NOTE: The actuator/damper door linkage can be removed and disassembled. Pay careful attention to reassemble it correctly.

⚠ ***CAUTION: The linkage will bind if the washers, spacers, and actuator/damper door linkage are not properly aligned***.

9. If actuator motor is working properly, install the front nose cone and return the bus to service.

Refrigeration Maintenance

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Check refrigerant charge. Make sure discharge pressure is 250 psig (1724 kPa) on R-22 and R-407C systems and 150 psig (1034 kPa) on R-134a systems. The ball in the top receiver tank sight glass should be floating and the liquid line sight glass (if equipped) should be full and clear—no bubbles. Charge: OK _______, Needs charging _______ ***NOTE: Check this twice monthly during air conditioning season.***	•	•	•
Visually check refrigerant hoses and tubing for signs of deterioration or chafing. Hoses and tubing OK _______ Hose and/or tubing needs replacement. Specify which ones _______	•	•	•
Visually inspect for leaks of refrigerant and oil No leaks _______, Leaks detected _______	•	•	•
Check dry eye in the liquid line sight glass for moisture content. OK _______, Perform system cleanup _______	•	•	•
Check compressor oil level and color (1/4 to 1/2 sight glass after 15 minutes of operation).	•	•	•
Install service gauge manifold set. Record operating pressures, temperatures, and suction line condition. Suction: Fast Idle _______ psig, Full Throttle_______ psig Discharge: Fast Idle _______ psig, Full Throttle_______ psig Ambient _______ F, Return Air _______ F, Suction Line _______			•
Check compressor oil for acidity. Safe _______, Marginal _______, Acidic _______			•
Check compressor efficiency. OK _______, Replace or rebuild compressor _______			•
Check evaporator pressure regulator (EPR) valve operation. See “Specifications” chapter for normal readings. _______ psig			•
Replace filter-drier (liquid line dehydrator) a minimum of once a year or any time the system is opened.			•
Check hot water control (coolant) valve operation. OK _______, Repair or Replace _______			•

Safety

WARNING: Make sure the unit and bus cannot start while servicing the system.

Many service procedures are regulated by federal, state, and local laws. EPA certified technicians must perform regulated refrigeration service procedures using approved equipment and complying with all federal, state, and local laws.

Refrigerant Service Safety Procedures

Observe these precautions while performing refrigerant procedures:

- Use the recommended procedures found in this manual when servicing equipment.

- Do not apply open flame or heat the tank above 125 F (52 C). To charge the A/C system, immerse the tank in 70 F to 80 F (21 to 27 C) water.
- Do not fill refrigerant tanks completely. Allow space for liquid expansion. To monitor the amount of liquid in a tank, weigh the tank before and during the filling operation.
- Do not weld or steam clean near A/C lines and components. Excessive heat builds up dangerous system pressures.
- Reinstall refrigerant tank cap after each use. This provides protection to the valve and safety plug.

DANGER: Breathing refrigerant reduces the oxygen level in the blood. Inhaling high concentrations of refrigerant vapor is harmful and can cause heart irregularities, unconsciousness, or death. Intentional misuse or deliberate inhalation may cause death.

WARNING: Do not use a Halide torch to test for leaks. When refrigerants come in contact with a flame, a highly toxic gas is produced. This toxic gas is extremely dangerous and may cause death!

- Do not breathe refrigerant fumes or vapor. Conduct test procedures in areas with good ventilation.
- Avoid skin contact with refrigerants. Refrigerant contact on skin causes frostbite.
- Do not vent refrigerants to the atmosphere. Recovery of refrigerant is required by most government regulations. Refer to local laws for the proper handling of refrigerants and refrigerant oils.
- Wear the proper clothing when handling refrigerants. Wear goggles to prevent exposure from liquid refrigerant to face and eyes. Use butyl-lined gloves when handling refrigerants.

General Refrigerant Handling Procedures

- Use clean tools to prevent contamination when opening a refrigeration system or oil containers.
- Do not expose refrigerant oil to air longer than necessary. Refrigerant oil absorbs moisture when exposed to air. Use sealed containers when storing refrigerant.
- Do not pour oil into another container unless absolutely necessary. If you must use another container, make sure it is clean and dry.
- Do not mix different refrigerants. Different refrigerants and oils are incompatible.

Polyolester Oil Handling Procedures

- Do not mix Polyolester oil with other compressor oils.
- Do not use equipment contaminated with automotive type polyalkylene glycol (PAG) oils.

Accessibility

Access Area:	Component:
Condenser Grille (top of unit)	• Condenser Coils • Refrigerant Lines
Condenser Fan Motor Orifice Panel	• Condenser Fan Motors • Ambient Sensor
Evaporator Roadside and Curbside Access Panels	• Blower Motor Assemblies • EPR Valve (curbside) • Coolant Valve (roadside
Return Air Filter Grille (bus interior)	• Control Panel • Expansion Valve • Liquid Line Sight Glass • Return Air Filters • Filter Drier • Receiver Tank • High Pressure Relief Valve

HVAC Service Equipment

Correct HVAC servicing requires the following equipment. This service equipment is available through the Thermo King tool catalog (TK 5955) and your local TK dealer.

NOTE: For some procedures, you may need additional equipment: long hoses, jumper wires, and a second evacuation pump.

Equipment	Use
Thermometer with remote reading dial	Do not use an infrared touchless thermometer for air temperature readings. It will give inaccurate readings.
Oxygen acetylene torch, solder, and flux	Flux must not contain ammonia or muriatic acid.
Suction line service filter with replaceable activated core.	Removes contaminants and moisture. Leave in system up to 48 hours, install as indicated for flow, service when pressure exceeds 3–5 psig (21–35 kPa).
Leak detector	Use an electronic halogen leak detector or soap solution.
DANGER: Do not use a Halide torch to detect leaks. When a flame comes in contact with refrigerant, toxic gases are produced that might cause suffocation.	
Oil test kit	Detects acid, water, and other contaminants.
Refrigerant gauge manifold set	Reads system pressures and allows for correct system servicing.
Quick disconnect access valves	Keep pressure in gauge lines when gauge manifold is removed from compressor.
2-Stage vacuum pump (greatly reduces evacuation time)	Must have a minimum rate of 5 cfm (0.14 m^3/minute), and efficiency rating of 20 microns, and correct vacuum lines and valves.
Electronic micron gauge	Must have vacuum level readings from 25,000–50 microns.
CAUTION: Do not use a mechanically actuated gauge. Excessive vacuum will destroy the gauge.	
TK Evacuation Station (TK no. 204-725)	Recommended; other stations may work.
Charging/evacuation hose	1/4 ID x 48 in. long, rated at 900 psig (6200 kPa) working pressure.
Charging/evacuation hose	1/2 ID x 48 in. long, rated at 500 psig (3400 kPa) working pressure.
Refrigeration ratchet wrenches (square box type).	Sizes 3/16 in., 1/4 in., 5/16 in., and 3/8 in.

Service Valve Positions

The suction and discharge service valves provide connections for the gauge manifold to the compressor for system diagnosis, service, and repair. Familiarize yourself with these valve positions:

Back-seated: Normal operating position. The service valve is fully closed:

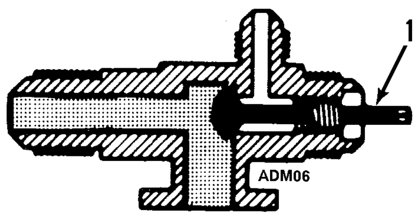


Figure 22: Valve Fully Counterclockwise (Back-seated)

Front-seated: Checking and removing the compressor. The service valve is open, and access to the system is closed:

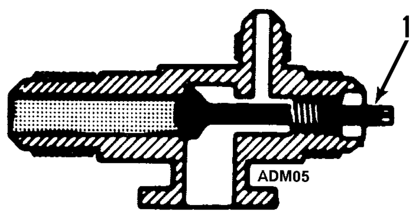


Figure 23: Valve Fully Clockwise (Front-seated)

DANGER: Do not start the unit with the discharge valve front-seated. Pressure buildup could cause an explosion.

Open to Service Port: Servicing position. Access to the system and the service ports:

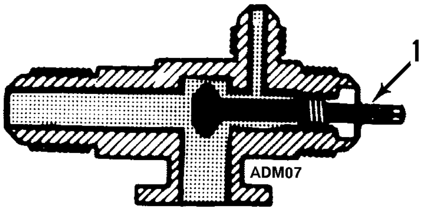


Figure 24: Valve Turned Half Way In (Open to Service Port

Gauge Manifold Connections

Before You Proceed

Note the following before you proceed with a gauge manifold connection:

- If a procedure requires the compressor to operate at a suction pressure below 5 in. vacuum (-17 kPa), place a jumper across the low pressure cutout switch to prevent compressor shutdown.
- Use of the quick disconnect access valve during evacuation increases the time required to reach the correct micron level.

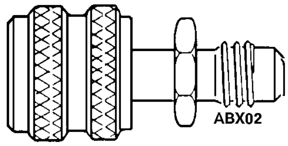


Figure 25: Quick Disconnect Access Valve

Gauge Manifold Positions

The gauges indicate low and high side pressures. Operate one or both hand valves to perform the different service operations:

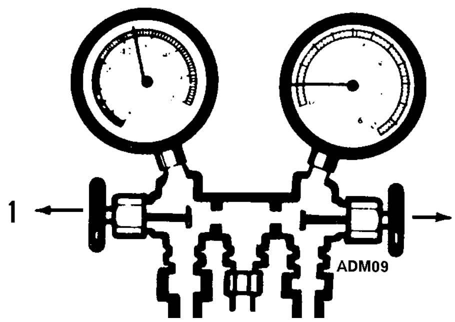


Figure 26: Hand Valves Open to Center Port

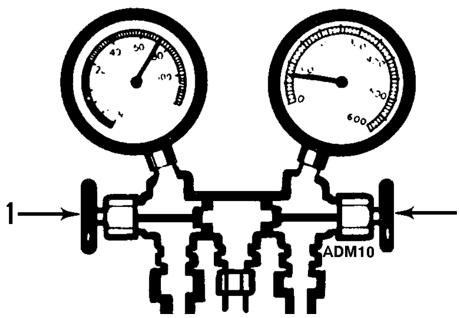


Figure 27: Hand Valves Closed to Center Port

Gauge Connections: Balancing Pressure, Removing Refrigerant, and Charging System

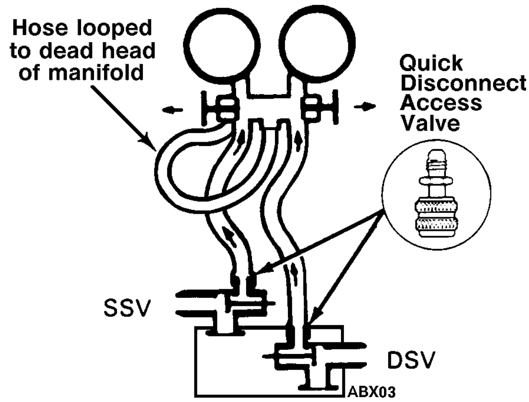


Figure 28: Balancing Pressure

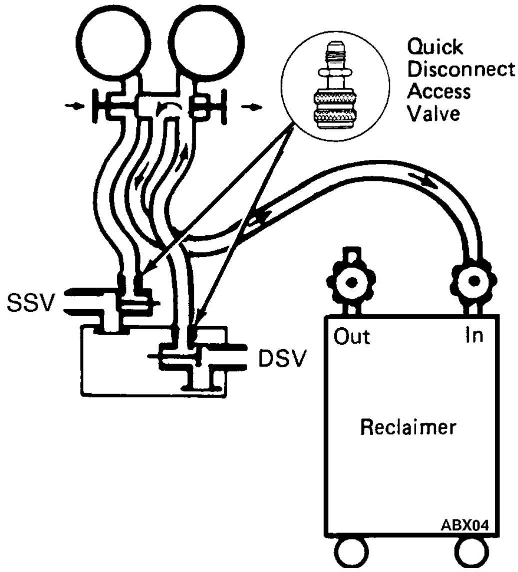


Figure 29: Removing Refrigerant

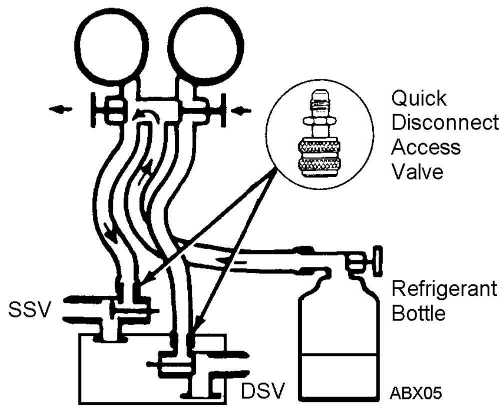


Figure 30: Charging the System

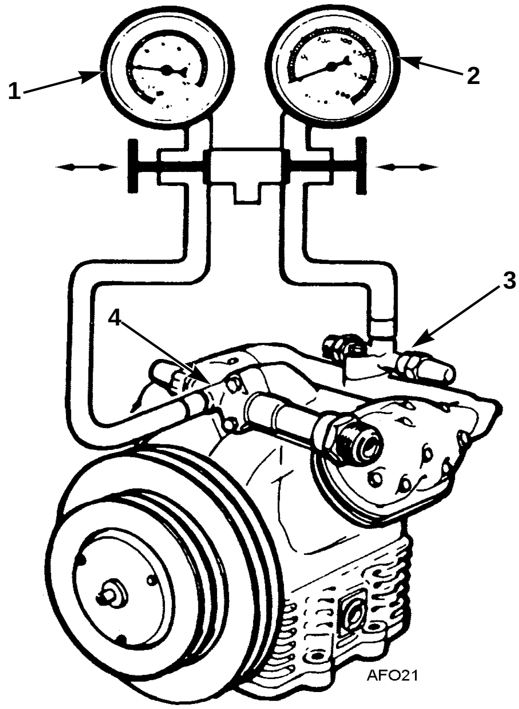
Attachment and Purging

Use this procedure for attaching a gauge manifold to a compressor before performing service procedures.

NOTE: Use of access valves or quick disconnect fittings is recommended to minimize refrigerant loss.

1. Inspect the gauge manifold for correct hose and fitting connections.
2. Clean dirt and moisture from the service ports.
3. Remove large valve stem caps from the compressor suction and discharge service valves.
4. Make sure both service valves are fully back-seated.
5. Remove the small service port caps from the suction and discharge service valves.
6. Attach the high side hose (high pressure gauge) to the discharge service valve port. Tighten the fitting finger tight.
7. Attach the low side hose (compound gauge) to the suction service valve port. Tighten the fitting finger tight.
8. Open the service manifold hand valves fully.
9. Attach the center manifold hose to the hose anchor. Tighten the fitting finger tight.
10. Open the discharge service valve.
11. Loosen the low side hose (compound gauge) at the compressor. Purge the discharge hose, manifold, and suction hose of air from the compressor end of the suction hose. Tighten the fitting.
12. Loosen the center hose at the hose anchor and purge the hose. Tighten the fitting.
13. Close the gauge manifold hand valves to the center port.
14. Open the suction service valve 1/2 turn. You can now use the gauge manifold to check system pressures and perform most service procedures.

NOTE: If you leave the manifold in place for more than a few minutes, tighten the suction and discharge valve packing or replace stem caps to stop refrigerant leaks.



1.	Compound Gauge
2.	High Pressure Gauge
3.	Discharge Service Valve (DSV)
4.	Suction Service Valve (SSV)

Figure 31: Connecting Gauge Manifold

Removing the Gauge Manifold

NOTE: Minimize oil and refrigerant transfer. Use the following gauge manifold removal procedure to maintain system integrity without the need to use a different gauge manifold for each type of refrigerant.

1. Jumper the low pressure cut out.
2. Operate the unit in the cool mode.
3. Back seat the discharge service valve.
4. Open both manifold hand valves.
5. Front seat the suction service valve and pump down the compressor to a 20” vacuum. Turn the unit off.
6. Establish compressor crankcase pressure between 1 and 3 psig.

7. Remove the gauge line from the suction service valve and cap the service port.
8. Remove the gauge line from the discharge service valve and cap the service port.
9. Back seat the suction service valve and cap the valve stem.
10. Cap the discharge service valve stem.
11. Secure all manifold lines to manifold hose anchors when the manifold is not in use.
12. Remove low pressure jumper and reconnect wiring.

Compressor Pumpdown

Use this procedure to:

- Test compressor for leaks to the atmosphere (a leak is indicated by a reading that goes to zero and stays there)
- Test compressor discharge valve plates for leakage (indicated by a reading that goes to zero, then rises above zero)
- Service or remove the compressor.

NOTE: When servicing or removing the compressor, open the suction service valve to equalize pressure to 2 to 3 psig (14 to 21 kPa) on the compound gauge before disconnecting service valves from the compressor.

1. Attach a gauge manifold to the compressor (see “Gauge Manifold Attachment, Purging, and Removal”).
2. Bypass the low pressure cutout switch (LPCO) to prevent the clutch from disengaging.
3. Start and run the unit for 15 minutes to stabilize pressures. Run the bus engine at a fast idle (900 to 1200 rpm).

   NOTE: When the crankcase pressure is greater than the suction pressure, the crankcase is isolated from the system. Closing the suction service valve and starting the unit for pumpdown causes the check valve to close and the compressor to go into a vacuum. If necessary, start and stop the unit several times until all the refrigerant has boiled off the oil. Allowing the compressor to warm up for 15 minutes results in a much smoother pumpdown.
4. Before starting the pumpdown, make sure oil has returned to the compressor. Make sure the sump body is lukewarm.
5. Front seat the suction service valve. Pump down the compressor to a 20 to 25 in. vacuum.
6. Stop the unit.
7. If the compound gauge rises out of 20 to 25 in. vacuum, run the unit again. Repeat this procedure until the reading remains below 0 psig for at least 15 seconds.

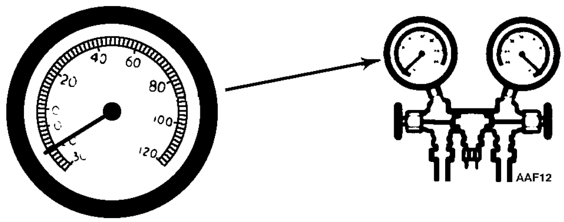


Figure 32: Compound Gauge

Low Side Pumpdown

Purpose: To test for internal (high side to low side) leaks and to perform service on low side without refrigerant loss.

1. Attach the gauge manifold to the compressor (see “Gauge Manifold Attachment, Purging, and Removal” in this chapter).
2. **Units Equipped with EPR Valve Only**. See the Specifications chapter to see which EPR valve the unit has, then do one of the following:

   a. **Internal Spring Type EPR**. After attaching the gauge manifold set to the compressor, attach the center gauge manifold hose to the Schrader valve on the inlet to the EPR valve. Open the low side hand valve on the gauge manifold to allow refrigerant to bypass the EPR valve during the pumpdown.

b. **Pilot Type EPR**. Close the EPR pilot line shutoff valve (if equipped). This valve is located near the EPR valve.

NOTE: Remember to open the pilot line shutoff valve when finished.

3. To prevent the compressor from stopping, install a jumper wire across the low pressure cutout (LPCO) switch.
4. Start the unit. Change the setpoint to the lowest possible setting to keep unit running in cool mode.
5. Run the bus engine at fast idle (900 to 1200 rpm) for 15 minutes or more to stablize the system.
6. Front seat the receiver tank outlet valve or the liquid line shutoff valve.
7. Observe the compound gauge reading. Pump down the low side to a 20–25 in. vacuum. Stop the unit.
8. Observe the compound gauge reading. Low side pressure should remain below a 15 in. vacuum for two minutes or longer. If pressure rises to zero and stops, there is a low side leak to the atmosphere. If pressure continues to rise above zero, the following may be responsible:
   - Refrigerant boiling out of the compressor oil. (Restart unit and pump down to 25 in. vacuum.)
   - High side to low side leaks at the compressor discharge valve plates or hot gas bypass valve if equipped.
9. To perform service on the low side, establish a slight positive pressure by opening the high side hand valve on the gauge manifold to bleed 2 to 3 psig (14 to 21 kPa) into the low side.

CAUTION: To prevent air and moisture contamination, do not open the low side of system while in vacuum.

Refrigerant Recovery

When refrigerant is removed from a unit for service, after leak testing, or to remove air, you must recover it with a recovery machine to limit the potential harm it could cause to the atmosphere.

CAUTION: Venting refrigerant is illegal. Check with your local government agencies for definitions of venting and your legal responsibilities.

Recovery from a Working Unit

This procedure is for units with an Orit 15 EPR valve or no EPR valve. For units with an Orit 10 EPR valve, see "Recovery from a Working Unit with an Orit 10 EPR Valve" below.

If the unit and compressor are operable, remove the refrigerant as a liquid. To remove refrigerant as a liquid:

1. Install a gauge manifold on the suction service valve (SSV) and the receiver tank outlet valve (RTOV).
2. If you have an Orit 15 EPR valve, close the pilot valve hand valve.
3. Attach the service line to the recovery machine inlet.
4. Pump down the unit’s low side to force the refrigerant into the condenser and receiver tank.
5. Set the recovery machine for liquid recovery. Open the high pressure gauge hand valve. Remove the refrigerant through the receiver tank outlet service valve.
6. Recover refrigerant until proper recovery level is achieved.

Recovery from a Working Unit with an Orit 10 EPR Valve

This procedure is for units with an Orit 10 EPR valve only. Use of a low-loss fitting on the service line is required for this procedure.

If the unit and compressor are operable, remove the refrigerant as a liquid. To remove refrigerant as a liquid:

1. Install a gauge manifold on the suction service valve (SSV) and the receiver tank outlet valve (RTOV). Install the service line onto the access port on the Orit 10 EPR valve.
2. Open the manifold low side hand valve.
3. Complete a low side pump down.
4. When you have achieved a 20 in. vacuum, close the low side hand valve on the gauge set.
5. Remove the service hose from the EPR valve and attach it to the recovery machine. You must use low loss fittings for this connection.
6. Set the recovery machine for liquid recovery and open the high pressure gauge hand valve. Remove the refrigerant through the receiver tank outlet service valve.
7. Recover refrigerant until proper recovery level is achieved.

Recovery from a Non-functioning Unit

When a unit or compressor is inoperable, you must remove refrigerant as a vapor. Remove it from any convenient service port on the compressor or receiver tank. Because refrigerant must evaporate in the unit before removal, it is less efficient and more time consuming than the liquid removal process.

To remove refrigerant as a vapor:

1. On units equipped with an Orit 15 valve or no EPR valve, attach gauge manifold hoses to the suction service valve (SSV) and discharge service valve (DSV).
2. On units equipped with an Orit 10 valve, attach the manifold hoses to the discharge valve and the access valve on the EPR valve.
3. Open both manifold hand valves.
4. Recover vapor refrigerant until you achieve correct EPA recovery levels.

Removing Air from Recovered Refrigerant

Not all recovery machines remove air from refrigerant. If you are unsure which type of machine you have, read the manual. Thermo King recommends that you follow manufacturer’s instructions exactly.

If the machine only removes the refrigerant to a drum, you can remove air by allowing the drum to stabilize for several hours, then venting the air from the top of the drum. Measure the drum temperature and pressure, then refer to the Temperature-Pressure chart to verify that only refrigerant in the drum. If air is in the drum, draw only liquid from that drum.

Refrigerant Evacuation

When Evacuation Is Required

Evacuation is required:

- When a new system is installed
- When the refrigerant has been removed from the system
- When the system is opened for service or maintenance repairs (example: compressor replacement, hose replacement, coil or tubing repairs, etc.)
- Whenever an extremely wet condition has developed inside a system.

  NOTE: A system contaminated with moisture must also have a more frequent filter-drier change schedule.

Problems Caused by Poor Evacuation

Noncondensables such as air and dry nitrogen in a system will cause:

- Elevated operating temperatures and pressures
- Breakdown of compressor oils
- Incorrect refrigerant charge.

Moisture and other contaminants (like cleaning solvents) in a system will cause:

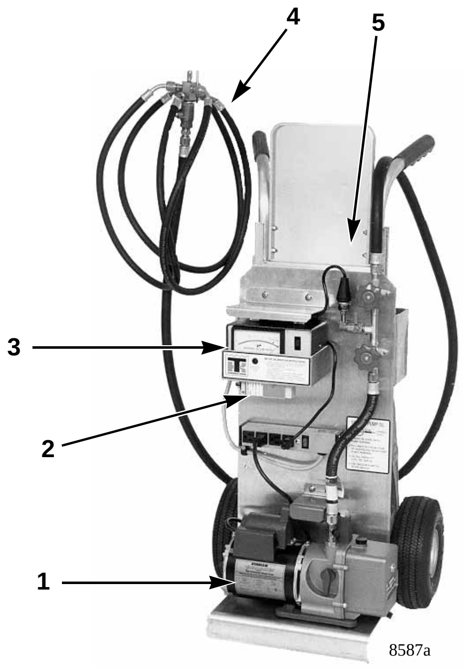
- Acid buildup in the oil, which corrodes components, scratches sight glasses, and causes copper plating
- Chemical reactions with refrigerants that degrade their properties
- Breakdown of the filter-drier core elements, which causes plugged filters and valves.

Evacuation Stations

An evacuation station consists of a vacuum pump, micron gauge, valve manifolds, and the special hoses required for deep vacuum operation. Portable gauges with separate hoses are also usable.

Thermo King Dealers have this equipment available. Contact your local Thermo King Dealer for more information.

CAUTION: You must use an electronic micron gauge with vacuum level readings from 25,000 to 50 microns for acceptably accurate readings. Do not use a mechanically actuated micron gauge. Read the instruction manual before operating the micron gauge.



1.	Two Stage Vacuum Pump
2.	Calibration Standard
3.	Micron Gauge
4.	Evacuation Quality Hoses
5.	Thermistor Sensor

Figure 33: Thermo King Evacuation Station TK No. 204-725

Evacuation Time Considerations

Evacuation time depends on system construction and the amount of contaminants. Factors that increase evacuation time are:

- Long hoses
- Hoses with small diameters
- Hoses constructed of materials other than heavy wall rubber or plastic polymer (TK No. 204-537 or 204-536)
- Expansion valves and other control valves that cause restrictions, requiring three-point evacuations. (Evacuation from both high and low side should be standard operating practice.)
- Schrader valves. Do not use Schrader valves unless absolutely necessary. They slow down the evacuation process dramatically.

- Excessive moisture. A large vacuum pump can cause moisture to freeze, slowing down the evacuation process.
- Amount of contamination. Excessive contamination can cause slow evacuation.
- Leaks. A constant pressure rise indicates a leak. Find and repair leaks before evacuation.
- Evacuation pump oil condition. Contaminated evacuation pump oil prevents the pump from operating at maximum efficiency.

Evacuation Procedure

CAUTION: You must use an electronic micron gauge with vacuum level readings from 25,000 to 50 microns for acceptably accurate readings. Do not use a mechanically actuated micron gauge. Read the instruction manual before operating the micron gauge.

CAUTION: Venting refrigerant is illegal. Check with your local government agencies for definitions of venting and your legal responsibilities.

1. Before evacuating, recover refrigerant to 0 psig (0 kPa) or EPA requirement and leak test the system.
2. Make connections to the refrigerant supply bottle prior to evacuation. Leave the valve on the refrigerant supply bottle closed during evacuation process. This prevents air and moisture contamination when charging.
3. Connect evacuation hoses to the following access ports:
   a. The high side port at the compressor discharge service valve port.
   b. The low side port at the compressor suction service valve port.
   c. If possible, connect a third evacuation hose to the service port on the receiver tank outlet valve or the liquid line service valve.

   NOTE: Systems equipped with EPR valves or other regulating devices may require the third connection to ensure full evacuation. Some systems have a built-in bypass that makes the third port connection unnecessary.
4. Connect the micron gauge:
   a. **If you are using the Thermo King Evacuation Station**, the micron gauge is part of the equipment. Follow operating instructions for the station.
   b. **If you are using a manifold gauge set**, connect the micron gauge at the vacuum pump hand valve. You must be able to isolate the micron gauge without breaking a line open before charging the unit.

   NOTE: Valves on the manifold gauge set should be the packless type with O-ring seals on valve stems.
5. Check evacuation equipment for leaks:
   a. With the unit access valves back seated securely, run the vacuum pump to evacuate only the hoses and manifold gauge set. The pump should pull the pressure down to 500 microns (or less) in a few minutes. If it does, go to step 5b. If the pressure does not reach 500 microns, proceed as follows:
      - Connect the micron gauge directly to the vacuum pump and run it again. If the pressure reaches 500 microns, check and repair the hoses, manifold gauge set, and connections. Repeat step 5a.
      - If the pump will not lower the pressure to 500 microns, change the vacuum pump oil, then repeat step 5a. If the vacuum pump is very contaminated, a second oil change may be necessary.
      - If the pump still does not lower the pressure to 500 microns, use a different micron gauge to confirm the reading. If the 500 micron pressure level is reached, replace the micron gauge and repeat step 5a.

- If the pump still cannot lower the pressure to 500 microns, replace the pump and repeat step 5a.

b. Once the evacuation equipment proves to be leak free, go to step 6.

6. Evacuate the system by opening the unit access valves to port and starting the vacuum pump.
7. Replace the service valve stem caps tightly. The packings will leak during evacuation.
8. When the micron gauge indicates a pressure reading of 1000 microns, continue the evacuation for another 30 minutes.
9. After 30 minutes, close the valve at the outlet of the vacuum pump to isolate the vacuum pump from the system. Leave the micron gauge connected to the system only. Stop the vacuum pump.
10. Watch the micron gauge for 10 minutes. The reading will rise as system pressure equalizes.
    - If the pressure reading stays below 1500 microns for 10 minutes, you can charge the system. Backseat the open service valves.
    - If the pressure continues to increase at a steady rate, there is a leak. Follow standard procedures to locate and repair the leak, then repeat the evacuation process.

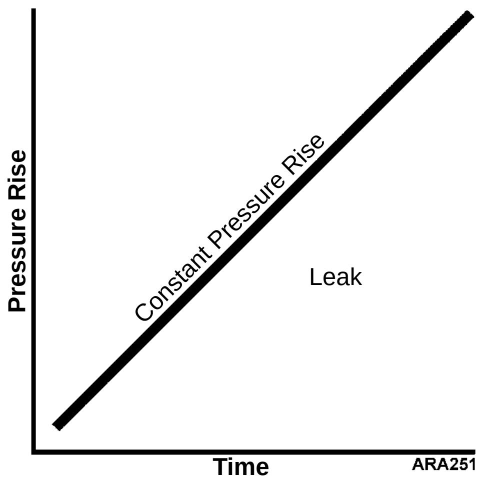


Figure 34: Leak

- If the pressure rises and levels off, evacuate for a longer period. The rise is due to moisture that must be removed. Start the vacuum pump, open the valve at the outlet of the vacuum pump, and repeat step 7 through step 9 until the micron level remains below 1500.

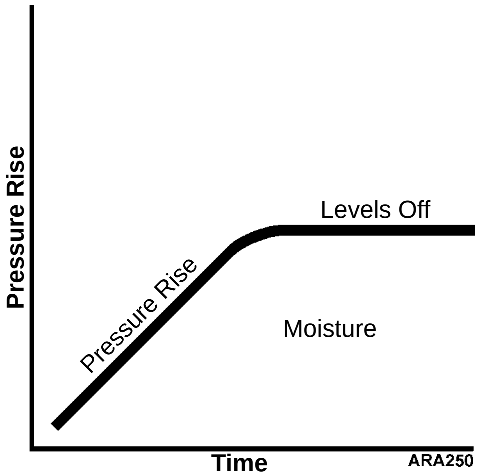


Figure 35: Moisture

NOTE: Large amounts of moisture in the system can, over a longer period of time, raise the system pressure back to near zero.

Refrigerant Charging

Checking the Refrigerant Charge

Make sure these criteria are met before checking the refrigerant charge:

- The ambient temperature must be above 80 F (27 C).
- The interior temperature must be between 70 and 80 F (21 and 27 C).
- The discharge pressure must be above 250 psig for R-22 and R-407C and above 150 psig for R-134a.
- All fans must be running at high speed.
- If alarm codes are indicated or there are bubbles in the liquid line sight glass, do not charge the unit and flag the bus for service.

To check the refrigerant charge:

1. Start the system and set the bus engine to run at high idle (1200 to 1500 rpm compressor speed).
2. Verify that the compressor is operating and the compressor clutch is pulled in.
3. Run the system for a minimum of 15 minutes. The compressor sump should be warm to touch.
4. After 15 minutes, observe the sight glass as follows:
   - **T Series**: Receiver tank sight glass should be at least 1/2 full with ball floating.
   - **Roofmount**: Liquid line sight glass should be clean and free of bubbles for 2 to 5 minutes.
5. If the receiver tank indicator ball is not floating or there are bubbles in the liquid line sight glass, the unit is low on charge. Leak check and repair the system, then add refrigerant per the “Charging from a Partially Charged State” procedure.

Charging an Evacuated Unit by Weight

IMPORTANT: Handle blended refrigerants only in liquid form to ensure that the mixture remains balanced.

1. Evacuate the system. See “Evacuation Procedure” in this chapter.
2. Connect a gauge manifold to the system. Connect the high side gauge line to the compressor discharge service valve port or to one of the service ports on the liquid line of the unit. (Ports can vary due to application differences.)
3. Connect a refrigerant supply bottle to the center hose of the gauge manifold. Purge all non-condensable gases from the hoses and gauge manifold before opening the unit service valves.
4. If you know the amount of refrigerant charge the unit holds, weigh the charge as follows:
   a. Weigh the full refrigerant bottle.
   b. Subtract the amount of charge required.
   c. The resulting number is the final bottle weight after a full system charge.

   Bottle weight (Total)
   –Unit charge
   =Final bottle weight

5. Make sure the suction service valve is closed. Open the discharge service valve or open the service valve to which the high side gauge line is connected.
6. With the unit off, open the high side gauge valve to allow liquid refrigerant to flow into the discharge or liquid line of the unit (see step 2).
7. Observe the scale. When the required amount of refrigerant has flowed into the unit, close the high side gauge valve and the discharge service valve (or the service valve to which the high side gauge line is connected).
8. If the refrigerant stopped flowing into the unit before the full refrigerant charge was reached:
   a. Close the high side gauge valve and close the discharge service valve (or the service valve to which the high side gauge line is connected).
   b. Start the system and run the bus engine at high idle (1200 to 1500 rpm compressor speed) for 2 to 3 minutes.
   c. Open the suction service valve. Crack open the low side gauge valve to allow liquid refrigerant to slowly flow into the compressor suction service valve port.

   NOTE: If the suction hose does not have a restrictive orifice, restrict the refrigerant flow with the low side gauge valve. Watch the suction gauge as you open the valve. Do not allow the suction pressure to rise more than 25 psig (172 kPa). Periodically close the low side gauge valve to verify the true suction pressure, then readjust the flow back to no more than 25 psig (172 kPa) above that value.

9. Watch the scale until the required amount of refrigerant is added. Close the low side gauge valve. Run the system 5 to 10 minutes.

10. Check the discharge pressure. If the discharge pressure is not above 250 psig (1724 kPa) for R-22 and R407C systems, or 150 psig (1034 kPa) for R-134a systems, partially block the condenser air flow to raise the pressure to that level. Maintain the interior bus temperature between 70 and 75 F (17 and 24 C).
11. Check the liquid line sight glass or the receiver tank sight glass (whichever is used). The liquid line sight glass should be full and clear with no bubbles. The indicator ball should be floating in the top of the receiver tank sight glass. If there are bubbles in the liquid line sight glass or if the receiver tank indicator ball is not floating, add liquid refrigerant through the suction service valve (see step b) until the liquid line sight glass is clear or the indicator ball floats.
12. After confirming the charge, close the refrigerant supply bottle valve, close all service valves, remove the manifold gauge set, and turn off the bus engine.
13. Replace all service caps. Leak check the unit and repair any leaks found.
14. Release the bus back into service.

Charging from a Partially Charged State

IMPORTANT: Handle blended refrigerants only in liquid form to ensure that the mixture remains balanced.

1. Connect a gauge manifold to the system (see “Gauge Manifold Attachment, Purging, and Removal”).
2. Connect a refrigerant supply bottle to the center hose of the gauge manifold. Purge all non-condensable gases from the hoses and gauge manifold before opening the unit service valves.
3. Start the unit. Run the bus engine at high idle (1200 to 1500 rpm compressor speed) for 2 to 3 minutes.
4. Check the discharge pressure. The discharge pressure must be above 250 psig (1724 kPa) for R-22 and R407C systems, or 150 psig (1034 kPa) for R-134a systems. If not, partially block the condenser air flow to raise the pressure. Maintain the interior temperature between 70 and 75 F (17 and 24 C).
5. Open the suction service valve. Crack open the low side gauge valve to allow liquid refrigerant to slowly flow into the compressor suction service valve port.

   NOTE: If the suction hose does not have a restrictive orifice, restrict the refrigerant flow with the low side gauge valve. Watch the suction gauge as you open the valve. Do not allow the suction pressure to rise more than 25 psig (172 kPa). Periodically close the low side gauge valve to verify the true suction pressure, then readjust the flow back to no more than 25 psig (172 kPa) above that value.
6. Watch the liquid line sight glass or the receiver tank sight glass (whichever is used). Add liquid refrigerant until the liquid line sight glass is clear or the indicator ball is floating in the top of the receiver tank sight glass. Close the low side gauge valve.
7. After confirming the charge, close the refrigerant supply bottle valve, close all service valves, remove the manifold gauge set, and turn off the bus engine.
8. Replace all service caps. Leak check the unit and repair any leaks found.
9. Release the bus back into service.

Leak Testing

Testing a Pressurized System for Leaks

- Inspect the system for refrigerant oil and dirt accumulation (which indicate refrigerant leaks), component damage, and the audible release of refrigerant.
- Blow out confined areas with compressed air to remove refrigerant accumulations. In windy conditions, shield the leak area.
- Use a regularly calibrated electronic leak detector capable of detecting fluorine-based refrigerants, or use a leak check solution to

leak test the refrigeration system. Leak check solutions work best in areas easily reached or where air is saturated with refrigerant. Apply liquid solution with a soft brush to prevent bubbles from forming and allow several minutes to work.

- Multiple leaks may exist. Always leak check beyond the first leak.
- Leak check before and after running the unit. Components and line temperature can affect leak size, and circulating refrigerant can temporarily plug leaks.

CAUTION: Do not use a Halide torch.

Testing an Empty System for Leaks

Use this procedure for systems that have lost most or all of their refrigerant.

1. Check the entire system for refrigerant oil leaks and component damage.
2. Attach a gauge manifold (see “Gauge Manifold Attachment, Purging, and Removal”).
3. Attach the center hose of the gauge manifold to a refrigerant bottle. Purge the center hose of air.
4. Pressurize the system with 2 to 3 psig (14 to 21 kPa) of refrigerant.
5. Close (front seat) both hand valves on the gauge manifold.
6. Disconnect the center hose from the refrigerant bottle.
7. Connect the center hose from the gauge manifold to a source of nitrogen. Adjust the pressure regulator to 200 psig (1379 kPa). See “Using Pressurized Nitrogen” for more information.

CAUTION: Nitrogen (N) is under 2200 psig (15169 kPa) pressure in a full cylinder at 70 F (21 C). Handle with care.

8. Pressurize the system with nitrogen gas to 200 psig (1379 kPa).
9. Close the supply valve on the nitrogen bottle.
10. Use an electronic leak tester or soap solution to inspect all joints and connections. If you detect leaks, loosen the supply line hose fittings to release the pressure.

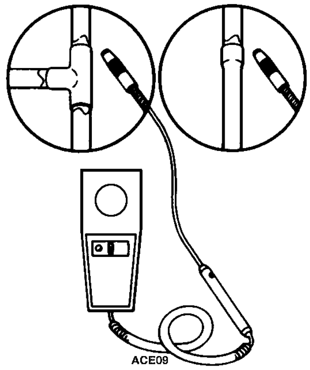


Figure 36: Testing for Refrigerant Leaks

11. Repair leaks as necessary. Recheck the system when repairs are complete.
12. When testing is complete, remove the remaining trace amount of refrigerant and nitrogen.
13. Evacuate the system and charge per Refrigerant Charging procedures in this chapter.
14. Release the bus back into service.

Using Pressurized Nitrogen

Use dry nitrogen (N) for dehydration, pressure testing, purging, and soldering. Observe the correct handling of high-pressure nitrogen cylinders:

- Keep the protective cap on the cylinder when not in use.
- Secure the cylinder in a proper storage area or fasten the cylinder to a cart.
- Do not expose to excessive heat or direct sunlight.
- Do not drop, dent, or damage the cylinder.
- Use a pressure regulator and a safety pressure relief valve as part of the pressure testing equipment. The safety pressure relief valve should be the non-adjustable, non-tampering type. The valve should bypass if the pressure exceeds its setting.

- Open the supply valve slowly. Use regulators and safety valves in good condition.
- The regulator should have two gauges, one for tank pressure and one for line pressure. The equipment allows you to leak test, purge, or dehydrate a system safely.

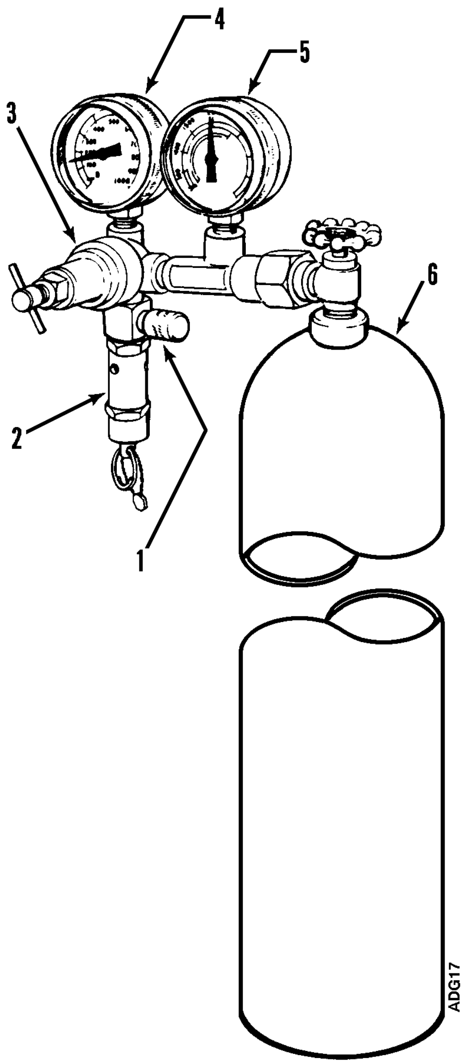
CAUTION: Nitrogen (N) is under pressure (2200 psig [15170 kPa]), or greater (full cylinder at 70 F [21 C]).

To use pressurized nitrogen to dehydrate, pressure-test, purge, or solder a system:

1. Attach a gauge manifold set to the system.
2. Close (front seat) both hand valves on the gauge manifold.
3. Connect the center hose from the gauge manifold to the pressure regulator outlet on the nitrogen supply bottle. Adjust the pressure regulator to the correct pressure for the required procedure.
4. Purge the system from high side to low side.

The following pressures apply:

Procedure	Maximum Pressure	
	psig	kPa
Leak Testing Low Side	150-175	1034-1206
Leak Testing High Side	100-250	689-1724
Purging Dehydration	10-20	69-138
Soldering	5	34



1.	Pressure Regulator Outlet (Pressure Test Line to System)
2.	Safety Valve
3.	Pressure Regulator
4.	Line Pressure
5.	Tank Pressure
6.	Tank

Figure 37: Typical Pressurized Gas Bottle with Pressure Regulator and Gauges

Contaminants

Types of Contaminants

An HVAC system is contaminated when it has anything other than the correct refrigerant and clean compressor oil. The following are the main contaminants, in order of importance:

Contaminant	Results of Contaminant
Air	• Oil breakdown • Refrigerant breakdown • Acid buildup • Valve leaks • System failure
Moisture	• Metal corrosion and plating • Freezing in expansion valve • Acid buildup • Filter-drier saturation and corrosion[1] • System failure
Dirt, Dust, Metal Particles	• Severe damage to close tolerance items (pistons, bearings, valve plates, expansion valve, etc.)
Acid	• Deterioration of soft metals and metal plating • Corrosion of compressor bearings • Holes in tubing

Figure 38: Contaminants in a System

[1] A corroded filter drier can be a source of particles in the system.

The following procedures describe how to clean a contaminated system: removing air, removing moisture, and replacing a compressor due to long-term contamination.

Removing Air: Unit Contaminated for a Short Period

Purpose: To remove air from a system in which the air was detected early and the damage to the system is minimal.

1. Attach a gauge manifold. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Attach a recovery machine and recover the refrigerant (and air) from the system to 0 psig (0 kPa) or EPA requirements.
3. Install a new filter-drier. See “Filter-Drier Removal and Installation” in this chapter.
4. Evacuate the system. See “Evacuation Procedure” in this chapter.
5. Charge the system. See “Charging Procedures” in this chapter.
6. Run the system. Monitor system pressures to confirm that the system is working properly. Observe the sight glasses to confirm that the charge level is good.
7. Remove the gauge manifold and other service equipment.
8. Perform a final leak test of fittings and caps to ensure that no leaks remain.
9. Place the system back in operation.

Removing Air: Unit Contaminated for a Long Period

Purpose: To remove air from a system in which the air was not detected early and damage to the system is extensive.

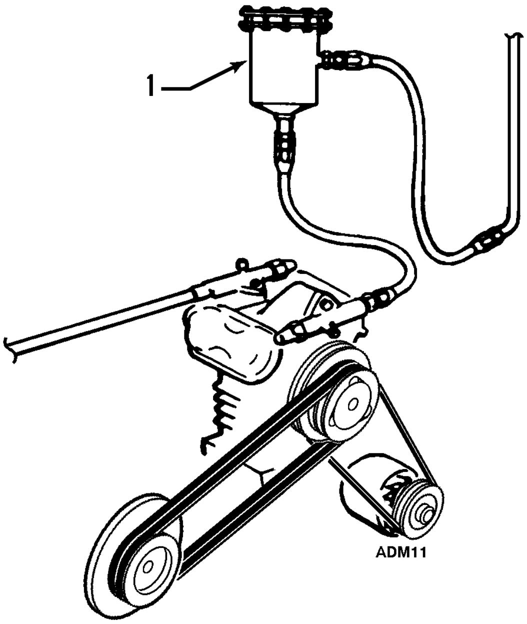
NOTE: To change the filters, perform a low side pump down.

1. Attach a gauge manifold. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Attach a recovery machine and recover the refrigerant (and air) from the system to 0 psig (0 kPa).
3. Test the compressor oil for acid. If the compressor oil is acidic, change it.
4. Remove the compressor heads and discharge manifold. Inspect the upper end of the compressor:
    a. If the discharge valve plates have bluish streaks, replace the valve plates.
    b. If the discharge valve plates have a brownish red coating, clean the assemblies with solvent. Flush, blow dry, oil, and reuse the plates.
    c. If you see damage inside the cylinders, such as scored cylinder walls or damage from particles or pieces of metal, replace the compressor.
    d. If the valve plates have been moving inside the head area and no damage to the block has occurred, inspect and replace parts as needed.

   e. Inspect the gaskets and cylinder O-rings to see if they are hard, brittle, or warped. Replace all gaskets and O-rings. Do not reuse the old ones.

NOTE: For torque sequences, see TK 6075, "X426 and X430 Compressor Overhaul for Bus Air Conditioning," or TK 40079 for X640 compressor.

5. Replace O-rings in the discharge line from the compressor to the condenser.
6. Install a suction line filter for system cleanup.



1.	Suction Line Filter

Figure 39: Suction Filter Kit

7. Install a new filter-drier. See "Filter-Drier Removal and Installation" in this chapter.
8. Evacuate the system. See "Evacuation Procedure" in this chapter.
9. Charge the system. See "Charging Procedures" in this chapter.
10. Run the system for 24 hours with all filters in place, then re-test the compressor oil for acid.
    a. If the oil is not acidic, perform a low side pumpdown, remove the suction line filter from the system, replace the filter-drier, and evacuate the low side.
    b. If the oil is still acidic, perform a low side pumpdown, change the compressor oil, replace the suction filter cartridge, and replace the filter-drier. Run the system for 24 hours, then retest the compressor oil for acid. Repeat this step until the compressor oil tests negative for acid.
11. Run the system. Monitor system pressures to confirm that the system is working properly. Observe the sight glasses and confirm that the charge level is good.
12. Remove the gauge manifold and other service equipment following proper procedures. See "Gauge Manifold Attachment, Purging, and Removal."
13. Perform a final leak test of fittings and caps to ensure that no leaks remain.
14. Place the system back in operation.

Removing Moisture

Purpose: To remove moisture from a system.

The following indicate moisture contamination:

- Moisture indicator has changed color
- Acid test shows compressor oil is acidic.

Use the following procedure to remove moisture:

1. Attach a gauge manifold. See "Gauge Manifold Attachment, Purging, and Removal"
2. Perform a low side pump down.
3. Change the compressor oil.
4. Install a new filter-drier. See "Filter-Drier Removal and Installation" in this chapter.
5. Evacuate the low side.
6. Run the system for 24 hours, then retest the compressor oil for acid.
    a. If the oil is not acidic, replace the filter-drier.
    b. If the oil is still acidic, perform a low side pumpdown, change the compressor oil, and replace the filter-drier. Run the system for 24 hours, then retest the compressor oil for acid. Repeat this step until the compressor oil tests negative for acid, or

until three new filter-driers have been used. If the oil is still acidic after three new filter-driers, replace the refrigerant charge. See “Removing Air: Unit Contaminated for Short Period” above.

7. Run the system. Monitor system pressures to confirm that the system is working properly. Observe the sight glasses and confirm that the charge level is good.
8. Remove the gauge manifold and other service equipment following proper procedures. See “Gauge Manifold Attachment, Purging, and Removal” in this chapter.
9. Perform a final leak test of fittings and caps to ensure that no leaks remain.
10. Place the system back in operation.

Replacing a Compressor

Purpose: To replace a compressor that has failed due to long-term system contamination.

The following indicate major compressor failure:

- The compressor will not turn; it is locked
- The compressor oil is black or gray.

1. Attach a gauge manifold. See “Gauge Manifold Attachment, Purging, and Removal” in this chapter.
2. Attach a recovery machine. Recover the refrigerant (and air) from the system to 0 psig (0 kPa) or EPA requirements.
3. Replace the damaged compressor with a new or rebuilt one. Use new oil.
4. Replace all O-rings in the discharge line from the compressor to the condenser. This prevents leaks from developing.
5. Install a suction line filter for system cleanup.
6. Install a new filter-drier. See “Filter-Drier Removal and Installation” in this chapter.
7. Evacuate the system. See “Evacuation Procedure” in this chapter.
8. Charge the system. See “Charging Procedures” in this chapter.
9. Run the system for 24 hours with all filters in place, then test the compressor oil for acid.
    a. If the oil is not acidic, perform a low side pumpdown, remove the suction line filter from the system, replace the filter-drier, and evacuate the low side.
    b. If the oil is still acidic, perform a low side pumpdown, change the compressor oil, replace the suction filter cartridge, and replace the filter-drier. Run the system for 24 hours, then re-test the compressor oil for acid. Repeat this step until the compressor oil tests negative for acid. In extreme cases, add a compressor oil filter to aid clean up. Leave it in place until the next service interval.
10. Run the system. Monitor the system pressures to confirm that the system is working properly. Observe the sight glasses and confirm that the charge level is good.
11. Remove the gauge manifold and other service equipment following proper procedures. See “Gauge Manifold Attachment, Purging, and Removal” in this chapter.
12. Perform a final leak test of fittings and caps to ensure that no leaks remain.
13. Place the system back in operation.

Ice Bath Test for Air and Other Non-Condensables

Purpose: To test refrigerant for contaminants.

Required Tools

- Gauge manifold set
- Sampling bottle
- Micron gauge
- Vacuum pump
- Thermometer
- Ice water bath (75 percent ice in small pieces, 25 percent water)
- Set of refrigeration wrenches.

Gauge Manifold Attachment Procedure

Attach the gauge manifold set as follows:

1. Connect the low side hose to the sample bottle.
2. Connect the center hose to the receiver tank service valve (or liquid line service valve). Leave the valve closed.
3. Connect a line to suction service valve on compressor. Leave valve closed. See Figure 40 on page 89.
4. Connect the high side hose to the evacuation pump.

Ice Bath Test Procedure

CAUTION: Use extreme care in taking the sample. It is critical that the sample not be contaminated.

1. Open the manifold gauges. Evacuate hoses, manifold, and sample bottle to 500 microns.

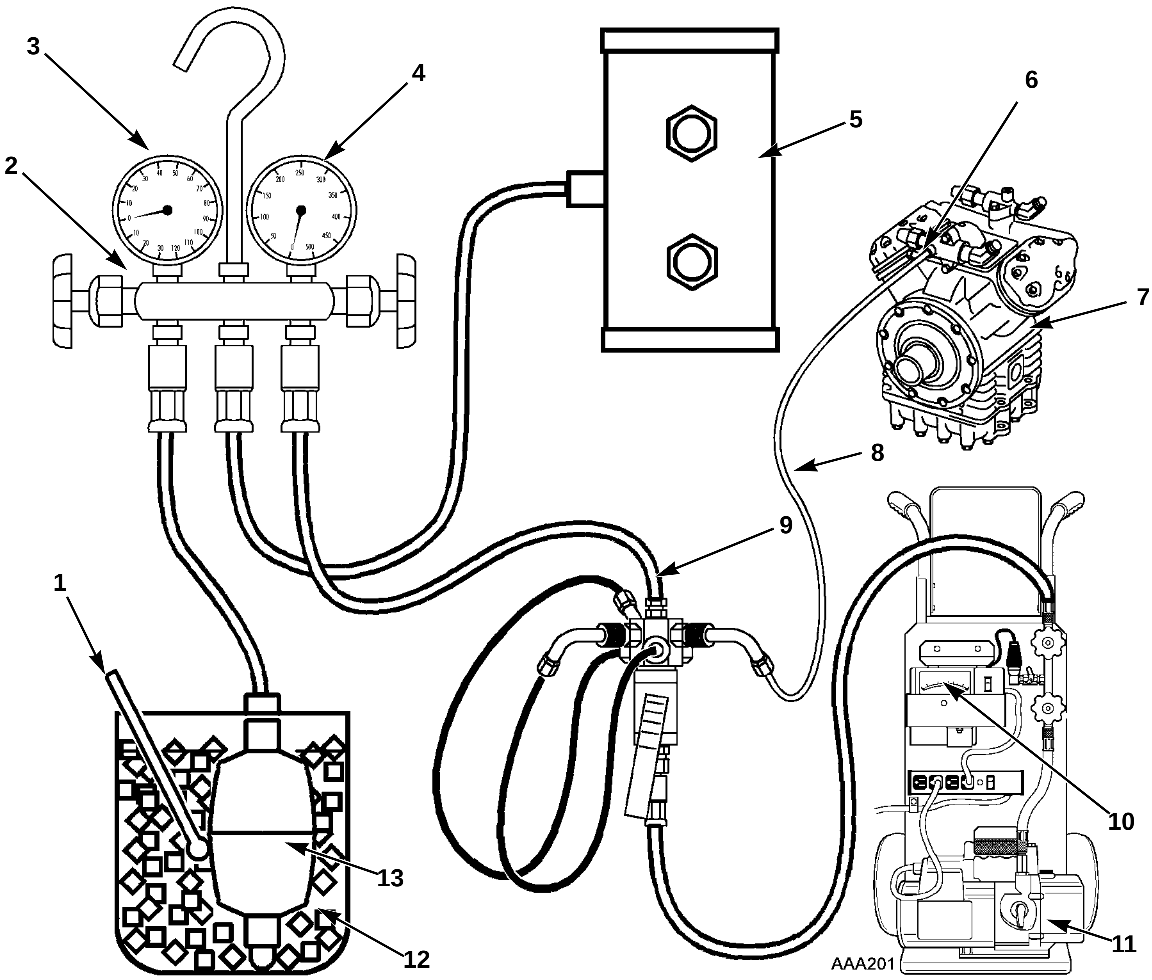
CAUTION: Ensure that there are no leaks in the system.

2. Run the compressor to circulate air, if any, in the system.
3. Close the high side gauge valve to isolate the micron gauge and pump.
4. Open the receiver tank service valve for a count of four. Close the valve for another count of four.
5. Close the low side gauge valve.
6. Submerge the sample bottle in the ice bath for 15 to 20 minutes. Make sure the sample is completely covered. Stir the ice bath occasionally.
7. Compare the low side gauge reading with your pressure/temperature chart for 32 F (0 C):

Refrigerant	Pressure[1]
R-22	57.5 psig (396.4 kPa)
R-407C	50.9 psig (351 kPa)
R-134a	27.3 psig (188.3 kPa)

[1] Reading must be ± 1 psig [7 kPa].

8. There are two outcomes of this test:
   a. **Non-condensables detected:** If pressures exceed specifications, reclaim the refrigerant and evacuate the unit according to evacuation procedures. After the system is evacuated, leak tested, and recharged with clean refrigerant, test system operation. If the system operation is satisfactory, return the bus to service.
   b. **Non-condensables not detected:** If ice bath testing proves negative (no non-condensible), make sure receiver tank or liquid line service valve is closed. Start the bus and run the compressor at fast idle. Open both gauge manifold valves, then *slowly* open suction service valve to line and bleed the refrigerant back into system. Leave compressor valve open until the pressure stabilizes. Back seat the suction service valve. Purge all lines.
   c. Remove gauges, lines, etc. Replace all service caps, and covers. Return bus to service.



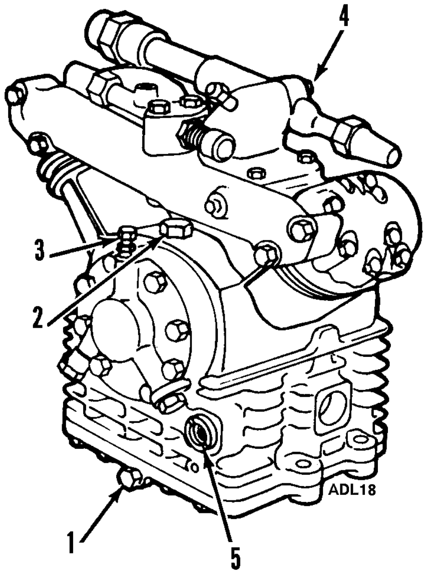
Refrigerant Pressures at 32 F (0 C):
R-22 = 57.5 psig (396.4 kPa)
R-134a = 27.3 psig (188.3 kPa)
R-407C = 50.9 psig (351 kPa)
(Reading must be ± 1 psig [7 kPa])

1.	Temperature 32 F (0 C)	8.	Suction Line
2.	Gauge Manifold Set	9.	Hose Manifold Assembly
3.	Suction Gauge	10.	Micron Gauge
4.	Discharge Gauge	11.	Vacuum Pump
5.	Receiver Tank	12.	Ice Bath 75%, 25% Ice Water
6.	Suction Service Valve	13.	Sample Bottle of Refrigerant
7.	Compressor		

Figure 40: Ice Bath Sample Method

Compressor Oil Procedures

The quantity of oil will not change unless there is a leak or someone has added or removed oil from the system. However, the level in the compressor sight glass will change depending on factors such as ambient temperature and system operating characteristics. To get an accurate reading, check the oil level when the system has run for at least 30 minutes. The correct level should be between 1/4 and 1/2 of the compressor oil sight glass.



1.	Oil Drain Plug
2.	Oil Fill Plug
3.	Oil Sump Pump
4.	Suction Service Valve Fitting
5.	Compressor Oil Sight Glass

Figure 41: Compressor Components

Checking the Oil Level

CAUTION: The unit must be running when you check the oil, but do not work on operating equipment when the unit is running. Serious injury or death could result.

1. Run the air conditioning system at a high idle engine speed (1200 to 1500 rpm) for at least 30 minutes. Operate it in reheat mode, or jump the unit heating to keep the A/C on.
2. Confirm by touch that the compressor sump area is warm. If it is cool, it may have liquid refrigerant mixed in the oil.
3. Be sure the compressor is sitting in a level position (i.e., not tilted). Check the compressor sight glass. The correct oil level should be between 1/4 and 1/2 of the sight glass. (General rule: If the oil level can be seen in the sight glass, the oil level is good.)

Adding Compressor Oil

CAUTION: Stop the bus engine and A/C system before adding oil. Ensure the unit and bus cannot be run during servicing.

CAUTION: Before adding oil, confirm which oil is in the system. The wrong oil can cause severe damage to your system.

CAUTION: The vacuum pump method is the only to add oil to a charged system. Do not use hand pump.

1. Estimate how much oil is needed. Verify the correct oil for the system.
2. Pump down the compressor. See "Compressor Pumpdown."
3. Turn off the bus power and operating safety switch to ensure that the bus cannot run.
4. Front seat the compressor discharge service valve.
5. Balance pressures to establish positive pressure and to recover excess refrigerant pressure.

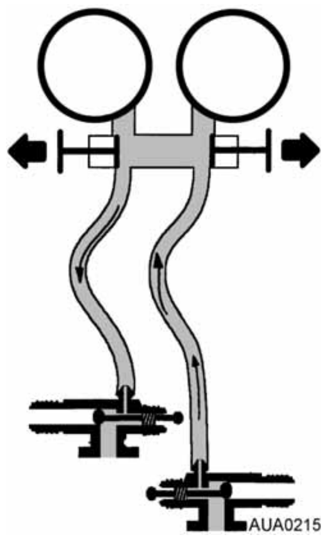
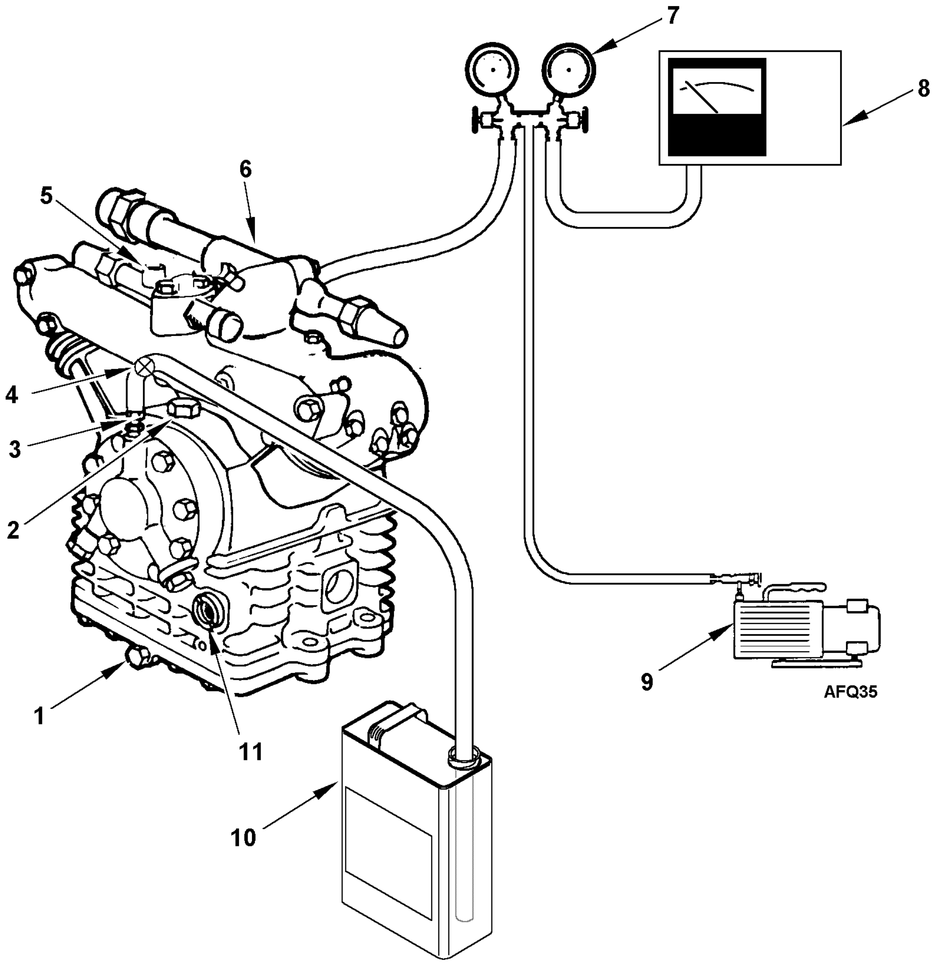


Figure 42: Balance System—Both Valves Front Seated

6. Connect a vacuum pump to the service gauges. (Service gauges should still be connected from the compressor pumpdown).
7. Connect a clean service hose to the oil pressure port. This is located on top of the compressor oil pump at the top rear of the compressor (see Figure 43 on page 92).
8. Open the oil container. Insert the clean service hose from the oil pressure port into the can to below the oil level.

CAUTION: If the oil level drops below the hose opening, air will be sucked into the compressor during this procedure. Ensure the hose is below the oil level at all times.

CAUTION: Refrigerant oil attracts moisture from the air. Do not leave oil containers open to the air for long periods of time.



1.	Oil Drain Plug	7.	Service Manifold Gauge
2.	Oil Fill Plug	8.	Micron Gauge
3.	Oil Pump Port	9.	Vacuum Pump
4.	Shut-off Valve	10.	Oil Container Filled with Compressor Oil
5.	Discharge Service Port	11.	Compressor Oil Sight Glass
6.	Suction Service Port		

Figure 43: Adding Compressor Oil

9. Turn on the vacuum pump. Lower the pressure inside the compressor to pull the oil into the sump through the compressor oil pump.
10. Observe the compressor oil sight glass. When the oil level is 1/4 to 1/2 in. (6 to 12 mm) from the bottom of the sight glass, secure the oil pump pressure port and replace the cap. Continue evacuating the compressor sump area to remove air and non-condensable gases that were pulled in with the oil.
11. When evacuation is complete, open all system valves, start the bus and A/C system, and recheck the compressor oil level.
12. Confirm the system refrigerant charge level. See "Charging Systems." Adjust the charge as required before returning the bus to service.

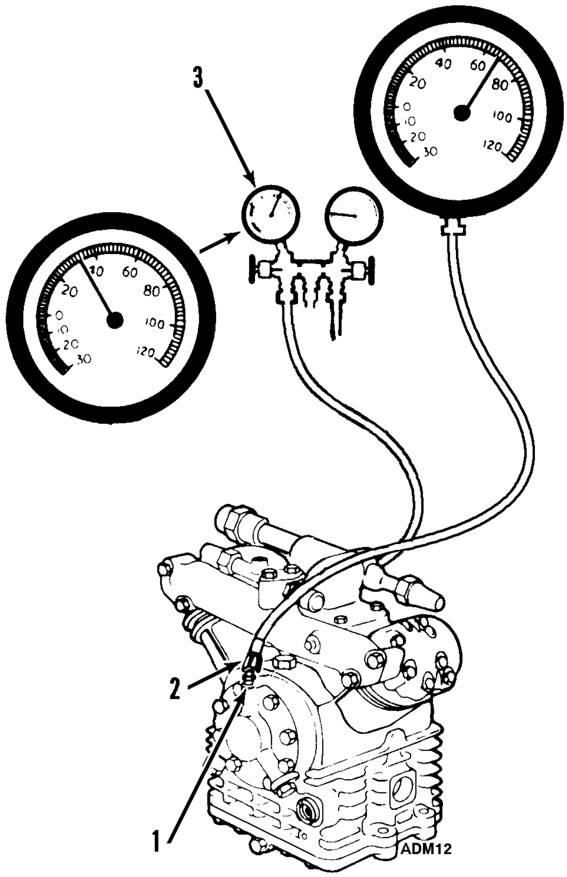
Removing Excess Oil

1. Pump down the compressor. See "Compressor Pumpdown."
2. Stop the compressor. Use the gauge manifold to adjust the compressor (low side) pressure to 2 to 3 psig (14 to 21 kPa). Measure the pressure at the compressor suction service valve port.
3. Loosen the drain plug but do not remove it. Allow the oil to drain slowly while watching the level in the compressor sight glass.

   NOTE: Heavy foaming of the oil as it leaves the compressor indicates refrigerant in the oil. If you observe foaming, run the system longer before performing this procedure.
4. Tighten the drain plug. Leak test the system. See "Testing System for Leaks."
5. Run the system. Confirm the refrigerant charge level. Check the oil level before returning the bus to service.

Checking Compressor Oil Pressure

1. Install a gauge on the compressor oil pump port ("A") located at the top of the oil pump cover (see Figure 44 below). If necessary, pump down the system and use a gauge line with a Schrader valve.
2. With the unit running, observe the gauge reading at compressor oil pump. This reading is both suction pressure and compressor oil pressure. Install a compound gauge on the suction service valve fitting. Run until the suction pressure stabilizes.



1.	Oil Pump Port "A"
2.	Schrader Valve in Hose
3.	Compound or Suction Pressure Gauge

Figure 44: Checking Oil Pump Pressure

3. Calculate the oil pressure by subtracting the suction pressure reading from the oil pump port gauge reading:

Example:

Pressure from oil pump port (A)	=	65 psig (448kPa)
Compound gauge (suction pressure) reading	–	35 psig (241 kPa)
Net compressor oil pressure	=	30 psig (207 kPa)

Compressor Efficiency Check

Perform a compressor efficiency check if the system is not cooling correctly and you have verified that all other system components are operating properly.

NOTE: This procedure applies to Thermo King X426, X430, and X640 compressors.

1. Install a gauge manifold set. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Bypass the Low Pressure Cutout (LPCO) to prevent the clutch from disengaging.
3. Start and run the unit at fast idle for 15 minutes to stabilize system pressures.

   Example: On an 80 F (27 C) day, your discharge pressure will be approximately 240 psig (1655 kPa) (with R-22 or 407C refrigerant).
4. Cover the inlet side of the condenser coil to increase the discharge pressure 70 to 100 psig (483 to 689 kPa) higher than normal.

   Example: If your discharge pressure is 240 psig (1655 kPa) after 15 minutes of operation, increae it 310 to 340 psig (2137 to 2344 kPa).
5. Front seat the suction service valve.
6. When the compressor reaches a 10 in. vacuum (-34 kPa), observe the discharge pressure. It should read as follows:

   a. R-134a — 125 psig or higher (862 kPa)

   b. R-22 & R-407C — 190 psig or higher (1310 kPa)

   NOTE: Foam or bubbles are indications of refrigerant in the oil. If this occurs, start the compressor a few times to complete the pumpdown. Starting the pumpdown from a warm compressor minimizes this condition.

IMPORTANT: If the head pressure cannot be raised by 100 psig (689 kPa) prior to the pumpdown or the vacuum will not stay below 15 in. (-51 kPa), the compressor may require repair or replacement. Check the following:

- Piston reed(s) or discharge valve plate reed(s) may be defective.
- Compressor may have excessive piston to sleeve clearance.
- Unit may be low on refrigerant.

NOTE: If the compressor will not pull at least a 15 inch (-51 kPa) vacuum, the piston reed may be defective or the piston to sleeve clearance may be excessive.

If the compressor will pull a deep vacuum, but not stay below 15 inches (-51 kPa) of vacuum for at least 15 seconds after unit is turned off, the discharge valve reed(s) are defective.

CAUTION: Eliminate all other possibilities before repairing the unit. Be sure you have allowed enough time for the refrigerant to leave the oil during the pumpdown. Repeat the test if necessary.

Compressor Removal and Installation

Operating Compressor Removal

NOTE: See TK Service Bulletin No. 390 for service valve torque values on the compressor for your unit.

1. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Place a jumper wire across the LPCO to allow the compressor to pull a slight vacuum.
3. Pump down the compressor to a vacuum of approximately 10 in. Hg (-34 kPa). Stop the unit.
4. Stop the bus and switch off the bus battery. If there is a safety off switch in the engine compartment, turn it off.
5. Front-seat the compressor discharge service valve.
6. Use the gauge manifold hand valves to raise the pressure in the compressor to 0 psig (0 kPa) before removal from bus.
7. Recover the refrigerant remaining in the compressor with a recovery or recycling machine.

CAUTION: Do not vent refrigerant to the atmosphere.

8. Unbolt the discharge and suction service valves from the compressor. Cap the ports on the compressor body to prevent contamination.
9. Move the valve and hose assemblies out of the way. Secure them in place to prevent interference with the following operations.
10. Loosen and remove the drive belts from the compressor.
11. Unbolt the compressor from its mounting cradle.
12. Disconnect the remaining wires and pressure lines from the compressor.
13. Remove the compressor from the bus.

NOTE: Check and note the oil level of the removed compressor. If the level is correct, the new compressor must have the same amount of oil.

Non-Operating Compressor Removal

1. Attach a gauge manifold to the compressor. See “Gauge Manifold Attachment, Purging, and Removal.”
2. Turn off the bus battery. If there is a safety off switch in the engine compartment, turn it off.
3. Front-seat the compressor suction and discharge service valves.
4. Recover the refrigerant remaining in the compressor with a recovery or recycling machine.

CAUTION: Do not vent refrigerant to the atmosphere.

5. Unbolt the discharge and suction service valves from the compressor. Cap the ports on the compressor body to prevent contamination.
6. Move the valve and hose assemblies out of the way. Secure them in place to prevent interference with the following operations.
7. Loosen and remove the drive belts from the compressor.
8. Unbolt the compressor from its mounting cradle.
9. Disconnect the remaining wires and pressure lines from the compressor.
10. Remove the compressor from the bus.

NOTE: Check and note the oil level of the removed compressor. If the level is correct, the new compressor must have the same amount of oil.

Compressor Installation

1. Check and adjust (if necessary) the oil level of the new compressor.

CAUTION: Do not mix oils and refrigerants that are not compatible. Serious damage to your system will result.

2. Mount the compressor.
   - If mounting bolts are used in the belt alignment process, do not tighten them now. Assemble all hardware loosely.
   - If mounting bolts are not used for belt alignment, then secure them.
3. Remove the protective caps from the service valve ports on the compressor body. Inspect the ports to ensure that nothing has been left inside the compressor. Clean the gasket surfaces for the service valves. Check the compressor body to ensure it is clean. Oil the gaskets with the system refrigerant oil.
4. Mount the service valves on the compressor body. Torque the mounting bolts to the specified torque value. Connect any other refrigerant or oil lines required by your system.
5. Attach a gauge manifold to the compressor.
6. Pressurize the compressor with nitrogen to 100 psig (689 kPa) and test for leaks.

7. Evacuate the compressor to a stabilized pressure below 1500 microns.
8. While the compressor is being evacuated, connect control wires, install and align the drive belts, and check the tightness of all bolts and connections.

   NOTE: See the bus manufacturer manual for alignment and belt tension tools and procedures.

9. When evacuation is complete, close the gauge manifold valves and remove the evacuation equipment. Leave the gauge manifold attached to the compressor to monitor system operation.
10. Back-seat the compressor suction and discharge service valves.
11. Run the bus A/C in high idle (1200–1500 rpm compressor speed).
12. Check that all fans are working and that the system is cooling.
13. Operate the system for at least 30 minutes, then check the compressor oil level. The oil level should be 1/4 to 1/2 from the bottom of the sight glass. Add or remove oil if necessary.

    NOTE: The compressor body must be warm to the touch before checking oil.

14. Check refrigerant charge and add refrigerant if needed.
15. Stop the bus. Recheck the tightness of all bolts. Recheck the drive belts for correct tension.
16. Place the system back in operation.

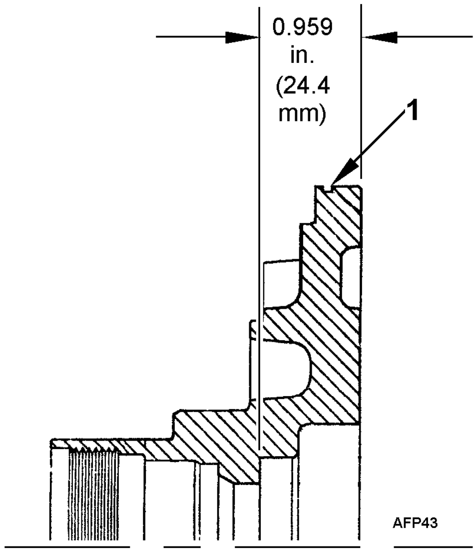
Compressor Crankshaft Seal

Set Screw Type Metal Bellows Crankshaft Seals

Thermo King has designed two stainless steel bellows crankshaft seal assemblies for the X426, X430 and X640 compressors used in bus air conditioning applications. These new stainless steel bellows seals provide higher tolerance to heat experienced in bus engine compartments, and reduce leak potentials by eliminating the carbon seal face.

Early Model SS Bellows Shaft Seal

Shaft Seal	Used with Drive Plate
TK No. 22-751	TK No. 22-790

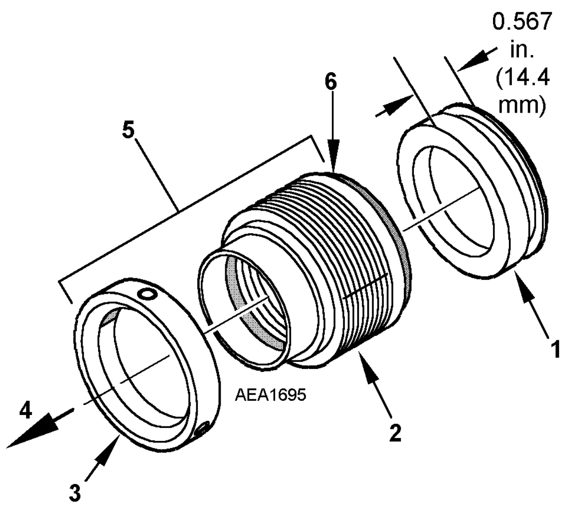


1.	***NOTE: Groove signifies for use with only stainless steel bellows seal, TK No. 22-751.***

Figure 45: Compressor Front Drive Plate TK No. 22-790

The early model stainless steel bellows assembly was manufactured between May 1992 and November 1996.

This early model style drive plate can be identified by a groove around the outer rim surface.



1.	Hard Ring
2.	Rotating Bellows
3.	Install Beveled Surface Against Crankshaft Shoulder
4.	Compressor Side
5.	Assembled Together in the Parts Box
6.	Carbon Sealing Face (1992 to1996)

Figure 46: Stainless Steel Bellows Crankshaft Seal TK No. 22-751

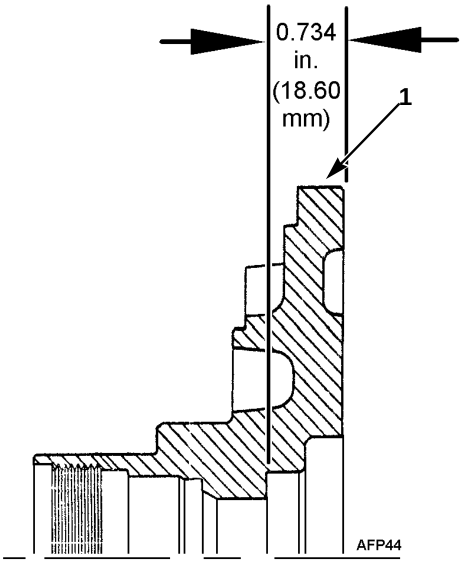
Starting November 1996 to date, Thermo King introduced a new improved stainless steel bellows crankshaft seal (TK No. 22-1100). This seal utilizes a bronze sealing face and is compatible only with the compressor front drive plate TK No. 22-754. This drive plate does not have a groove on the outer rim.

Later Model SS Bellows Shaft Seal

Shaft Seal	Used with Drive Plate
TK No. 22-1100	TK No. 22-754

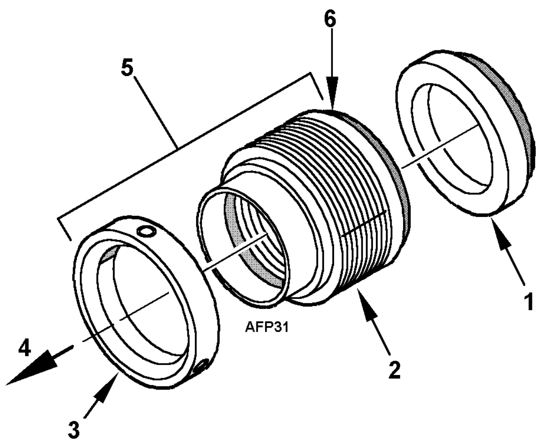
Drive plate TK No. 22-754 is compatible with older compressors that use the Neoprene Bellows crankshaft seal (units manufactured prior May 1992). Older model compressors which use this front drive plate can be upgraded to use the new stainless steel bellows crankshaft seal (TK No. 22-1100).

New stainless steel shaft seal and new style seal plate, when used together, are compatible with older model X426, X430, and X640 compressors.



1.	***NOTE: No groove for use with Neoprene Bellows Seal or Stainless Steel Bellows Seal TK No. 22-1100.***

Figure 47: Compressor Front Drive Plate TK No. 22-754



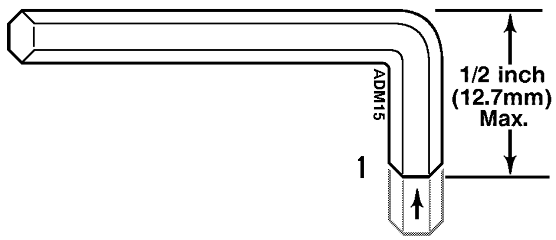
1.	Hard Ring
2.	Rotating Bellows
3.	Install Beveled Surface Against Crankshaft Shoulder
4.	Compressor Side
5.	Assembled Together in the Parts Box
6.	Bronze Sealing Face (1996 to date)

Figure 48: Stainless Steel Bellows Crankshaft Seal TK No. 22-1100

Installation of Set Screw Type Metal Bellows Seal

1. Remove the compressor from the unit and remove the clutch or drive coupling to access the seal plate.
2. Clean the outside of the seal plate.
3. Remove the seal plate from the compressor.
4. Remove the old hard ring (mating ring), lip seal, and o-rings from the seal plate.
5. Loosen the set screws that secure the bellows to the crankshaft. These set screws typically use an 1/8 inch Allen wrench, which is provided with the new seal kit.

   NOTE: A "modified" 1/8 in. (3.2 mm) Allen wrench with a 1/2 in. (12.7 mm) shank is included with the Stainless Steel Bellows Crankshaft Seal Kit. If you lose this wrench, you can modify a standard 1/8 in. (3.2 mm) Allen wrench. The shortened shank should be no longer than 1/2 in. (12.7 mm). See the figure below.

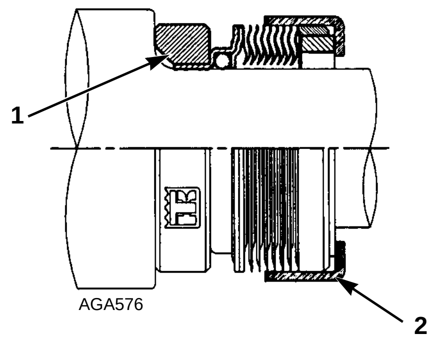


1.	Shorten Wrench

Figure 49: Special Allen Wrench

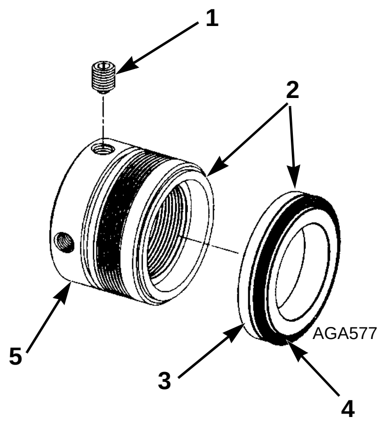
6. Remove the old bellows from the crankshaft. Use a small pry bar or screwdriver on each side of the bellows, but do not scratch the crankshaft when removing the bellows.
7. Back out the set screws from the new bellows and apply a small amount of removable thread locking compound (Loctite 242-31-blue TK No. 203-400) to the set screw threads.

CAUTION: Keep the orange protective cap in position until final assembly.



1.	Clamp Ring Installed with Chamfer Facing Crankshaft Shoulder
2.	Orange Protective Cap

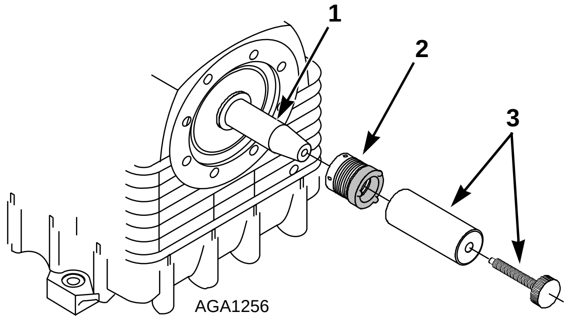
Figure 50: Cross Section of Set Screw Type Bellows Seal



1.	Set Screw
2.	Seal Faces
3.	Hard Ring
4.	O-ring
5.	Bellows

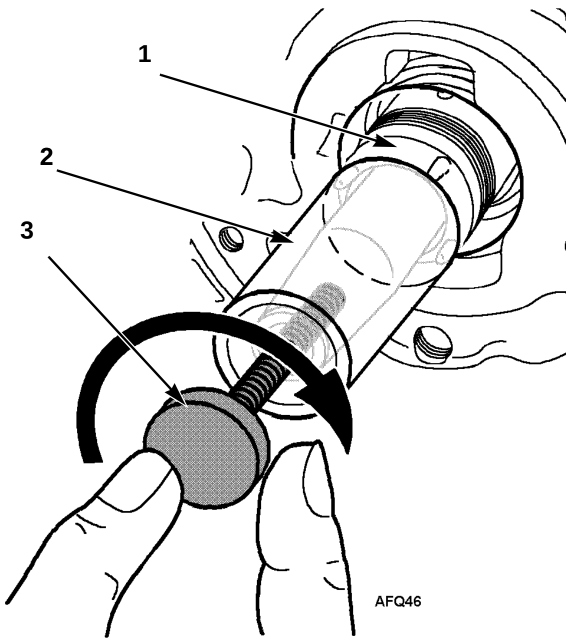
Figure 51: Set Screw Type Bellows Seal

8. Apply clean compressor oil (same type used in compressor) to the o-ring inside the bellows.
9. Slide the bellows onto the crankshaft with the chamfer inside the clamp ring facing the crankshaft shoulder (see Figure 52 on page 100). Leave the orange protective cap on the bellows.
10. Use seal installation tool TK No. 204-995 to install the bellows squarely on the crankshaft. Clean the seal installation tool and place it on the crankshaft.



1.	Crankshaft
2.	Bellows
3.	Seal Installation Tool TK No. 204-995

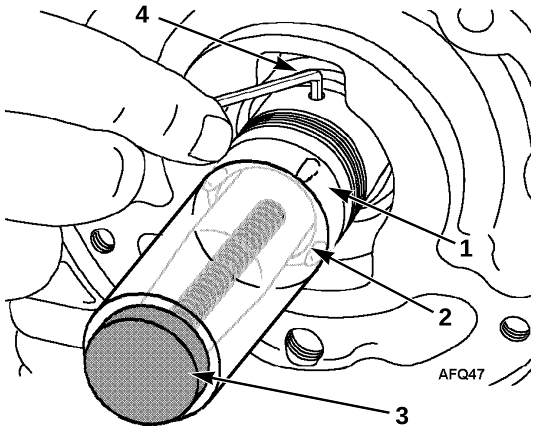
Figure 52: Bellows Installation with Tool TK No. 204-995



1.	Orange Protective Cap
2.	Seal Installation Tool TK No. 204-995
3.	Tighten Knob On Seal Installation Tool

Figure 53: Seal Installation Tool Placed on Compressor Crankshaft

11. Turn the knob on the seal installation tool until the tool bottoms out.



1.	Orange Protective Cap
2.	Seal Installer Tool TK No. 204-995
3.	Knob Completely Tightened to Crankshaft
4.	Special Allen Wrench (Kit Supplied)

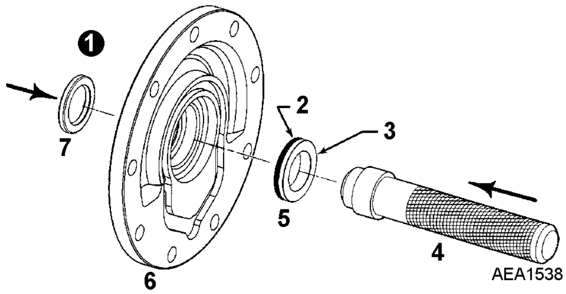
Figure 54: Seal Installation Tool Secured To Crankshaft and Tightening Set Screws

12. Tighten the set screws to approximately 45 in.-lb (5.0 N•m) with the Allen wrench provided.
13. Remove the seal installation tool.
14. Install the new lip seal in the seal plate with the lip side facing out and the flat side facing toward the compressor.
15. Apply clean compressor oil to the new o-ring and install it in the seal plate. Apply clean compressor oil to the new hard ring. Ensure that the hard ring installation tool (TK No. 204-953) is clean. Use the hard ring installation tool to push the hard ring (with the polished surface toward the installation tool) fully into the seal plate. Do not pinch the o-ring.

If the installation tool is not available, use the pad in the new seal packaging to protect the polished surface of the hard ring during assembly. A substitute installation tool should have a diameter approximately the same size as the O.D. of the polished surface.

CAUTION: After dipping seal parts in compressor oil, assemble immediately. The rubber parts/o-rings will swell slightly, and be impossible to install after several minutes exposed to air.

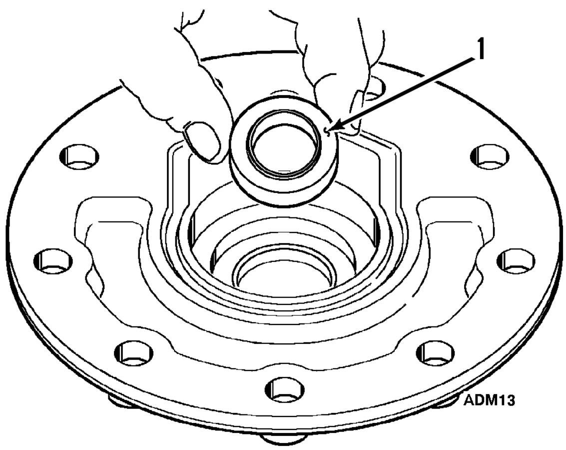
CAUTION: DO NOT pinch O-ring.



1.	Install Seal with Lip Facing Outward
2.	O-ring Facing Seal Plate
3.	Polished Face Surface
4.	Mating Ring Installation Tool (TK No. 204-953)
5.	Mating Ring
6.	Seal Plate
7.	Seal

Figure 55: Seal Installation

CAUTION: Do not touch or damage the polished seal face surfaces.



1.	Do Not Touch Surface. Hold Only By The Side Edge.

Figure 56: Installation of Mating Ring (Hard Ring)

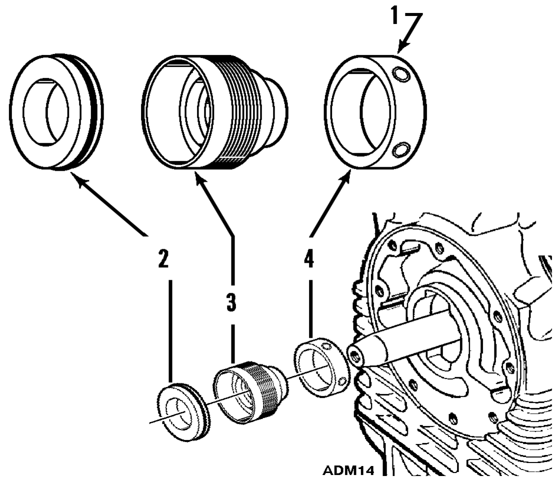
16. Remove the orange protective cap from the bellows. Clean the hard ring and the primary ring (bronze ring on the bellows) with the alcohol wipes found in package labeled “1”. Then clean the polished mating surfaces of both rings with the lint free dry wipes from package number “2”. Apply clean compressor oil to the polished surfaces of the seal and to the lip seal from package number “3” before assembling.

CAUTION: Oil applied to the seal faces must be absolutely clean.

17. Install the seal plate on the compressor body.

CAUTION: Do not bump the hard ring into the end of the crankshaft during assembly.

18. Hold the seal plate against the spring tension of the bellows until three opposing seal plate mounting screws are started. Then turn each of these screws one turn at a time to evenly pull the seal plate to the compressor body. snug. Install the remaining mounting screws. Torque the mounting screws to **28 ft-lb (38 N•m) in a criss-cross pattern**.



1.	Inside Diameter Chamfer Seats Against Crankshaft Shoulder
2.	Mating Ring (Hard Ring)
3.	Rotating Bellows
4.	Locking Collar

Figure 57: Installation of Seal Assembly

Brass Sealing Washers Used In Discharge Line Connections

A brass sealing washer is used on the discharge line. It replaces the neoprene O-ring in the discharge line. Neoprene O-rings are still used on some suction fittings.

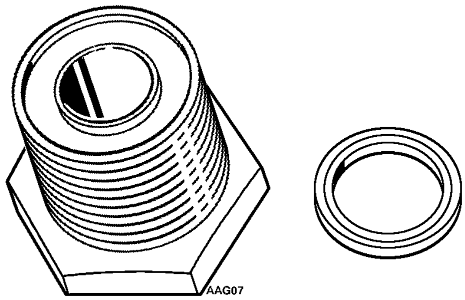


Figure 58: Fitting and Brass Sealing Washer

You must use the following procedures when using the metal washer:

Handling: Handle the washer with care so as not to damage the sealing ridges.

Fitting Cleanliness: Wipe clean of contamination (i.e., oil grease, O-ring particles, etc.) Do not use abrasive cleaners.

Sealing Surfaces: Do not use washers with damaged sealing surfaces. The sealing surfaces in the fitting must be free of visible defects such as scratches and pitting.

Mounting: When positioning the washer in a fitting that points downward, apply a small amount of petroleum jelly to the outer edge of the fitting groove. This will retain the washer when attaching the tube or hose.

Tightening Torque: Tighten the No. 16 fitting to 70 to 80 ft-lb (95 to 109 N•m). Tighten No. 20 fitting to 100 to 110 ft-lb (136 to 149 N•m).

CAUTION: When tightening fittings, use a backup wrench. You could damage the tubes if you don’t.

Leak Check: After installation, leak check with an electronic leak detector before releasing the full charge. Charge and top off if necessary.

Tightness Check: Check fittings for tightness and leaks in 3 months, then at 6 month intervals.

NOTE: All O-ring seals used on JIC fittings and all O-ring face seals used on suction fittings are made of neoprene.

SAE J639 Service Fittings

Some units with R-134a and R-407C are equipped with SAE J639 service fittings which require special gauge manifold sets to fit the SAE J639 fittings.

The gauge manifold set number is TK No. 204-747. The service fittings for this unit are shown below.

