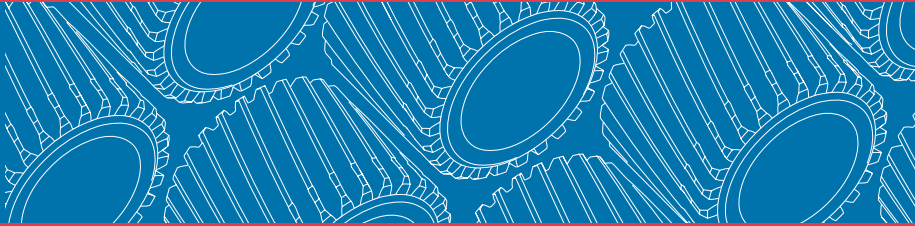




**Allison**  
**Transmission®**



# **Mechanic's Tips**

## **MT(B) 600 Series Transmissions**

**MT1357EN**

# Mechanic's Tips

## Allison Transmission

**MT 640, MT 643, MTB 643(R),  
MT 644, MT 647, MTB 647,  
MT 650, MT 653DR, MTB 653DR,  
MT 654CR, MTB 654CR**



Allison Transmission, Inc.  
P.O. Box 894 Indianapolis, Indiana 46206-0894  
[www.allisontransmission.com](http://www.allisontransmission.com)

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## WARNINGS, CAUTIONS, AND 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. 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 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 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.

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## **PREFACE**

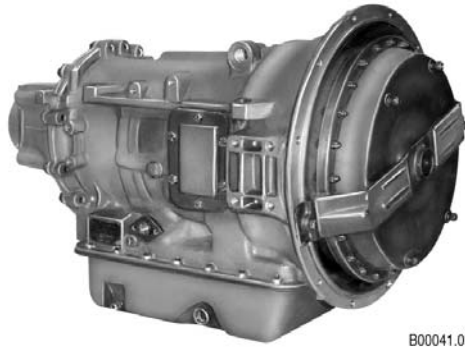
This handbook is a ready reference for the mechanic removing, installing, or maintaining MT(B) 600 Series Automatic Transmissions. All features of both the vehicle and transmission that become involved in the installation procedures are discussed. The information presented will help the mechanic to remove, install, and maintain the transmission in a manner that assures satisfactory operation and long service life.

## **TRADEMARKS USED**

DEXRON-III<sup>®</sup> is a registered trademark of General Motors Corporation

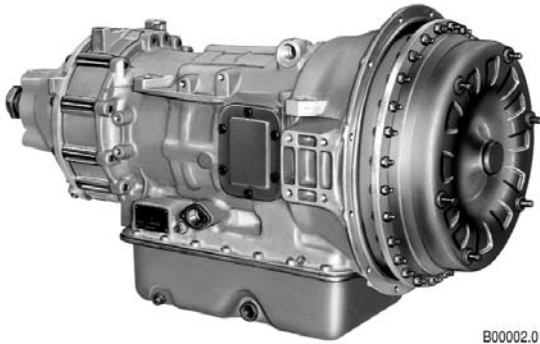
Loctite<sup>®</sup> is a registered trademark of the Loctite Corporation

Teflon<sup>®</sup> is a registered trademark of the DuPont Corporation



B00041.01

**Model MT 643 Transmission — Right-Front View**



B00002.01

**Model MT 653 Transmission — Right-Front View**



B03239

**Model MTB 644/647 Transmission — Right-Front View**

|   |                                     |                        |
|---|-------------------------------------|------------------------|
|  | <h1>PREVENTIVE<br/>MAINTENANCE</h1> | <h1>SECTION<br/>I</h1> |
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## 1-1. PERIODIC INSPECTION AND CARE

Clean and inspect the exterior of the transmission at regular intervals. The severity of service and operating conditions will determine the frequency of such inspections. Inspect the transmission for the following items:

- Loose bolts (transmission and mounting components)
- Fluid leaks (correct immediately)
- Shift linkage freely positioned by transmission detent
- Full (and ease of) movement of mechanical modulator linkage
- Leaks in the vacuum or air line and modulator
- Damaged or loose fluid lines
- Worn or frayed electrical connections
- Worn, out-of-phase driveline U-joints and slip fittings
- Loose or missing speedometer cable and fittings
- Damaged PTO linkage and driveline

Check transmission fluid regularly. Once consistent daily hot level checks have been established, and daily inspection shows no sign of transmission leakage, less frequent checks can be made.

## 1-2. IMPORTANCE OF PROPER FLUID LEVEL



Because the transmission fluid cools, lubricates, and transmits hydraulic power, it is important that the proper fluid level be maintained at all times. If the fluid level is too low, the input pump will draw air into the system and the converter and clutches will not receive an adequate supply of fluid. If the level is too high, clutch rotation will aerate the fluid, the transmission will overheat, and fluid may be expelled through the breather or dipstick tube. Check the transmission fluid for changes in viscosity or color. Thin, milky fluid indicates aeration is occurring due to improper fluid, incorrect fluid level, or a defective or missing sealing on the intake pipe of the internal filter.



### 1-3. DIPSTICK MARKINGS

Earlier models use a dipstick marked FULL and ADD. Later models use a dipstick marked REF FILL (COLD RUN) and HOT RUN. Figure 1-1 shows typical dipstick markings for MT 600 Series transmissions. Figure 1-2 illustrates the marks in relation to the transmission.



**NOTE:** The ADD and FULL dimensions on earlier dipsticks coincide with the HOT RUN band dimension on later dipsticks. If desired, the dipstick on earlier models can be recalibrated to show HOT RUN and REF FILL (COLD RUN).

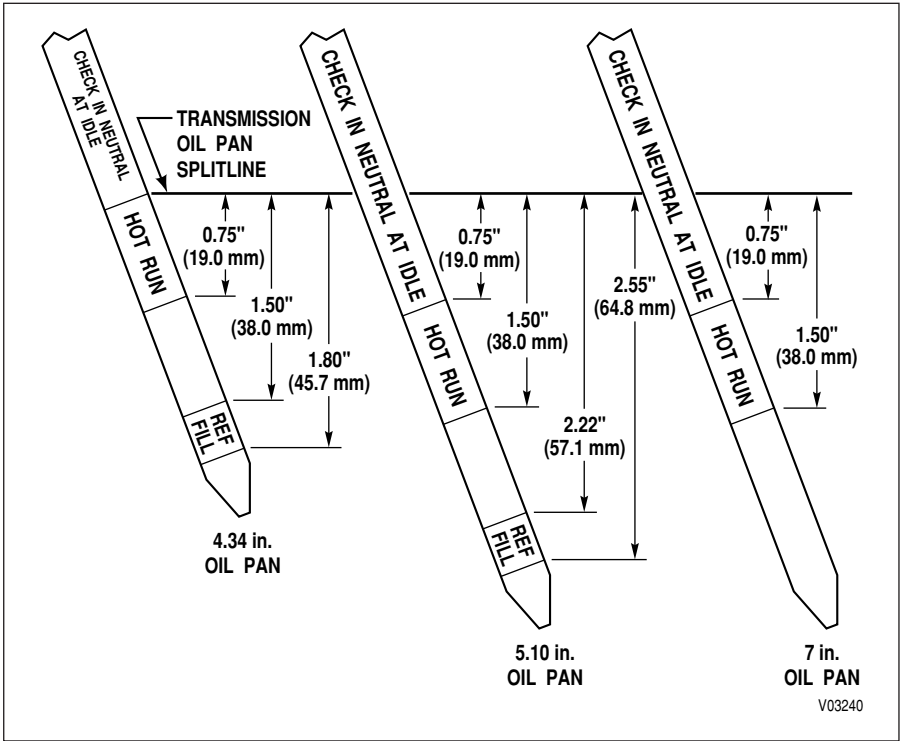


Figure 1-1. Typical Dipstick Markings

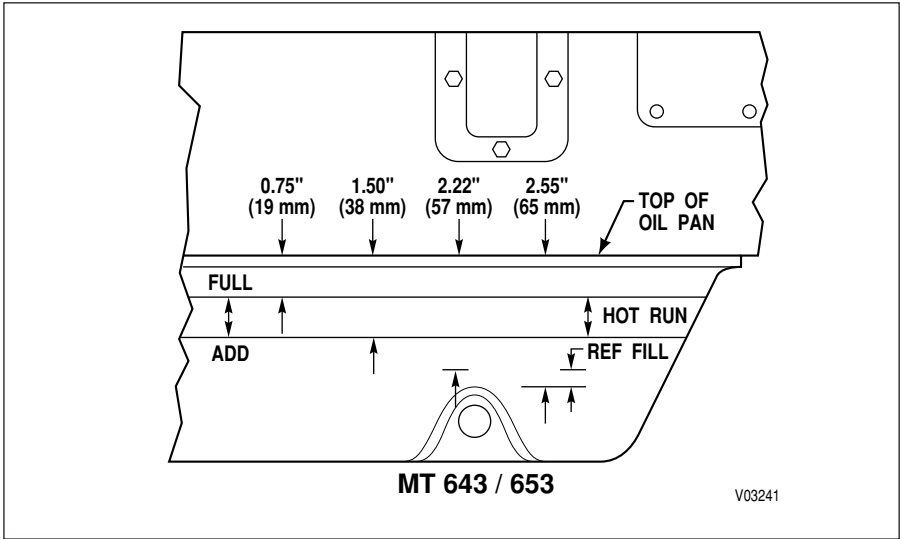


Figure 1–2. How Fluid Levels Are Established

### 1–4. FLUID CHECK PROCEDURE



**WARNING:** To help avoid injury and property damage caused by sudden and unexpected vehicle movement, do not perform maintenance or service procedures until you:

- Put the transmission in **N** (Neutral).
- Set the parking brake and service brakes, and make sure they are properly engaged.
- Check the wheels and take any other steps necessary to keep the vehicle from moving.



**CAUTION:** Dirt or foreign matter must not be permitted to enter the fluid system. It can cause valves to stick, cause undue wear of transmission parts, or clog passages.

Always check the fluid level a minimum of two times. Consistency is important in maintaining accuracy. If inconsistent readings persist, check the transmission breather and the vent hole in the dipstick fill tube to ensure they are clean and free of debris. The vent hole is located on the underside of the fill tube just below the seal of the dipstick cap.

Check the fluid level by the following procedures and record any abnormal fluid level, milky appearance, or any trace of coolant in the fluid on your maintenance records.