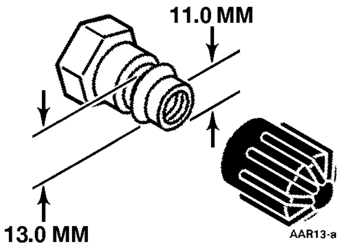


Figure 59: Suction Adapter with or without Depressor

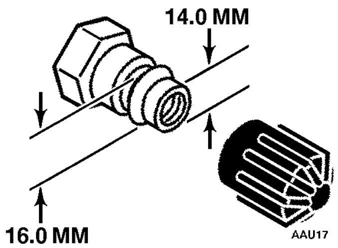
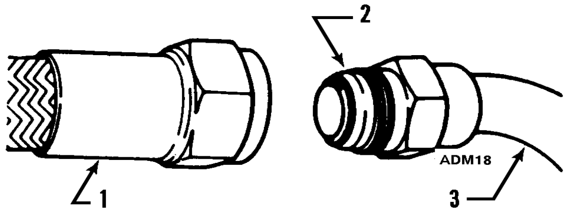


Figure 60: Discharge Adapter with or without Depressor

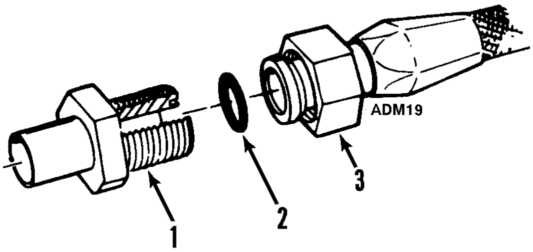
O-Ring Seal Fitting Replacement

1. Pump down the low side or recover the refrigerant charge as necessary. See “Low Side Pump Down” and “Refrigerant Recovery.”
2. To break threaded line connections, use two wrenches. A neoprene O-ring is used at flexible line connections and at condenser line connections to ensure a positive seal. Install a new O-ring seal whenever a line connection is broken. O-rings should never be reused.



1.	Flexible Line Connector
2.	O-ring Seal Positioned in Groove
3.	Compressor Line

Figure 61: JIC Fitting



1.	Adapter
2.	O-ring
3.	Connector Nut

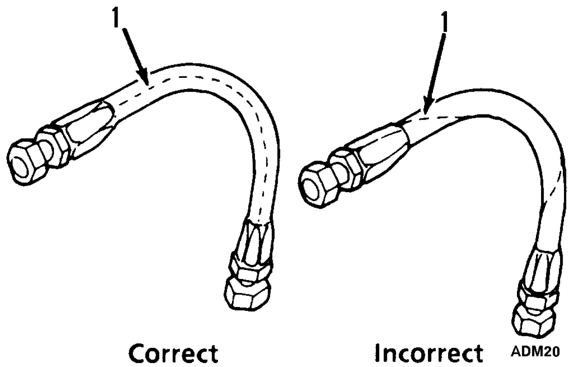
Figure 62: O-ring Face Seal

3. Before the line is connected, apply clean compressor oil of the same type used in the system to O-ring and flares to facilitate connection. Use two wrenches to tighten the flexible connections. To connect a flexible line to a metal line, hand tighten connector nut on flexible line against the adapter fitting. Support the adapter fitting with a wrench, and tighten the connector nut with another wrench until the fitting bottoms out. The connection bottoms out when tight, reducing the chance of over or under torque.

Refrigeration Hose Inspection

Inspect hose assemblies in operation frequently for leakage, kinking, abrasion, corrosion, and other signs of wear or damage. Replace worn or damaged hoses immediately. Check the lay line of the hose to be sure that the hose is not twisted.

If the hose is installed with a twist in it, high operating pressure tends to force it straight. This can loosen the fitting nut. Twisting can cause reinforcement separation, and the hose could burst at the point of strain.



1.	Lay Line

Figure 63: Hose Alignment

Suction and Discharge Hose Installation

Use three (3) wrenches for hose installation:

1. To hold suction line from twisting
2. To turn hose fitting
3. As backing wrench on attaching connection.

Causes of Failure

1. Improper storage can cause:
    - Permanent deformities
    - Crushed hoses
    - Corroded hoses.
2. Incorrect handling can cause:
    - Dents
    - Cover Damage
    - Crushed hoses
    - Twists or bends in hoses.
3. Incorrect installation can cause:
    - Incorrect bend radius
    - Incorrect hose routing
    - Incorrect clamping
    - Excessive compression
    - Excessive tension
    - Excessive hose torsion.

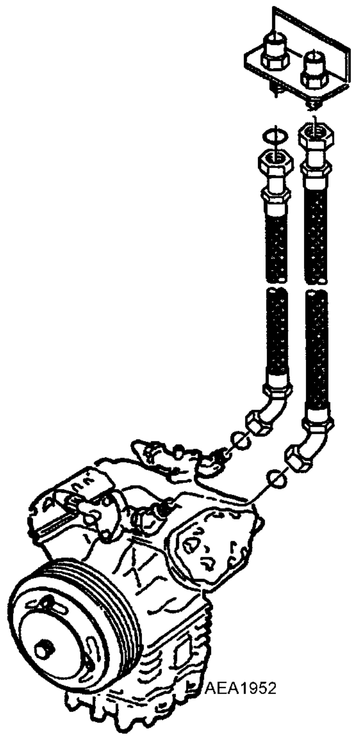
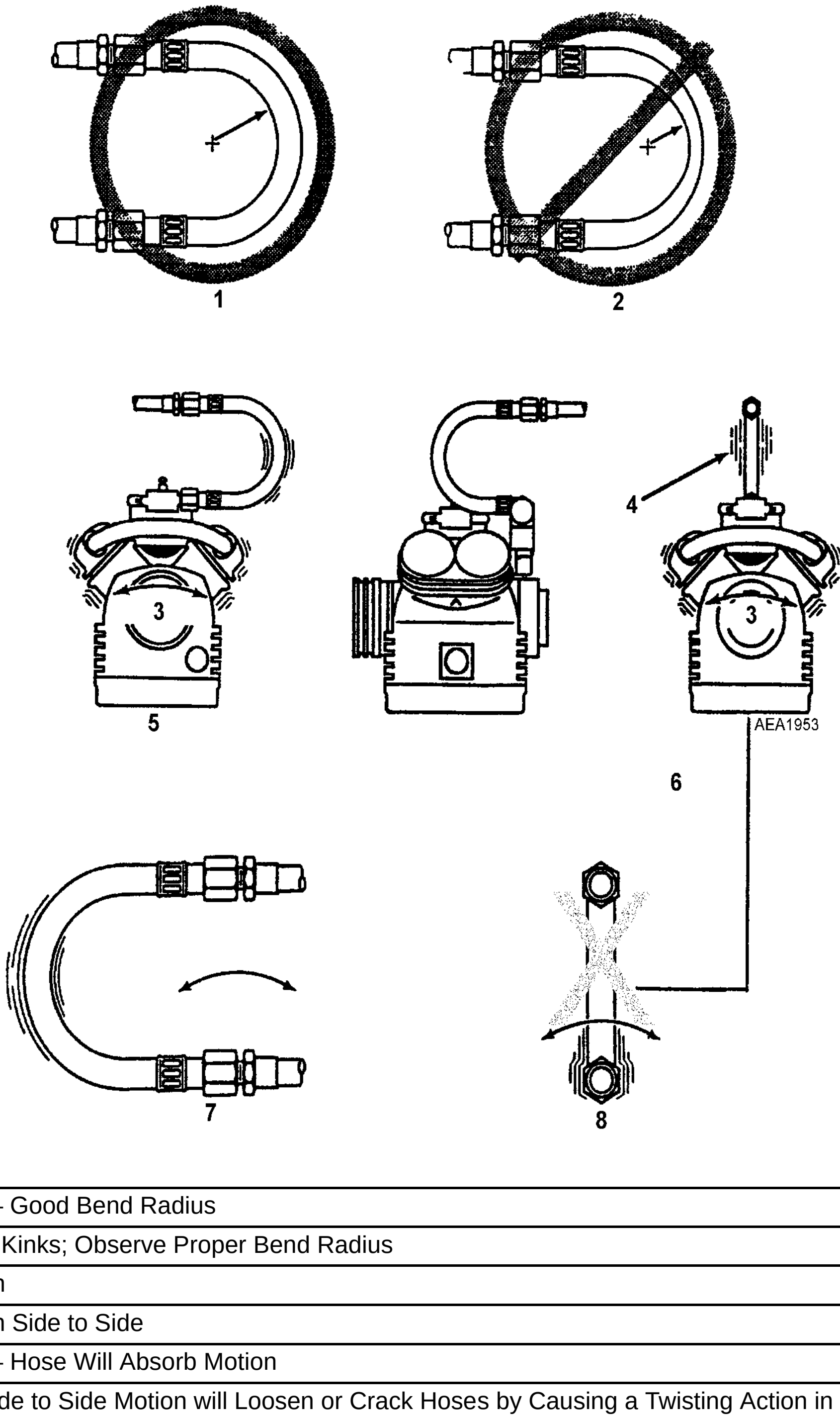


Figure 64: Typical Suction and Discharge Hose Installation

All flexible lines should be kept as short as the specific application allows. Observe the handling, design, and installation instructions in this chapter.

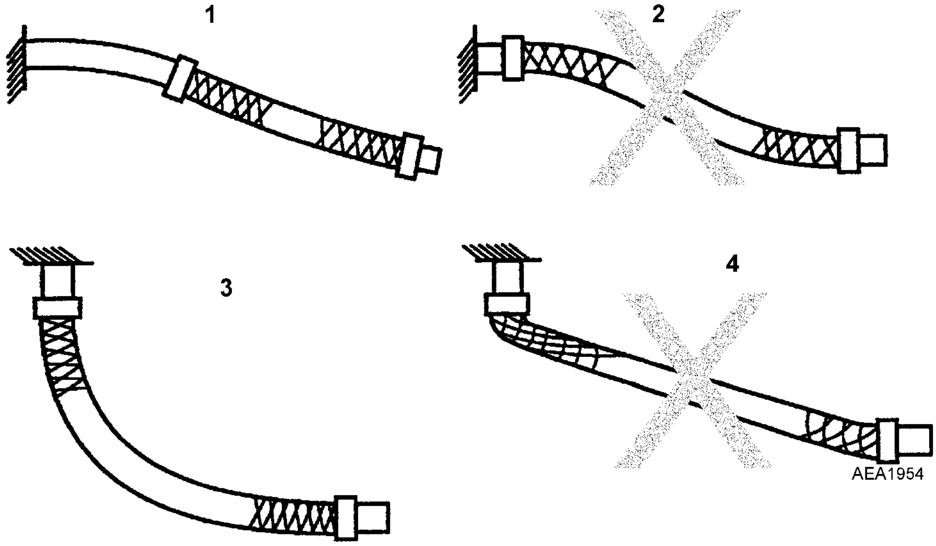


1.	Yes — Good Bend Radius
2.	No — Kinks; Observe Proper Bend Radius
3.	Motion
4.	Motion Side to Side
5.	Yes — Hose Will Absorb Motion
6.	NO Side to Side Motion will Loosen or Crack Hoses by Causing a Twisting Action in the Hoses
7.	This Movement OK
8.	This is not OK

Figure 65: Hose Routing

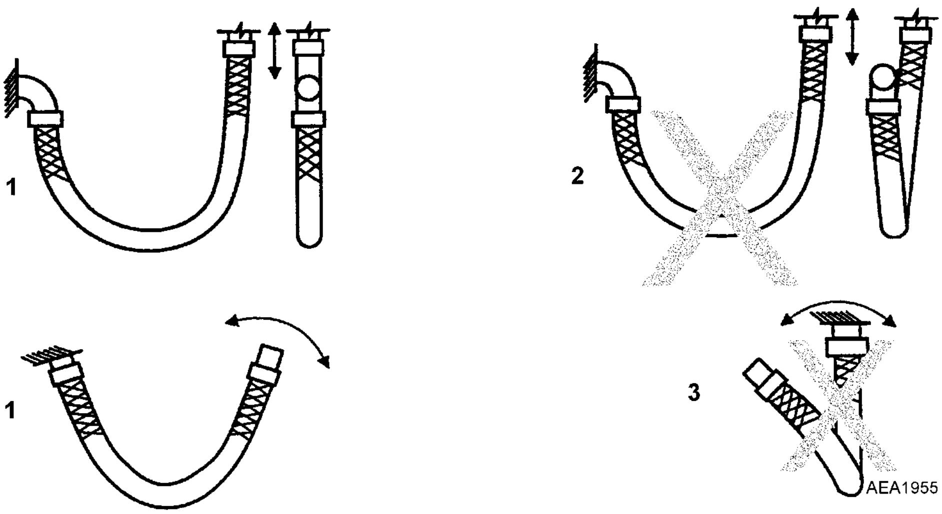
Design

These guidelines illustrate ideal situations. They should be followed as closely as possible.



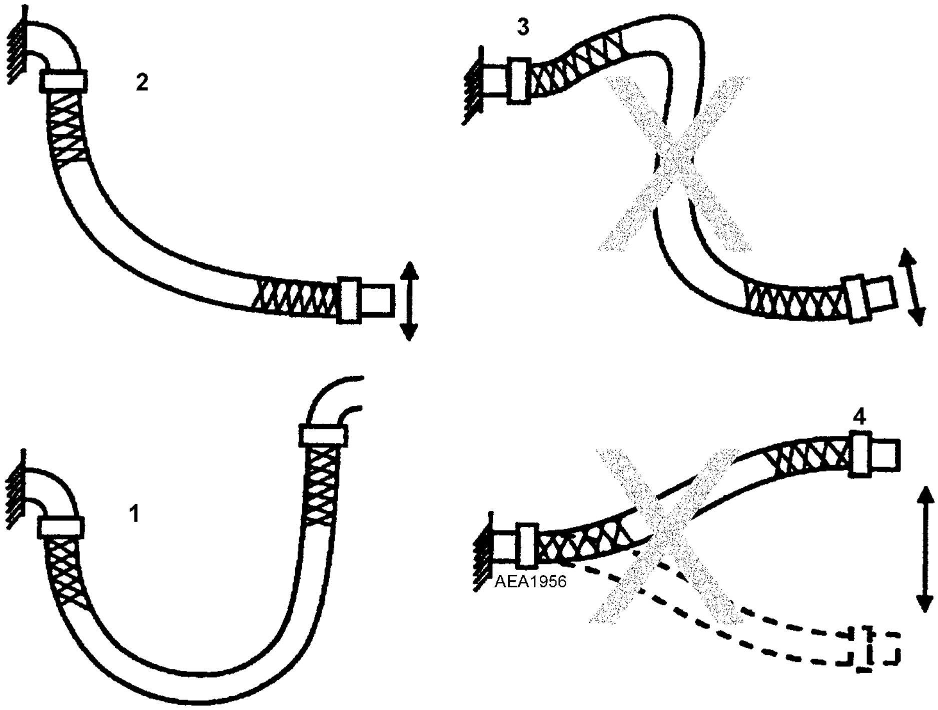
1.	Correct Use of Curved Fitting; Smooth Bend
2.	Incorrect—Sharp Bend; Possible Compression
3.	Correct
4.	Incorrect

Figure 66: Ideal Hose Routing



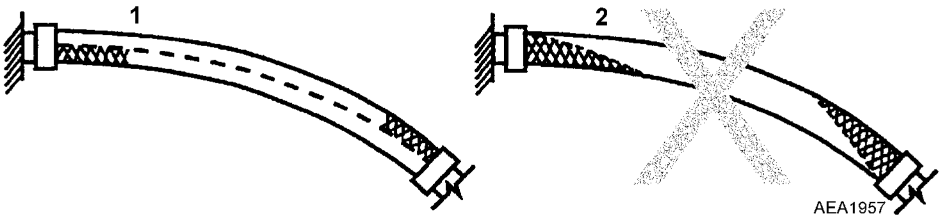
1.	Correct
2.	Incorrect — Motion Subjects Hose to Torsional Stresses
3.	Incorrect — Motion Carries Hose Out of Plane of Original Hose Axis

Figure 67: Correct and Incorrect Hose Alignment



1.	Correct
2.	Correct — Neutral Hose Ends Maintained
3.	Incorrect
4.	Incorrect — Stress Reversal Bending Next to Fittings

Figure 68: Correct and Incorrect Hose Alignment



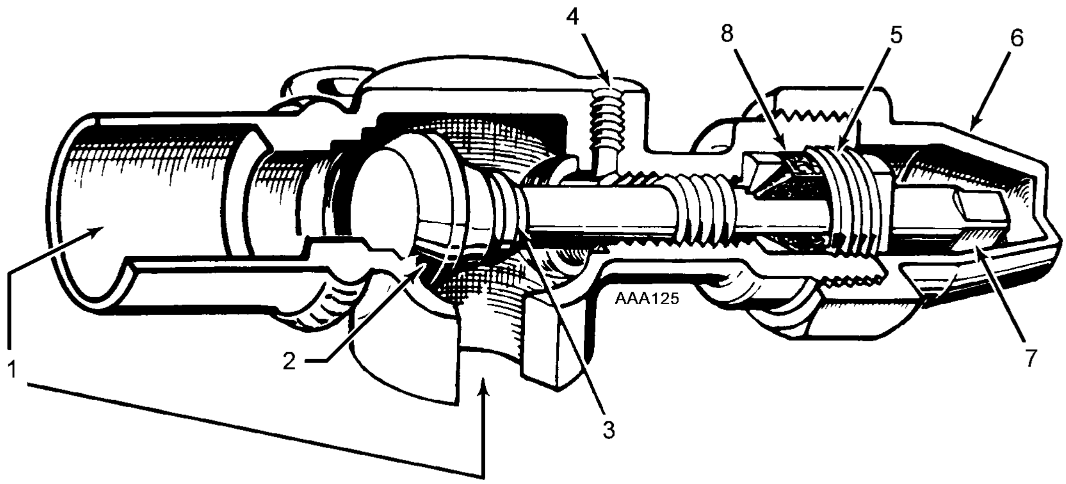
1.	Correct
2.	Incorrect — Twisted on Installation

Figure 69: Correct and Incorrect Hose Alignment

Service Valves

Maintenance on the discharge service valves and suction service valves involves periodically tightening the packing nut. The valves are a permanently assembled unit and must be replaced in total if defective.

CAUTION: Do not overtighten packing nut.



1.	Inlet or Outlet Depending on Application	5.	Packing Gland Nut
2.	Front Seat	6.	Protective Cap
3.	Back Seat	7.	Stem
4.	Service Port	8.	Packing Material

Figure 70: Service Valve

Suction Service Valve Removal

Use this procedure when the discharge service valve does not require service.

1. Pump down the low side and equalize the pressure in the low side to slightly positive (see "Low Side Pumpdown").
2. Remove the suction hose from the suction service valve before loosening the service valve mounting bolts.
3. Remove service valve mounting bolts and remove the service valve from the compressor body.
4. Clean all surfaces, being careful not to allow dirt, etc. into the compressor port.

Discharge Service Valve Removal

Use this procedure when servicing the discharge service valve, or both service valves.

1. Recover the refrigerant charge (see "Refrigerant Recovery").

   NOTE: If the suction service valve is to be removed, refer to steps 2 through 4 of "Suction Service Valve Removal".

2. Loosen the discharge hose to service valve connection before loosening the service valve mounting bolts.
3. Remove service valve mounting bolts and remove the service valve from the compressor body.
4. Clean all surfaces, being careful not to allow dirt, etc. into the compressor port.

Service Valve Installation

1. Confirm that surfaces are clean and free from scratches.
2. Coat the gaskets or o-ring with refrigerant oil (same oil used in this system).
3. Mount the gasket or o-ring and valve on the compressor body using the mounting hardware that you removed. Tighten bolts finger tight, then tighten to a torque value of 22 ft-lb (30 N•m).
4. Attach the hoses to the service valves and torque per specifications.
5. Leak test the system following standard procedures.

6. If all refrigerant was removed from the system, evacuate the complete system. If only the low side was opened, evacuate the low side only. Follow procedures in this manual to complete the evacuation down to an equalized pressure below 1500 microns.
7. If the system is empty, charge the system. If the low side was pumped down, open the receiver tank outlet valve or the liquid line shutoff valve.
8. Start the unit and check the refrigerant charge and compressor oil level.

High Pressure Relief Valve Removal and Installation

The valve contains a spring loaded piston that lifts when the refrigerant pressure exceeds the spring force. When pressure drops below setpoint, the valve will reset. The valve might leak refrigerant after it has relieved excess pressure. Tapping the valve lightly may help the valve reseat and seal properly. The valve is non-repairable and requires no adjustment. If the valve fails to reseat properly, the valve must be replaced.

NOTE: Before starting replacement procedure, use your parts manual to identify the correct valve for your unit.

Removal

1. Recover the refrigerant charge.
2. Unscrew and remove the high pressure relief valve. Discard the old valve.

Installation

1. Apply a refrigerant oil (same type as used in the system) to the o-ring and threads of the high pressure relief valve.
2. Install and tighten the high pressure relief valve.
3. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
4. Recharge the unit with the proper refrigerant and check the compressor oil.

Condenser Coil Removal and Installation

CAUTION: Use extreme care when working with the exposed coil fins. Coil fins are very sharp and can cause painful lacerations.

Removal

1. Recover the refrigerant charge.
2. Remove the screws securing the orifice panel to the frame. Remove the orifice panel assembly.
3. Unsolder the condenser inlet and outlet tubes.
4. Seal the inlet tube to prevent contamination.
5. Remove the screws securing the condenser to the frame.
6. Lift the condenser coil directly outward from the unit.

CAUTION: Remove the condenser coil carefully to prevent fin damage.

DANGER: Do not solder on a closed system. Pressure can build up and may cause an explosion. Use Nitrogen purge or open a service during soldering procedures to prevent pressure buildup.

NOTE: Purge the residual pressure before unsoldering tubes.

7. Repair the condenser coil as necessary.

Installation

1. Place the condenser coil in the frame.
2. Secure the condenser coil to the frame and tighten the screws.
3. Solder the inlet and outlet tubes to the condenser coil.
4. Pressurize the system and leak test the solder joints and the rest of the system.
5. If no leaks are found, evacuate the system.
6. While evacuating the system, finish assembling the unit. Recheck hardware to ensure tightness.
7. Recharge the unit with the proper refrigerant and check the compressor oil.

Receiver Tank Removal and Installation

CAUTION: Inspect receiver tank for corrosion. Clean any areas of existing corrosion and paint with rust preventive paint to prevent further corrosion. Replace any receiver tank that shows excess corrosion that could cause refrigeration leakage.

Removal

NOTE: On rooftop units the receiver tank is typically located in the center of the evaporator near the condenser. The receiver tank may be protected by sheet metal plates. The plates must be removed to remove the receiver tank.

NOTE: On T Series units the receiver tank is typically located on the curbside of the unit next to the frame.

NOTE: If soldering is required, it is strongly recommended that dry nitrogen be used to purge the system during any solder operations (see "Using Pressurized Nitrogen").

1. Recover the refrigerant charge.
2. Remove the evaporator covers, if required.
3. Remove the center mounting channel, if required.
4. Remove the upper plate holding the receiver tank in position, if required.
5. Hook up your refrigerant recovery or reclaiming machine to the system.

CAUTION: Some recovery machines will not recover refrigerant in a liquid form. Follow procedures for your machine.

CAUTION: Purge the system with dry nitrogen during any solder operations (see "Using Pressurized Nitrogen). Failure to use nitrogen during soldering procedures will cause scale build-up inside the system and cause system malfunction.

6. If unsoldering, hook up and turn on the dry nitrogen purge.

NOTE: Purge the residual pressure before unsoldering tubes.

7. Disconnect or unsolder the liquid line fittings between the condenser and tank.
8. Remove the hardware holding # 12 fitting (liquid line) to the bulkhead, if required.
9. Disconnect the fitting from the filter-drier inlet, if required.
10. Remove the receiver tank outlet valve mounting bolt if equipped and unsolder lines from tank, if required.
11. Disconnect the condenser pressure switch wires from the wire harness and remove the condenser pressure switch from the receiver inlet line, if needed.
12. Remove the receiver tank mounting bolts and remove the receiver tank.
13. Secure nitrogen purge, and cover open tubes until ready to install new tank. This will keep dirt, etc. out of the system.

CAUTION: Discard the receiver tank—it is not repairable and must not be reused for any other purposes. Only the sight glass is repairable.

Installation

1. If soldering, clean all fittings in preparation for soldering. A hard silver bearing solder (such as TK No. 203-364) is required for this operation. **A soft solder must not be used.** Follow all standard shop procedures for the soldering process. Refer to “Silver Brazing and Soft Soldering” TK publication no. 7949 for additional information.

CAUTION: Do not put soldering flux inside the refrigerant system.

2. Mount the new receiver tank using the mounting hardware from the old tank, or replace with new parts.
3. Install the receiver tank outlet valve mounting bolt, if so equipped.
4. Apply refrigerant oil (same type as used in the system) to condenser pressure switch threads (tee assembly), if so equipped.
5. Install the condenser pressure switch securely and connect the switch wires to the wire harness, if removed.
6. Connect the fitting to the filter-drier inlet, if required. Use a backing wrench to prevent tubing from twisting.
7. If soldering, turn on the dry nitrogen purging gas. This will prevent oxygen in the air from causing scale buildup inside the new tank or tubing.

   NOTE: Scale of this type left in the system will contaminate the compressor oil, plug filters or expansion valves and support chemical break down and reaction between other components of the system.

8. Connect or resolder hardware holding #12 (liquid line) fitting to the bulkhead, if required. Use a backing wrench to prevent tubing from twisting.
9. Connect or resolder the liquid line fittings between the condenser and the tank.
10. Secure nitrogen purge. Clean flux and other external scaling from the tank and tubing.
11. Replace the upper plate that holds the receiver tank in position, if required.
12. Replace the center mounting channel, if removed.
13. Replace evaporator covers, if removed.
14. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
15. Recharge the unit with the proper refrigerant and check the compressor oil.

Filter-Drier Removal and Installation

NOTE: Some systems may be equipped with a Pilot operated EPR Valve. If the unit is equipped with a pilot line shutoff valve, this valve MUST be closed during a low side pump down.

Removal

1. Determine if the unit has one or two hand valves and proceed as follows:
   a. If the unit has one hand valve, pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown”).
   b. If the unit has two hand valves, shut the valves off, then proceed to step 2 (no low side pumpdown necessary).
2. If the unit has a filter-drier outlet valve, close it to minimize moisture infiltration into the system.
3. Disconnect the filter-drier fittings and remove the filter-drier from the system. **Hold the filter-drier with a backup wrench to keep from twisting the tubes.**

Installation

1. Clean all fittings.
2. Remove the protective caps from the new filter-drier, install new o-rings (supplied with new filter drier), and apply oil of the same type used in the compressor to the o-rings and threads.

NOTE: Some filter-drier connections do not use o-rings.

3. Install the new filter-drier as quickly as possible and observe the following considerations:
   - Observe the “IN” designation printed on the inlet side of the filter-drier. To prevent improper installation of the filter-drier, ensure the arrow on the filter-drier points in the direction of refrigerant flow.
   - Hold the filter-drier with a backup wrench to keep from twisting the tubes when tightening or removing the nuts.
   - The longer the filter-drier remains open to air, the more moisture it will absorb.
4. Evacuate the low side or the filter-drier as follows:
   - If the unit does not have a filter-drier outlet valve, evacuate the low side.
   - If the unit has a filter-drier outlet valve, hook the evacuation equipment to the service port on the filter-drier outlet valve and evacuate the filter-drier and tubing between the between the two service valves.
5. Once the evacuation has been completed, back seat the service valves, remove the evacuation equipment, replace caps and open the service valves and pilot line shutoff valve (if equipped).
6. Leak test all fittings, secure the valve packing, to prevent leakage of refrigerant.
7. Run the system and check the refrigerant charge level and compressor oil level.

Evaporator/Heater Coil Removal and Installation

⚠ ***CAUTION: Use extreme care when working with the exposed coil fins. Coil fins are very sharp and can cause painful lacerations.***

Removal

1. Recover the refrigerant charge.
2. Unlatch and carefully lift the evaporator access panel.
3. Remove the cover supports.
4. Remove the hardware holding the cover hinges and covers in position.
5. Remove the covers and set aside.
6. Unbolt the unit control panel, harnesses, and tubing from center support channel.
7. Remove the center support channel and set aside.
8. Unsolder the suction line.

DANGER: Do not solder on a closed system. Pressure can build up and may cause an explosion. Use Nitrogen purge or open a service valve during soldering procedures to prevent pressure build up.

NOTE: Purge the residual pressure before unsoldering suction tubes.

9. Remove hardware and support plates holding coil assemblies in position.
10. Use a hoist to lift the curbside and roadside evaporator/heater coil assemblies. Remove them from the unit frame.
11. Unbolt the coil header plate from the coil supports (both ends).

DANGER: Do not solder on a closed system. Pressure can build up and may cause an explosion. Use Nitrogen purge or open a service valve during soldering procedures to prevent pressure build up.

NOTE: Purge the residual pressure before unsoldering suction tubes.

12. Unsolder the joints holding evaporator/heater coils in position.
13. Remove leaking evaporator/heater coil assembly.

Installation

⚠ ***CAUTION: Handle the coil carefully to prevent fin damage.***

1. Position the new evaporator/heater coil to match bolt pattern on interconnecting plates and mating tubes.
2. Solder refrigerant and coolant lines to the header plates (while purging with nitrogen).
3. Replace the evaporator/heater coil assemblies into the unit frame. Use a hoist to lift the curbside and roadside evaporator/heater coil assemblies. Carefully lower the unit to bus roof.
4. Install hardware and support plates that hold coil assemblies in position.

NOTE: Purge the residual pressure before unsoldering suction tubes.

5. Resolder the suction line.
6. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
7. Locate and install the center support channel.
8. Bolt unit control panel. Install harnesses and tubing into center support channel.
9. Replace covers.
10. Install hardware that holds cover hinges and covers in position. Secure as required.
11. Replace cover supports. Secure as required.
12. Close evaporator covers and secure latches.
13. Recharge the unit with the proper refrigerant and check the compressor oil.

Expansion Valve

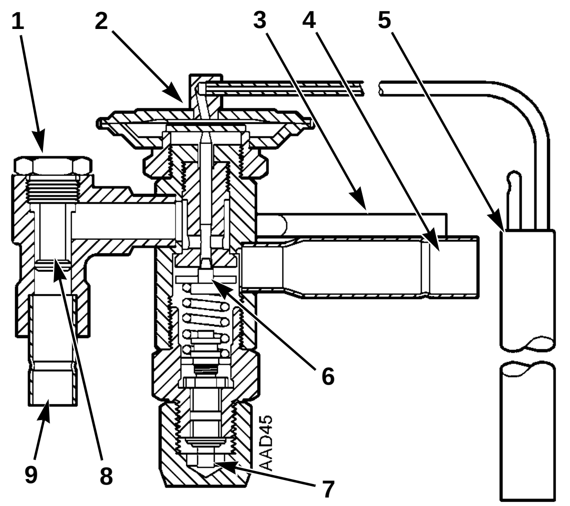
The thermostatic expansion valve meters liquid refrigerant into the evaporator coil at a pre-determined rate to keep the coil fully refrigerated and to ensure complete vaporization of the refrigerant before it leaves the coil. The expansion valve is controlled by the temperature and the pressure in the suction line.

Thermo King expansion valves are factory preset and do not require adjustment. When diagnosing refrigeration problems, eliminate all other possible causes before servicing the valve.

The expansion valve must be serviced by an experienced refrigeration mechanic.

Usually three types of service are performed on the expansion valve.

1. Replace the expansion valve because the power element is damaged. A broken power element causes the valve to close and the unit to operate in a vacuum.
2. Clean and secure the power element sensor bulb to the suction line. Poor contact of the sensor bulb causes the valve to operate by air temperature. This will be indicated by frosting of the suction line, and a slight rise in suction pressure will be noted due to flooding of the coil. Be sure to wrap the bulb and suction line with insulating tape.
3. Remove and clean the inlet screen.



1.	Removable Liquid Line Fitting	6.	Needle and Seat
2.	Power Head	7.	Adjusting Stem
3.	External Equalizer	8.	Inlet Screen
4.	Outlet	9.	Inlet
5.	Sensor Bulb		

Figure 71: Expansion Valve

Removal

1. Pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown).
2. Be sure the unit and the bus cannot be run while the system is being serviced.
3. Remove the sensor bulb from the clamps. Take care not to kink the capillary tube.

4. Unsolder and disconnect the equalizer, inlet and outlet line connections. Remove the expansion valve.

Installation

1. Clean the tubing connections before installing the valve.
2. Compare the new valve to the one just removed. Adjust the length of the sensor bulb capillary tube. Secure it to valve body in the same manner as the original valve. This prevents damage to the tube by vibration induced chaffing. Once the length is adjusted, feed the bulb through the required routing.
3. Position the valve in the unit and solder the equalizer, inlet, and outlet lines. Use a heat sink to prevent damage to the valve.
4. Position the remote sensor bulb in the clamp on the side of the suction line in exactly the same spot from which it was removed. Take care not to kink the capillary tube.
5. Pressurize the low side and check for leaks.
6. If no leaks are evident:
    a. Evacuate the low side (refer to the procedure in this chapter).
    b. Open all valves.
    c. Run the system and check the refrigerant charge and oil level.
    d. Release the bus to service.

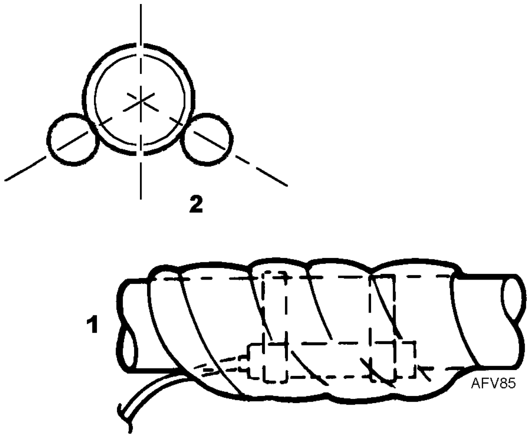
Cleaning In-line Screen

1. Pump down the low side and equalize the pressure in the low side to slightly positive of the refrigeration system (see “Low Side Pump Down).
2. Be sure the unit and the bus cannot be run while the system is being serviced.
3. Remove the removable liquid line fitting.
4. Remove the screen from the expansion valve.

    NOTE: A small tool with slight hook may be needed to pull the screen from the expansion valve.

5. Clean the screen and replace in the expansion valve.
6. Reinstall the removable liquid line fitting.
7. Evacuate the low side (refer to the procedure in this chapter).
8. Open all valves.
9. Run the system and check the refrigerant charge and oil level.
10. Release the bus to service.

Sensor Bulb Contact



1.	Side View - Bulb installed on side of suction line
2.	End View - Bulb on side of suction line 4 or 8 o’clock position

Figure 72: Sensor Bulb Location

1. Remove the insulating tape from the sensor bulb.
2. Loosen two copper bands.
3. Remove the sensor bulb from the suction line.
4. Clean the suction line and the sensor bulb with fine abrasive paper or cloth. Do not use acids or polishes to clean copper.
5. Coat the sensor bulb and suction line with a light film of oil to prevent oxidation.
6. Install the sensor bulb in clamps on the side of the line in the original position. Tighten the clamps and replace the insulation on the bulb.

Superheat: Measurement and Adjustment

NOTE: Be sure the temperature reading instrument and compound pressure gauge are accurately calibrated.

Measurement

1. Pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown”).
2. Install a pressure gauge in the in the external equalizer line to expansion valve. This will give you an accurate suction pressure reading.
3. Open the receiver tank outlet valve (or liquid line shutoff valve) and run the unit. Allow the system to run until oil has returned to the compressor and the interior of the bus has cooled to within 5 F (2.8 C) of the thermostat setpoint.
4. To obtain the expansion valve superheat setting:
   - Measure suction line temperature near the expansion valve sensor bulb (located on the suction line).
   - Using the Pressure-Temperature Chart, convert the pressure measured at the equalizer line to the equivalent temperature.
   - Subtract the suction pressure to temperature conversion (obtained from Pressure-Temperature Chart) from the suction line temperature.

Example:

Suction Line Temperature (F) Near Sensor Bulb

-Suction Pressure to Temperature Conversion (F)

=Superheat (F)

NOTE: To properly check the superheat, you must have stable operating conditions. To establish stable operating conditions, run the unit at least 15 minutes at 1000 rpm engine speed so the evaporator air inlet temperature reaches 70 to 80 F (21 to 27 C). Read the pressure and temperature simultaneously when calculating the superheat. The superheat should be 10 to 15 F (5.5 to 8 C).

CAUTION: Thermo King expansion valves are factory preset and do not require adjustment. Establishing controlled conditions in the field is difficult. Before adjusting the expansion valve, check the following causes for an out-of-range reading.

5. Check the following:
   - Dirty air filters or other cause of reduced airflow.
   - Sensor bulb leaking, bulb placed improperly on refrigerant line, or bulb not properly wrapped with insulating tape.
   - Kinked capillary tube.
6. After the above items have been checked, replace the expansion valve with a factory preset part if necessary.

Adjustment

1. Remove the cap over the adjusting stem.
2. To reduce superheat, turn the adjusting stem counterclockwise.
3. Make no more than one turn of the stem at one time. Observe the change in superheat closely to prevent overshooting the desired setting. As much as 30 minutes may be required to obtain the new balance after the adjustment has been made.
4. When the proper readings have been achieved, pump down the low side and equalize the pressure in the low side to slightly positive.
5. Remove the pressure gauge and thermometer from the equalizer line.
6. Install the equalizer line, open the receiver tank outlet valve (or liquid line shutoff valve), and check for leaks.

7. Replace the cap for the adjustment stem. Torque it to 12.5 to 15 ft-lb (17 to 20.3 N•m).
8. Return bus to service.

EPR Valve Considerations

Some systems have an evaporator pressure regulator (EPR) valve. For R-22 and R-407C systems, the EPR valve is set to 50 psig (345 kPa). For R-134a systems, the EPR valve is set to 24 psig (165 kPa). This valve functions during low load conditions to limit the evaporator coil temperature. Under these conditions with the valve operating, pressure readings taken with a compound gauge may be misleading, and service operations such as low side pumpdowns are not effective when the EPR valve is functioning.

For service purposes, the EPR valve is provided with a pilot line shutoff valve. To correctly perform service procedures, close this shutoff valve.

CAUTION: When operating normally, the EPR valve closes when pressure in the evaporator coil reaches 50 psig (345 kPa) for R-22 and R-407C systems. For R-134a systems, the EPR valve is set to 24 psig (165 kPa). For this reason, a low side pumpdown performed in the usual manner will not evacuate the system as expected. To prevent releasing refrigerant unexpectedly, follow the instructions in this manual regarding the EPR for service operations.

CAUTION: If the EPR pilot line shutoff valve is closed for service operations, it must be opened before placing the unit back in service.

NOTE: The following information pertains to units with Reliance motors and IntelligAIRE I or IntelligAIRE II.

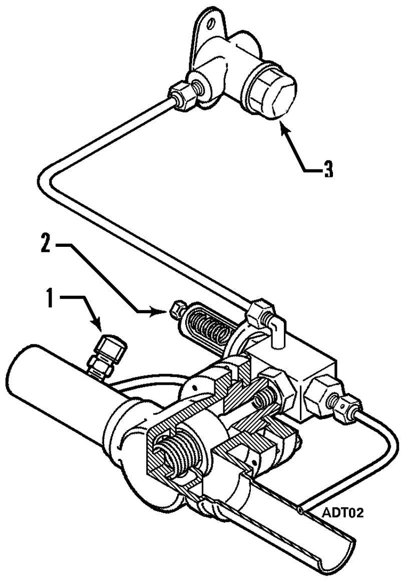
In order to prevent setting a **Code 14 alarm** (Evaporator/Drive Fault shutdown), you must add a jumper wire from the fault wire on the evaporator drive to a good chassis ground. This will temporarily fool the ECM into believing that the drive is still running.

WARNING: Make absolutely sure that you remove this jumper wire when you have completed checking and repairs to the EPR valve.

Evaporator Pressure Regulator (EPR) Valve (Pilot Type)

NOTE: Eliminate all other possible causes before servicing the EPR valve. The EPR valve must be serviced by an experienced air conditioning mechanic.

CAUTION: Improper adjustment of this valve may cause damage to the system.



1.	Test Fitting (Schrader Valve Port)
2.	Adjustment Screw
3.	Pilot Line Shutoff Valve

Figure 73: Pilot Type EPR Valve with Pilot Line Shutoff Valve

NOTE: The EPR valve DOES NOT get out of adjustment. The valve is factory set, but should be checked as part of the delivery checkout procedure.

NOTE: Adjustment if required, should be done by qualified personnel only.

If it appears that adjustment is necessary, there are two possibilities:

1. The valve has been set incorrectly at some previous time;
2. The valve has mechanically malfunctioned (i.e., dirt in seat, warped valve) or something else in the unit is wrong—identify and correct the problem.

CAUTION: The ambient temperature and the bus interior must be above 80 F (28 C). This should be maintained for proper setting of the valve. Improper adjustment of this valve may cause damage to the system.

CAUTION: Do not attempt to adjust this valve if the ambient and bus interior temperature are not above 80 F (28 C). Improper setting, and damage to the system may result.

NOTE: A compressor discharge pressure of 250 psig (1,724 kPa) for R-22/R-407C systems or 150 psig (1034 kPa) for R-134a systems should be maintained while adjusting the valve.

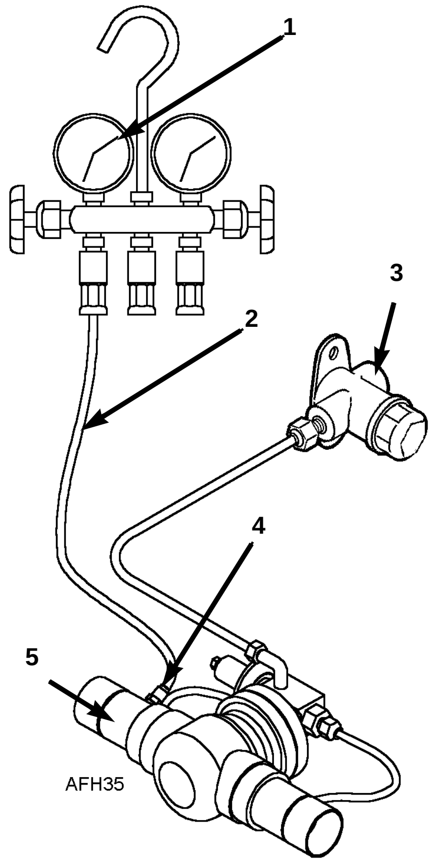
Procedure for Checking and Adjusting the EPR Valve

NOTE: The following information pertains to units with Reliance motors and IntelligAIRE I or IntelligAIRE II.

In order to prevent setting a **Code 14 alarm** (Evaporator/Drive Fault shutdown), you must add a jumper wire from the fault wire on the evaporator drive to a good chassis ground. This will bypass the ECM drive fault.

WARNING: Make absolutely sure that you remove this jumper wire when you have completed checking and repairs to the EPR valve.

1. Install service gauges on the compressor and jumper the low pressure cutout.
2. Install a compound gauge on the pressure tap on the evaporator side of the EPR valve.



1.	Suction Gauge	4.	Pressure Tap
2.	Suction Line	5.	Pilot Type EPR Valve
3	Pilot Line Shutoff Valve		

Figure 74: Pilot Type EPR Valve

3. Replace all covers removed to install the compound gauge on the EPR valve.
4. Be careful not to pinch the hose on the compound gauge, seal all areas that will leak air when the unit is running.
5. Start the bus, run at either fast idle or slow idle for at least ten minutes. This will return the oil to the compressor.
6. If necessary, turn the heat mode on and raise the interior temperature above 80 F (28 C). Then return the unit to the cool mode.

   NOTE: You will need two people to finish the test.

7. One person raises the engine/compressor speed to maximum governed speed. (if not governed 2/3-throttle point.)

CAUTION: You must increase the compressor speed (step# 7). If you don't, the set point WILL NOT BE CORRECT <u>and damage to the air conditioning system, may result.</u>

8. When the bus engine is maintained at high speed, shut off the evaporator fan motor(s).
9. Watch the compound gauge installed on the EPR. The pressure will drop and stabilize. This should take one minute or less.
10. When the compound gauge stabilizes this is the setpoint. The setpoint should be at the pressure stated on the following table.

Refrigerant	Pressure Setting
R-134a	24 ± 1 psig (166 ± 7 kPa, 1.6 ± 0.07 bar)
R-22	50 ± 1 psig (345 ± 7 kPa, 3.4 ± 0.07 bar)
R-407C	50 ± 1 psig (345 ± 7 kPa, 3.4 ± 0.07 bar)
R-12	27 ± 1 psig (186 ± 7 kPa, 1.9 ± 0.07 bar)

EPR Pressure Setting Table

NOTE: There should be a large difference between the compound gauge (EPR valve) and the suction service valve gauge readings (20-30 psig of the compressor may even go into a vacuum).

11. Lower the engine/compressor speed to high idle and switch to the evaporator fan motor(s) back on.
12. Run the unit at high idle for more than 5 minutes to clear the liquid refrigerant in the coil or compressor damage may occur.
13. If the EPR valve requires adjustment, turn the adjusting screw CW (clockwise) to increase the setting (raise the coil Pressure/temperature) and CCW (counterclockwise) to decrease the setting (lower the coil temperature/pressure). Do not turn more than 1/4 turn at a time.
14. After every adjustment, all covers must be reinstalled and then run for at least 5 minutes before rechecking the EPR setting.
15. Recheck the EPR setting (steps 6 through 10).
16. If the setting is still incorrect, repeat steps 13 and 14.
17. When the setting is correct, recheck the setting twice (steps #6 through #10), you should get the same reading.
18. When test is complete, remove all gauges, jumper wires and reinstall all covers back to their proper position.

WARNING: Make absolutely sure that you remove this jumper wire when you have completed checking and repairs to the EPR valve.

19. Check the refrigerant charge, oil level and return to service.

Repair

Service of the EPR valve includes replacement of the pilot assembly, internal parts, or the entire valve. There are only two possible valve malfunctions: failure to open and failure to regulate.

Failure to Open

- Dirt or foreign material holding pilot port open. Disassemble and clean pilot port.

Failure to Regulate

- Pilot line (high pressure supply line) pinched, shut, or plugged — replace or clean pilot line.
- T-seal (Tetraseal) between adaptor and valve body does not seal. If this should occur, pressure can bleed out of the chamber faster than can be supplied by the pilot valve; replace Tetraseal.

  NOTE: The T-seal should be replaced any time the pilot assembly is removed from the valve body.

- Dirt or foreign material lodged between piston and sleeve, causing hang-up or excessive scoring in the sleeve or the piston. This allows the high pressure to bleed out of the chamber above the piston. Clean or, if necessary, replace the piston and the sleeve.

- Inlet strainer to pilot line plugged with foreign material. Clean or replace strainer.
- Refrigerant flow through pilot line restricted by oil in the pilot line either due to a trapped pilot line or too much oil in the system. Check the pilot line to be sure that it is open and that it does not serve as an oil trap.

Pilot Assembly Replacement (ORIT-15)

Refer to Figure 76 “Pilot Type EPR Valve Components” on page 120 and Figure 77 “Cutaway View of ORIT 15 Pilot Type EPR Valve” on page 121 to help identify components.

CAUTION: The pilot line shutoff valve must be closed to properly pump down the low side.

1. Pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown”).
2. Disconnect the three lines connected to the pilot assembly. They are:
   - Pilot line (high pressure supply line)
   - Evaporator pressure sensing line
   - Compressor suction pressure sensing line.
3. Place a wrench on the bottom connection of the pilot assembly. Turn counterclockwise and remove the pilot assembly from the adapter.
4. Replace the copper flare gasket and install the new pilot assembly. Place a wrench on the bottom connection of the pilot assembly. Turn clockwise until the pilot assembly is firmly in place. Do not align the three lines that connect to pilot assembly at this time.

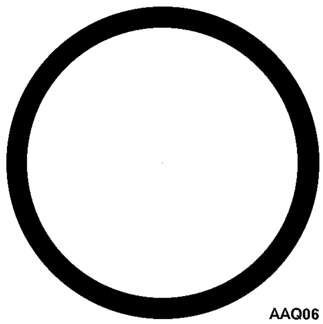


Figure 75: Tetraseal Size for ORIT-15

5. Remove the cap screws and remove the adaptor from the main valve body.
6. Replace the gasket under the adapter.

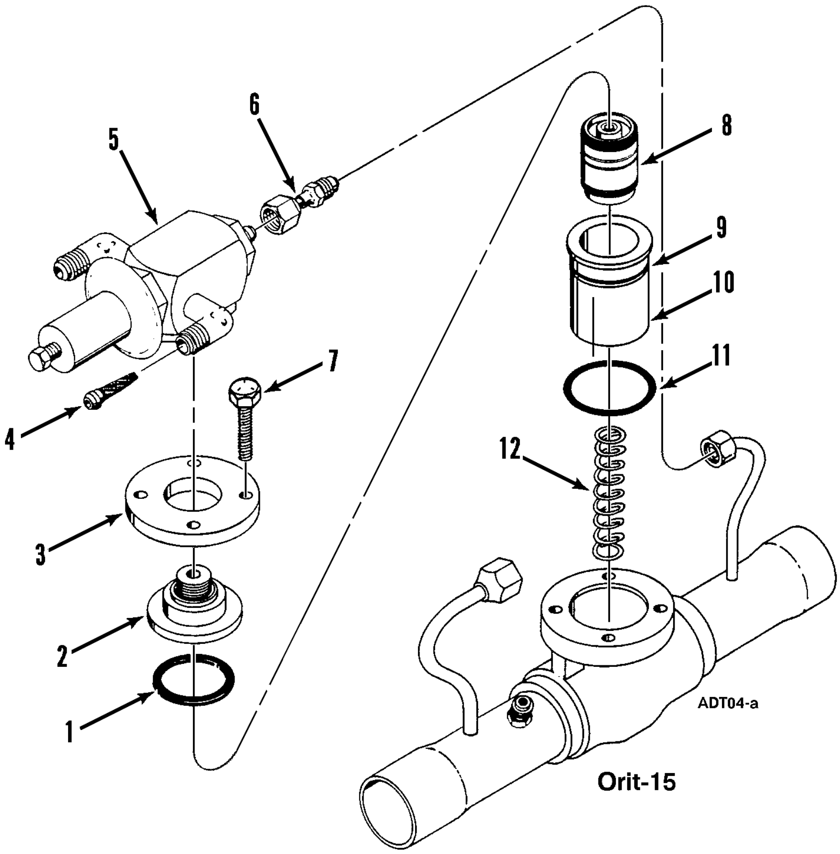
   NOTE: Two gaskets are supplied with each pilot assembly kit. The correct gasket for the ORIT-15 is the Tetraseal (not composition) gasket.

7. Reassemble the valve. Replace the cap screws with the cap screws included with the pilot assembly kit. Before completely tightening the cap screws, rotate the pilot valve to properly align the three lines that connect to pilot assembly. Attach and tighten these connections. Then tighten the cap screws to a torque of 15 ft-lb (20.3 N•m). The pilot assembly replacement is now complete.
8. Pressurize the low side and check for leaks.
9. If no leaks are found, evacuate the low side.
10. Open all valves and start the unit.
11. Check the unit operation, the refrigerant charge level, and compressor oil level.

Piston (Internal Parts) Replacement (ORIT 15)

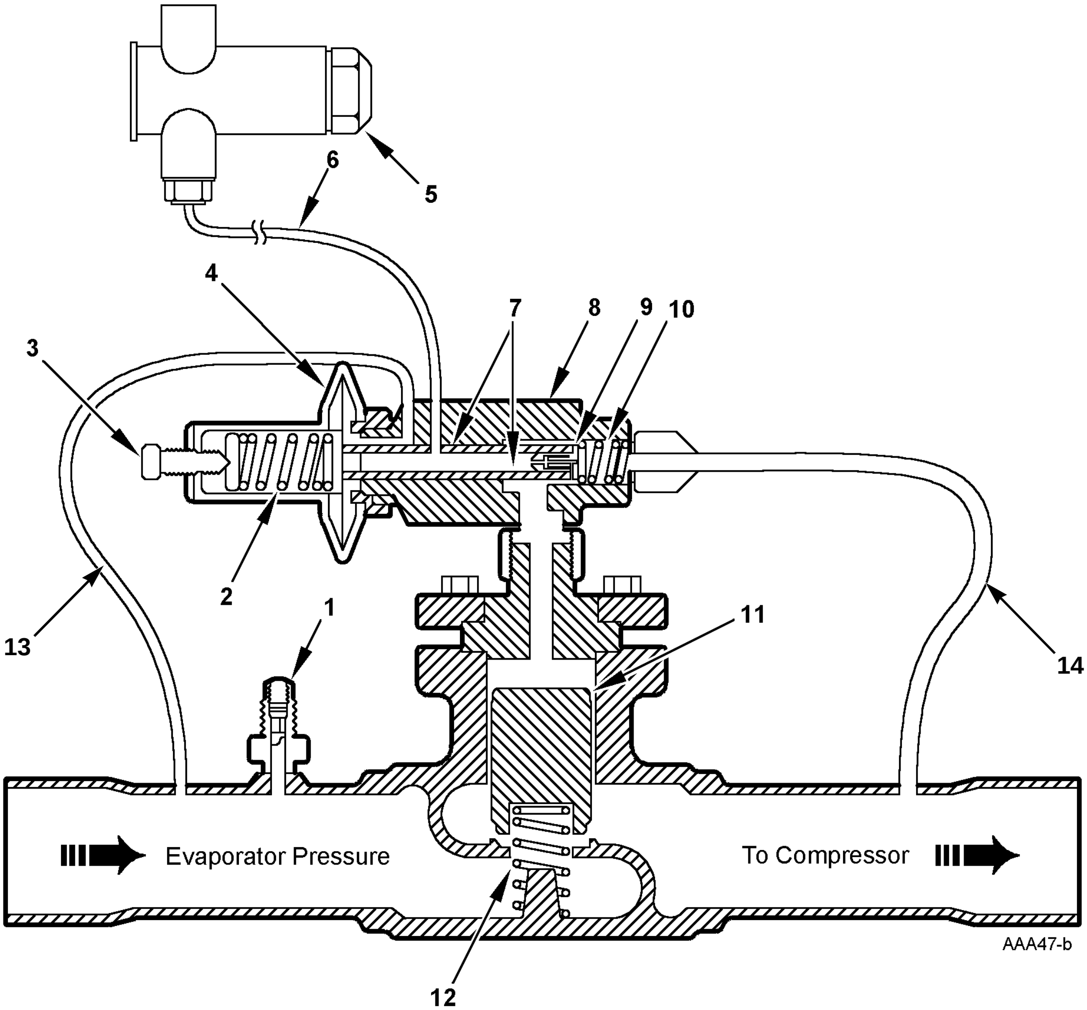
1. Pump down the low side and equalize the pressure in the low side to slightly positive (see “Low Side Pumpdown”).
2. Disconnect the three lines connected to the pilot assembly. They are:
   - Pilot line (high pressure supply line)
   - Evaporator pressure sensing line
   - Compressor suction pressure sensing line.

3. Remove the cap screws and remove lift the complete pilot assembly, adaptor, and body flange off the main valve body.
4. Remove the piston assembly by screwing one of the cap screws into the threaded hole in the center of the piston and using the cap screw as a handle. Inspect all other internal parts for wear or dirt.
5. Replace the piston assembly, body sleeve, and kick off spring.
6. Install a new gasket and reassemble the valve. Before completely tightening the cap screws, rotate the pilot valve to properly align the three lines that connect to pilot assembly. Attach and tighten these connections. Then tighten the cap screws to a torque of 15 ft-lb (20.3 N•m). The pilot assembly replacement is now complete.
7. Pressurize the low side and check for leaks.
8. If no leaks are found, evacuate the low side.
9. Open all valves and start the unit.
10. Check the unit operation, the refrigerant charge level, and compressor oil level.



1.	Tetraseal	7.	Screw—cap
2.	Adaptor	8.	Piston—assembly
3.	Flange—body	9.	O-ring groove
4.	Screen—inlet strainer	10.	Sleeve—body
5.	Kit—pilot assembly	11.	O-ring
6.	Adaptor—outlet	12.	Spring—bottom

Figure 76: Pilot Type EPR Valve Components



1.	Test Fitting	8.	Pilot Assembly
2.	Adjustment Spring	9.	Pin Guide
3.	Adjustment Screw	10.	Bottom Spring
4.	Pilot Diaphragm	11.	Main Valve Piston
5.	Pilot Line Shutoff Valve	12.	Kick Off Spring
6.	Pilot Line (High Pressure)	13.	Evaporator Pressure Sensing Line
7.	Push Rods	14.	Compressor Suction Pressure Sensing Line

Figure 77: Cutaway View of ORIT 15 Pilot Type EPR Valve

EPR Valve Removal

CAUTION: Systems equipped with EPR valves require a pump down procedure, which is different from other systems. Follow this procedure closely or pressure will be left inside the low side of your system. Failure to do so may result in personal injury. Refer to "Low Side Pump Down" procedure found in the Refrigeration Maintenance chapter of this manual.

1. Follow procedures to pump down the low side of the system or remove all the refrigerant from the system. Complete removal of refrigerant is the preferred method.
2. Remove the Schrader valve from the test fitting on the EPR valve to vent excessive heat from the system.
3. Disconnect the pilot line from the pilot assembly.
4. Use heat shields to protect the unit insulation during soldering.

CAUTION: Use a nitrogen purge during soldering to prevent internal scaling.

5. Heat the joints and remove the failed valve, being careful not to damage the connecting tubing.

EPR Valve Installation

NOTE: New EPR valves are factory set. After installation, verify the setting and adjust only if necessary.

1. Clean the tubes for soldering and apply a minimum amount of flux to the tubes. Follow standard Thermo King soldering procedures for this operation —(Reference "Silver Brazing & Soft Soldering" TK 7949.)
2. Place the new valve in position and wrap damp rags around the valve as a heat sink.
3. To protect the core from heat damage, remove the Schrader valve core from the new EPR valve which allows the system to vent during soldering.
4. Disconnect the pilot line to the pilot assembly.
5. Replace the heat shields to protect the insulation.

CAUTION: Use a nitrogen purge during soldering to prevent internal scaling.

CAUTION: Use care to prevent excess solder from flowing into the valve during soldering.

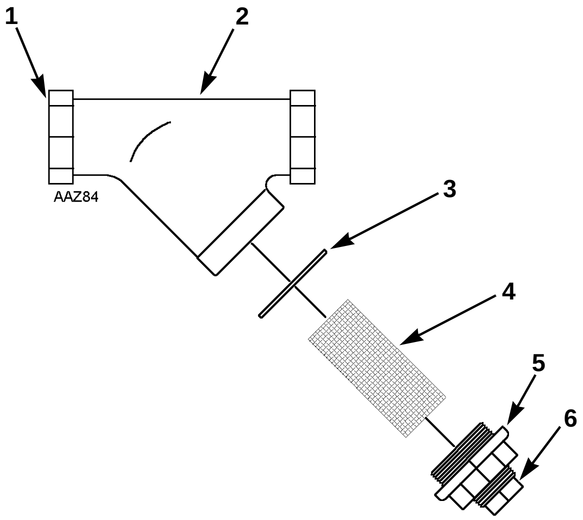
CAUTION: To avoid heat damage when soldering the valve, direct the flame away from the valve body and avoid excessive heat on the diaphragm of the pilot valve.

6. Solder the valve into place using Thermo King's recommended solder, flux and procedures.

   NOTE: To reduce the chance of overheating the EPR valve, use 95-5 solder (TK No. 204-167) or equivalent may be used. Use Flux TK No. 204-417.

7. Replace the Schrader valve core.
8. Connect the pilot line to the pilot assembly.
9. Then proceed with evacuation, leak testing, and charging procedures to prepare the system for operation. Open all valves and start the unit.
10. Check the unit operation, the refrigerant charge level, and compressor oil level.

In-line Coolant Strainer



1.	Coolant Inlet	4.	SS 20 Mesh Strainer
2.	“Wye” Strainer	5.	Cover
3.	Gasket	6.	Drain/Blow-Off 3/8” NPT C/W Plug

Figure 78: In-line Coolant Filter

Inspect the in-line coolant filter by removing the mesh strainer yearly and pre-season.

Strainer Maintenance Procedure

Removal

CAUTION: Do not begin any service procedure without turning the service switch to OFF.

1. Depressurize the bus coolant system.
2. Remove the drain blow-off plug to drain the coolant from the line.
3. Remove the cover and gasket.
4. Remove the strainer and inspect it.
5. Clean it by back flushing the mesh strainer with water to remove all sediment.
6. Ensure the screen is clean before assembling.

Installation

1. Insert the mesh strainer into the “Wye” Strainer.
2. Install the cover and gasket. Tighten securely.
3. Install the drain blow-off plug. Tighten securely.
4. Replace the lost coolant with 50 percent antifreeze and 50 percent water.
5. Place the unit service switch in the ON position.
6. Start the bus and run the boost pump.
7. Check the strainer for leaks. If leaks are found, repair them.
8. Ensure the heating unit is functioning properly before returning the bus to service.

Structural Maintenance

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Inspect condenser coil for cleanliness.	•	•	•
Inspect evaporator/heater coil for cleanliness.	•	•	•
Inspect outer areas of the unit for loose, damaged, or broken parts. OK _______, Make repairs _______ Specify defect________________________________	•	•	•
Clean or replace return air filter (more frequently if necessary).	•	•	•
Clean condenser and evaporator drains. Make sure that the evaporator drain hose check valves (kazoos) are in place and in good condition.	•	•	•
Check the engine coolant hoses and hose clamp condition on heater coil system.			•
Clean condenser and evaporator coils**.**			•
Check engine coolant for antifreeze protection down to -30 F (-34 C) to prevent heater coil freeze up. Antifreeze protection _______ F, (_______ C).			•
Tighten compressor, unit, and fan motor mounting bolts and brackets (more frequently if necessary).			•
Check condenser air seals.			•

WARNING: Ensure the unit and the bus will not start while you are servicing the system.

Unit Compressor and Electric Motor Mounting Bolts

Check and tighten all unit compressor and electric motor mounting bolts yearly.

Unit Inspection

Inspect the unit monthly for loose or broken wires or hardware, compressor oil leaks, or other physical damage which might affect unit performance and require repair or replacement of parts.

Evaporator, Heater and Condenser Coil Inspection and Cleaning

The evaporator, heater, and condenser coils should be inspected to be free of dirt, lint, and debris during regularly scheduled A, B, and C maintenance intervals. Viewing the coil with a shop light, placed on the opposite side of the coil, provides a means of determining if a dirt buildup is present within the fins of the coil. Light should be visible directly through the coil fins across the entire face area of the coil.

When the coil is found to be dirty, the following cleaning procedure should be used:

1. Remove surface lint, dirt, and debris from the air inlet side of the coil using a soft bristle brush or shop vacuum. Brush or vacuum in the direction of the fins to prevent fin damage.
2. Spray the fins of the coil with low or medium pressure, warm soapy water (dish soap works well) using a garden-type, pressurized sprayer. This breaks down dirt and oil film.

   NOTE: Do not use high-pressure washers, which may damage fins. Do not use caustic cleaning solutions, which may result in corrosion.

3. Flush the coil clean with clear, low or medium pressure water, first in the opposite direction of the airflow through the coil using a garden hose with a spray nozzle. This removes the major amounts of dirt buildup.
4. Flush in the other direction to remove dirt. Be careful not to spray through the evaporator and heater coils into the inside of the bus. If necessary, place cardboard or a suitable plate across the inlet face of the evaporator/heater coils to prevent spraying into the bus.
5. Inspect drain pans and drain hoses. They should be clean, open (not kinked), and draining freely.
6. Continue to flush the entire face area of the coils and drain pans until clear water comes out of all of the drain hoses at the ground level.
7. Inspect each evaporator/heater coil drain lines at ground level to ensure that they each have a rubber check valve (“kazoo”) in place. Missing or damaged evaporator/heater drain line check valves allow air to be drawn up the drain lines, thus preventing evaporator condensate water from draining. Also, dirt and engine fumes are drawn up the drain lines. Install new check valves if missing, or replace them if they are damaged or hardened.
8. Inspect each of the condenser coil drain lines at ground level to be open and unobstructed. There should not be a check valve on the condenser coil drain lines as they will plug due the high volume of rainwater, bus wash water, and dirt present in the condenser coil area.
9. Inspect and straighten coil fins using an appropriate coil fin comb.

Drain Lines

Clean the evaporator and condenser drains monthly to be sure the lines remain open. Make sure kazoos (end valves) are in place on the evaporator drain.

Coolant Antifreeze in Heating Units

Thermo King specification requires that all bus air conditioning units equipped with heater coils must be operated with a mixture of 50 percent ethylene glycol and 50 percent water in the bus coolant system.

When heating is required, the coolant valve and the boost pump are energized. This permits coolant to flow through the heating coil.

If cooling only is required, there is no coolant circulation through the heater coil. In some conditions, the evaporator can run below freezing point and if there is no antifreeze in the coolant, the heater coil can freeze and will be damaged.

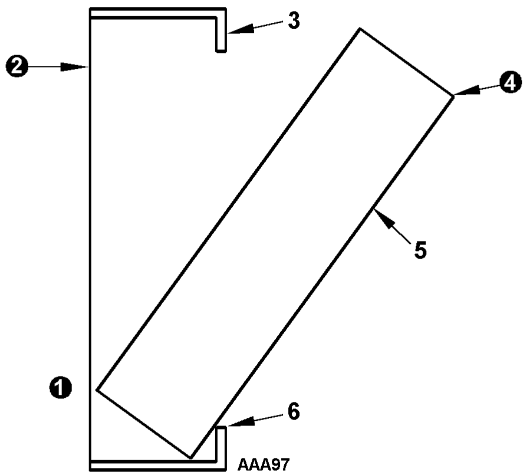
Also be aware that the system could possibly have been installed on the bus and tested with pure water. If the coolant in the engine was replaced by antifreeze and the heating system in the AC unit was not operated, there will still be only pure water in the heater coil. This can freeze at low ambient or when the unit is operating in cooling mode.

Fresh Air Intake Filter

The fresh air filter is accessible from inside the bus.

1. Remove the screws, then swing down grille with filter.
2. Remove the fresh air filter from the grille using mild pressure. Pull down.
3. Using compressed air, blow in direction opposite normal air flow to remove accumulated dust.
4. Wash filter material in warm soapy water. Flush water in direction opposite to normal air flow.
5. Remove excess water.
6. Insert fresh air filter per Figure 79 below (behind sheet metal bend 1 and under sheet metal bend 2). Replace filter if necessary.

NOTE: All units are not equipped with the fresh air intake option.



1.	Fresh Air Inlet	4.	Install
2.	Fresh Air	5.	Filter
3.	Bend 2	6.	Bend 1

Figure 79: Fresh Air Filter Insertion

Evaporator Coil Return Air Filter

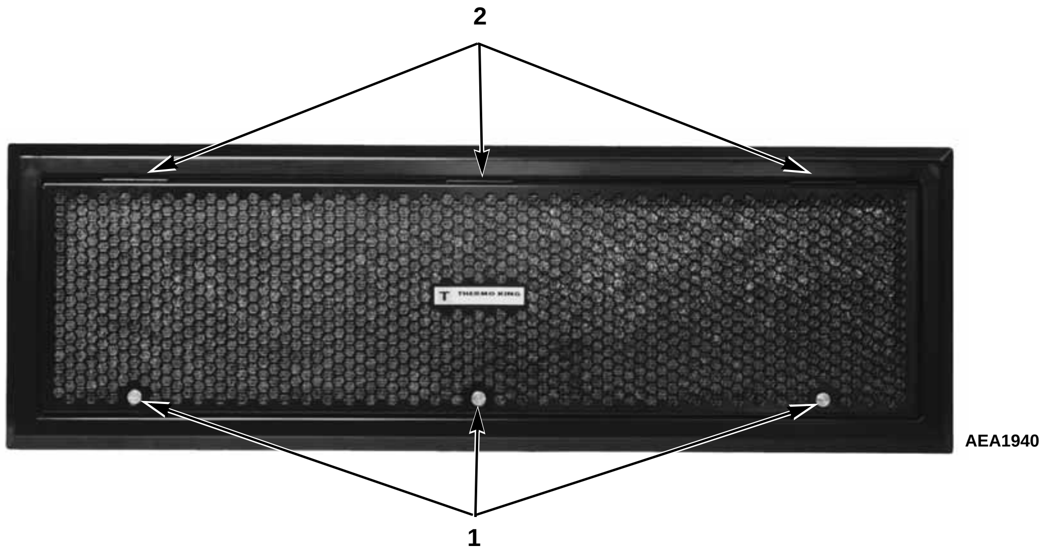
The location and accessibility of the evaporator coil return air filter can vary depending on unit application. On some rooftop units it can be accessed by opening the evaporator cover or the filter can be installed on the backside of the return air grille. This also applies to T Series rear mount units.

1. Unscrew evaporator covers and remove the filters.
2. Using compressed air, blow in direction opposite normal air flow to remove accumulated dust.
3. Wash filter material in warm soapy water. Flush water in direction opposite to normal air flow.
4. Remove excess water and install filter. Replace filter if necessary.
5. Close and secure evaporator access covers.

Internal Return Air Filter

The internal return air filter covers the control panel and is accessed from inside the bus.

1. Unscrew the three screws and swing down the return air grille and remove the return air filter.
2. Using compressed air, blow in direction opposite normal air flow to remove accumulated dust. Wash filter material in warm soapy water. Flush water in direction opposite to normal air flow.
3. Remove excess water and install filter. Replace filter if necessary.
4. Close return air filter grille. Tighten all screws securely.



1.	Screws	2.	Hinges

Figure 80: Return Air Filter (Internal)

Clutch Maintenance (X426, X430, X640 Compressors)

Quarterly Clutch Maintenance

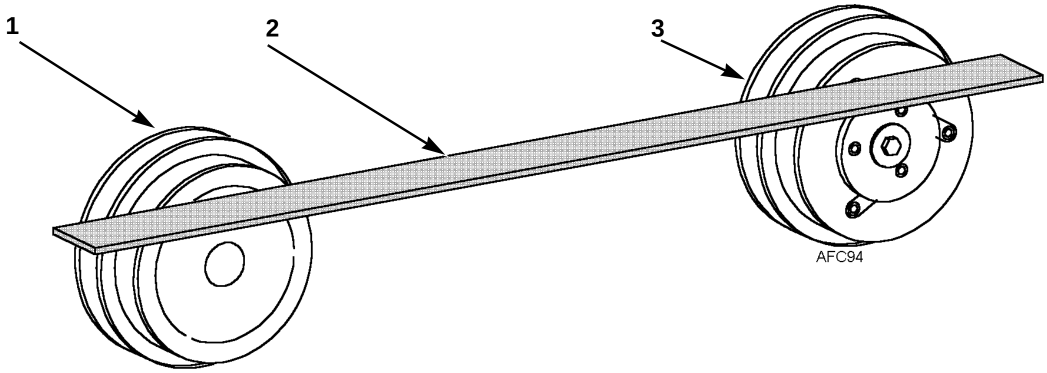
Checking Alignment

NOTE: To prevent the unit compressor/clutch from being accidentally started from the driver's control section while performing preventive maintenance functions, turn the bus service switch to OFF.

It is important to check pulley alignment quarterly. Properly aligned belts last longer.

1. Using a straightedge, check pulley/ belt alignment. Lay a straightedge across the front of both pulleys. See Figure 81 on page 129.
   a. Straightedge must make contact on 4 points. See Figure 82 on page 129.
   b. Incorrect alignment increases pulley and bearing wear. See Figure 83 on page 130 and Figure 84 on page 130 incorrect alignment.

If pulleys are aligned incorrectly, adjust compressor base.



1.	Engine Pulley
2.	Straightedge
3.	Compressor Pulley

Figure 81: Checking Pulley Alignment with Straightedge 3/4 View

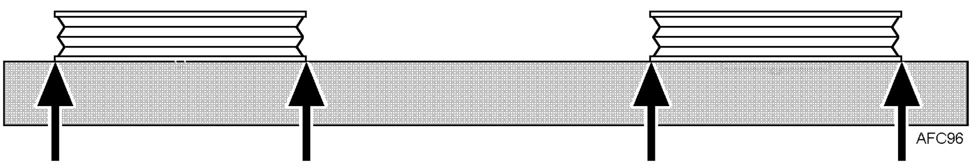


Figure 82: Straightedge Alignment Showing 4 Points of Contact – Correct

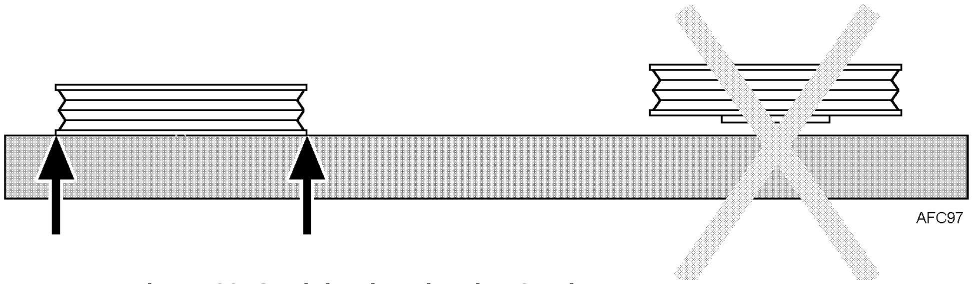


Figure 83: Straightedge showing 2 point contact – Incorrect

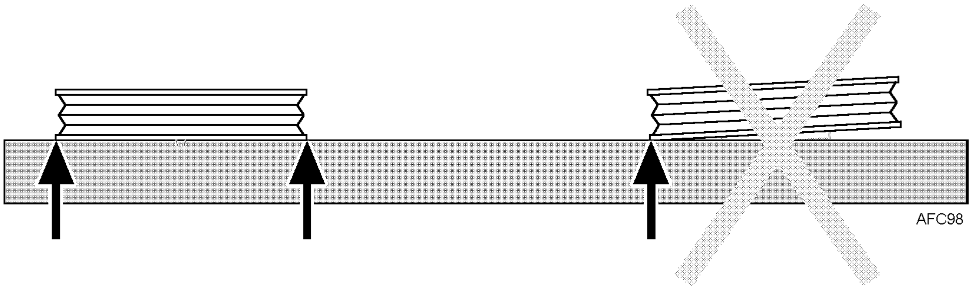


Figure 84: Straightedge showing 3 point contact – Incorrect

WARNING: Take precautions to ensure the unit and the bus will not accidentally start while you are servicing the system.

2. Lubricate the clutch bearing with 1 oz. (28 gm) Exxon Unirex N2 high temperature grease (TK No. 204-476). Do not over lubricate.

Figure 85: Greasing Clutch

NOTE: Use only Exxon Unirex N2 high temperature grease (TK No. 204-476).

3. Check and, if necessary, adjust the air gap between the armature and pulley/flywheel mating surfaces to 0.045 ± 0.005 in. (1.143 ± 0.127 mm).

4. If the surface of the armature and the pulley/flywheel have grooves from wear, an alternate method may be used. Turn the air gap adjusting screws in until the mating surfaces touch. Turn out each screw 1-1/2 turns. This should provide an air gap of 0.045 ± 0.005 in. (1.143 ± 0.127 mm).

5. Adjust the drive belts to the tension recommended by the bus manufacturer or the belt manufacturer. Tension is not to exceed 220 lb (979 Newtons) on new belts and 180 lb (800 Newtons) on used belts.

Annual Clutch Maintenance

With the compressor in the bus, perform the following annually.

1. Check the clutch voltage: The normal reading is 24 Vdc. The minimum reading acceptable is 20 Vdc.

2. Check the field coil resistance (ohms) and current draw (amps); refer to “Clutch Coil Electrical Check” on page 134.

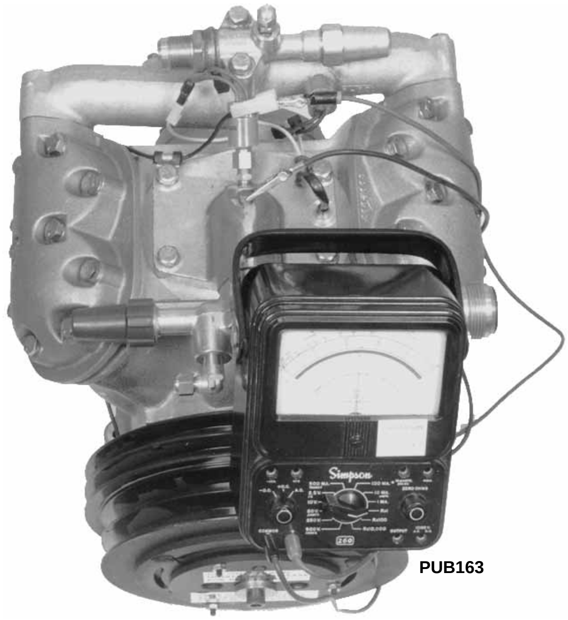
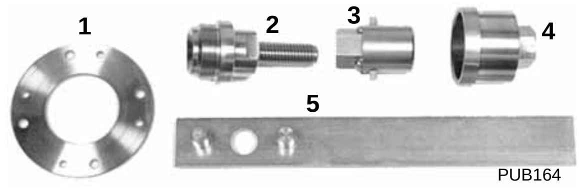


Figure 86: Checking Clutch Field

3. Remove the armature and check the mating surfaces for flatness and signs of excessive wear; refer to “Clutch Inspection” on page 133.
4. Remove the front seal and check the condition of the grease (refer to “Clutch Disassembly” on page 131). Lubricate as required and reinstall the seal (refer to “Clutch Reassembly” on page 135).
5. Using a dial indicator, check the horizontal pulley/flywheel run out (side-play). The maximum allowable runout is 0.010 in. (0.254 mm).

Clutch Disassembly

NOTE: To properly disassemble the clutch, use TK Clutch Puller (refer to Tool Catalog TK 5955). Do not attempt to pull the clutch pulley by using a standard puller tool attached around the outer perimeter of the pulley. The pulley will be warped and rendered unusable.



1.	Collar	4.	Body
2.	Spindle	5.	Wrench
3.	Bearing Nut Driver		

Figure 87: Clutch Puller

1. Hold the clutch from turning by using a spanner in the holes provided in the armature and remove the armature retaining bolt.
2. Using the spindle portion of the body and spindle tool, install the threaded spindle into the clutch armature. Be sure the crankshaft key is flush with the end of the compressor crankshaft before installing the spindle (or cleaning the threads). If the armature threads are dirty or damaged, use a 3/4x10 tap to restore them.
3. Use a 1-1/4 in. wrench, or a crescent wrench, and turn the spindle in until the armature is free. Taking care not to lose the crankshaft key, remove the armature.

Figure 88: Removing Armature

4. Remove the four screws fastening the seal assembly.

Figure 89: Removing Seal Assembly

5. Pry the front seal assembly out and clean the old grease from the front cavity.
6. Install the bearing nut driver. Using a 1-1/8 in. wrench, remove the bearing retainer nut.

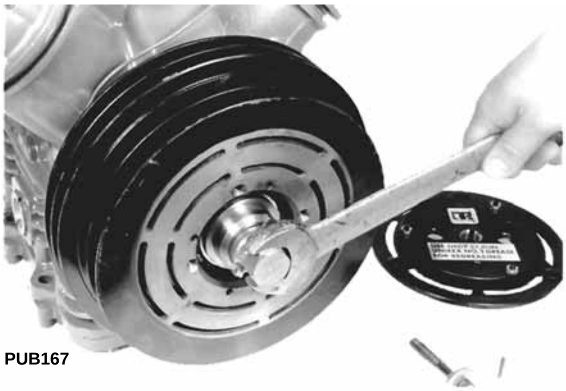


Figure 90: Removing Bearing Retaining Nut

NOTE: If the key in the bearing nut driver becomes worn, replace it with a section of 1/4 in. key stock.

7. Reverse the spindle and screw it into the inner threads of the compressor seal plate hub.
8. Install the collar onto the tool body, then screw the body onto the spindle.

Figure 91: Installing Tool Body and Collar

9. Secure the collar to the clutch pulley (or flywheel on propshaft clutches) with four 1/4-20 bolts.

Figure 92: Securing Collar to Pulley

10. Back the tool body off the spindle. Allow the pulley to rotate to prevent scoring the bearings. As the tool body backs off, the clutch pulley and bearing will be pulled off along with the collar.

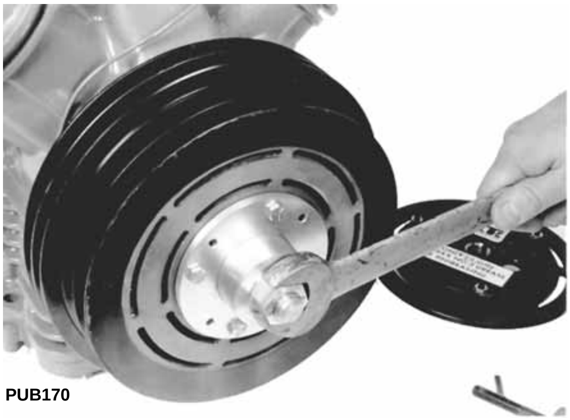


Figure 93: Removing Pulley

11. Remove the rear seal and internal snap ring from the clutch pulley. Using a press, remove the clutch bearing.
12. If necessary for repair or replacement, remove the field coil.

Clutch Inspection

Pulley and Armature Mating Surface Condition

Check the mating surfaces as follows:

1. Using a straight edge and 0.010 in. (0.254 mm) feeler gauge, check the armature and pulley (or flywheel) mating surfaces for warpage. Use the following guidelines to determine the course of action to follow.
    a. If no more than 20% of the pulley surface is warped over 0.010 in. (0.254 mm), the component may still be used without the need for any surface machining. If the armature is warped, replace it.
    b. If warpage exceeds 0.010 in. (0.254 mm) from 20 to 50% over the face of the armature and/or pulley (flywheel), the armature should be replaced. The pulley may be resurfaced; refer to “Resurfacing Operation”.
    c. Warpage exceeding 0.010 in. (0.254 mm) over more than 50% of the armature and/or pulley surface means the armature should be replaced and the pulley may have to be replaced. Make an attempt to resurface the pulley (see “Resurfacing Operation”). It may be possible to restore the pulley to a usable condition. Check again for warpage after the resurfacing operation is complete. If the pulley still fails to meet specification, replace it.
2. Check the mating surfaces of both components for excessive grooving. A slight amount of grooving is acceptable. However, if the galled portions on the mating surfaces project more than 0.010 in. (0.254 mm), replace the armature and attempt to resurface the pulley (see “Resurfacing Operation”).

Figure 94: Checking for Warpage

Resurfacing Operation

NOTE: Machining of the mating surfaces of the pulley (flywheel) should be done on a precision machine tool such as a lathe or automotive brake grinding machine.

Perform the machining operation as follows:

1. Using a micrometer, measure the thickness of the outer edge of the pulley (flywheel). Mark the dimension down to use for future reference.

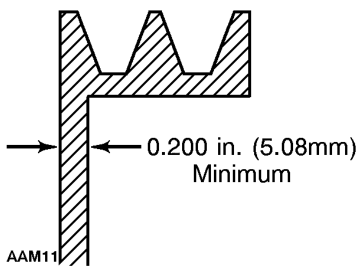
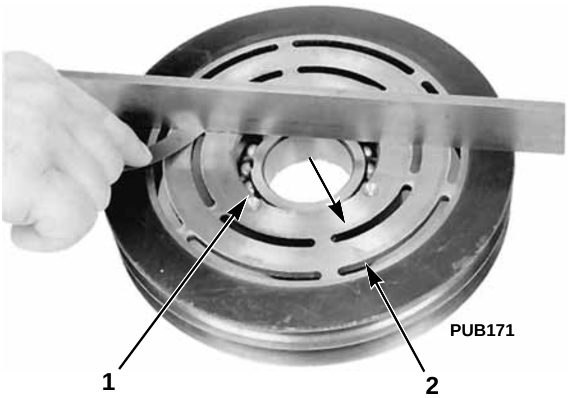


Figure 95: Pulley Thickness

NOTE: Minimum pulley thickness is 0.200 in. (5.08 mm) when machining is complete. If the pulley thickness is less than 0.200 in. (5.08 mm), replace the pulley.

NOTE: If the center portion of the pulley (out to the outside of the four chamfered center holes) is higher than the outer perimeter surface area of the pulley, the pulley mating surface has been previously machined. Determine the difference in height between the two surfaces and add this dimension to the thickness measurement of the outer perimeter of the pulley. This will ensure that too much material will not be removed from the pulley.

2. Install the pulley into the tool to be used for machining.
3. Machine the entire face of the pulley. Re-countersink the seal mounting holes.



1.	Seal Mounting Holes
2.	Machined Surface

Figure 96: Pulley Surface

4. DO NOT remove more than 0.025 in. (0.635 mm) of the pulley mating surface. Remove approximately 0.005 in. (0.127 mm) each cut until 90% of the surface is cleaned up. If this cannot be done without machining more than 0.025 in. (0.635 mm) off the pulley, replace the pulley. Removal of more than 0.025 in. (0.635 mm) of material will weaken the pulley and cause it to fail during operation. Stop the machine occasionally and measure the pulley thickness to determine the amount of material removed. Subtract the dimension acquired from the original dimension to find the amount of material removed.

   Do not machine pulley face to a perfectly smooth finish (64 finish maximum smoothness allowed) or slippage may result.

Clutch Coil Electrical Check

Coil current (amps) and resistance (ohms) must be checked with the coil at a certain temperature. Refer to the charts below to obtain the proper resistance and current readings at different coil temperature readings.

12 Vdc				
Coil Temperature	Coil Resistance (Ohms)	dc Voltage Current (amps)		
		10 V	11 V	12 V
50 F (10 C)	2.8	3.60	3.90	4.30
75 F (24 C)	2.9	3.45	3.80	4.15
100 F (38 C)	3.0	3.30	3.70	4.00

NOTE: Values are nominal for test conditions. 10% variation is acceptable.

24 Vdc					
Coil Temperature	Coil Resistance (Ohms)	dc Voltage Current (amps)			
		20 V	22 V	24 V	27 V
50 F (10 C)	11.2	1.80	1.95	2.15	2.42
75 F (24 C)	11.6	1.73	1.90	2.08	2.33
100 F (38 C)	12.0	1.65	1.85	2.00	2.25

NOTE: Values are nominal for test conditions. 10% variation is acceptable.

Clutch Bearing

Use the following criteria when determining whether bearing can be greased or it should be replaced.

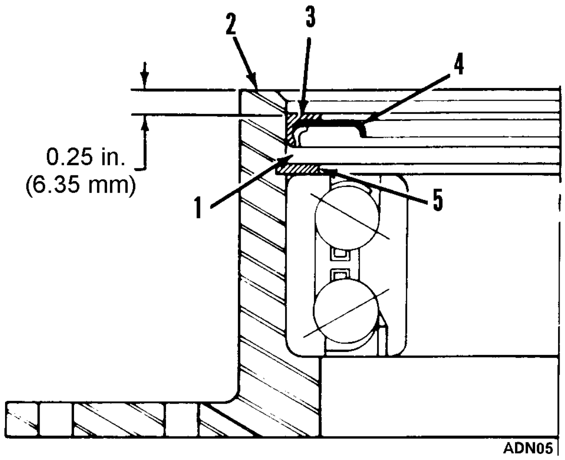
1. The bearing, (refer to Parts Manual) is manufactured especially for Thermo King and has special internal clearances.

   NOTE: Only genuine Thermo King bearings should be used. Reduced bearing life will result if genuine Thermo King bearings are not used.

2. If wear is evident, replace the bearing.
3. Regrease the bearing by using Exxon Unirex N2 high temperature grease (TK No. 204-476).

Clutch Reassembly

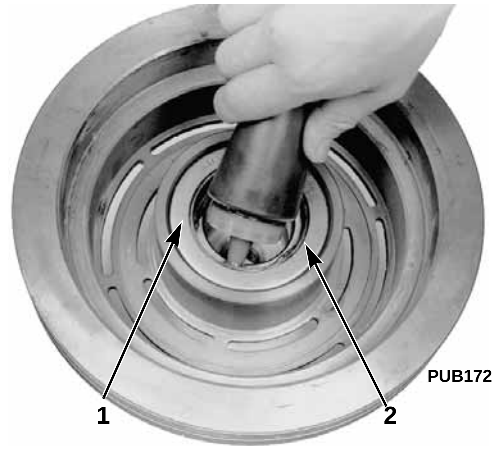
1. Install the new bearing (refer to Parts Manual for Bearing and Seal Kit), but press only on the outer race. Pressing the inner race will damage the bearing. Warming the pulley/flywheel will allow an easier fit. Install internal snap ring.
2. Install new rear seal (refer to Parts Manual). The seal should be seated 0.25 in. (6.35 mm) into the clutch pulley.



1.	Grease Cavity	4.	Teflon Seal
2.	Inner Hub Face	5.	Seal Ring
3.	Outer Seal Support		

Figure 97: Side View of Pulley Bearing Assembly Showing Rear Seal Position

3. Pack rear seal cavity about 1/3 full of Exxon Unirex N2 high temperature grease (TK No. 204-476).



1.	Seal
2.	Grease Cavity

Figure 98: Packing Rear Seal Cavity

4. To facilitate later installation of the key, rotate the compressor crankshaft so the keyway faces up.

   NOTE: On 7.75 in. O.D. diameter pulleys, a bearing spacer must be installed on the compressor seal plate before the pulley is installed. See Figure 109: "7.75 in. Pulley Assembly" on page 141.

5. Screw the spindle into the inner threads of the compressor seal plate hub. Reverse the tool body and press the clutch pulley back onto the compressor seal plate hub. Ensure the bearing inner race seats on the shoulder of the hub.

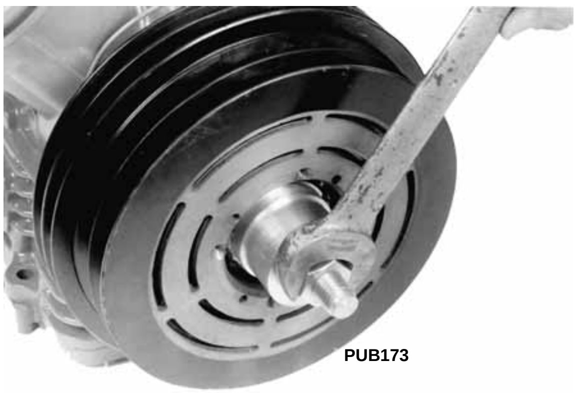


Figure 99: Pressing on Pulley

6. Reinstall the bearing retainer nut. Use the nut driver to assist in torquing it to 100 ft-lb (135 N•m).

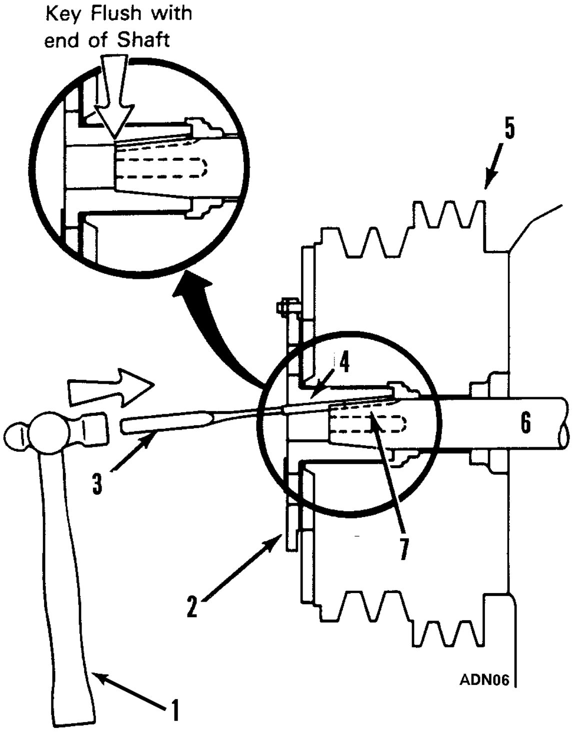
Figure 100: Reinstalling Pulley

7. Pack the front cavity behind the front seal 1/3 full with Exxon Unirex N2 high temperature grease (TK No. 204-476).
8. Place o-ring (refer to Parts Manual) onto back of front seal assembly (refer to Parts Manual) and reinstall the seal.

   NOTE: Check the armature threads to be sure they are cleaned and not damaged before reassembling. If the armature threads are dirty or damaged, use a 3/4 x 10 tap to restore them.

9. Install the armature on the taper of the compressor crankshaft. Align the keyways of both the crankshaft and armature hub. Place the crankshaft key into the keyway slot and gently tap with a flat punch until the crankshaft key is flush with the end of the crankshaft. See the following drawings.

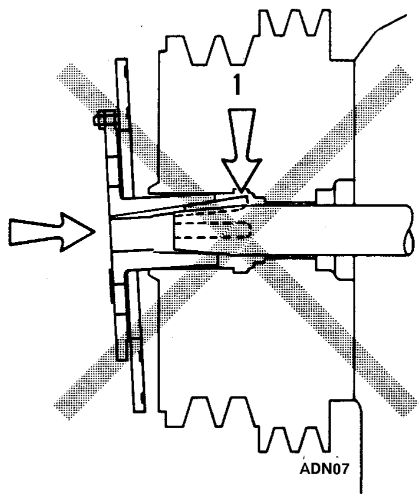
CAUTION: Do not push the key in past the end of the crankshaft or the armature will be damaged.



1.	Hammer	5.	Pulley
2.	Armature	6.	Crankshaft
3.	Flat Punch	7.	Shaft Keyway
4.	Key		

Figure 101: Correct

CAUTION: Forcing the armature on the crankshaft will cause damage and misalignment.



1.	Misaligned Key

Figure 102: Incorrect

CAUTION: DO NOT tighten the hub and armature until the crankshaft key is flush with the end of the crankshaft. Failure to do so will cause misalignment of the crankshaft key resulting in a wobbly hub and armature assembly and ultimately clutch failure.

10. After the crankshaft key is properly installed, torque the clutch retaining screw to 45 ft-lb (61N•m).

    NOTE: Be sure the taper portion of the washer I.D. is installed with the largest I.D. toward the screw head.

11. Check and adjust the air gap between the armature and pulley. The air gap should be 0.045 ± 0.005 in. (1.143 ± 0.127 mm). See "Air Gap" below.

Air Gap

Air gap inspection and adjustment should be scheduled monthly during the air conditioning season.

Setting Air Gap With New Components

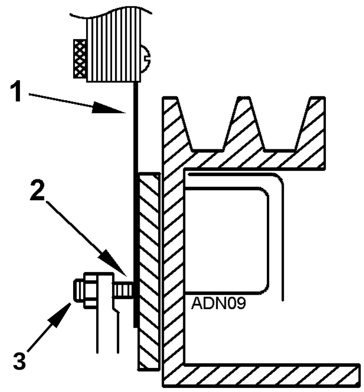
For a new armature and a new or resurfaced pulley/flywheel the air gap is set as follows:

1. Loosen the lock nuts on the three Allen head screws.
2. Adjust the Allen head screws to get an air gap of 0.045 ± 0.005 in. (1.143 ± 0.127 mm) between the mating surfaces of the armature and the pulley/flywheel.
3. Tighten the lock nuts. Make sure the Allen head screws do not turn by holding them with an Allen wrench (see Figure 105 on page 138).

Air Gap Check

Once the clutch pulley surface wears, it is impractical to check the air gap between the armature plate and pulley with a feeler gauge. The feeler gauge will measure from the top of the worn pulley ridge to the armature plate and *not* the true air gap between the armature plate and the pulley front face. Check air gap in the following method:

1. Energize clutch coil with appropriate voltage if practical, or mate the surfaces by pushing in on the armature by hand.
2. Check air gap between the three adjusting screws and armature plate using a 0.045 in. (1.143 mm) feeler gauge.



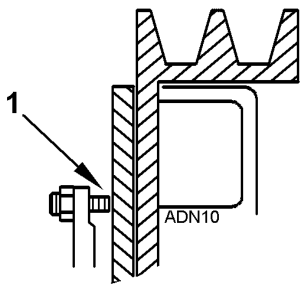
1.	Feeler Gauge
2.	Air Gap Measured Here
3.	Adjusting Screw Assembly

Figure 103: Air Gap Measurement

3. If the air gap is greater or less than 0.045 ± 0.005 in. (1.143 ± 0.127 mm), the clutch is in need of adjustment.

Air Gap Adjustment

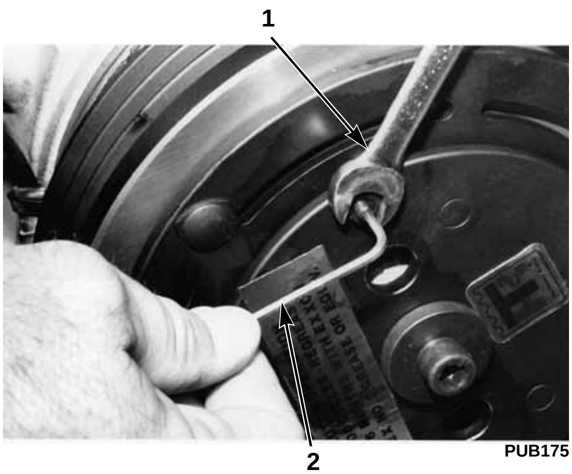
1. Loosen the locknuts on the three adjustment screws.
2. Energize clutch coil with appropriate voltage if practical, or mate the surfaces by pushing in on the armature by hand.
3. Using a 3/32 in. (2.4 mm) Allen wrench, turn each adjustment screw in clockwise (CW) until the screw bottoms out on the armature plate.



1.	Allen Screw Bottoms Out

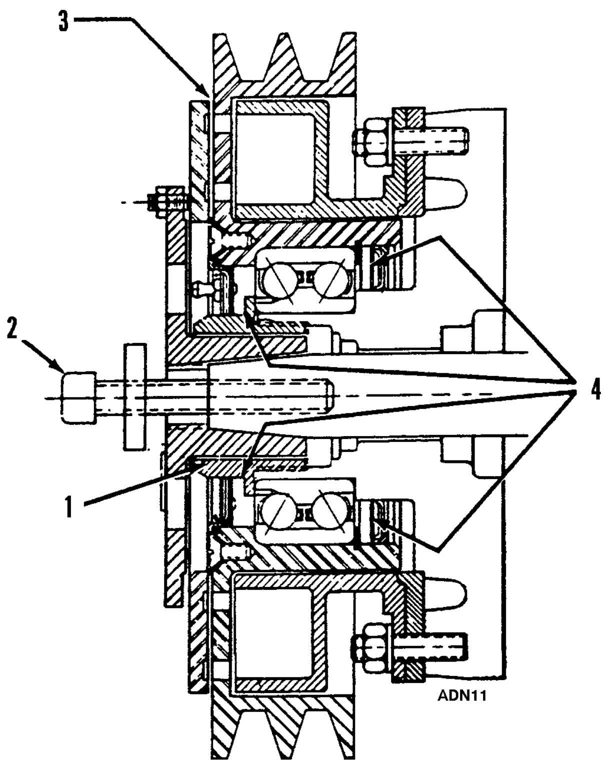
Figure 104: Air Gap Adjustment Bottoms Out

4. Back each adjusting screw out counterclockwise (CCW) 1-1/2 turns. This equals a 0.045 in. (1.143 mm) air gap.
5. Double check air gap with feeler gauge (see Figure 103 on page 137).
6. Tighten the lock nuts. Make sure the adjusting screws do not turn by holding them with an Allen wrench.



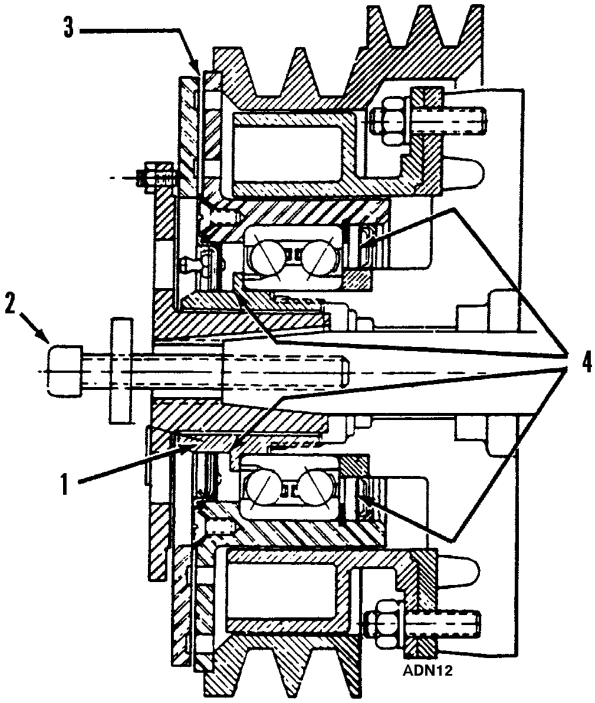
1.	Wrench Tightening Locknut
2.	3/32 in. (2.4 mm) Allen Wrench

Figure 105: Air Gap Adjustment Procedure



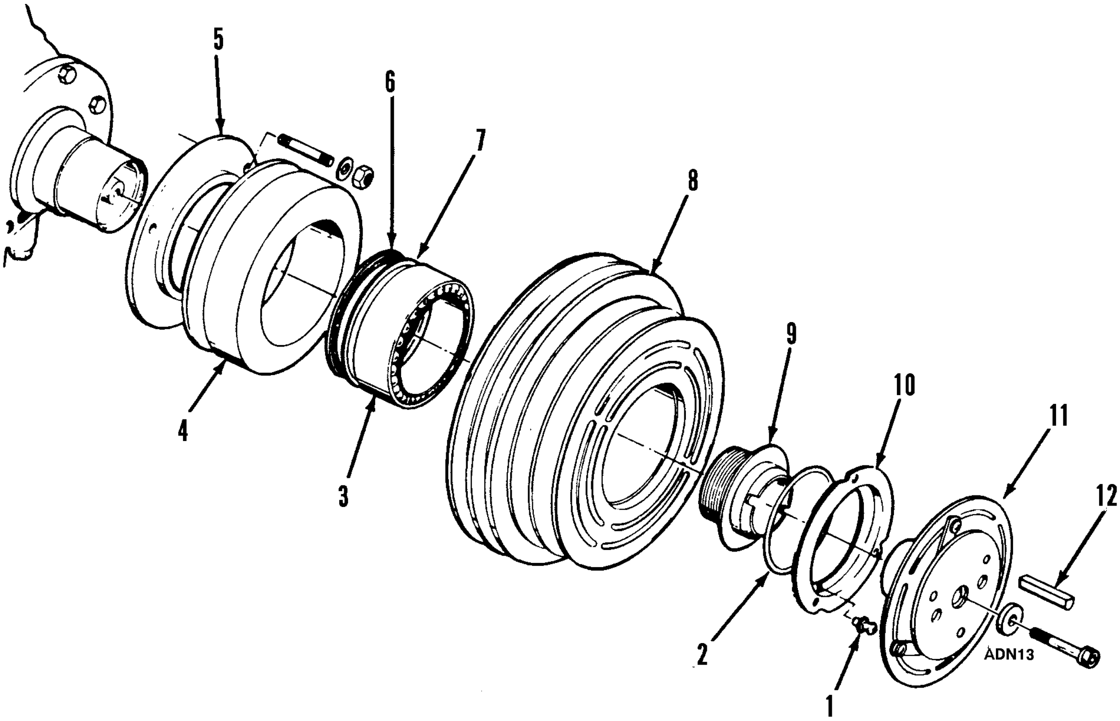
1.	Torque to 100 ft-lb (135 N•m) (Bearing Retaining Nut)
2.	Torque to 45 ft-lb (61 N•m)
3.	Set Air Gap at 0.045 ± 0.005 in. (1.143 ± 0.127 mm)
4.	Fill Cavity 1/3 Full with Grease, Exxon Unirex N2 high temperature grease (TK No. 204-476).

Figure 106: Clutch Assembly — 8.0 in., 9.0 in. and 9.0/10 in. Diameter Pulley



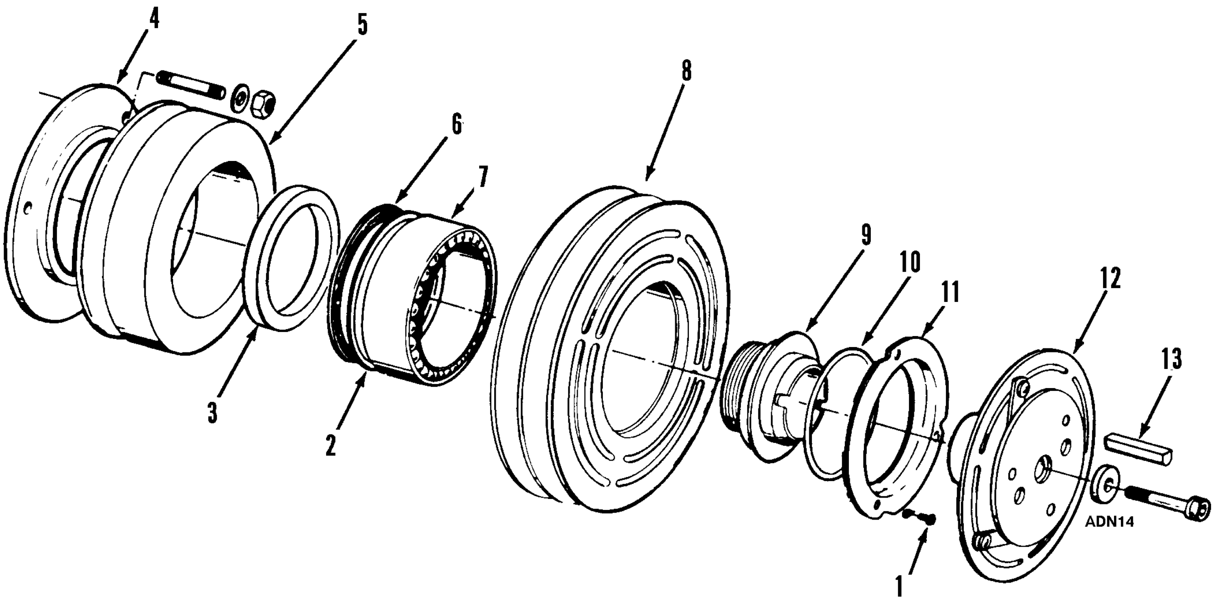
1.	Torque to 100 ft-lb (135 N•m) (Bearing Retaining Nut)
2.	Torque to 45 ft-lb (61 N•m)
3.	Set Air Gap at 0.045 ± 0.005 in. (1.143 ± 0.127 mm)
4.	Fill Cavity 1/3 Full with Grease, Exxon Unirex N2 high temperature grease (TK No. 204-476).

Figure 107: Clutch Assembly — 7.75 in./8.9 in. Diameter Pulley



1.	Grease Fitting	7.	Bearing Retaining Ring
2.	O-ring	8.	Pulley
3.	Bearing	9.	Bearing Retaining Nut
4.	Field	10.	Front Seal
5.	Aluminum Flux Shield	11.	Hub and Armature
6.	Rear Seal	12.	Shaft Key

Figure 108: 9 in. Pulley Assembly



1.	Grease Fitting	8.	Pulley
2.	Bearing Retaining Ring	9.	Bearing Retaining Nut
3.	Bearing Spacer	10.	O-ring
4.	Aluminum Flux Shield	11.	Front Seal
5.	Field Assembly	12.	Hub and Armature
6.	Rear Seal	13.	Shaft Key
7.	Bearing		

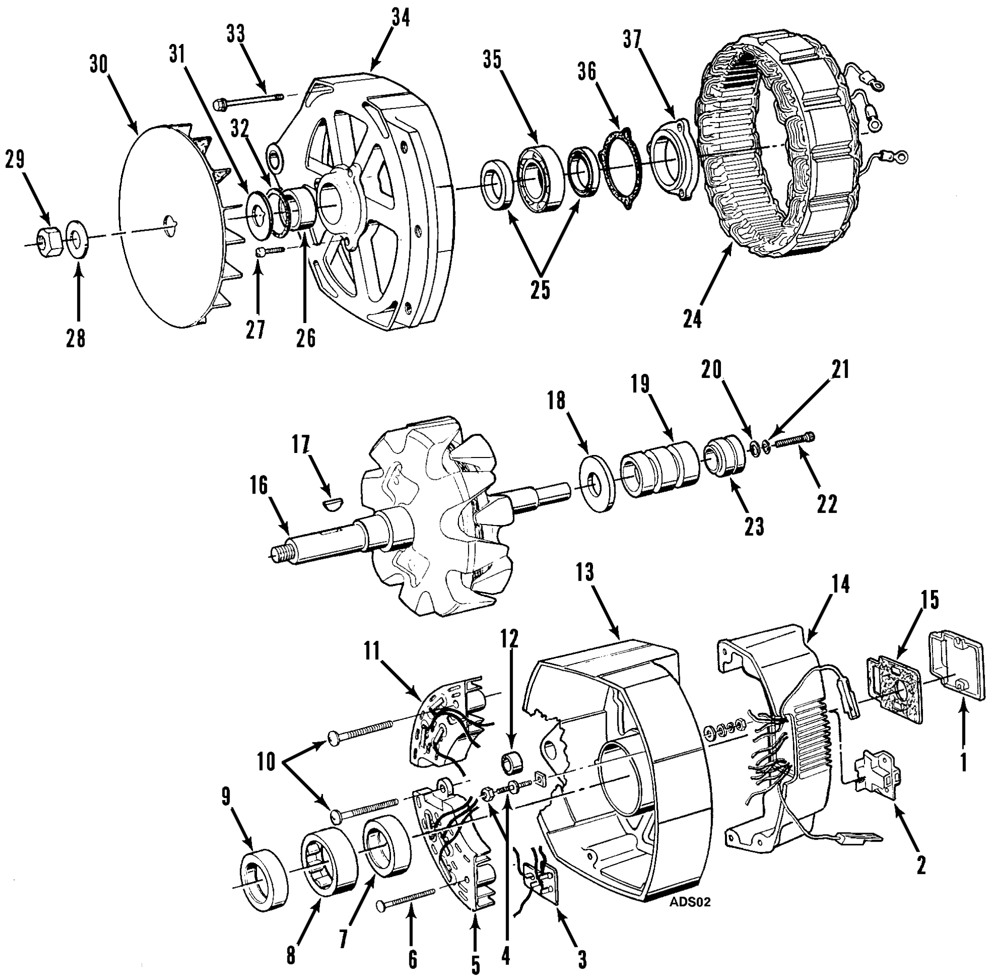
Figure 109: 7.75 in. Pulley Assembly

125/150 Ampere Batteryless Alternator Service Procedures

Maintenance Inspection Schedule

The two year limited warranty provided by Thermo King for the optional 125/150 amp batteryless alternators is contingent upon evidence of the implementation of the following routine maintenance procedures.

Routine Preventive Maintenance Procedures	5,000 Miles (8000 km)	15,000 Miles (24000 km)	50,000 Miles (80000 km)
1. Check belt condition. Replace if worn or cracked.	•		
2. Belt installation, alignment and tensioning. • **Alignment**: Must be within 1/32 in. (0.8 mm) of the true centerline. • **Tension**: Set belt tension to the engine manufacturer's recommendations. If no recommendation is available, tighten belts to the point where the alternator fan cannot be turned by hand. ***CAUTION: Tighten, applying pressure to the alternator front housing only. DO NOT apply pressure to rear housing or stator.***	•		
3. Inspect for air inlet restrictions. Assure air inlet openings at rear of alternator are not restricted with foreign substances (dirt, grease, paper, etc.)	•		
4. Inspect pulley hardware and through bolts. Torque pulley hardware to 50 to 60 ft-lb (68 to 81 N•m). Torque through bolts to 45 to 53 in.-lb (5 to 6 N•m). Use Loctite™ No. 242 (Blue Type) on through bolt threads.		•	
5. Check alternator excitation and output voltages. **125 Amp Alternator** Excitation voltage: 9 to 15 Vdc model—8XC3022V (12 Vdc bus) 18 to 30 Vdc model—8SC3021V (24 Vdc bus) Output voltage: 22 to 28 Vdc at fast engine idle. **150 Amp Alternator** Excitation voltage: 9 to 15 Vdc model—8XC3129V (12 Vdc bus) 18 to 30 Vdc model—8SC3127V (24 Vdc bus) Output voltage: 22 to 28 Vdc at fast engine idle.		•	
6. Inspect brushes and slip ring assembly. Replace brushes if oil soaked, cracked or worn to less than 3/16 in. length. Clean slip rings when brushes are replaced and only to remove very minor roughness. Use fine sandpaper or crocus cloth. Replace slip ring assembly if surfaces are worn beyond restoration. Use Loctite™ No. 242 (Blue Type) on brush assembly screws.		•	
7. Inspect bearings by rotating shaft by hand. If noisy, disassemble alternator and inspect the bearings and seals. Replace if worn.		•	
8. Inspect stator. Replace stator if damaged insulation is evident.			•
9. Inspect rotor shaft. Replace if rotor shaft is found to have stripped threads, worn key slot, worn bearing surfaces or scuffed pole finger.			•



1.	Cover	14.	Regulator—Voltage	27.	Screw
2.	Brush—Assembly	15.	Gasket	28.	Flatwasher
3.	Terminal Board	16.	Rotor	29.	Nut
4.	Stud	17.	Key	30.	Fan
5.	Diode	18.	Retainer	31.	Washer
6.	Screw	19.	Bearing	32.	Shield
7.	Seal	20.	Flatwasher	33.	Bolt
8.	Bearing	21.	Lockwasher	34.	Housing
9.	Seal	22.	Screw	35.	Bearing—Front
10.	Screw	23.	Slip Ring	36.	Gasket
11.	Diode	24.	Stator—Assembly	37.	Retainer—Bearing
12.	Bushing	25.	Seal—Bearing		
13.	Housing	26.	Spacer		

Figure 110: Alternator Assembly

Description

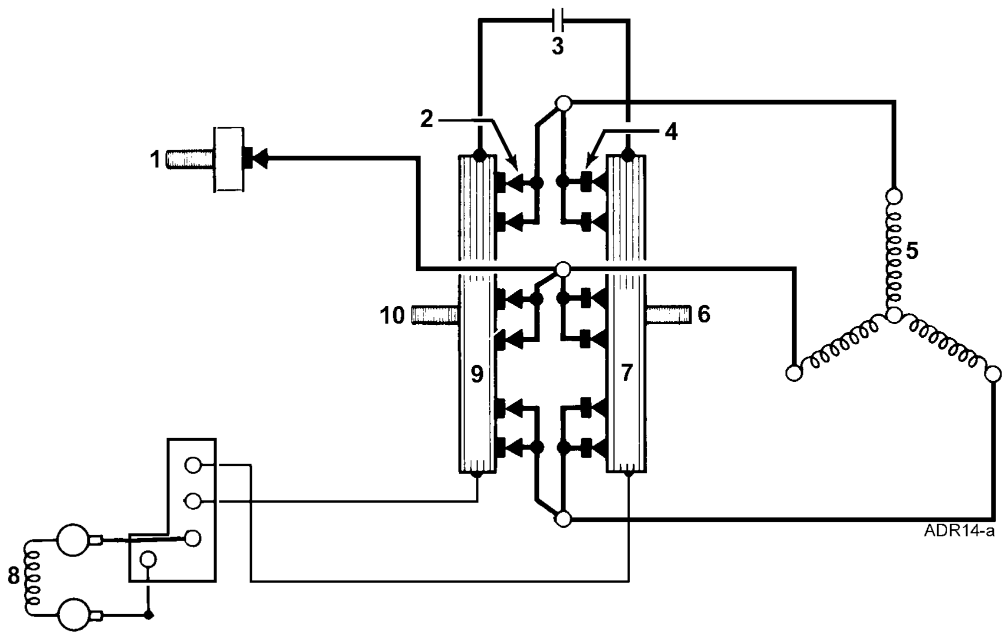
The 125 or 150 amp batteryless alternator is belt-driven by the bus engine or the power pack engine. It is designed to power bus air conditioner electrical loads up to 125 or 150 amps. The alternator excitation current is continuously supplied from the bus or power pack batteries, 12 or 24 Vdc), when the air conditioning system is turned on. Because the field windings and voltage regulators differ, different alternators are required for 12 Vdc and 24 Vdc bus battery applications. The regulator, mounted on the rear housing of the alternator, contains the electronic components necessary for alternator operation. The voltage regulator controls alternator output voltage over the range of rpms and load conditions.

System Operation

When the air conditioning system is turned on, current flows from the bus battery (and typically through a 10 amp circuit breaker and the unit On/Off switch) to the excitation stud. Voltage at the excitation stud is applied to the positive side of the field through the brush and slip ring. The negative side of the field goes to the regulator and is switched to chassis ground to control field current. Field current varies from 1.8 to 6.7 amps. The value of field current may be measured at the excitation stud.

Field current is greatest at low alternator speeds and tapers off as alternator speed and load current varies. The voltage regulator has purple and yellow sensed leads. The yellow lead, when connected to the alternator output stud through a switch or by direct connection, controls alternator output voltage at 20 Vdc. This is non-adjustable. The purple lead, when connected to the output stud, controls alternator output voltage at 27 ± 0.5 Vdc. This setting, however, is adjustable. A slotted screw below the excitation stud on the back of the alternator allows setpoint voltage for the purple lead to be adjusted from 22 to 28 Vdc.

A 3900 µF, 75W, 12 Vdc capacitor is connected externally across the positive and negative leads alternator output at the A/C unit. The capacitor replaces the battery to act as a filter, to stabilize output voltage and improve motor brush life.

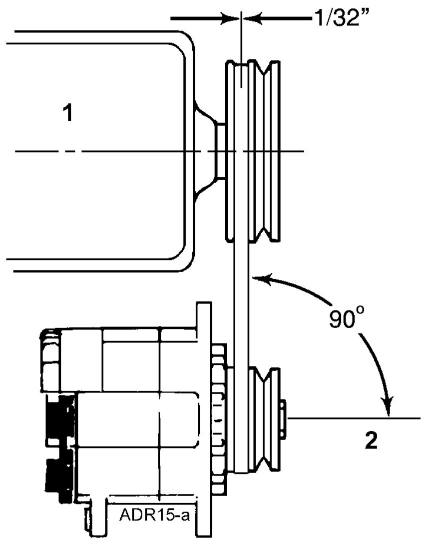


1.	Indicator Light Terminal	5.	Stator	8.	Rotor (Field)
2.	Positive Rectifier Diodes	6.	Negative Output Terminal	9.	Positive Heat Sink
3.	0.5µF 160 Volt Capacitor	7.	Negative Heat Sink	10.	Positive Output Terminal
4.	Negative Rectifier Diodes				

Figure 111: Alternator System

Belt Alignment

Be sure the center line of all pulleys related to the alternator drive are within 1/32 in. (0.8 mm) of the true center line.



1.	Air Conditioning Compressor
2.	Alternator Pulley and Drive Pulley Must be in Line with Each Other

Figure 112: Pulley Alignment

Belt Tension

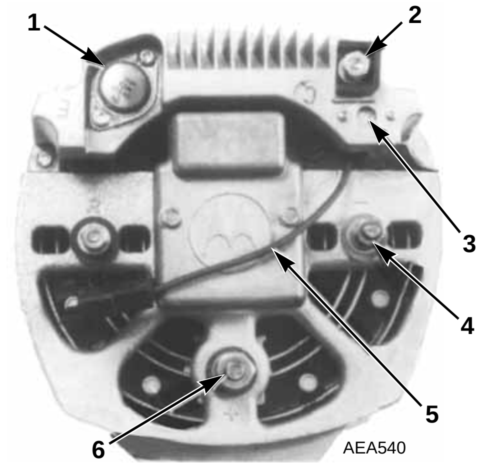
Tighten the drive belts by applying pressure to the alternator front housing *only. Do not* apply pressure to the rear housing or stator. Set the belt tension to unit maintenance manual specifications.

Test Procedures for Batteryless Alternator

Before beginning test procedures to determine the cause of improper alternator output power, check the following:

- Belt tension and condition.
- Wires between alternator and control box.
- Wires between alternator and motor.
- Wires from bus electrical system to control box.
- Condition of wires and components in control box.
- Circuit breaker to see if it needs to be reset.
- Alternator brushes.
- Fan motor brushes.

If the above items are found not to be the reason for the difficulty, test the alternator. The end result of conducting tests on the batteryless alternator is to determine whether the alternator or regulator is defective. The regulator is not repairable and should be replaced as a unit. The alternator is tested and repaired in the same manner as with a battery charging alternator.



1.	Transistor Case
2.	Excitation Stud
3.	Regulator Setpoint Adjustment Screw
4.	Negative Terminal
5.	Purple Lead
6.	Positive Terminal

Figure 113: Alternator Components

Symptom: No Voltage at Output

1. Using an ammeter, check for possible short or open circuit by verifying there is zero output current.
2. Check at excitation stud on the regulator for required battery voltage.

12V Alternator	24V Alternator
10 to 16 Vdc	20 to 32 Vdc

NOTE: Disconnect the output cable before doing the test in step 3.

3. Attach a voltmeter to the output studs. With the engine running, attach a jumper lead to the alternator NEG stud and momentarily touch the transistor case on the back of the regulator with the opposite end of the lead (Full Field). If the regulator is shorted, this test will cause the output voltage to rise to a value determined by alternator rpm and the load applied to the alternator output. If the greater than 28 volts, the regulator is bad.

CAUTION: DO NOT leave the jumper lead in contact with transistor case longer than the time required to determine whether or not there is output voltage. The output voltage is not controlled during this test. If uncontrolled voltage is allowed for an excessive period, damage to the alternator could result.

4. If there is still no output, check the alternator for open field winding, faulty brushes, defective stator, etc.

Symptom: High Voltage at Output

1. Visually check to verify the regulator sense lead, purple or yellow, is connected to the alternator positive stud, not to the alternator NEG stud or case. If correctly connected, check to ensure all connections are tight and there is no evidence of corrosion.
2. Leaving the terminal board connected, remove the voltage regulator (four mounting screws). Check the connections on the regulator terminal board for shorts or possible ground.
3. If no shorts or ground are evident, remove the regulator and terminal board (four hex nuts on terminal board), and replace the regulator assembly.

Symptom: Low Voltage at Output

1. Ensure the proper regulator sense lead, purple—high, yellow—low, is connected to the alternator output. Check adjustment of the regulator setpoint adjustment screw below the excitation stud. It must be turned fully clockwise to obtain 27 Vdc output.
2. Measure voltage at the regulator excitation stud. It must read as follows:

12V Excitation	24V Excitation
10 Vdc minimum	20 Vdc minimum

3. Attach a voltmeter to the output studs. With the engine running, attach a jumper lead to the alternator NEG stud and momentarily touch the transistor case on the back of the regulator with the opposite end of the lead (Full Field). If voltage reading rises to normal operating value or greater, replace the regulator. Recheck output after replacing the regulator.

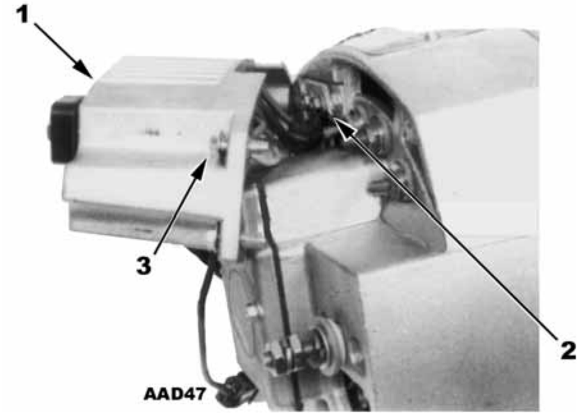
CAUTION: DO NOT leave the jumper lead in contact with the transistor case longer than the time required to obtain voltage output readings. The output voltage is not controlled during this test. If uncontrolled voltage output is allowed for an excessive period, damage to the alternator could result.

4. If low voltage continues, connect an accurate dc ammeter in series, start the engine, and operate at a minimum of 4,000 rpm (alternator rpm), using a tachometer or strobe light to achieve proper reading. Check the output current. If current reading exceeds 125 amps for the 125 amp alternator, or 150 amps for the 150 amp alternator, check alternator load (motors). If necessary, reduce the load and recheck output current.
5. If low voltage continues, check the alternator for defective brushes, diodes, stator windings or for a shorted field. Refer to “Overhaul Procedures” on page 148.

Overhaul Procedures

Voltage Regulator Assembly Removal

1. Remove the four (4) mounting screws from the regulator.



1.	Regulator
2.	Regulator Connecting Panel
3.	Regulator Mounting Screws (4 Used)

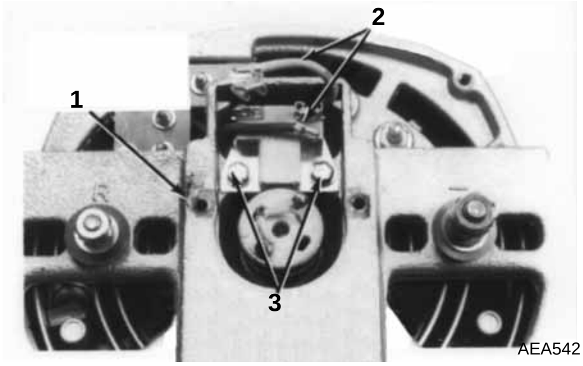
Figure 114: Voltage Regulator Removal

2. Hold the regulator away from the rear housing, and remove the hex nuts and lockwashers from the terminal board.
3. Detach the regulator connecting panel.

NOTE: In the event of a regulator malfunction, replace the entire unit.

Brush Assembly Removal

1. Remove the two (2) brush cover retaining screws.
2. Disconnect the yellow and green leads from the brush terminals.
3. Disassemble the two (2) brush assembly mounting screws and remove the brush assembly.

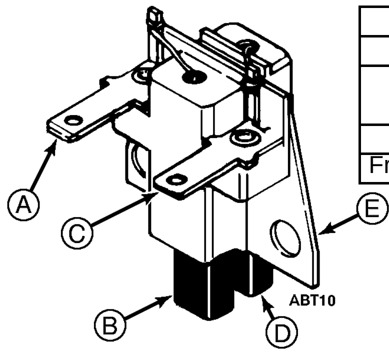


1.	Brush Cover Retaining Screws (Removed)
2.	Disconnect Brush Terminal Leads
3.	Remote Brush Assembly Mounting Screws

Figure 115: Brush Assembly Removal

Brush Assembly Inspection and Testing

Use the accompanying diagram as a guide and test for continuity with the use of a 12 Vdc test lamp or ohmmeter as indicated.



TEST
Continuity:
From A to B From C to D
No Circuit:
From E to A or C

Test With 12 Vdc Test Lamp or Ohmmeter

Figure 116: Test Brush Assembly for Continuity

If the brushes are not oil soaked or cracked, rotor contacting surfaces are smooth and the brushes are 3/16 in. (4.8 mm) or more in length, they may be reused.

Pulley and Fan Removal

1. Install a spanner wrench in the two holes on the pulley.

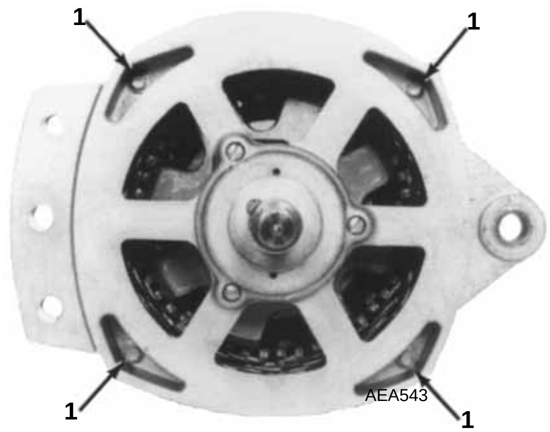
2. Hold the pulley stationary using the spanner wrench, and remove the hex nut using a socket wrench. Remove the flatwasher, and slide the pulley and fan off the shaft.

3. Remove the metal retainer and dust seal from the front housing.

Separating Housings

1. Remove four (4) through bolts and separate front and rear housings (rotor and front housing, one assembly; stator and rear housing, other assembly).

2. If stator tends to stick in housing during removal, use a wood dowel and hammer to dislodge it. Place the dowel on the lamination only to prevent breakage.



1.	Through Bolts

Figure 117: Remove Through Bolts to Separate Housings

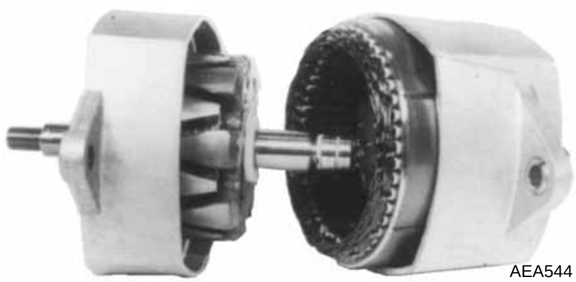
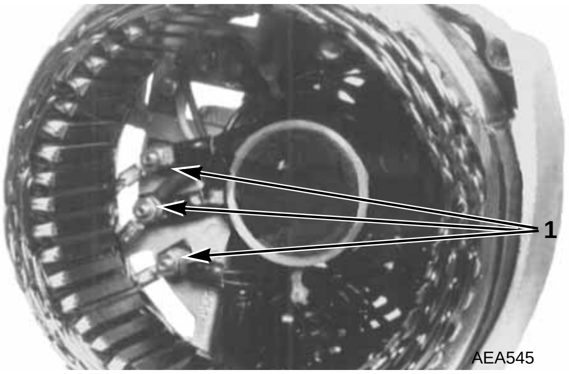


Figure 118: Housing Separation

Stator Removal

1. Remove the three (3) hex nuts and lockwasher from the AC terminals.



1.	Remove 3 Hex Nuts and Lockwashers

Figure 119: Stator Removal

2. Use a VOM to test stator windings for continuity. Refer to photo for wire lead identification and test for continuity between terminals “A” and “B”, “B” and “C”, and “A” and “C”. There should be no circuit between any winding and the laminations.

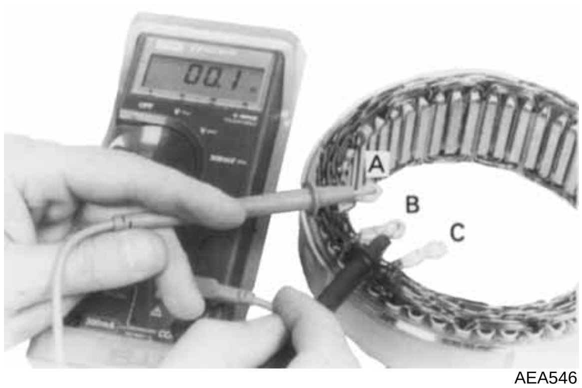


Figure 120: Test Stator Windings for Continuity

Figure 121: Test for Continuity Between Windings and the Laminations

3. A 120 Vac test lamp using a 25 watt bulb may be used for stator continuity and ground testing. However, do not use this device where transistors or diodes are connected to the circuit under test.

4. If the stator can be reused, clean it with solvent, rinse with soap and water and blow dry with low pressure compressed air before reinstalling.

Rectifier Diode Assembly Removal

1. Remove external hardware from the positive output terminal stud, the negative output terminal stud and the indicator lamp stud.
2. Disconnect the three rectifier leads from the ac terminals.
3. Disconnect the terminal board lead by removing the hex nut from the negative diode assembly heat sink.
4. Disconnect the capacitor lead by removing the hex nut from the positive diode assembly heat sink.
5. Remove both diode assemblies from the alternator housing.

Rectifier Diode Testing

Each rectifier heat sink contains six (6) individual diodes of identical polarity. Two (2) adjacent diodes are connected in parallel with a soldered link. One stator lead is soldered to the link in the positive rectifier group, the second stator lead is connected to a pair of negative diodes. All stator leads are connected in this manner forming a full wave, three phase rectifier bridge.

1. In order to test a diode for an open, it must be disconnected from an adjacent diode before testing. Using a heat sink to protect the diodes, unsolder the connecting link from the diode furthest away from the stator lead. Bend the connecting link away from the diode terminal after unsoldering is completed.

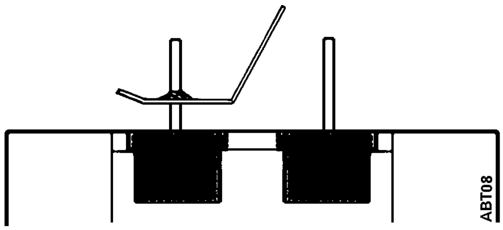
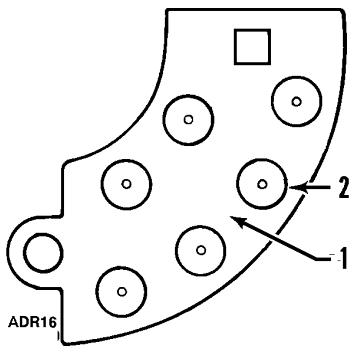


Figure 122: Bend Connecting Link

2. Use a commercial diode tester, ohmmeter or 12 Vdc test lamp to test each diode. Refer to the diagram and table below for proper test procedures.



1.	*Cathode (Positive Bridge) Anode (Negative Bridge)
2.	*Anode (Positive Bridge) Cathode (Negative Bridge)

Figure 123: Rectifier Bridge Diode Test

Ohmmeter or Lamp Lead Placement							
Bridge Positive		**Bridge Negative**		**Ohmmeter Scale**	**Ohmmeter Reading**	**Lamp**	
Red (+)	**Blk (-)**	**Red (+)**	**Blk (-)**	**Rx**		**On**	**Off**
Anode	(Sink) Cathode	(Sink) Anode	Cathode	1	5 to 15 ohm	X	
(Sink) Cathode	Anode	(Sink) Cathode	Anode	100	Infinity		X

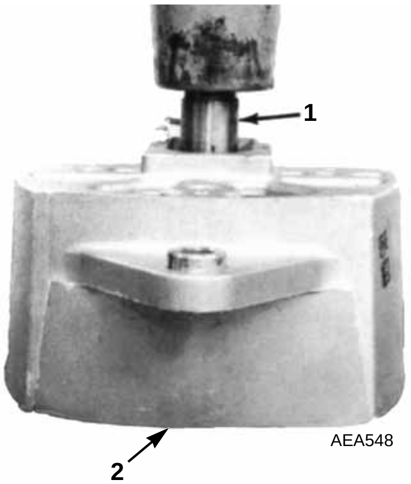
Rectifier Diode Replacement

CAUTION: Only rosin core solder should be used for all soldering operations. The use of acid core solder will result in rapid corrosion of the windings and eventual failure of the complete alternator unit.

1. Unsolder the connecting link and press out the defective diode.
2. Press in the new diode and reassemble the connecting link.
3. If necessary, replace the rib-necked terminal screws. Install fluted area of the new bolt in grooves formed by the original unit.

Completing Rear Housing Disassembly

1. Remove the rear housing regulator terminal board and AC terminal assemblies.
2. Support the rear housing in an arbor press. Using a driver that will pass the housing cavity, drive the bearing and both seals out in one operation.



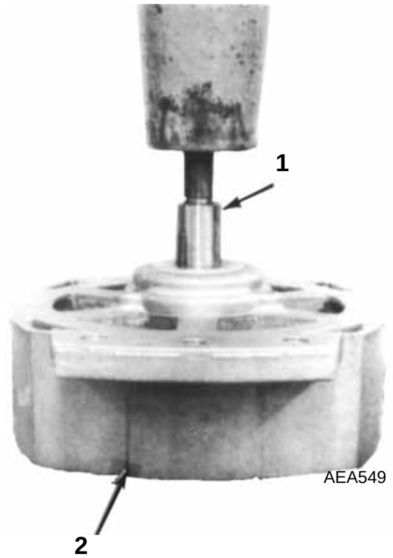
1.	Driver
2.	Rear Housing

Figure 124: Rear Bearing and Seal Removal

3. Inspect the housing for cracks, stripped threads and signs of excessive wear in the bearing core. Replace the housing, if necessary.

Front Housing and Rotor Disassembly

1. Remove the bearing retainer screw and place the assembly in an arbor press.
2. Using support blocks under the housing, push the rotor, front bearing and retainer assembly out of the housing.



1.	Rotor Shaft
2.	Front Housing

Figure 125: Rotor Separation from Front Housing

3. Using a bearing puller, place puller jaws around the bearing retainer and remove the bearing and retainer in one operation.
4. Use a pin punch to extract grease seals from the front housing and retainer. The seals are identical and interchangeable.

Rotor Inspection and Testing

Check the rotor assembly for the following electrical and mechanical properties.

Rotor Resistance

Rotor resistance measured at slip rings should be:

Alternator Rating	Excitation Voltage	Rotor Resistance @ 77 F (25 C)
125 amps	12 Vdc	1.8 ± 0.1 ohms
	24 Vdc	6.7 ± 0.3 ohms
150 amps	12 Vdc	1.8 ± 0.1 ohms
	24 Vdc	3.6 ± 0.2 ohms

Rotor Current Draw

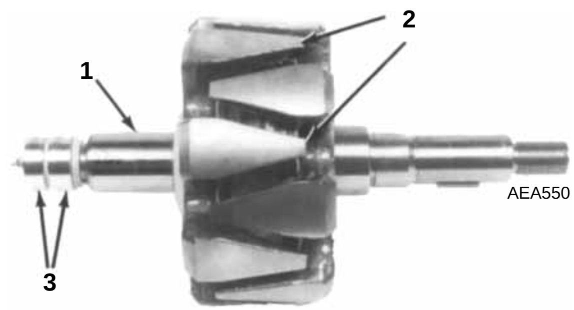
Rotor current draw should be:

Alternator Rating	Excitation Voltage	Rotor Current Draw @ 70 to 80 F (21 to 27 C)
125 amps	12 Vdc	6.67 amps
	24 Vdc	3.58 amps
150 amps	12 Vdc	6.67 amps
	24 Vdc	6.67 amps

Grounded Slip Rings or Winding

Test with ohmmeter, 12 Vdc test lamp or 110 Vac test lamp.

Test should indicate no circuit between slip rings and ground. Place test leads on slip ring edges to avoid arcing on brush contact surfaces.



1.	Rear Inner Race
2.	Pole Fingers
3.	Slip Rings

Figure 126: Rotor Inspection and Testing

Slip Ring Condition

Clean brush contact surfaces with fine crocus cloth, wipe dust and residue away. Visually inspect wear area. If surfaces show signs of extreme wear, replace the slip ring assembly.

Rotor Shaft and Body

Inspect for the following:

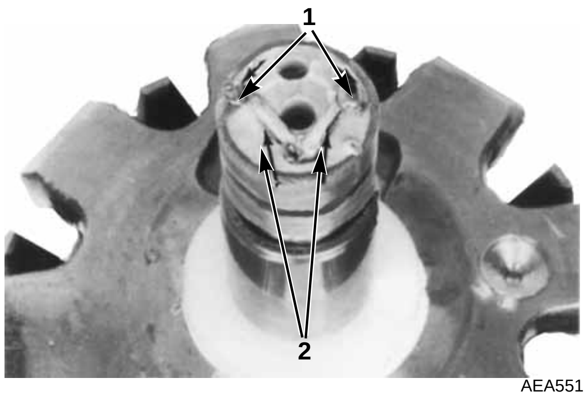
1. Stripped shaft threads.
2. Worn key slot.
3. Worn bearing surface.
4. Scuffed pole fingers.
5. Worn inner race.
6. Check rotor mechanical dimensions.

With the exception of item 5, replace rotor if any of the above defects are noted.

NOTE: An inner race and slip rings are included as part of a new replacement rotor assembly.

Slip Ring Removal

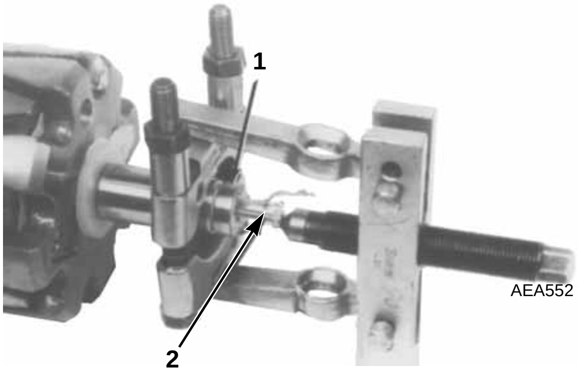
1. Unsolder the rotor coil leads from the slip ring terminals, and carefully unwind the ends of the rotor coil leads.



1.	Slip Ring Terminals
2.	Rotor Leads

Figure 127: Unsolder the Rotor Leads from the Slip Ring Terminals

2. Install a cap screw or appropriate sized driver in the hole at the end of the slip rings. The cap screw or driver must be of sufficient length to allow the slip rings to clear the end of the rotor shaft.
3. Use a puller to remove the slip rings from the rotor shaft.

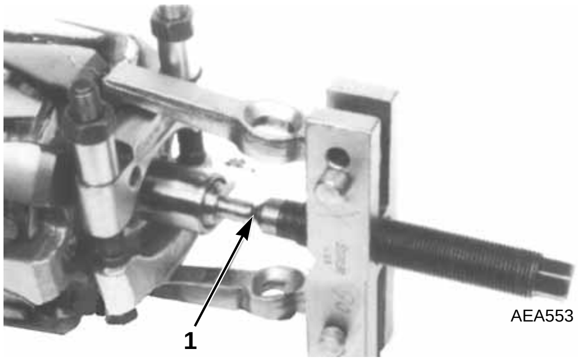


1.	Slip Ring Assembly
2.	Capscrew

Figure 128: Remove Slip Rings from Rotor Shaft

Inner Race Removal

Use a bearing puller to remove the bearing. Place a flatwasher over the shaft end to protect rotor shaft from possible tool damage.

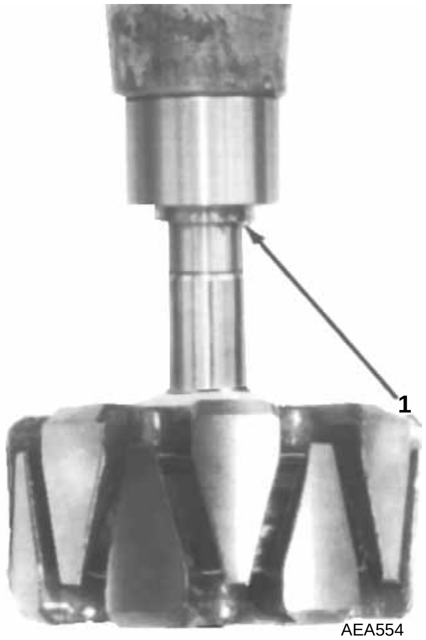


1.	Install a Flatwasher Between the Rotor Shaft and Puller Tool

Figure 129: Inner Race Removal

Inner Race Installation

1. Support the pulley end of the rotor on blocks placed on an arbor press.
2. Place the inner race over the shaft end and ensure the rotor leads are clear of work area.
3. Use a bearing driver that contacts only the inner bearing race. Press the bearing on the shaft until the inner race contacts the shoulder.



1.	Use a Driver that Contacts Only the Inner Bearing Race

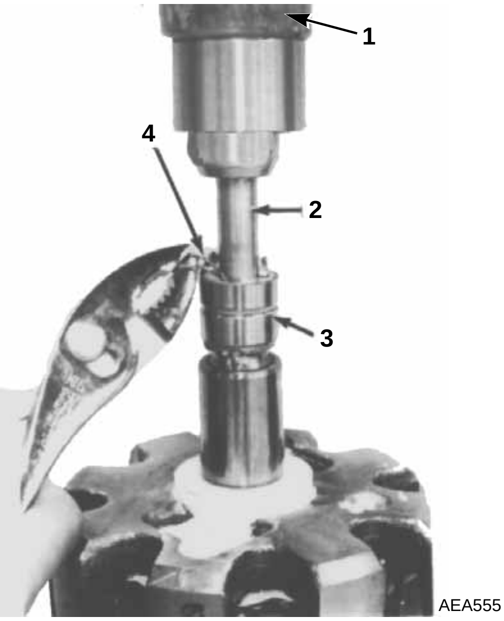
Figure 130: Inner Race Installation

Slip Ring Installation

1. Guide both rotor leads through a single square passage in the slip ring hub.

   NOTE: Be sure to stop the press immediately when the slip rings reach their final position. Otherwise damage to the ceramic hub may occur.

2. Maintain alignment of the rotor leads and the passage and press the slip rings on the shaft.



1.	Press
2.	Driver
3.	Slip Rings
4.	Guide Rotor Leads Through the Passage in the Slip Ring Hub

Figure 131: Slip Ring Installation

3. Install the cap screw and lockwasher. Torque the cap screw to 45 ft-lb (61 N•m).

4. Wrap leads around slip ring terminals and solder with rosin core solder. *Do not* overheat. Use a synthetic seal such as GE Silicon Rubber to secure the wires to the end of the rotor.

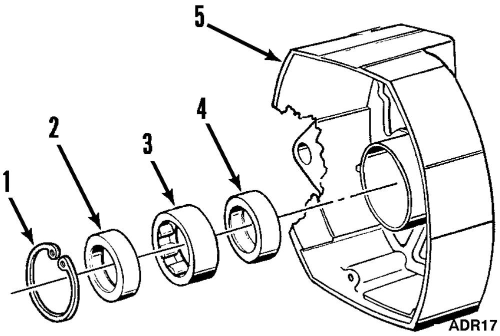
5. Ensure a short circuit or ground did not develop during repair by retesting the electrical circuit.

Rear Housing and Seal Installation

1. Place the rear housing in an arbor press.

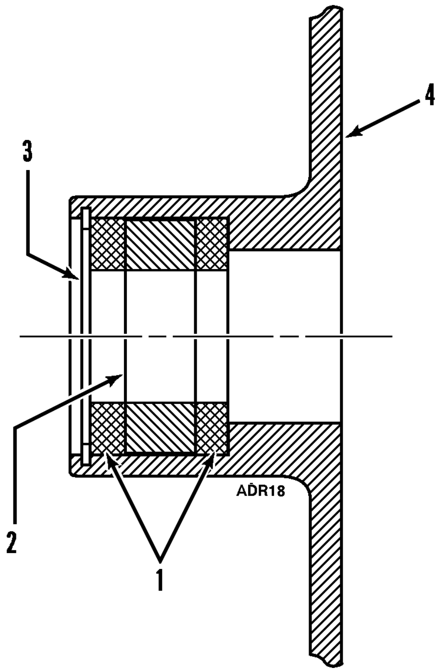
   NOTE: The rear bearing/seal assembly has been changed on the 88C series alternators to provide a positive retention of the bearing and seal in the housing. Refer to the following drawings.

2. Apply a light coating of grease to all surfaces of the grease seals.



1.	"C" Ring	4.	Rear Seal
2.	Forward Seal	5.	Rear Housing
3.	Bearing		

Figure 132: Disassembled View



1.	Seals	3.	Retaining Ring
2.	Bearing	4.	Housing

Figure 133: Side View

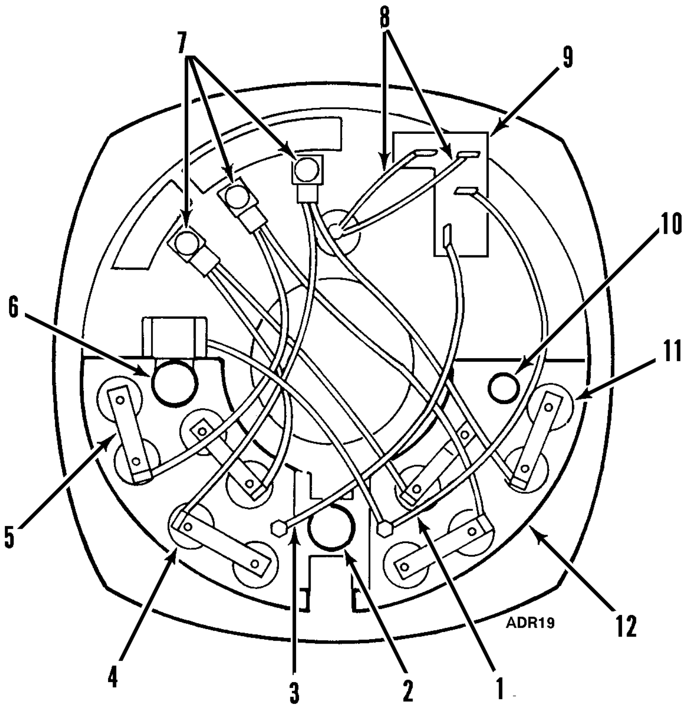
NOTE: For alternator parts consult the unit's parts manual.

3. Install the rear seal in the housing with a driver small enough to pass through the bearing bore. Ensure the metallic side of the seal faces away from the bearing.
4. Pack the cavity between the rear seal and bearing 2/3 full of grease and install the rear bearing.
5. Pack the cavity between the forward seal and bearing 2/3 full of grease. Install forward seal. Ensure the metallic side of the seal faces away from the bearing.
6. The "C" ring, that is included with the housing, is then inserted into the housing groove using an appropriate snap ring tool. Ensure the retainer ring is fully seated in the housing groove.

Assembling Rectifier Diodes

Pay close attention to the arrangement of rectifier diode heat sinks and insulators to assure correct installation. Note that the negative output stud is a metal to metal contact with the negative rectifier heat sink. The positive output stud is also in metal to metal contact with the positive output heat sink. The stud of the indicator light terminal is insulated from both rectifier heat sinks but does make contact with the heat sink of the regulator diode assembly.

1. Assemble insulating washers over positive and negative output studs, and install this rectifier assembly into the rear housing.
2. Temporarily secure assembly in place. Place a 5/16 in. flatwasher and nut over output stud and finger tighten to hold assembly in the housing.



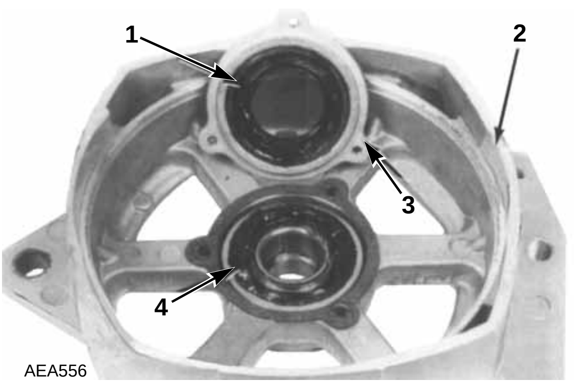
1.	Capacitor Lead	7.	AC Terminals
2.	Positive Output Terminal	8.	Brush Leads
3.	Terminal Board Lead	9.	Regulator Correcting Panel
4.	Negative Diode Assembly	10.	Indicator Lamp Terminal
5.	Connector (6 Used)	11.	Diode (12 Used)
6.	Negative Output Terminal	12.	Positive Diode Assembly

Figure 134: Rectifier Diode Assembly

3. Assemble square insulator in matching opening in positive rectifier heat sink. Install terminal plate lead with 1/4 in. ring terminal, the #10 carriage bolt and regulator diode assembly over the square insulator. Push the carriage bolt through the heat sink and place an insulating washer between the heat sink and rear housing.
4. Remove 5/16 in. hex and flatwasher, install correct assembly fasteners, and carefully tighten to secure assemblies in housing.
5. Assemble internal leads to terminals, installing the terminal board negative lead last. Dress leads down, and secure with wire-wrap to avoid contact with the rotor assembly.

Install Seals, Bearing and Retainer in Front Housing

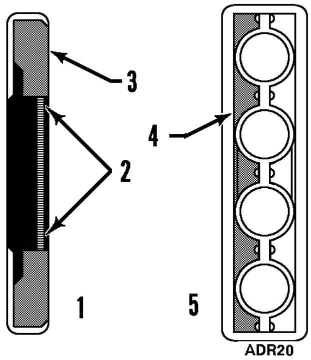
1. Place the front housing, exterior side down, on the bed of an arbor press.
2. Apply a light grease coating to all surfaces of the seals. Using the correct driver, install a seal in housing with grease cavity facing up. Press on the outer edge of the seal only until the seal bottoms in the housing.



1.	Seal
2.	Front Housing
3.	Front Bearing Retainer
4.	Seal and Bearing (Already Installed)

Figure 135: Install the Front Housing Seal

3. Install a seal in bearing retainer with grease cavity facing away from the retainer. Pack both seal cavities 2/3 full of grease.



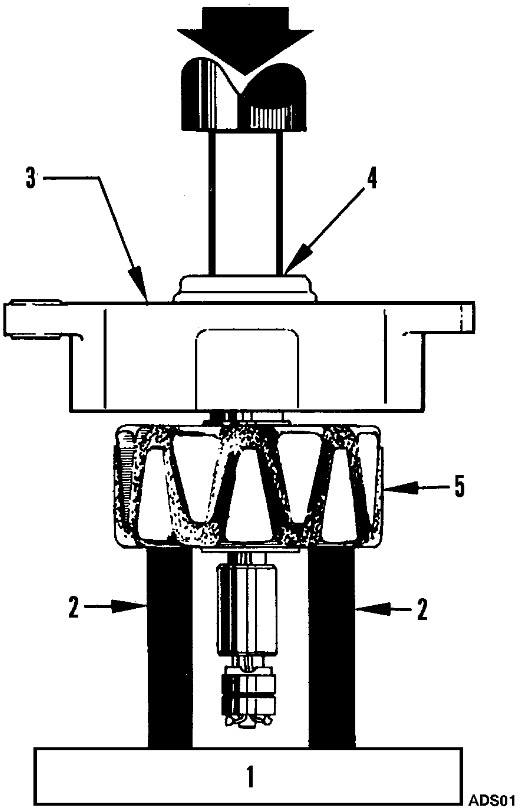
1.	Seal
2.	Pack Lip Area
3.	Pack Inside Cavity
4.	Pack One Half Side of Bearing
5.	Bearing

Figure 136: Pack Bearing With Grease

4. Pack one side of the bearing with grease and install bearing, grease side down, into the housing. Use a driver that contacts only the outer bearing race, and press bearing into housing until it contacts the seal.
5. Assemble retainer gasket and retainer onto the front housing. Apply Loctite 290 or 242 medium strength retaining compound to threads of mounting screws, and install the screws. Tighten the screws to 30 to 35 in-lb (3.7 to 3.9 N•m).

Assemble Front Housing to Rotor

1. Using two steel blocks for support, place the rotor assembly on the bed of an arbor press.
2. Assemble the front housing over the rotor shaft, and press housing down until the bearing contacts the rotor shoulder. Use a driver sleeve that contacts only the inner bearing race.



1.	Bed of Arbor Press
2.	Steel Block
3.	Front Housing Assembly
4.	Driver Sleeve Contacts Inner Bearing Race Only
5.	Rotor

Figure 137: Assemble Front Housing to Rotor

Install Fan and Pulley

1. Install the shaft key and mount the fan and pulley over the shaft
2. Install the flatwasher and nut onto the shaft finger tight. Hold the pulley using a spanner wrench, and tighten the pulley nut to 50 to 60 ft-lb (67.8 to 81.3 N•m).

Assemble Stator to Rear Housing

1. Straighten the stator leads and pass through openings in the rear housing while assembling stator to the housing.
2. Connect the stator leads to the ac terminals, install fasteners and tighten.

Assemble Housings

1. Making sure the housings are in alignment with one another, carefully assemble the housings together to avoid stator and slip ring damage.
2. Add Loctite 242 to threads of through bolts, install bolts and tighten evenly to 45 to 53 in-lb (5 to 6 N•m).

Install Voltage Regulator and Brush Assembly

1. Install voltage regulator connecting panel on terminal studs, mount lockwashers and hex nuts and tighten.
2. Apply Loctite 242 to mounting screw threads and install the regulator.
3. Assemble the brush assembly to the unit and secure with the mounting screws.
4. Connect the yellow and green brush terminal leads, install the cover and secure with the mounting screws.
5. Spin the rotor by hand to assure free rotation of the rotor bearings.

Evaluation Tests

The following will determine the current and voltage producing capability of the repaired alternator prior to installation. The field rheostat is used to control alternator field current.

Mount the alternator in a test fixture capable of providing 4,000 alternator rpm. Select required battery voltage and circuit polarity. Connect test fixture leads and instruments to alternator terminals as shown. Place field rheostat in maximum resistance position.

Turn drive motor On, adjust to 4,000 alternator rpm. Slowly reduce field rheostat resistance. Alternator should develop a charge. Continue reducing resistance until alternator reaches rated output in amperes. *Do not* operate alternator any longer than necessary in this manner because of lack of voltage control. If the alternator delivers its rated output, terminate the test.

Air Conditioning Diagnosis and Analysis

Analysis Overview

Servicing a system consists of checking system pressures and temperatures while the bus engine is running at high idle, typically about 1000 engine rpm. When servicing a system, you should be aware of two main factors in operation:

- Running at high idle operates the system in the lower half of its normal operating range. Therefore, when testing a system, be mindful about conditions that could occur at operating extremes. Otherwise, you may not find the problem.
- Systems vary greatly. You should be familiar with the system you are working with and be aware of differences among systems. Examples of possible differences are:
  - Two speed condenser fans
  - Two and three speed evaporator fans
  - Reheat or cycling clutch modes
  - Thermostats adjustable from 62 F to 82 F (17 C to 28 C).
  - Electronic thermostats with limited or no adjustment possible
  - Systems with or without EPR valves
  - Compressors configured in any of the following ways:
    - No unloaders
    - With unloaders
    - Different displacements and sizes
- Smaller systems (such as the ShuttleAIRE™) for small buses) have different characteristics and can be more sensitive or less sensitive to conditions such as charge level than other units.

Diagnosis Procedure

1. Identify components in the system. To identify components, see the above list, your unit service manual, and the unit itself.
2. Verify that the bus has the proper air flow throughout the system. The air conditioning ducts must be free from obstructions.
3. Determine that each component is working correctly.
   - Are the evaporator fans running and in the proper range of speed?
   - Do the inlet air filters require cleaning?
   - Is the condenser coil clean? Coils with top air inlets in particular can fill with leaves and other debris.
   - Are the condenser fans running and at proper speed?
   - What is the unit thermostat setpoint and what is the interior temperature of the bus?
   - Is there refrigerant in the system?
   - If the system is running, what is the refrigerant charge level? (Check the sight glasses closely—use a flashlight.)
   - If the system does not function, is power present at the main power studs on the unit? Is there power to the unit controls?
   - What are the compressor discharge and suction pressures while the unit is operating? (See the table on the page 160.)

Typical Operating Pressures

The following table shows typical operating pressures when the system is operating at normal ambient temperatures in the High Idle mode (engine speed 800 to 1000 rpm and X426, X430, or X640 compressor speed 900 to 1500 rpm).

EPR	Refr.	Discharge Pressure[1]	Suction Pressure[2]
With EPR	R-22/ R-407C	190-270 psig (1310-1862 kPa) (13.4-19.0 kg/cm^2) (13.1-18.7 bar)	20-75 psig (138-517 kPa) (1.4-5.3 kg/cm^2) (1.4-5.2 bar)
Without EPR	R-22/ R-407C	190-270 psig (1310-1862 kPa) (13.4-19.0 kg/cm^2) (13.1-18.7 bar)	50-80 psig (345-552 kPa) (3.5-5.6 kg/cm^2) (3.4-5.5 bar)
With EPR	R-134a	100-175 psig (689-1207 kPa) (7.0-12.3 kg/cm^2) (6.9-12.1 bar)	10-45 psig (69-310 kPa) (0.7-3.2 kg/cm^2) (0.7-3.1 bar)
Without EPR	R-134a	120-175 psig (827-1207 kPa) (8.4-12.3 kg/cm^2) (8.3-12.1 bar)	30-50 psig (207-345 kPa) (2.1-3.5 kg/cm^2) (2.1-3.4 bar)

[1] When checking the refrigerant charge, the discharge pressure must be above 250 psig (1724 kPa) for R-22 and R-407C systems, or above 150 psig (1034 kPa) for R-134a systems. Block the airflow to the condenser coil if needed, to raise pressure.

WARNING! Do NOT turn off the condenser fans to raise head pressure.

[2] Suction pressure will vary greatly depending on unit evaporator coil load (bus interior temperature). For best results, allow the unit to reach the thermostat setpoint (normally set at 70 ± 3 F [17 ± 2 C]).

System Analysis

Failure of the system to stay within normal ranges can have several causes. Causes and solutions of these problems are described in the System Analysis Table on the following pages.

System Analysis: Causes for Failure to Stay Within Temperature Range

Cause	Solution(s)
Excessive load • Frequent stops • Long loading stops • Open or loose windows and doors • Loose body panels • Poor insulation • Too many passengers	1. Perform structural maintenance inspections regularly. 2. Repair leaks. See the Structural Maintenance chapter in this manual.
Blocked filter or dirt on coils • Dust and lint buildup on evaporator return air filter • Dirt buildup on condenser or evaporator coils	1. Clean the evaporator air filter by reverse flushing with warm, soapy water. Recoat the filter with RP Filter Coat, TK# 203-334 or equivalent. 2. Flush the coils with warm soapy water at medium pressure. See the Structural Maintenance chapter in this manual.
Incorrect belt tension • Loose: compressor will not operate at the correct speed and the belts can slip, damaging the clutch and pulley. • Tight: Create a load on the bearings and clutch, causing premature wear and possible pulley breakage.	Adjust per the belt specification. For belt specification, see the Specifications chapter in this manual or bus or belt manufacturer information.
Excessive oil in circulation • Restriction in filter-drier causing low suction pressure • Restriction in expansion valve causing low suction pressure	Remove excess oil. See the “Removing Excess Oil” procedure in this manual. ***NOTE: For accurate results, check the oil when the compressor is warm and the system is operating in normal range.***
Restriction of liquid line • Low suction pressure at high speeds • Temperature change at point of restriction • Flashing of refrigerant is occurring	1. Check the filter-drier. 2. Check the in-line service valves. 3. Check the expansion valve inlet screen. 4. Check for yellow sight glass, indicating a “wet” system. 5. See the procedures in this manual for replacing the filter-drier, in-line service valves, and expansion valve, and for checking for moisture content.
Low refrigerant charge • Low suction pressure • Hot liquid line • Warm suction line • Hotter than normal compressor discharge temperatures • Decreased cooling capacity ***NOTE: An EPR valve will amplify these conditions.***	Charge the system. See the Charging procedures in the Refrigeration Maintenance chapter in this manual.
High refrigerant charge • High compressor discharge pressure • Malfunction of unloaders	Evacuate and recharge the system. See the Evacuation and Charging procedures in this manual.
Air in refrigeration system • Dark oil • High compressor discharge temperatures • High compressor discharge pressure • False refrigerant level indication (air trapped in receiver tank) • Erratic action of expansion valve (possibly hissing noises at expansion valve)	1. Test for air in the system. See “Removing Contaminants” in this manual. 2. Evacuate and recharge the system See the Evacuation and Charging procedures in this manual.

System Analysis: Causes for Failure to Stay Within Temperature Range

Cause	Solution(s)
Expansion valve set incorrectly 1. Low superheat: • Flooding at the compressor • High suction pressures • Decreased cooling capacity 2. High superheat: • Warm suction line temperature • Low suction pressures • Decreased cooling capacity	Adjust the expansion valve. See the Expansion Valve Adjustment (Superheat) section in this manual. ***NOTE: The expansion valve is preset and should not require adjustment. Verify that the expansion valve is the problem by rechecking all other components before adjusting.***
Expansion valve malfunctioning 1. Valve sticks open due to dirt or ice in the valve: • Excessive sweat on suction line • High compressor oil level, indicated by sump being cool to the touch • Refrigerant charge level appears low 2. Valve sticks closed due to loss of charge in sensor bulb: • High discharge pressure • Low suction pressure • No cooling • Warm suction line and coil • Low oil level in compressor 3. Valve operation is erratic: • Low system charge level • Air in the system • Moisture frozen in valve • Dirt in valve inlet screen • Block in liquid line before expansion valve • Sensing bulb not in good contact with suction line	1. Verify that the expansion valve is the cause by rechecking all other possible causes. (The expansion valve rarely fails.) 2. If the expansion valve is bad, replace it. See the Expansion Valve Removal and Installation section in this manual.
Plugged filter-drier • Restriction of refrigerant at filter-drier • Outlet line cooler than inlet line • Frost or sweating on outlet line • Particles in the system caused by breakdown of filter-drier (extreme cases only)	1. To prevent plugging, perform routine maintenance inspection of the filter-drier. 2. To replace, see the Filter-Drier Removal and Installation section in this manual.

Troubleshooting Compressor Suction and Discharge Pressures

The following tables describe high and low suction and discharge pressure symptoms for systems with and without EPR valves.

Troubleshooting Systems With EPR Valves

<table>
<tr><th></th><th colspan="2">A. Compressor Suction Pressure</th></tr>
<tr><th>Suction Line Condition</th><th>Low</th><th>High</th></tr>
<tr><td>Frosty/Cold</td><td>1. Normal operation: Bus is controlling on thermostat with light load and at higher speeds
2. EPR valve set too high
3. Airflow through evaporator is restricted:
• Air filter dirty
• Evaporator coil dirty
• Plugged evaporator filter
4. Evaporator blower motor problem
• Electrical malfunction’
• Fan blades broken or incorrectly adjusted
5. EPR valve set too low: Coil frosted up</td><td>1. Normal operation: Heavy load on the evaporator
2. Expansion valve malfunction:
• Sensor bulb making poor contact with suction line
• Needle eroded—valve can not control properly
• Adjustment has been incorrectly set (low superheat)
3. Overcharge of refrigerant</td></tr>
<tr><td>Dry/Warm</td><td>1. Low refrigerant charge
2. Restriction in liquid line
3. Expansion valve malfunction:
• Inlet screen plugged
• Sensor bulb lost charge
• Adjustment has been incorrectly set (high superheat)
4. Too much oil in system
5. Restricted suction line
6. Airflow through condenser coil too cold</td><td>1. Compressor malfunction:
• Leaking discharge valves
• Leaking/Broken piston reeds
• Worn piston/sleeve assembly (blow-by)
2. Heavy load on evaporator:
3. Compressor turning too slowly
4. Belt or clutch slipping</td></tr>
<tr><td></td><td colspan="2">B. Compressor Discharge Pressure</td></tr>
<tr><td></td><td>Low</td><td>High</td></tr>
<tr><td>Suction Line Condition Does Not Apply</td><td>1. Low refrigerant charge
2. Light load on evaporator:
• Bus interior temperature cool
• Dirty air filters
• EPR set too low—coil frosted up
• Airflow through evaporator is low for some reason
3. EPR valve incorrectly adjusted—too high causing low refrigerant flow
4. Compressor speed low
5. Airflow through condenser is cold
6. Belt or clutch slipping
7. Compressor malfunction:
• Leaking discharge valves
• Leaking/Broken piston reeds
• Worn piston/sleeve assembly (blow-by)</td><td>1. Airflow into condenser is low or restricted
• Dirty coil
• Debris in the coil inlet
2. Condenser fan or motor problem:
• Motor running on low speed
• Motor not running—electrical malfunction
• Fan blades broken or incorrectly adjusted
3. Restriction on high side of the system: In-line service valve partially closed
4. Non-condensables in the system: Air, nitrogen, and other gases (?)
5. Hot air entering the condenser coil
6. Overcharge of refrigerant</td></tr>
</table>

Troubleshooting Systems Without EPR Valves

	A. Compressor Suction Pressure	
Suction Line Condition	**Low**	**High**
Frosty/Cold	1. Normal operation: Bus is controlling on thermostat with light load and/or at higher speeds 2. Airflow through evaporator is restricted: • Air filter dirty • Evaporator coil dirty • Plugged evaporator filter 3. Evaporator blower motor problem • Electrical malfunction' • Fan blades broken or incorrectly adjusted	1. Normal operation: Heavy load on the evaporator 2. Expansion valve malfunction: • Feeler bulb making poor contact with suction line • Needle eroded—valve can not control properly • Adjustment has been incorrectly set (low superheat) 3. Overcharge of refrigerant
Dry/Warm	1. Low refrigerant charge 2. Restriction in liquid liner 3. Expansion valve malfunction: • Inlet screen plugged • Sensor bulb lost charge • Adjustment has been incorrectly set (high superheat) 4. Too much oil in system 5. Restricted suction line 6. Airflow through condenser coil too cold	1. Compressor malfunction: • Leaking discharge valves • Leaking/Broken piston reeds • Worn piston/sleeve assembly (blow-by) 2. Heavy load on evaporator: 3. Compressor turning too slowly 4. Belt or clutch slipping
	B. Compressor Discharge Pressure	
	Low	**High**
Suction Line Condition Does Not Apply	1. Low refrigerant charge 2. Compressor speed low 3. Airflow through condenser is cold 4. Restrictions to refrigerant flow: • Liquid line restricted • Suction line blockage 5. Belt or clutch slipping 6. Compressor malfunction: • Leaking discharge valves • Leaking/Broken piston reeds • Worn piston/sleeve assembly (blow-by)	1. Airflow into condenser is low or restricted • Dirty coil • Debris in the coil inlet 2. Condenser fan or motor problem: • Motor running on low speed • Motor not running—electrical malfunction • Fan blades broken or incorrectly adjusted 3. Restriction on high side of the system: In-line service valve partially closed 4. Non-condensables in the system: Air, nitrogen, and other gases (?) 5. Hot air entering the condenser coil 6. Overcharge of refrigerant

Temperature-Pressure Charts

Temperature Pressure Relationship Vapor Pressure, psig				
F	C	R-22	R-134a	R-407C
-50	-45.6	6.1	18.5	11.0
-48	-44.4	4.8	17.4	9.9
-46	-43.3	3.4	16.9	8.7
-44	-42.2	2.7	16.2	7.5
-42	-41.1	2.0	15.4	6.2
-40	-40.0	0.5	14.7	4.8
-38	-38.9	1.3	13.7	3.4
-36	-37.8	2.2	12.7	1.9
-34	-36.7	3.0	11.7	0.3
-32	-35.6	3.9	10.7	0.6
-30	-34.4	4.8	9.8	1.5
-28	-33.3	5.8	8.6	2.3
-26	-32.2	6.9	7.4	3.2
-24	-31.1	7.9	6.2	4.2
-22	-30.0	9.0	5.0	5.2
-20	-28.9	10.1	3.8	6.2
-18	-27.8	11.3	2.2	7.2
-16	-26.7	12.6	0.7	8.3
-14	-25.6	13.8	0.3	9.5
-12	-24.4	15.1	1.0	10.7
-10	-23.3	16.4	1.8	11.9
-8	-22.2	17.9	2.7	13.2
-6	-21.1	19.4	3.6	14.5
-4	-20.0	20.9	4.5	15.9
-2	-18.9	22.4	5.4	17.4
0	-17.8	23.9	6.3	18.9
2	-16.7	25.6	7.3	20.4
4	-15.6	27.4	8.4	22.0
6	-14.4	29.1	9.4	23.7
8	-13.3	30.9	10.5	25.4
10	-12.2	32.7	11.6	27.1
12	-11.1	34.7	12.8	29.0
14	-10.0	36.8	14.1	30.8
16	-8.9	38.8	15.4	32.8
18	-7.8	40.9	16.7	34.8
20	-6.7	43.0	18.0	36.9
22	-5.6	45.3	19.5	39.1
24	-4.4	47.7	21.0	41.3
26	-3.3	50.0	22.5	43.6
28	-2.2	52.4	24.0	45.9
30	-1.1	54.8	25.6	48.4
32	0.0	57.5	27.3	50.9
34	1.1	60.2	29.1	53.5
36	2.2	63.0	30.9	56.1
38	3.3	65.7	32.7	58.9
40	4.4	68.5	34.5	61.7
42	5.6	71.6	36.5	64.6
44	6.7	74.7	38.6	67.6
46	7.8	77.8	40.7	70.7
48	8.9	80.9	42.8	73.8
50	10.0	84.0	44.9	77.1

Temperature Pressure Relationship Vapor Pressure, psig				
F	C	R-22	R-134a	R-407C
52	11.1	87.5	47.3	80.4
54	12.2	91.0	49.7	83.9
56	13.3	94.5	52.1	87.4
58	14.4	98.0	54.5	91.0
60	15.6	101.6	56.9	94.8
62	16.7	105.5	59.6	98.6
64	17.8	109.5	62.4	102.5
66	18.9	113.4	65.1	106.5
68	20.0	117.4	67.9	110.7
70	21.1	121.4	70.7	114.9
72	22.2	125.8	73.8	119.3
74	23.3	130.2	76.9	123.7
76	24.4	134.7	80.1	128.3
78	25.6	139.1	83.2	133.0
80	26.7	143.6	86.4	137.8
82	27.8	148.5	89.9	142.7
84	28.9	153.5	93.5	147.8
86	30.0	158.4	97.0	153.0
88	31.1	163.4	100.6	158.3
90	32.2	168.4	104.2	163.7
92	33.3	173.9	108.2	169.2
94	34.4	179.4	112.2	174.9
96	35.6	184.9	116.2	180.7
98	36.7	190.4	120.2	186.7
100	37.8	195.9	124.3	192.8
102	38.9	201.9	128.9	199.0
104	40.0	208.0	133.3	205.3
106	41.1	214.1	137.8	211.9
108	42.2	220.2	142.3	218.5
110	43.3	226.3	146.8	225.3
112	44.4	233.0	151.8	232.3
114	45.6	239.7	156.8	239.4
116	46.7	246.4	161.8	246.7
118	47.8	253.1	166.8	254.1
120	48.9	259.9	171.9	261.7
122	50.0	267.2	177.4	269.4
124	51.1	274.6	183.0	277.4
126	52.2	282.0	188.6	285.5
128	53.3	289.4	194.2	293.7
130	54.4	296.8	199.8	302.2
132	55.6	304.8	205.9	310.8
134	56.7	312.9	212.0	319.6
136	57.8	321.0	218.2	328.6
138	58.9	329.1	224.3	337.7
140	60.0	337.2	230.5	347.1
142	61.1	346.0	237.2	356.7
144	62.2	354.9	244.0	366.4
146	63.3	363.7	250.8	376.4
148	64.4	372.6	257.6	386.5
150	65.6	381.5	264.4	396.9

Shaded Numerals — Inches HG Below 1 ATM

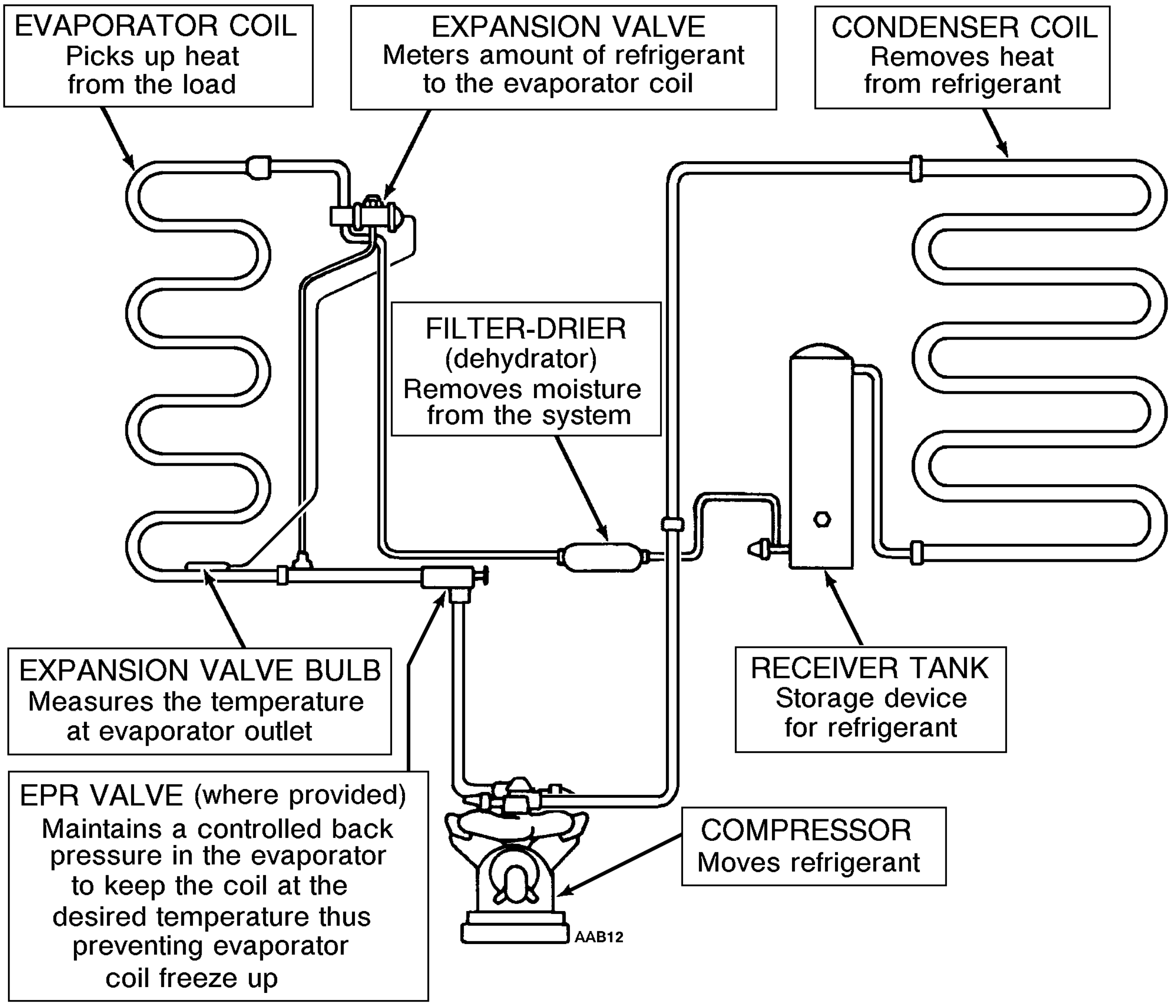
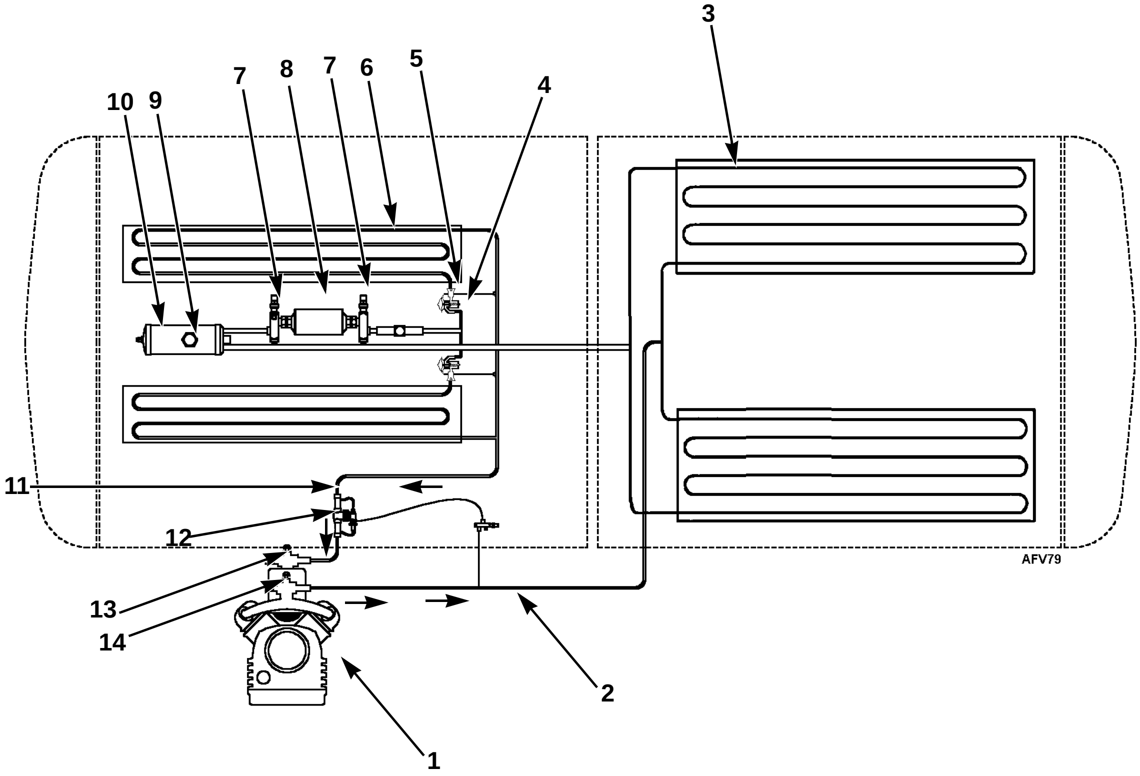


Figure 138: Typical Refrigeration Diagram with Description of Operation



1.	Compressor	8.	Filter-Drier
2.	Discharge Line	9.	Receiver Tank Sight Glass
3.	Condenser Coil	10.	Receiver Tank
4.	Expansion Valve	11.	Suction Line
5.	Distributor	12.	EPR Valve
6.	Evaporator Coil	13.	LPCO Switch
7.	Filter-Drier Shutoff Valve	14.	HPCO Switch

Figure 139: LRT HP/SP System Diagram

Index

Wiring and Schematic Diagrams Index

Dwg No.	Drawing Title	Page
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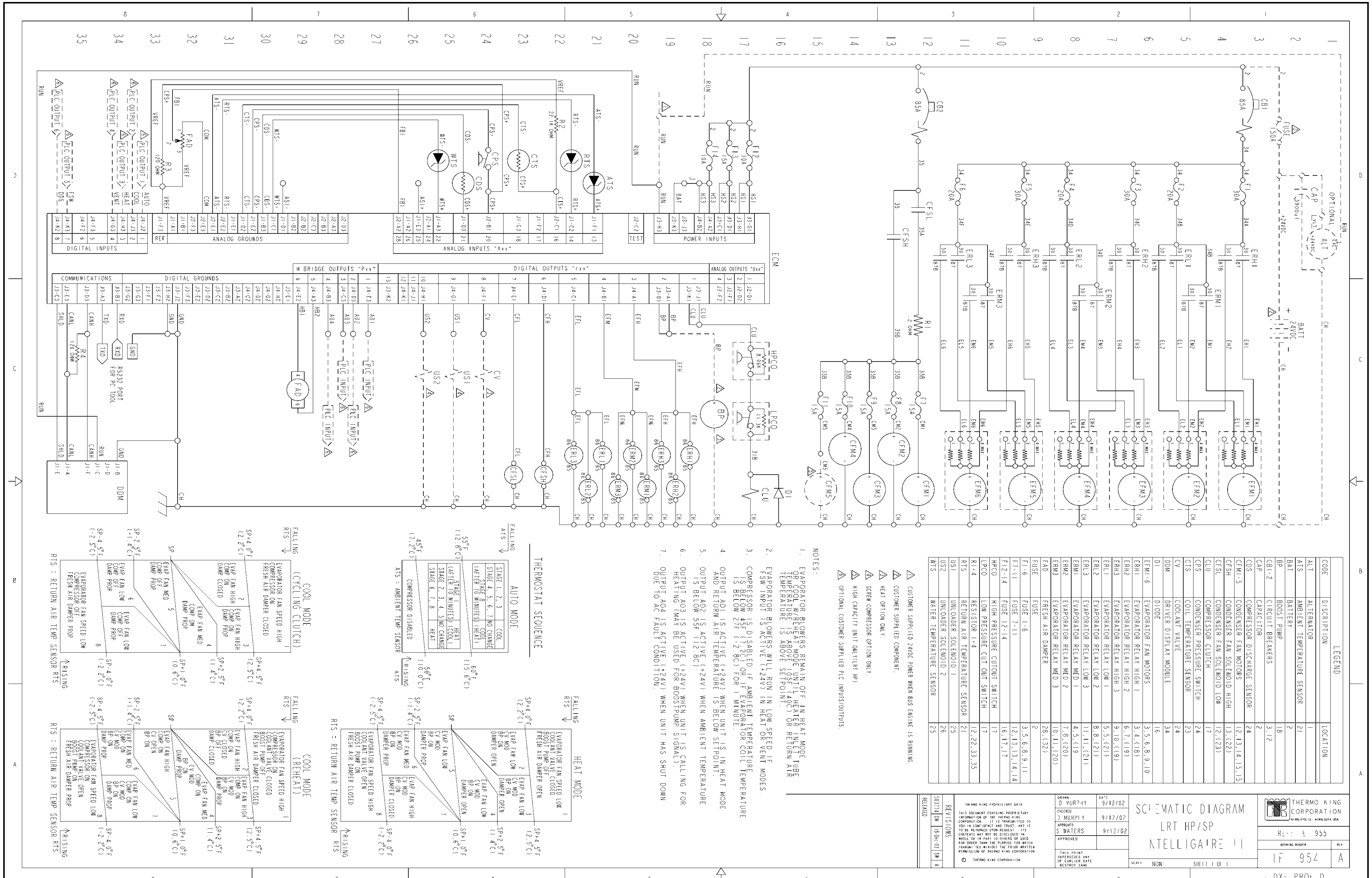
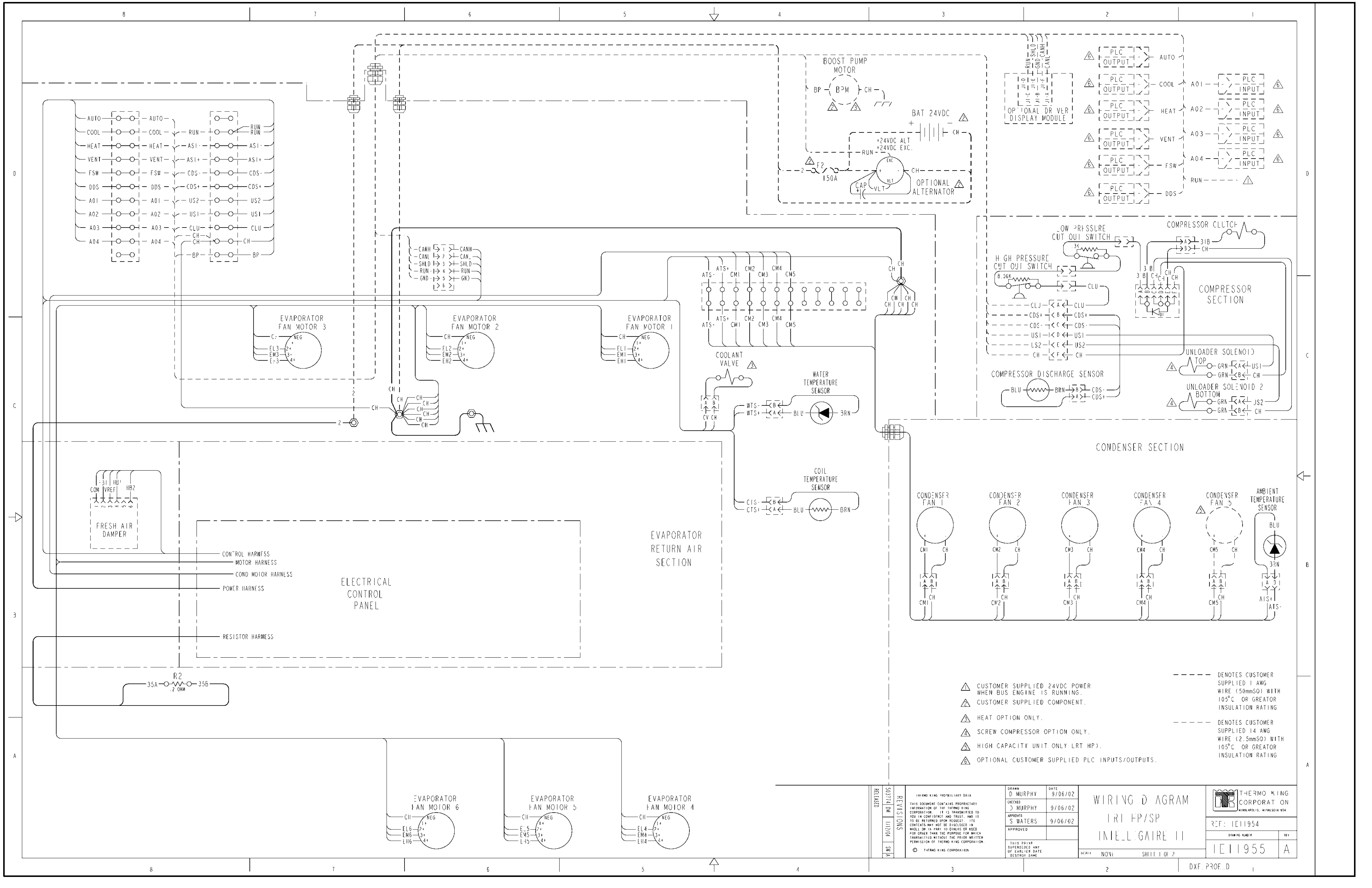
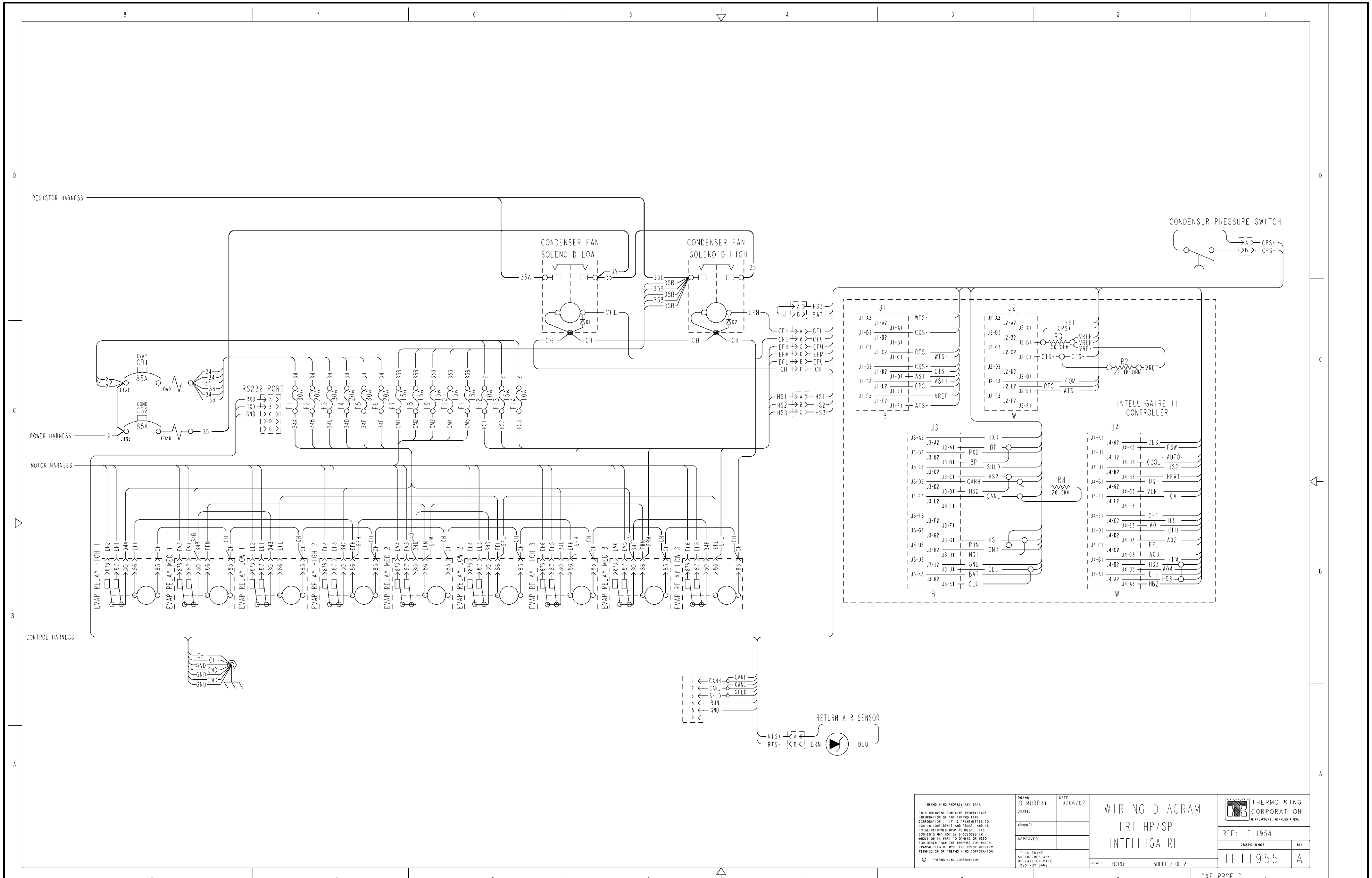
1E11955	Wiring Diagram, LRT HP/SP, IntelligAIRE II	176–177

Schematic Diagram, LRT HP/SP, IntelligAIRE II, page 1 of 1



Wiring Diagram, LRT HP/SP, IntelligAIRE II, page 1 of 2





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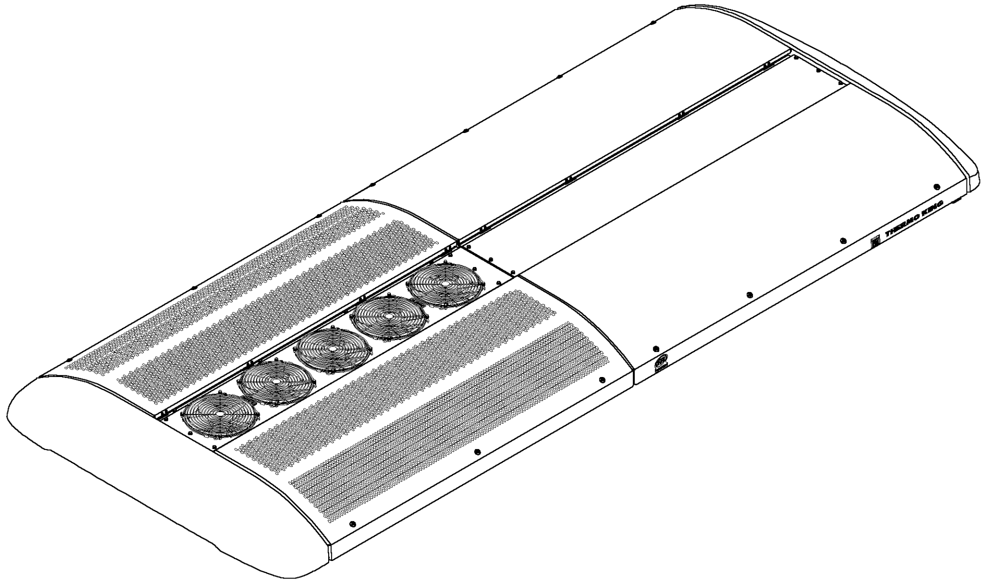

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General Information

Tables of Contents

This Parts Manual contains a numerical table of contents listing each assembly name, its associated Grid number and page number. The numerical table of contents is arranged numerically by Grid number. There are references in a parts list referring to other Grid numbers, the numerical table of contents is arranged to facilitate finding the referenced illustrations. At the rear of this parts manual are two indexes, a numerical and alphabetical. The indexes contain all of the part numbers and descriptions which appear in this manual.