### a. Cold Check



**NOTE:** The only purpose of the Cold Check is to determine if the transmission has enough fluid to be safely operated until a Hot Check can be made.

- Park the vehicle on a level surface, set the parking brake and/or emergency brakes, and chock the vehicle wheels.
- Run the engine at 1000–1500 rpm for one minute to purge air from the system. Return engine to idle, then shift to **D** (Drive) and then to **R** (Reverse) to fill the hydraulic circuits with fluid. Then, shift to **N** (Neutral) and allow the engine to idle (500–800 rpm). The sump temperature should be between 60–120°F (16–49°C).



**CAUTION:** The fluid level rises as sump temperature increases. **DO NOT** fill above the COLD RUN band if the transmission fluid is below normal operating temperature.

- Clean around the end of the fill tube before removing the dipstick. Wipe the dipstick clean and check the fluid level. If the fluid on the dipstick is within the REF FILL (COLD RUN) band, the level is satisfactory for operating the transmission until the fluid is hot enough to perform a HOT RUN check. If the fluid level is not within the REF FILL (COLD RUN) band, add or drain fluid as necessary to bring the level to the middle of the REF FILL (COLD RUN) band.
- Perform a hot check at the first opportunity after the normal operating sump temperature 160–200°F (71–93°C) is reached.

### b. Hot Check



**NOTE:** The fluid level rises as the temperature increases. To ensure an accurate check, operate the transmission until the sump fluid temperature is 160–200°F (71–93°C) or converter-out temperature is 180–220°F (82–104°C).

- Park the vehicle on a level surface and shift to **N** (Neutral). Set the parking brake and/or emergency brakes and chock the vehicle wheels. Allow the engine to idle (500–800 rpm).
- Clean around the end of the fill tube before removing the dipstick. Wipe the dipstick clean and check the fluid level. The safe operating range is any

level within the HOT RUN band on the dipstick. If the level is not within this band, add or drain fluid as necessary to bring the level to the top of the HOT RUN band.

## 1-5. KEEPING FLUID CLEAN



**CAUTION:** Containers or fillers that have been used to handle any antifreeze or engine coolant solution must not be used for transmission fluid. Antifreeze and coolant solutions contain ethylene glycol which, if introduced into the transmission, can cause the clutch plates to fail.

It is absolutely necessary that the fluid put into the transmission be clean. Fluid must be handled in clean containers, fillers, etc., to prevent foreign material from entering the transmission. Lay dipstick in a clean place while filling the transmission.