Assemblies and Subassemblies

When parts are indented in the description list, they are preceded with a bullet (•). This indicates that the part(s) is available separately or included in an assembly.

GRID NO. 67D6
SWITCH PANEL ASSEMBLY

REF	PART#	DESCRIPTION	QTY
	45-1239	PANEL - assy, switch	1
1	99-1960	• PANEL	1
	99-6280	• • NAMEPLATE - panel	1
2	33-743	• GASKET	1

For example: the switch panel nameplate (99-6280) is available separately, available as part of the switch panel (99-1960) and with the panel assembly (45-1239).

ABBREVIATIONS The following abbreviations appear in parts manuals

A
AC . . . . alternating current
A/R . . . . as required
accum . . . . . . accumulator
adj . . . . adjusting
al . . . . aluminum
alt. . . . . alternator
A or amp . . . . ampere
assy . . . . assembly

B
bd . . . . board
brg . . . . bearing
brkr . . . . breaker
brkt . . . . bracket

C
C . . . . Celsius
cw . . . . clockwise
ccw . . . . counter-clockwise
cam . . . . camshaft
compr . . . . . . compressor
cond. . . . . condenser
conn. . . . . connecting, connector
cyl . . . . cylinder

D
def . . . . defrost
deg . . . . degree
dehyd. . . . . . . dehydrator
dia . . . . diameter
DC . . . . direct current
disch . . . . discharge
diff . . . . differential

E
EMI . . . . Extended
. . . . Maintenance Interval
EEC. . . . . European Economic Community
eng . . . . engine

E (continued)
evap. . . . . evaporator
exch . . . . exchanger
exp . . . . expansion
ext . . . . external

F
F. . . . . Farenheit
fill . . . . fillister
fi . . . . fuel injection
fl . . . . flare
fpt . . . . female pipe thread
ft . . . . feet
ftg . . . . fitting

H
hex . . . . hexagon
hh . . . . hexagon head
hd . . . . head
hp . . . . horsepower
hsg . . . . housing

I
id . . . . inside diameter
in . . . . inch (2.54 centimeters)
incl . . . . includes
inj . . . . injection
int . . . . internal
int th . . . . internal tooth

L
liq . . . . liquid
lg . . . . long

M
mm . . . . milimeter
mpt . . . . male pipe thread
mod . . . . modulating

N
neg . . . . negative
No. . . . . number
NS . . . . not supplied
NSS . . . . not sold separately

O
os . . . . oversized
od . . . . outside diameter

P
pcb . . . . printed circuit board
pkg . . . . package
ph . . . . phase
pos . . . . positive
psi. . . . . pounds per square inch

R
rad . . . . radiator
rcvr . . . . receiver
ref . . . . reference
reg . . . . regulator
req . . . . required
rpm . . . . revolutions per minute

S
sec . . . . second
sld. . . . . solder
soc hd. . . . . . . socket head
sol. . . . . solenoid
spl. . . . . special
sq . . . . square
ss . . . . stainless steel
std. . . . . standard
stl . . . . steel
suct. . . . . suction
sw . . . . switch

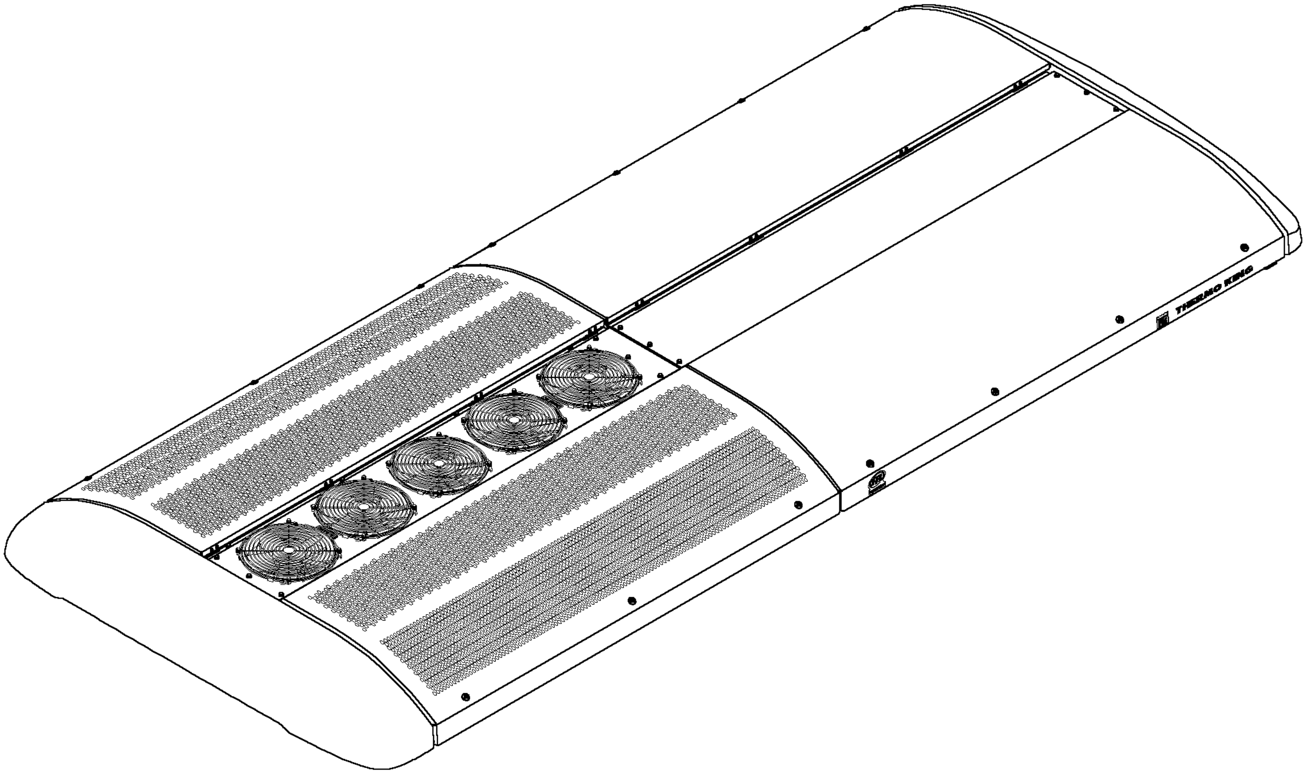
T
term . . . . terminal
temp . . . . temperature
thk. . . . . thick

U
us . . . . undersize

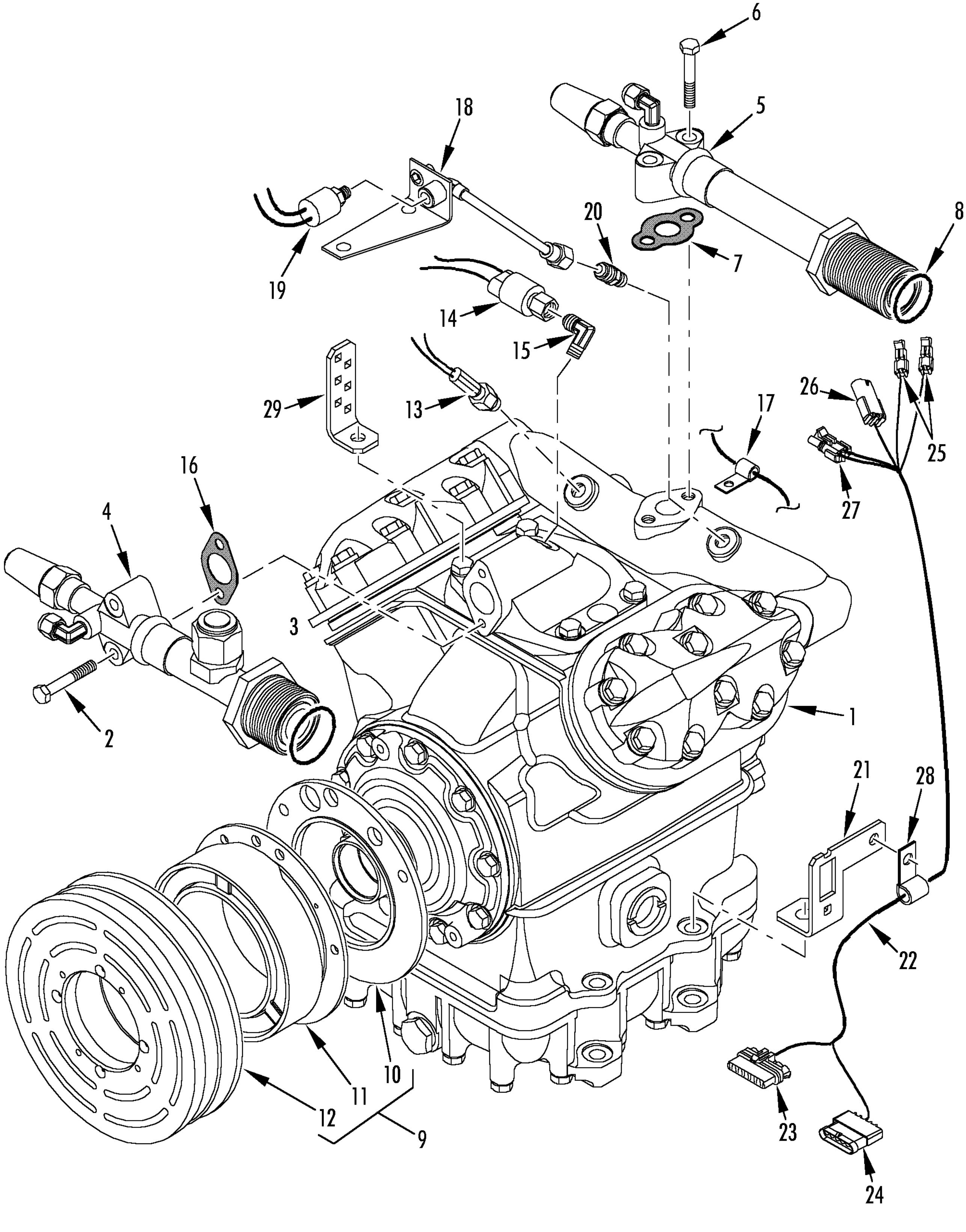
V
vib . . . . vibrasorber

W
W . . . . watt
w/ . . . . with
w/o . . . . without

LRT-HP
Contents



B/M	DESCRIPTION	Date
920401	System - LRT-HP	12/04
099916	Condenser - LRT-HP 7.5 Meter	12/04
006541	Evaporator - HP 7.5 Meter	12/04
720747	Compressor Kit - X430 R22	12/04
800009	Installation Kit	12/04
720777	Return Air Filter Grille Kit	12/04



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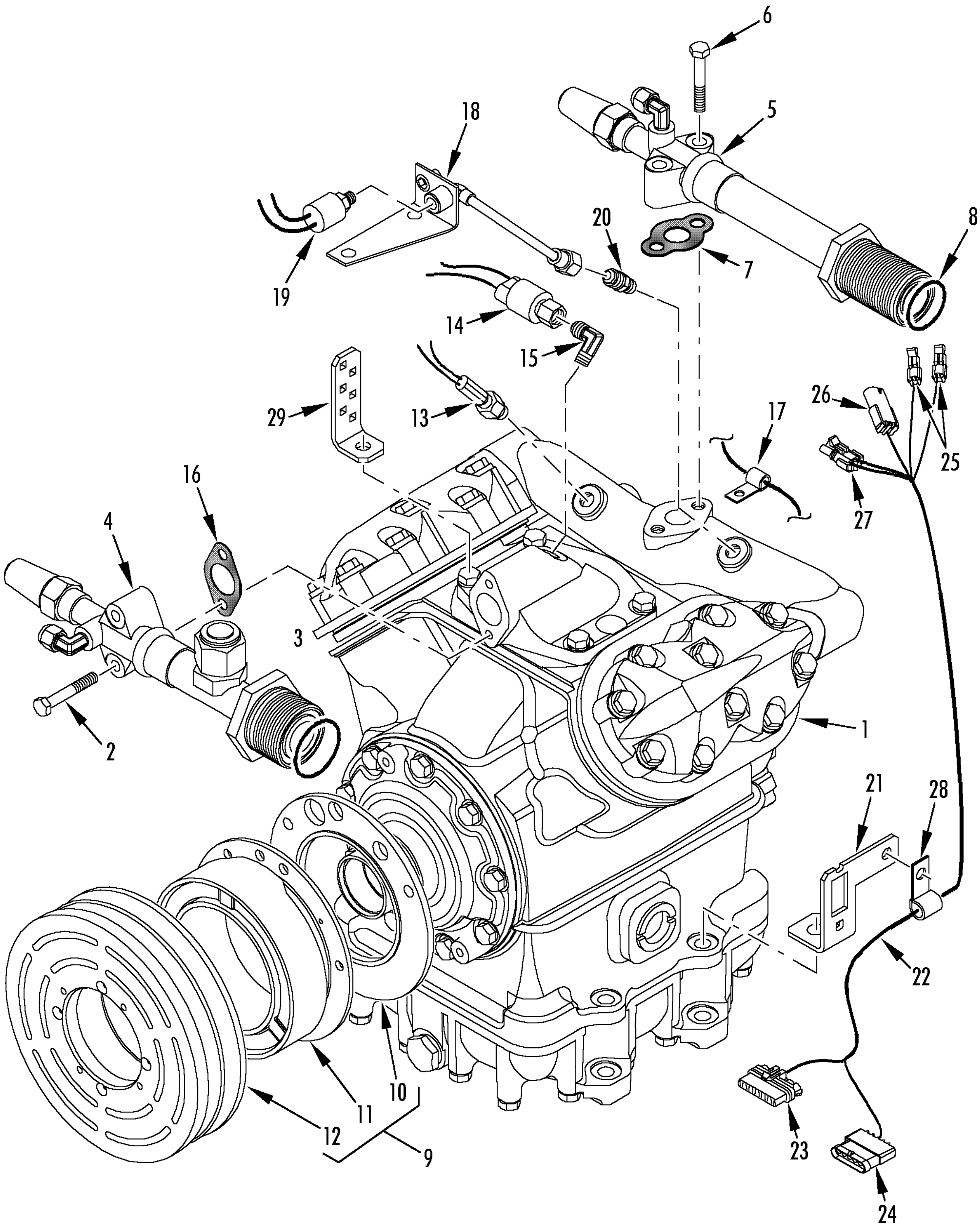
REF	PART#	DESCRIPTION	QTY
1	102-499	COMPRESSOR - X430 (see 135G6)	1
	8102-499	COMPRESSOR - X430 (remanufactured)	1
2	55-6776	SCREW - suction valve	2
	55-6804	WASHER - sealing	2
3	33-1777	O-RING - suction	1
4	61-3071	VALVE - suction (see 197F5)	1
5	61-3070	VALVE - discharge (see 197F6)	1
6	55-201	SCREW - discharge valve	2
	55-895	FLATWASHER	2
7	33-2805	GASKET - discharge valve	1
8	33-2789	WASHER - sealing (discharge)	1
9	NSS	CLUTCH - assembly	1
	107-192	• KIT - clutch drive repair	1
10	77-1083	• PLATE	1
11	45-1998	• FIELD - clutch (24VDC)	1
12	77-1752	• PULLEY (2-B grooves, 7.75 in od)	1
	77-2543	• HUB & ARMATURE	1
13	41-3345	SENSOR - discharge (for connectors see 115D14)	1
14	41-4147	SWITCH - lpco (for connectors see 115D14)	1
	41-5183	• SWITCH - only	1
15	55-308	ELBOW - low pressure switch	1
	33-768	GASKET - elbow	1
	203-393	SEALER - thread	A/R
16	33-2541	GASKET - suction valve	1
17	55-9298	CLAMP - harness	3
18	91-8288	BRACKET & TUBE	1
19	41-4486	SWITCH - hpco (for connectors see 115D14)	1
	41-4809	• SWITCH - only	1
20	55-459	COUPLING	1
21	92-1743	BRACKET - harness	1
	55-2961	SCREW - bracket	1
	55-2641	FLATWASHER	2
	55-4955	NUT	1
22	41-4810	HARNESS - compressor (for connectors see 115D14)	1
23	41-1789	• CONNECTOR - tower (6 pin)	1
24	44-8294	• CONNECTOR (6 pin)	1
	41-1787	• COVER - connector	1
	41-4280	• DIODE	1
	41-1790	• LOCK - secondary (6 pin connector)	1
25	44-7327	• CONNECTOR (1 terminal)	2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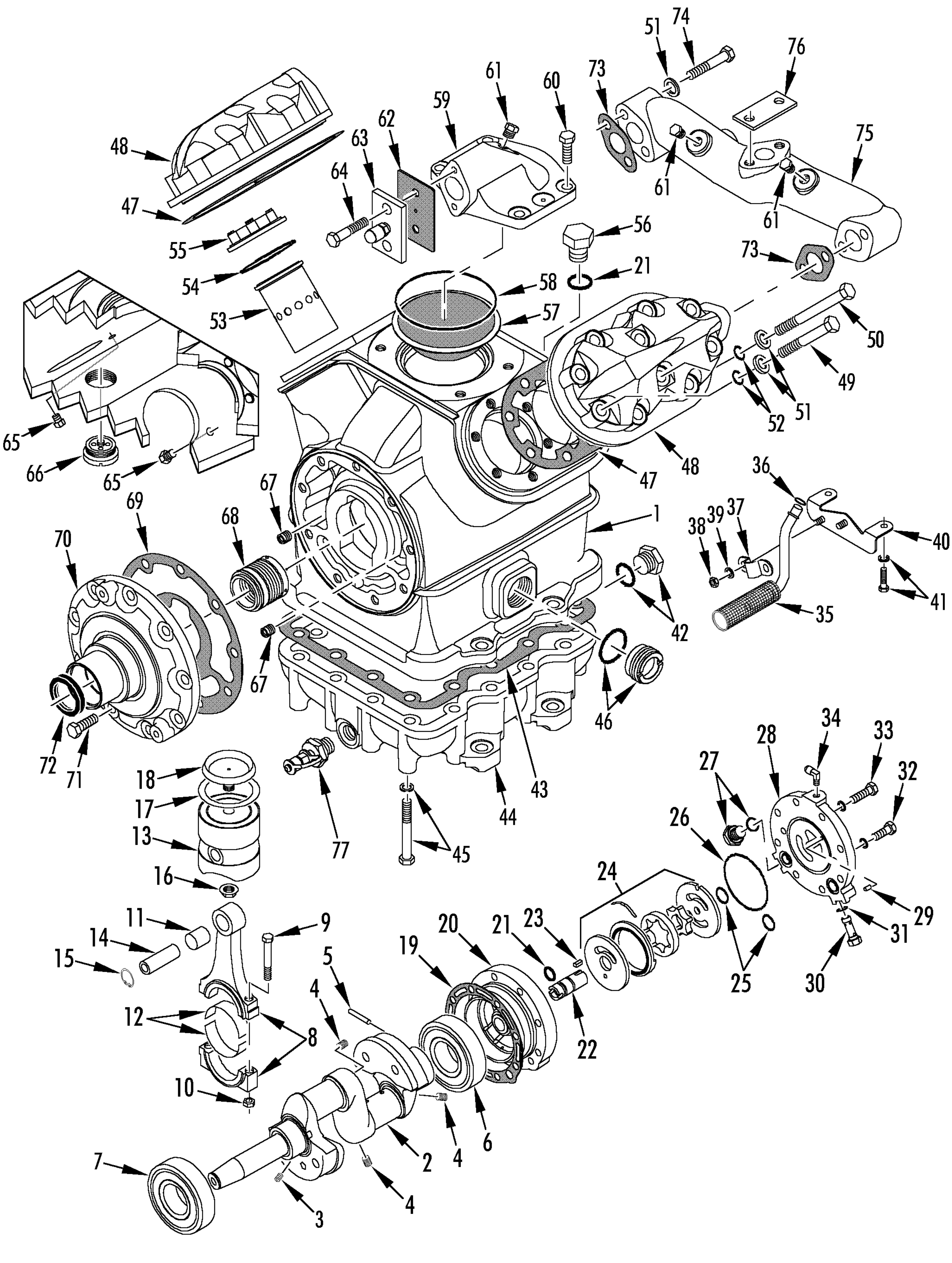
REF	PART#	DESCRIPTION	QTY
26	44-5835	• CONNECTOR (2 terminal)	1
27	44-5838	• CONNECTOR (2 terminal)	1
28	55-9701	CLAMP - harness	2
	55-2957	SCREW - clamp	2
	55-2086	FLATWASHER	2
	55-4953	NUT	2
29	92-4388	BRACKET - compressor harness	1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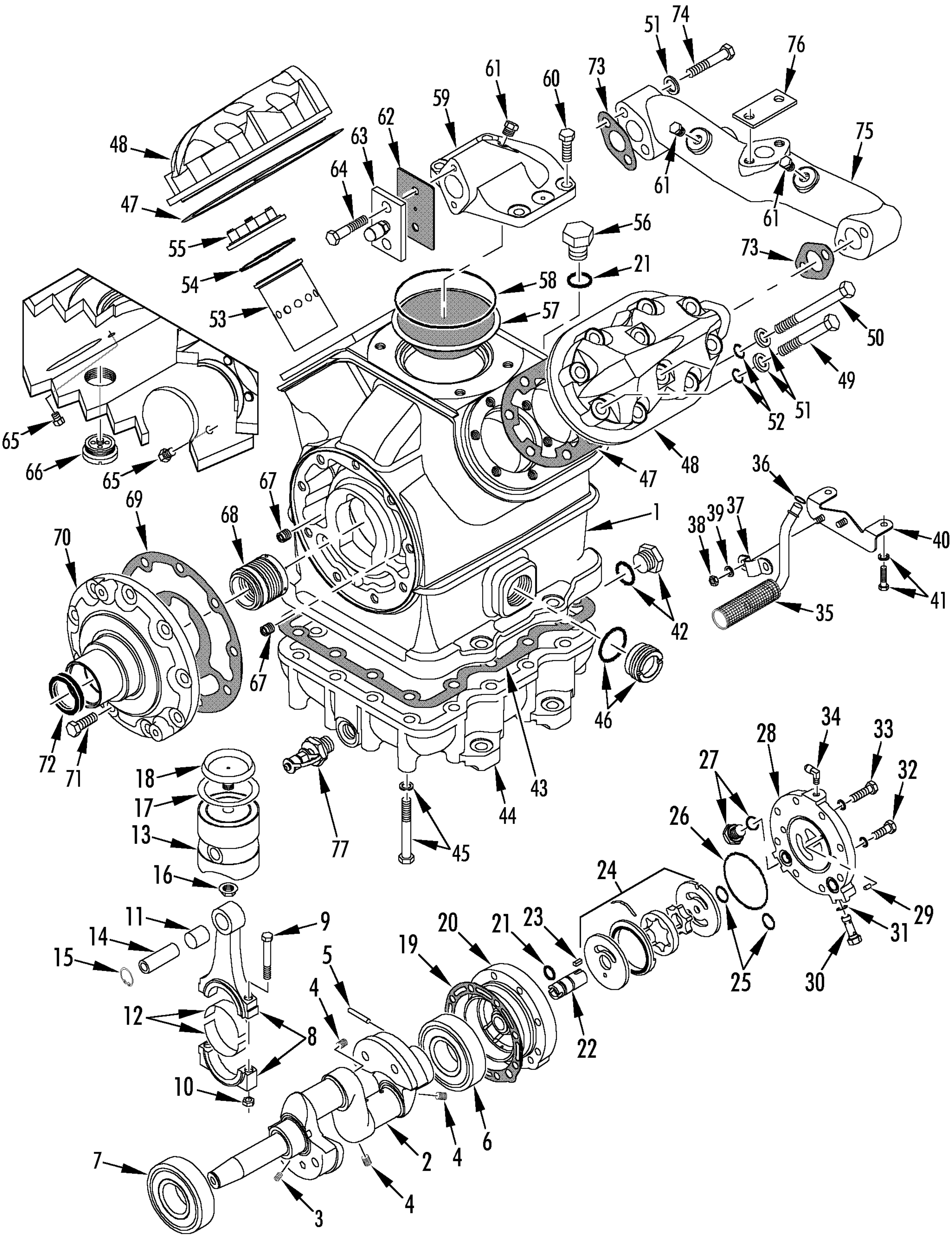
REF	PART#	DESCRIPTION	QTY
	102-499	COMPRESSOR - X430 (dry, no oil)	1
	8102-499	COMPRESSOR - X430 (dry, remanufactured)	1
1	23-129	• BODY - compressor	1
2	22-655	• CRANKSHAFT	1
	55-1409	•• RIVET - counterweight	A/R
3	22-123	• PLUG - oil metering	1
4	55-4720	• PLUG	3
5	55-4213	• PIN - dowel	1
6	77-169	• BEARING - ball	1
7	77-2306	• BEARING - ball	1
8	22-639	• ROD - connecting	4
9	55-5062	•• BOLT - connecting rod	2
10	51-666	•• NUT (12 point)	2
11	11-475	•• BUSHING - piston pin	4
12	22-1003	• BEARING SET - connecting rod (standard)	1
	22-1004	• BEARING SET (0.005 us)	4
	22-1005	• BEARING SET (0.010 us)	4
	22-1006	• BEARING SET (0.020 us)	4
	22-1007	• BEARING SET (0.030 us)	4
13	22-1218	• PISTON	4
14	NSS	•• PIN - piston	4
15	55-2122	•• RING - retaining	8
16	51-115	•• NUT	1
	55-895	•• FLATWASHER	1
17	NSS	•• REED - piston	1
18	NSS	•• HEAD - piston	1
19	* 33-1549	• GASKET - pump end	1
20	22-1249	• HOUSING - oil pump	1
	822-1249	• HOUSING - oil pump (remanufactured)	1
21	* 33-1223	•• O-RING	2
22	22-1149	• SHAFT - oil pump	1
23	55-9760	• KEY - shaft	1
24	22-1160	• PUMP - oil (incl items 21-23)	1
25	* 33-239	• O-RING	2
26	* 33-1175	• O-RING	1
27	55-6752	• PLUG - oil pump cover	1
	33-2095	•• O-RING	4
28	22-555	• COVER - pump	1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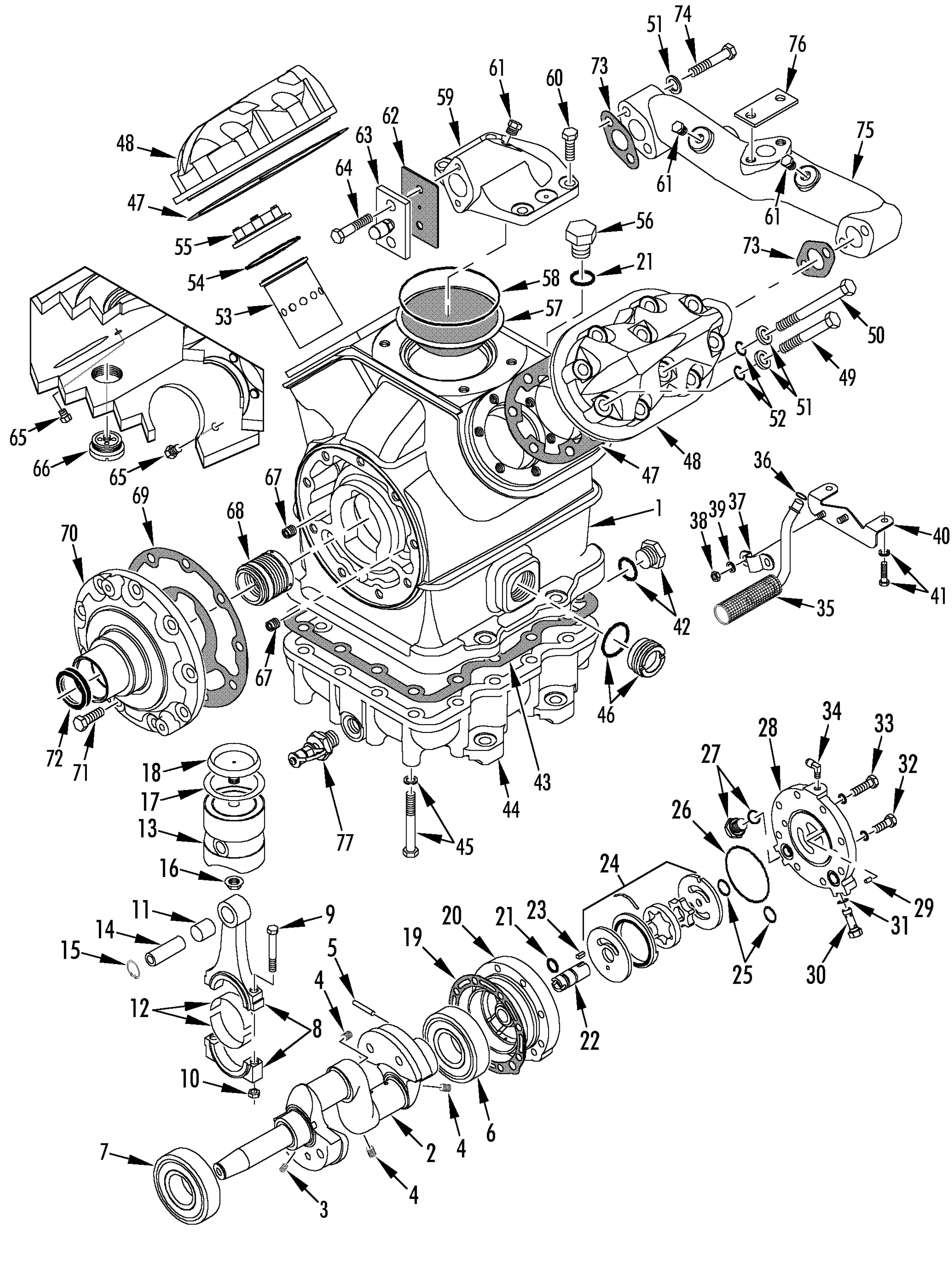
REF	PART#	DESCRIPTION	QTY
29	55-4211	• PIN - dowel	1
30	22-784	• REGULATOR	1
31	* 33-672	•• O-RING	1
32	55-681	• SCREW - cover to housing	2
	* 51-149	• FLATWASHER	2
33	55-183	• SCREW - pump	8
34	11-9001	• VALVE - tee	1
	203-393	• SEALER - thread	A/R
	55-1983	• CAP - valve	1
35	22-611	• SCREEN - oil pickup	1
36	* 33-2205	• O-RING	1
37	99-4848	• CLAMP - screen	1
38	55-291	• NUT	1
39	55-366	• LOCKWASHER	2
40	99-4849	• BRACKET - screen	1
41	55-165	• SCREW - bracket	2
	55-366	• LOCKWASHER	2
42	55-6751	• PLUG - magnetic	2
	33-2095	• O-RING	4
43	* 33-2515	• GASKET - oil sump	1
44	22-747	• SUMP - oil	1
45	55-1417	• SCREW - oil sump	16
	* 55-896	• FLATWASHER	16
46	22-350	• SIGHT GLASS	3
	* 33-822	• O-RING	3
47	* 33-2552	• GASKET - cylinder head	2
48	22-789	• HEAD - cylinder	2
49	55-6805	• SCREW (2 in lg)	12
50	55-6806	• SCREW (2-5/8 in lg)	8
51	55-6804	• WASHER - sealing	24
52	33-2019	• O-RING	24
53	22-656	• SLEEVE - cylinder	4
54	* 33-408	• O-RING	4
55	22-990	• PLATE - valve	4
56	55-6750	• PLUG - oil fill	1
57	22-306	• SCREEN - suction	1
58	33-1221	• O-RING	1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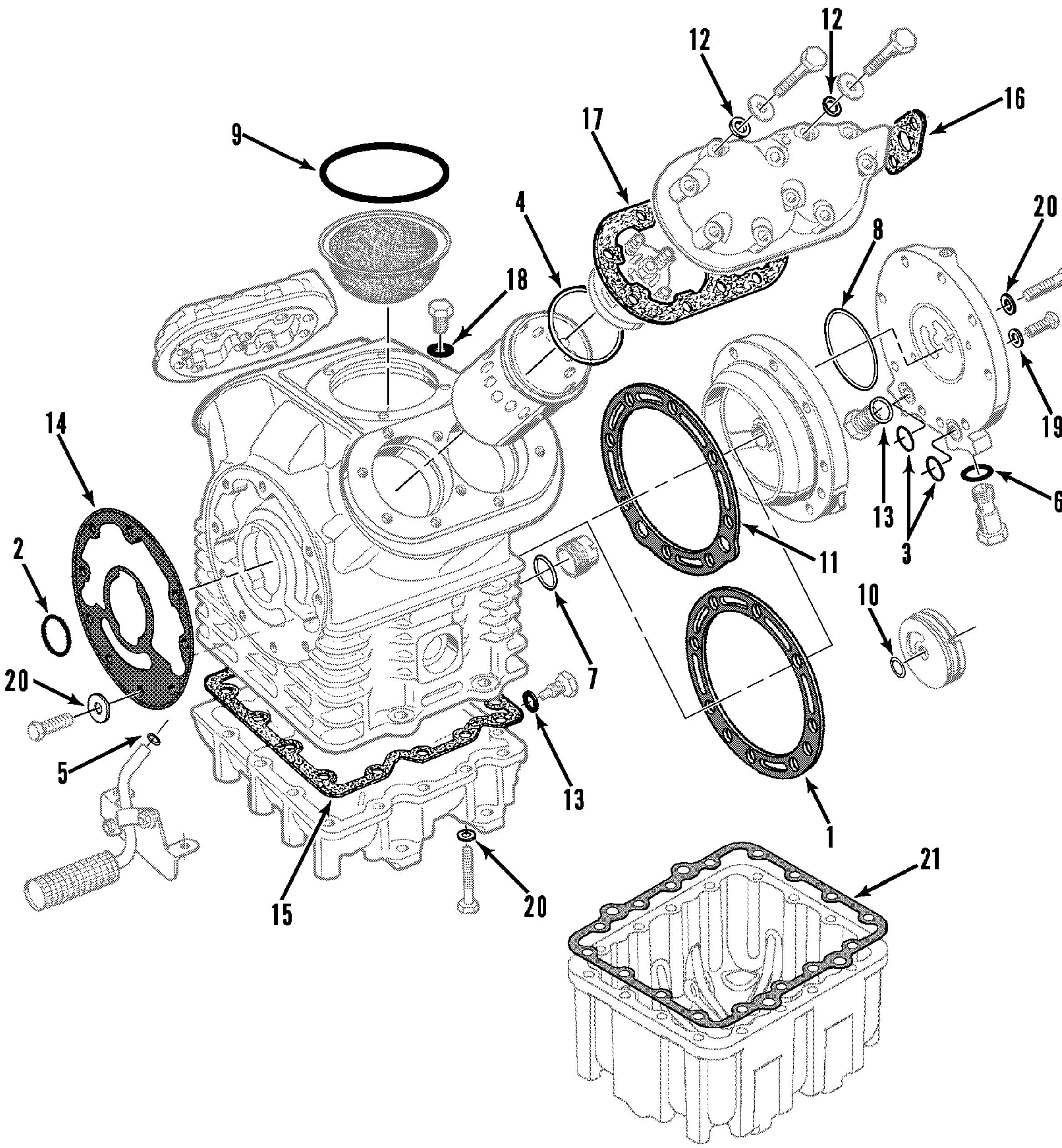
REF	PART#	DESCRIPTION	QTY
59	66-9941	• MANIFOLD - suction	1
60	55-9106	• SCREW - manifold & plate	14
	55-896	• FLATWASHER	14
61	55-3364	• PLUG - manifold	3
62	33-2541	• GASKET - suction	1
63	91-5630	• PLATE - suction	1
64	55-141	• SCREW - plate	2
65	22-653	• VALVE - check	2
66	22-787	• VALVE - check (oil return)	1
67	22-568	• VALVE - check	2
68	22-1100	• SEAL - crankshaft	1
69	33-2513	• GASKET - drive end	1
70	22-754	• PLATE - bearing	1
71	55-9106	• SCREW - housing	9
	55-896	• FLATWASHER	9
72	*33-2120	• SEAL - dirt	1
73	*33-2805	• GASKET - manifold	2
74	55-6822	• SCREW - manifold	4
75	22-1055	• MANIFOLD - discharge	1
76	91-5629	• PLATE - discharge	1
77	22-1248	PLUG - drain, probalyzer	1
	22-1235	• PROBALYZER	1
	203-513	OIL - compressor (R134a, R404A)	A/R
	67-404	OIL - compressor (R12, R22, R502, R403B, R402A, R401B)	A/R
	*30-243	KIT - gasket	1
	203-346	KIT - acid test	1
	203-518	KIT - acid test (polyol ester kit)	1

NOTE: This compressor is dry, no oil. Add oil depending on the refrigerant in your unit.

CAUTION: Both discharge manifold gaskets MUST be the same part number (thickness).

NOTE: The heads on this compressor do not have ports. If needed, use cylinder head P/N 22-788, which has a 1/8 pipe port.



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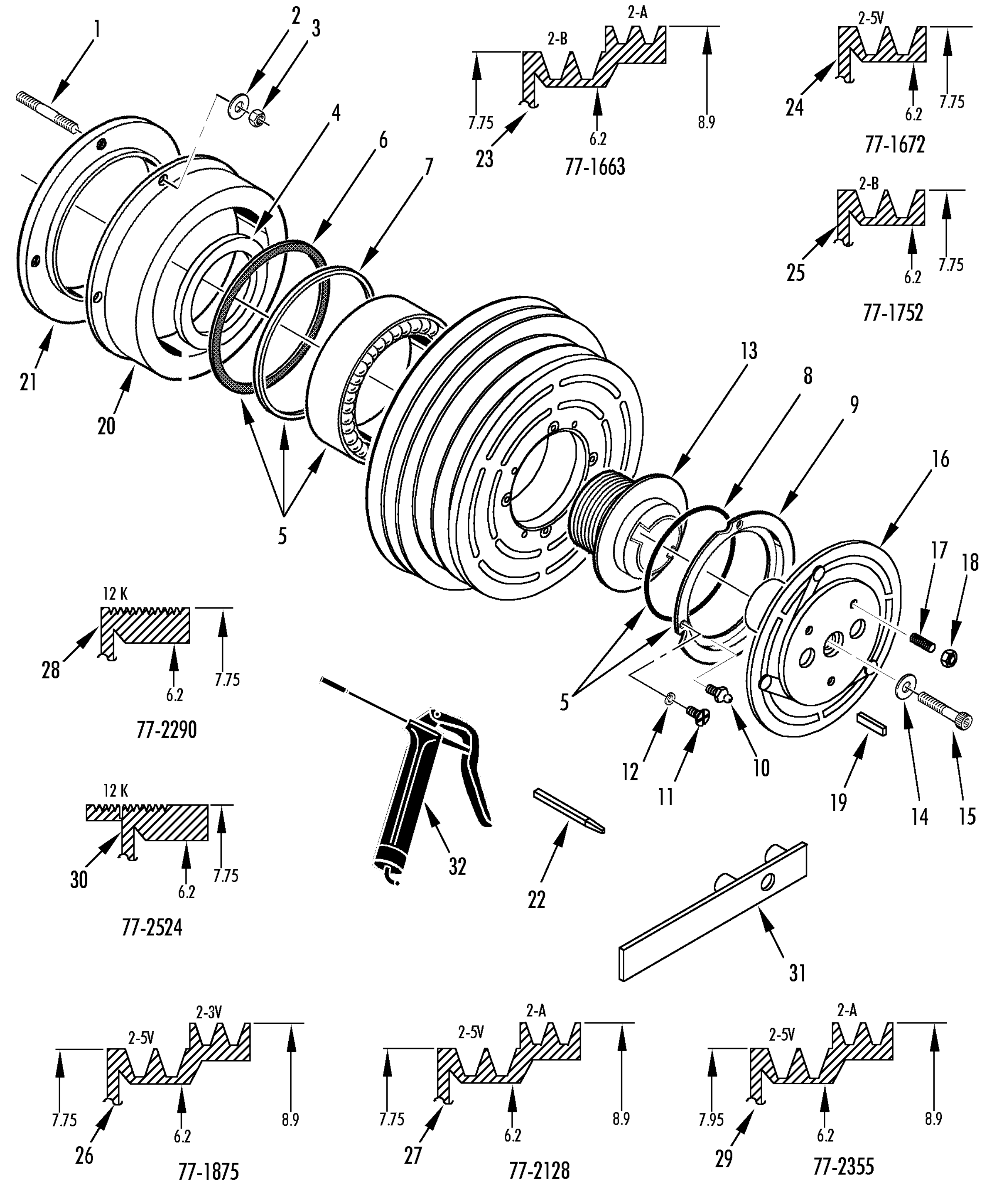
REF	PART#	DESCRIPTION	QTY
	30-243	KIT - gasket	1
1	33-110	• GASKET - pump housing (X426)	1
2	33-235	• O-RING - dust seal	1
3	33-239	• O-RING - oil galley	2
4	33-408	• O-RING - cylinder sleeve	4
5	33-2205	• O-RING - oil pickup tube	1
6	33-672	• O-RING - regulator	1
7	33-822	• O-RING - sight glass	1
8	33-1175	• O-RING - oil pump cover	1
9	33-1221	• O-RING - throttling valve	1
10	33-1223	• O-RING - oil pump	1
11	33-1549	• GASKET - pump housing (X430)	1
12	33-2019	• O-RING - cylinder head screw	24
13	33-2095	• O-RING - oil pump plug	2
14	33-2513	• GASKET - drive plate	1
15	33-2515	• GASKET - oil sump	1
16	33-2805	• GASKET - manifold	3
17	33-2552	• GASKET - cylinder head	2
18	55-381	• WASHER - oil fill	1
19	55-895	• WASHER - oil pump	2
20	55-896	• WASHER - compressor seal (3/8)	57
21	33-3797	• GASKET - oil sump (7 qt)	1

CAUTION: Both discharge manifold gaskets MUST be the same part number (thickness).

NOTE: The 7 qt oil sump gasket (33-3797) is not included in Kit 30-243. Order gasket 33-3797 separately.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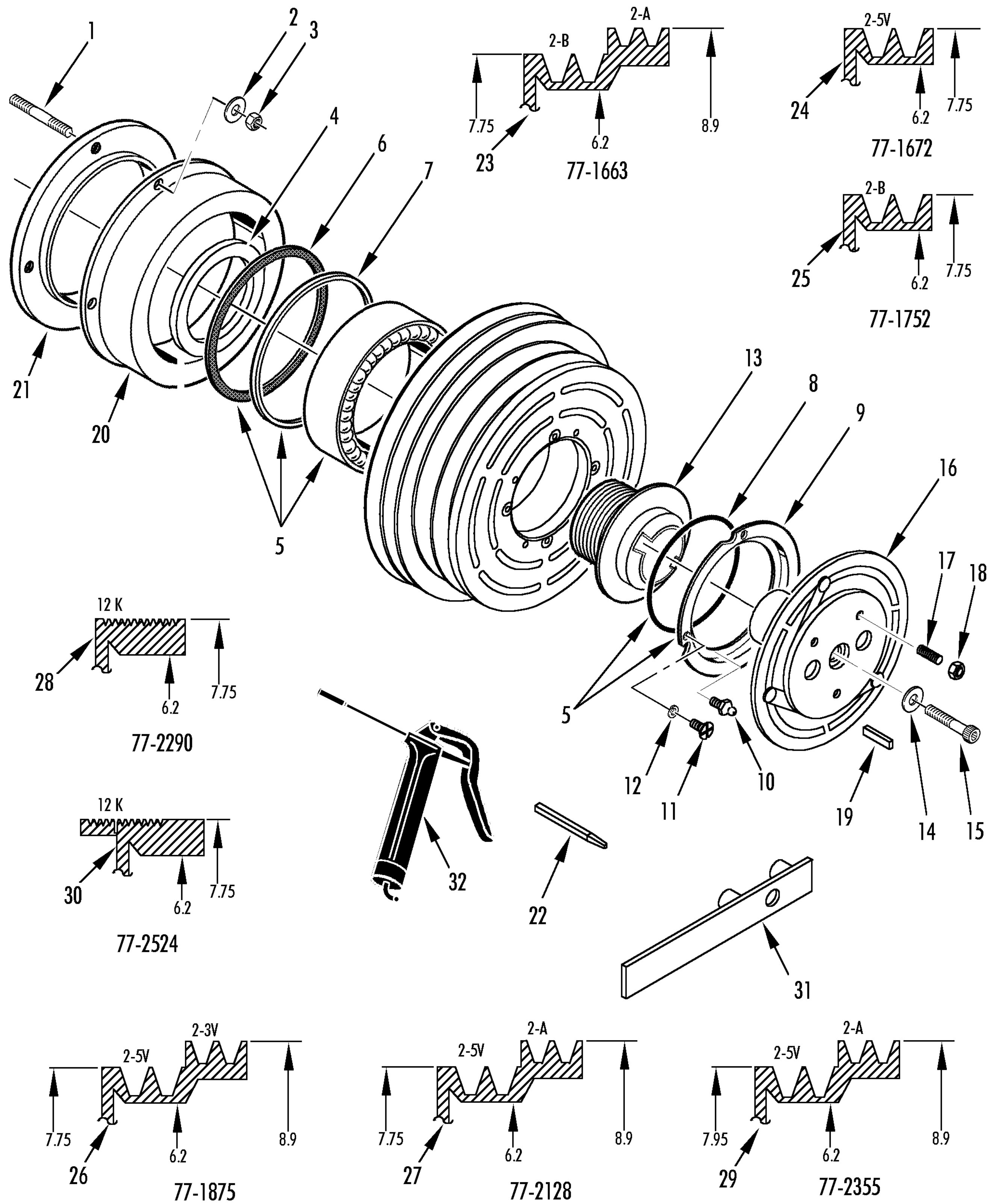
77-2355

REF	PART#	DESCRIPTION	QTY
	107-192	KIT - clutch drive repair (does not incl pulley, field or plate)	1
1	55-3451	• STUD - clutch	3
2	55-790	• LOCKWASHER	3
3	55-789	• NUT	3
4	77-1491	• SPACER - bearing	1
5	70-105	• KIT - bearing (incl 6 thru 10 & grease)	1
	77-1233	•• BEARING	1
6	33-1238	•• SEAL - rear	1
7	55-2717	•• SNAP RING - internal	1
8	33-928	•• O-RING	1
9	33-1285	•• RETAINER & SEAL - front	1
10	55-4021	••• FITTING - grease	1
11	55-110	• SCREW - seal	4
12	55-2718	• LOCKWASHER	4
13	77-1487	• NUT - clutch	1
14	77-2498	• WASHER	1
15	55-5283	• SCREW (3.00 in lg)	1
	55-3631	SCREW (3.25 in lg)	1
16	77-2392	• HUB & ARMATURE (0.224 thick armature)	1
	77-2543	• HUB & ARMATURE (0.344 thick armature)	1
17	55-6559	• SCREW - set	3
18	55-664	• NUT	3
19	55-9088	KEY - shaft	1
20	45-1227	FIELD - clutch (24V, before 9/01)	1
	45-1998	FIELD - clutch (after 8/01)	1
	45-1389	FIELD - clutch (24V)	1
	45-1965	FIELD - clutch (24V, internally wired)	1
	44-7374	FIELD - clutch (12V)	1
	99-2477	NAMEPLATE - 24 Volt	1
	44-3657	NAMEPLATE - 12 Volt	1
	99-2975	NAMEPLATE - Caution	1
	33-564	GROMMET - wire	1
21	77-1083	PLATE	1
22	204-972	TOOL - keyway alignment	1
23	77-1663	PULLEY (2-B/2-A grooves, 7.75/8.9 in od)	1
24	77-1672	PULLEY (2-5V grooves, 7.75 in od)	1
25	77-1752	PULLEY (2-B grooves, 7.75 in od)	1
26	77-1875	PULLEY (2-5V/2-3V grooves, 7.75/8.9 in od)	1
27	77-2128	PULLEY (2-5V/2A grooves, 7.75/8.9 in dia)	1
28	77-2290	PULLEY (12K grooves, 7.75 in od)	1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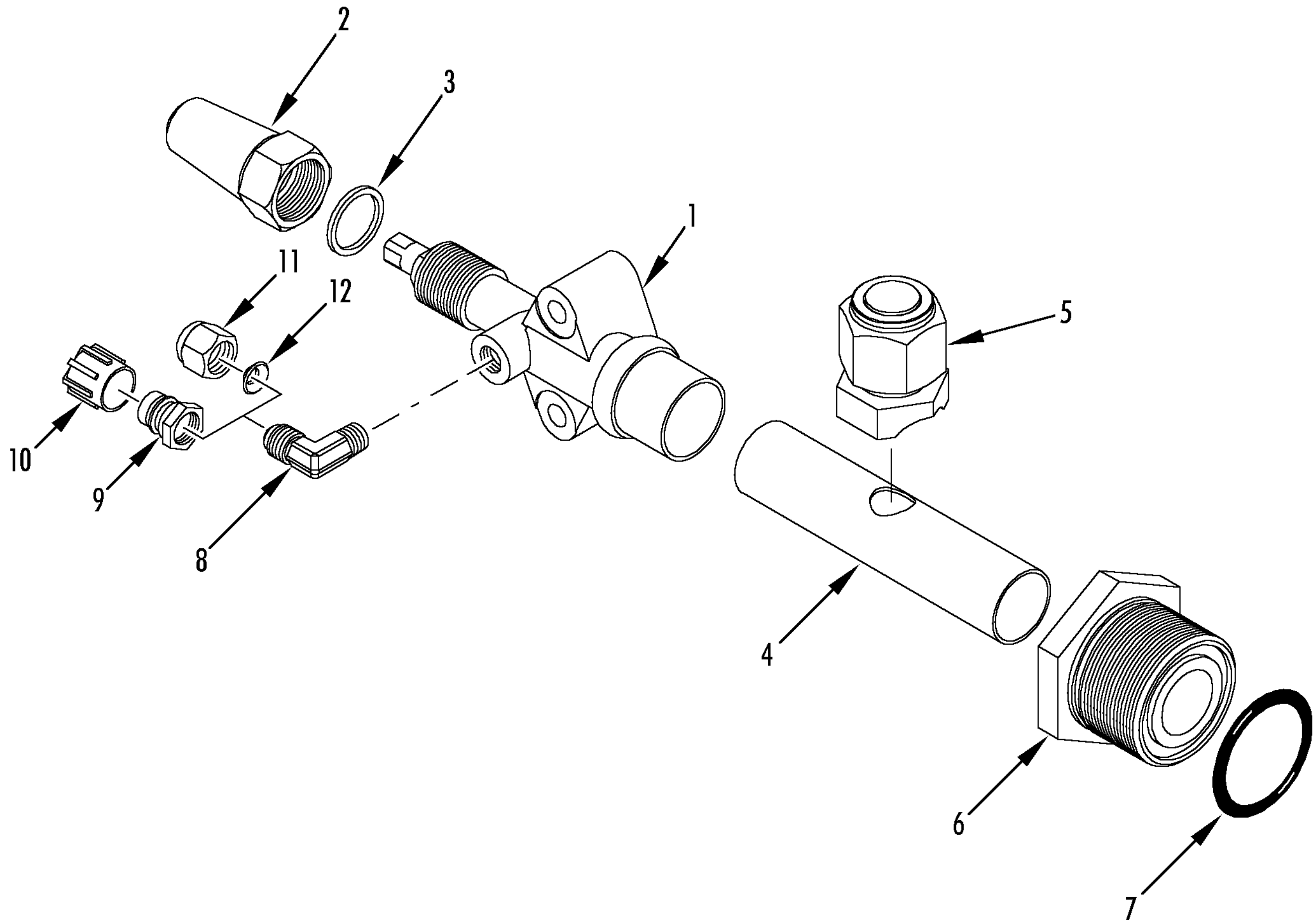
REF	PART#	DESCRIPTION	QTY
29	77-2355	PULLEY (2-5V/2-A groove, 7.95/8.9 in od)	1
30	77-2524	PULLEY (12K grooves, 7.75 inch od)	1
31	204-481	PULLER - clutch	1
32	204-477	GUN - grease	1
	204-476	GREASE - bearing (3.5 ounce)	A/R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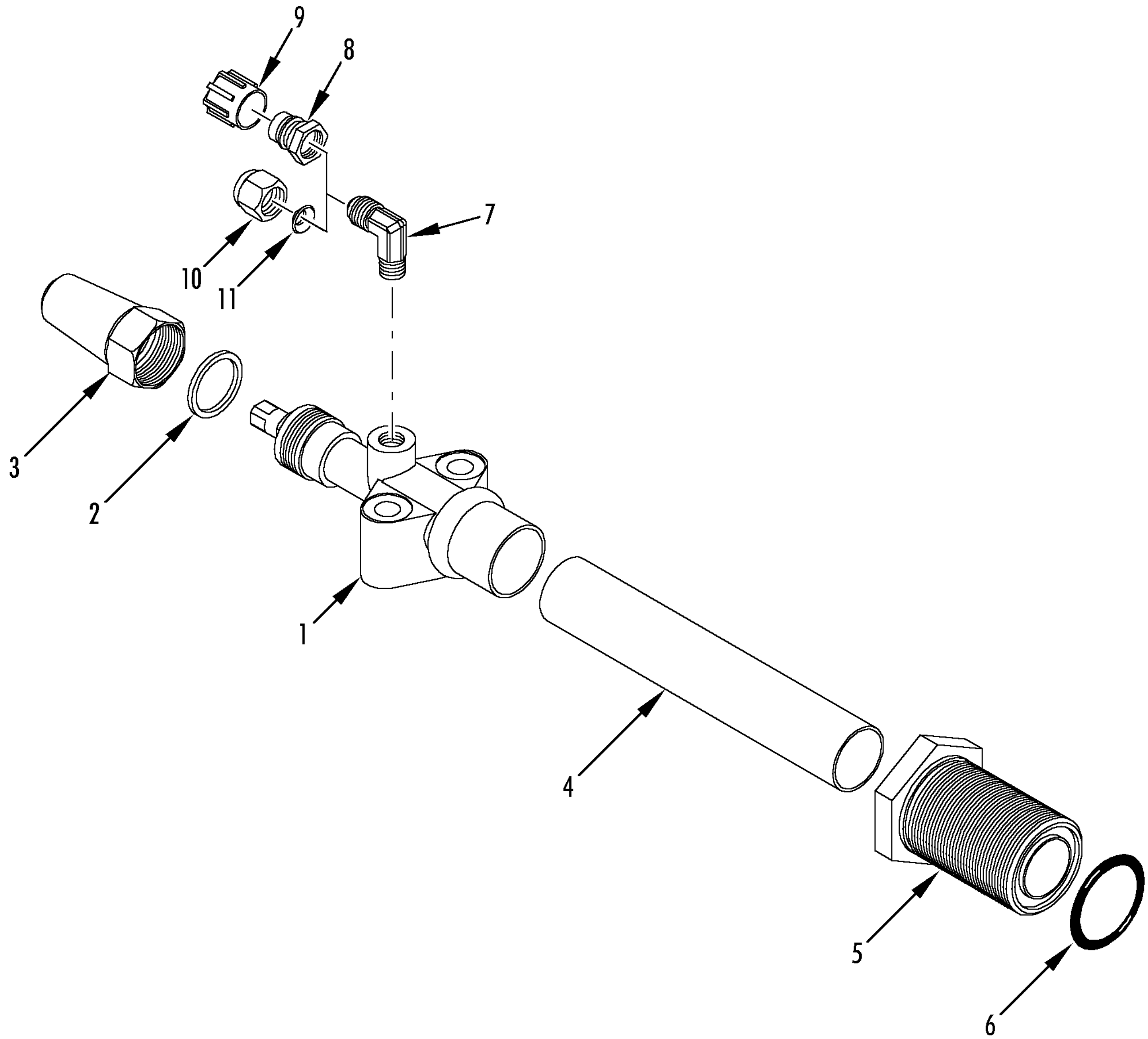
REF	PART#	DESCRIPTION	QTY
	61-3071	VALVE - suction	1
1	66-3576	• VALVE - suction	1
2	66-2296	•• CAP - service valve	1
3	33-3007	••• GASKET - cap	1
4	66-8839	• TUBE - suction	1
5	55-9947	• FITTING - tube	1
	55-9436	• ADAPTER - tube to flare	1
	33-2095	• O-RING	1
	55-2785	• NUT - hex flare	1
6	55-7553	• ADAPTER - bulkhead (#24, ORS)	1
7	33-1777	O-RING	1
8	55-466	ELBOW	1
9	66-7180	FITTING - suction (R134a)	1
10	66-7183	• CAP (blue, R134a)	1
11	55-1983	CAP - elbow (R22)	1
12	33-768	GASKET - elbow	1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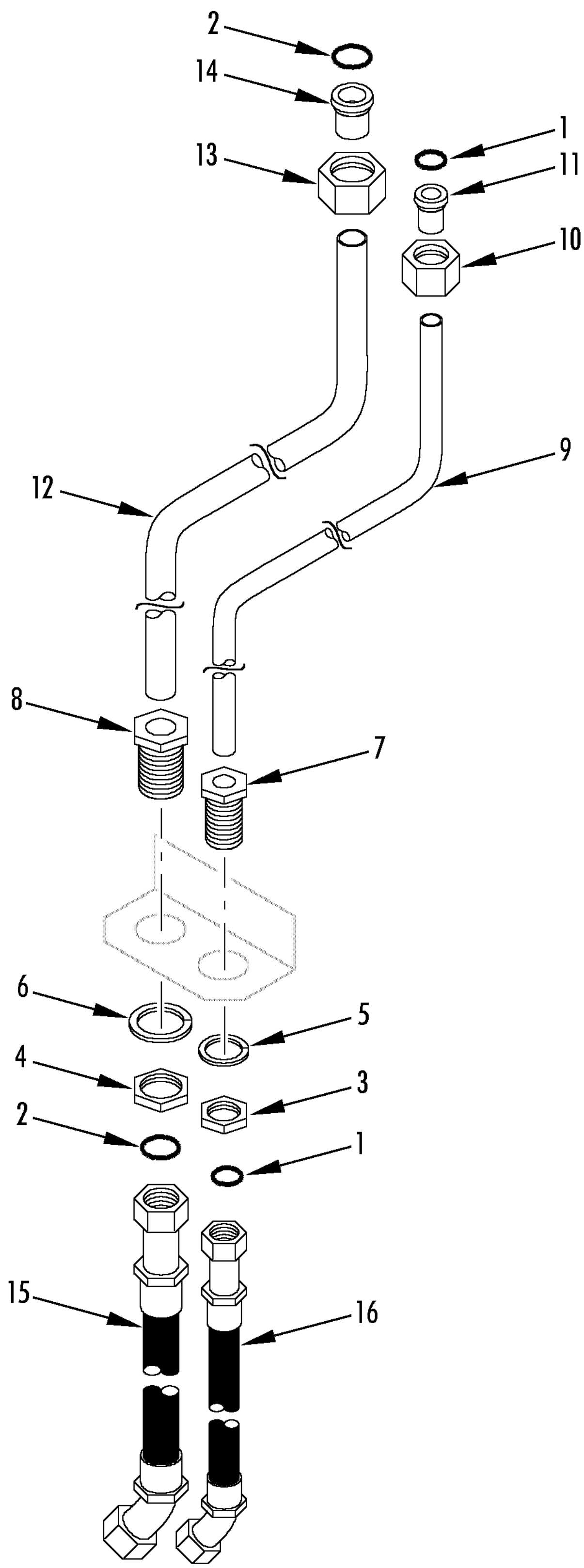
REF	PART#	DESCRIPTION	QTY
	61-3070	VALVE - discharge	1
1	66-2140	• VALVE - discharge	1
2	66-2296	•• CAP - service valve	1
3	33-3007	••• GASKET - cap	1
4	61-278	• TUBE - discharge	1
5	55-7832	• ADAPTER - bulkhead (#20, ORS)	1
6	33-920	O-RING	1
7	55-308	ELBOW	1
	33-768	GASKET - elbow	1
8	66-8086	FITTING - discharge (R134a)	1
9	66-7182	• CAP (red, R134a)	1
10	55-1983	CAP - elbow (R22)	1
11	33-768	GASKET - cap (R22)	1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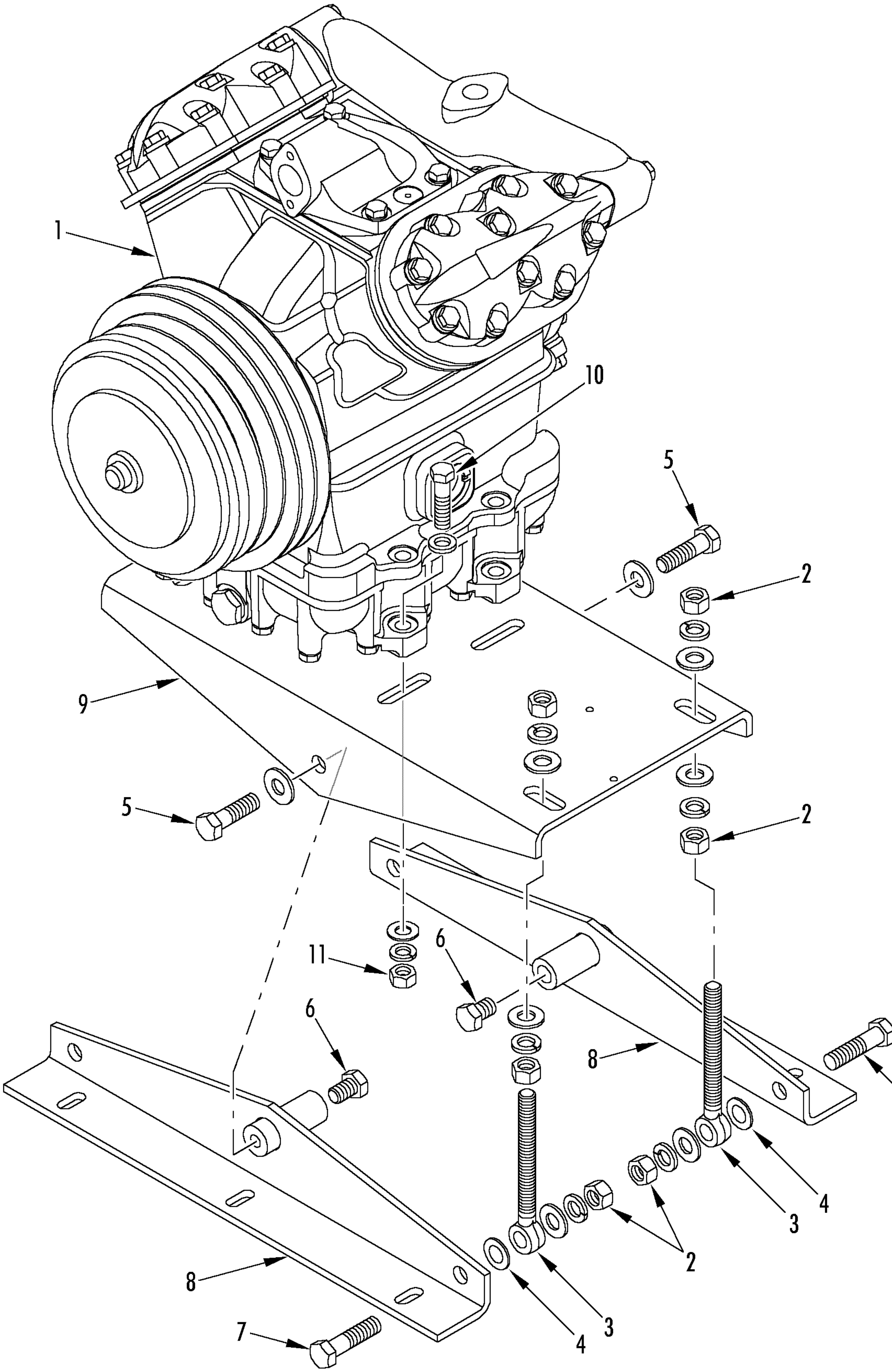
REF	PART#	DESCRIPTION	QTY
1	33-1785	O-RING - discharge	4
2	33-1777	O-RING - suction	4
3	55-5740	NUT - bulkhead (#16)	2
4	55-5739	NUT - bulkhead (#20)	2
5	55-5741	LOCKWASHER (1.5 id)	2
6	55-5742	LOCKWASHER (1.75 id)	2
7	55-7380	ADAPTER - bulkhead (#16)	3
8	55-7832	ADAPTER - bulkhead (#20)	3
9	61-2553	TUBE - discharge (assembly)	1
10	55-7201	• NUT - shoulder (#16)	1
11	55-5938	• SLEEVE - adapter (#16)	1
12	61-2354	TUBE - suction (assembly)	1
13	55-5935	• NUT - shoulder (#20)	1
14	55-5939	• SLEEVE - adapter (#20)	1
15	NPN	OEM Supplied	1
16	NPN	OEM Supplied	1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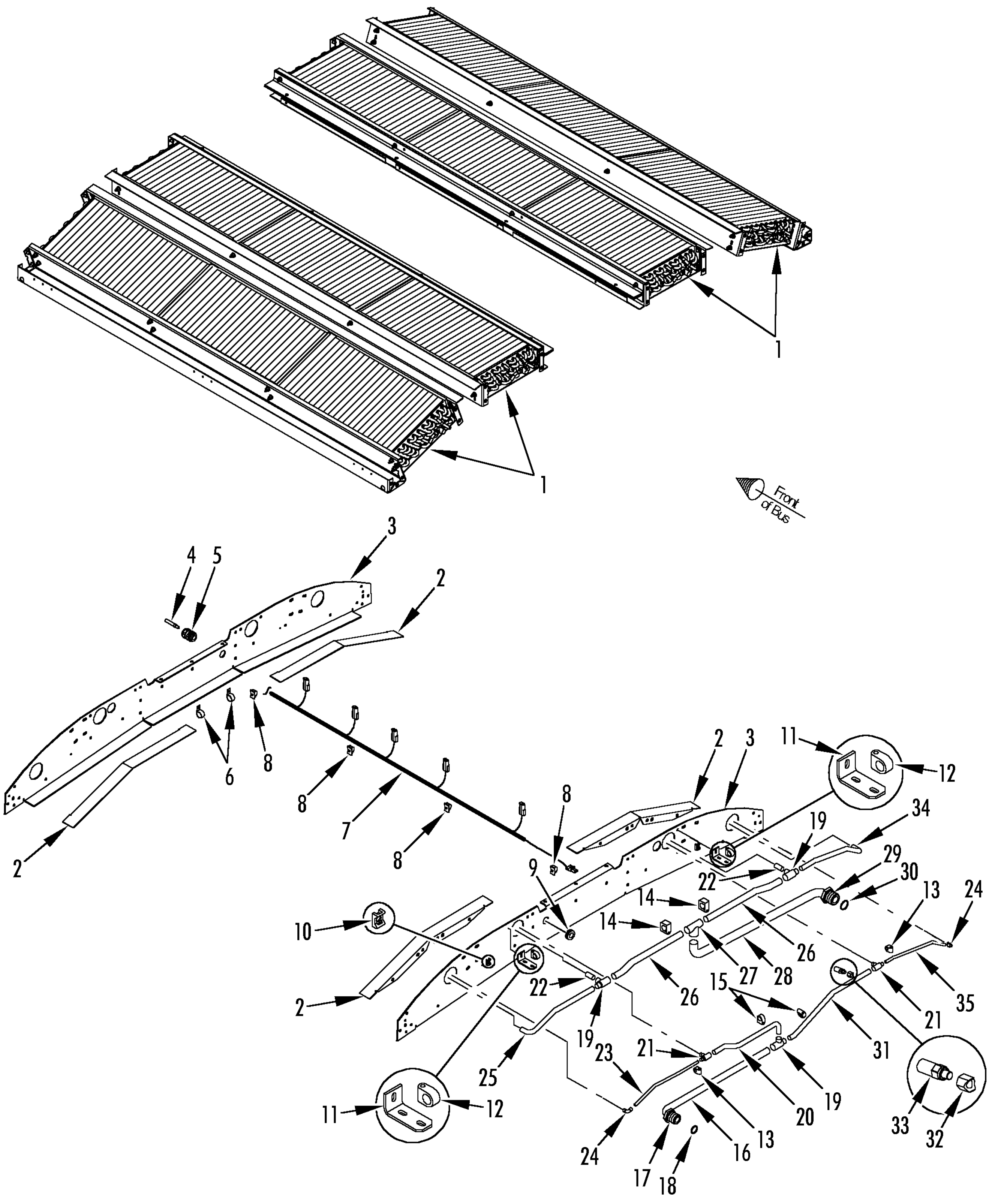
REF	PART#	DESCRIPTION	QTY
1	102-499	COMPRESSOR - X430 (see 135G6)	1
2	55-2166	NUT - eyebolt (alternator bracket)	6
3	92-4391	EYEBOLT	2
4	51-1129	SPACER	3
5	55-1670	SCREW - eyebolt & base	2
	55-7123	WASHER - belleville	2
6	55-6750	SCREW - backup	2
7	55-2747	SCREW - base & eyebolt	2
	55-2173	FLATWASHER	6
	55-2159	LOCKWASHER	6
8	91-1030	BASE	2
9	98-7096	PLATE - compressor	1
10	55-3423	SCREW - compressor	4
	55-399	WASHER - special	4
11	55-3122	NUT - compressor	4
	55-2200	LOCKWASHER	4
	55-2221	FLATWASHER	4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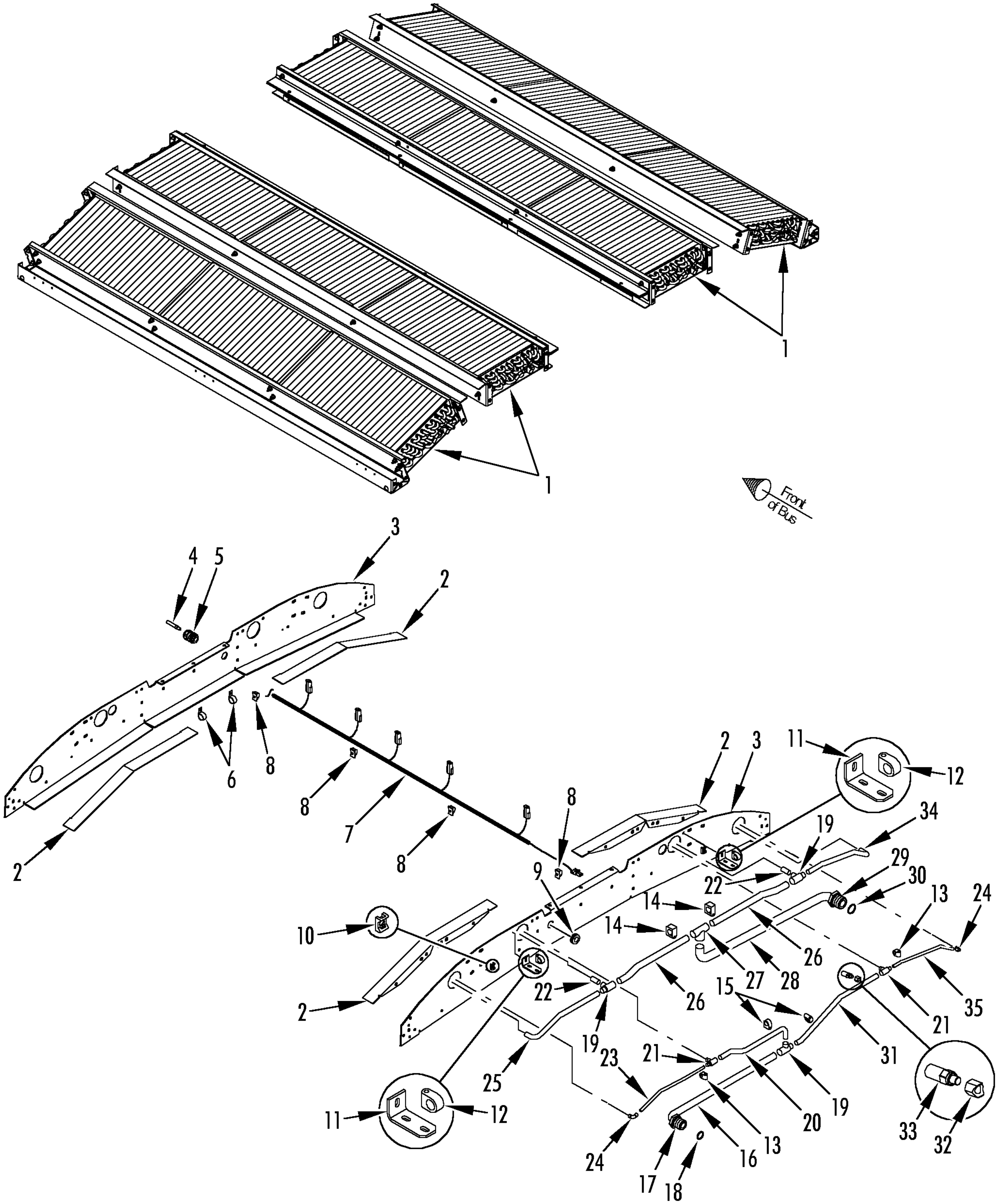
REF	PART#	DESCRIPTION	QTY
1	67-2111	COIL - condenser (see 200D2)	4
	55-8711	INSERT (1/4-20)	16
2	92-4647	BRACKET - block off	4
3	98-7101	PLATE - condenser end cap	2
	55-2957	SCREW - plate	30
	55-1800	LOCKWASHER	30
	55-2086	FLATWASHER	30
4	41-4817	CONNECTOR - liq tite	1
	55-2635	NUT - lock	1
5	40-872	SENSOR - temperature	1
	41-5802	• SENSOR - ungraded (18 in, NSS)	1
	41-5210	• COLLAR - crimp	2
	92-846	• HEATSHRINK (1/2 in)	2
6	55-9721	CLAMP - harness (0.875 dia)	2
	55-2957	SCREW - clamp	2
	55-1800	LOCKWASHER	2
	55-2086	FLATWASHER	2
7	41-6556	HARNESS - condenser (for connectors see 115D14)	1
8	99-9647	CLIP - harness	4
9	33-810	GROMMET (3/4 id)	1
10	55-6093	MOUNT - cable tie	2
	51-1167	RIVET - mount	2
11	92-4648	BRACKET - tubing	2
	55-2957	SCREW - angle	2
	55-2086	FLATWASHER	4
	55-4953	NUT	2
12	55-6388	CLAMP - tube	2
	55-3121	SCREW - clamp	2
	55-2086	FLATWASHER	4
	55-4953	NUT	2
13	91-758	CLAMP - tube	2
	55-3675	SCREW - clamp	2
	55-2086	FLATWASHER	4
	55-4953	NUT	2
14	91-5114	CLAMP - tube	2
15	91-758	CLAMP - tube	2
	55-3344	SCREW - clamp	2
	55-1800	LOCKWASHER	2
	55-2086	FLATWASHER	2
	55-4414	WASHER - spl (0.281 id)	2
	55-8979	INSERT	2
16	61-3072	TUBE - liquid line, roadside	1



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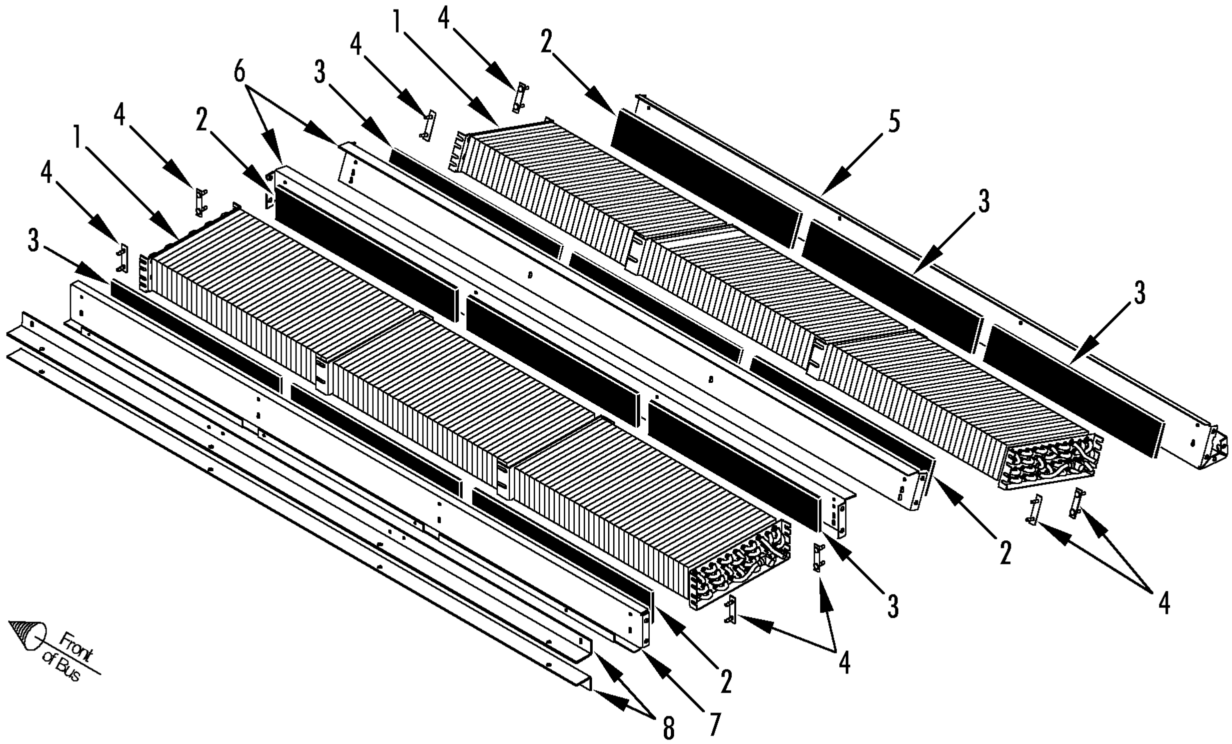
REF	PART#	DESCRIPTION	QTY
17	66-5247	• ADAPTER - bulkhead (#16, ORS)	1
18	33-1785	O-RING (15/16 id)	1
19	306-1850	TEE (7/8 x 5/8 x 5/8)	3
20	61-3073	TUBE - liq tee to tee	1
21	66-7106	TEE (5/8 x 5/8 x 3/8)	2
22	61-3074	TUBE (1.30 in lg)	2
23	61-3075	TUBE - liq tee to elbow	1
24	55-2876	ELBOW (3/8 x 3/8 sld)	2
25	61-3076	TUBE - disch reducer to tee	1
26	61-3077	TUBE - tee to reducer	2
27	55-6508	TEE (7/8 x 7/8 x 1 1/8)	1
28	61-3078	TUBE - discharge, curbside	1
29	55-6415	• ADAPTER - bulkhead (#20, ORS)	1
30	33-1777	O-RING (1-3/16 id)	1
31	61-3079	TUBE - liq line	1
32	99-3060	FITTING - saddle	1
33	66-7392	VALVE - relief (see 119B8)	1
34	61-3080	TUBE - discharge tee to tee	1
35	61-3081	TUBE - liquid tee to elbow	1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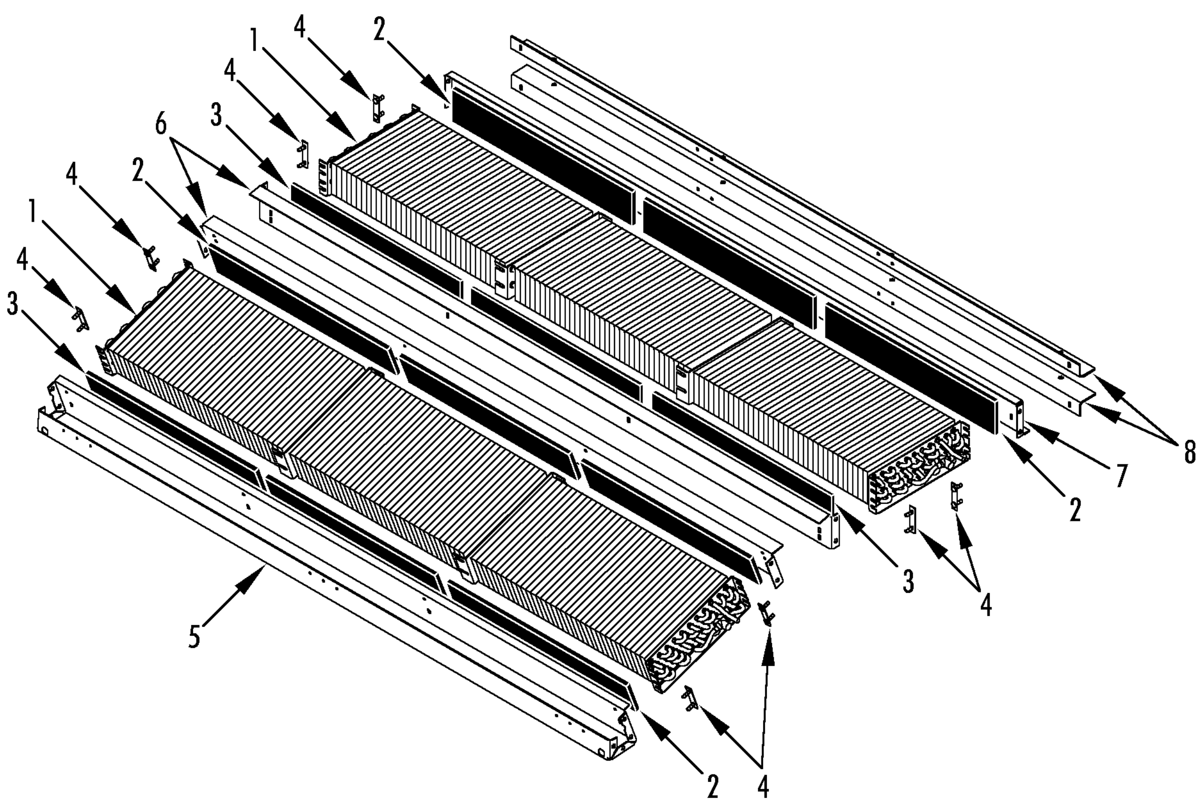
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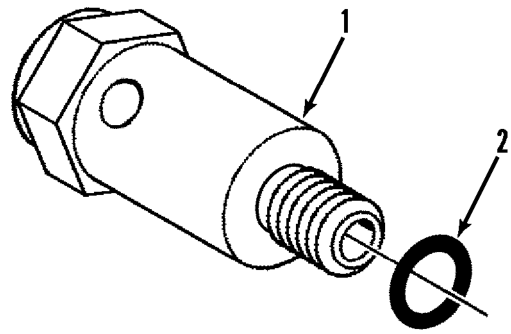
REF	PART#	DESCRIPTION	QTY
1	67-2111	COIL - condenser	4
2	92-4644	INSULATION - coil (22.50 in x 3.50 in)	8
3	92-4645	INSULATION - coil (21.25 in x 3.50 in)	16
4	92-4646	PLATE - boltstrip	32
5	98-7097	CHANNEL - support (condenser)	2
	55-8711	INSERT (1/4-20)	24
	55-4953	NUT - channel	16
	55-2086	FLATWASHER	16
6	98-7098	PLATE - support (condenser)	4
	55-4953	NUT - plate	32
	55-2086	FLATWASHER	32
7	98-7099	PLATE - support (condenser)	2
8	98-7100	ANGLE - plate	4
	55-8711	INSERT - plate	16
	55-8979	INSERT - angle	16
	55-4953	NUT - angle	16
	55-2086	FLATWASHER	16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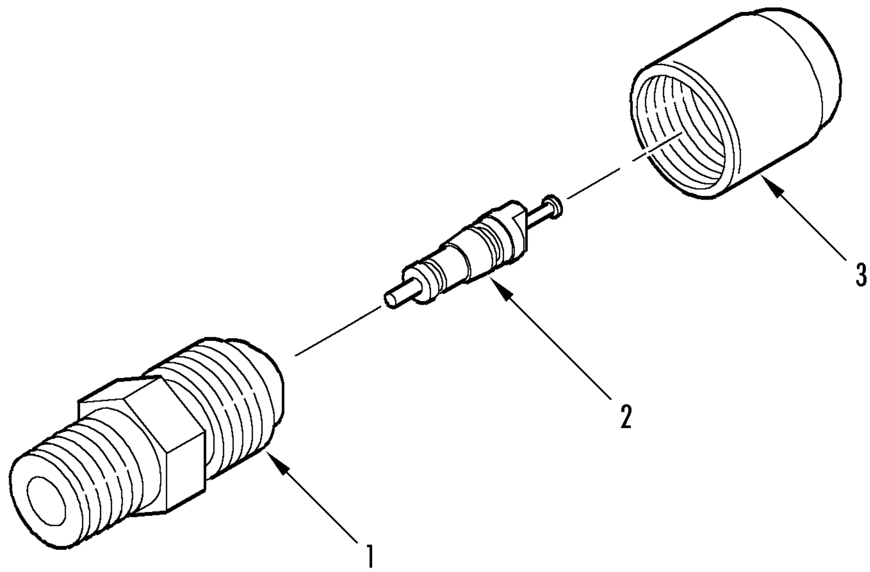
REF	PART#	DESCRIPTION	QTY
1	66-7392	VALVE - relief (assembly, brass)	1
2	33-1015	• O-RING - relief valve	2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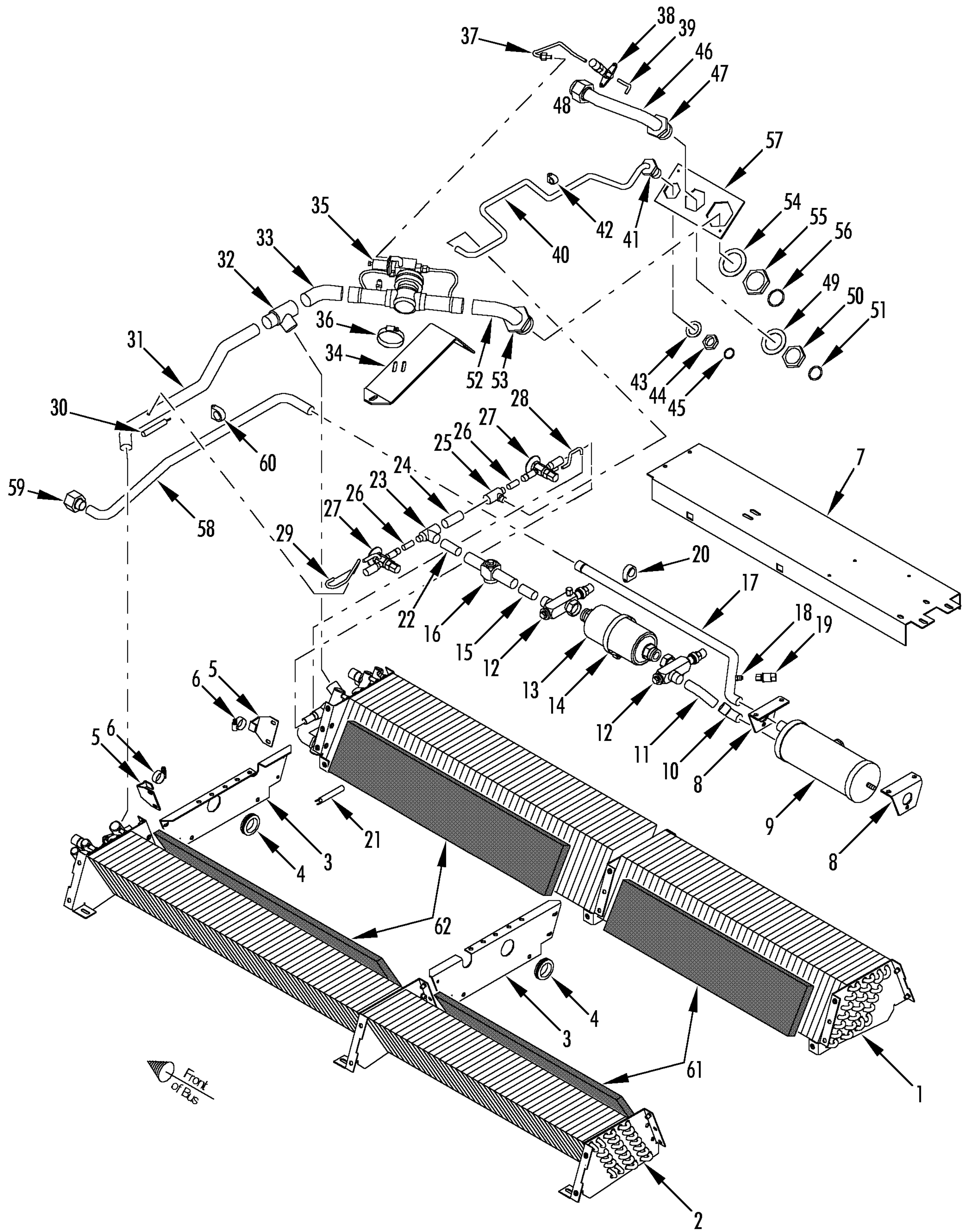
REF	PART#	DESCRIPTION	QTY
	11-2886	VALVE - pressure	1
1	55-7213	• BODY	1
2	11-7777	• CORE - valve	1
3	55-5672	• CAP	1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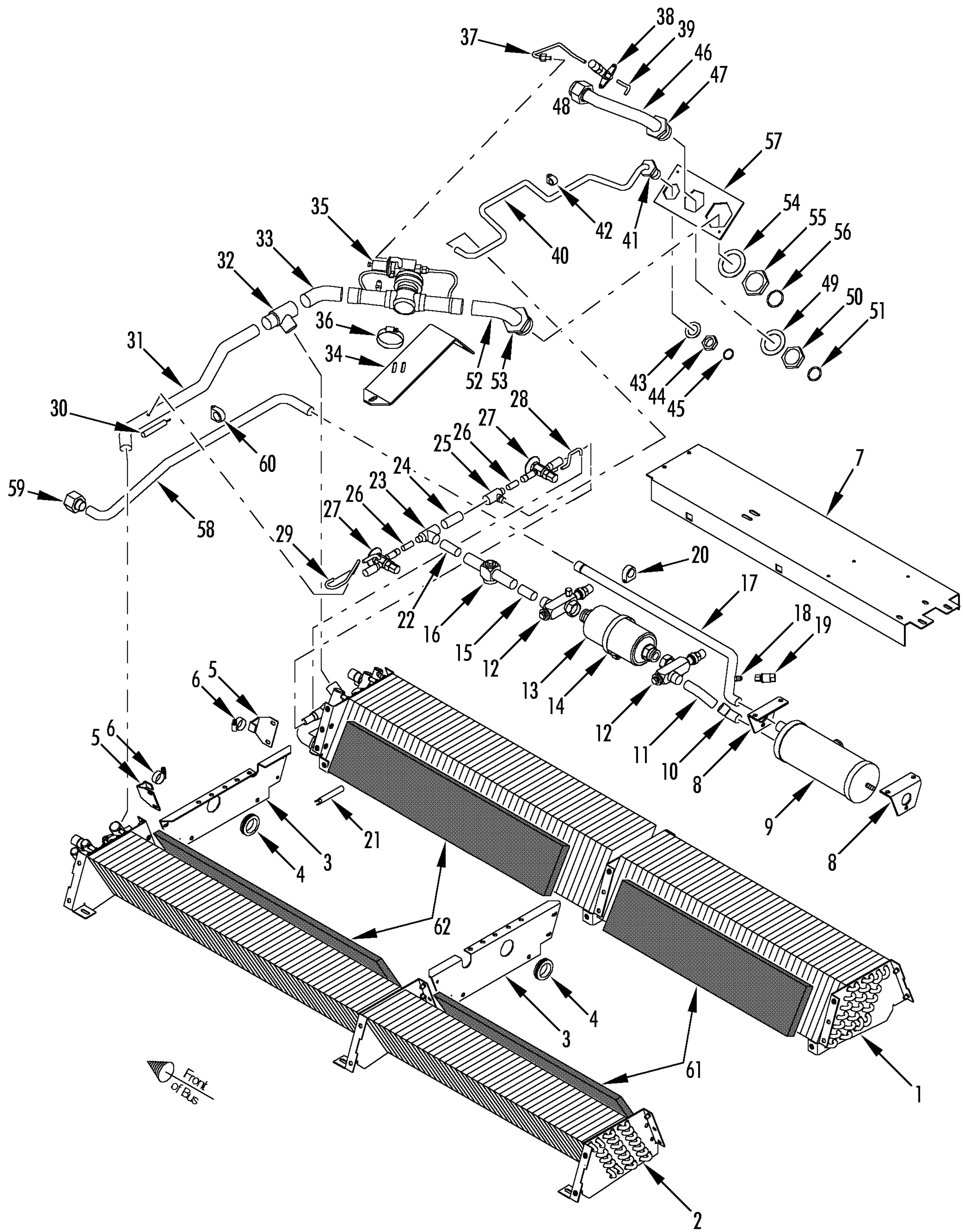
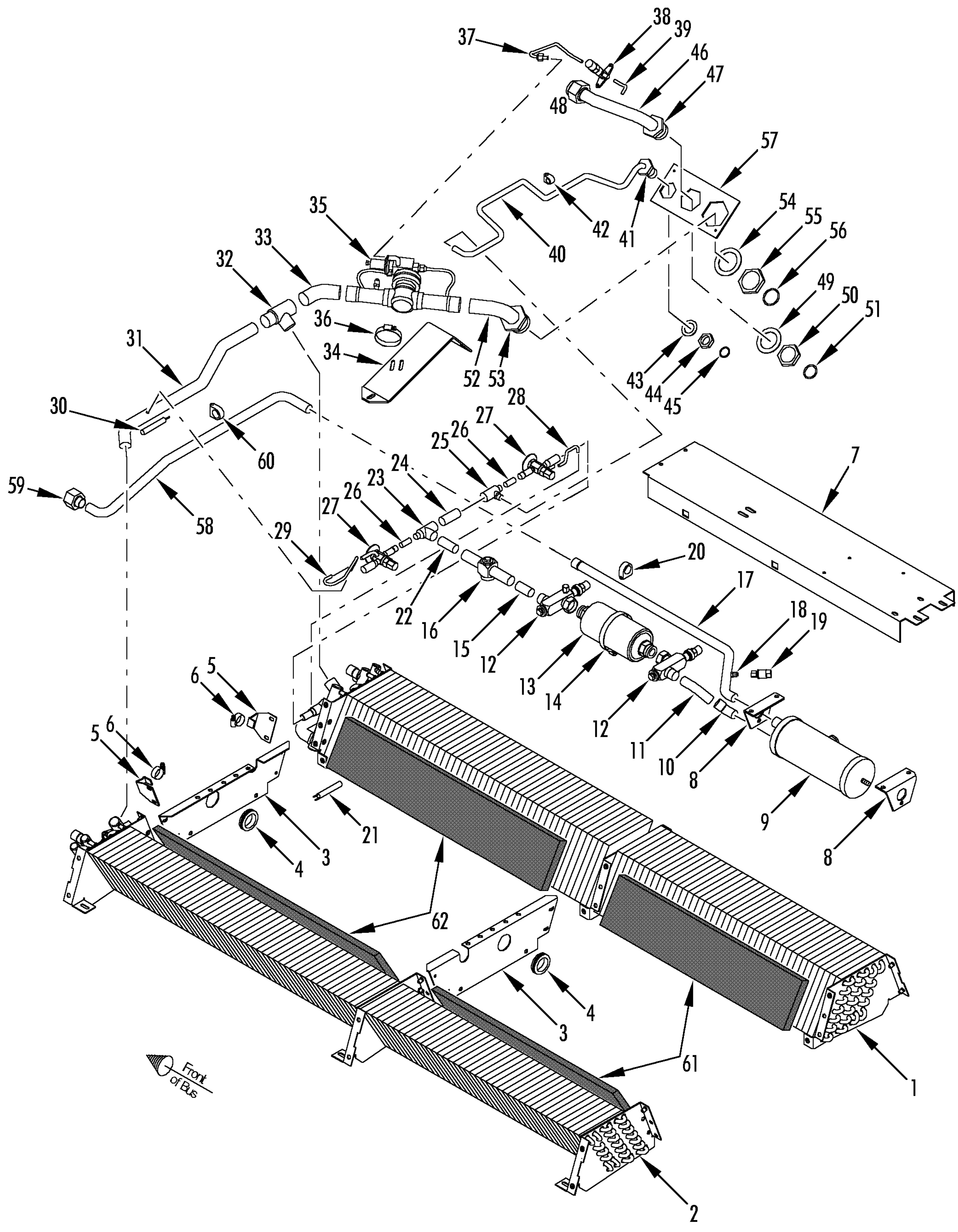
Front of Bus