## 1-6. RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE

### RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE — NON-MT 643R TRANSMISSIONS

Hydraulic fluids (oils) used in the transmission are important influences on transmission performance, reliability, and durability.

- The following transmission fluid and viscosity grades are recommended.
  - DEXRON®-III fluids for standard duty, on-highway applications
  - Type C-4 fluids (Allison approved SAE 10W or SAE 30) for severe duty and off-highway applications
  - Type C-4 SAE 30 for all applications where the ambient temperature is consistently above 95°F (35°C)
  - Type C-4 SAE 30 for dropboxes
- Some DEXRON®-III fluids are also qualified as Type C-4 fluids. To ensure the fluid is qualified for use in Allison transmissions, check for a DEXRON®-III or C-4 fluid license, or approval numbers on the container, or consult the lubricant manufacturer. Consult your Allison Transmission dealer or distributor before using other fluid types; fluid types such as Type F, and universal farm fluids may or may not be properly qualified for use in your Allison transmission.



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

- When choosing the optimum viscosity grade of fluid to use, duty cycle, preheat capabilities, and/or geographical location must be taken into consideration. Table 1–1 lists the minimum fluid temperatures at which the transmission may be safely operated in a forward or reverse range. Operation at ambient temperatures lower than those shown will require preheating with auxiliary heating equipment or by running the vehicle with the transmission in N (Neutral) for a minimum of 20 minutes before attempting range operation.

## RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE — MT 643R TRANSMISSIONS

- Due to the added heat load from the input retarder, MT 643R transmissions require special fluid considerations. The approved fluids list is more restrictive than for non-retarder MT 643R transmissions. Also, the fluid change intervals are shorter than for non-retarder MT 643R transmissions.
- Only high quality, heavy duty diesel engine oils that are approved Allison C-4 fluids with a viscosity of either SAE 30 or SAE 15W-40 are recommended for use in MT 643R transmissions. For specific name brands, contact the local Allison Transmission Regional Office.
- Refer to Table 1–1 for minimum fluid temperatures at which the transmission may be safely operated with various fluids. Operation at ambient temperatures lower than those shown will require preheating with auxiliary heating equipment or by running the vehicle with the transmission in N (Neutral) for a minimum of 20 minutes before attempting range operation.

**Table 1–1. Transmission Fluid Operating Temperature Requirements**

| Viscosity Grade    | Ambient Temperature Below Which Preheat Is Required |         |
|--------------------|---|---------|
|                    | Fahrenheit  | Celsius |
| SAE 0W-20 (Arctic) | –31   | –35     |
| DEXRON®-III        | –22   | –30     |
| SAE 10W            | –4  | –20     |
| SAE 15W-40         | 5   | –15     |
| SAE 30             | 32  | 0       |
| SAE 40             | 50  | 10      |

## 1–7. FLUID AND FILTER CHANGE INTERVALS



Fluid and filter change frequencies are determined as follows.

- Table 1–2 is a general guide. The fluid must be changed whenever there is evidence of dirt or high temperature indicated by

discoloration or strong odor. More frequent changes may be required when operations are subject to high levels of contamination or overheating.

- Fluid change intervals can be optimized by monitoring fluid oxidation according to the tests and limits in the Fluid Contamination section of this manual.

**Table 1–2. Fluid and Filter Change Intervals**

| <b>Transmission Application</b>  | <b>Fluid Change</b>   | <b>Internal Sump Filter</b>   | <b>Governor Filter</b>                 | <b>External Auxiliary Filters**</b>   |
|--|---|---|--|---|
| MT 600 Series (On-Highway, Non-MT 643R)  | 25,000 miles (40 000 km) or 12 months*  | <b>Paper Filter:</b><br>25,000 miles (40 000 km) or 12 months*<br><b>Stainless Steel Screen:</b><br>At overhaul | 25,000 miles (40 000 km) or 12 months* | After first 5000 miles (8 000 km) and at normal fluid change intervals, thereafter* |
| MT 643R  | After first 5000 miles (8000 km) then at 20,000 miles (32 000 km) or 12 months* | <b>Paper Filter:</b><br>At every other fluid change<br><b>Stainless Steel Screen:</b><br>At overhaul            | 20,000 miles (32 000 km) or 12 months* | After first 5000 miles (8000 km) then at each fluid change, thereafter              |
| MT 600 Series (Off-Highway)  | 1000 hours maximum or 12 months*  | <b>Paper Filter:</b><br>1000 hours maximum or 12 months*<br><b>Stainless Steel Screen:</b><br>At overhaul       | 1000 hours maximum or 12 months*       | After first 500 hours and at normal oil change intervals, thereafter*               |
| * Whichever occurs first.<br>** An Allison high-efficiency filter may be used until the Change Filter light indicates it is contaminated or until it has been in use for 3 years, whichever occurs first. No mileage restrictions apply. |   |   |  |   |

A stainless steel screen sump filter is available for all later model MT 600 Series transmissions except the MT(B) 654CR. This filter does not require replacement at the regular fluid change intervals, but transmissions equipped with a sump screen must have an auxiliary filter in the external transmission cooling circuit. Refer to Service Information Letter (SIL) 6-TR-96 (latest revision).

## 1-8. FLUID AND FILTER CHANGE PROCEDURE



### a. Drain

- The transmission should be at operating temperature to assist draining.
- Remove the drain plug from the pan. In earlier models without a drain plug, remove the fill tube.
- Examine the drained fluid for evidence of contamination (refer to Paragraph 1-9).
- Remove the pan and gasket. Discard the gasket. Remove the washer head screw that retains the filter. Remove the filter and filter tube. Discard the filter (if being replaced) and the filter tube sealring. Clean the pan.



**NOTE:** Transmissions equipped with a stainless steel screen sump filter or a 7.0 inch (180 mm) pan do not require pan removal. Refer to Service Manual SM1317EN or SM1546EN for specific procedures.

- Install a new governor feed filter at the rear of the transmission. Refer to the latest revision of Service Manual SM1317EN or SM1546EN for the exact location.
- Install a new filter if required. Insert a new sealring onto the filter tube. Install the filter tube and filter into the main housing. Install the pan and pan gasket if removed. Tighten the pan screws to 10–15 lb ft (14–20 N·m).



**NOTE:** To prevent leakage, pan washer head screws must retain a 5 lb ft (7 N·m) minimum torque after gasket sets.

- Install the drain plug into the pan and tighten it to 15–20 lb ft (20–27 N·m). If the fill tube was removed (earlier models), install the fill tube and tighten the fill tube fitting in the pan boss to the torque shown in Paragraph 6-1.
- If an external auxiliary filter is present, replace the filter element. Refer to Table 1-2 for replacement intervals.

### b. Fill

- Refill the transmission. (Refer to Paragraph 1-6 and Table 1-3.)
- The refill amount is less than the initial fill because some of the fluid remains in the external circuits and transmission cavities.
- Check the fluid level as outlined in Paragraph 1-4.

**Table 1–3. Transmission Fluid Refill Capacities**

| <b>Pan Type</b>  | <b>Quantity</b>          |
|--|--------------------------|
| 4.3 inches (110 mm)  | 12 U.S. qt. (11 liters)* |
| 5.1 inches (130 mm)  | 15 U.S. qt. (14 liters)* |
| 7.0 inches (180 mm)  | 17 U.S. qt. (16 liters)* |
| * The amount of transmission fluid shown does not include the amount required to fill the external circuits. |                          |

## **1–9. FLUID CONTAMINATION**

### **a. Examine at Fluid Change**

At each fluid change, examine the fluid which is drained for evidence of dirt or engine coolant (water). A normal amount of condensation will emulsify in the fluid during operation of the transmission. However, if there is evidence of coolant, check the cooler (heat exchanger) for leakage between the cooler and fluid areas. Fluid in the coolant side of the cooler (heat exchanger) is another sign of leakage. This, however, may indicate leakage from the engine oil system.

### **b. Metal Particles**



**CAUTION:** If excessive metal contamination has occurred, replacement of the cooler and inspection of all bearings within the transmission is recommended.

Metal particles in the fluid or on the magnetic drain plug (except for the minute particles normally trapped in the filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination requires complete disassembly of the transmission and cleaning of all internal and external circuits, cooler, and all other areas where the particles could lodge. (Refer to Paragraph 1–10, Auxiliary Filter.)