REF	PART#	DESCRIPTION	QTY
1	67-2112	COIL - evaporator, curbside	1
2	67-2113	COIL - evaporator, roadside	1
	55-2957	SCREW - coil	9
	55-1800	LOCKWASHER	9
	55-4414	WASHER - spl (0.281 id)	9
3	92-4650	PLATE - evap, center	2
	55-2957	SCREW - plate	12
	55-1800	LOCKWASHER	12
	55-2086	FLATWASHER	12
4	33-1770	GROMMET (1.50 in id)	2
5	92-4651	PLATE - support, expansion valve	2
	55-2957	SCREW - plate	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
6	55-2818	CLAMP (0.750 dia)	2
7	98-7102	PLATE - mount tubing	1
	55-2957	SCREW - plate	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
8	92-4652	BRACKET - receiver tank	2
	55-2957	SCREW - bracket	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
	55-8979	INSERT	4
9	67-2114	TANK - receiver	1
	66-9918	• INDICATOR - liquid	1
	33-2419	• O-RING (1-1/6 od)	1
	55-4955	NUT - receiver tank	2
	55-2641	FLATWASHER	3
10	55-2825	ELBOW (7/8 ftg)	1
11	61-3082	TUBE - receiver tank to shutoff valve	1
12	66-5946	VALVE - shutoff	2
	55-8926	SCREW - valve	2
	55-2363	LOCKWASHER	2
	55-4931	WASHER - spl	2
13	306-221	DEHYDRATOR	1
14	55-7800	CLAMP (1.00 in dia)	1
15	61-3083	TUBE (1.750 in lg)	1
16	66-6976	INDICATOR - liquid	1
17	61-3084	TUBE - liquid, receiver tank	1
18	66-9842	• VALVE	1
19	41-2264	SWITCH - hpco	1


Front of Bus

REF	PART#	DESCRIPTION	QTY
	41-6358	• SWITCH - only	1
20	55-7013	CLAMP - tube	1
	55-3462	SCREW - clamp	1
	55-2086	FLATWASHER	2
	55-4953	NUT	1
21	41-5136	SENSOR - temp	1
22	61-3085	TUBE (2.00 in lg)	1
23	55-7503	TEE (7/8 x 1/2 x 1/2)	1
24	61-3086	TUBE (2.125 in lg)	1
25	51-1168	TEE (7/8 x 1/2 x 1/2)	1
26	61-1349	TUBE (1.20 in lg)	1
27	61-3087	VALVE - expansion (R22)	2
28	61-3088	TUBE - equalizer, roadside	1
29	61-3089	TUBE - equalizer, curbside	1
30	41-6407	SENSOR - temp	1
31	61-3090	TUBE - suction	1
32	55-4308	TEE (1 3/8 x 1-1/8 x 1-1/8)	1
33	61-3091	TUBE - suction, reducer	1
34	92-4653	BRACKET - support valve	1
	55-2957	SCREW - bracket	3
	55-1800	LOCKWASHER	3
	55-2086	FLATWASHER	3
35	66-5136	VALVE - epr (see 129C13)	1
36	55-1636	CLAMP - valve	1
37	61-3092	TUBE - equalizer, shutoff valve	1
38	66-4102	VALVE - shutoff	1
	55-2991	SCREW - shutoff valve	2
	55-2964	LOCKWASHER	2
	55-2001	FLATWASHER	2
39	61-3093	TUBE - equalizer shutoff valve	1
40	61-3094	TUBE - liquid line	1
41	55-7064	ADAPTER - bulkhead (#10)	1
42	55-6389	CLAMP - tube	1
	55-3121	SCREW - clamp	1
	55-1800	LOCKWASHER	1
	55-2086	FLATWASHER	1
43	55-6843	LOCKWASHER (1.02 in id)	1
44	55-6811	NUT - bulkhead (1-1/4)	1
45	33-1223	O-RING (9/16 id)	1
46	61-3095	TUBE - discharge	1
47	55-6415	• ADAPTER - bulkhead (#20)	1
48	55-5935	• NUT - shoulder	1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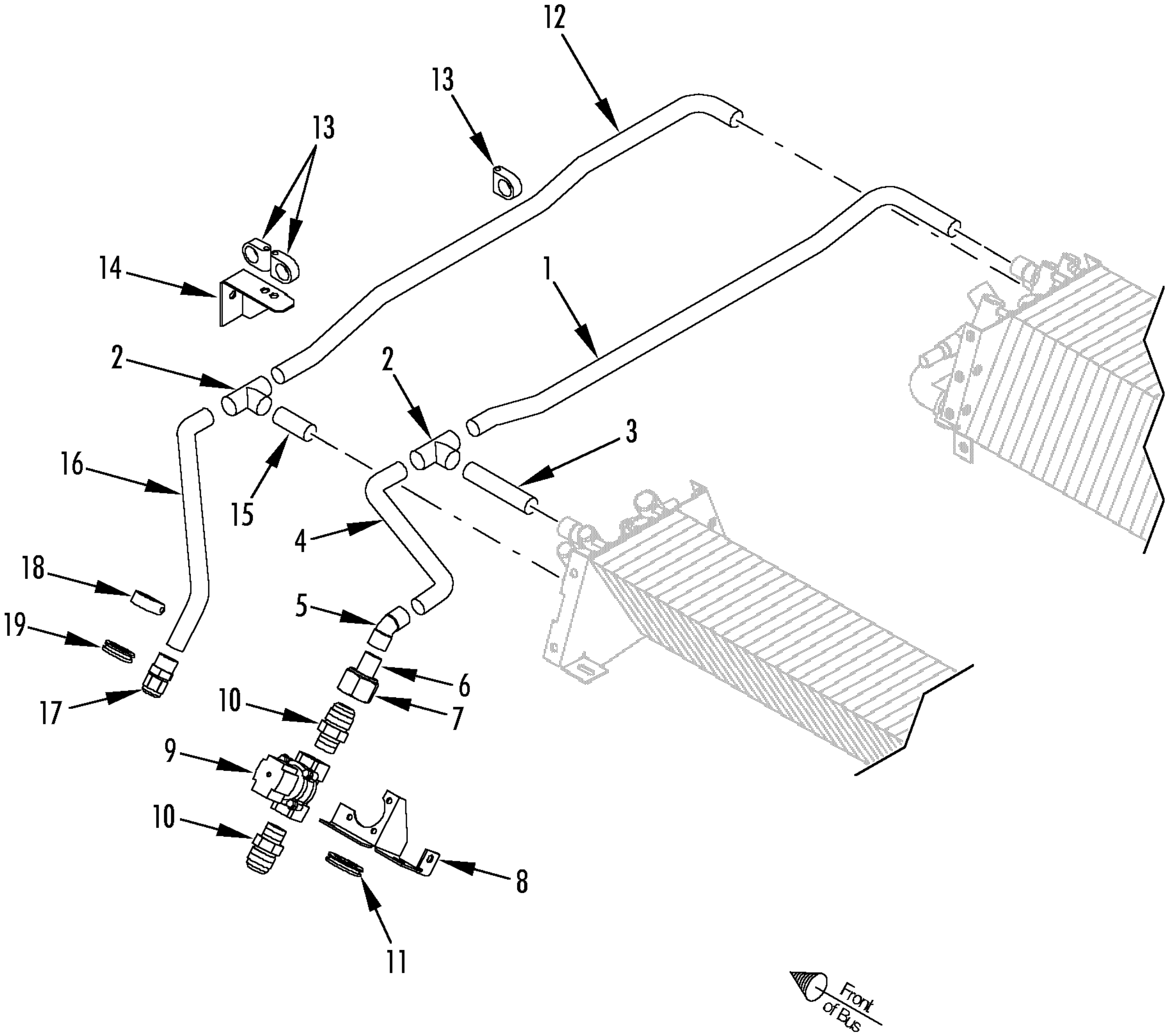
REF	PART#	DESCRIPTION	QTY
	55-5939	• SLEEVE - adapter (#20)	1
49	55-5742	LOCKWASHER	1
50	55-9231	NUT - bulkhead (1-11/16-12)	1
51	33-1777	O-RING (1-3/16 id)	1
52	61-3096	TUBE - suction	1
53	55-6570	• ADAPTER - bulkhead	1
54	55-5999	LOCKWASHER (2-01 id)	1
55	55-9422	NUT - bulkhead (2-12)	1
56	33-920	O-RING (1-1/2 id)	1
57	92-4654	PLATE - bulkhead fittings	1
	55-2864	RIVET - plate	2
58	61-3097	TUBE - liquid line	1
59	55-7201	NUT - shoulder	1
	55-9339	SLEEVE (#16)	1
60	55-7013	CLAMP - tube	1
	55-3344	SCREW - clamp	1
	55-2086	FLATWASHER	2
	55-4953	NUT	1
61	92-4655	FILTER - air (30.50 in x 6.50 in x 1.0 in)	2
62	92-4656	FILTER - air (37.00 in x 6.50 in x 1.0 in)	2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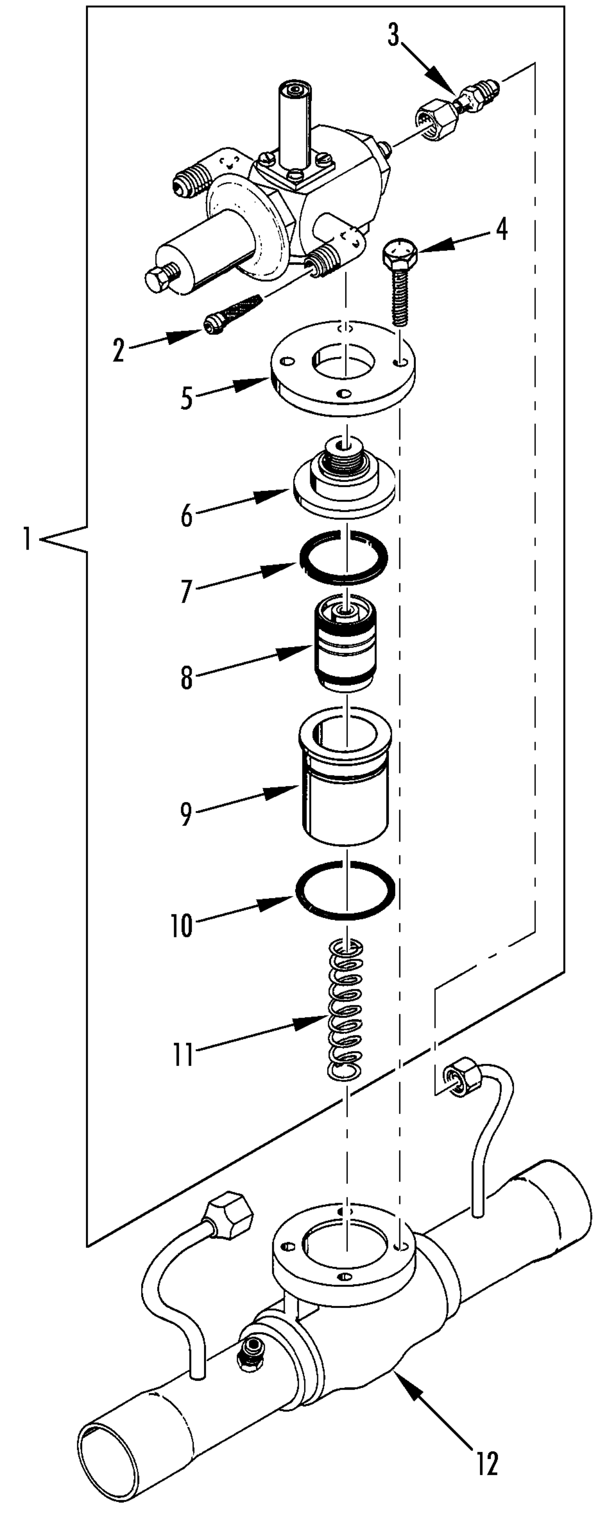
REF	PART#	DESCRIPTION	QTY
1	61-3098	TUBE - water outlet, curbside	1
2	55-6174	ELBOW (7/8 x 7/8 x 7/8)	2
3	61-3099	TUBE (4.25 in lg)	1
4	61-3100	TUBE - water outlet	1
5	55-4276	ELBOW (45 deg, 7/8 sld)	1
6	61-3101	TUBE - water outlet	1
7	55-9951	NUT (7/8, brs)	1
8	92-4657	BRACKET - solenoid valve	1
	55-2957	SCREW - bracket	2
	55-1800	LOCKWASHER	2
	55-2086	FLATWASHER	2
9	41-5610	• VALVE - solenoid (water, 24V see 147A1, for connectors see 115D14)	1
10	55-9334	COUPLING - valve	1
11	33-1217	GROMMET (1.375 in id)	1
12	61-3102	TUBE - water inlet, roadside	1
13	55-7013	CLAMP - tube	3
	55-3462	SCREW - clamp	3
	55-1800	LOCKWASHER	3
	55-2086	FLATWASHER	3
	55-8711	INSERT	3
14	92-4658	BRACKET - support	1
	55-2957	SCREW - bracket	1
	55-1800	LOCKWASHER	1
	55-2086	FLATWASHER	1
	55-8711	INSERT	1
15	61-3086	TUBE (2.125 in lg)	1
16	61-3103	TUBE - water inlet, roadside	1
17	55-4274	• ADAPTER (3/4 fl x 7/8 sld)	1
18	55-7013	CLAMP - tube	1
	55-3344	SCREW - clamp	1
	55-2086	FLATWASHER	2
	55-4953	NUT	1
19	33-3917	GROMMET	1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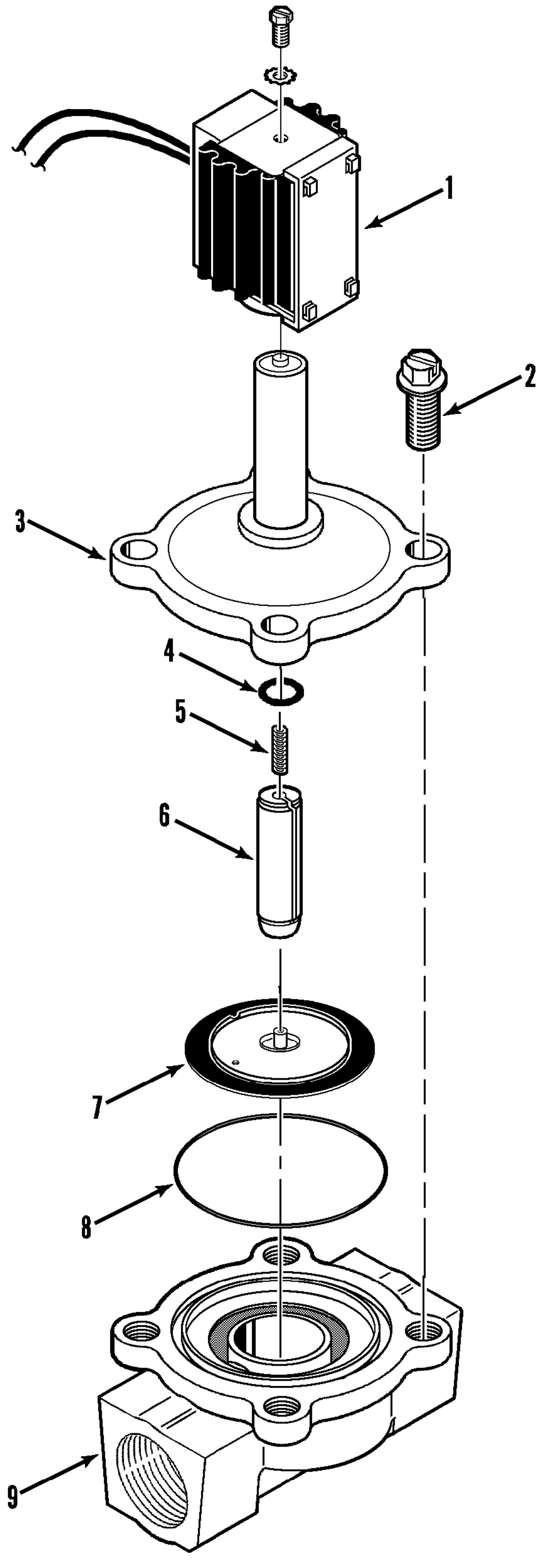
REF	PART#	DESCRIPTION	QTY
	66-8122	VALVE - epr (R134a)	1
	66-5136	VALVE - epr (R12, R22, R407C)	1
1	60-180	KIT - internal parts	1
2	NSS	• SCREW	1
3	NSS	• ADAPTER - outlet	1
4	NSS	• SCREW - cap	4
5	NSS	• FLANGE	1
6	NSS	• ADAPTER	1
7	NSS	• GASKET	1
8	NSS	• PISTON - assembly	1
9	NSS	• SLEEVE	1
10	NSS	• O-RING	1
11	NSS	• SPRING	1
12	NSS	BODY - valve	1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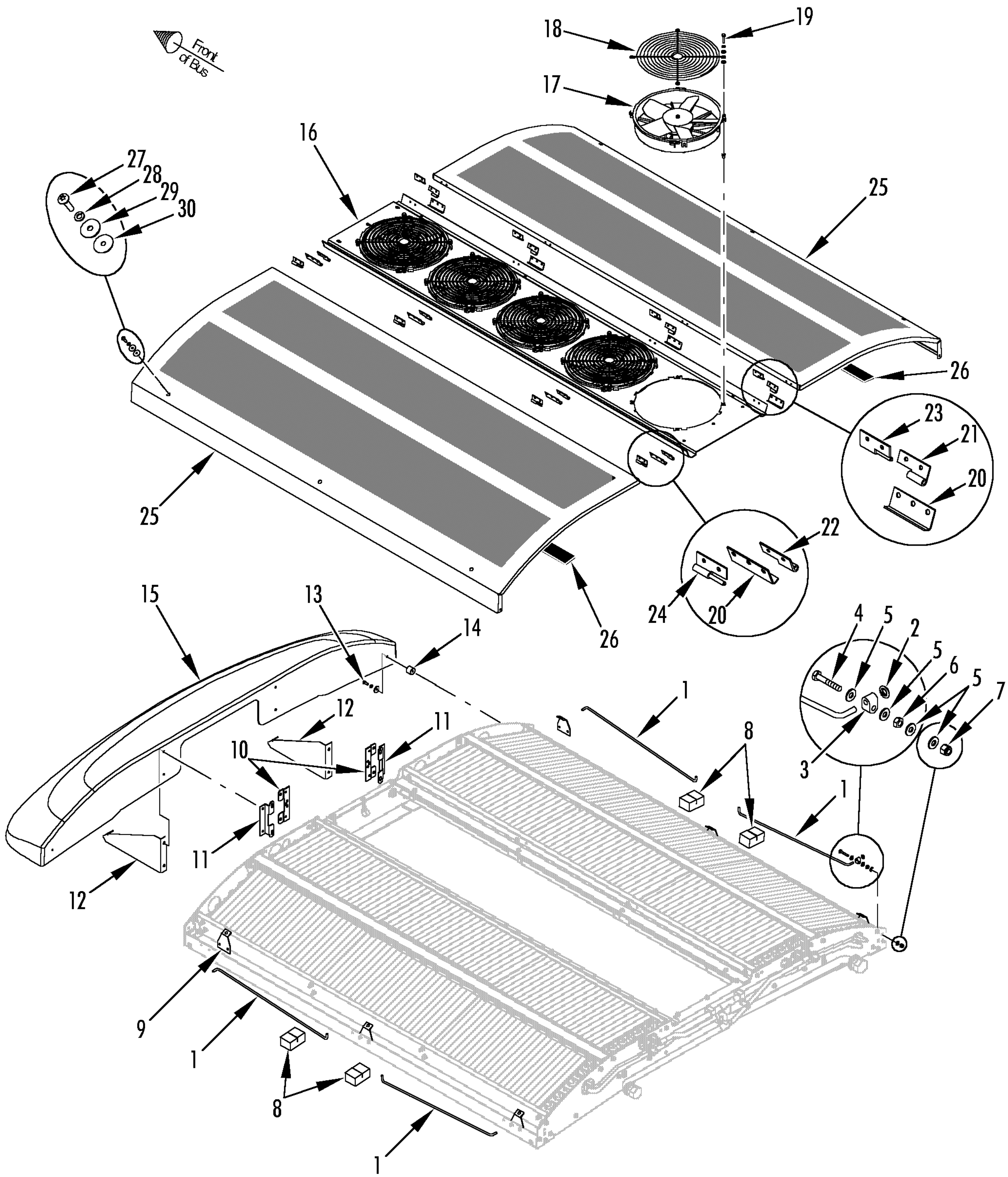
REF	PART#	DESCRIPTION	QTY
	41-4801	VALVE - solenoid (12V)	1
	41-4529	VALVE - solenoid (24V)	1
1	41-3681	• COIL (12V)	1
	44-7553	• COIL - valve (24V)	1
2	NSS	• SCREW	4
	60-262	• KIT - solenoid repair	1
3	NSS	•• COVER - body	1
4	NSS	•• GASKET	1
5	NSS	•• SPRING	1
6	NSS	•• PLUNGER	1
7	NSS	•• DIAPHRAGM	1
8	NSS	•• SEAL	1
9	NSS	•• BODY	1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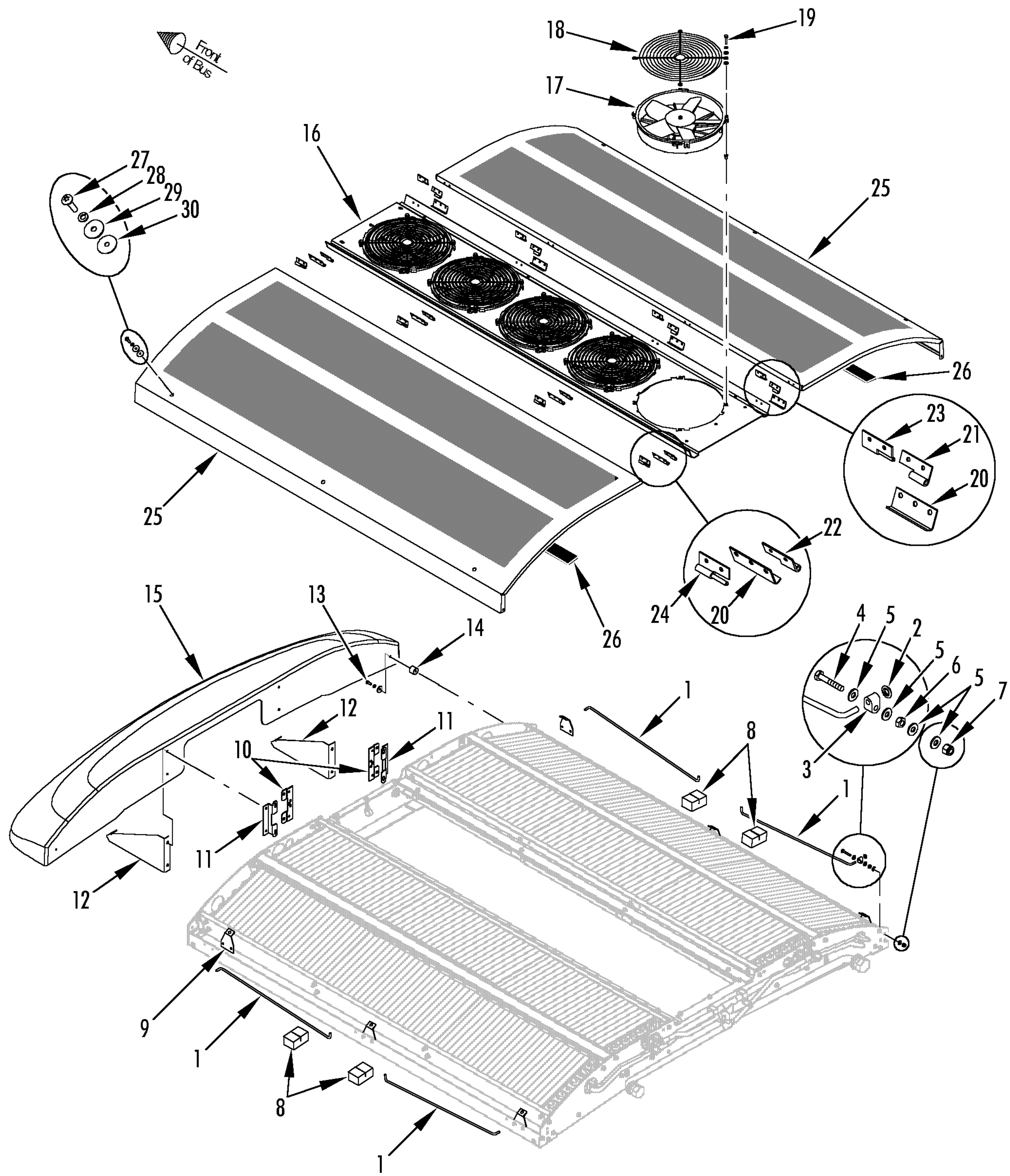
REF	PART#	DESCRIPTION	QTY
1	92-4147	ROD - prop, covers	4
2	55-6416	CAP	4
3	55-6544	CLAMP	4
4	55-3121	SCREW - clamp	4
5	55-2086	FLATWASHER	16
6	55-1801	NUT - hex	4
7	55-4953	NUT - lock	4
8	92-4148	BLOCK - prop rod	4
9	92-4659	BRACKET - support, cover	6
	55-8711	INSERT (1/4-20)	6
	55-3027	SCREW - bracket	12
	55-2964	LOCKWASHER	12
	55-2001	FLATWASHER	12
	55-8798	INSERT	12
10	92-4660	BRACKET - support, nose cone	2
	55-8711	INSERT (1/4-20)	2
	55-2977	SCREW - bracket	6
	55-1800	LOCKWASHER	6
	55-2086	FLATWASHER	6
	55-8979	INSERT	2
11	92-4661	BRACKET - mount	2
	55-2977	SCREW - bracket	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
12	92-4662	SUPPORT - nose cone	2
	55-2977	SCREW - support to bracket	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
	55-8711	INSERT	4
	55-4953	NUT - mtg support to nose cone	2
	55-4414	WASHER - spl (0.281 id)	4
13	55-3018	SCREW - nose cone	2
	55-1800	LOCKWASHER	2
	55-2086	FLATWASHER	2
14	51-1169	SPACER - nose cone	2
	55-3018	SCREW - spacer to coil	2
	55-1800	LOCKWASHER	2
	55-2086	FLATWASHER	2
15	98-7103	NOSE CONE	1
16	98-7104	PANEL - center condenser fans	1
	55-2977	SCREW - panel (1/4-20 x 1.6 in lg)	6
	55-2957	SCREW - panel (1/4-20 x 7/8 in lg)	8


Front of Bus
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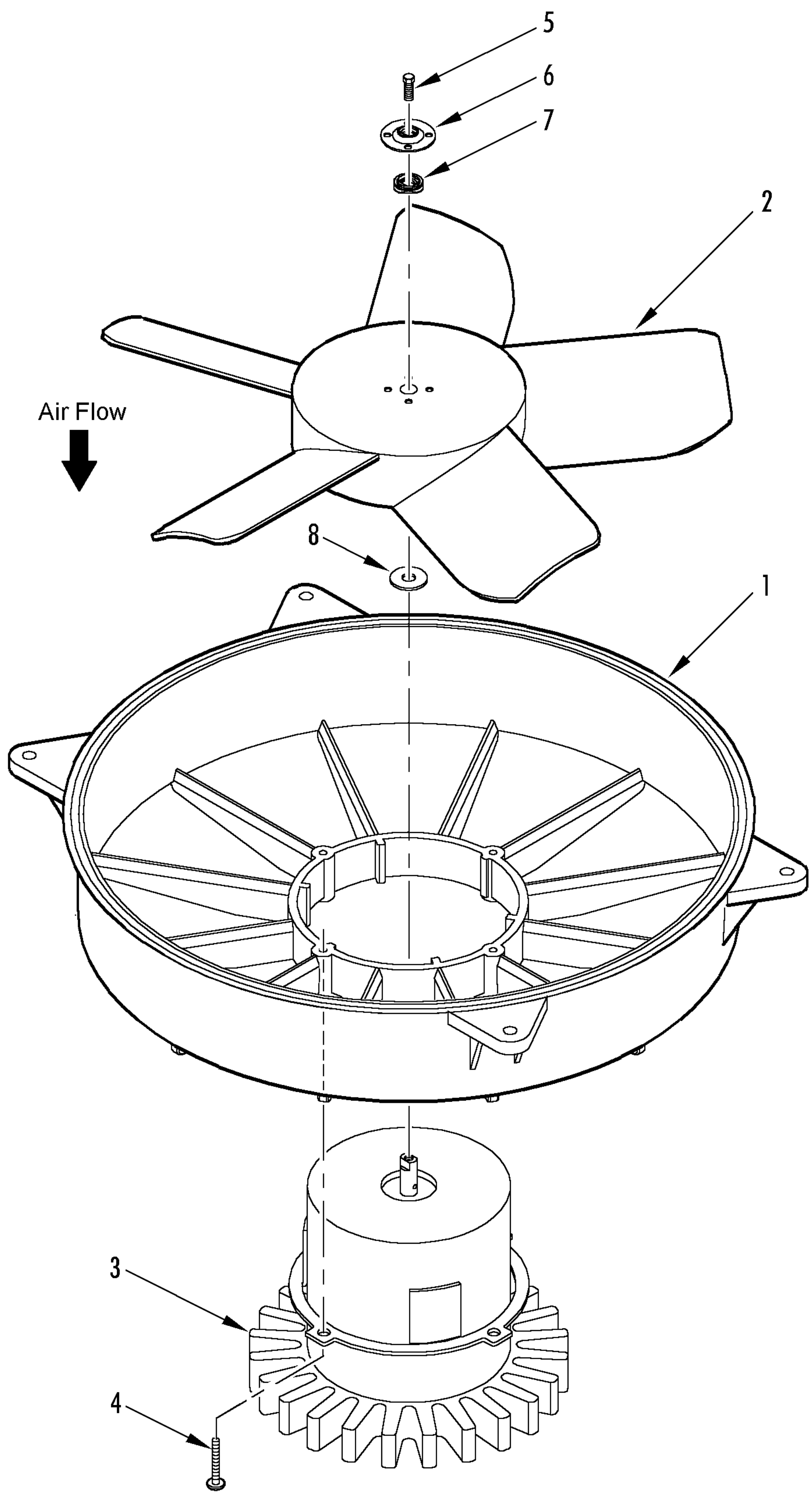
REF	PART#	DESCRIPTION	QTY
	55-1800	LOCKWASHER	14
	55-2086	FLATWASHER	14
17	78-1344	FAN - condenser (24VDC)	5
18	98-5425	GUARD - fan	5
19	55-2979	SCREW - guard & fan	20
	55-1800	LOCKWASHER	20
	55-2086	FLATWASHER	40
	55-8711	INSERT	20
20	92-4146	BRACKET - guide, cover	8
21	99-8770	HINGE - cover, curbside	4
22	99-8056	HINGE - cover, roadside	4
	55-3027	SCREW - hinge to panel	16
	55-2001	FLATWASHER	16
	55-4560	NUT	16
23	92-4145	HINGE - cover, curbside	4
24	92-4663	HINGE - cover, roadside	4
	55-5975	SCREW - hinge	16
	55-2996	LOCKWASHER - int th	16
	55-2965	NUT	16
25	98-7105	COVER - cond	2
26	92-3185	STRIP - insulation (cut to 6.25 ft)	A/R
27	55-5965	SCREW - cover	6
28	55-1800	LOCKWASHER	6
29	55-4742	WASHER - spl (0.266 in id)	6
30	51-1170	WASHER - nylon	6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Air Flow
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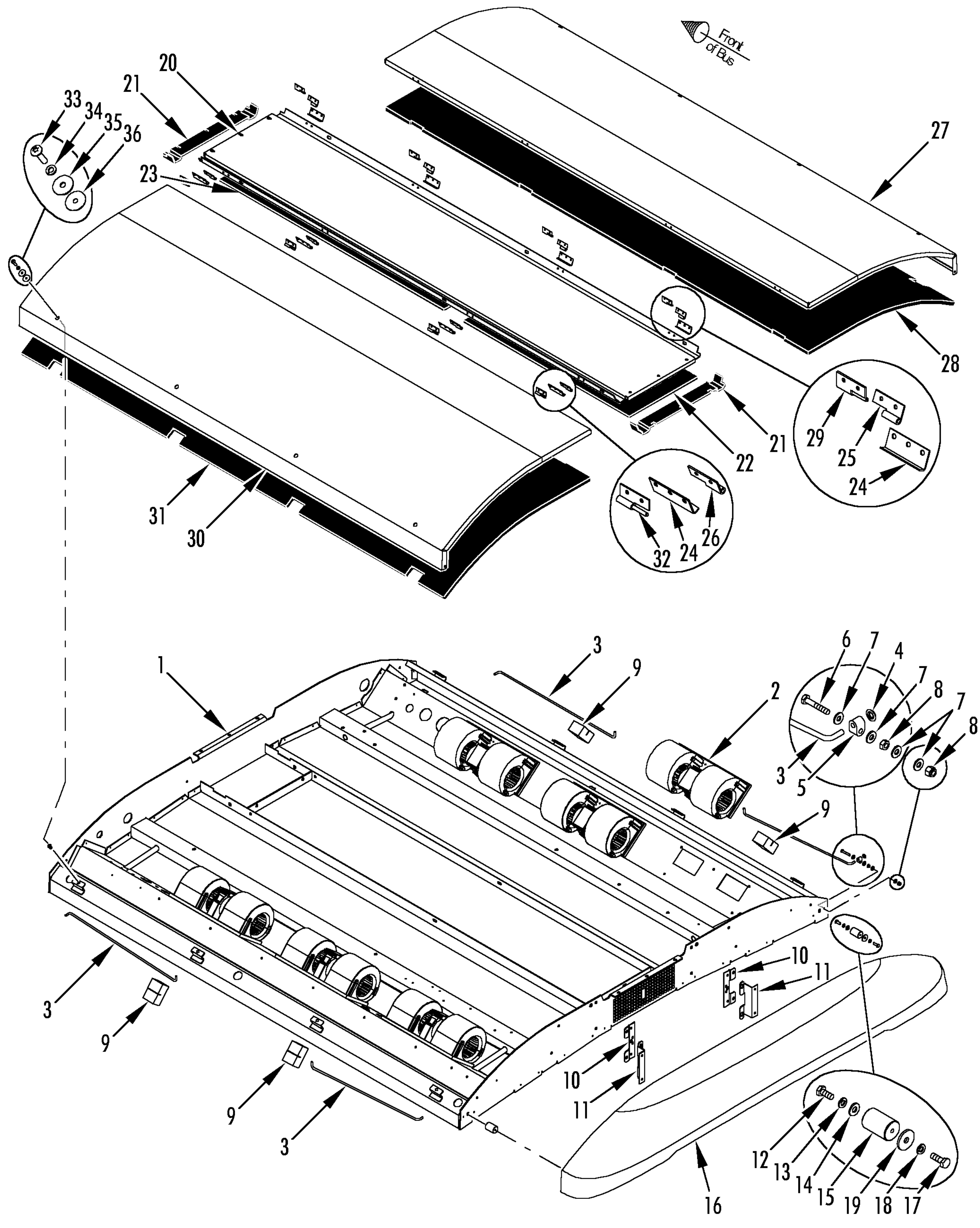
REF	PART#	DESCRIPTION	QTY
	40-912	KIT - motor, condenser fan (complete, downward air flow)	1
1	98-5603	• SHROUD - fan	1
2	78-1224	• FAN - condenser (downward air flow)	1
3	NSS	• MOTOR - fan (0.28 hp, 10 amp 24VDC)	1
4	55-9317	• SCREW - shroud to motor	4
5	55-9547	• SCREW - fan	1
6	55-9546	• WASHER - drive	1
7	77-2606	• GASKET - hub	1
8	55-9545	• WASHER - thrust	1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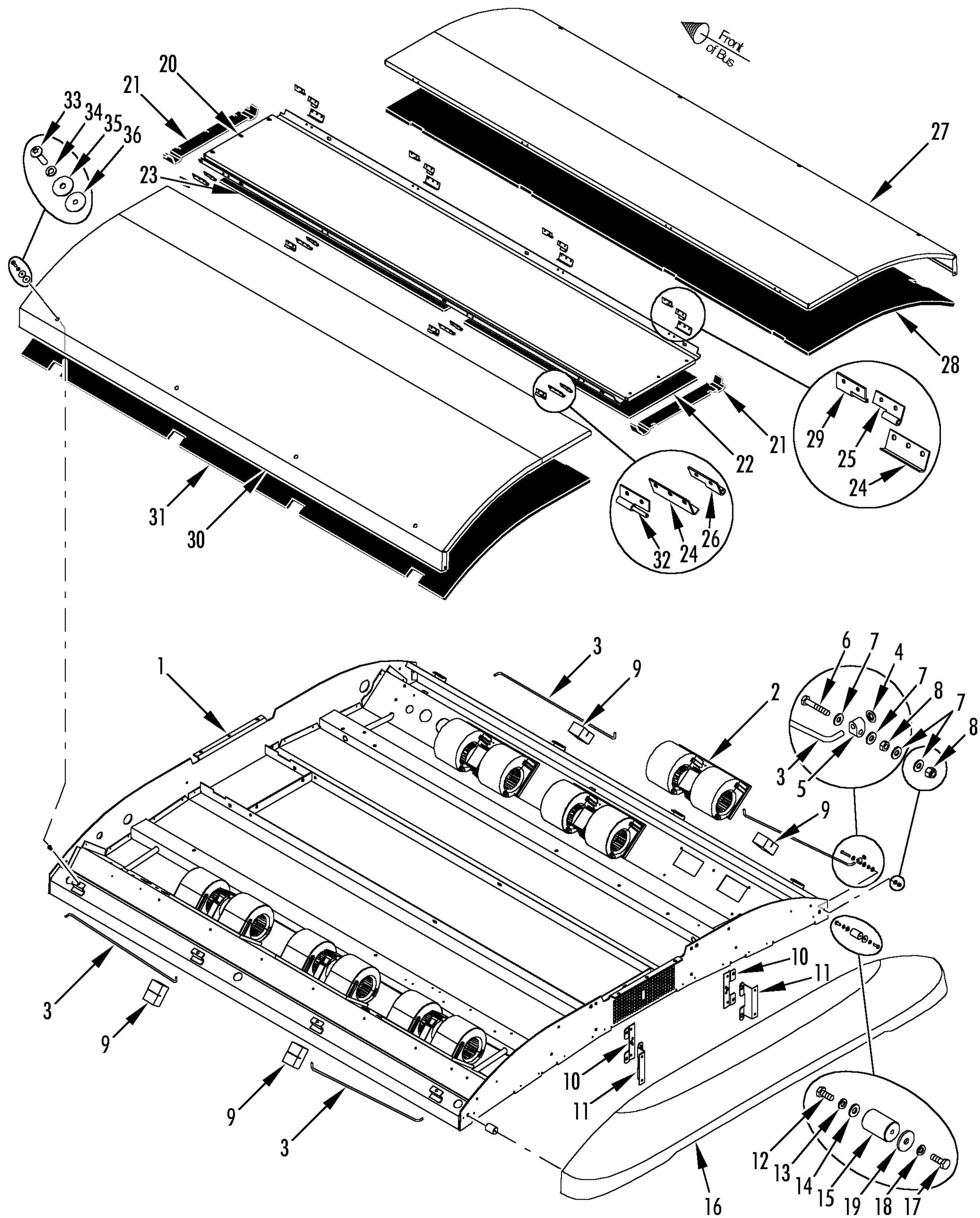
REF	PART#	DESCRIPTION	QTY
1	98-7106	FRAME - evaporator	1
	55-8711	INSERT (1/4-20)	22
	55-8979	INSERT (1/4-20 brs)	12
	51-724	INSERT (8-32)	30
	55-8798	INSERT (10-32)	2
2	78-1297	BLOWER - dual evaporator	6
	55-2989	SCREW - evaporator	30
3	92-4147	ROD - prop, covers	4
4	55-6416	CAP	4
5	55-6544	CLAMP - rod	4
6	55-3121	SCREW - clamp	4
7	55-2086	FLATWASHER	16
8	55-4953	NUT	4
9	91-4148	BLOCK - foam, prop rod	4
10	92-4660	BRACKET - support, nose cone	2
	55-2957	SCREW - bracket	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
	55-8711	INSERT	4
11	92-4664	SUPPORT - nose cone	2
	55-2977	SCREW - support to bracket	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
	55-2977	SCREW - nose cone to support	4
	55-2086	FLATWASHER	4
	55-4014	WASHER - spl (0.281 id)	4
	55-4953	NUT	4
12	55-3018	SCREW - support to nose cone	2
13	55-1800	LOCKWASHER	2
14	55-2086	FLATWASHER	2
15	51-1171	SPACER - nose cone	2
16	98-7107	NOSE CONE - evaporator	1
17	55-1587	SCREW - nose cone	2
18	55-1800	LOCKWASHER	2
19	55-4414	WASHER - spl (0.281 id)	2
20	98-7108	CHANNEL - support, center	1
	55-2957	SCREW - channel	12
	55-1800	LOCKWASHER	12
	55-2086	FLATWASHER	12
21	92-4665	STRIP - insulation	2
22	92-4666	INSULATION - panel	1
23	92-4667	INSULATION - panel	1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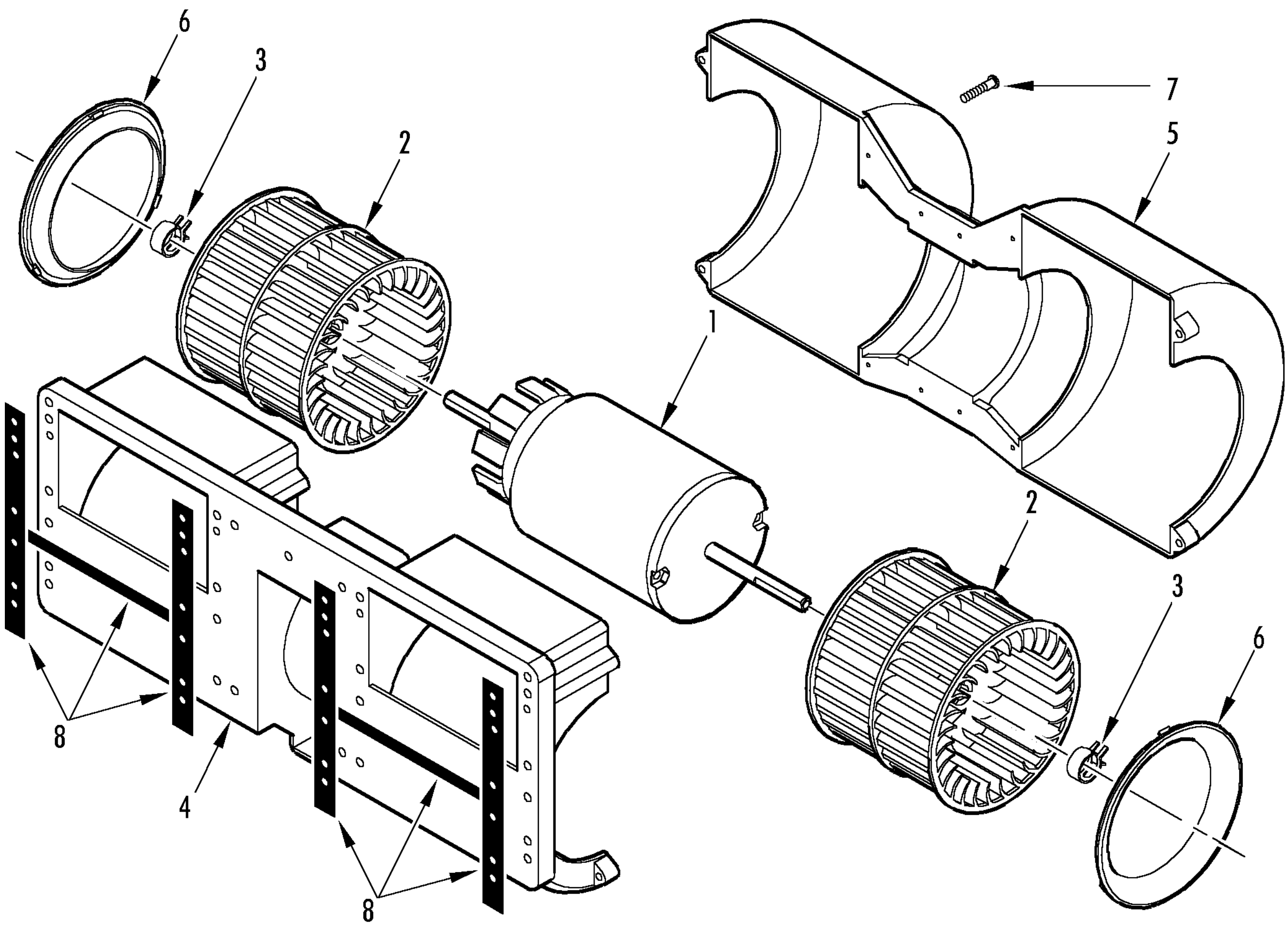
REF	PART#	DESCRIPTION	QTY
24	92-4146	BRACKET - guide, cover	8
25	99-8056	HINGE - cover, roadside	4
26	99-8870	HINGE - cover, curbside	4
	55-3027	SCREW - hinge to channel	16
	55-2001	FLATWASHER	16
	55-4560	NUT	16
27	98-7109	COVER - evaporator, roadside	1
28	92-4668	INSULATION - cover	1
29	92-4145	HINGE - cover, curbside	4
	55-5975	SCREW - hinge	8
	55-2996	LOCKWASHER - int tooth	8
	55-2965	NUT	8
30	98-7109	COVER - evaporator, curbside	1
31	92-4668	INSULATION - cover	1
32	92-4663	HINGE - cover, roadside	4
	55-5975	SCREW - hinge	8
	55-2996	LOCKWASHER - int tooth	8
	55-2965	NUT	8
33	55-5965	SCREW - cover	8
34	55-1800	LOCKWASHER	8
35	55-4742	WASHER - spl (0.266 id)	8
36	51-1170	WASHER - nylon	8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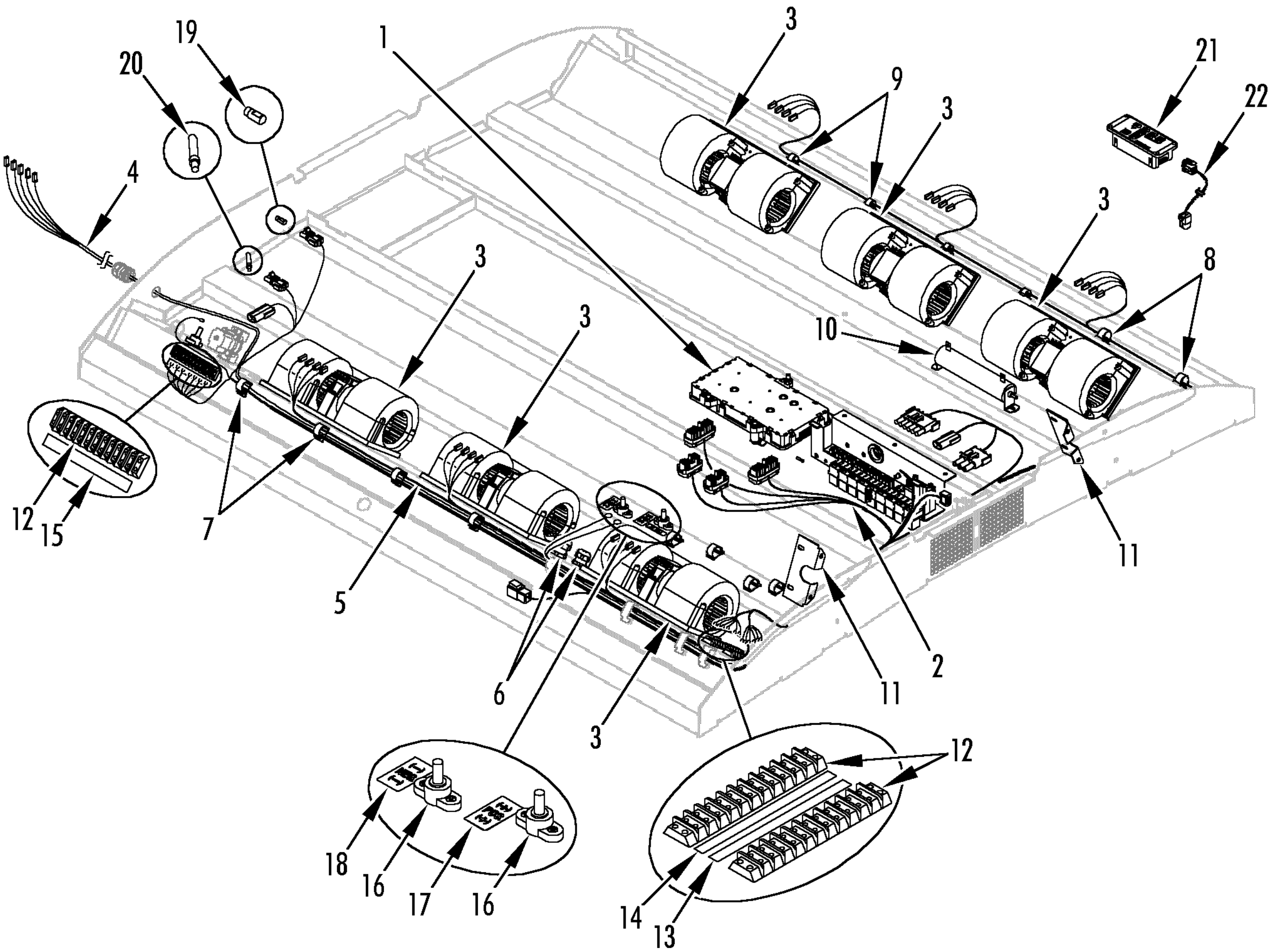
REF	PART#	DESCRIPTION	QTY
1	78-1461	MOTOR - blower	1
2	77-2576	• WHEEL - blower	2
3	55-9318	• CLIP - spring	2
4	98-5608	• HOUSING - bottom	1
5	98-5609	• HOUSING - top	1
6	77-2577	• RING - inlet	2
7	55-9319	• SCREW - special	12
8	99-4976	STRIP - neoprene (50 ft)	A/R
	55-3511	SCREW - blower & motor	30
	55-2202	LOCKWASHER	30
	55-2201	FLATWASHER	30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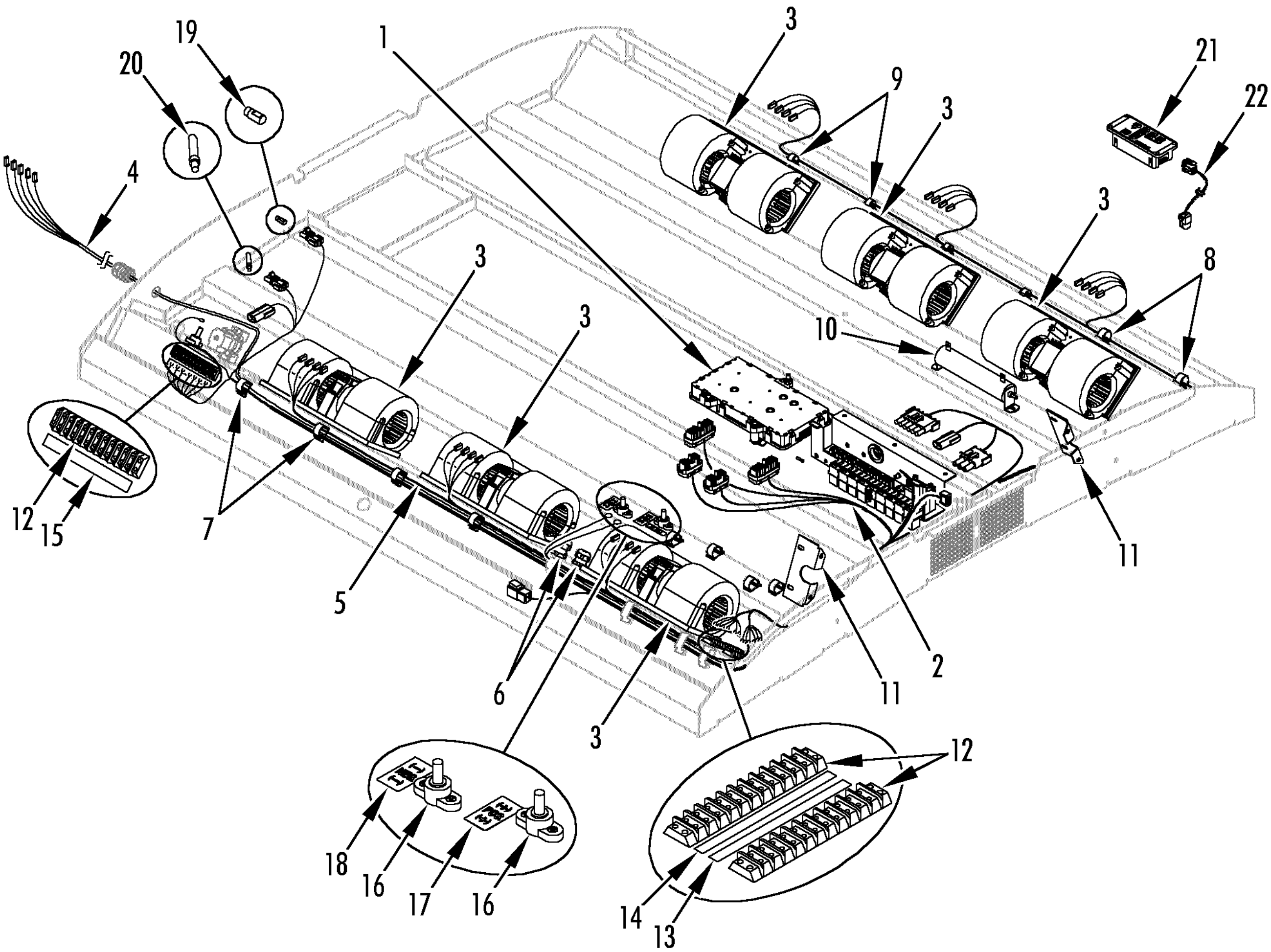
REF	PART#	DESCRIPTION	QTY
1	ASQ	PANEL - control (see 200C3)	1
2	41-6559	HARNESS - main, IntelligAIRE II	1
	41-8197	CONNECTOR - jumper	1
3	78-1297	BLOWER - dual, evaporator (see 197F1)	6
4	41-6560	HARNESS - blowers	1
5	41-6561	HARNESS - blowers	1
6	41-4817	CONNECTOR - liquid tite	3
	55-2635	NUT - lock	3
	41-4188	CONNECTOR - liquid tite	1
	55-2636	NUT - lock	1
7	99-9648	CLIP - wire (0.750 dia)	13
8	91-2633	CLIP - wire	3
9	99-9647	CLIP - wire (0.500 dia)	5
10	44-7131	RESISTOR (0.2 Ohm)	1
	55-2957	SCREW - resistor	2
	55-3018	SCREW - connection	2
	55-2086	FLATWASHER	8
	55-1800	LOCKWASHER	4
	55-1801	NUT	2
11	92-4669	PLATE - block	2
	55-2957	SCREW - plate	4
	55-1800	LOCKWASHER	4
	55-2086	FLATWASHER	4
	33-489	GROMMET (1.250 id)	2
	99-2280	EXTRUSION - rubber	A/R
12	44-6255	BOARD - terminal	3
	55-3687	SCREW - terminal board	6
13	92-4670	MARKSTRIP	1
14	92-4671	MARKSTRIP	1
15	92-4672	MARKSTRIP	1
16	51-1172	STUD - junction block	3
	51-749	SCREW - block	6
	55-3066	LOCKWASHER - int th (3/8)	3
	55-448	FLATWASHER (3/8)	4
	55-671	NUT - hex jam (3/8)	3
17	99-4660	NAMEPLATE - positive	1
18	99-4661	NAMEPLATE - negative	1
19	41-2264	SWITCH - hpco (R22)	1
	41-6358	• SWITCH - only (R22)	1
	41-6598	SWITCH - hpco (R134a)	1
	41-6599	• SWITCH - only (R134a)	1
20	41-6407	SENSOR	1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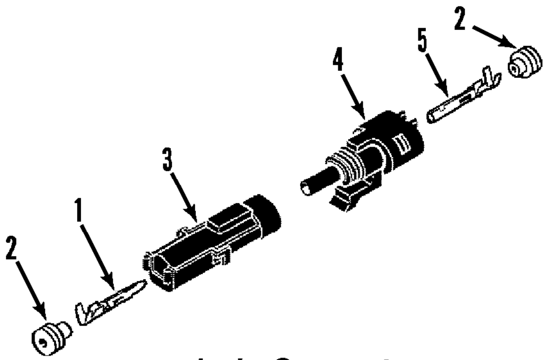
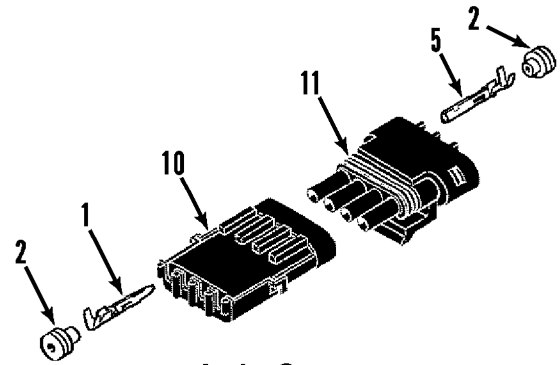
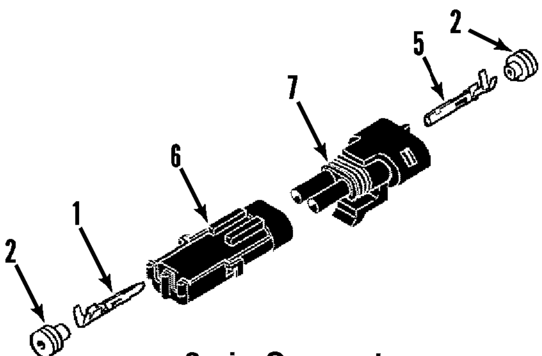
REF	PART#	DESCRIPTION	QTY
21	41-3618	MODULE - display, standard	1
22	41-6562	HARNESS - display (LRT-HP)	1
	41-5974	HARNESS - display (LRT-SP)	1



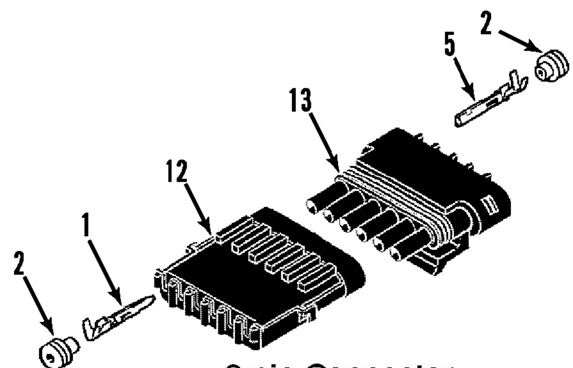
1 pin Connector



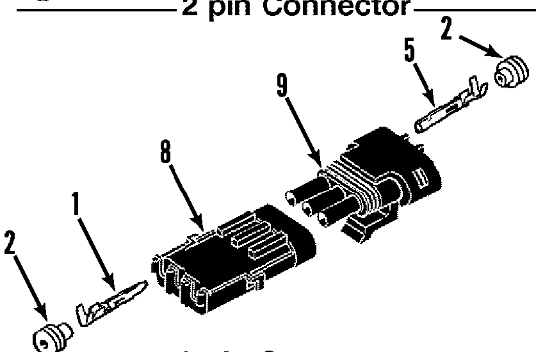
4 pin Connector



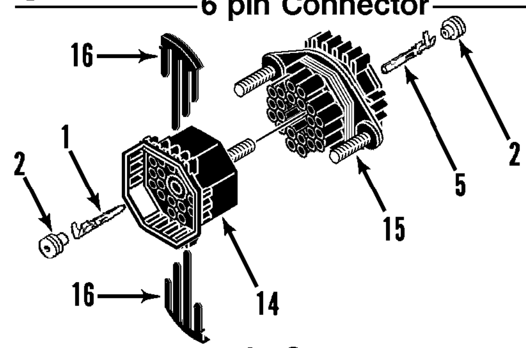
2 pin Connector



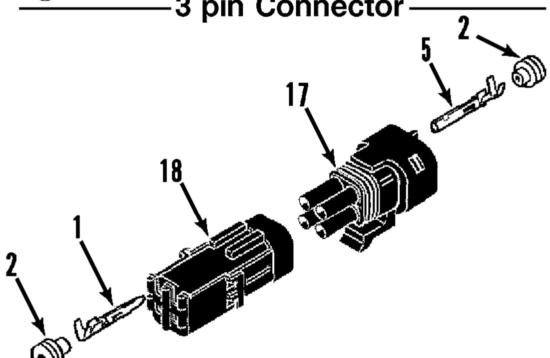
6 pin Connector



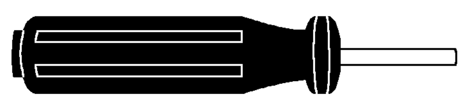
3 pin Connector



22 pin Connector



4 pin Connector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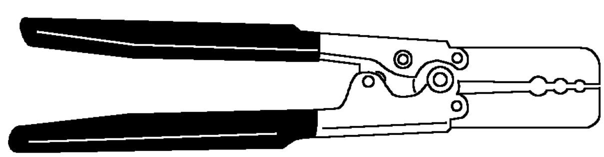
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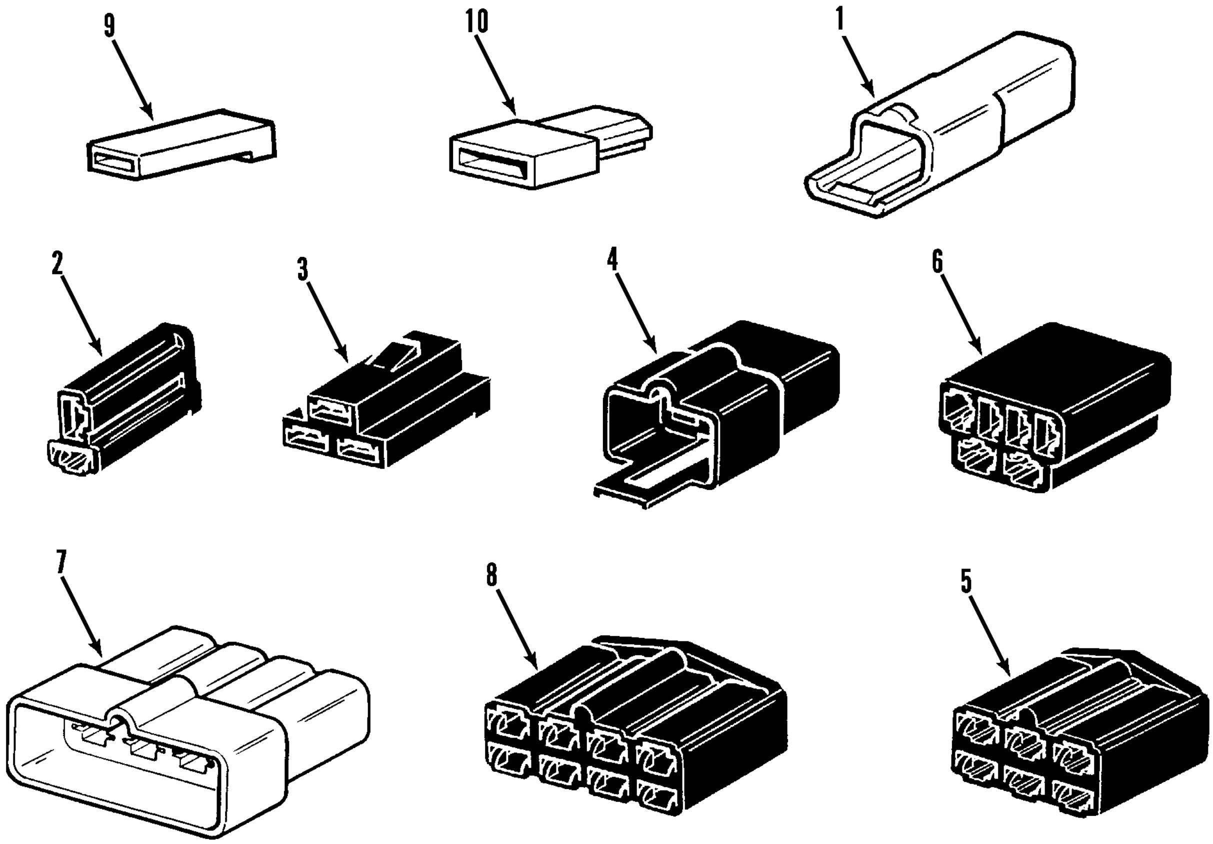
REF	PART#	DESCRIPTION	QTY
1	44-5836	TERMINAL - male (14-16 gauge)	A/R
	44-5883	TERMINAL - male (18-20 gauge)	A/R
	44-8851	TERMINAL - male (22 gauge)	A/R
2	44-8681	SEAL (red, 0.066 - 0.079 id)	A/R
	44-5885	SEAL (green, 0.087 - 0.110 id, 18-20 gauge)	A/R
	44-5837	SEAL (gray, 0.110 - 0.137 id, 14-16 gauge)	A/R
	44-6324	SEAL (blue, 0.137 - 0.165 id, 12-14 gauge)	A/R
	44-7812	PLUG - cavity (green, no hole)	A/R
3	44-7330	SHROUD (1 pin)	1
4	44-7327	CONNECTOR - tower (1 pin)	1
5	44-5839	TERMINAL (14-16 gauge, female)	A/R
	44-5884	TERMINAL (18-20 gauge, female)	A/R
	44-8853	TERMINAL (22 gauge, female)	A/R
6	44-5835	SHROUD (2 pin)	1
7	44-5838	CONNECTOR - tower (2 pin)	1
8	44-9569	SHROUD (3 pin)	1
9	44-6959	CONNECTOR - tower (3 pin)	1
10	44-7880	SHROUD (4 pin)	1
11	44-7881	CONNECTOR - tower (4 pin)	1
12	44-8294	SHROUD (6 pin)	1
13	44-7872	CONNECTOR - tower (6 pin)	1
14	44-7884	SHROUD (22 pin)	1
15	44-7829	CONNECTOR - tower (22 pin)	1
16	44-7811	LOCK - secondary	2
17	41-1527	CONNECTOR - tower (4 pin)	1
18	41-1310	SHROUD (4 pin)	1
19	204-623	TOOL - pin removal	1
20	204-624	TOOL - terminal crimper	1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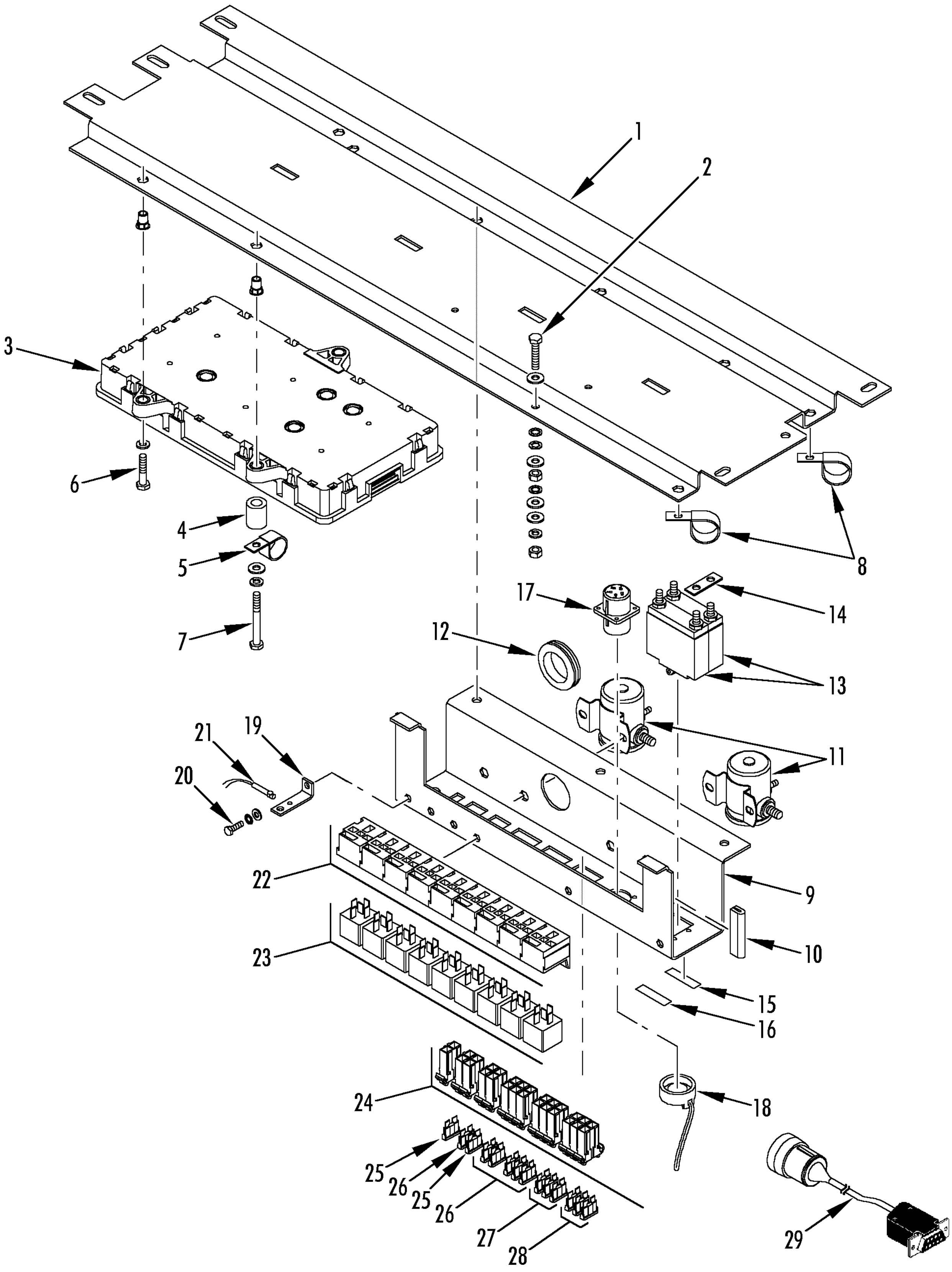
REF	PART#	DESCRIPTION	QTY
1	44-6381	CONNECTOR (1 pin)	A/R
2	44-5219	CONNECTOR (2 pin)	A/R
3	44-6248	CONNECTOR (3 pin)	A/R
4	44-5827	CONNECTOR (4 pin)	A/R
5	44-5030	CONNECTOR (6 pin)	A/R
6	44-5622	CONNECTOR (6 pin)	A/R
7	44-5718	CONNECTOR (8 pin)	A/R
8	44-5719	CONNECTOR (8 pin)	A/R
9	44-6292	CONNECTOR (1 pin)	A/R
10	44-6451	CONNECTOR (1 pin)	A/R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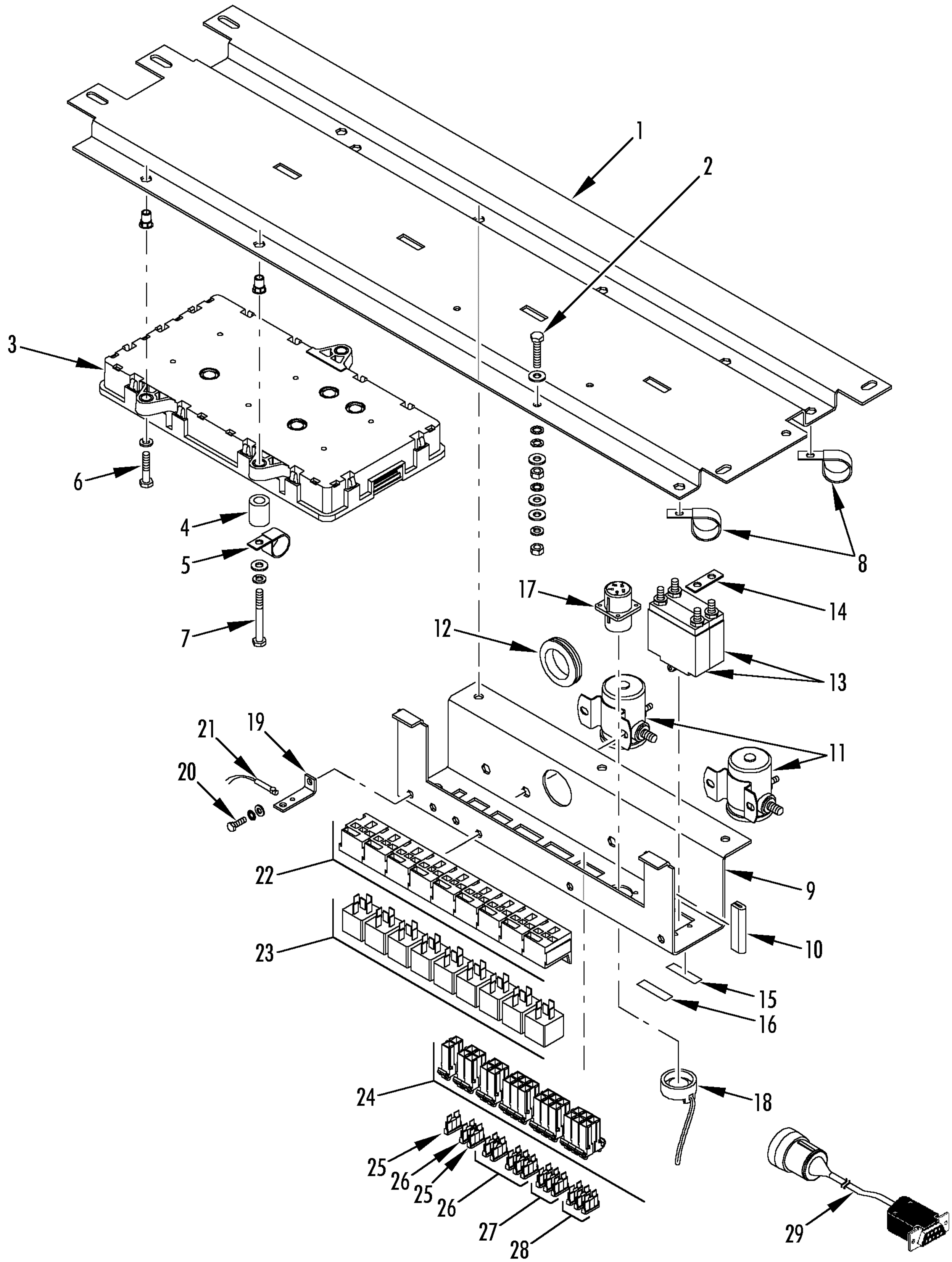
REF	PART#	DESCRIPTION	QTY
1	98-7110	PLATE - control panel	1
2	55-2979	SCREW - plate	6
	55-1800	LOCKWASHER	6
	55-2086	FLATWASHER	6
3	41-3616	MODULE - IntelligAIRE II (deluxe)	1
4	51-1173	SPACER (0.750 od x 1.00 in lg)	1
5	55-9721	CLAMP	1
6	55-3095	SCREW - module (2-1/4 in lg)	1
7	55-2979	SCREW - module (1-1/4 in lg)	1
	55-1800	LOCKWASHER	3
	55-2086	FLATWASHER	3
	55-8711	INSERT	3
8	55-9311	CLAMP (1.00 in dia)	2
9	98-7111	BRACKET - breaker & fuses	1
	55-2957	SCREW - bracket & clamps	5
	55-1800	LOCKWASHER	5
	55-2086	FLATWASHER	5
	55-8711	INSERT	5
10	99-2280	EXTRUSION	A/R
11	41-3987	SOLENOID - starter	2
	55-2957	SCREW - solenoid	4
	55-2993	LOCKWASHER (int th)	4
	55-2086	FLATWASHER	6
12	33-489	GROMMET (1.25 id)	1
13	41-2455	BREAKER - circuit (manual reset)	2
	55-3513	SCREW - circuit breaker	4
	55-3014	LOCKWASHER	4
	55-3013	FLATWASHER	4
14	41-2118	JUMPER	1
15	92-1293	MARKSTRIP	1
16	92-1294	MARKSTRIP	1
17	41-2405	RECEPTACLE (5 pin)	1
	55-3183	SCREW - receptacle	4
18	55-3528	CAP - dust	1
	33-928	GASKET - cap	1
19	91-6752	BRACKET - sensor	1
20	55-3027	SCREW - bracket	1
	55-2996	LOCKWASHER	1
	55-2001	FLATWASHER	1
21	41-664	SENSOR - temp	1
22	44-5537	SOCKET - mini plug	9
	55-3027	SCREW - socket	3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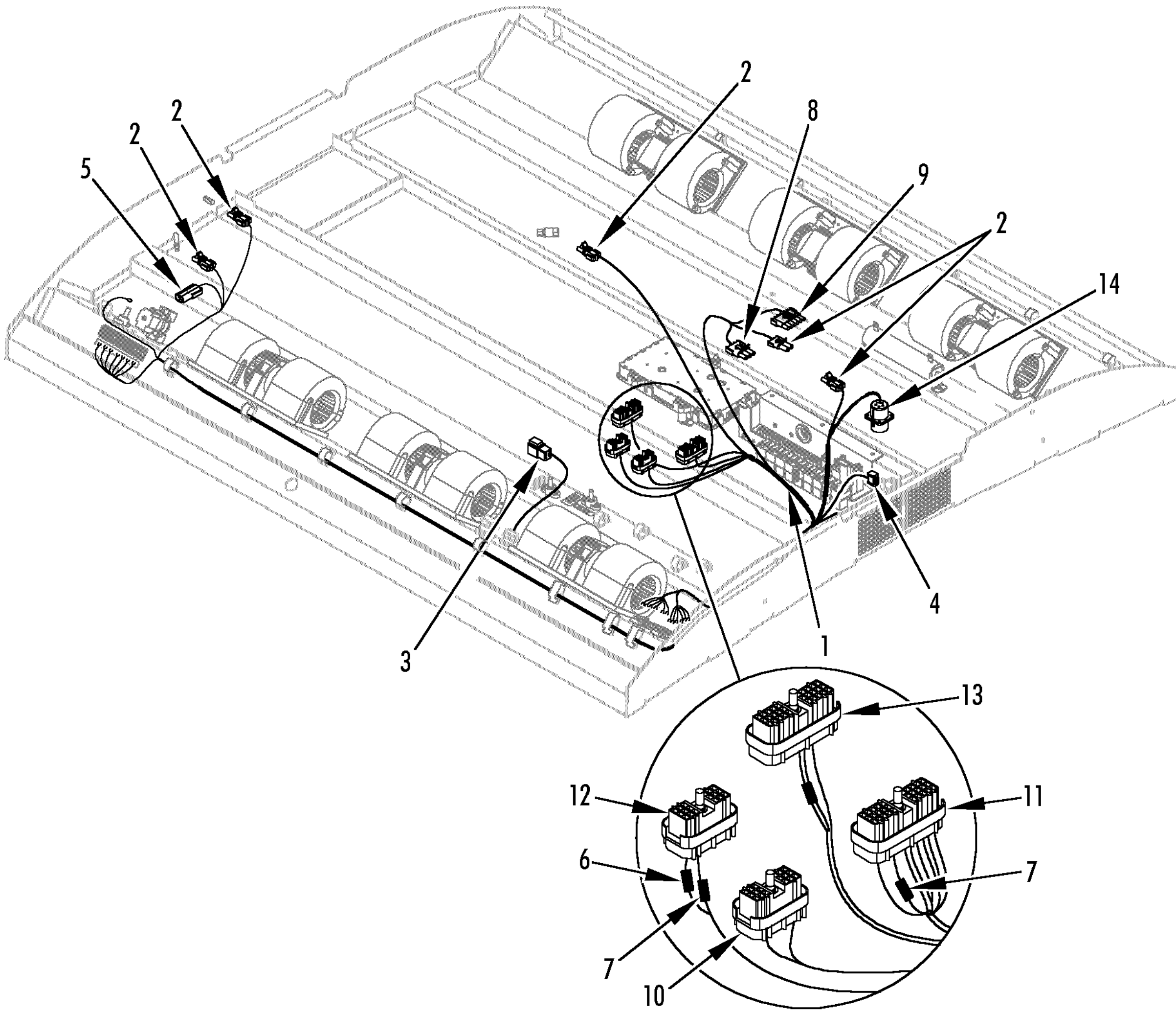
REF	PART#	DESCRIPTION	QTY
	55-2996	LOCKWASHER	3
	55-2001	FLATWASHER	3
23	44-9392	RELAY (DPST)	9
24	41-2973	FUSEHOLDER	14
25	44-9758	FUSE (10 amp)	2
26	44-9344	FUSE (15 amp)	6
27	41-2978	FUSE (20 amp)	3
28	41-1771	FUSE (30 amp)	3
29	204-1040	CABLE - download	1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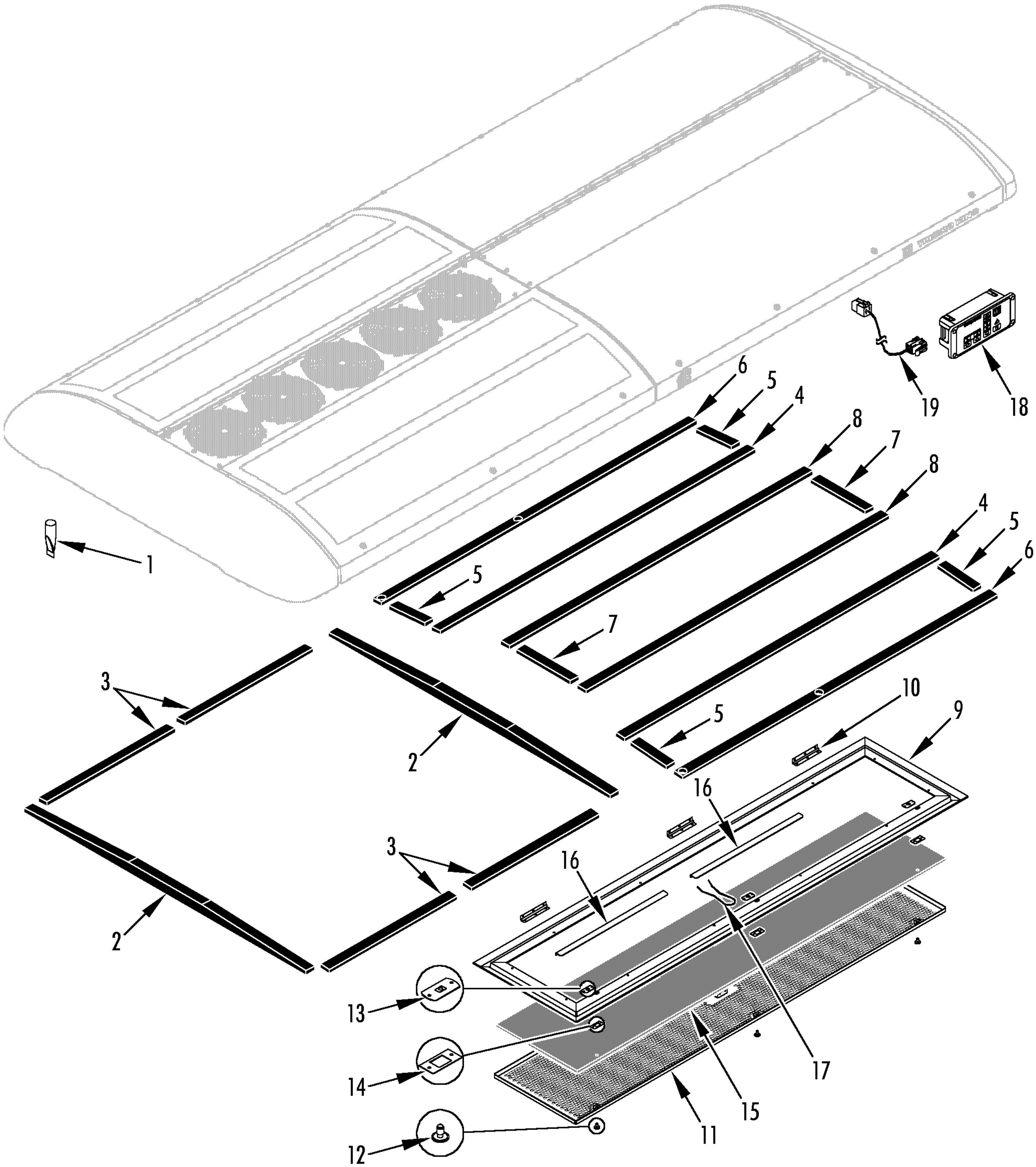
REF	PART#	DESCRIPTION	QTY
1	41-6559	HARNESS - main	1
2	44-5838	• CONNECTOR - tower (2 pin, see 115D14)	5
3	41-4281	• CONNECTOR (6 pin)	2
	41-4282	• WEDGE - connnector	2
4	41-3288	• CONNECTOR - 6 way	1
5	44-5835	• CONNECTOR - shroud (2 term)	1
6	41-6117	• RESISTOR (22.1 Kohm, V4 watt)	1
7	41-4537	• RESISTOR (120 ohm, 1/2 watt)	2
8	44-6959	• CONNECTOR - tower (3 pin, see 115D14)	1
9	44-7872	• CONNECTOR - tower (6 pin, see 115D14)	1
10	44-8858	• CONNECTOR (18 pin, black)	1
11	44-8857	• CONNECTOR (30 pin, black)	1
12	41-4135	• CONNECTOR (18 pin, white)	1
13	41-4136	• CONNECTOR (30 pin, white)	1
14	41-2405	• CONNECTOR receptacle (5 pin)	1



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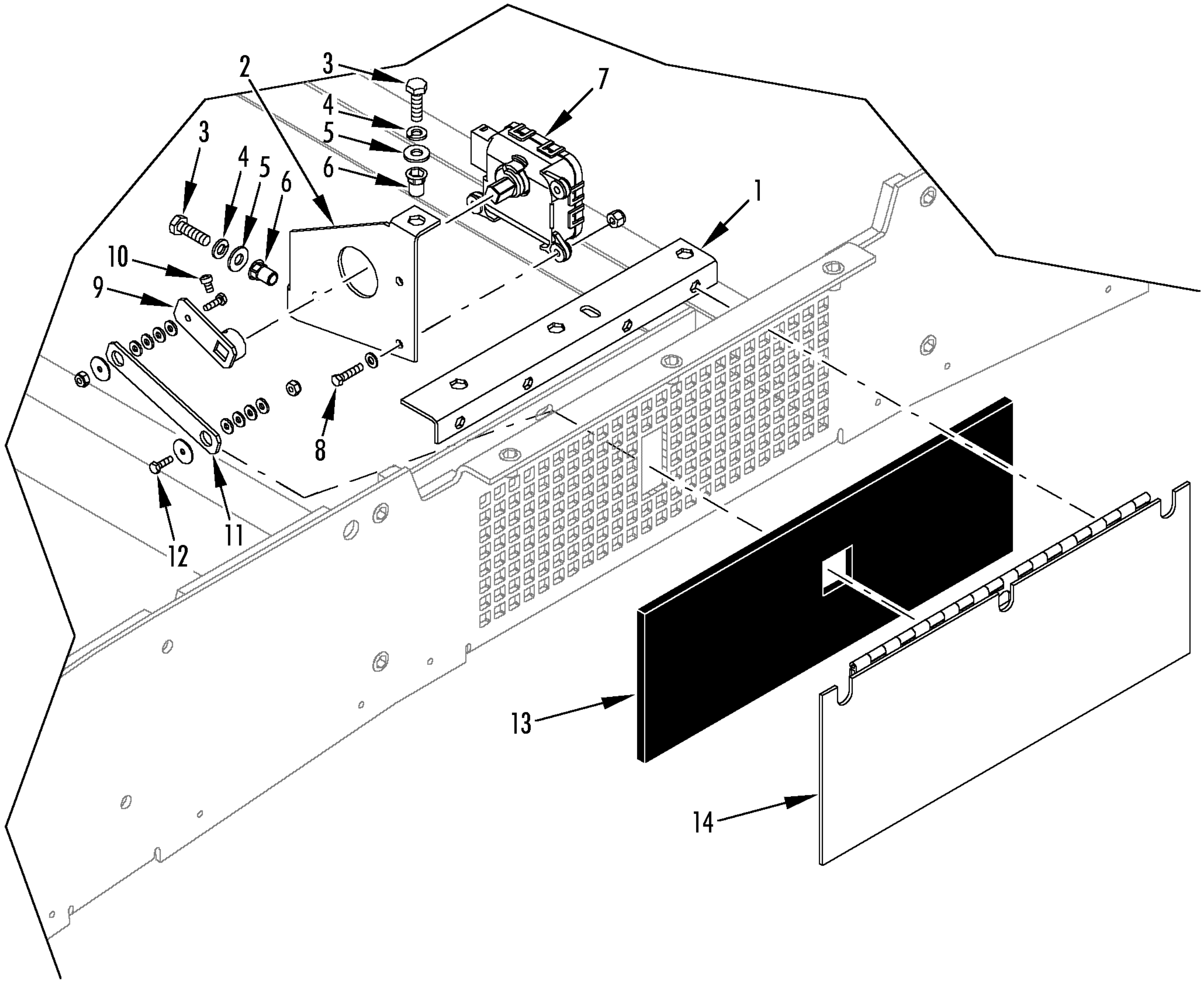
REF	PART#	DESCRIPTION	QTY
1	66-1273	VALVE - drain	2
2	33-4099	GASKET - condenser, center	2
3	33-4100	GASKET - condenser, sides	4
4	33-4101	GASKET - discharge, inside	2
5	33-4102	GASKET - discharge, center	4
6	33-4103	GASKET - discharge, outside	2
7	33-4104	GASKET - return air, center	2
8	33-4105	GASKET - return air, side	2
9	98-7112	FRAME - return air grille	1
10	91-8903	• HINGE - frame	3
	55-2012	• RIVET - hinge	9
11	98-7113	SCREEN - return air	1
	91-7101	• BODY - latch	3
12	55-9283	SCREW - lock	3
	55-7112	WASHER - spl (0.255 id)	3
13	55-2074	NUT - speed	3
14	91-7625	LOCKPLATE	3
	55-2012	RIVET - lockplate	21
15	92-4674	FOAM - reticulated	1
16	92-4675	BRACKET - filter	2
17	91-9343	CLIP - filter	1
18	41-3618	MODULE - display standard	1
	55-2997	SCREW - module	4
	55-3014	LOCKWASHER	4
19	41-6562	HARNESS - display	1


1
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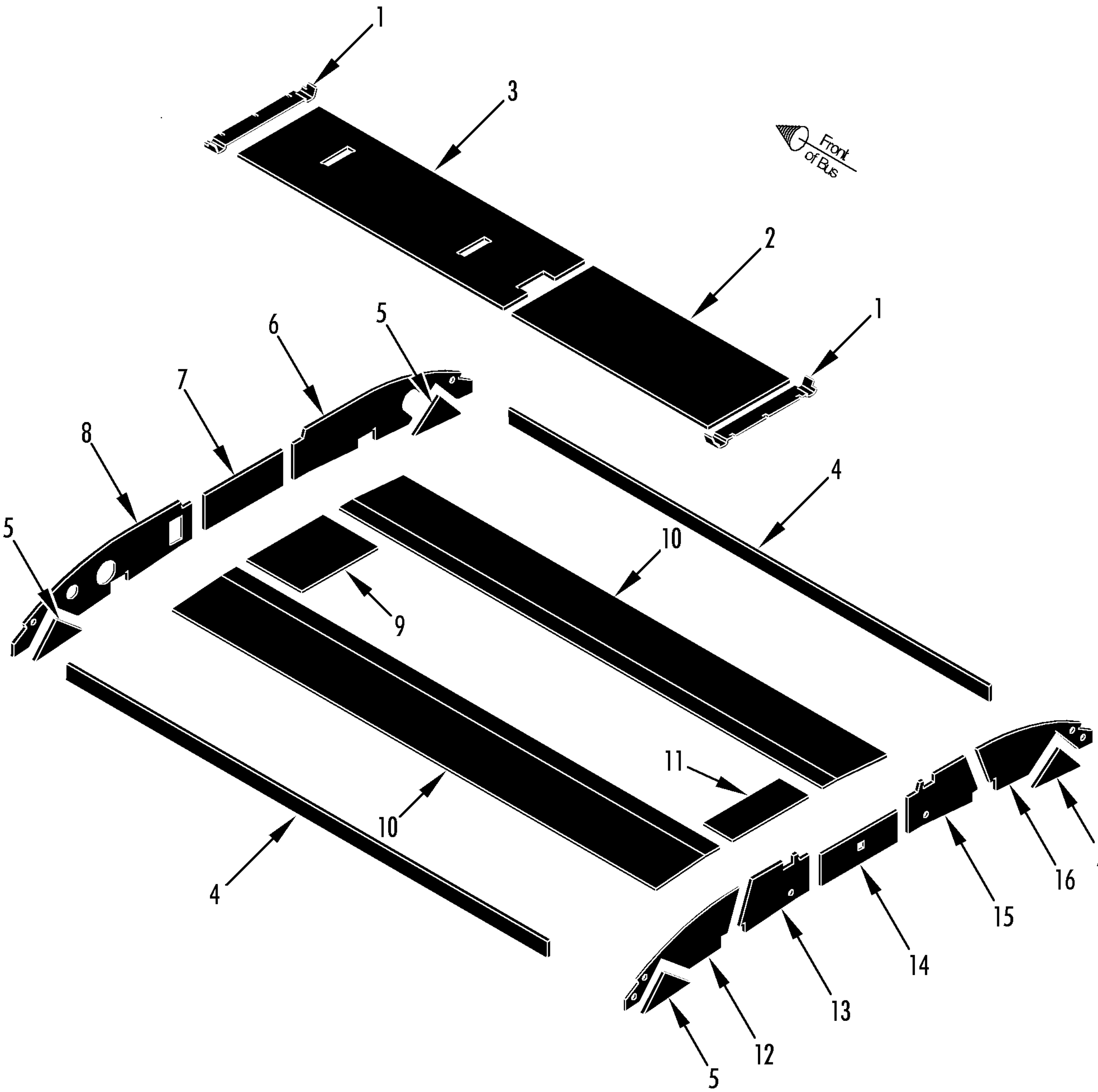
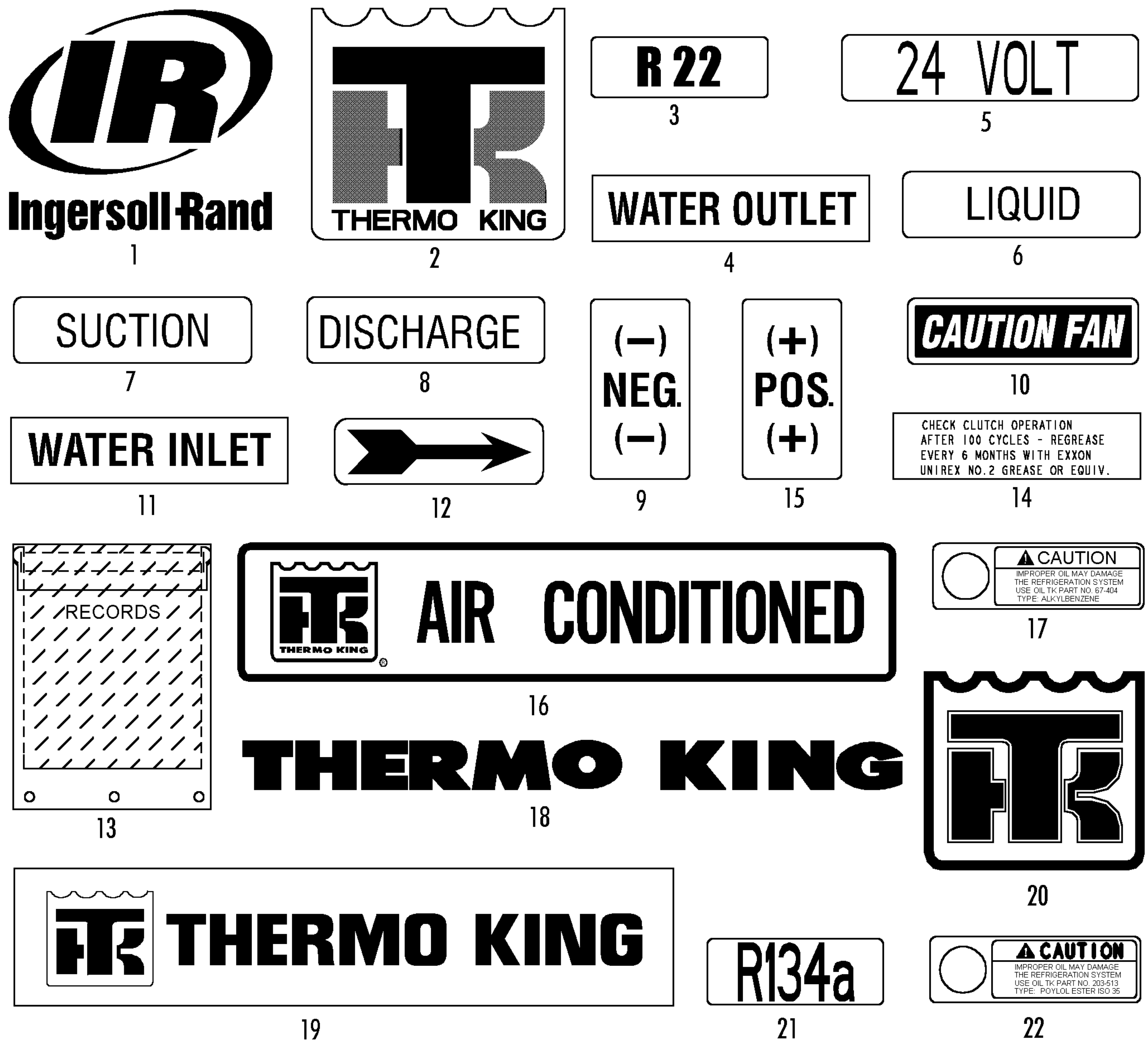
8
9
10
11
12
13
14

REF	PART#	DESCRIPTION	QTY
1	92-4676	BRACKET - fresh air damper	1
	55-2991	SCREW - bracket	4
	55-2964	LOCKWASHER	4
	55-2001	FLATWASHER	4
	55-8798	INSERT	4
2	92-4677	BRACKET - actuator	1
3	55-8711	SCREW - bracket	2
4	55-2957	LOCKWASHER	2
5	55-1800	FLATWASHER	2
6	55-2086	INSERT	2
7	41-3255	ACTUATOR	1
8	55-5665	SCREW - actuator	3
	55-2201	FLATWASHER	6
	55-4223	NUT	3
9	92-4678	ARM - acutator	1
	203-392	SEALER - antiseize	A/R
10	55-2374	SCREW - set	1
11	92-4679	PLATE - link, damper door	1
12	55-3003	SCREW - plate	2
	55-6157	WASHER - spl	2
	55-3013	FLATWASHER	8
	55-5754	NUT	2
13	33-4106	GASKET - damper	1
14	92-4680	DOOR - damper	1
	55-2991	SCREW - door	3
	55-2964	LOCKWASHER	3
	55-2001	FLATWASHER	3



1
3
Front of Bus
2
1
6
5
7
8
4
5
10
9
11
10
4
5
16
15
14
13
12
5

REF	PART#	DESCRIPTION	QTY
1	92-4665	PANEL - insulation, center	2
2	33-4107	PANEL - insulation, center front	1
3	92-4667	PANEL - insulation, center rear	1
4	33-4108	PANEL - insulation, side	2
5	33-4109	PANEL - insulation, side panels	4
6	33-4110	PANEL - insulation, front	1
7	33-4111	PANEL - insulation, center	1
8	33-4112	PANEL - insulation, front	1
9	33-4113	PANEL - insulation, center front	1
10	33-4114	PANEL - insulation, sides	2
11	33-4115	PANEL - insulation, rear	1
12	33-4116	PANEL - insulation, rear	1
13	33-4117	PANEL - insulation, front wall	1
14	33-4106	PANEL - insulation, damper	1
15	33-4118	PANEL - insulation, front wall	1
16	33-4119	PANEL - insulation, rear	1


Ingersoll-Rand
1
THERMO KING
2
R 22
3
24 VOLT
5
WATER OUTLET
4
LIQUID
6
SUCTION
7
DISCHARGE
8
(–) NEG. (–)
9
(+) POS. (+)
15
CAUTION FAN
10
WATER INLET
11
12
CHECK CLUTCH OPERATION
AFTER 100 CYCLES - REGREASE
EVERY 6 MONTHS WITH EXXON
UNIREX NO.2 GREASE OR EQUIV.
14
RECORDS
13
THERMO KING AIR CONDITIONED
16
CAUTION
IMPROPER OIL MAY DAMAGE
THE REFRIGERATION SYSTEM
USE OIL TK PART NO. 67-404
TYPE: ALKYLBENZENE
17
THERMO KING
18
20
THERMO KING
19
R134a
21
CAUTION
IMPROPER OIL MAY DAMAGE
THE REFRIGERATION SYSTEM
USE OIL TK PART NO. 203-513
TYPE: POYLOL ESTER ISO 35
22

REF	PART#	DESCRIPTION	QTY
1	92-1307	NAMEPLATE - IR logo (red/black)	1
	92-1773	NAMEPLATE - IR logo (white/white)	1
2	99-4954	NAMEPLATE - TK logo	1
3	91-3976	NAMEPLATE - R22	2
4	91-5528	NAMEPLATE - Water Outlet	2
5	99-2477	NAMEPLATE - 24 Volt	2
6	99-3036	NAMEPLATE - Liquid	2
7	99-3037	NAMEPLATE - Suction	1
8	99-4595	NAMEPLATE - Discharge	1
9	99-4661	NAMEPLATE - Negative	1
10	99-6141	NAMEPLATE - Caution, Fan	3
11	99-7876	NAMEPLATE - Water Inlet	1
12	99-9084	NAMEPLATE - arrow	3
13	91-1087	HOLDER - Warranty Card	1
14	99-7517	NAMEPLATE - Check Clutch Operation	1
15	99-4660	NAMEPLATE - Positive	1
16	99-6884	NAMEPLATE - TK Air Conditioned	1
17	92-1300	NAMEPLATE - Caution Improper Oil	1
18	91-1154	NAMEPLATE - Thermo King (black)	2
19	91-9638	NAMEPLATE - Thermo King	1
20	91-3247	NAMEPLATE - TK logo (1.88 x 2.12)	1
21	91-5459	NAMEPLATE - R134a	1
22	91-7938	NAMEPLATE - Caution	1

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Battery Systems

Four 8D batteries, limited maintenance batteries series parallel for 24 volt. 1150 CCA are supplied with your coach.