### **c. Coolant Leakage**

If engine coolant leaks into the transmission hydraulic system, take immediate action to prevent malfunction and possible serious damage. Completely disassemble, inspect, and clean the transmission. Remove all traces of the coolant and varnish deposits resulting from coolant contamination. Replace friction clutch plates contaminated with ethylene glycol.



**d. Fluid Analysis**

Transmission protection and fluid change intervals can be optimized by transmission fluid analysis. Consult your local telephone directory for fluid analysis firms. Use one fluid analysis firm as results from various firms cannot be accurately compared. Refer to the Technicians’ Guide for Automatic Transmission Fluid (GN2055EN) for additional information.

To optimize transmission protection, the following is the minimum series of tests required to properly monitor the condition of the transmission and transmission fluid/filter system.

- Wear Metals (ppm): Fe, Cu, Pb, Al
- Additive and Contaminant Metals (ppm): Ba, B, Ca, Mg, P, Si, Na, Zn
- Non-metal Contaminants: Fuel (% vol), Soot, (% wt), Water (% vol)
- Viscosity (cSt) at 40°C (ASTM D445)
- Viscosity (cSt) at 100°C (ASTM D445)
- TAN (Total Acid Number) (ASTM D664)
- Particle Counts (particles/ml) at >5, >10, >20, >30, and >40 microns

ppm = parts per million      cSt = centiStokes      ml = milliliter

To optimize fluid change intervals, monitor fluid oxidation per the tests and limits shown in Table 1–4. A fluid is considered suitable for use if it meets all four limits listed in the table, regardless of color or odor. If one of the limits is exceeded, however, the fluid in the subject transmission should be sampled again immediately to verify the exceeded limit. If verified, the fluid should be changed regardless of time or mileage.

**Table 1–4. Fluid Oxidation Measurement Limits**

| Condition  | Limit                         |
|--|-------------------------------|
| Viscosity  | ± 25% Change From New Fluid   |
| Carbonyl Absorbance                              | + 30* Change From New Fluid   |
| Total Acid Number (TAN)                          | + 3.0** Change From New Fluid |
| Solids   | 2% By Volume Maximum          |
| * Carbonyl absorbance units/cm                   |                               |
| ** mg of KOH required to neutralize a g of fluid |                               |

**1–10. AUXILIARY FILTER**

If a condition occurs that introduces debris into the transmission hydraulic system, completely clean up the cooler and lines.

Because repeated cleaning and flushing may not remove all debris, installation of an auxiliary filter is recommended. This recommendation applies whether the transmission is overhauled or replaced by a new or rebuilt unit.

- For models without a retarder, install an auxiliary filter in the cooler-out line (between the cooler and transmission) if such a filter does not already exist.
- For models with an output retarder, replace the main cooler and install an auxiliary filter in the line between the retarder control valve and the lube port (right side of the transmission).
- For models with an input retarder, install an auxiliary filter in the secondary cooler circuit.



**CAUTION:** DO NOT install an auxiliary filter in the MT 643R primary cooler circuit. This reduces retarder effectiveness. An auxiliary filter in the secondary cooler circuit is sufficient.