Slide Out Battery Compartment

The batteries are mounted in a slide-out tray behind the right side engine compartment grille. (see fig. 1) The battery compartment also contains a master battery power switch box for both the 12 volt and 24 volt circuits.

To Access Batteries:

1. Turn both thumb screws retaining the bottom of the right side Engine Compartment Access Grille (figure 1) and open the grille fully.

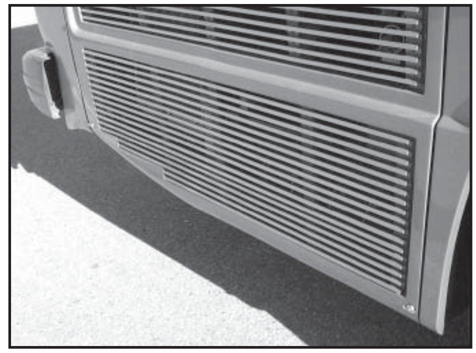


Figure 1

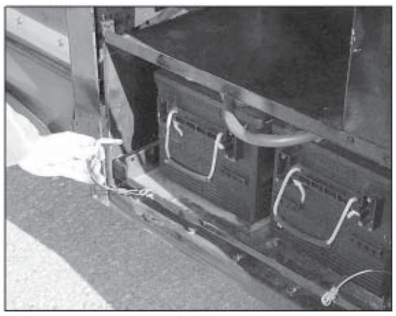


Figure 2

2. Remove the tray retaining pins at both sides of the battery tray (figure 2).
3. Grasp the grab handles on the outward side of the batteries and pull firmly outward. (figure 3)

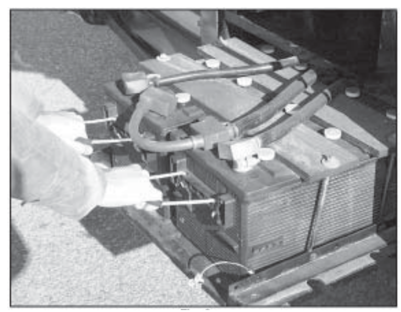


Figure 3

To Remove Batteries:

1. Turn off both the 12 and 24 volt battery circuits.
2. Be sure to disconnect the ground-side battery cables first.
3. Disconnect the circuit-side battery cables.
4. Unbolt the nuts and washers from the battery tie down bolts and remove the retaining plate(s).
5. Lift out battery.

WARNING!! Charging batteries produce hydrogen gas, which is explosive. Charge batteries in well-ventilated area, free from sparks and open flame. Use only properly insulated tools and always take full precautions to prevent accidental arcing between terminals.

Battery Tray Maintenance

Lead-acid batteries are heavy, so a firm grasp is required to slide out the battery tray. However, the tray is designed to slide without undue force. If the tray resists sliding, check seals, hinges, pins, and locks for mechanical damage. Check especially for signs of corrosive damage which may indicate damaged batteries. Clean the battery compartment with a nonabrasive degreaser. Every three months, lubricate hinges, slides, pins, and locks with a graphite-type or spray-type lubricant.

Battery Charging and Jump Starting

Instructions

> **NOTE:** When the coach is to be left not running for more than 8 hours the battery switches (both 12V and 24V) should be switched off. When the coach is not going to be run for an extended period of time (several weeks or months), or is placed in storage, the battery switches should be placed in the off position, and the battery cables should be removed from the batteries. This will ensure that should one cell go bad all batteries will not be drained through the bad cell.

General

These procedures have been written using a Blue Bird Express 4500 coach. The batteries described in these procedures are the primary storage batteries used for starting the vehicle. These procedures do not apply to any other batteries that may be installed on the coach.

These batteries are located in a compartment forward of the engine compartment on the curb side of the coach. Battery switches and grounds referred to are also located in the same compartment.

The batteries are connected to the coach with 3 cables; 24 volt positive, 12 volt positive, and ground. When instructed to disconnect the batteries (for example when welding on the frame) remove all three cables and secure them so that they cannot fall back on or next to the battery terminals. When reinstalling the cables use care to insure proper installation. If installed improperly the batteries and power equalizer (as well as other components) may be damaged or destroyed.

Battery Charging

When left for long periods of time, when lights or ignition switches are left on overnight with the battery switches on, or when other occurrences drain the batteries of the coach, the batteries may need to be charged. The batteries may be removed from the coach and charged individually, or may be charged in the battery tray and connected.

Whether a 2 battery system or a 4 battery system, each individual battery that this coach utilizes is a 12 volt DC battery. Installed in the coach two batteries are connected in series in order to provide 24 volt service. In the 4 battery system the batteries are connected in two parallel pairs, and those two pairs are then connected in series with each other to increase the available current.

2 Battery System with a 24 volt DC charger

(refer to Figure 1)

With a 24 volt DC charger connect the charger's red (positive) cable to the positive terminal of battery 2, and then connect the charger's black (negative) cable to the negative terminal of battery 1. Follow the instructions and charge at the rate recommended by the charger manufacturer.

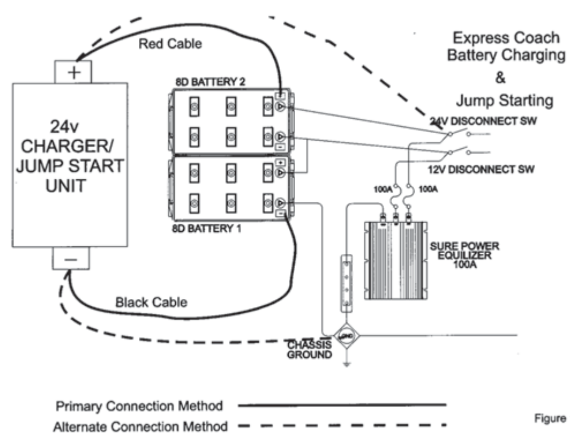


Figure 1

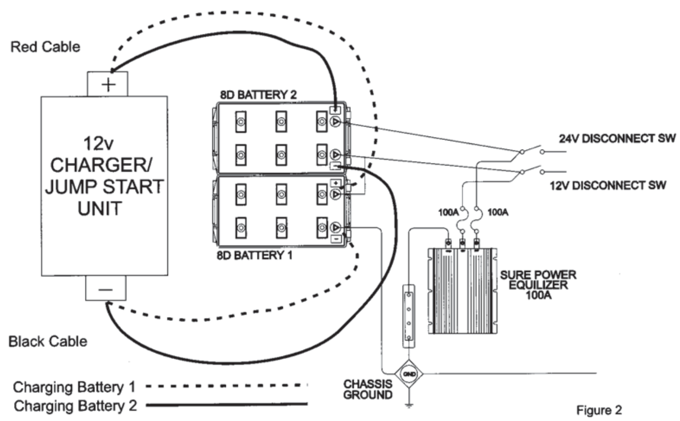


Figure 2

2 Battery System with a 12 volt DC charger

(refer to Figure 2)

With a 12 volt DC charger connect the charger's red (positive) cable to the positive terminal of battery 2, and then connect the charger's black (negative) cable to the negative terminal of battery 2. Follow the instructions and charge at the rate recommended by the charger manufacturer.

When battery 2 is satisfactorily charged, remove the cables from battery 2 and repeat the procedure on battery 1.

4 Battery System with a 24 volt DC charger

(refer to Figure 3)

With a 24 volt DC charger connect the charger's red (positive) cable to the positive terminal of battery 3, and then connect the charger's black (negative) cable to the negative terminal of battery 1. Follow the instructions and charge at the rate recommended by the charger manufacturer.

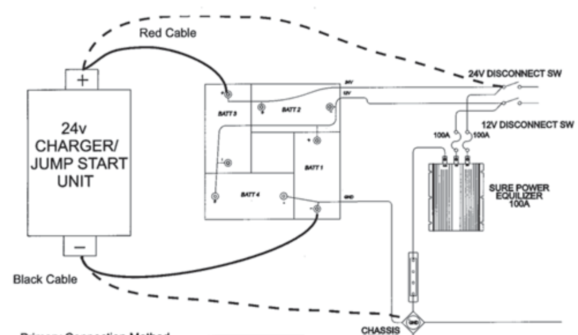


Figure 3

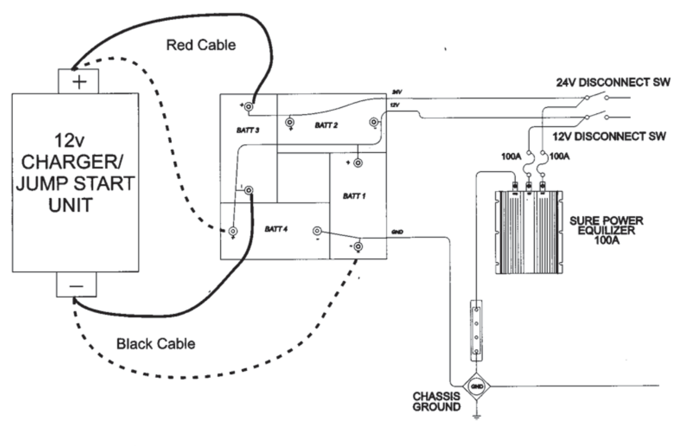


Figure 4

4 Battery System with a 12 volt DC charger

(refer to Figure 4)

With a 12 volt DC charger connect the charger's red (positive) cable to the positive terminal of either battery 2 or 3, and then connect the charger's black (negative) cable to the negative terminal of battery 2 or 3. Follow the instructions and charge at the rate recommended by the charger manufacturer.

When batteries 2 & 3 are satisfactorily charged, remove the cables from batteries 2 & 3 and repeat the procedure on batteries 1 & 4. Connect the red cable to the positive terminal of battery 1 or 4 and the black cable to the negative terminal of battery 1 or 4.

Jump Starting

While jump starting the coach is always a last resort to proper operation and maintenance, when the need to start the vehicle from another power source occurs, the jumper cables must be connected correctly. Never cross the jumper cable connections (red to black) because the batteries and the charging unit may both be severely damaged or destroyed.

Jump starting this coach requires a 24 volt DC power source. If a 24 volt DC power source is not available the coach cannot be jump started and the only option is to charge the batteries separately as outlined in the Battery Charging procedures.

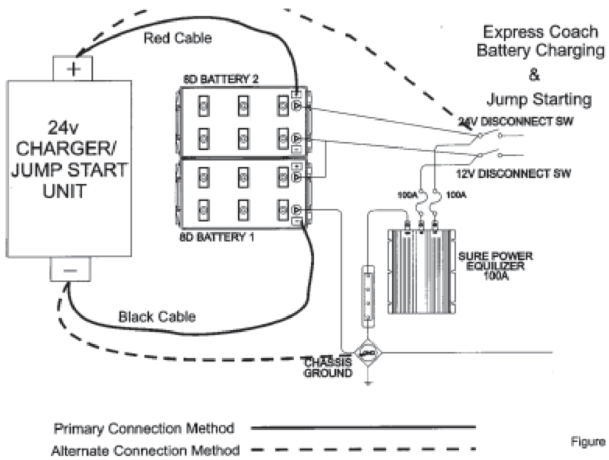


Figure 1

2 Battery System with a 24 volt DC charger

(refer to Figure 1)

With a 24 volt DC power supply connect the power supply's red (positive) cable to the positive terminal of battery 2, and then connect the charger's black (negative) cable to the negative terminal of battery 1. Follow the power supply's manufacturer instructions for jump starting if they are available.

An alternate connection method is to connect the power supply's red connector to the 24 volt battery disconnect switch and to connect the power supply's black connector to chassis ground.

4 Battery System with a 24 volt DC charger

(refer to Figure 3)

With a 24 volt DC charger connect the charger's red (positive) cable to the positive terminal of battery 3, and then connect the charger's black (negative) cable to the negative terminal of battery 1. Follow the power supply's manufacturer instructions for jump starting if they are available.

An alternate connection method is to connect the power supply's red connector to the 24 volt battery disconnect switch and to connect the power supply's black connector to chassis ground.

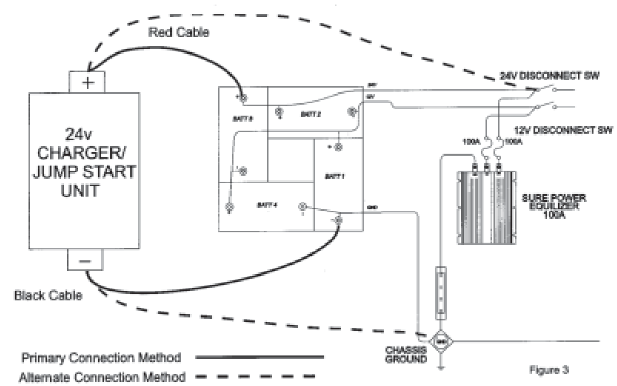


Figure 3

Waste System

This coach comes equipped with a Monogram Sanitation Toilet with Clear Rinse Pump.

Operation

The waste tank is precharged with water to a predetermined level. A deodorant chemical should be added to the precharge.

When the flush button is depressed, compressed air flows into the upper pump chamber. The compressed air pushes the pump diaphragm downward displacing the fluid in the lower pump chamber for rinsing the bowl. Releasing the flush button reverses the air flow and allows the diaphragm to return to the starting position. As the diaphragm moves upward, the air in the upper chamber is exhausted through an air flow governor. A spring is used to return the diaphragm to its original position. As the diaphragm moves upward fluid is drawn through the pin filter into the lower chamber for the next flush cycle. A complete flush cycle takes approximately sixty seconds.

Servicing intervals for the System are determined by the bus operator.

During servicing, the tank is rinsed, contaminated fluid is eliminated from the pump and the tank precharged in the shortest time possible for any system. For best results, a minimum static water pressure of 50 PSIG (3.5 bar) is recommended. To further minimize service time, higher pressures may be used.

NOTE: Air pressure to the System is regulated between 5 and 7 PSIG (0.3 and 0.5 bar).

Components

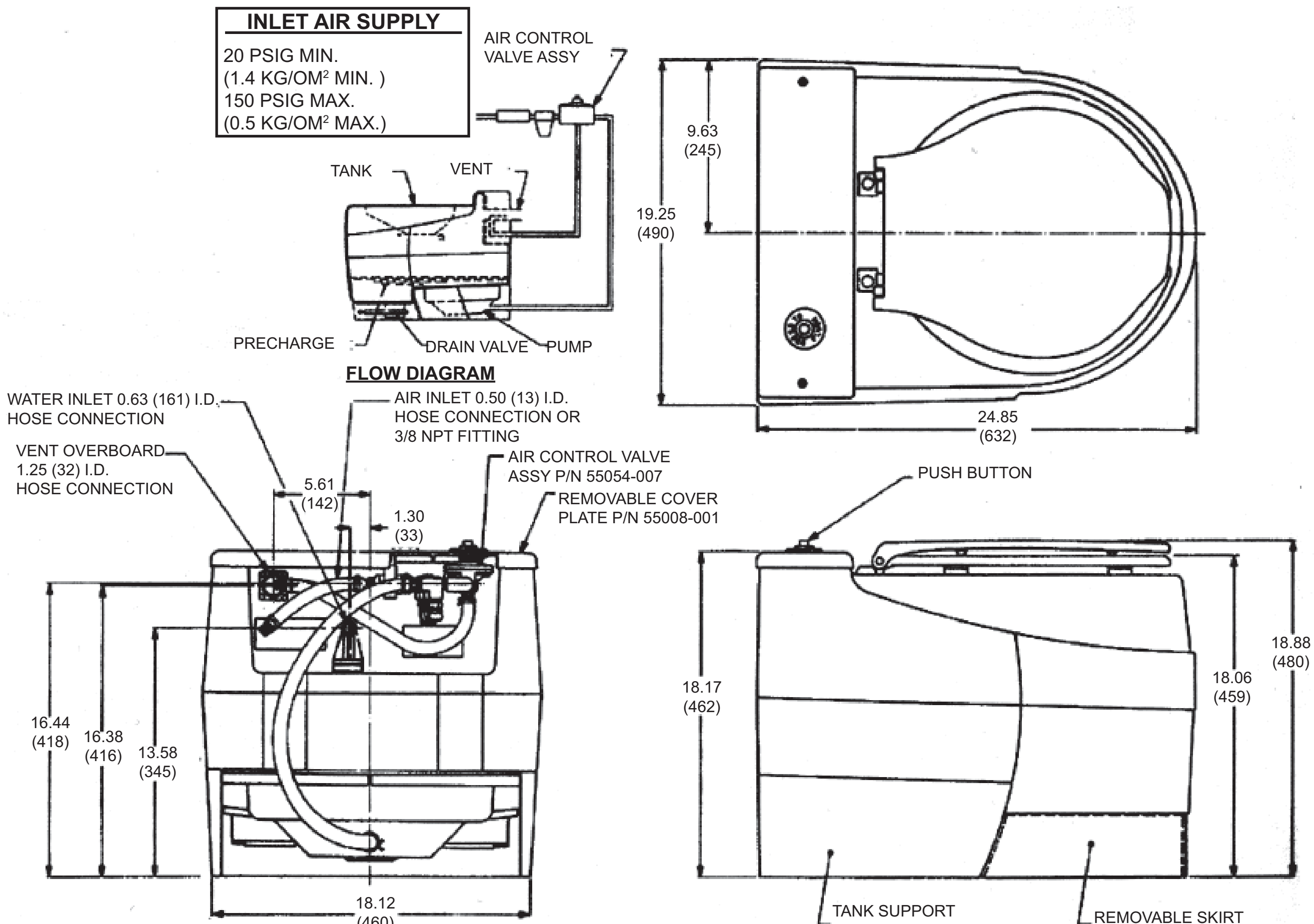
The toilet consists of the following components:

- Trim Plate
- Bowl with Flapper
- Pump Hanger
- Clear Rinse Pump with Pin Filter
- Return Hose
- Rinse Hose
- Hose Clamps

Maintenance

There is no scheduled maintenance with this model toilet.

Monogram Systems Recirculating Toilet Diagram



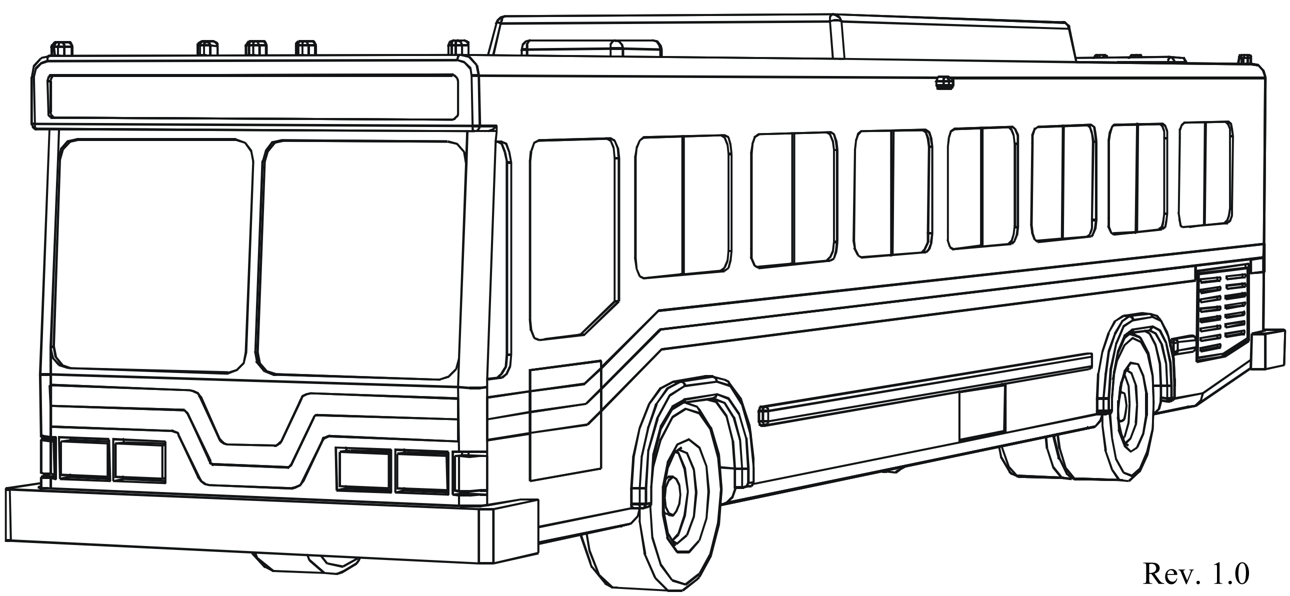
NOTES;
1. DIMENSIONS IN PARENTHESIS OR IN METRIC SYSTEM

NOTE: This is a standard schematic of air flush toilet. Actual installation may vary.

DINEX G2A MULTIPLEX SYSTEM

FOR

BLUE BIRD BUS



Rev. 1.0
08-30-02

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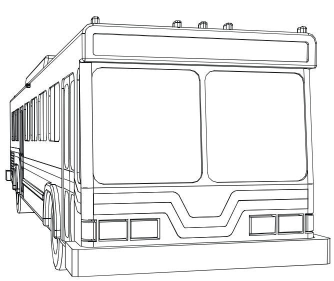
e-mail: gts@fast.net



http://www.iocontrols.com

Contents

1

Key Nomenclature

Data Bus	The multiple pair of common wires providing the multiple DATA path and/or power supply to link each network element. Similar to a telephone line.
Module	The network functional unit which contains the intelligent co-processor unit. The vital communications data link to IO devices, inputs and outputs.
Bus Controller	The communication traffic controller that directs and regulates communication between each functional unit on the data bus. Think of the Bus Controller as a telephone switchboard.
Node	An individual functional module in the network. The telephone receiver in a network.
ID	The unique address symbol (either a number or a character) which is assigned to each functional unit in the network. A telephone number.
I/O	Inputs (sensors and switches) and Outputs (actuators or lamp loads). These are the fundamental system functions.
DNET	The unique name for DINEX G2A system to be defined as UPLINK data port. Acting as Slave Function.
CNET	The unique name for DINEX G2A system to be defined as DOWNLINK data port. Acting as Controller Function.

Clean Power________(Computer Power) The isolated power source for modules in the network. "Clean Power" avoids data corruption from a common power source such as battery or electrical interference.

LED_______________A light emitting diode. A small semi-conductor lamp.

Reset______________Restart the system.

Cellnet Controller____This CNC module has the capability to act as a subset of Master Bus Controller (G2A-MBC-32) which includes 32-inputs and power management function.

HCNC_____________A high speed cell network controller.

DIO_______________An intelligent slave module.

Multiplex___________A way of transmitting several lines of communication simultaneously on the same data link.

Inputs_____________Switches and sensors, which supply information to the modules to perform an operation. A circuit is "active" when it is turned on. A circuit is "inactive" when it is turned off. The computer can make use of both "active" and "inactive" data to perform a specific function.

Data_______________The information from module to module over Multiplex system.

Outputs____________All physical actions that are performed by the modules, such as turning on or off lights, solenoids and other devices.

Ring Loop__________Data bus structure in which the modules are connected to form a "ring."

Ladder Charts_______Ladder charts, circuits, or diagrams are logic diagrams. They are not schematics. The primary function of a ladder diagram is to show how devices are related one to the other.

2

General Description

What is MULTIPLEX (MPX)?

- MPX simplifies the way electrical devices are hooked up together.
- MPX allows for two or more data transmissions to take place on the same wire.
- In the world of traditional wiring systems -- such as wiring harnesses, and relays -- as much as three miles of wires can be used. These harnesses run hundreds of signals, using hundreds of wires, just to keep a single transit vehicle operational.
- Instead of having three miles of complicated wiring harnesses and a number of failure prone connectors, multiplexing sends multiple signals at the same time through a common pair of wires to turn-on or turn-off various electrical devices.

Some of the problems encountered with the old technology are:

- Cumbersome systems,
- Relay based,
- Over-crowded -- making upgrading and maintenance difficult,
- Prone to connector and harness failure,
- Costly to troubleshoot and repair,
- Expensive vehicle downtime.

Multiplex hardware which makes-up the system is composed of:

- A separate power supply,
- Several control modules.
- And a unique cabling system made up of connectors and multi-stranded wires that run through a cable.

Some of the benefits of MPX are:

- A simple system,
- Reduced number of connectors,
- Immediate ease of troubleshooting,
- Reduced vehicle down-time,
- Ease of operation.

What will DINEX G2A Intelligent MPX do for me?

DINEX-G2A-MPX advances transit vehicle control techniques into the computer age.

- The DINEX-G2A-MPX system provides a reliable, cost-effective alternative to the old technologies.
- The DINEX-G2A-MPX system replaces relays, flashers, connectors, and outdated wiring harnesses.
- The DINEX-G2A-MPX system offers an intelligent network for the control, monitoring and data acquisition in transit bus and rail cars.
- The DINEX-G2A-MPX system's bottom line is to make your life easier and less costly.

How does DINEX-G2A-MPX system do all this?

- The DINEX-G2A-MPX is a microprocessor-based system. It uses multiplex data-bus architecture.
- The DINEX-G2A-MPX uses a small, compact, powerful module to perform full computer functions. This central module controls a family of small, lightweight microprocessor-based control and monitor functions.

DINEX G2A Working in Bus

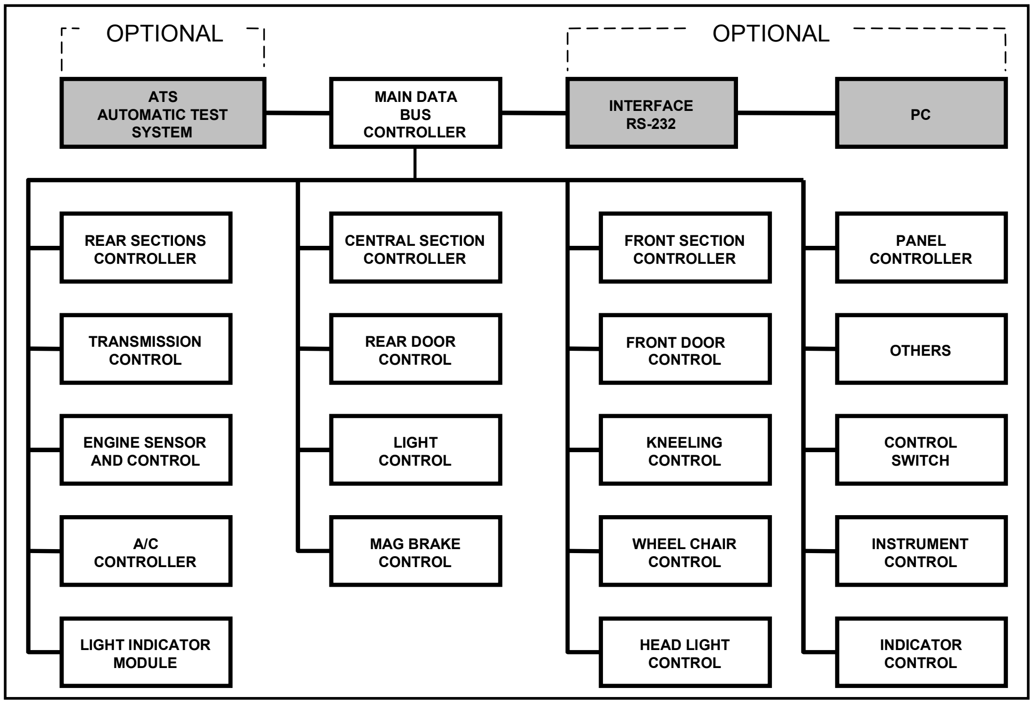
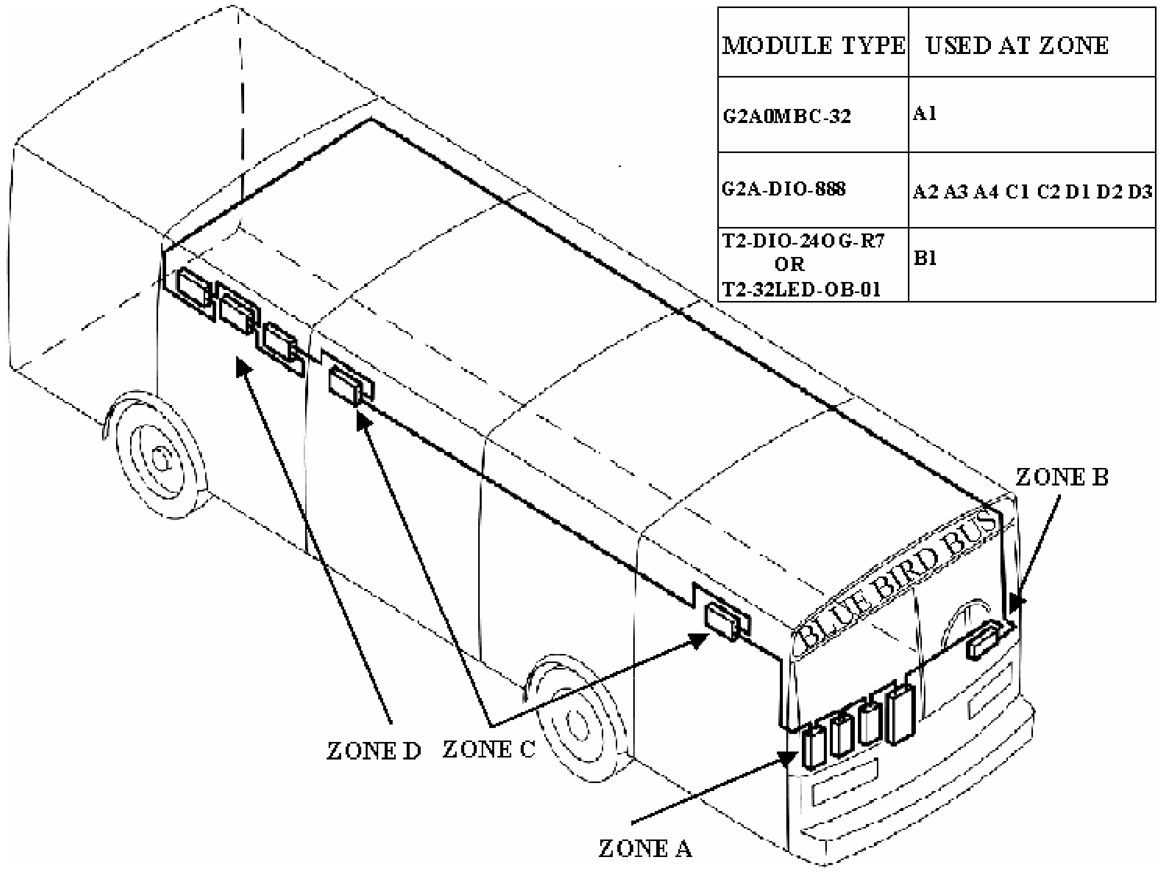


FIGURE: 2.1 – DINEX G2A SYSTEM

Typical Module Locations



MODULE TYPE	USED AT ZONE
G2A0MBC-32	A1
G2A-DIO-888	A2 A3 A4 C1 C2 D1 D2 D3
T2-DIO-24OG-R7 OR T2-32LED-OB-01	B1

(Some locations may vary due to customer options)

FIGURE: 2.2 – TYPICAL MODULE LOCATIONS

Modules are located in zones as near to the needed inputs and outputs as possible. The locations of the modules reduce the amount of “hard” wire necessary to reach the module. Some examples of zone locations are:

Zone A	Door Area/ Main Panel
Zone B:	Above Driver
Zone C:	Front Door / Rear Door
Zone D:	Engine Area

- **How the DINEX G2A System Works?**
- **Main Data Bus Controller with PMS Module: G2A-MBC-32**
- **Intelligent Digital Input/Output Control Module: G2A-DIO-888**
- **Intelligent Digital 24 Output GW module: T2-DIO-24OG-R7**
- **32 LED Indicator Panel: T2-32LED-OB-01**

3

Introduction To System Components

How the DINEX G2A System Works?

The inputs to the Main Bus Controller (MBC) Module are supplied by the driver operated controls and the various switches and sensors linked together in the system.

G2A-MBC-32 module can receive up to 32 inputs. It does not have outputs and feedback channels.

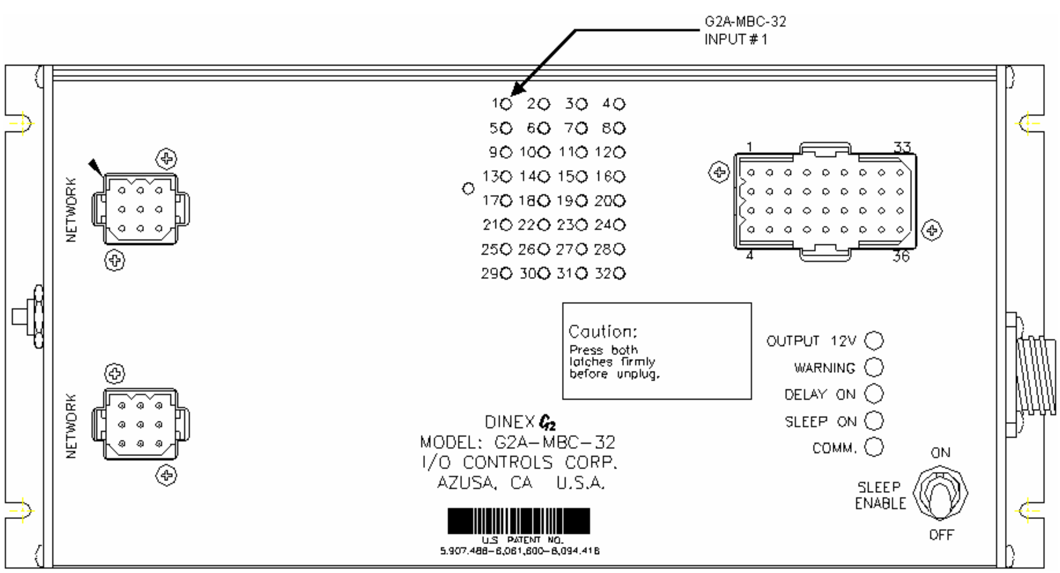


FIGURE: 3.1 -- G2A-MBC-32

When the driver turns on a switch, the inputs are activated and a signal goes to the MBC.

The MBC is the COMMAND CENTER or the switchboard.

The MBC receives inputs as an on or off signal and relays the signal to the module that executes the commands. After the module executes the command it keeps track of how the system is working. Each module in the system has a unique address.

The MBC uses the DATA CABLE to link up with the various modules required to do the job.

The DATA CABLE is made up of eight, small gauge wires. The twist pair wire keeps out all unwanted noise that might distort the data. Data travels through the cable at 115,200 BPS or 1/1,000,000th of a second.

The DATA CABLE talks to all components through a unique "loop" link-up. The MBC checks in with each module and issues instruction. As a check, it rechecks its inputs to verify that the job has been done.

LEDs tell the driver/operator if the modules are working as he has instructed. Single-controller systems are used in the Data Bus Cable. MBC is the only controller in a system and is the only programmable module among the system components.

The Main Bus Controller (MBC) is the general-in-command. It has the special built-in features, such as a computer, which tells all listeners what to do. After the MBC issues a command it tracks the work in progress.

The MBC communicates all instructions via a data cable to all modules in the network. Each module is identified by an address, like an employee, social security, or phone number. The MBC contacts modules by using this special ID number.

G2A-MBC-32 module can receive up to 32 inputs. The G2A-MBC-32 module does not have outputs and feedback channels.

Multiplex modules are each assigned a unique address. This address allows the MBC to communicate directly with each specific module. Each module has a sub-address that relates to a specific circuit.

Most DIO modules can control up to eight output circuits and receive eight more inputs, and, optionally, 8 feedback channels.

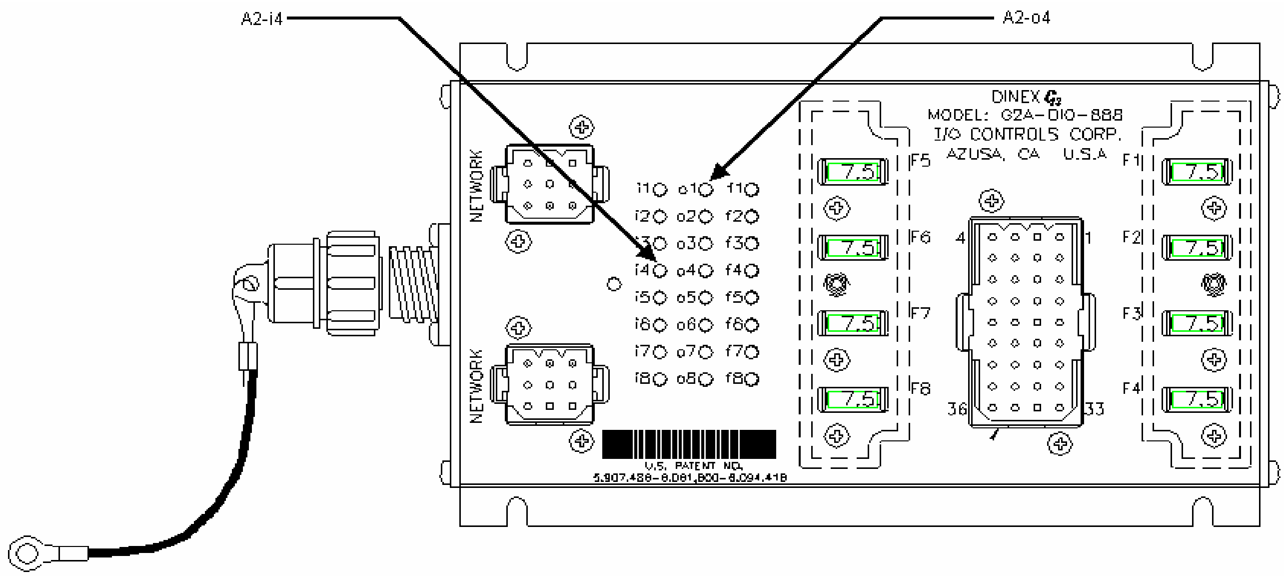


FIGURE: 3.2 -- G2A-DIO-888

For example, in the figure of G2A-DIO-888 above,

A = module location on the bus
4 = module number
i4 = input point on the module

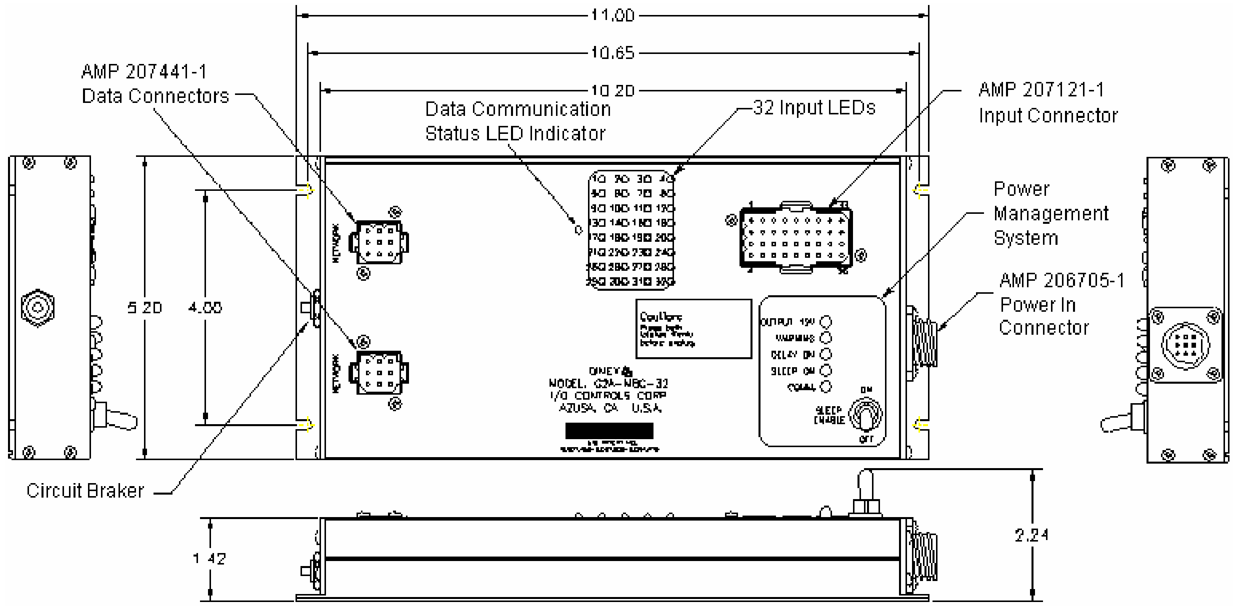
Thus, MBC-1 = input from master switch/run position
A2-i4 = input from interlock stop light pressure switch
A2-o1 = output to stop light lamps

The loop and how it works:

The MBC uses the main data bus cable to communicate with all the modules in turn, one after the other.

The MBC only addresses each module -- using its unique address -- one at a time, telling it what to do and then the MBC rechecks its inputs to verify the job has been done as ordered.

The Main Bus Controller with PMS Module
G2A-MBC-32



AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	CNET-A
6	CNET-B
7	PROG_L
8	RESET_L

AMP 206705-1	
1	12V (+)
2	12V (-)
3	RESERVED
4	WARNING OUTPUT
5	MASTER SW POS. 6
6	A 485
7	B 485
8	GND
9	BATTERY 24V

AMP 207121-1	
1-32	INPUT 1-32
33	COM1 FOR INPUT 1-16
34	COM2 FOR INPUT 17-24
35	COM3 FOR INPUT 25-28
36	COM4 FOR INPUT 29-32

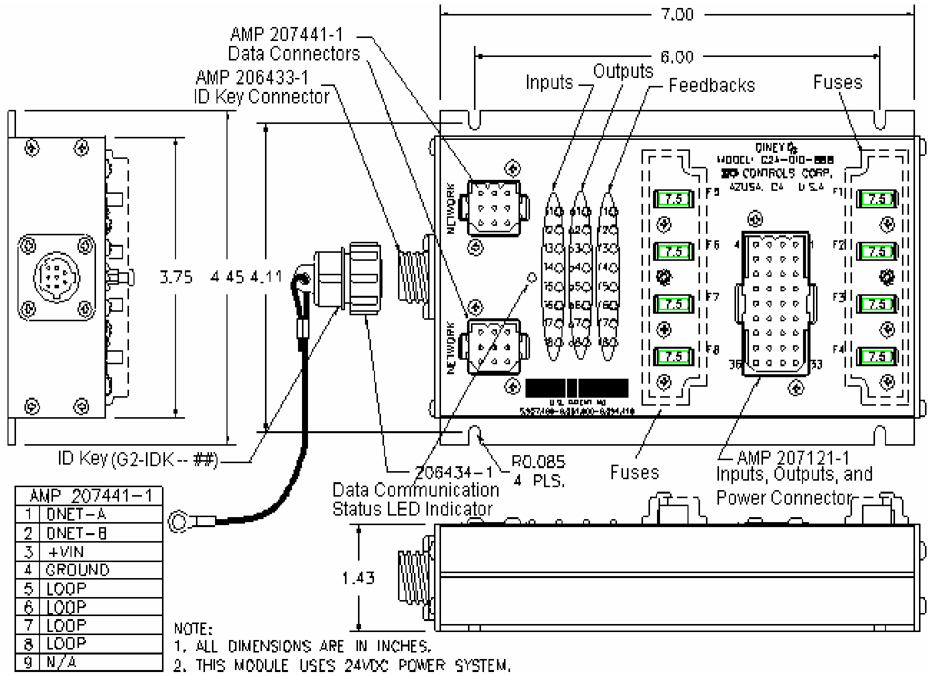
NOTE:
1. ALL DIMENSIONS ARE IN INCHES.
2. THE CAVITY ON THE SLEEP ENABLE SWITCH NEEDS TO BE FACING UP IN THE ON POSITION.

FIGURE: 3.3 -- G2A-MBC-32 MODULE DIAGRAM

The Main Bus Controller – G2A-MBC-32 -- is the top-level device. It is the command post for what's happening throughout the operating system.

- The Main Bus Controller controls and monitors up to 16 modules in a single level of data bus.
- It interfaces with 32 inputs and contains its own power management unit for entire system.
- It interfaces with switches, such as limit switches, temperature and pressure switches, and can directly control other modules.
- LED status indicators are provided on all input points.
- It stores instructions for control and monitor.
- It supports Automatic Test Equipment.
- All I/O points are optically isolated.
- It replaces relays with solid state, electrical switching.
- The MBC is simple to replace in the field.
- It has Built-In Self Test functions in software.

Intelligent Digital Input/Output Control Module G2A-DIO-888



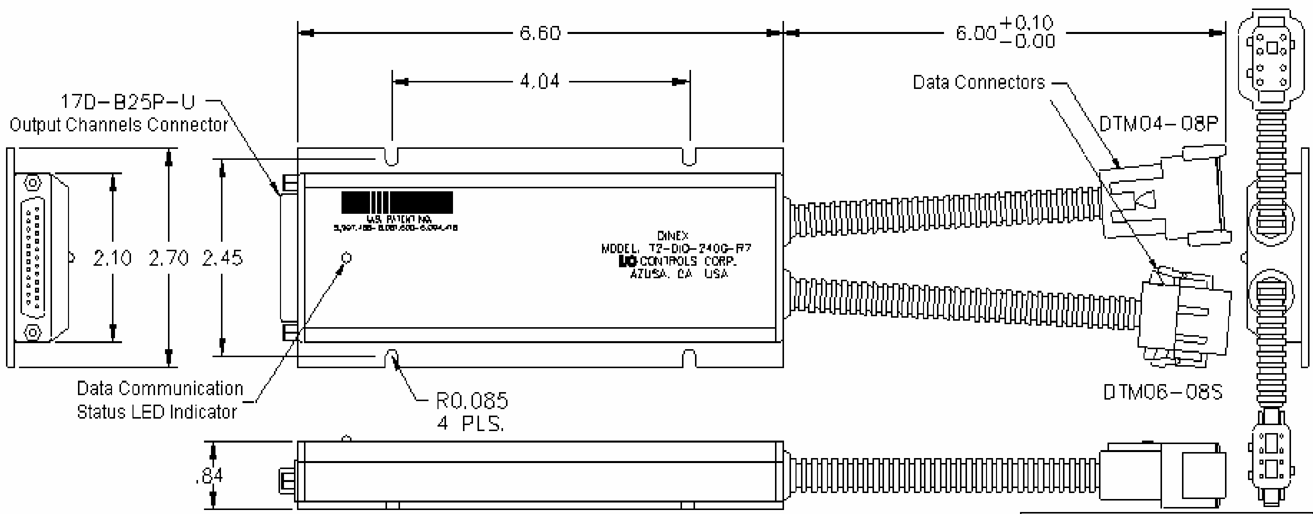
AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP
6	LOOP
7	LOOP
8	LOOP
9	N/A

AMP 207121-1		
PIN	SOURCE OUTPUT CONNECTION	SINK OUTPUT CONNECTION
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH 5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V	POWER 24V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

FIGURE: 3.4 -- G2A-DIO-888 MODULE DIAGRAM

- DIO normally can only handle 8 inputs, 8 feedbacks and 8 outputs.
- Special DIO units allow additional input controls (up to 32 inputs total).
- Replace like devices with like devices. READ THE LABELS first before replacing one unit with another.
- DIOs are on/off units only and are not programmable.
- Feed-back circuits are used for BIST (Built-In Self Test)

Intelligent Digital 24 Outputs Gateway Module
T2-DIO-24OG-R7



NOTE:
1 ALL DIMENSIONS ARE IN INCHES

CONNECTOR	17D-B25P-U																								
PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
OUTPUT CHANNEL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	GND

DTM04-08P/DTM06-08S		
PIN	COL.	FUNCTION
1	YEL	DNET RS-485+
2	GRN	DNET RS-485-
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED

FIGURE: 3.5 -- T2-DIO-24OG-R7 MODULE DIAGRAM

- For driving LED modules.
- Total 24 outputs
- LEDs on the instrument panel are the outputs.
- Acts as gateway on DINEX network and other host systems.

32LED Indicator Panel
T2-32LED-OB-01

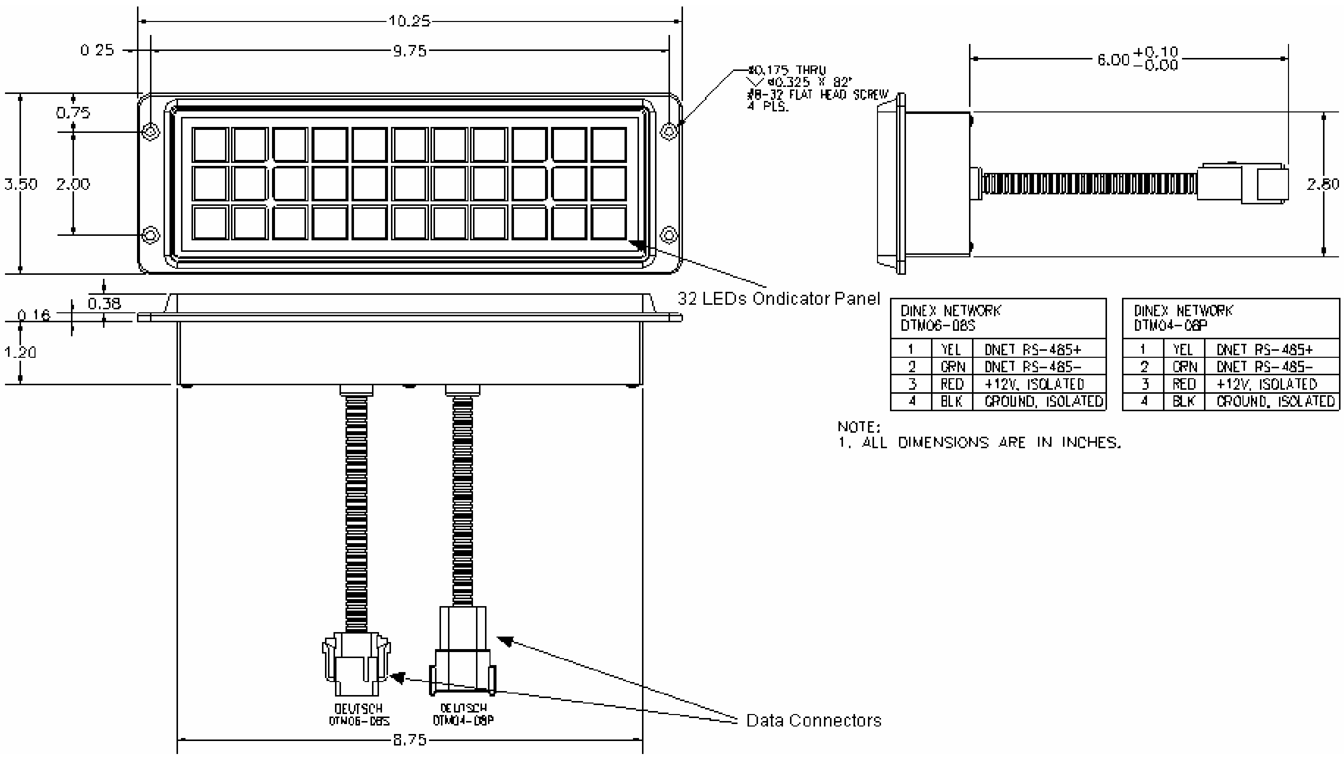


FIGURE: 3.6 -- T2-32LED-OB-01 PANEL DIAGRAM

- Instrument Panel LEDs are multiplexing modules.
- Total 32 LED indicators.
- LEDs on the instrument panel are the outputs.
- Each indicator contains multiple LED elements.
- The LED cluster can be removed/replaced as a unit or LEDs can be removed/replaced individually.
- Replacement LEDs are not labeled (each label is a separate piece).
- First indication that an LED is failing maybe a dimming of the LED.

4

- Dinex G2A System "Tree" Structure
- Dinex G2A System Ring-Loop Hookup Structure
- Dual Voltage Capability

How Is It All Hooked Together ?

Dinex G2A System "Tree" Structure

The Dinex G2A System "Tree" hierarchy and data bus layout is shown below:

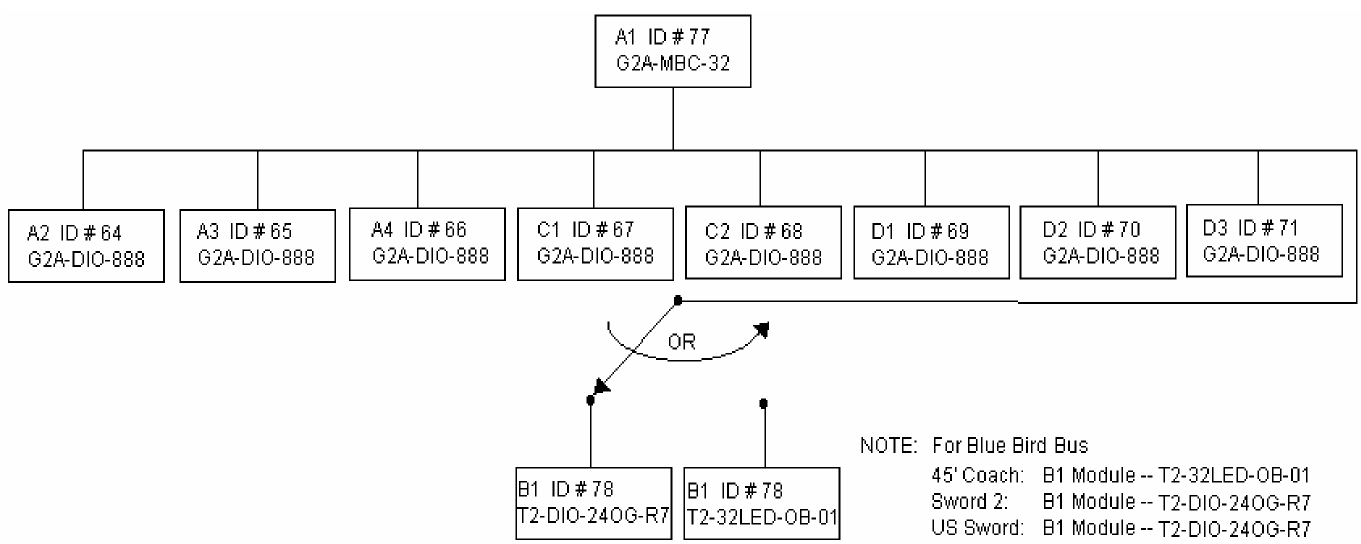


FIGURE: 4.1 – DINEX G2A SYSTEM "TREE" STRUCTURE DIAGRAM

G2A-MBC-32 = MAIN BUS CONTROLLER MODULE WITH PMS
G2A-DIO-888 = DIGITAL INPUT/OUTPUT MODULE
T2-DIO-24OG-R7 = 24 OUTPUTS GATEWAY MODULE
T2-32LED-OB-01 = DASHBOARD LAMP CLUSTER OR TELL-TALE PANEL

Dinex G2A System Ring-Loop Hookup Structure

The Dinex G2A System – Ring-Loop Hookup Structure shown below:

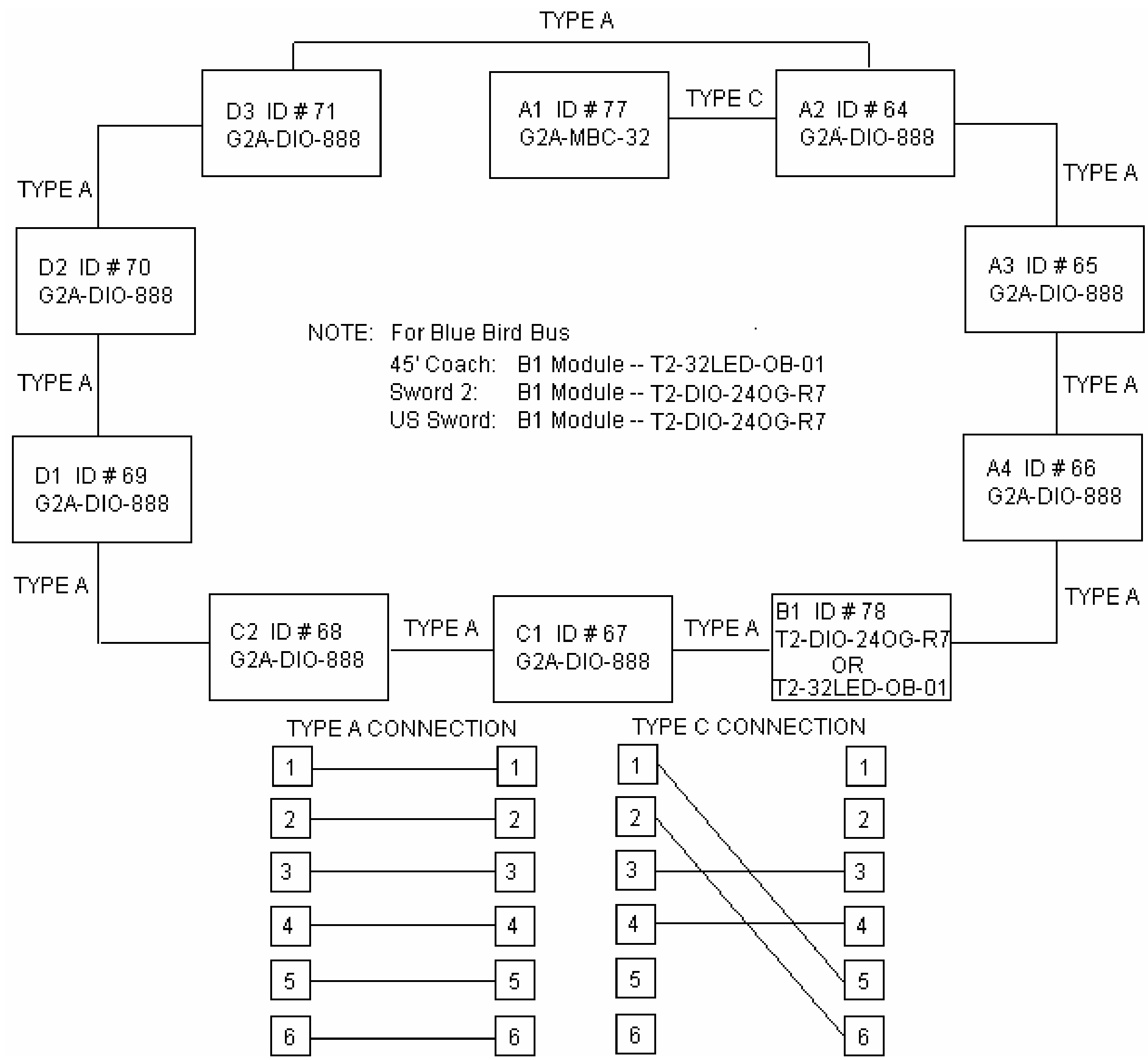
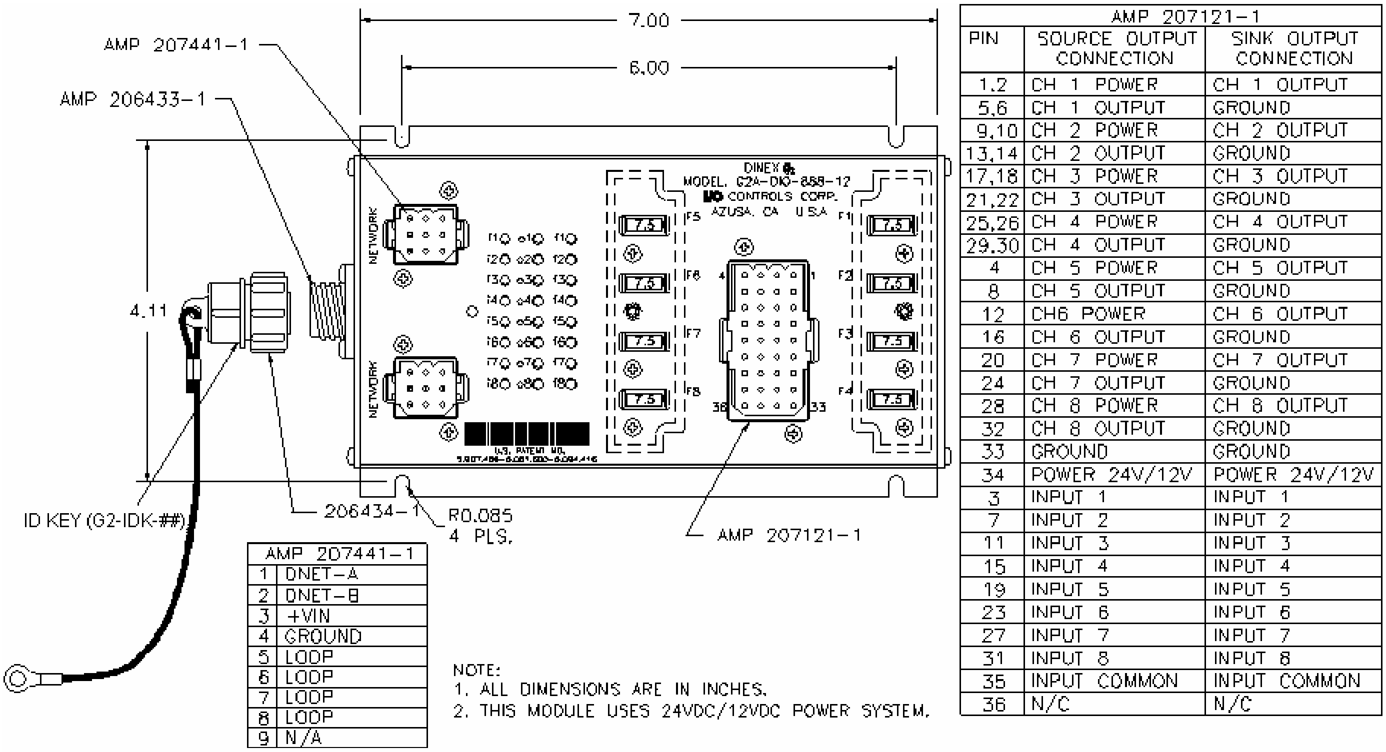


FIGURE: 4.2 – DINEX G2A SYSTEM RING-LOOP HOOKUP DIAGRAM

Dual Voltage Capability



AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP
6	LOOP
7	LOOP
8	LOOP
9	N/A

AMP 207121-1		
PIN	SOURCE OUTPUT CONNECTION	SINK OUTPUT CONNECTION
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH 5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V/12V	POWER 24V/12V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

FIGURE: 4.3 – INPUTS, OUTPUTS, & POWER CONNECTION DIAGRAM

NOTE: When removing wires from panel power studs, be sure to tag and reinstall removed wires to the same location.

- DIO modules have split circuits to allow two different output circuit voltages (12 or 24 volts) from a single module.
- Power can be 12/12, 12/24, 24/12, 24/24 volts depending on the voltage requirements of circuits being controlled.
- Pin #35 supplies power to the eight inputs.
- "Inputs" to the multiplex system are grounded at a switch.
- Ground wire is in the AMP type connector PIN # 33

Dual Voltage Capability

- **Three Basic Steps to Diagnosis and Troubleshooting**
- **Visual Inspection**
- **BIST (Built-In Self Test)**

5
Diagnosis and Troubleshooting

Diagnosis and Troubleshooting

The DINEX G2A system is composed of a network of rugged modules connected to a single data bus. This data bus interfaces with DINEX G2A modules. The DINEX G2A modules interface with sensors, switches, actuators and vehicle control devices.

The simplified wiring of the DINEX G2A network control system makes troubleshooting relatively simple in most cases.

Three Basic Steps to Diagnosis and Troubleshooting:

- Visual Inspection
- I/O Test Kit Verification
- Software Testing and Programming
- BIST (Built-In Self Test)

1. **Visual Inspection**

   Eighty-five percent of failed circuits can be diagnosed by using modules' LEDs -- failures usually related to defective parts, i.e., bulbs, switches, etc. This chapter discusses in depth how to diagnose and troubleshoot through visual inspection

Note: If the three steps fail to locate or solve the faults, then the module is suspect. The module must be returned to the manufacturer for repair.

No internal repairs are permitted unless authorized by the factory.

2 **I/O Test Kit Verification**

The I/O Control Test Kit provides for the testing of modules and the communication network. The I/O Control Test Kit will assist you in diagnosing those faults not found during visual inspection. *The next chapter will introduce these test kits in more details.*

3. **Software Testing and Programming**

Software Testing provides a way of verifying module programming or programming of replacement modules. *Please refer to bus manufacturer's control logic diagrams/ladder charts for software testing and programming.*

4. **BIST (Built-In Self Test)**
The BIST may be invoked any time. It is a passive test which uses the feedback circuits to check the output circuits. It also checks the DINEX module communications.

Visual Inspection:

- Visual inspection of the LEDs on the DINEX G2A modules will normally lead to the identification of 85% of all faults.
- Use Ladder Logic Diagrams -- to identify the relationship and the hook-up of devices -- and,
- Electrical Schematics -- to trace the circuits linked to a malfunctioning module indicated by the LED -- is all that is required at the Visual Inspection Level.
- Input Circuit LEDs.
- Ground connection – Verify that pin 16 of the large round AMP connector has a good chassis ground connection.

All modules, except PMS and junction boxes, have green LEDs to monitor input circuits. Each input has its own address. The lighted green LED indicates active input

Note: Some vehicle options -- such as mirror heaters, air dryers, etc.-- will not turn on the amber LED until a preset temperature is reached.

LED marker lights will not turn on the amber LED's at all.

- Output Circuit LEDs

DIO-888s use two LEDs, amber and red, to monitor output. If the circuit is off, the amber LED is lighted. The circuit is complete and ready, but is not active.

A lighted red LED indicates that the circuit is active.
The amber LED is off.

- Using LED on the modules to diagnose failed components.
- The “tools” necessary to diagnose faults are LEDs on the modules, “Ladder Charts” (or logic diagrams) and Electrical Schematics.
- When an LED does not indicate proper circuit operation, the electrical schematic can be used to trace the circuit from the module(s) to the input or output.
- Multiplex Test Equipment, Step 2, should not be necessary until, and only until, visual inspection has failed to indicate the failure or to confirm the functionality of the operation.

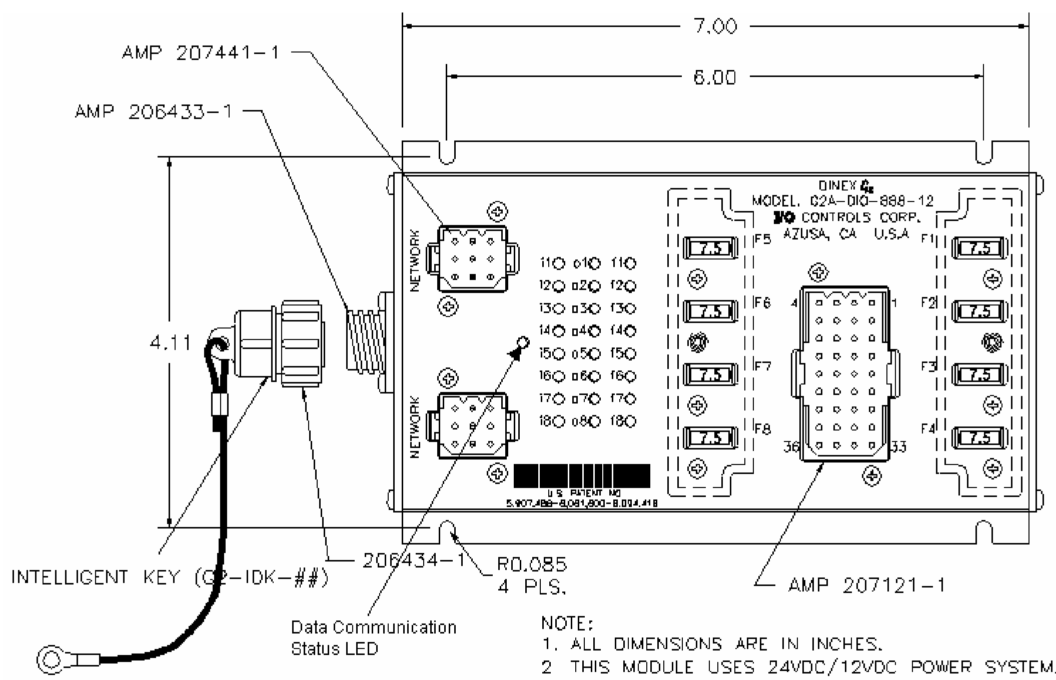
Checking the Input LEDs

- The MBC and DIO modules have green LEDs to monitor all inputs.
- Each input point has a unique location or sub-address. When the green LED is on, the input is ACTIVE.

LEDs Monitor Circuits

NOTE: During normal operation, the red and amber LEDs alternate off and on.

- With the circuit turned off: An amber LED comes on. (The amber LED indicates circuit integrity.) A circuit is complete and ready, but IT DOES NOT MEAN THE CIRCUIT IS ACTIVE.
- When the circuit is in use: A red LED will come on. This indicates that



the circuit is ACTIVE. The amber LED turns off.

FIGURE: 5.1 – DATA COMMUNICATION STATUS LED DIAGRAM

The Data Communications Status LED

NOTE: On some models, according to specification of each particular customer, the Data Communication Status LED is located on the left side panel of the module.

- The MBC, and DIO modules have Data Communications Status LED mounted on the left side of the face of the module, as shown in the figure above for a DIO module.

- The Data Link LED flashes at a rapid rate to indicate that the module is communicating.
- Modules in communication with DIOs respond with flashing LEDs. When multiple circuits respond, check the Data Link LED to see if it is flashing.

Tips on locating the site of a Failure using LEDs on the DIO modules

- If the load circuit is open -- i.e., bulb blown, burned solenoid, broken wire, etc.—the amber LED will not light up.
- If both amber and red LEDs are on when the circuit is active, check the fuse.
- If a module's red LED is out,
  a) check the data communication status LED on the left side of the module
  b) check cable for loose connections or damage,
  c) or check the related input status.

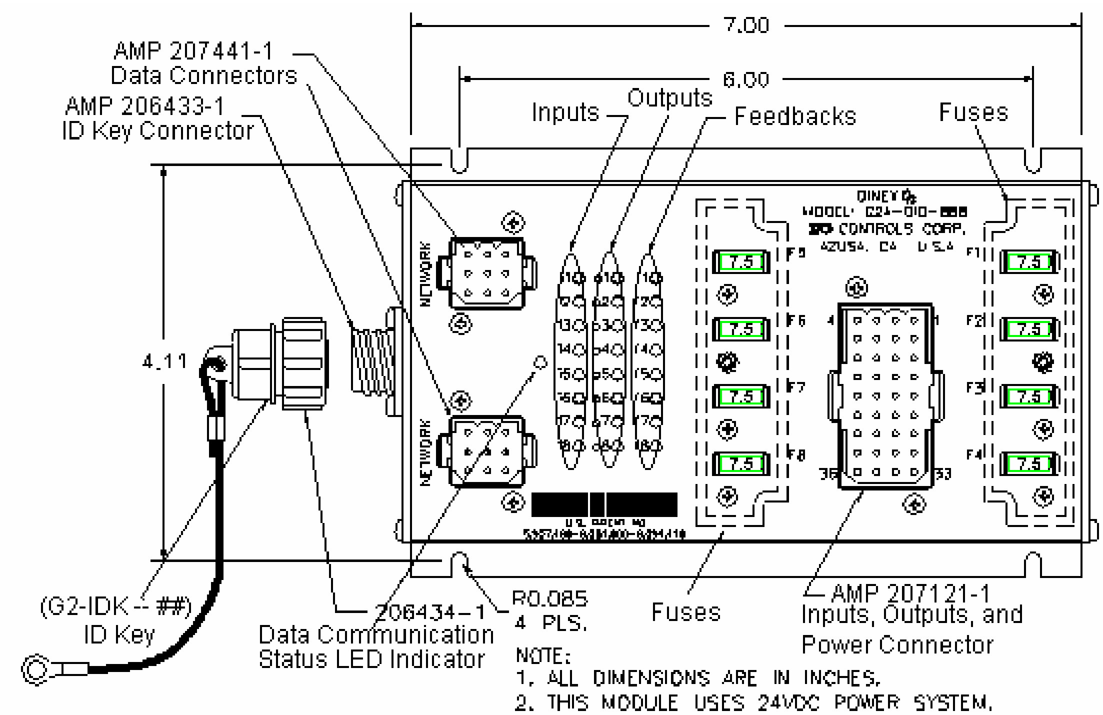


FIGURE: 5.2 –LEDS VISUAL INSPECTION DIAGRAM

Tips on locating the site of a Failure using LEDs on the DIO modules

- Internal circuits in the multiplex units (DIO) allow a small amount of current to flow to the output load -- even when the load is inactive.
- Current from the battery bus bar will pass through the amber LED, a large resistor, and the load to get to ground.
- A blown fuse will still allow current to flow through the amber LED and the red LED will be on because the circuit is trying to activate itself.

The No Connection Circuit

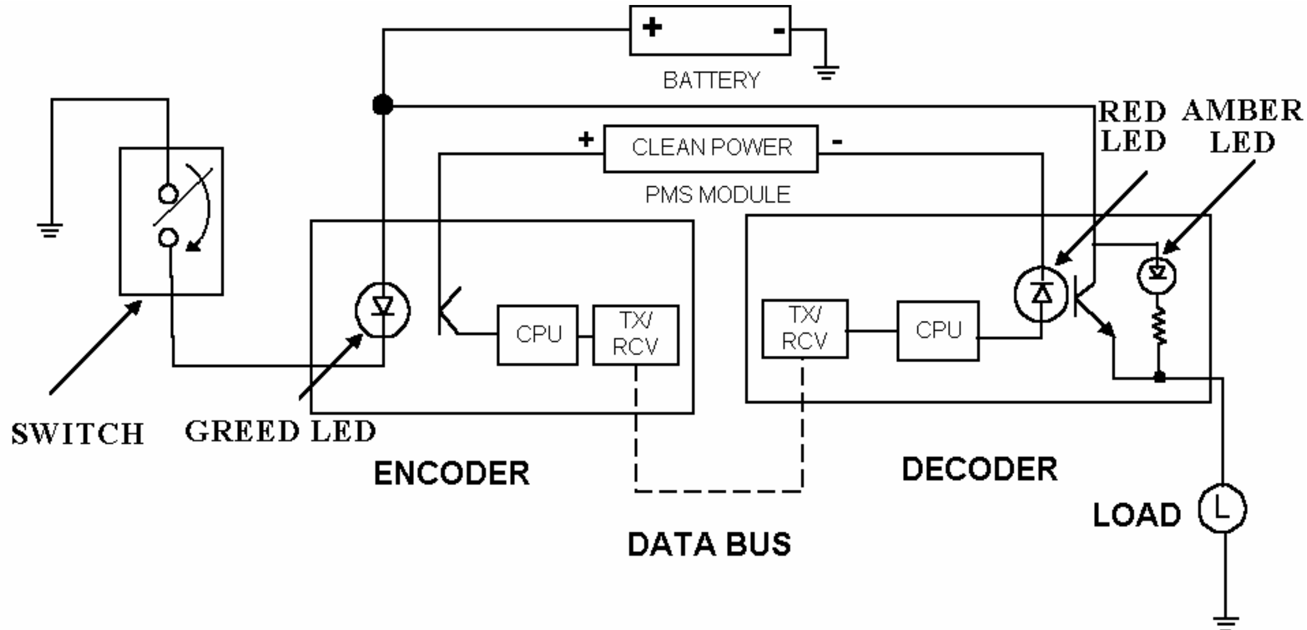


FIGURE: 5.3 – FUNCTIONAL DIAGRAM OF DINEX MPX SYSTEM

- The simplified circuit on the previous page shows that there are no direct links among input, the data bus, and the output.

  -The green LED turns on the sensor and switch inputs.

  -A light sensing (solar) transistor closes and a CPU sends out a signal on the data bus.

  -The receiving CPU lights the red LED.

  -Another light sensing transistor closes and completes the circuit from the battery to the load.
- No direct wire links eliminates the need for external diodes.
- Danger of voltage spikes damaging the data loop or modules is eliminated.

LADDER CHARTS

Understanding the Ladder Charts

Think of ladder charts as logic diagrams, see below:

Active And Inactive Inputs

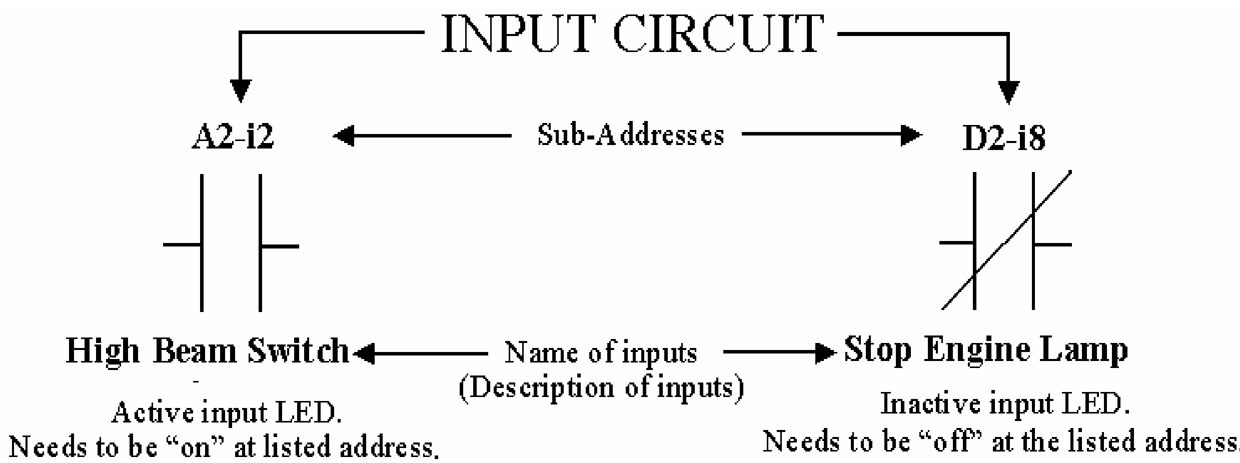


FIGURE: 5.4 – ACTIVE & INACTIVE COMPONENT DIAGRAM

- The MBC can be programmed to use open (inactive) or closed (active) switch input to determine a course of action.
- Imagine a relay that is normally open. Imagine the LED as a relay coil:

  -With no power to the relay, the LED is off. The relay is in the normally open position.

  -When power is applied, the LED is on and the relay is in the closed position. The current flows through the control load.

About Ladder Charts

- Simple charts make diagnosing circuits easy.
- All conditions must be met to complete an action.
- Charts indicate any parallel circuits for an action.

What Do Ladder Charts Look Like?

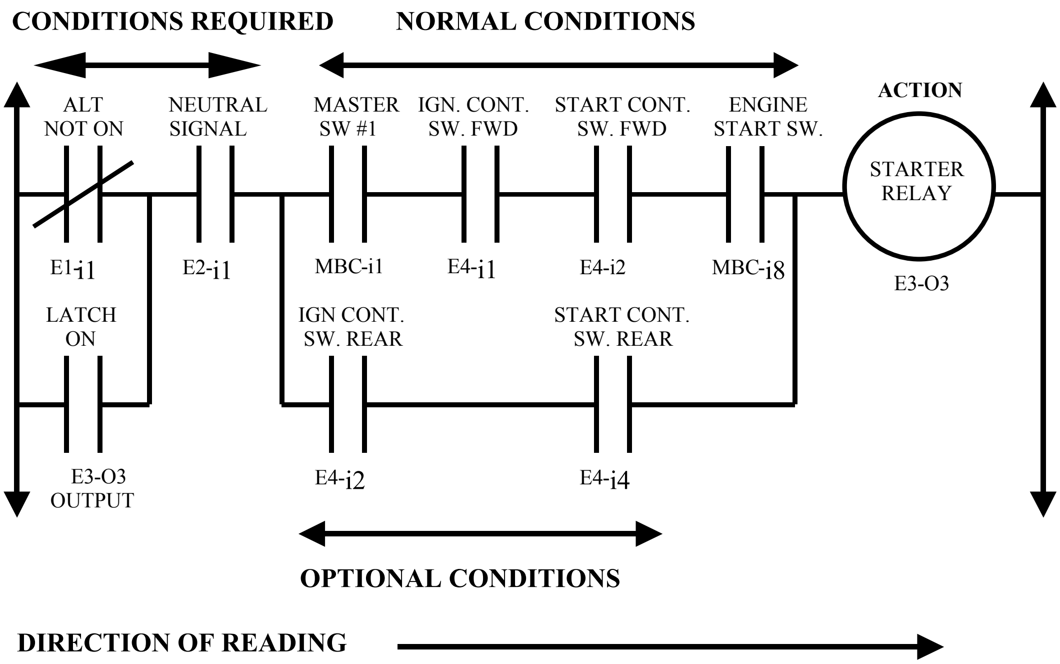


FIGURE: 5.5 – LADDER CHARTS DIAGRAM

More About Ladder Charts

- The Ladder Chart above shows each step necessary for a vehicle to be started.
    1. The alternator must not be charging.
    2. Vehicle is in neutral.
    3. From the front -- the master switch is on.
    4. From the rear -- the rear ignition and starter switches may be used.
    5. From the rear -- the ignition and starter control switches are set in front start position.
    6. Use the starter button.
    7. "Latch On" function circuit is set for starter relay.
        a. Circuit remains complete as long as starter is cranking, even if alternator starts to charge.
        b. Starter can not be re-engaged if alternator is charging.

BIST (Built-In Self Test)

On the buses, the 'Left Turn' and 'Right Turn' lamps on the Dashboard LED display can display a flash code if there is any Dinex module communication failure or Output Feedback problem. These are generally known as BIST flash codes, for Built In Self Test. The Right Turn, Left Turn, and Diagnostic Light Test switch must all be on at once in order to begin a flash code cycle.

Once begun, the flash code sequence will go through and check all of the modules, so there is no need to hold all three switches continuously. The flash code sequence will cycle again if the three switches are on, otherwise the BIST sequence will check each module and then stop. The warning buzzer is usually on when the Diagnostic Light Test switch is on, but the buzzer is silenced during the BIST. If there is no BIST failure, then the warning buzzer will sound periodically while all three switches are held on and neither the Left Turn nor the Right Turn dashboard lamp will light.

The Right Turn lamp on the Dashboard LED display will flash quickly to show which module has a failure. The Left Turn lamp will flash slowly to show which output channel(s) from the failed module is actually bad. If the Left Turn lamp does not flash, then this indicates a module communications failure rather than an output failure.

RIGHT TURN Lamp is:	Meaning
Off	Dinex module is OK
One Flash	Module A2 #64 Fault
Two Flashes	Module A3 #65 Fault
Three Flashes	Module A4 #66 Fault
Four Flashes	Module C1 #67 Fault
Five Flashes	Module C2 #68 Fault
Six Flashes	Module D1 #69 Fault
Seven Flashes	Module D2 #70 Fault
Eight Flashes	Module D1 #71 Fault
14 Flashes	Module A1 (MBC) #77 Fault (internal)
15 Flashes	Module B1 #78 Fault
9 - 13, or 16 Flashes	Incorrect Dinex program, Incorrect Accessory (Palm PC).

LEFT TURN Lamp is:	Meaning
Off	Nothing (Or Communication Fail)
One Flash	Module output #1 failure
Two Flashes	Module output #2 failure
Three Flashes	Module output #3 failure
Four Flashes	Module output #4 failure
Five Flashes	Module output #5 failure
Six Flashes	Module output #6 failure
Seven Flashes	Module output #7 failure
Eight Flashes	Module output #8 failure

- T2-MK-808 Test Kit
- T2-MK-Program Test Kit

6

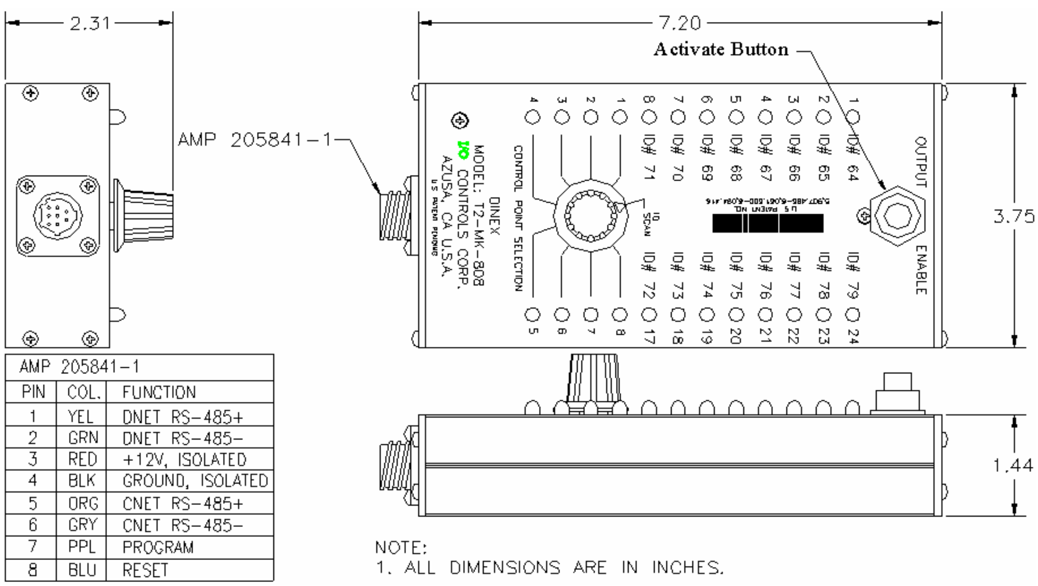
Testing Tools

G2A-MK-808 Test Kit

General Description

G2A-MK-808 is designed to diagnose and test G2A-DIO-888-K modules to support first line maintenance personnel. It is capable of testing the communications network function and simulating the direct output control of individual output point and monitor input status. It is also designed to check and support the integrity of the network. It does this by monitoring and scanning the ID of each network node. The versatility of G2A-MK-808 makes it the primary tool of the DINEX-G2A-MPX system.

Warning: ONLY AUTHORIZED AND TRAINED PERSONNEL SHALL USE THIS EQUIPMENT. The T2-MK-808 will override all safety preconditions. Mishandling may prove hazardous and harmful to the operator or third party. Special caution and authorization are required to operate this tool.



AMP 205841-1		
PIN	COL.	FUNCTION
1	YEL	DNET RS-485+
2	GRN	DNET RS-485-
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED
5	ORG	CNET RS-485+
6	GRY	CNET RS-485-
7	PPL	PROGRAM
8	BLU	RESET

FIGURE: 6.1 – G2A-MK-808 MODULE DIAGRAM

G2A-MK-808 Tests DIO 888 Modules

- Tests communications network,
- Simulates outputs,
- Monitors inputs.

Target Device

G2A-DIO-888, and the network.

Major Test Component and Accessories

- G2A-MK-808
- I/O cables and ID Scan cable

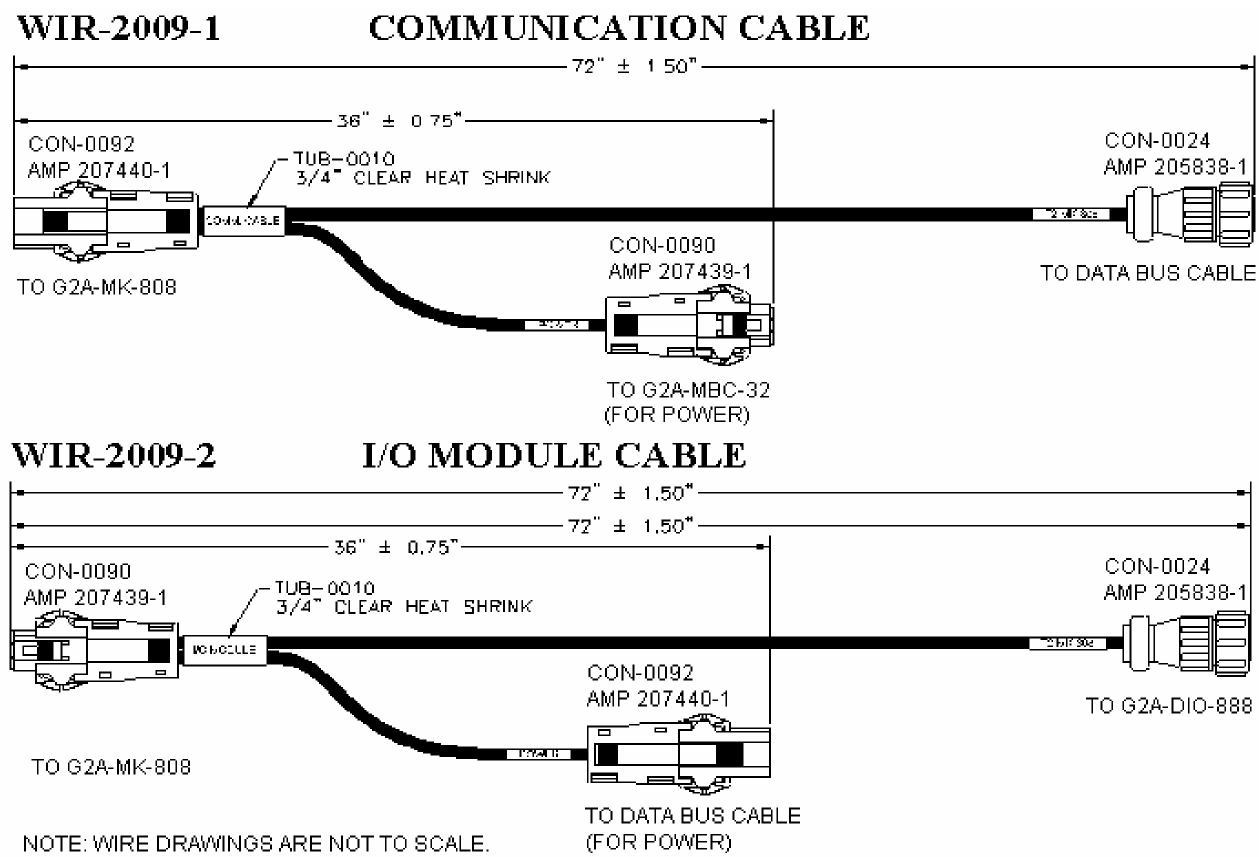


FIGURE: 6.2 – G2A-MK-808 CABLES DIAGRAM

Operating Procedure

Module ID and Input/Output Test

Note: *Make sure that the module is connected to the tester cable first and removed last at the end of testing.*

1. Power up the vehicle battery. Ensure that the MBC's PMS is in "wake up" mode to provide isolated power to DINEX G2A system.

2. Turn the dial on the G2A-MK-808 to "IDSCAN" position.

3. Disconnect both data bus cable connectors from the target module.

4. Connect the test cable ('I/O Modules' Cable) to target test module Connect (G2A-DIO-888) by following cable markings, i.e. connect the "I/O Modules" side of the test cable to the data side of module, connect the "Power" side of the test cable to either of the disconnected data cable connectors.

5. Target module's ID will now light up the corresponding LED on the tester.

6. Rotate the tester's dial to select the target output channel (1 through 8).
   i. -Push the activate button to activate the selected output.

   ii. -Repeat for different output channels.

7. At the same time the module input LEDs on the tester will light on or off corresponding to the module input status.

8. Check the activation status of the target module and the corresponding output point and input to verify the function and circuit integrity.

   i. -Outputs - If the red LED on the module does not come on during the test of a selected output, the module or connection is suspect.

   ii. -Inputs - If an input LED on the module is lit and the corresponding LED on the tester fails to light up, the module or connection is suspect.

   iii. –A bad or open ground on the large AMP connector pin 23 can prevent proper module operation.

Network Integrity Test

1. Disconnect the Y cable used for I/O module test from the G2A-MK-808.
   (Reconnect the I/O Module to the ring loop)

2. Replace the Y cable with another Y cable that is marked 'Comm. Cable' for Network test onto the G2A-MK-808. Follow the cable markings.

3. Disconnect both data cables from the G2A-MBC-32.

4. Set the select switch on the G2A-MK-808 to ID Scan.

5. Connect G2A-MK-808 cable to the connector of MBC data bus.

6. The corresponding tester LED should illuminate, indicating that the correct modules are connected to the main data bus.

7. Verify the network configuration and check integrity.

8. Reconnect both data cables back to the G2A-MBC-32.

T2-MK-PROGRAM Test Kit

General Description

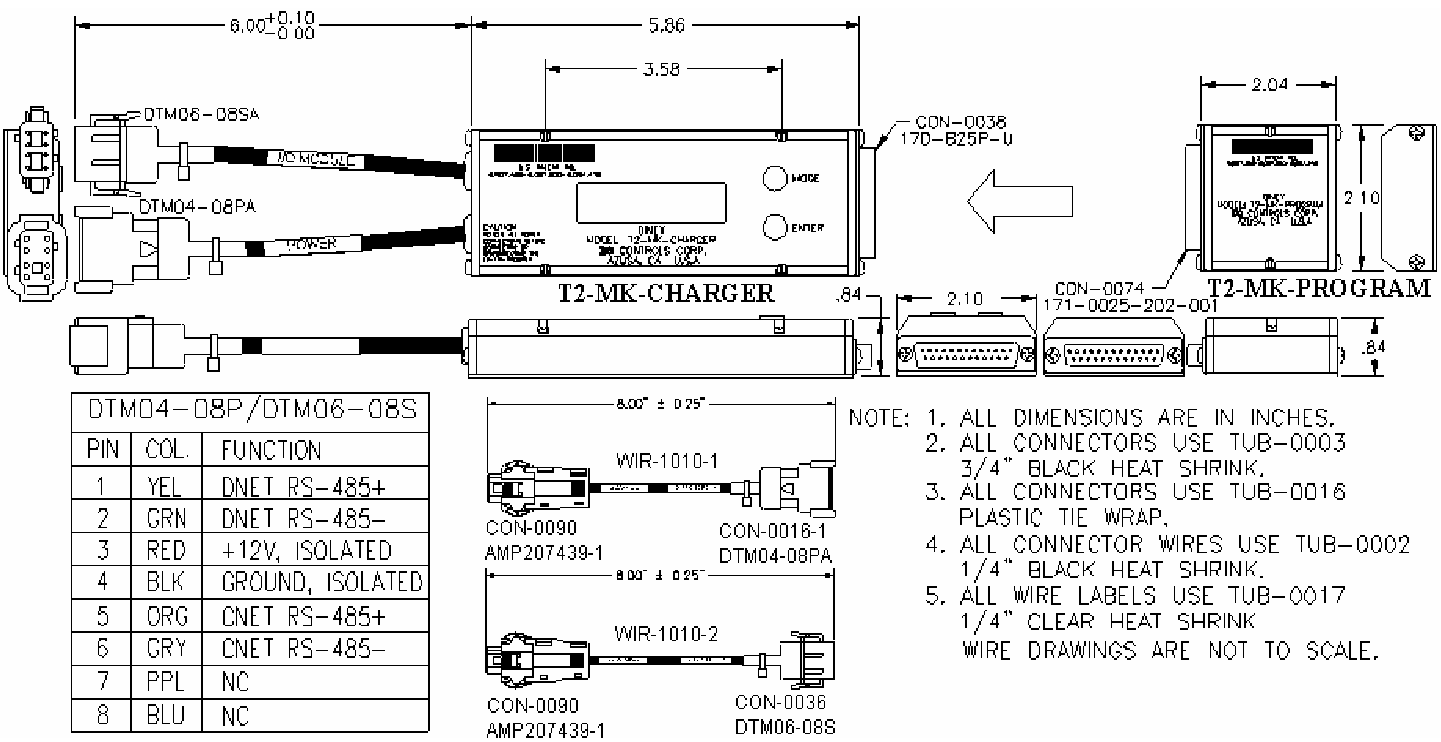
The PROGRAM KIT is designed to download program smoothly.

- T2-MK- PROGRAM holds program memory.
- T2-MK-CHARGER-R2 loads the program to the target MBC module in less than 60 seconds.

Module program changes (resulting from faults or updates) are easily corrected in the DINEX T2 system using the T2-MK-PROGRAM and T2-MK-CHARGER-R2, see the illustration above. The Charger will download the program to the target MBC in less than 60 seconds.

The PROGRAM and CHARGER are intended to be used as a pair without the aid of any additional equipment.

The LED device on the T2-MK-CHARGER-R2 can be helpful to monitor the status of downloading a new program, or verifying the program currently in the module.



DTM04-08P/DTM06-08S

PIN	COL.	FUNCTION
1	YEL	DNET RS-485+
2	GRN	DNET RS-485-
3	RED	+12V, ISOLATED
4	BLK	GROUND, ISOLATED
5	ORG	CNET RS-485+
6	GRY	CNET RS-485-
7	PPL	NC
8	BLU	NC

FIGURE: 6.3 – T2-MK-CHARGER & T2-MK-PROGRAM DIAGRAM

Target Devices

G2A-MBC-32

<u>NOTE:</u> *When replacing a new G2A-MBC-32 module, the same system unique program must be loaded to the new module as was used in the "old" system.*

When the control system needs customer design changes, the updated program or programs must be loaded to the specific G2A-MBC-32 module to ensure that the system performs as required.

Up-loading a program <u>to</u> T2-MK-PROGRAM kit from a PC
(for Level 2 & Level 3 or Factory used only)

Operating Procedure

1. Prepare the PC-compatible computer with the T2-MK-232 (an RS232 to RS485 converter module) in normal programming mode.

2. Identify the target, G2A-MBC-32 module and verify the program to be downloaded.

3. Select the correct program to be downloaded.

4. Connect the T2-MK-CHARGER-R2 and the T2-MK-PROGRAM modules together via their DB-25 connectors.

5. Apply power to the T2-MK-CHARGER-R2 by connecting the 9-volt AC Power adapter supplied with the T2-MK-232 kit.

6. Select "Upload Mode" on the T2-MK-CHARGER and press ENTER

7. Execute the normal PC program upload/downloading procedure to upload:
    i. Select file to be uploaded
    ii. Select COM port
    iii. Select "G2A"
    iv. Select baud rate: 115K for G2A system
    v. Ignore the code length selection (It's fixed length: 3FFF in hexadecimal)
    vi. Press button called 'Program & Verify'

8. If an error message window is shown up, reset the CHARGER module by unplugging the power adapter. Plug it in again to reset the CHARGER. And repeat Step 6 again till a download completion message window is displayed.

9. Program download is now completed. The T2-MK-PROGRAM modules are ready for service.

Verifying or downloading the program <u>from</u> T2-MK-PROGRAM kit to the target module <u>IN THE VEHICLE</u>

Operating Procedure

1. Turn on the vehicle battery power.

2. Identify the target G2A-MBC-32 module and verify the program to be downloaded.

3. Choose the correct pre-loaded T2-MK-PROGRAM module to be downloaded.

4. Connect the T2-MK-CHARGER-R2 and the T2-MK-PROGRAM modules together via their connectors.

5. Connect the cable assembly via the 8-pin connector to target module, but disconnect the target module from the ring loop at both connections.

6. Select 'Verify' mode. By pressing 'Enter' button, it starts to verify the program in the PROGRAM module and the program in the target module.

7. If the 'Verify' OK, they both contain an identical program. The CHARGER will display 'checksum' and 'Revision number' on the LED device.

8. If the 'Verify' process shows 'Checksum Error', it means the target module has different program than in the PROGRAM module. Select 'Download mode' to start downloading process.

9. If 'Download Error – verify cksum err' status shows on the LED device, the download process is not successful. Repeat Step 6

through 9 till ‘Download Completed – Verify OK! Rev. #’ message is displayed.

10. Unplug the connector from the target module.

11. Disconnect program-related connectors.

12. Program download is now complete. Reconnect connectors to original configuration as required.

Factory Troubleshooting and Repair

Note: DINEX module internal components are not field-repairable

- If Levels 1 through 3 troubleshooting and diagnostics fail to show the cause for failures or poor performances, the suspect module must be returned to the manufacturer for more rigorous troubleshooting and repair.

- I/O Failure
- Module Failure
- System Failure

7

Failure Analysis and Corrective Action

I/O Failure

This operation is to be used where a limited number of input or output points have malfunctioned within each module.

Visual Check -- Output Mode

- Check the fuse.
- Check feedback amber* and red LEDs. Amber* LED checks the circuit integrity. If the circuit is open for any reason during non-active/ red LED off mode, the amber* LED will be off. If the circuit is functioning the amber* LED will be on.
- The red LED confirms that the output is activated by the computer. If both the red and amber* LEDs are on, check the fuse.

Use Of Tools

- Use the T-MK-808 to confirm the test.

Corrective Action

NOTE: *Some applications use green LED instead amber LED, according to the specifications of various bus manufacturers.*

- Check to see if a fuse is burned out.
- Check for possible short circuit.
- If amber* LED is off, check for open circuit.
- If both red and amber* LEDs are off, replace module and check circuit.

Module Failure

When a full bank of functions is not working, a module failure has occurred or the output section is missing the power connection.

Visual Check

- Check the communications.
- Check LEDs. If an LED is off, and remains off, module-networking capability is malfunctioning.
- Check powers supply yellow LED. Is every yellow LED on? If the yellow LED is on, system power is fine.

Use of Tools

- T-MK-808 is used to check ID and IO.

Corrective Action

- Check DATA BUS wires integrity. Reset the module by disconnecting the data bus. Replace module.

System Failure

This level of failure is indicated when the system operates as follows:

- Abnormally.
- System is dead.
- Control of the system is lost.

Before proceeding

- Reset the system.
- Shut down/ reset the battery.

Visual Check

- Check every network module LED. All modules should be blinking rapidly.
- If LEDs are not blinking rapidly, check the MBC data bus connection.
- If LED's are blinking, run the BIST and check for DINEX module communication failure indication.

Use of Tools

- Use G2A-MK-808 ID checking mode for data bus integrity.

Corrective Action

- After resetting the system, if the condition persists. Replace the MBC module

- G2A-MBC-32: Main Bus Controller with Power Management System Module
- G2A-DIO-888: Intelligent Digital Input/Output Module
- T2-DIO-24OG-R7: Intelligent Digital 24 Output Gateway Module
- T2-DIO-32LED-OB-01: 32LED indicator Panel

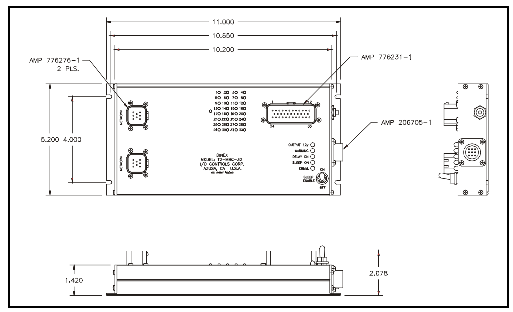
8

Technical Specification

G2A-MBC-32
Main Bus Controller with
Power Management System Module

MODULE FEATURES

- Controller.
- Stores instructions for control and monitor.
- Programmable logic for sequence of operations.
- Software compiler available.
- Controls and monitors up to 16 sub-nodes.
- Interface for 32 Inputs.
- Four groups of 16-8-4-4 input points may be source reference or ground reference inputs.
- Built-in timer interrupts function.
- Supports multiple, hierarchical network levels.
- Supports connections to other computers and Automatic Test Equipment.
- For control and monitoring of devices.
- All I/O points are optically isolated.
- LED status indicators provided on all I/O points.
- Replaces relays with solid state, electrical switching.
- Polarity of I/O signals is set by hard wiring, the next assembly wiring harness as appropriate.
- Communication with 115K Baud Dinex G2 Modules



STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, light weight and rugged.
- Simple to field replace.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication
- Fault tolerant RS485 data communication bus.
- 115 Kbps data communication rate.

- LED status indicator during communication operation.
- Dual communication ports for ring-loop hook-up capability.

APPLICATIONS

- Main Bus Controller for Multiplexing Systems.
- Master Bus Controller replacing computers.
- Controller for on-board Self-Tests and/or connections to external Automatic Test Equipment for diagnostics.
- Interfaces to switches, such as limit switches, temperature and pressure switches, pushbutton and selector switches.

PRODUCT DESCRIPTION

The Main Bus Controller (G2A-MBC-32) is a network controller with power driver, which provides the complete functions acting as a full-size computer. The module can be established as a Bus Controller which controls multiple nodes or which can directly control other node modules. The MBC module can provide a direct interface for the operator interface, including switches, LED indicators and digital displays.

OPTIONS

Module

- Alternate connector types and configurations, or color coded wire pigtails.
- Resistance for exposure to the ambient environment, without a required enclosure.
- Optional RS-232 Port by special order.

Support Equipment

- DINEX T2-MK-232 Converter Box for RS232 serial port (PC compatible) to DINEX data communication bus.
- Handheld Field Programmer.
- Simulator.

TECHNICAL SPECIFICATIONS

General

- Operating temperature range: -40°C to +85°C
- Humidity: 10% to 100%, saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

MODULE

Inputs

- Input voltage: 16-32 VDC
- Reverse voltage protection: 32 VDC
- Input current at rated pick-up voltage: 5mA
- Input current at maximum voltage: 15mA
- Turn on/off time: 15 millisecond maximum

LED Indicators

- green indicators for inputs.

Module and Programming

- High speed microprocessors.
- 8000 programming lines of stack code.
- Integrated word look-up table.
- 16K byte of EEPROM.
- network data exchange registers
- Fast program cycle time 3 microseconds.
- I/O excursion time 1575 microseconds.
- Extended compiler instruction set.
- Swap and rotate capability.
- Programming direct jump capability.
- Extended instruction set built into firmware.
- Direct control of other sub-level Cell Net Controllers.
- Built-in error detection, check sum protocol for faster operation.
- Uses standard ASCII text editor to generate source code, such as Microsoft DOS Edit.
- Uses Dinex Ladder Logic GUI language to generate source code, object code, system documentation.

Network Linking Capability

- One uplink to higher level controller.
- 16 downlinks to lower level controller and/or other DINEX modules.
- Note: The 32 input section uses one downlink address. Those 32 inputs may be made available to a redundant MBC controller.

PROGRAMMING SUPPORT SOFTWARE

- DINEX Ladder Logic GUI language
- DINEX G2 Utility Program.
- High Speed Compiler (PC compatible).
- IOL2.3 Downloader (PC compatible).
- Debugger/Single Step Execution.

SUPPORT DOCUMENTATION

- DINEX G2 Utility Program User Reference Manual.

PIN ASSIGNMENT

AMP 207121-1	
1-32	INPUT 1-32
33	COM1 FOR INPUT 1-16
34	COM2 FOR INPUT 17-24
35	COM3 FOR INPUT 25-28
36	COM4 FOR INPUT 29-32

AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	CNET-A
6	CNET-B
7	PROG_L
8	RESET_L

AMP 206705-1	
1	12V (+)
2	12V (-)
3	RESERVE
4	WARNING OUTPUT
5	MASTER SW POS. 6
6	A 485
7	B 485
8	GROUND
9	BATTERY 24V

G2A-DIO-888
Intelligent Digital Input/Output Module

MODULE FEATURES

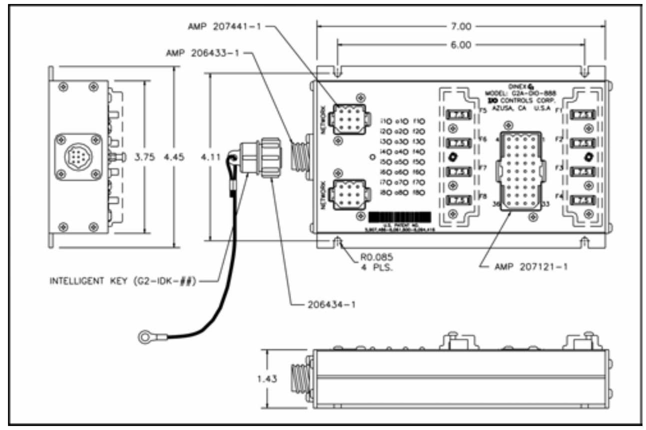
- 8 input points.
- 8 output points, high power DC version.
- 8 internal feedback monitoring LEDs, for determining the status of control devices and loads.
- 8 internal feedback current less than 100 uA.
- Each Output point is fuse protected, and includes an easily accessible, sealed fuse holder.
- All I/O points are optically isolated.
- Outputs may be any combination of source and sink outputs.
- LED status indicators provided on all I/O points.
- Polarity of input/output signals is set by hard wiring the next assembly wiring harness as appropriate.
- Replaces relays with solid state, electrical switching.
- Communication with 115K Baud Dinex G2A modules

STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication
- Fault tolerant RS485 data communication bus.
- 115 Kbps data communication rate.
- LED status indicator during communication operation.
- Dual communication ports for ring-loop hook-up capability.



APPLICATIONS

- Used for turning on and off electrical power to control devices and loads, such as solenoid valves, lights, electrical clutches, heaters and motor starters.
- Can apply electrical power to fareboxes, radios and other electrical subsystems.
- Interfaces to switches, such as limit switches, temperature and pressure switches, pushbutton and selector switches.

PRODUCT DESCRIPTION

The G2A-DIO-888 module is a digital input and output module for on/off state devices. The module includes both inputs for monitoring switches and outputs for control devices in a very compact package. Internal feedback monitoring provides the ability to determine if a load is active, in addition to the wiring and output fuse.

Each I/O point is optically isolated and fused for protection against voltage spikes, transients and short circuits. The optical isolation also provides electrical noise immunity.

Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

There are 8 inputs can be wired as ground-switched inputs or voltage-switched inputs. Polarity of input signals is set by hard wiring the next assembly wiring harness as appropriate.

The output section has two connections for circuit power and ground for purposes of applying power to control the output switching transistors. Each output may be a source output or a sink output. Polarity of output signals is set by hard wiring the next assembly wiring harness as appropriate

OPTIONS

Module

- Alternate connector types and configurations, or color coded wire pigtails.
- Resistance for exposure to the ambient environment, without a required enclosure.

Support Equipment

- DINEX T2-MK-232 Converter Box for RS-232 serial port (PC compatible) to DINEX data communication bus.
- Handheld Field Programmer.
- Simulator.

TECHNICAL SPECIFICATIONS

General

- Operating temperature range: -40°C to +85°C
- Humidity: 10% to 100%, saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

MODULE

Inputs

- Input voltage: 8-32 VDC
- Reverse voltage protection: 32 VDC
- Input current at rated pick-up voltage: 5mA
- Input current at maximum voltage: 15mA
- Turn on/off time: 15 millisecond maximum

Outputs

- Load voltage: 8-32 VDC
- Continuous load output current: 7.5 Amp
- High power output option for ch1 to ch4: 15 Amp continuous load
- Leakage current at nominal load voltage: 100 uA max.
- Turn on/off time: 15 millisecond maximum
- Total output current is 40 Amp Maximum

LED Indicators

- 8 green indicators for inputs.
- 8 red indicators for outputs.
- 8 amber indicators for internal feedback monitoring of load.

PIN ASSIGNMENT

		AMP 207121-1
PIN	*POWER OUTPUT CONNECTION*	**SINK OUTPUT CONNECTION**
1,2	CH 1 POWER	CH 1 OUTPUT
5,6	CH 1 OUTPUT	GROUND
9,10	CH 2 POWER	CH 2 OUTPUT
13,14	CH 2 OUTPUT	GROUND
17,18	CH 3 POWER	CH 3 OUTPUT
21,22	CH 3 OUTPUT	GROUND
25,26	CH 4 POWER	CH 4 OUTPUT
29,30	CH 4 OUTPUT	GROUND
4	CH5 POWER	CH 5 OUTPUT
8	CH 5 OUTPUT	GROUND
12	CH6 POWER	CH 6 OUTPUT
16	CH 6 OUTPUT	GROUND
20	CH 7 POWER	CH 7 OUTPUT
24	CH 7 OUTPUT	GROUND
28	CH 8 POWER	CH 8 OUTPUT
32	CH 8 OUTPUT	GROUND
33	GROUND	GROUND
34	POWER 24V/12V	POWER 24V/12V
3	INPUT 1	INPUT 1
7	INPUT 2	INPUT 2
11	INPUT 3	INPUT 3
15	INPUT 4	INPUT 4
19	INPUT 5	INPUT 5
23	INPUT 6	INPUT 6
27	INPUT 7	INPUT 7
31	INPUT 8	INPUT 8
35	INPUT COMMON	INPUT COMMON
36	N/C	N/C

AMP 207441-1	
1	DNET-A
2	DNET-B
3	+VIN
4	GROUND
5	LOOP 5
6	LOOP 6
7	LOOP 7
8	LOOP 8
9	N/A

T2-DIO-24OG-R7
Intelligent Digital 24 Output Gateway Module

MODULE FEATURES

- For driving the LED module.
- 24 transistor 20 mA sink output points.
- Acts as gateway on DINEX network and other host system.
- Isolation output.

STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Potted for environmental protection.
- Built-in high speed RISC microprocessor with EEPROM.
- Designed with CMOS circuitry for low power consumption.
- 2 data communication connectors for in/out.

Multiplex Communication
- Fault tolerant RS-485 data communication bus.
- 115K bps data communication rate.
- LED status indicator during communication operation.

APPLICATIONS

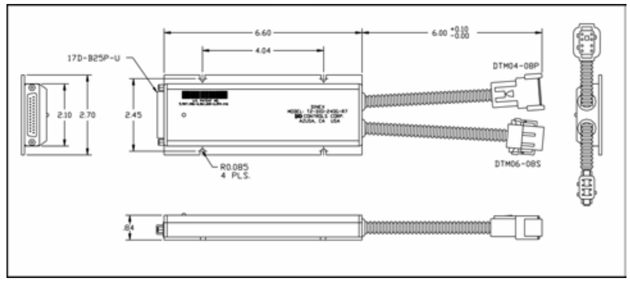
- Interfaces with panel LED display module or with load less than 20mA output.

PRODUCT DESCRIPTION

The T-DIO-24OG-R2 is a digital gateway module for on/off state signals. The module is designed for grounding the output in open collector format.
Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

OPTIONS

Module
- Alternate connector types and configurations, or color coded pigtails.



TECHNICAL SPECIFICATIONS

General
- Operating temperature range: - 0°C to +65°C
- Optional extended temperature: - 35°C to +85°C
- Humidity: 10% to 100%, non-saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

INTERFACE INFORMATION

Computer input power: 9 VDC +3/-2V at 200mA Maximum, isolated supply.
Data communication bus and power connector:
IOC MPX side: DEUTSCH DTM04-08PA 8-pin

Connector

Pin # 1 =RS-485 A
Pin # 2 =RS-485 B
Pin # 3 =V+
Pin # 4 =GND
Pin # 5 =direct circuit bypass
Pin # 6 =direct circuit bypass
HOST side: AMPHENOL 17D-B25P DB-25 male connector or equivalent.
Pin #1 to PIN # 24 = BIT #1 to BIT # 24
Pin #25 = GND

SUPPORT DOCUMENTATION

DINEX Utility Program User Reference Manual.

T2-LED32-OB-01
32LED Indicator Panel

MODULE FEATURES

- For monitoring of devices.
- 32 low level LED output.
- Each point assigned as an output point.
- Non-isolated IO.
- Acts as node in DINEX network.

STANDARD DINEX FEATURES

Network
- Integrates with intelligent network control system.
- Allows system expansion.
- Easy to use and program.
- Interfaces to Personal Computers and other host computers.

Construction
- Small, compact, lightweight and rugged.
- Simple to field replaces.
- Potted for environmental protection.
- Designed with CMOS and FET circuitry for low power consumption.

Multiplex Communication
- Fault tolerant RS-485 data communication bus.
- 115K bps data communication rate.
- LED status indicator during communication operation.

APPLICATIONS

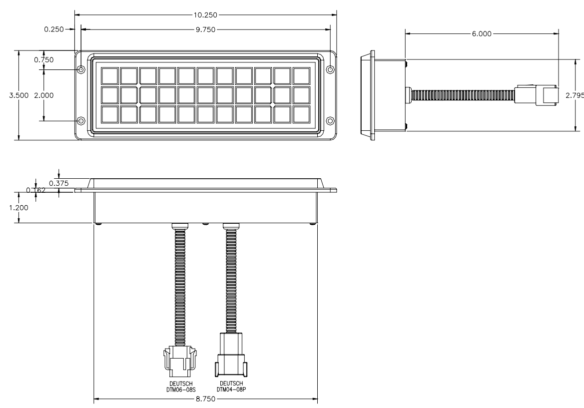
- As instrument panel warning light cluster.
- Customized LED arrangement.

PRODUCT DESCRIPTION

The T2-32LED-OB-01 module is a digital LED output unit for on/off state signals. The module includes 32 high brightness LED blocks for warning indicator or status indicator.
Each module has a unique programmable field address and each I/O point can be separately monitored and controlled by a Cell Net Controller or computer.

OPTIONS

Module
- Alternate connector types and configurations, or color coded pigtails.
- Discrete input connections for special items. Such as stop engine signal, check engine signal, directly connected to engine controls. Such a fire signal or ABS signal, directly connected to other control system.



TECHNICAL SPECIFICATIONS

General
- Operating temperature range: - 40°C to +85°C
- Humidity: 10% to 100%, non-saturated
- Shock: up to 20 g
- Vibration: 5 to 35 Hz, 2mm double amplitude, 2 hours

Outputs
Non-isolated LED blocks.

■ ID Keys for G2A System

9

Appendix

ID Keys for G2A System

General Description

In Dinex G2A system, each module has been signed a unique 'ID' number to identify himself. The unique address symbol (two digits of numerical number) which is assigned to each ID key. Each ID key should be connected with each functional unit (module) in the network. Each ID Key's number can not be changed (no re-writable). Some special module has built in ID function such as MBC, T2-DIO-24OG-R7, and RT2-32LED-OB-01; the ID number can be changed.

Typical Information

Module's Name	Zone Location	ID # XX
A1 (MBC)	Zone A	ID # = 77 (built in & re-writable)
A2	Zone A	ID # = 64
A3	Zone A	ID # = 65
A4	Zone A	ID # = 66
B1	Zone B	ID # = 78 (built in & re-writable)
C1	Zone C	ID # = 67
C2	Zone C	ID # = 68
D1	Zone D	ID # = 69
D2	Zone D	ID # = 70
D3	Zone D	ID # = 71

FIGURE: 9.1 – ID KEY'S TABLE

NOTE: *On some models, according to specification of each particular customer, the module's ID number may be assigned differently.*

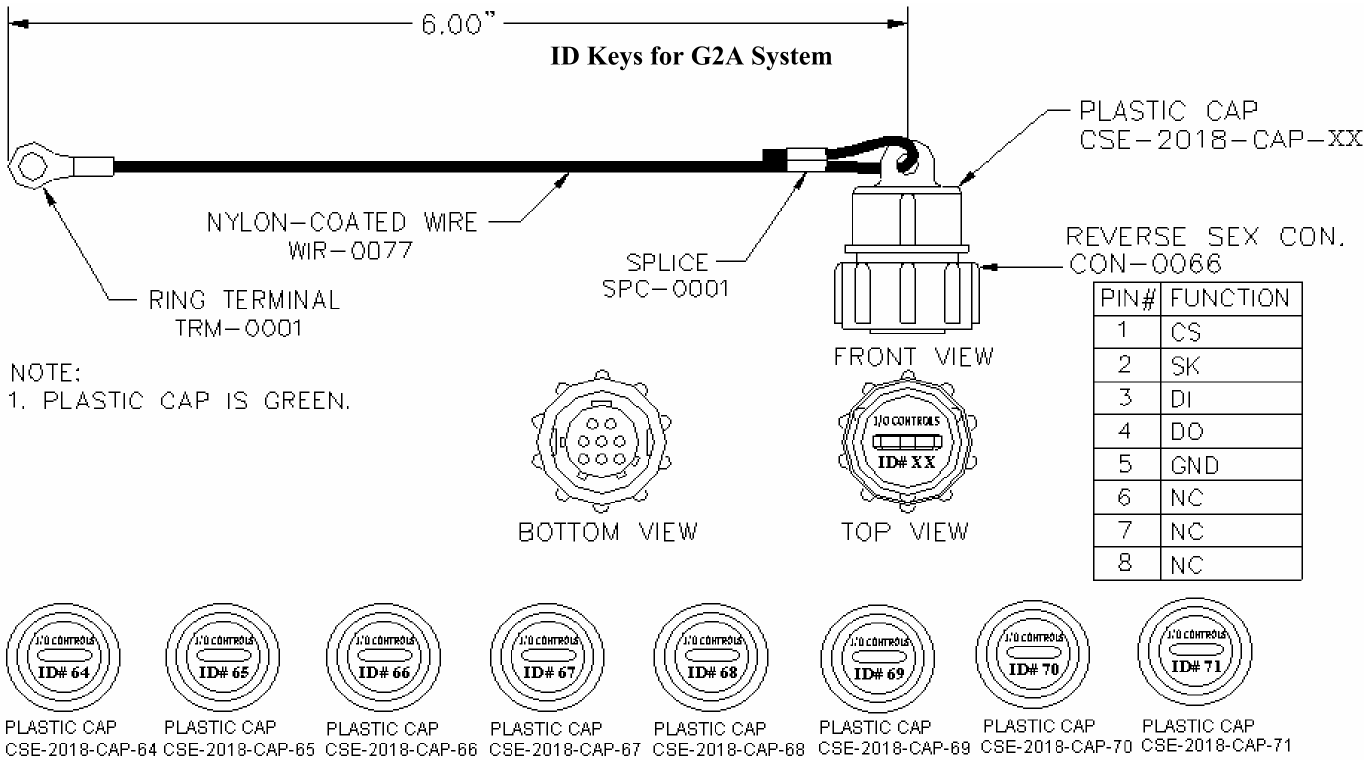


FIGURE: 9.2 – ID KEY'S DIAGRAM

Schedules "A", "B" and "C"

Vehicle #: ______________________

Mileage: ______________________

Inspector ______________________ Date: ______________________

Please Print

On the following pages you will find a comprehensive preventive maintenance schedule that encompasses suggested scheduled maintenance for the following intervals. Schedule A should be performed every 3,000 miles or weekly, Schedule B every 6,000-8,000 miles and Schedule C every 54,000 miles. Please note that if only Schedule A is indicated as being needed you only have to perform procedures that include A but if A and B are indicated everything for A and B must be done and if A, B, and C are indicated all work for A, B, and C must be done.

Procedure to be checked	Perform for A	B	C	Pass	Fail	If Failed - Reason
1. FLUIDS CHECK						
Oil	☒			☐	☐	
Coolant	☒			☐	☐	
Transmission Fluid	☒			☐	☐	
Hydraulic Fluid	☒			☐	☐	
Windshield Washer Fluid	☒			☐	☐	
2. LIGHTS						
Brake Lights	☒			☐	☐	
Turn Signals	☒			☐	☐	
Headlights	☒			☐	☐	
Emergency Flashers	☒			☐	☐	
Clearance or Marker Lights	☒			☐	☐	
Interior Lights	☒			☐	☐	
Driving and/or fog lights	☒			☐	☐	
Back-Up Lights	☒			☐	☐	
3. INTERIOR SYSTEMS						
Doors	☒			☐	☐	
Windshield Wipers	☒			☐	☐	
Horn	☒			☐	☐	
CB (if applicable)	☒			☐	☐	
Radio (if applicable)	☒			☐	☐	
PA (if applicable)	☒			☐	☐	
ADA Wheelchair Lift (if applicable)	☒			☐	☐	
Make sure all A/C Vents are open and ready for use	☒			☐	☐	
Rear Back Up Camera (if applicable)	☒			☐	☐	

Schedules "A", "B" and "C"

Continued

Vehicle #: ____________________

Mileage: ____________________

Date: ____________________

Inspector ______________________________
Please Print

Procedure to be checked	Perform for A	B	C	Pass	Fail	If Failed - Reason
4. EXTERIOR						
Tires and Wheels	☒			☐	☐	
Mirrors	☒			☐	☐	
5. DRIVE ON (Check Operation and/or Combination of Components)						
Wash engine/compartment incl. radiator, battery area, wheels. ***(Note: Secure vehicle properly)***		☒		☐	☐	
Test operation of starter		☒		☐	☐	
Check all dashboard gauges for operation		☒		☐	☐	
Check low air warning buzzer and light (below 60 psi)		☒		☐	☐	
Check and record air governor operation		☒		☐	☐	
Cut out ______psi Cut in ________psi		☒		☐	☐	
Parking brake set (between 20-40 psi)		☒		☐	☐	
Check Service and Parking brake operation		☒		☐	☐	
Brake application air leak check. (No continuous leak after application)		☒		☐	☐	
Check fast idle operation		☒		☐	☐	
Record max engine rpm ____________		☒		☐	☐	
Record oil pressure @ idle __________		☒		☐	☐	
Check safety equipment, fire extinguisher, reflectors, first aid kit		☒		☐	☐	
Record inspection date of fire extinguisher __________		☒		☐	☐	
Check main A/C and heater operation & filter clean		☒		☐	☐	
Check defrost A/C operation & filter clean		☒		☐	☐	
Check condition and mounting of all seats		☒		☐	☐	
Check condition of all windows and operation of emergency exit windows		☒		☐	☐	
Check operation and condition of doors and controls		☒		☐	☐	
Check floor and covering for looseness and condition including stepwells		☒		☐	☐	

Schedules "A", "B" and "C"
Continued

Vehicle #:

Mileage:

Date:

Inspector ______________________
Please Print

Procedure to be checked	Perform for A	B	C	Pass	Fail	If Failed - Reason
6. SERVICE						
Secure vehicle properly and use locknut/tagout procedures	☒	☒	☒	☐	☐	
Check mirrors	☒	☒		☐	☐	
Check body condition and repairs		☒		☐	☐	
Check bumpers, mud flaps and brackets		☒		☐	☐	
Take oil and transmission samples		☒		☐	☐	
Change fuel filters		☒		☐	☐	
Drain engine oil, replace oil filters (fill oil filters before replacement)		☒		☐	☐	
Clean and reinstall crankcase magnetic drain plug (Torque to engine mfg.)		☒		☐	☐	
Refill engine crankcase to engine mfg. specs.		☒		☐	☐	
Check coolant level & record freeze point ________ (Verify coolant type before adding)		☒		☐	☐	
Check coolant cap for condition		☒		☐	☐	
Pressure test coolant system and cap to rated pressure		☒		☐	☐	
Check for leaks and hose connection while under pressure for 30 minutes		☒		☐	☐	
Check hydraulic fluid level and change filters (Verify hydraulic fluid before adding)		☒		☐	☐	
7. UNDERCHASSIS AND LUBE						
Lube all recommended grease fittings (including PTO, Hydraulic pump and drive)		☒		☐	☐	
Inspect front end for looseness, wear, air bags, A-arms, shocks for leaking		☒		☐	☐	
Check ride height, front and drive adjust		☒		☐	☐	
Measure brake adjustment all wheel ends		☒		☐	☐	
Inspect brake pads, rotors for wear		☒		☐	☐	
Check for leaks, engine, transmission, hydraulic system, steering, and coolant system		☒		☐	☐	
Check driveline		☒		☐	☐	
Inspect air dryer and drain air tanks		☒		☐	☐	
Inspect fuel tanks for mounting and vent tubes		☒		☐	☐	

Schedules "A", "B" and "C"

Continued

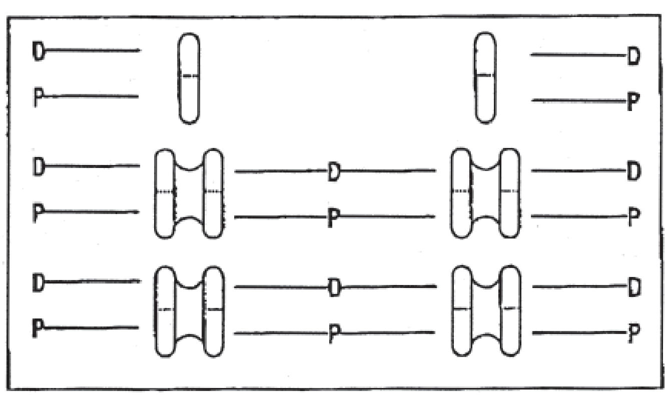
Vehicle #: ____________________

Mileage: ____________________

Inspector ____________________ Date: ____________________

Please Print

Procedure to be checked	Perform for A	B	C	Pass	Fail	If Failed - Reason
8. UPPER CHASSIS, ENGINE AND ELECTRICAL						
Inspect radiator fan for operation and speed		☒		☐	☐	
Inspect hydraulic cooling fan for operation and speed		☒		☐	☐	
Check air filter restriction indicator (MAX 18")		☒		☐	☐	
Change filter if 18" is exceeded and clear reminder		☒		☐	☐	
Check batteries and terminals for tightness and condition		☒		☐	☐	
Inspect engine compartment lights, switches and wiring for condition and operation		☒		☐	☐	
Inspect all belts for condition and check tension with a tension gauge		☒		☐	☐	
9. ENGINE AND TRANSMISSION (w/engine running)						
Record engine oil pressure @ engine compartment _______ psi		☒		☐	☐	
Record engine fault code history and clear fault codes		☒		☐	☐	
Record transmission fault code history and clear codes		☒		☐	☐	
10. TIRES AND WHEELS						
Record tire depth in 32nds on outline below		☒		☐	☐	
Check condition of tires side wall (cut, rubbing, etc.)		☒		☐	☐	
Check wheel nut torque		☒		☐	☐	
Check wheels for condition cracks		☒		☐	☐	
Check valve stems for condition and record tire pressure on outline below and inflate to proper pressure		☒		☐	☐	



Schedules "A", "B" and "C"
Continued

Vehicle #: ____________________

Mileage: ____________________

Inspector ____________________ Date: ____________________

Please Print

Procedure to be checked	Perform for A	B	C	Pass	Fail	If Failed - Reason
11. FINAL INSPECTION						
Check oil level		☒		☐	☐	
INSPECTION PART 2 - 54,000 MILES						
Drain Transmission, change filters, refill to mfg. specs.			☒	☐	☐	
Change water filter (if equipped)			☒	☐	☐	
Service hydraulic filters			☒	☐	☐	
Take coolant sample			☒	☐	☐	

Additional Remarks:

Inspector/Mechanic ____________________ **Date** ____________________

Signature

Supervisor ____________________ **Date** ____________________

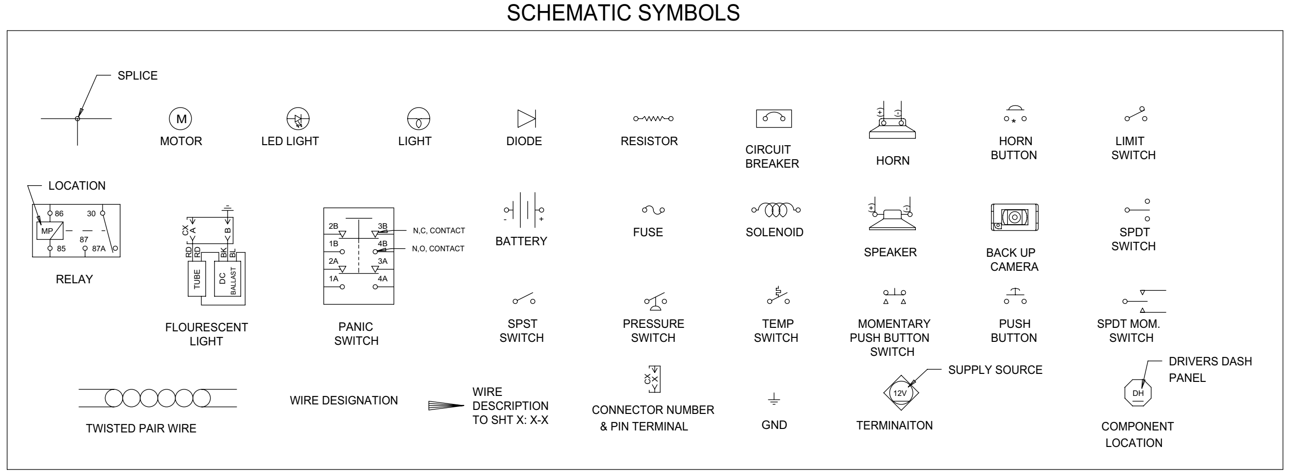
Signature

Schematic Index

M4RE
WIRING SCHEMATIC INDEX

Rev.	DESCRIPTION	SHEET	BB #	
B A	INDEX	1	0065553	
B A	POWER DISTRIBUTION	2	0074386	
B	CAT 12 ENGINE	3	0076872	
A	TRANSMISSION,ALLISON GEN 4	4	0095198	E
	MBC MODULE	5	0065557	
	A-2 MODULE	6	0065558	
	A-3 MODULE	7	0065559	
	A-4 MODULE	8	0065560	
	B-1 MODULE	9	0065561	
	B-2 MODULE	10	0065562	
	C-1 MODULE	11	0065563	
	C-1 MODULE INS FEATURE 30961-01	11A	0071324	
	C-2 MODULE	12	0065564	
	C-2 MODULE INS FEATURE 30961-01	12A	0071305	
	D-1 MODULE	13	0065565	
A	D-2 MODULE	14	0065566	
	D-3 MODULE	15	0065567	
	J1587 AND J1939 DATALINK	16	0065568	
A	RICON,LIFT	17	0065569	D
A	WIPER SYS AND STRG COLUMN SW	18	0065570	
	DATALOOPS AND MBC POWER	19	0065571	
	CARRIER,HVAC - ROOF	20	0065572	
B	MCCI,FRONT HVAC	21	0065573	
A	MIRRORS AND WEBASTO HEATER	22	0065574	
	ENGINE CONTROL BOX	23	0065575	
A	BENDIX,6S/6M ABS SYSTEM	24	0065576	
	DASH GAUGES	25	0065577	
A	VISION,SIGN SYSTEM	26	0065578	
	BACK UP CAMERA SYSTEM	27	0065579	
A	REI,SYSTEM 2000	28	0065580	
	RESTROOM	29	0065581	
	LUGG BAY LOCKS AND LIGHTS	30	0065582	
A	HATCH FAN,VISOR AND LAPTOP	31	0065583	
B	THERMO KING, HVAC - ROOF	32	0089599	

SCHEMATIC SYMBOLS



CONTROL WIRE NUMBERING/COLOR CODE SYSTEM

COLOR	LAST DIGIT OF WIRE NUMBER
TAN	1
RED	2
ORANGE	3
YELLOW	4
GREEN	5
BLUE	6
PURPLE	7
GRAY	8
BLACK	9
PINK	0
WHITE	USED FOR ALL GROUNDS

FIRST SERIES OF THE LETTER = THE MULTIPLEX ZONE
FIRST SERIES OF THE NUMBER = THE VOLTAGE AND PIN ASSIGNMENT OF THE CONNECTOR AT THE MODULE

A2-105
A2 = A ZONE
A2 = A2 MODULE
105 = (1 = 12 VOLTS) (05 = PIN#5 COLOR GREEN)

EXAMPLE: D2-214
D2 = D ZONE
D2 = D2 MODULE
214 = (2 = 24 VOLTS) (14 = PIN #14 COLOR YELLOW)

BLUE BIRD NON I/O CONTROL WIRE NUMBERING/COLOR CODE SYSTEM
24 VOLT WIRES ARE RED
12 VOLT WIRES ARE ORANGE

EXAMPLE: 24VIGN10
24V = 24 VOLTS COLOR RED
IGN = IGNITION
10 = 10 GAUGE WIRE

EXAMPLE: 12VBATT12
12V = 12 VOLTS COLOR ORANGE
BATT = BATTERY
12 = 12 GAUGE WIRE

ALL OTHER WIRES THAT DO NOT FIT INTO THESE CATAGORIES WILL BE FUNCTION CODED

SCHEMATIC LEGEND

AC	REAR A/C COMPARTMENT
BC	BATTERY COMPARTMENT
BZ	B ZONE
CB	CURB SIDE REAR BULKHEAD
CZ	C ZONE
DB	DRIVERS BARRIER
DH	DRIVERS DASH PANEL
DO	DRIVER'S OVERHEAD PANEL
DS	DESTINATION SIGN AREA
DZ	D ZONE
EB	ENGINE CONTROL BOX
EC	ENGINE COMPARTMENT
FD	FRONT DOOR HEADER
FB	FOOT CONTROL BOX
FF	FUEL FILL AREA
FP	FUSE PANEL
MP	MAIN ELECTRICAL PANEL
RD	REAR DOOR HEADER
RP	REAR POWER DISTRIBUTION CENTER
SB	STREET SIDE REAR BULKHEAD
SC	STEERING COLUMN
SP	SIDE SWITCH PANEL
TB	TERMINAL BLOCK
TP	TEST PORT PANEL

LET.	WAS	REVISIONS	DR.	APP.	CCN
E	0065556	CHGD,PART NUMBER TO 0095198	PB	08/02/05 PB	13160P
D	0065569	CHGD,PART NUMBER TO 0090826	CM	05/17/05 CM	13160H
C	--	CHANGED FRT HVAC TO MCCI & ADDED TK ROOF HVAC	PB	03/17/05 PB	13053M
B	--	UPDATED SCHEMATIC INDEX	SS	SS 12/06/04	13005A
A	--	UPDATED SCHEMATIC INDEX	SS	CE 11/21/03	13089S

CONFIDENTIAL

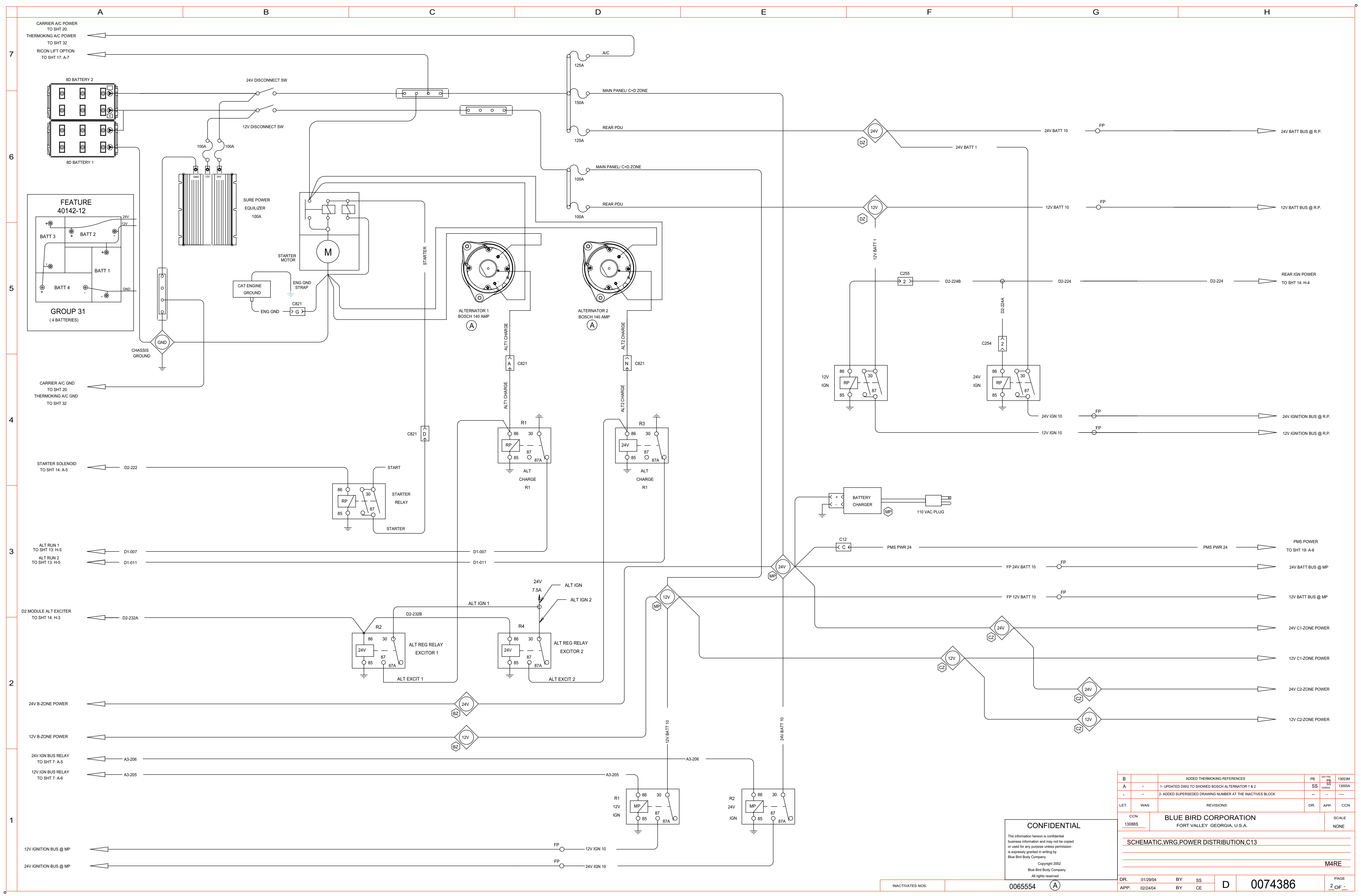
CCN 13006X
BLUE BIRD CORPORATION
FORT VALLEY GEORGIA, U.S.A.
SCALE NONE

SCHEMATIC,WRG,INDEX
M4RE

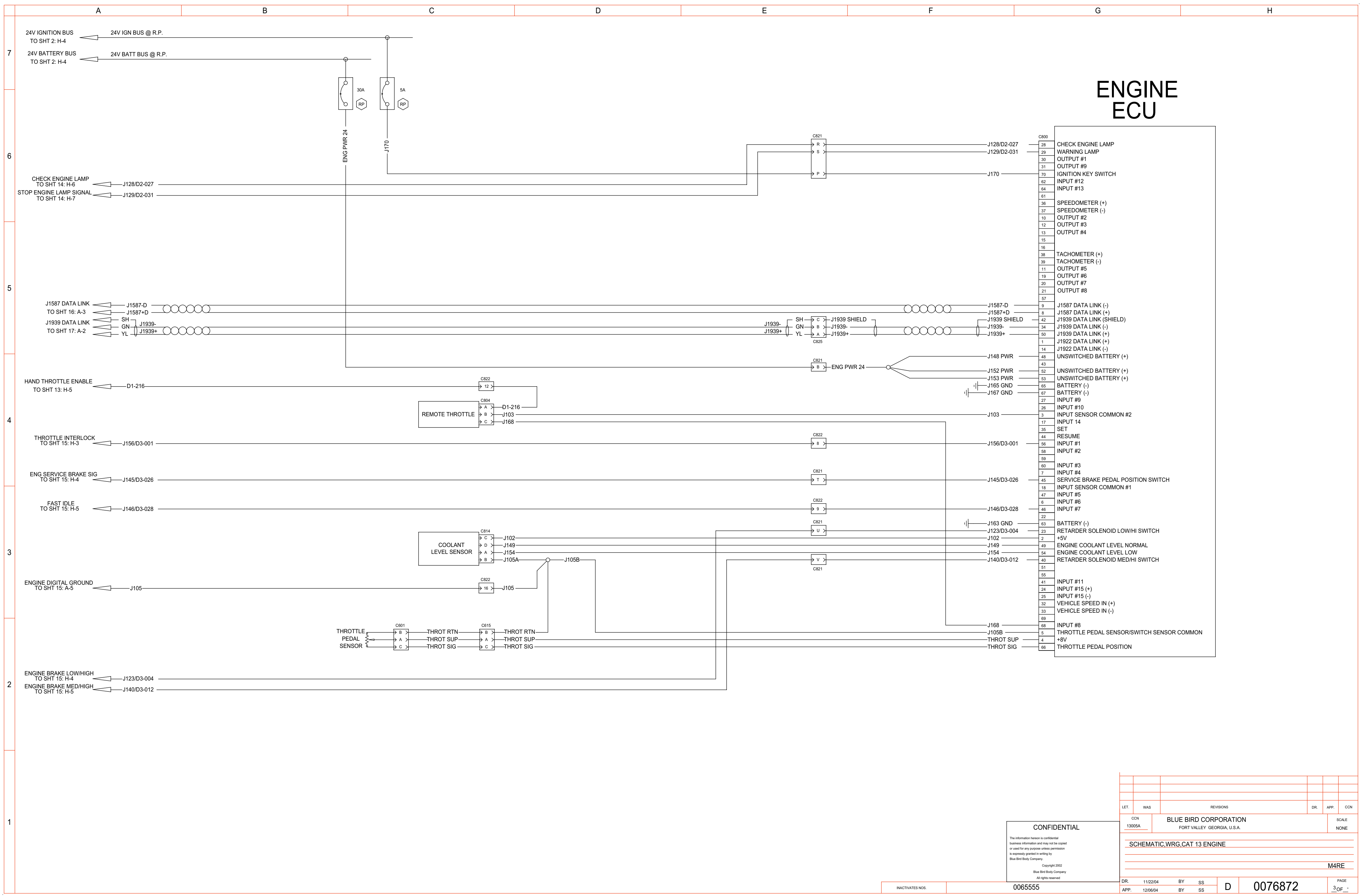
INACTIVATES NOS.

DR. 05/01/03 BY Matt P
APP. 05/01/03 BY KD
D 0065553
PAGE 1 OF -

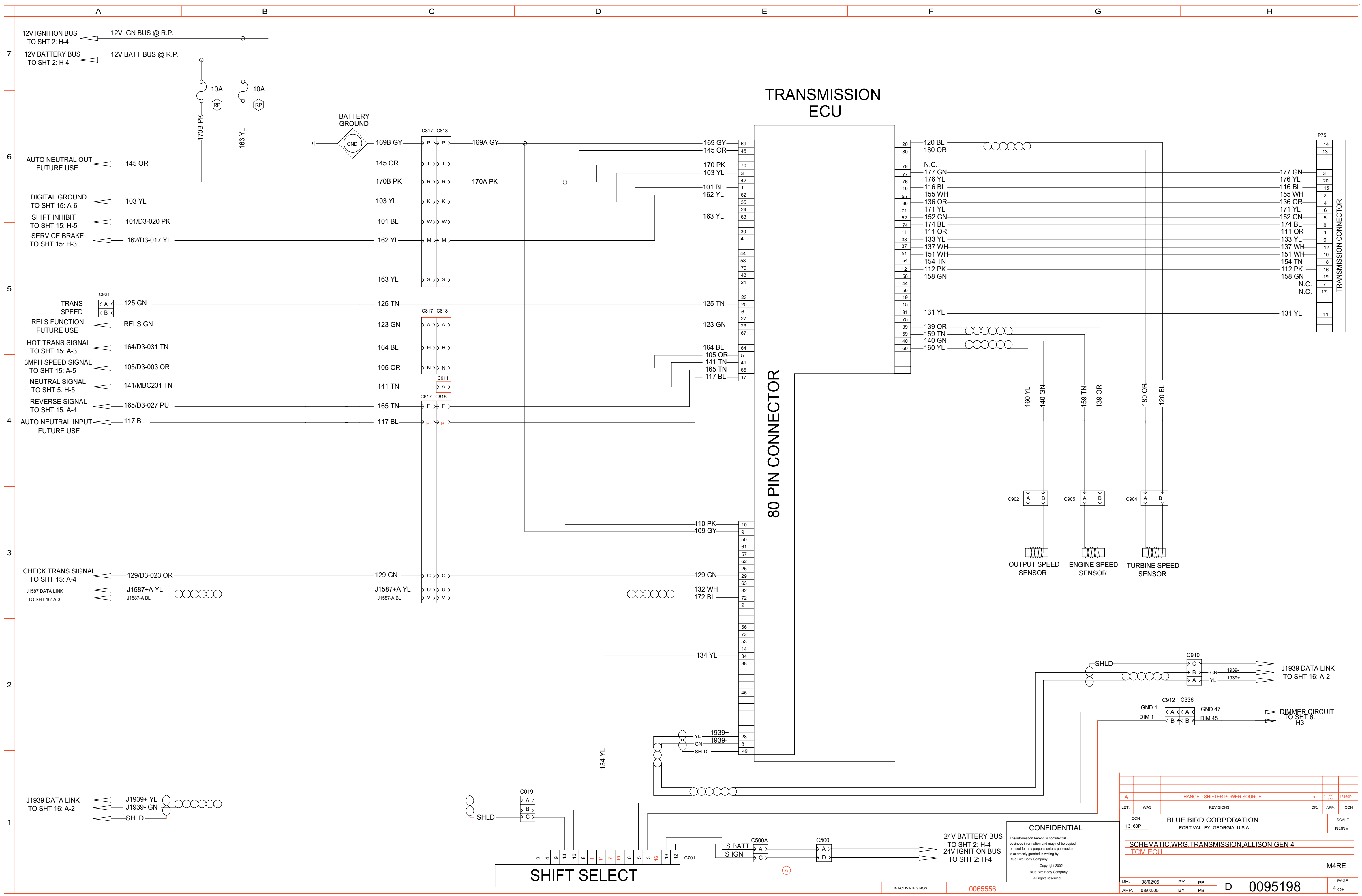
0074386 - Power Distribution



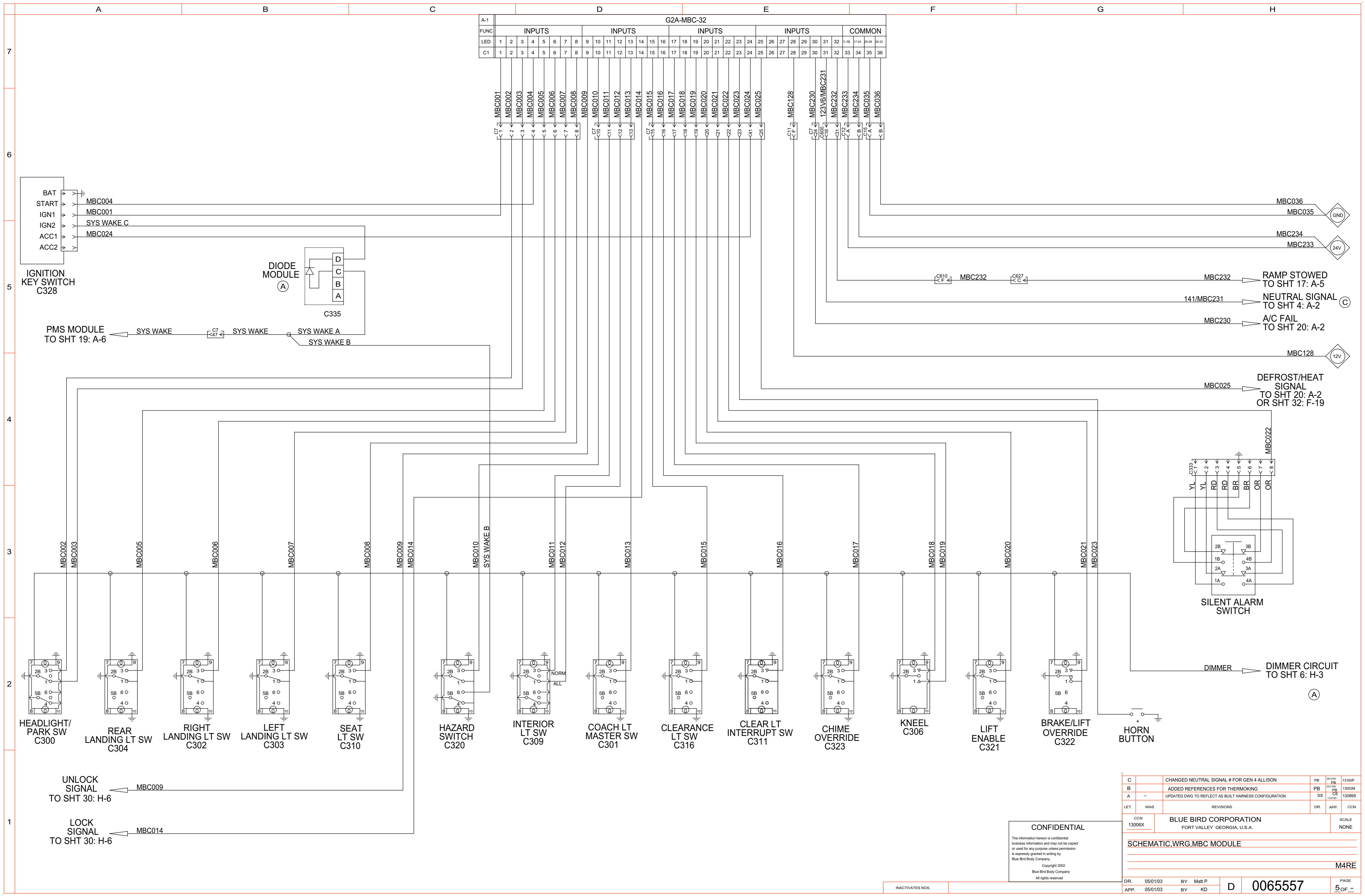
0076872 - Cat 12 Engine



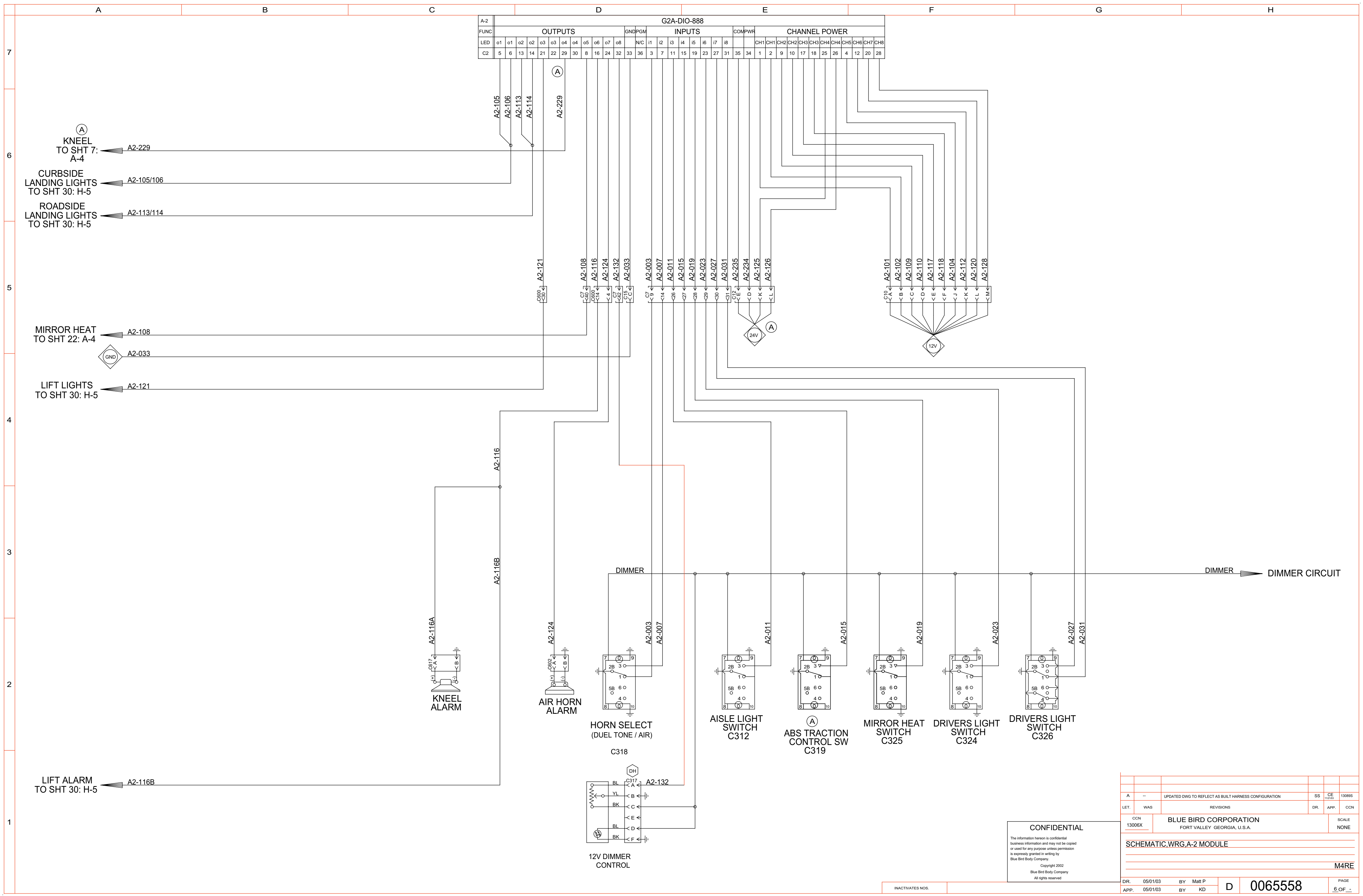
0095198 - Transmission Allison Gen 4



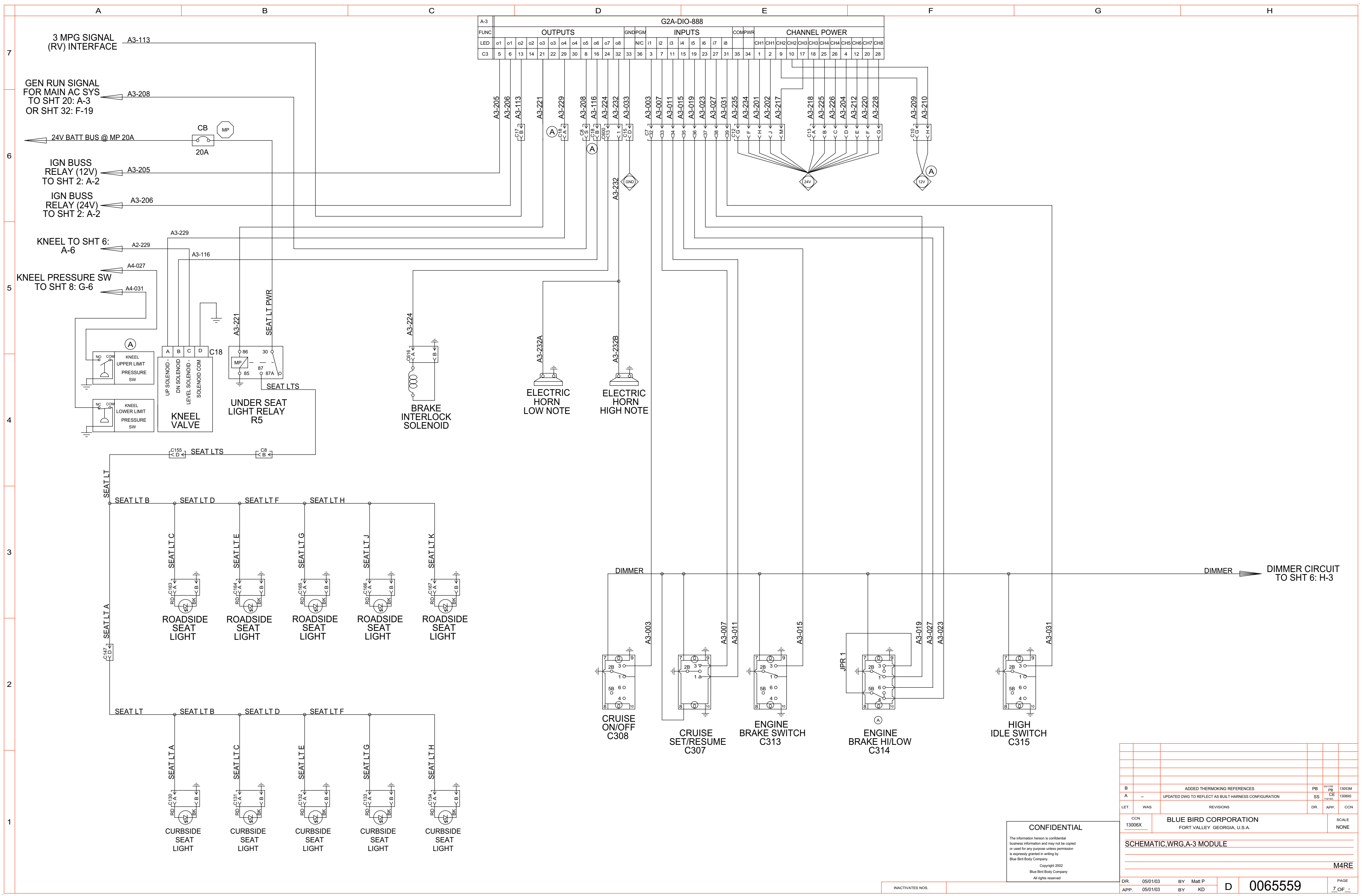
0065557 - MBC Module



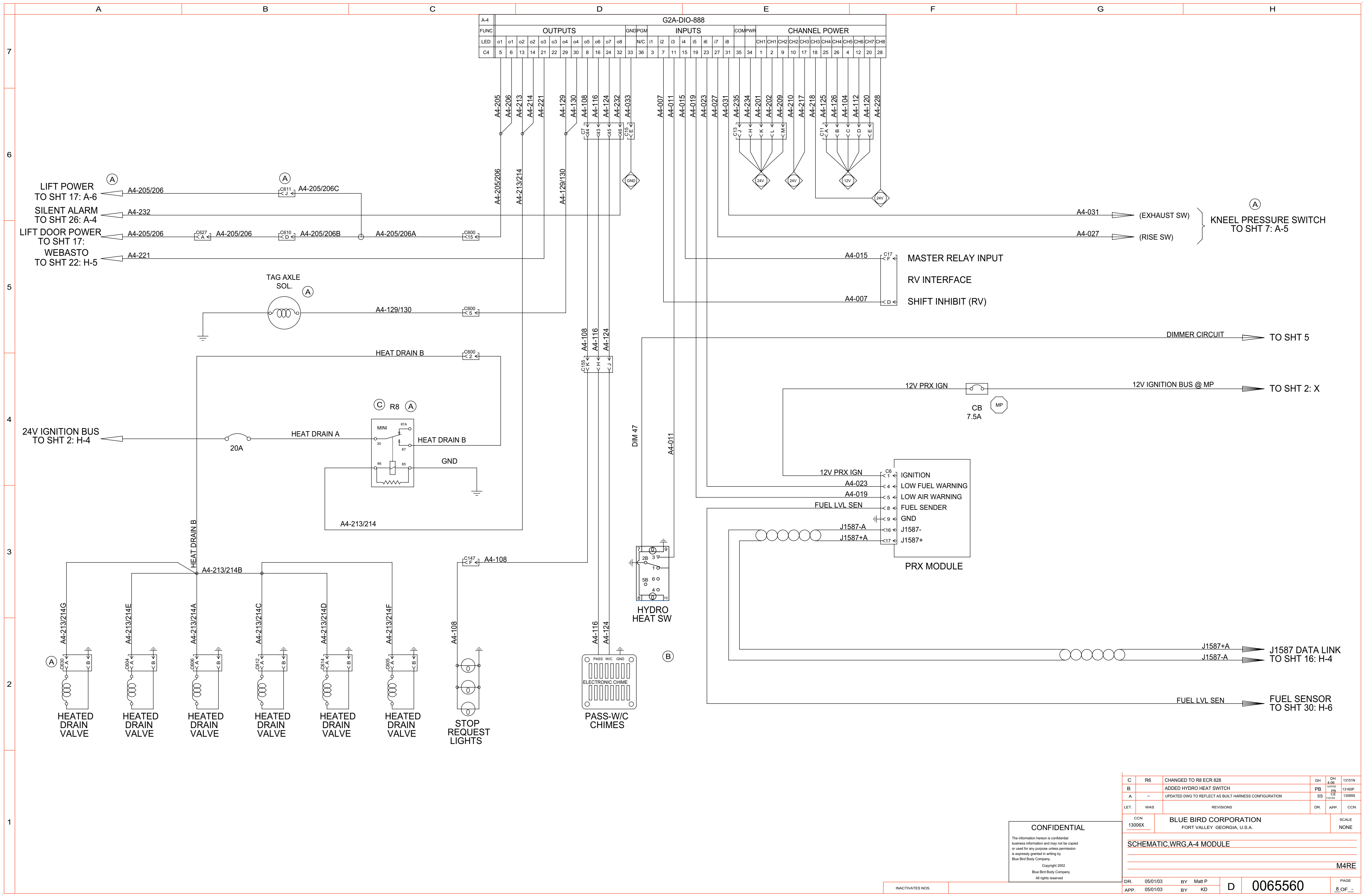
0065558 - A-2 Module



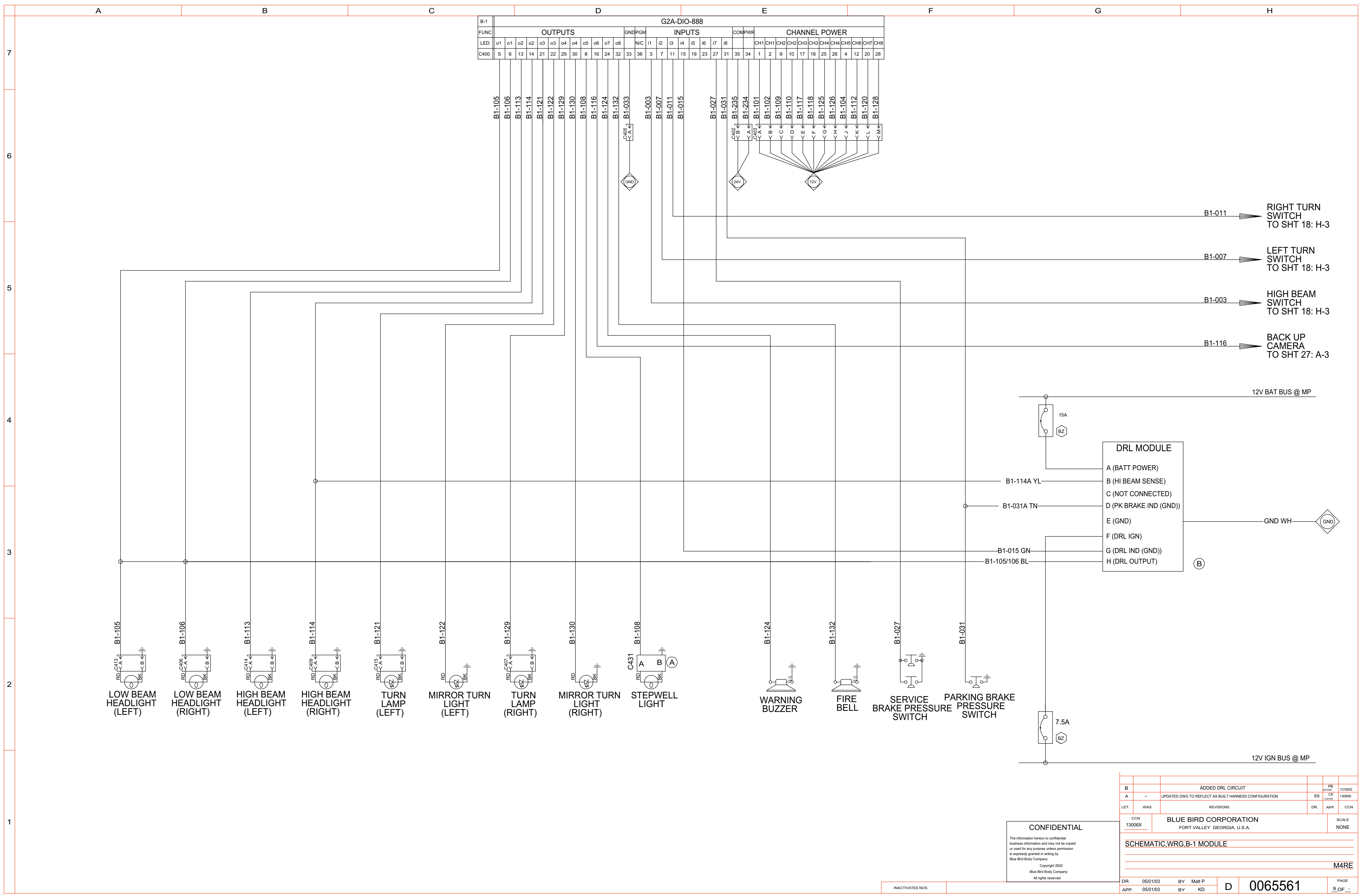
0065559 - A-3 Module



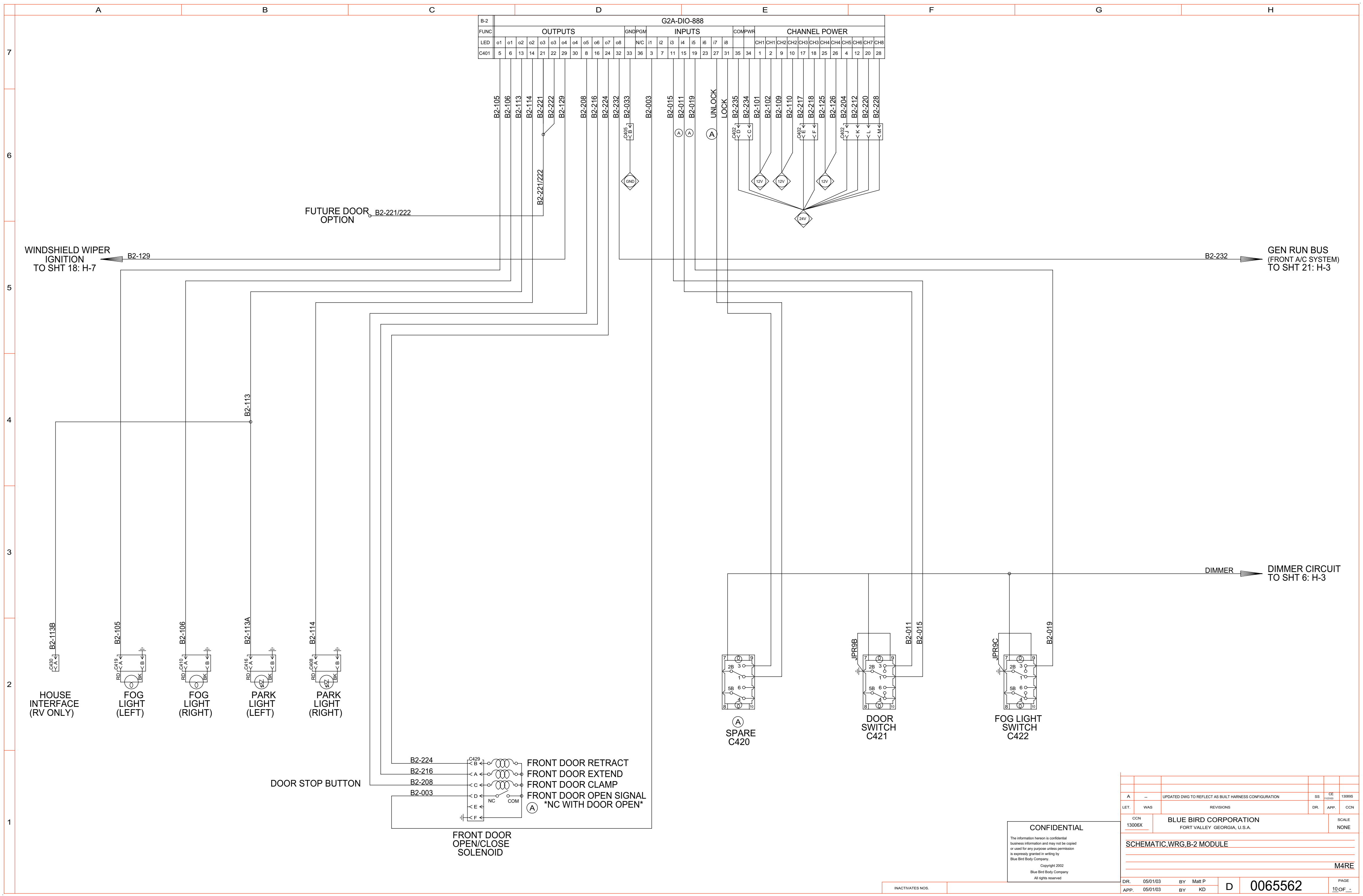
0065560 - A-4 Module



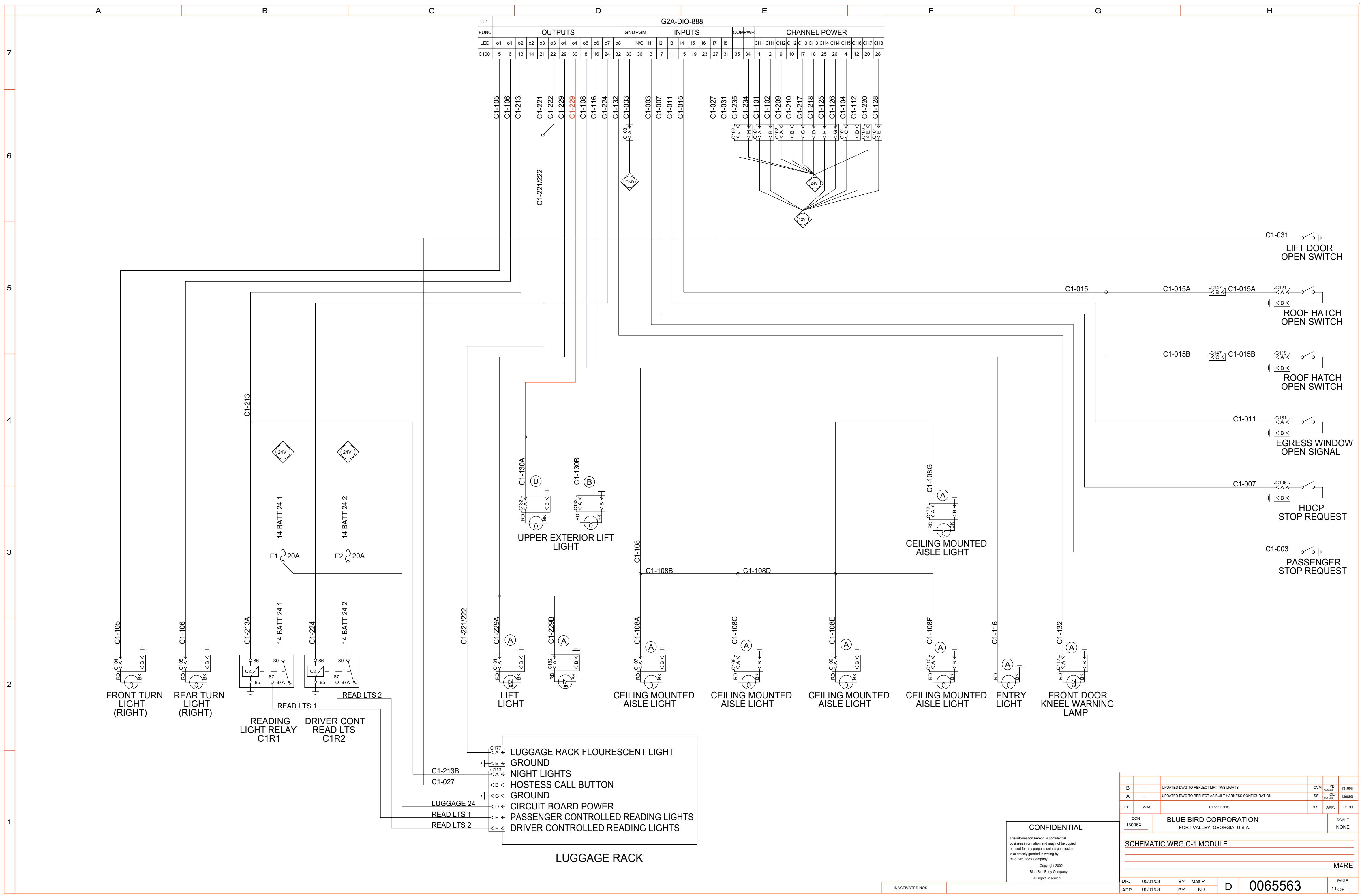
0065561 - B-1 Module



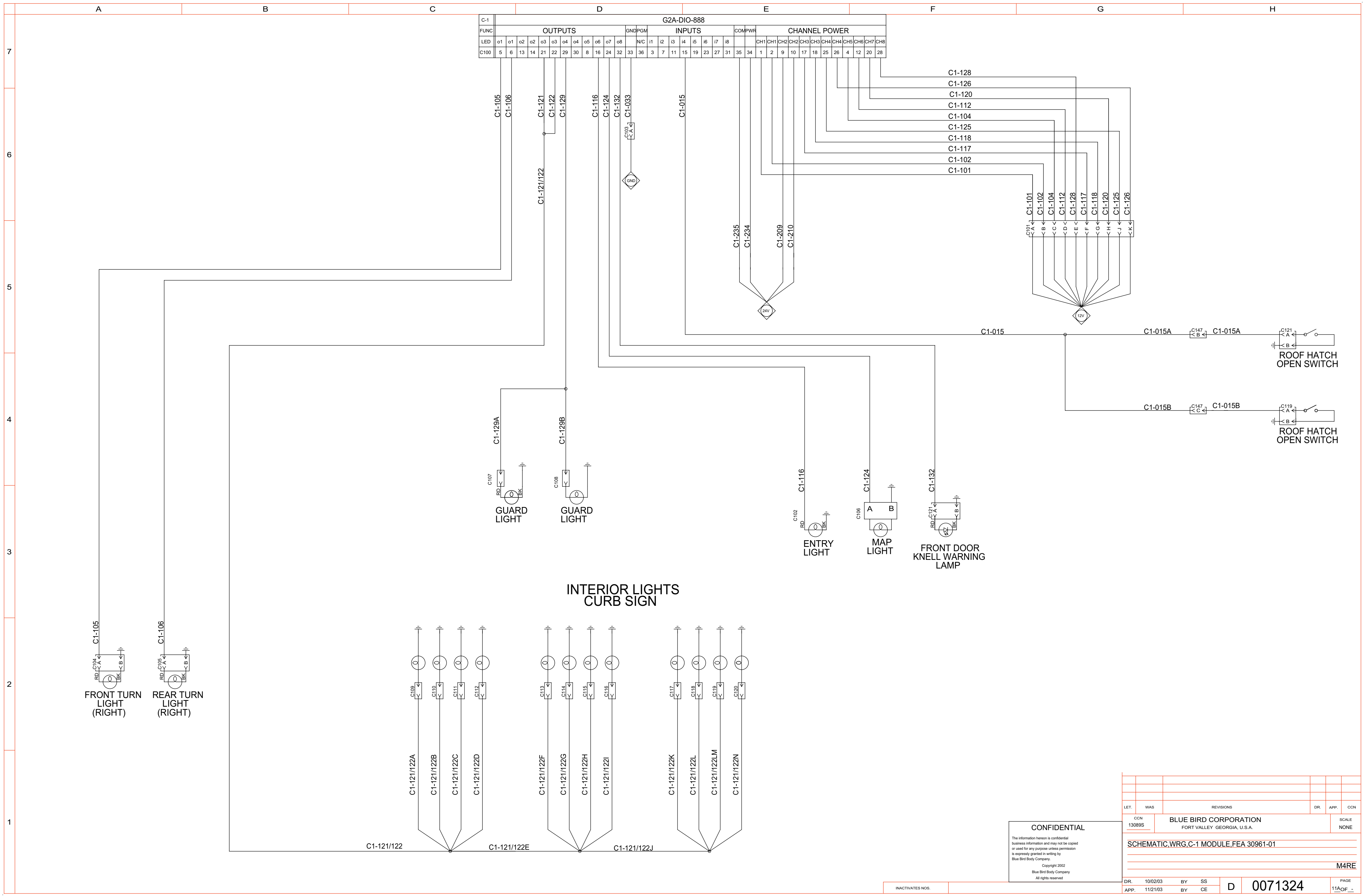
0065562 - B-2 Module



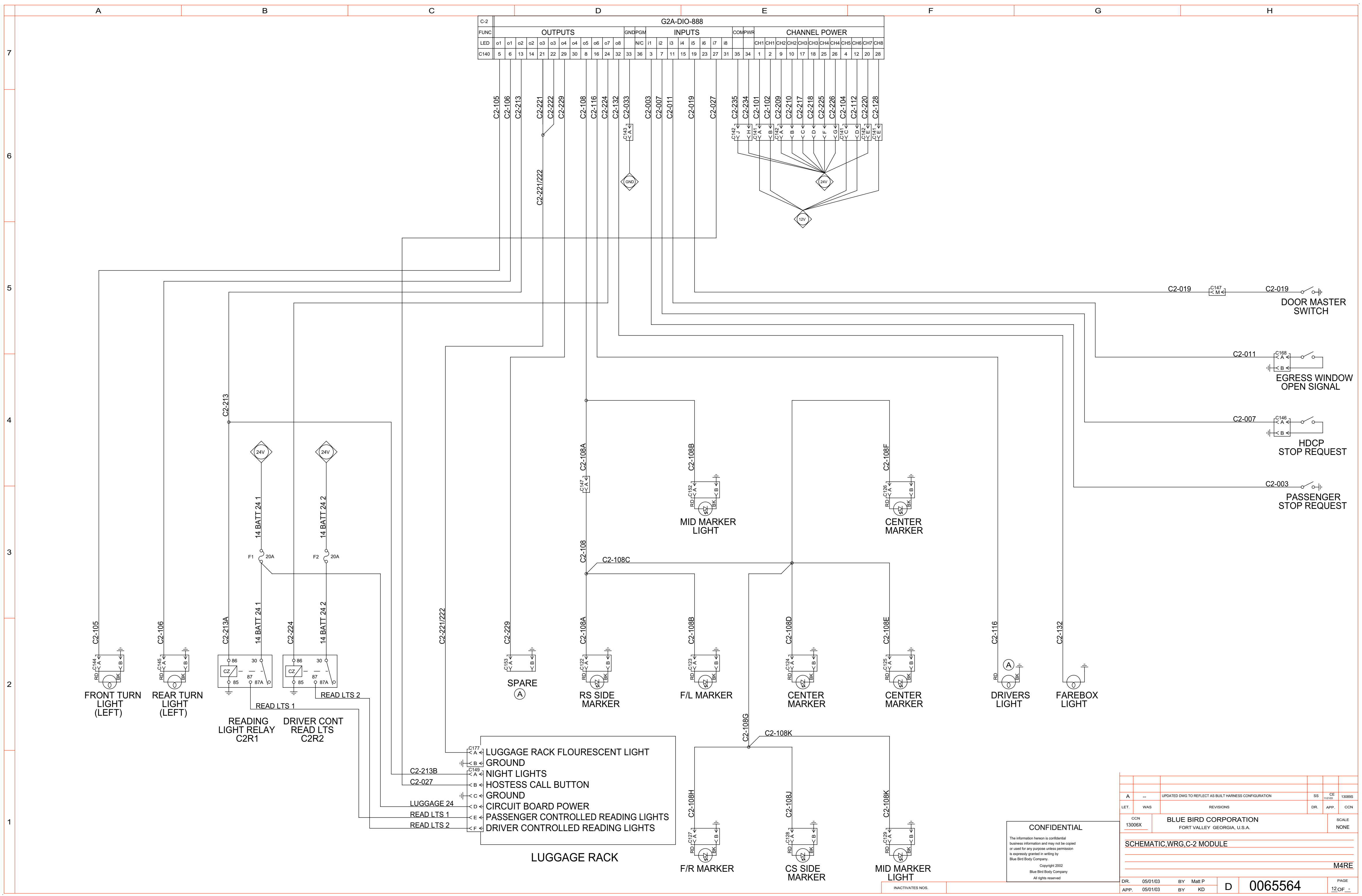
0065563 - C-1 Module



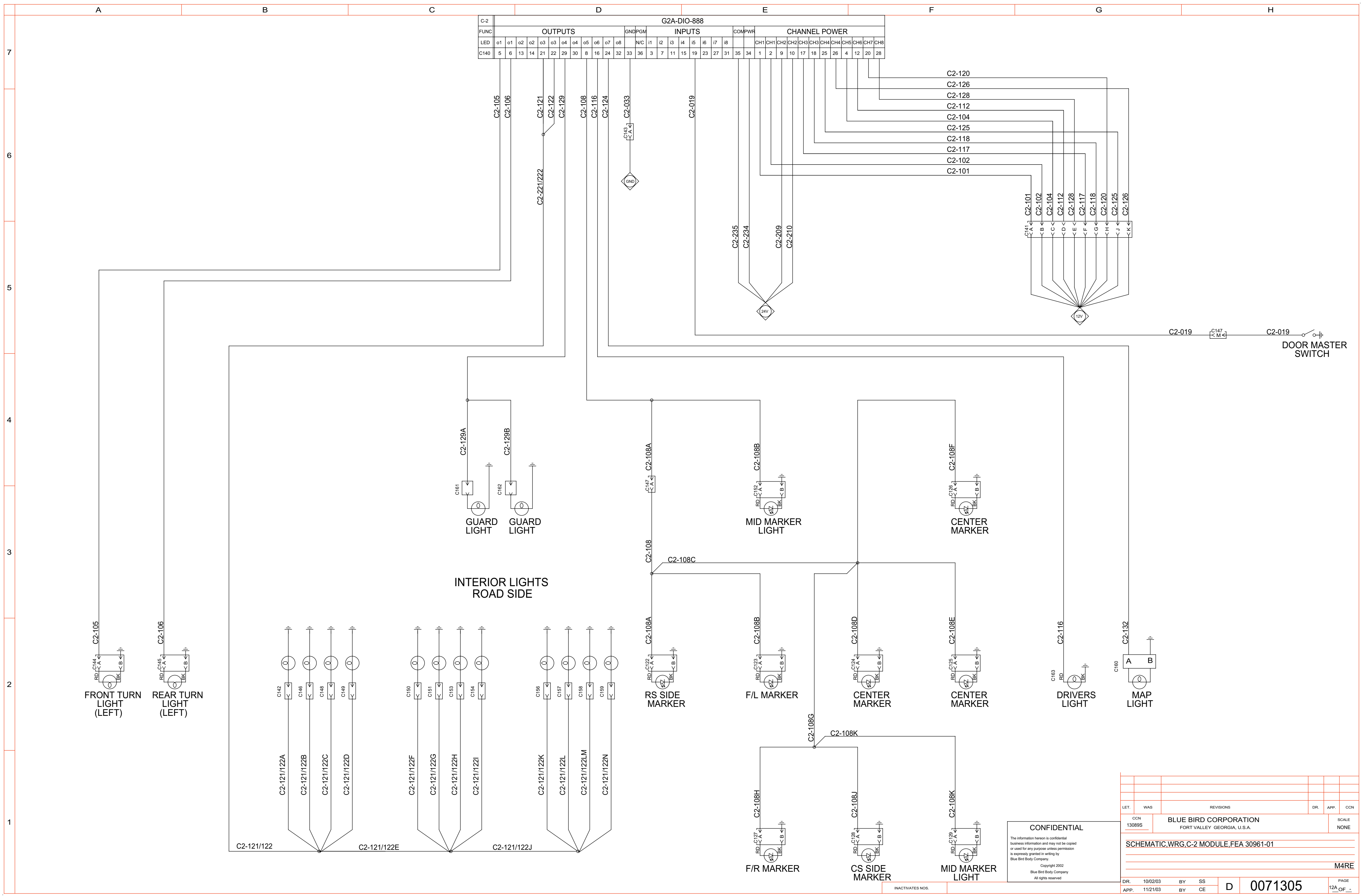
0071324 - C-1 Module INS Feature 30961-01



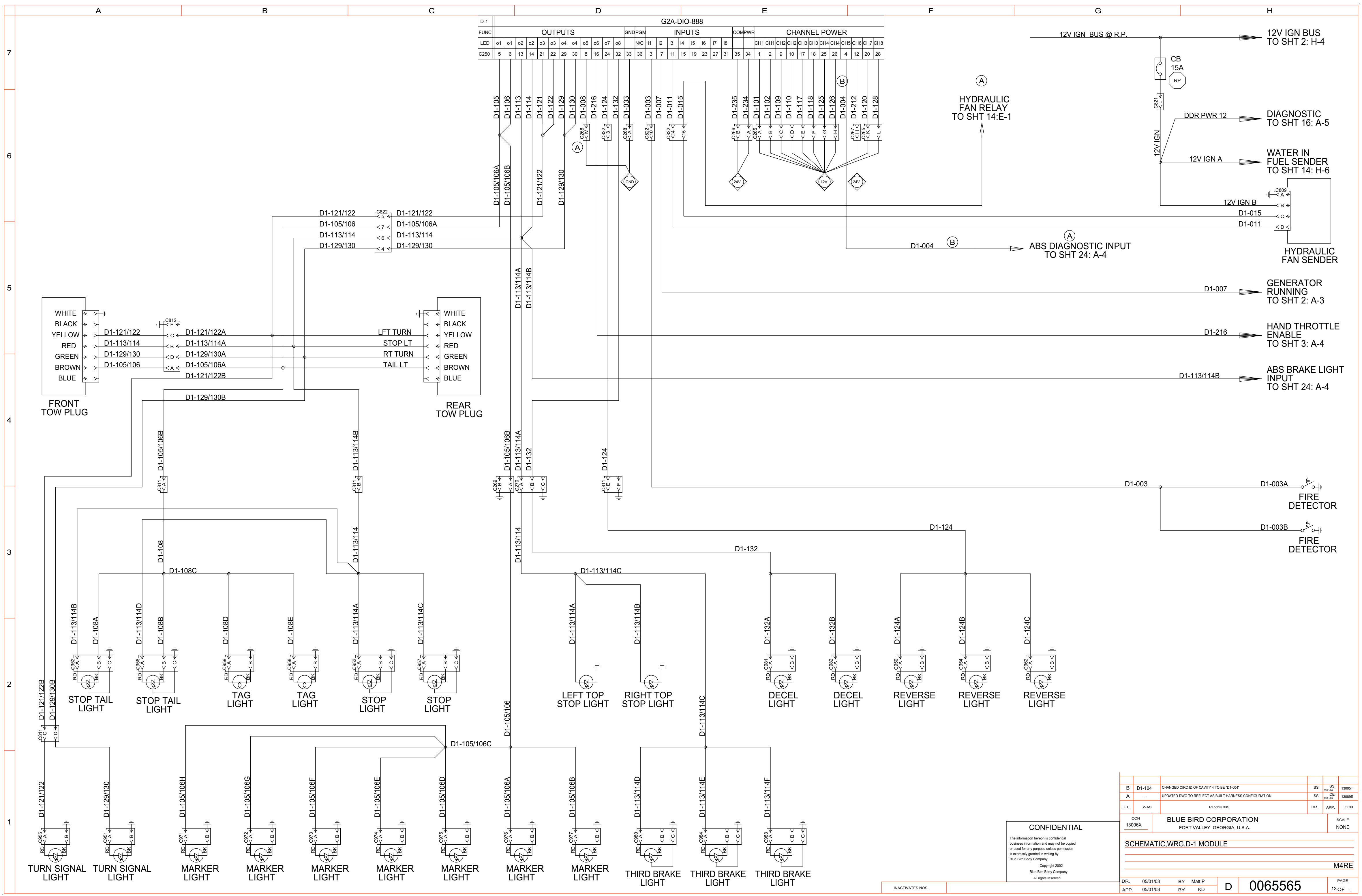
0065564 - C-2 Module



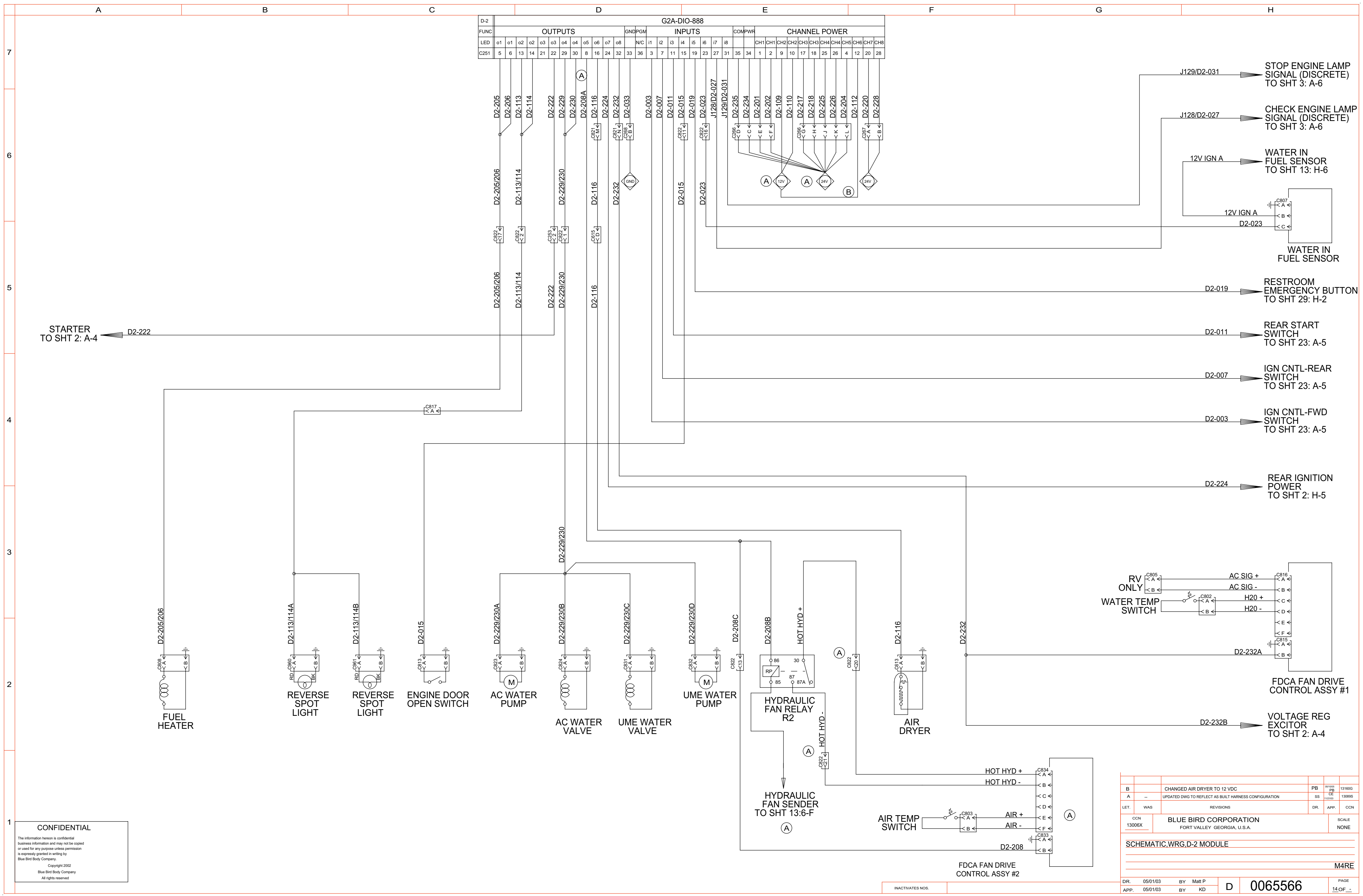
0071305 - C-2 Module INS Feature 30961-01



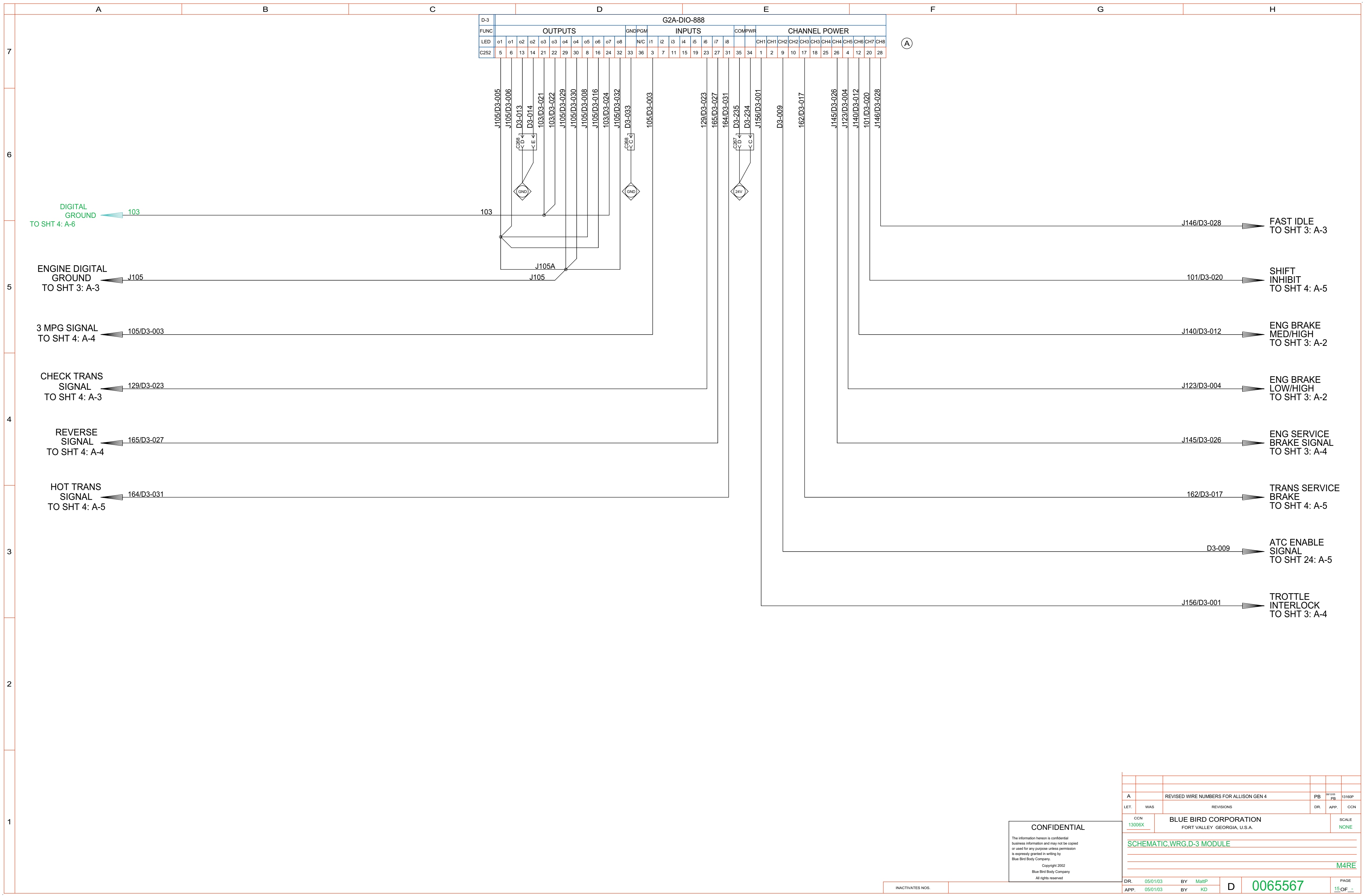
0065565 - D-1 Module



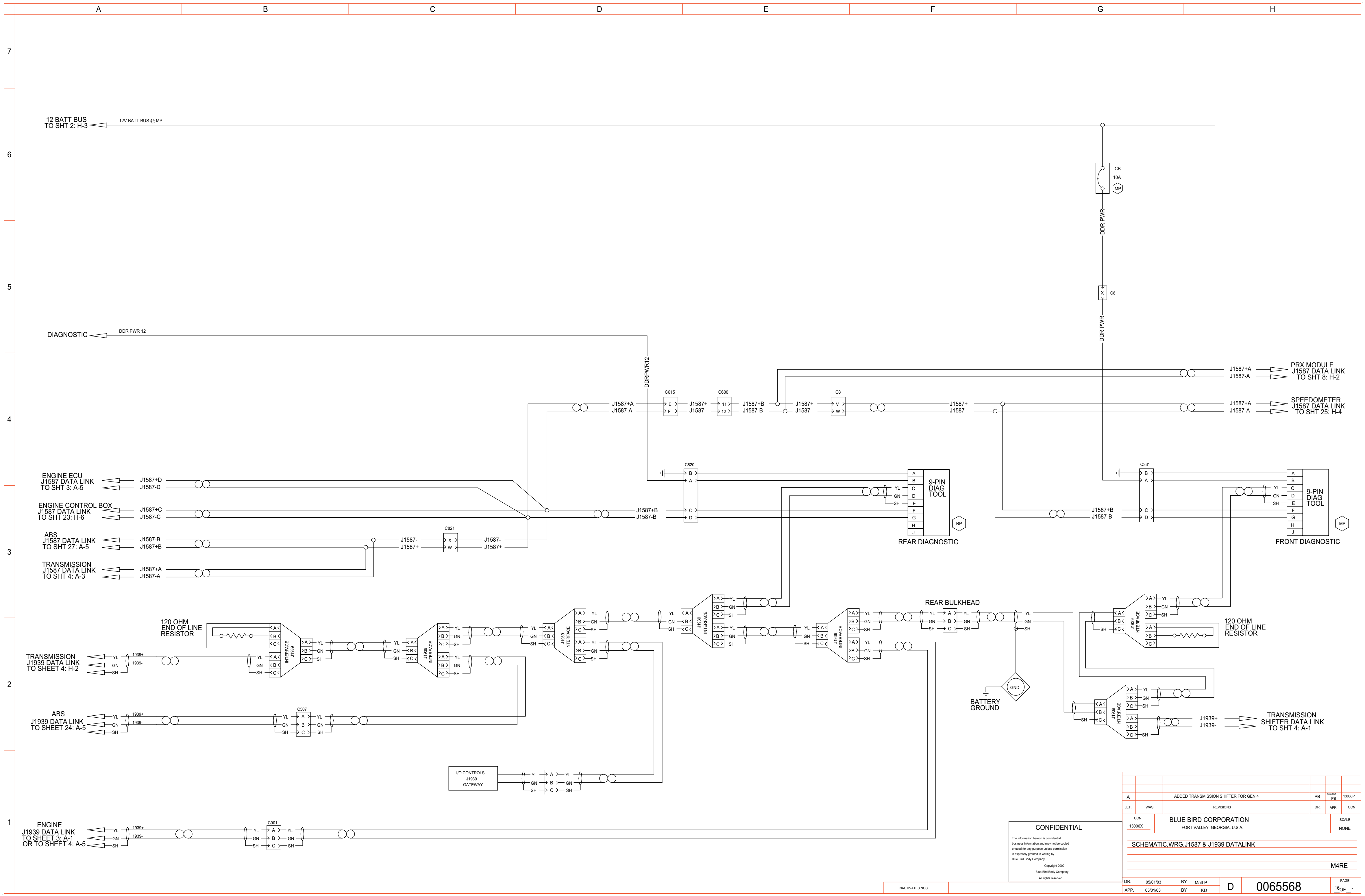
0065566 - D-2 Module



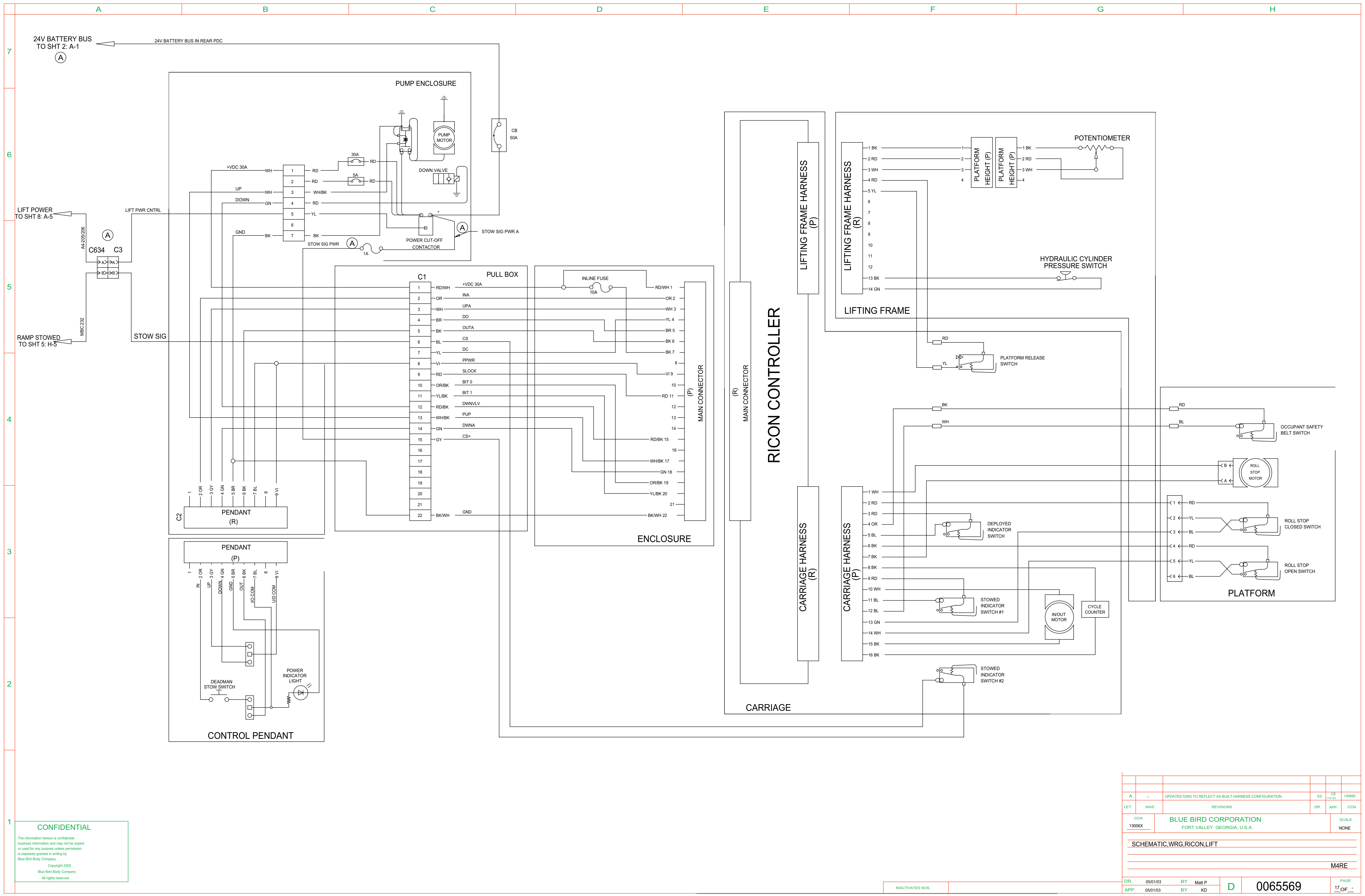
0065567 - D-3 Module



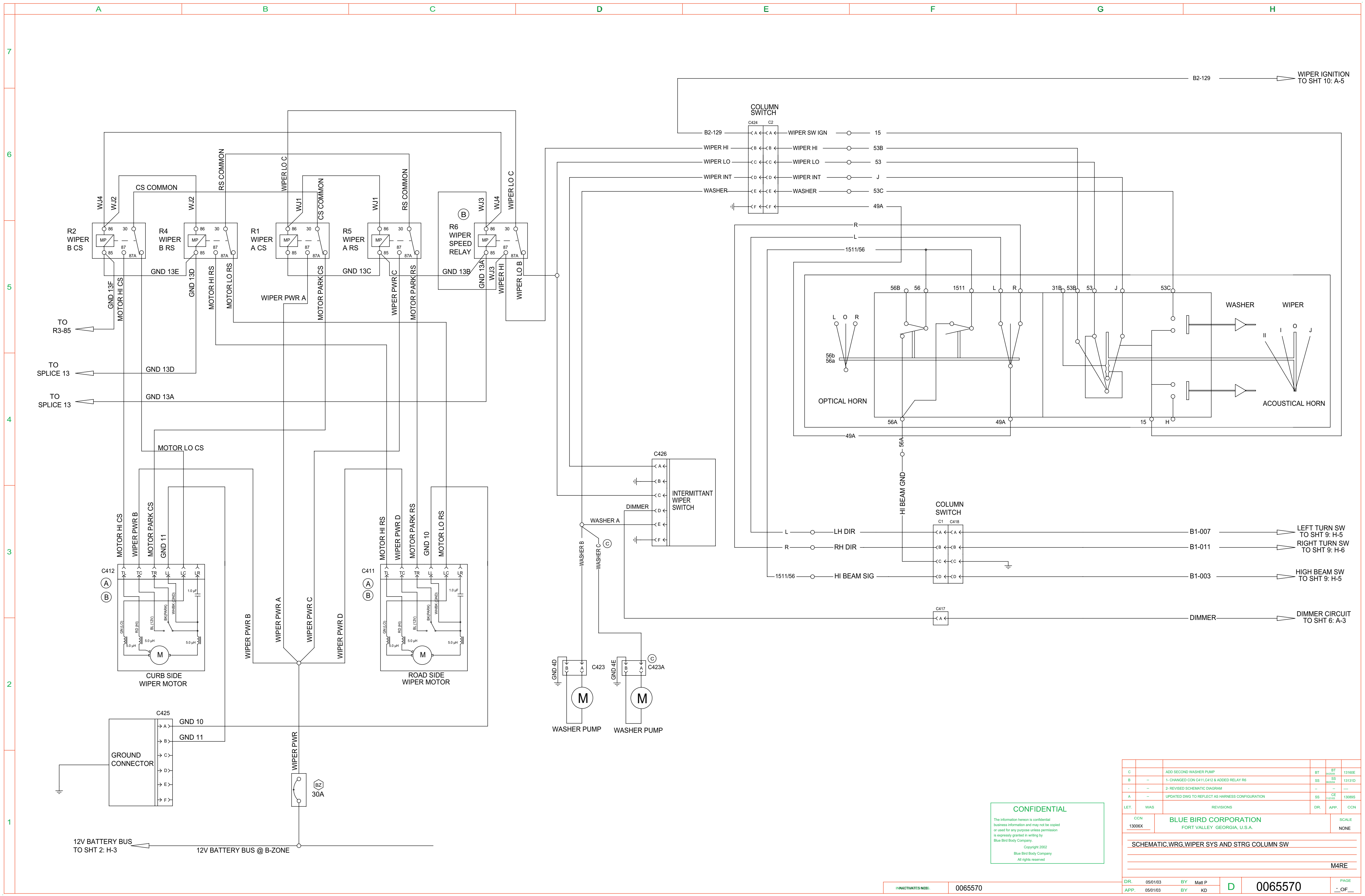
0065568 - J1587 and J1939 Datalink



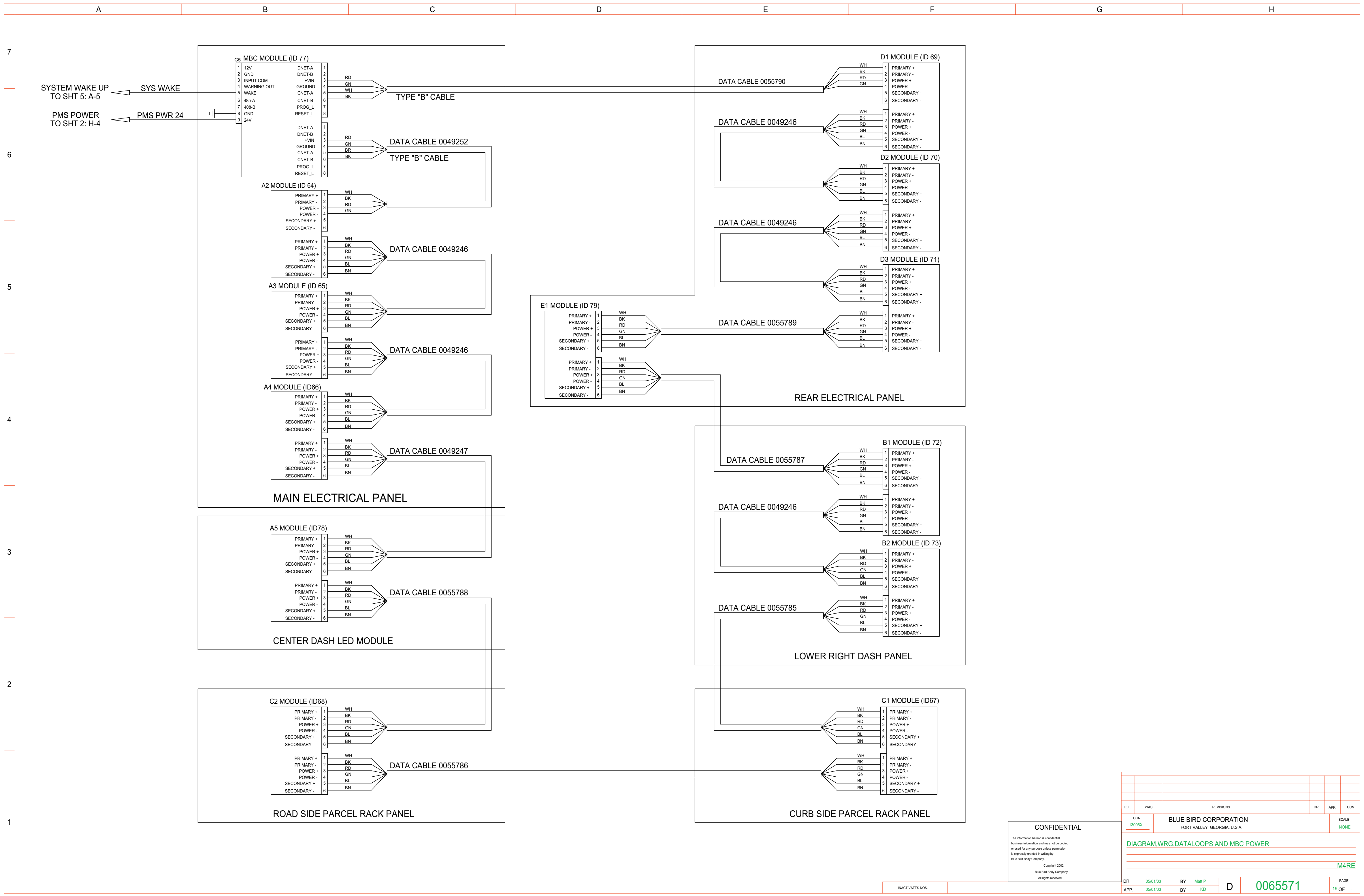
0065569 - Ricon Lift



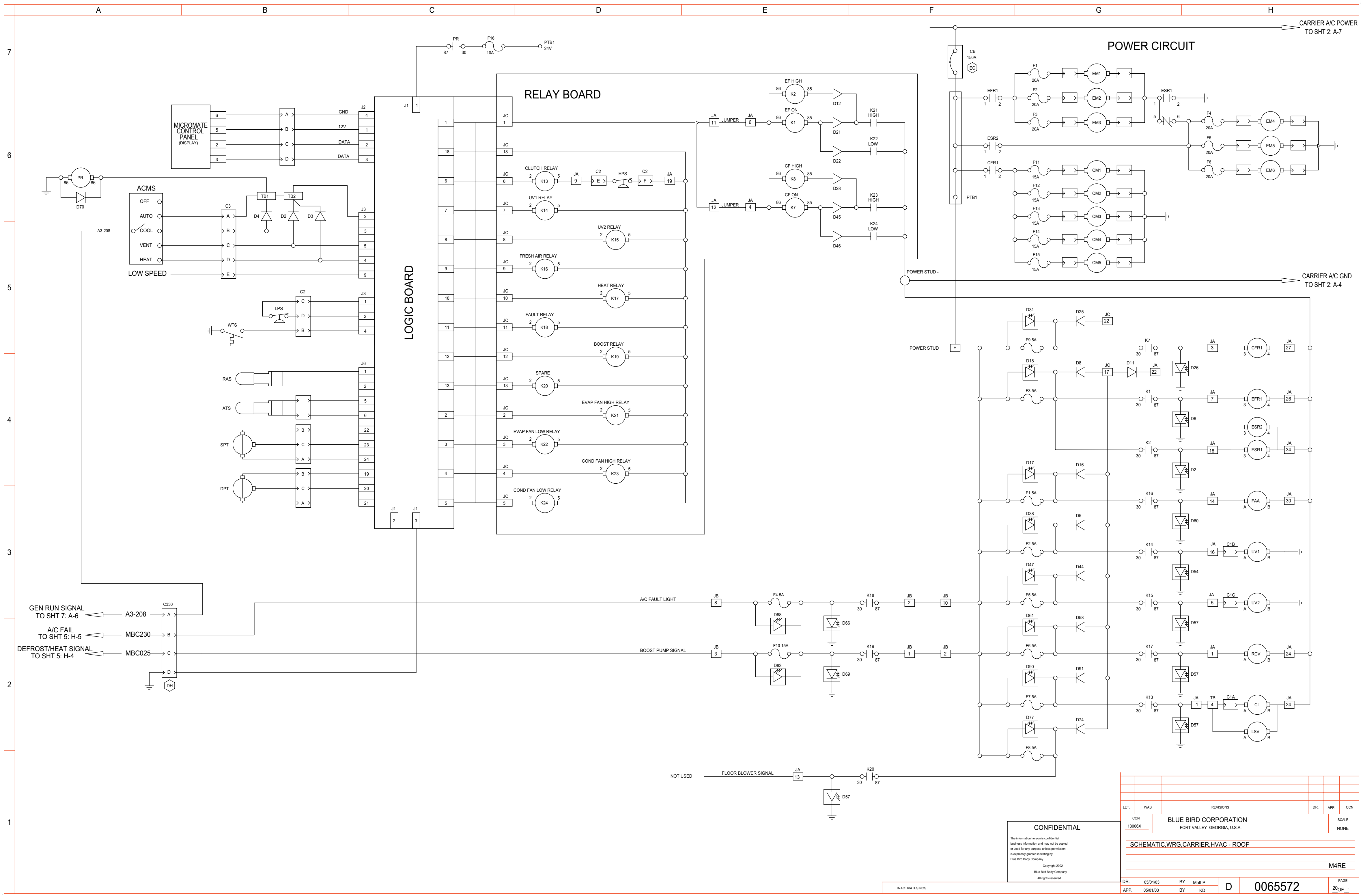
0065570 - Wiper Sys and Strg Column Sw



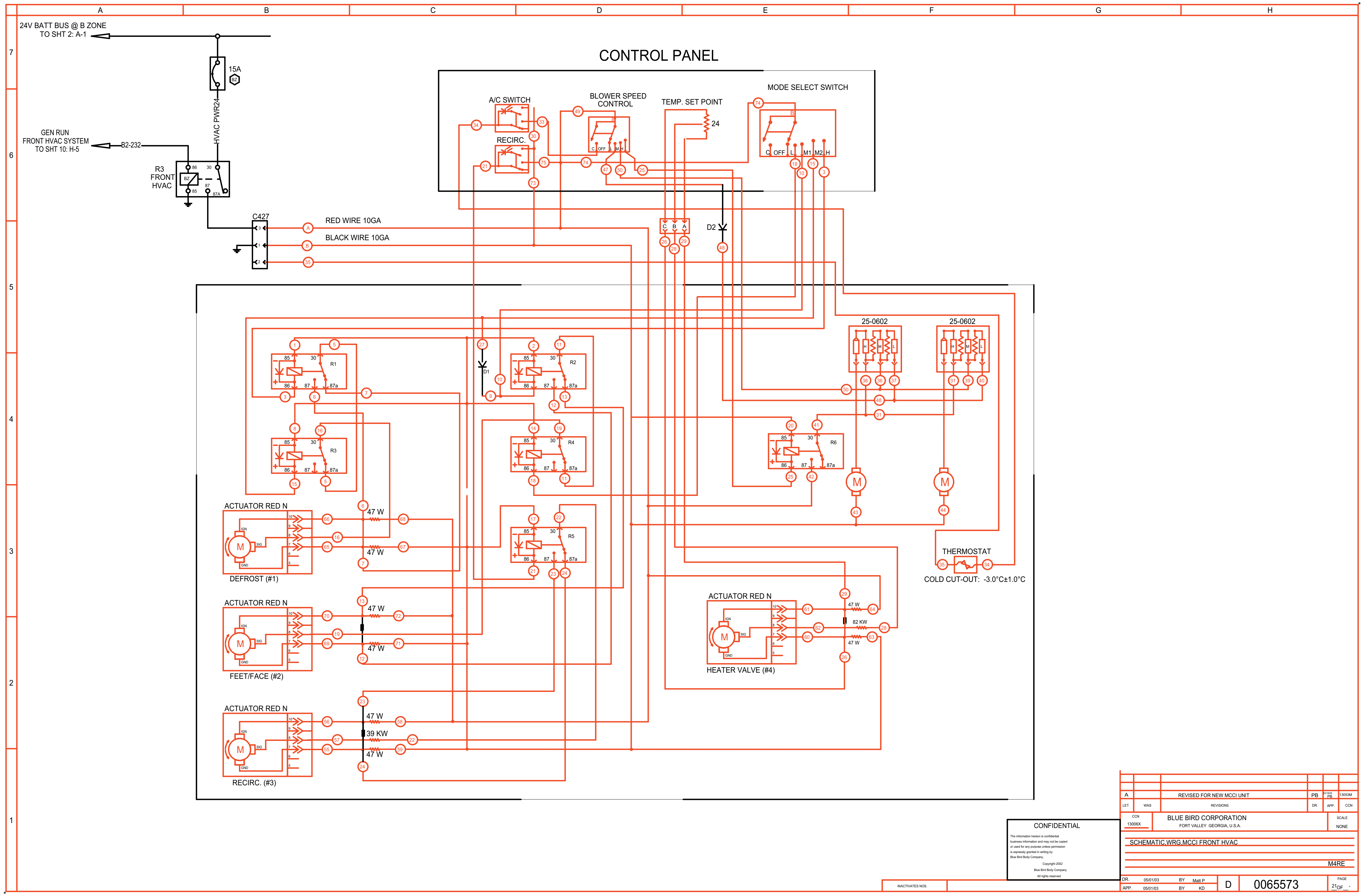
0065571 - Dataloops and MBC Power



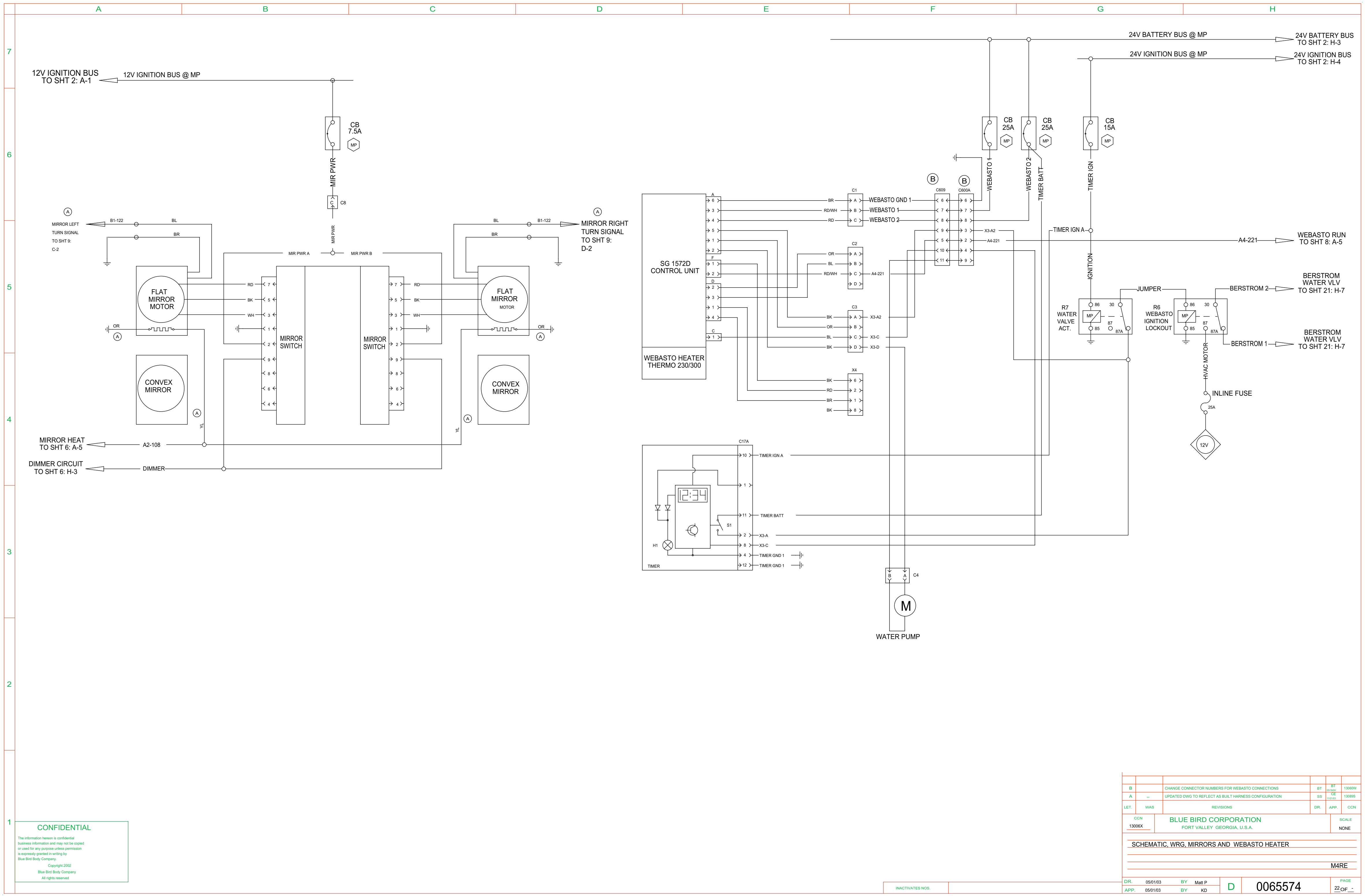
0065572 - Carrier HVAC - Roof



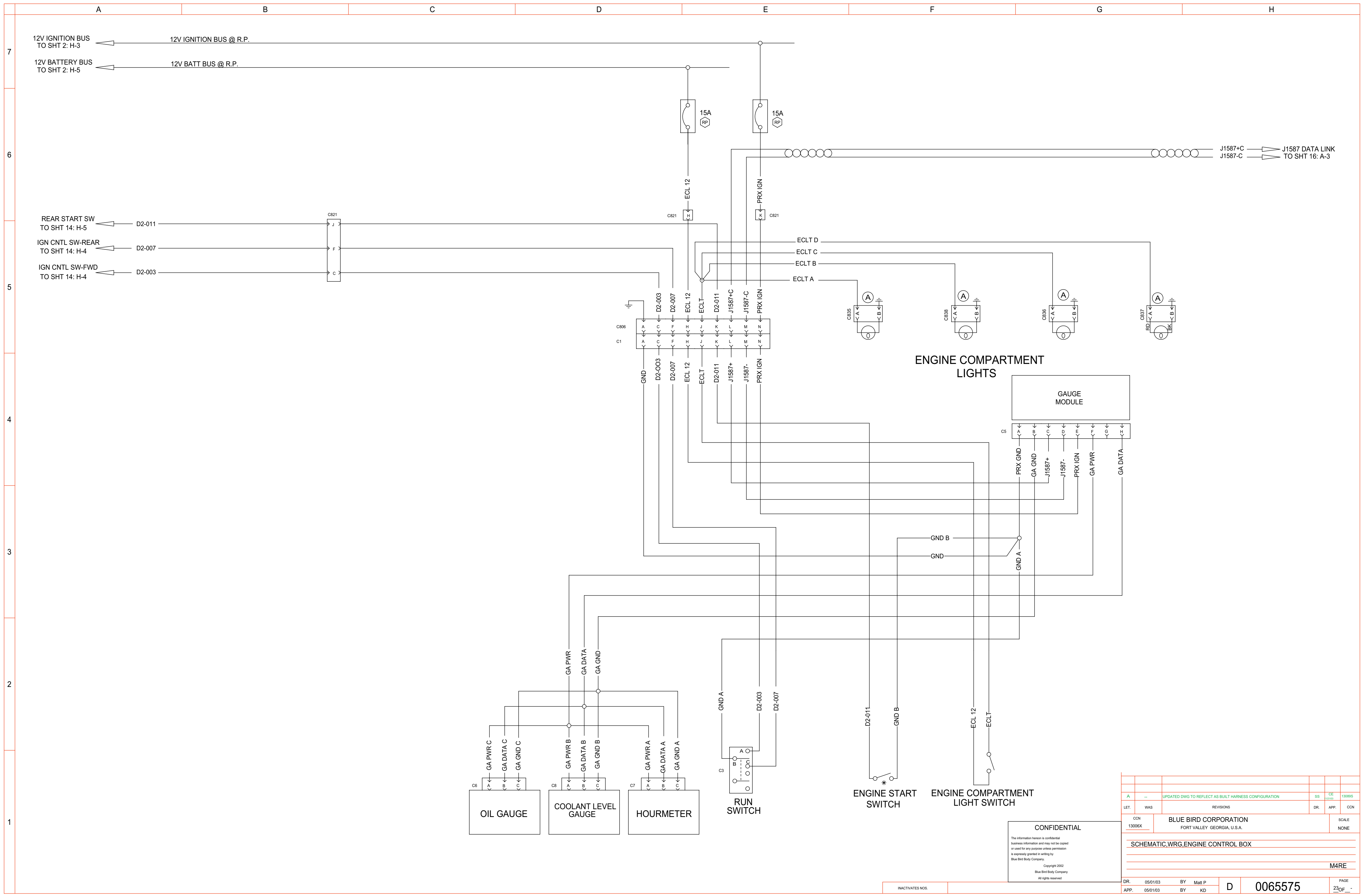
0065573 - MCCI, Front HVAC



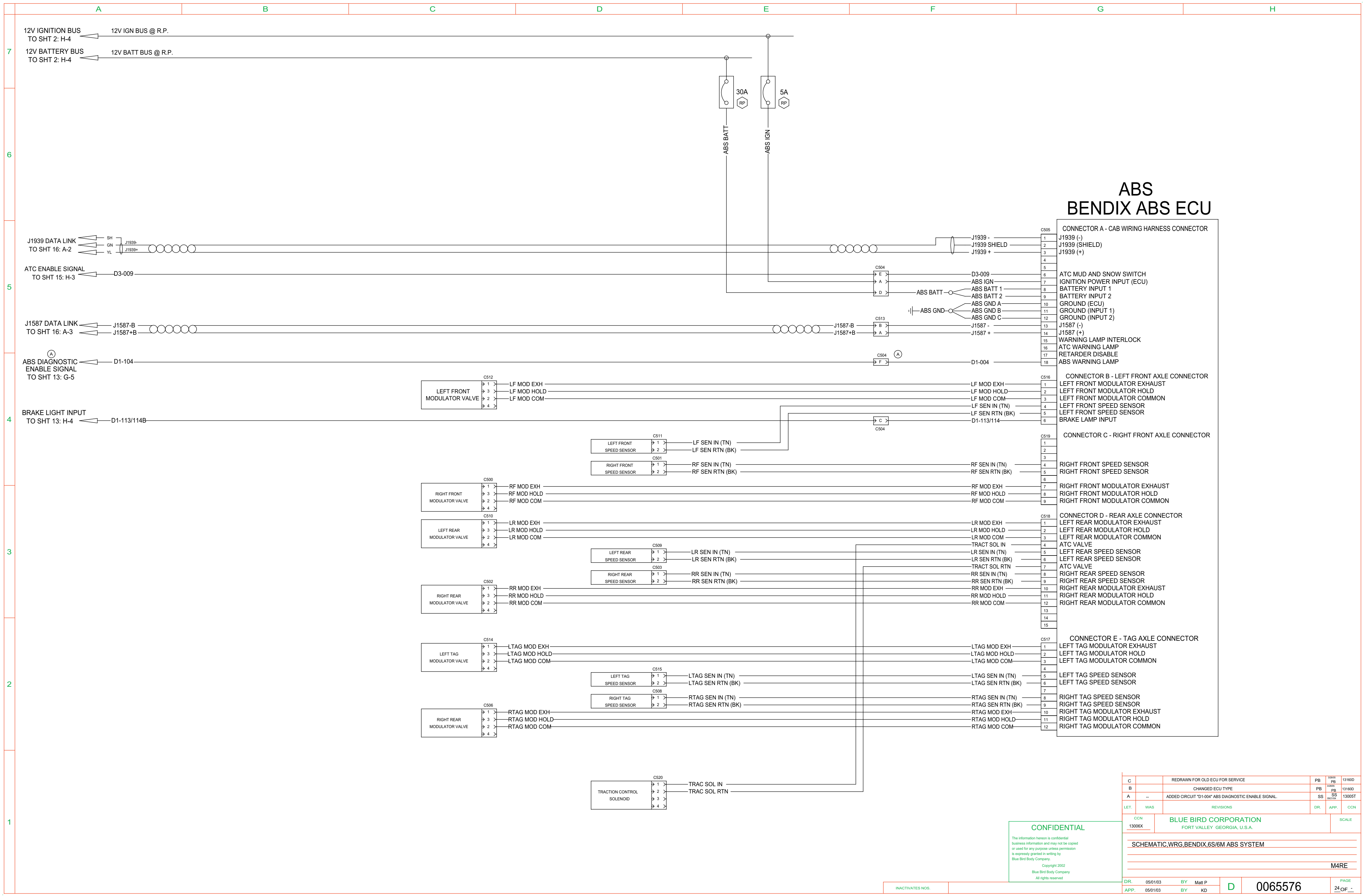
0065574 - Mirrors and Webasto Heater



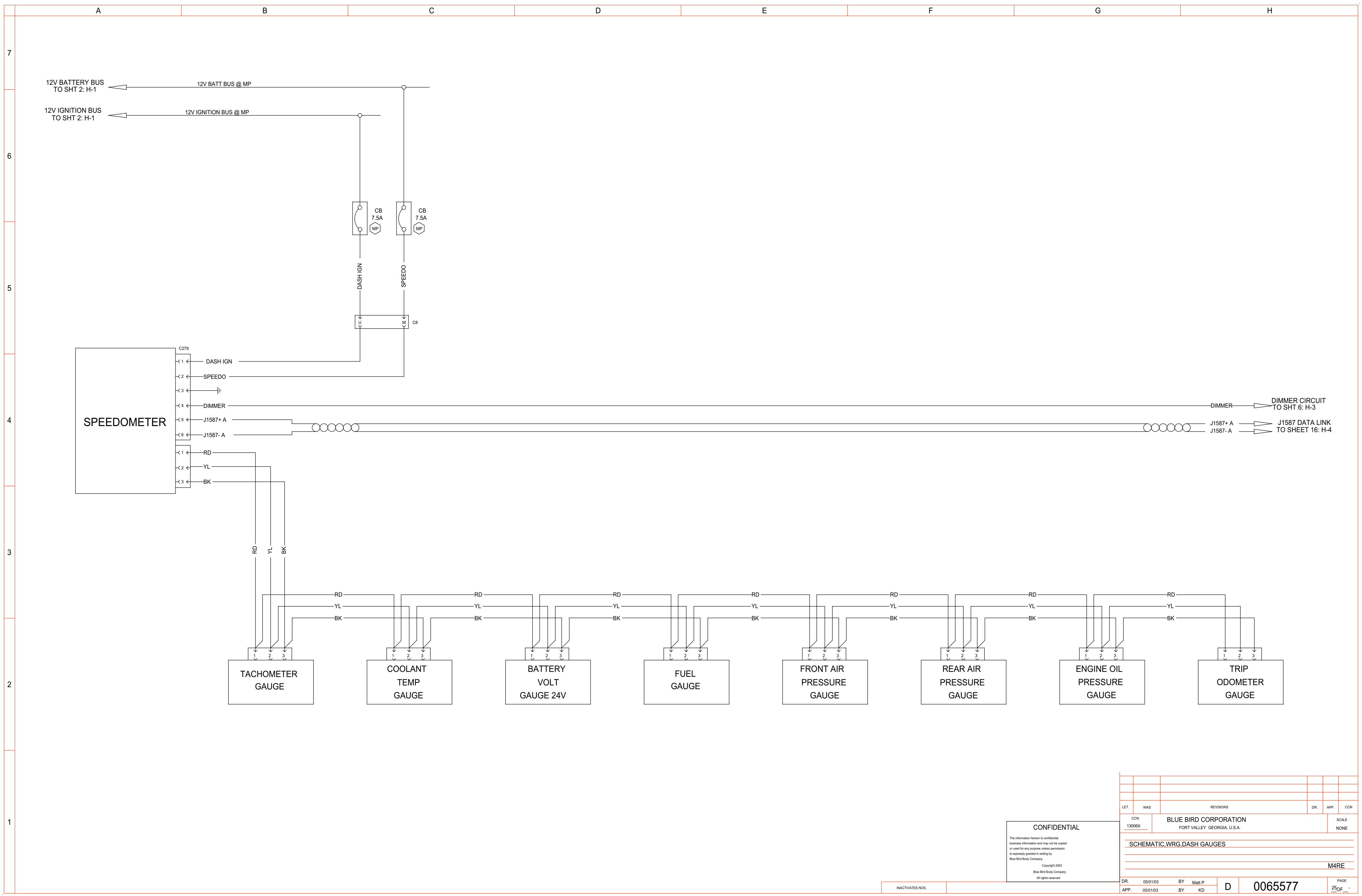
0065575 - Engine Control Box



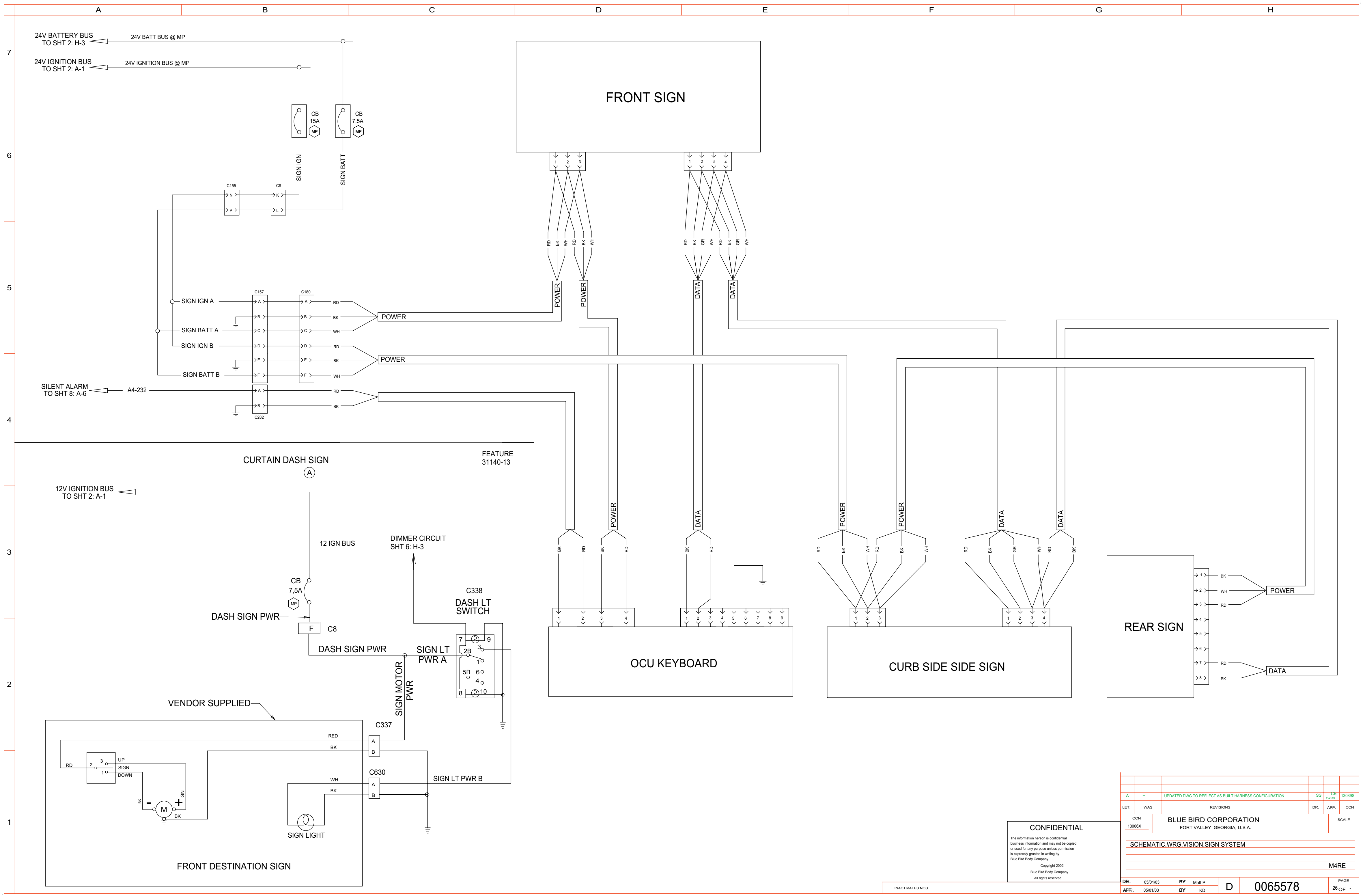
0065576 - Bendix, 6S/6M ABS System



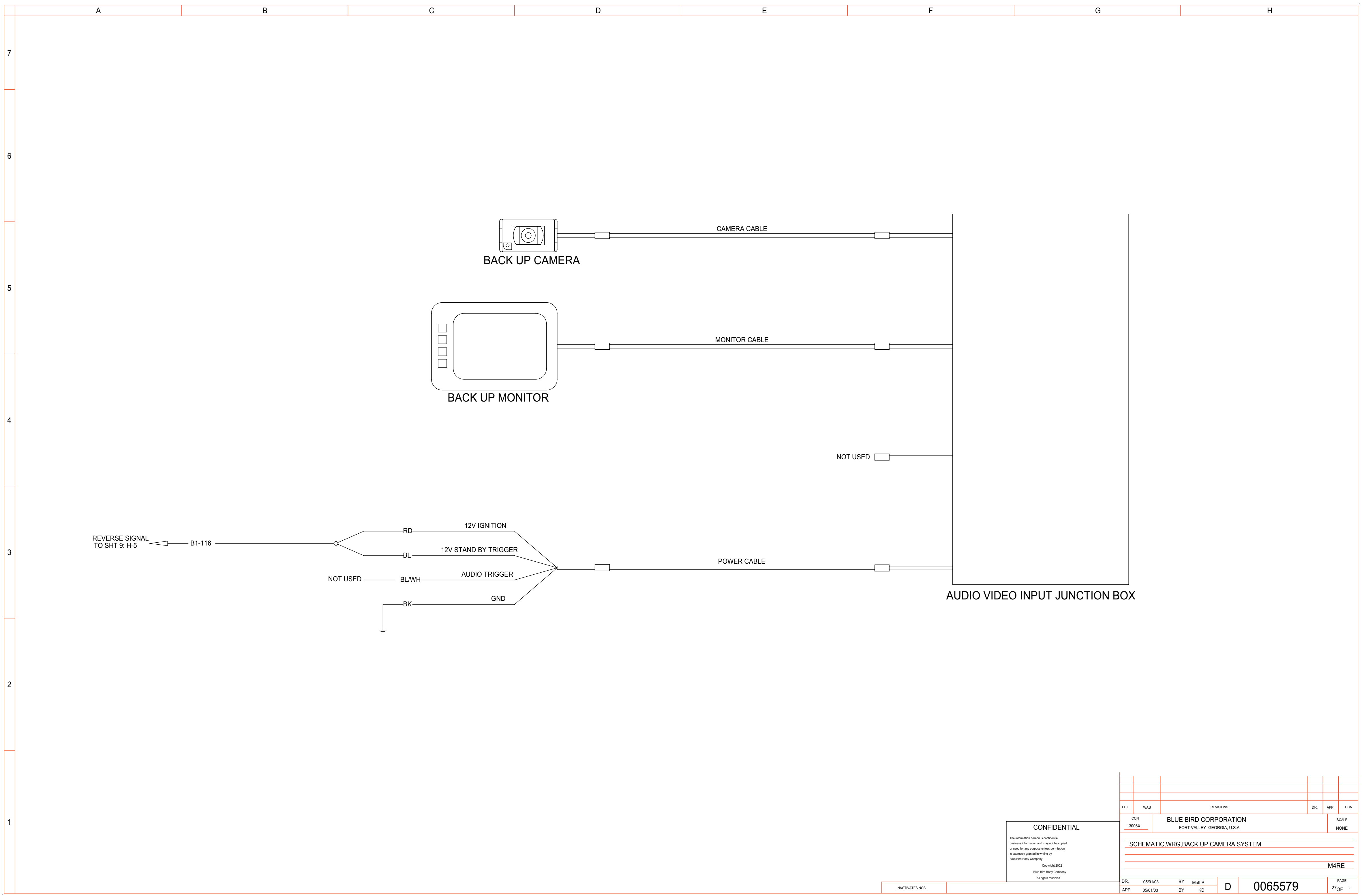
0065577 - Dash Gauges



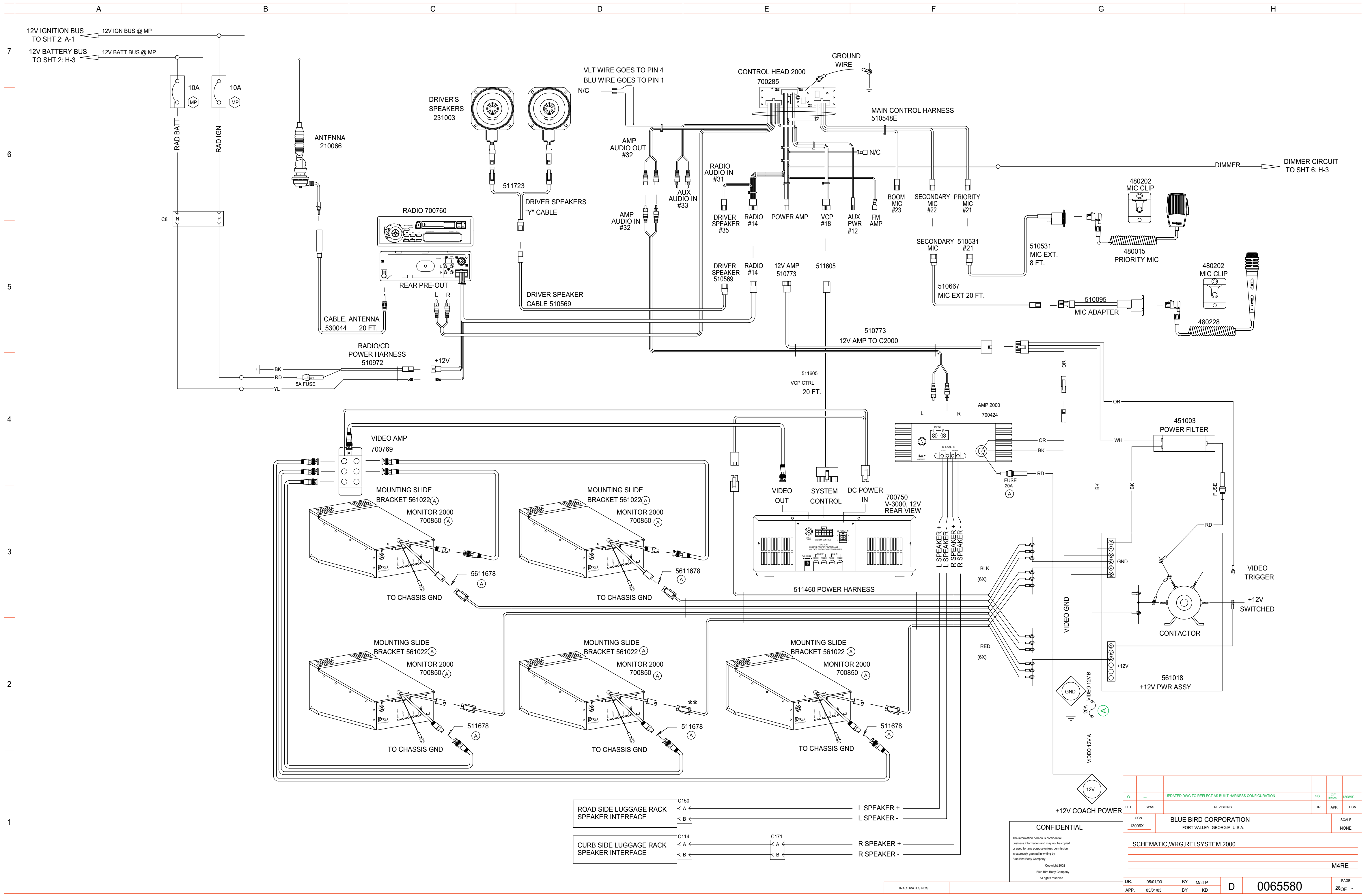
0065578 - Vision Sign System



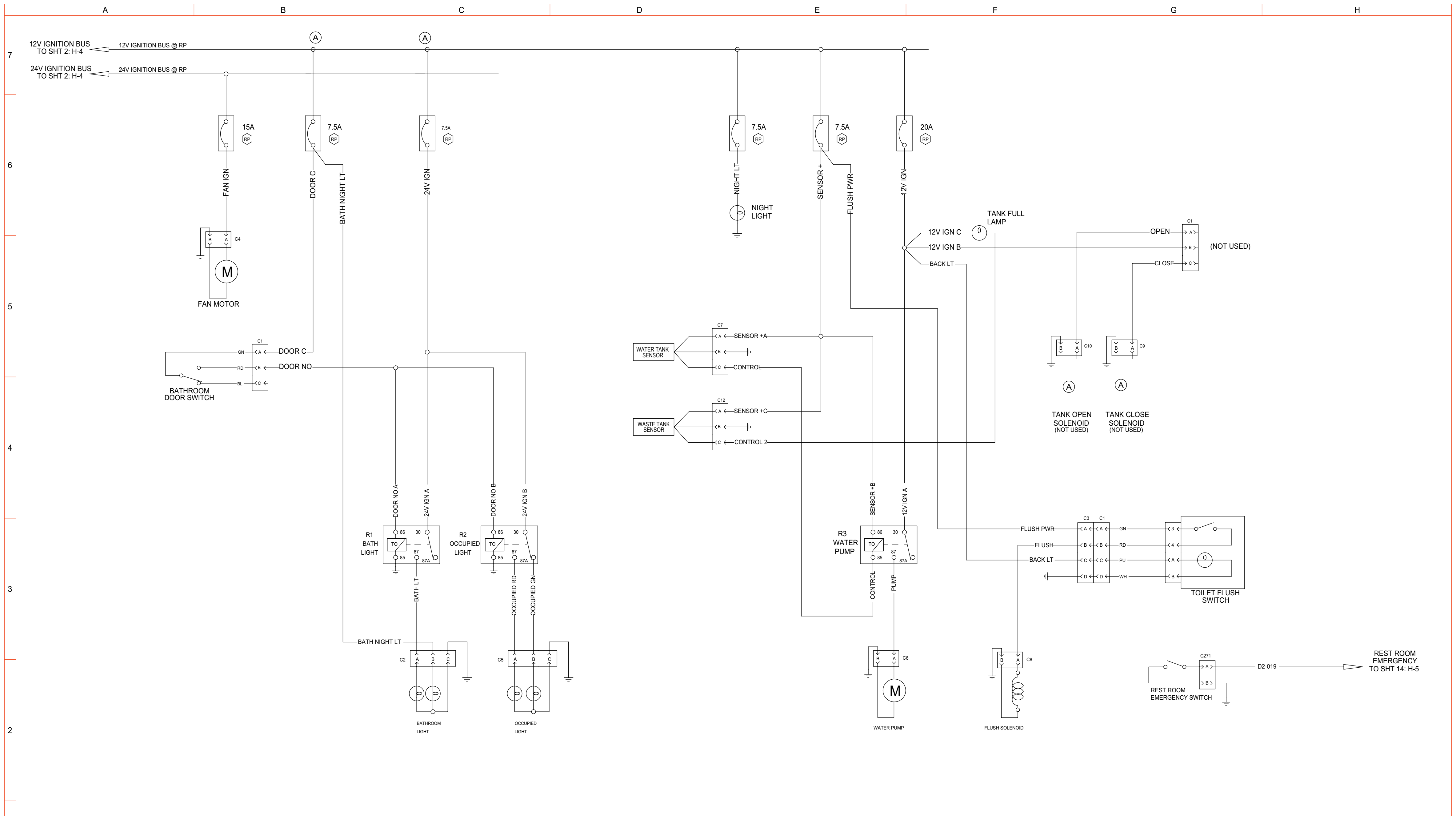
0065579 - Back Up Camera System



0065580 - REI, System 2000



0065581 - Restroom



LET.	WAS	REVISIONS	DR.	APP.	CCN
A	--	UPDATED DWG TO REFLECT AS BUILT HARNESS CONFIGURATION	SS	CE 11/21/03	13089S

CCN 13006X

BLUE BIRD CORPORATION
FORT VALLEY GEORGIA, U.S.A.

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SCHEMATIC, WRG, RESTROOM

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DR. 05/01/03 BY Matt P
APP. 05/01/03 BY KD

D 0065581

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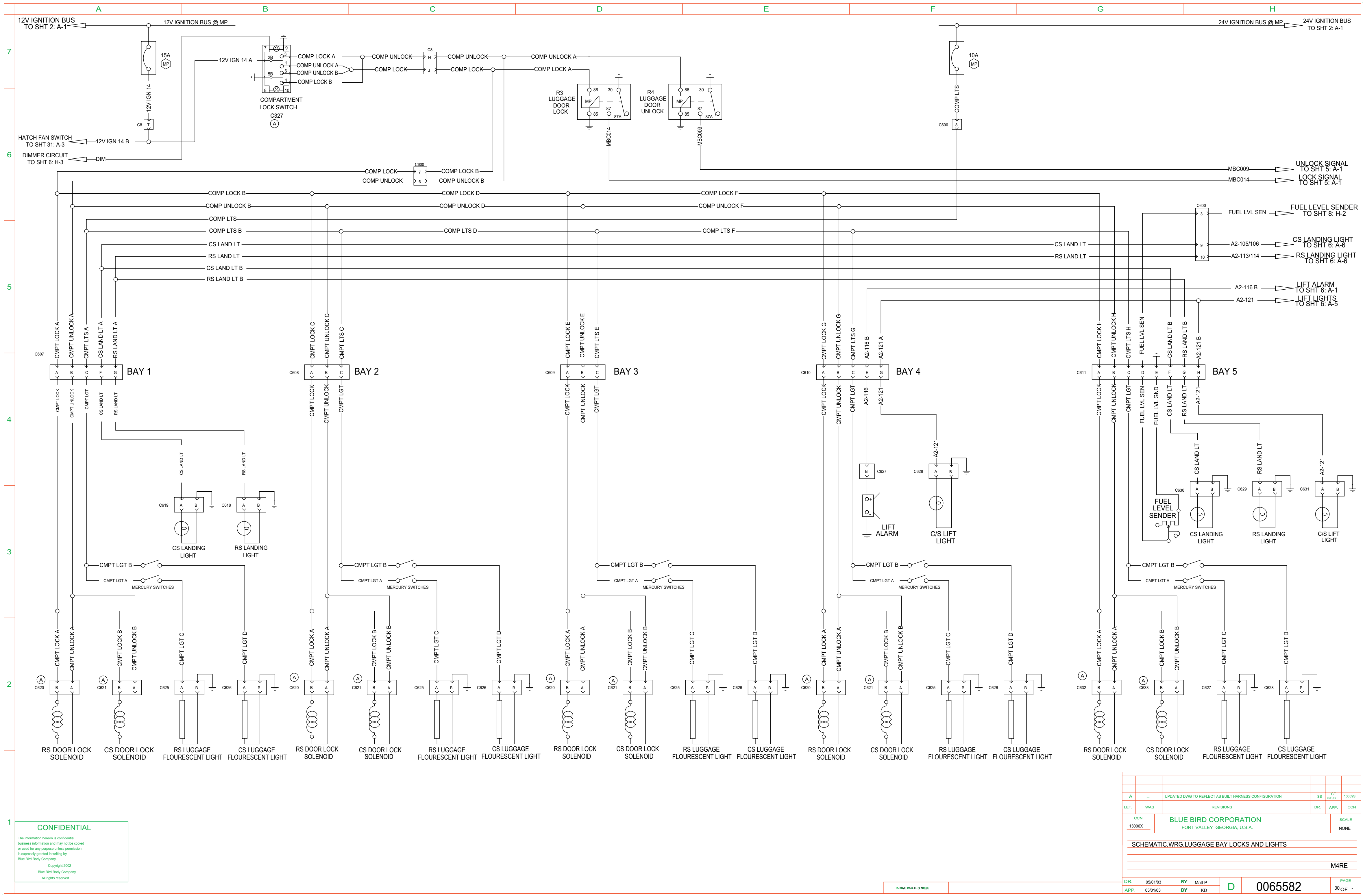
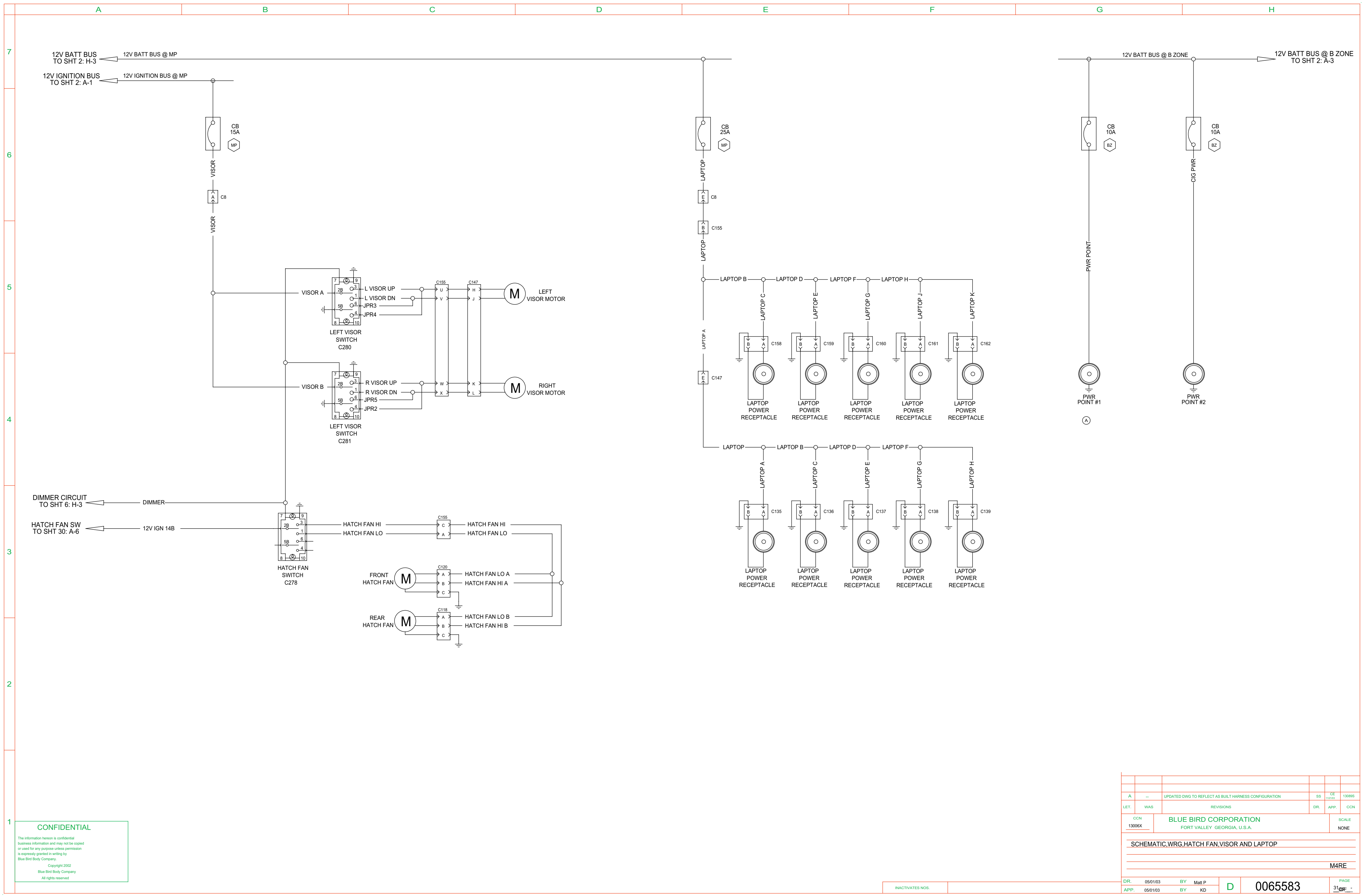
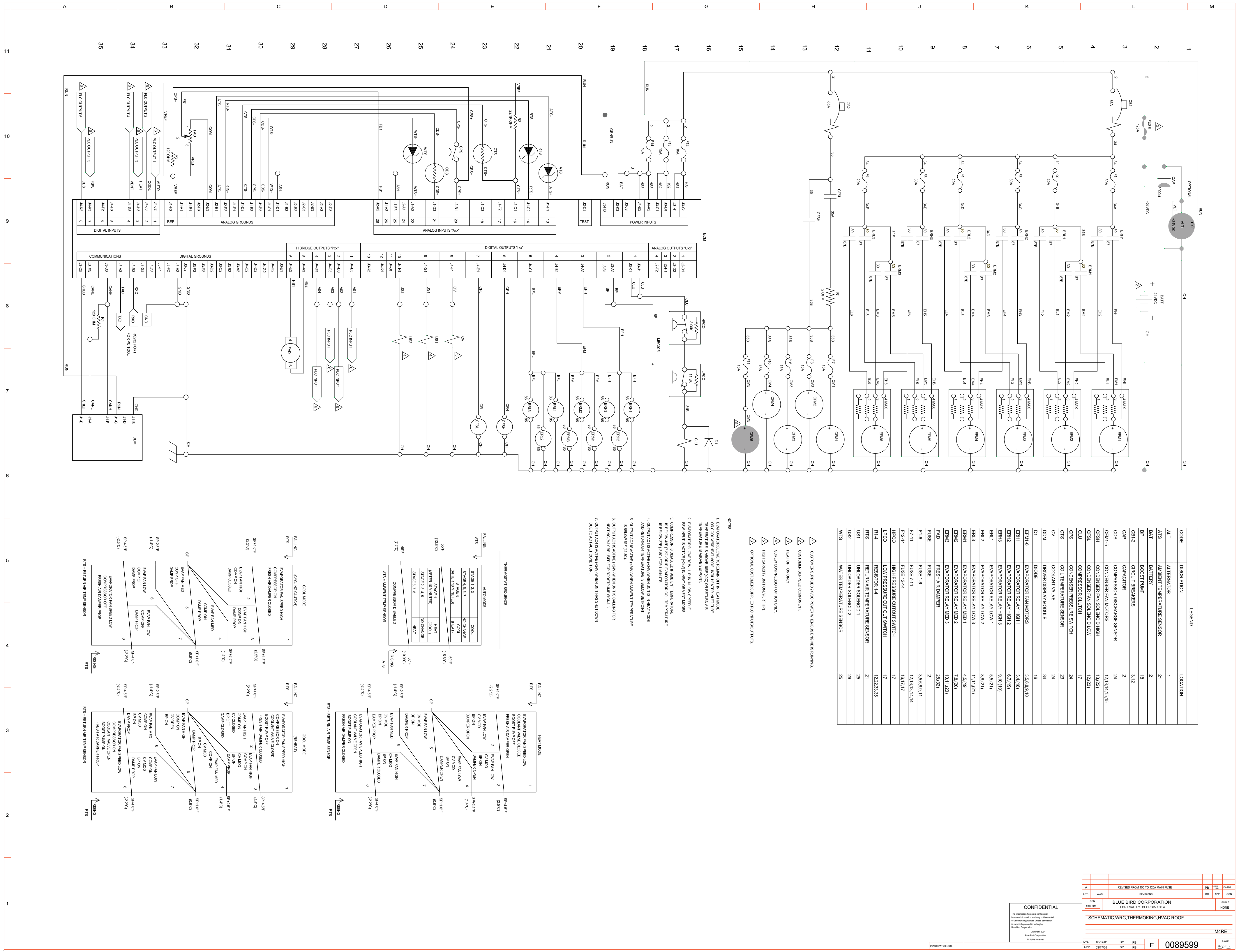
0065582 - Luggage Bay Locks and Lights



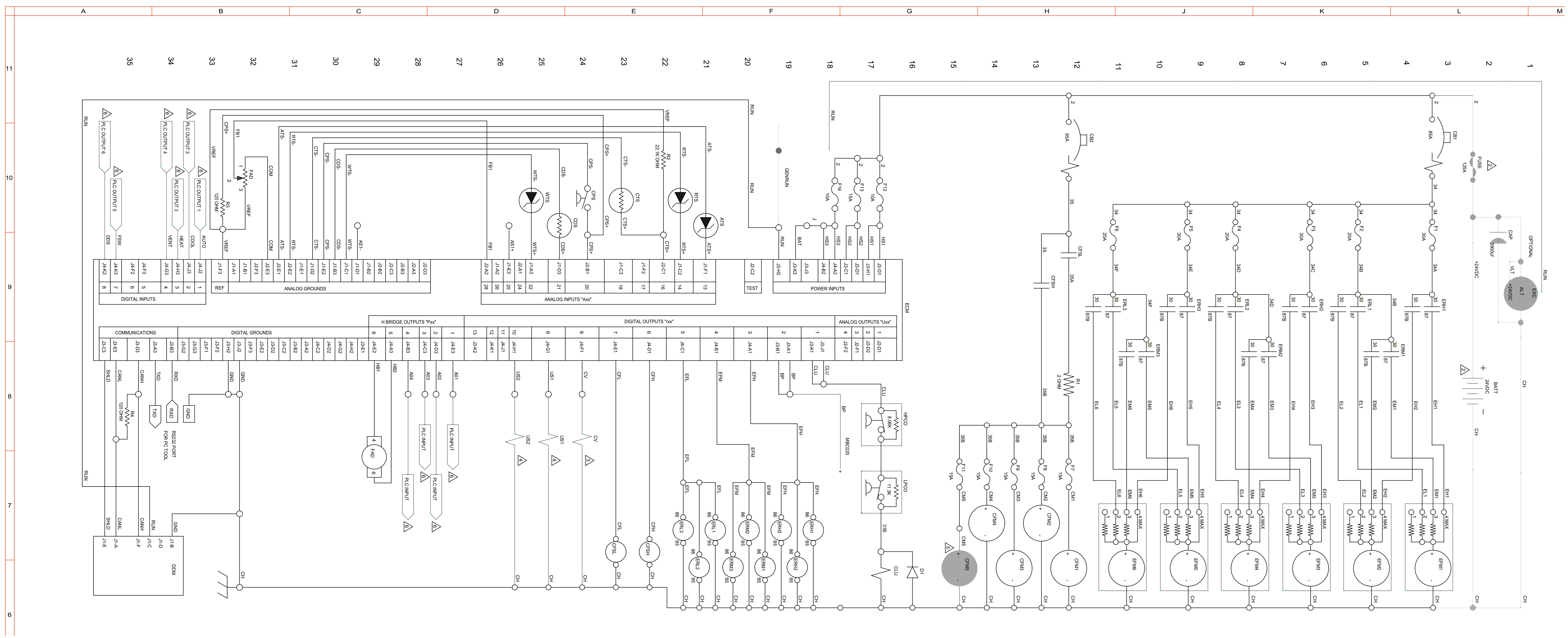
0065583 - Hatch Fan, Visor and Laptop



0089599 - Thermo King HVAC - Roof



0089599 - Thermo King HVAC - Roof - Exploded View A



0089599 - Thermo King HVAC - Roof - Exploded View B

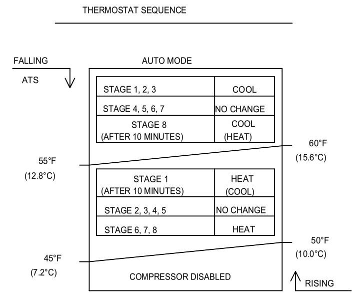
LEGEND		
CODE	DISCRIPTION	LOCATION
ALT	ALTERNATOR	1
ATS	AMBIENT TEMPERATURE SENSOR	21
BAT	BATTERY	2
BP	BOOST PUMP	18
CB1-2	CIRCUIT BREAKERS	3,12
CAP	CAPACITOR	2
CDS	COMPRESSOR DISCHARGE SENSOR	24
CFM1-5	CONDENSER FAN MOTORS	12,13,14,15,15
CFSH	CONDENSER FAN SOLENOID HIGH	13,(22)
CFSL	CONDENSER FAN SOLENOID LOW	12,(23)
CLU	COMPRESSOR CLUTCH	17
CPS	CONDENSER PRESSURE SWITCH	24
CTS	COIL TEMPERATURE SENSOR	23
CV	COOLANT VALVE	24
DDM	DRIVER DISPLAY MODULE	34
D1	DIODE	16
EFM1-6	EVAPORATOR FAN MOTORS	3,5,6,8,9,10
ERH1	EVAPORATOR RELAY HIGH 1	3,4,(18)
ERH2	EVAPORATOR RELAY HIGH 2	6,7,(19)
ERH3	EVAPORATOR RELAY HIGH 3	9,10,(19)
ERL1	EVAPORATOR RELAY LOW 1	5,5,(21)
ERL2	EVAPORATOR RELAY LOW 2	8,8,(21)
ERL3	EVAPORATOR RELAY LOW 3	11,11,(21)
ERM1	EVAPORATOR RELAY MED 1	4,5,(19
ERM2	EVAPORATOR RELAY MED 2	7,8,(20)
ERM3	EVAPORATOR RELAY MED 3	10,11,(20)
FAD	FRESH AIR DAMPER	28,(32)
FUSE	FUSE	2
F1-6	FUSE 1-6	3,5,6,8,9,11
F7-11	FUSE 7-11	12,13,13,14,14
F12-14	FUSE 12-14	16,17,17
HPCO	HIGH PRESSURE CUTOUT SWITCH	17
LPCO	LOW PRESSURE CUT OUT SWITCH	17
R1-4	RESISTOR 1-4	12,22,33,35
RTS	RETURN AIR TEMPERATURE SENSOR	21
US1	UNLOADER SOLENOID 1	25
US2	UNLOADER SOLENOID 2	26
WTS	WATER TEMPERATURE SENSOR	25

1. CUSTOMER SUPPLIED 24VDC POWER WHEN BUS ENGINE IS RUNNING.
2. CUSTOMER SUPPLIED COMPONENT.
3. HEAT OPTION ONLY.
4. SCREW COMPRESSOR OPTION ONLY.
5. HIGH CAPACITY UNIT ONLY(LRT HP).
6. OPTIONAL CUSTOMER SUPPLIED PLC INPUTS/OUTPUTS.

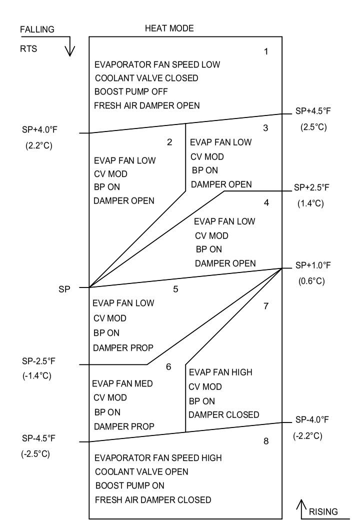
NOTES:

1. EVAPORATOR BLOWERS REMAIN OFF IN HEAT MODE OR COOL W/REHEAT MODE UNTIL HEATER INLET TUBE TEMPERATURE IS ABOVE 105F (40C) OR RETURN AIR TEMPERATURE IS ABOVE SETPOINT.
2. EVAPORATOR BLOWERS WILL RUN IN LOW SPEED IF FSW INPUT IS ACTIVE (+24V) IN HEAT OR VENT MODES.
3. COMPRESSOR IS DISABLED IF AMBIENT TEMPERATURE IS BELOW 45F (7.2C) OR IF EVAPORATOR COIL TEMPERATURE IS BELOW 27F (-2.8C) FOR 1 MINUTE.
4. OUTPUT AO1 IS ACTIVE (+24V) WHEN UNIT IS IN HEAT MODE AND RETURN AIR TEMPERATURE IS BELOW SETPOINT.
5. OUTPUT AO2 IS ACTIVE (+24V) WHEN AMBIENT TEMPERATURE IS BELOW 55F (12.8C).
6. OUTPUT AO3 IS ACTIVE (+24V) WHEN UNIT IS CALLING FOR HEATING (MAY BE USED FOR BOOSTPUMP SIGNAL).
7. OUTPUT AO4 IS ACTIVE (+24V) WHEN UNIT HAS SHUT DOWN DUE TO AC FAULT CONDITION.

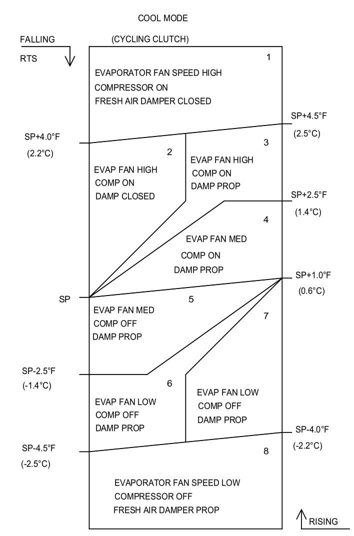
THERMOSTAT SEQUENCE



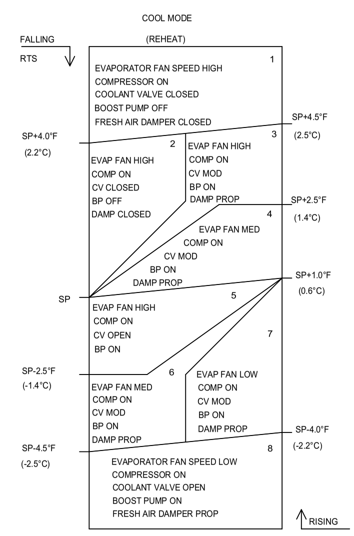
HEAT MODE



COOL MODE
(CYCLING CLUTCH)



COOL MODE
(REHEAT)



LET.	WAS	REVISIONS	DR.	APP.	CCN
A		REVISED FROM 150 TO 125A MAIN FUSE	PB	PB	13053M

CONFIDENTIAL

CCN 13053M

BLUE BIRD CORPORATION
FORT VALLEY GEORGIA, U.S.A.

SCALE NONE

SCHEMATIC,WRG,THERMOKING,HVAC ROOF

M4RE

DR. 03/17/05 BY PB
APP. 03/17/05 BY PB

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INACTIVATES NOS.