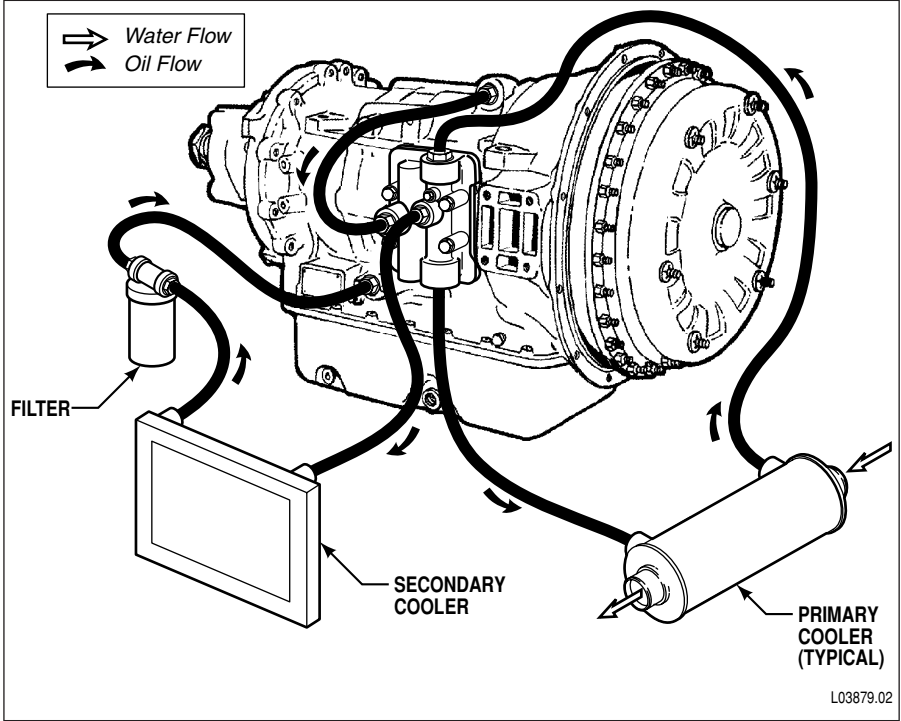


Figure 1-3. Typical MTR Cooling System

If any doubt exists about the cleanup of the cooler, replace the cooler.

Consult your nearest Allison Transmission dealer/distributor or the chassis OEM for detailed filter information and availability.

The auxiliary filter should have a 40-micron or finer filter element and a maximum filter pressure drop of 3 psi (21 kPa) at 8 gpm (30 liters/minute) at 180°F (82°C). The maximum external circuit pressure drop at normal operating temperature must not exceed 23 psi (159 kPa) for the MT(B) 640, 643, 650, 653 and 50 psi (345 kPa) for the MT(B) 644, 647, 654CR at 2000 rpm in N (Neutral).

The following auxiliary filters are recommended:

**Table 1–5. Auxiliary Filter Recommendations**

| Filter Assembly   | Filter Element   |
|---|--|
| Allison 29510923*<br>AC PM 13-16<br>AC PM 16-1<br>Fram HP 1-2**<br>Purolator OF-15C-1<br>Purolator PER-20-10  | Allison 29510922*<br>PF 897<br>PF 141<br>HP 1<br>OF-2C-1<br>PER-20 |
| * High-efficiency filter and element are available from your authorized Allison distributor. Refer to SIL 12-TR-93 (latest revision).<br>** Use with MT 640, 643, 650, 653 only |  |

## 1–11. BREATHER

The breather is located at the top of the transmission housing. It serves to prevent pressure buildup within the transmission; it must be kept clean and the passage must be kept open. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Use care when cleaning the transmission. Spraying steam, water, or cleaning solution directly at the breather can force the water or solution into the transmission.

## 1–12. TRANSMISSION STALL TEST AND NEUTRAL COOL-DOWN CHECK



### a. Purpose

The stall test provides a method for determining if the malfunction is in the engine or in the transmission when a vehicle is not performing satisfactorily.

The neutral cool-down check utilizes the two minute cooling period on the stall test to gather fluid temperature data for troubleshooting reference.



**NOTE:** Before conducting the stall test, obtain the engine manufacturer’s data from the engine manufacturer or from your equipment dealer or distributor.

### b. Transmission Stall Test Procedure

The engine stall point (rpm) under load is compared to the engine manufacturer’s specified rpm for the stall test.



**WARNING:** To help avoid injury and property damage caused by sudden and unexpected vehicle movement, do not begin a stationary stall test until you:

- Put the transmission in **N** (Neutral).
- Set the parking brake and service brakes, and make sure they are properly engaged.
- Chock the wheels and take any other steps necessary to keep the vehicle from moving.
- Warn people to keep clear of the vehicle and its path.



**CAUTION:** Never maintain the stall condition for more than 30 seconds at any one time because of the rapid rise in fluid temperature. Do not let the converter-out fluid temperature exceed 300°F (149°C). Do not rely on converter-out fluid temperature to limit stall duration. During stall conditions, internal temperatures rise much faster than converter-out fluid temperature. Run the engine at 1200–1500 rpm in **N** (Neutral) for two minutes to cool the transmission fluid between tests. If the stall test is repeated, do not let the engine overheat.

- Connect a tachometer of known accuracy to the engine, and install a temperature probe into the converter-out (to cooler) line. Bring the transmission to the normal operating temperature of 180–220°F (82–104°C).
- With the vehicle securely blocked and the parking brake and service brake applied, shift to any forward range. Then, accelerate the engine to wide-open throttle and record the maximum rpm the engine will attain. (This test may also be conducted in **R** (Reverse) range if necessary.)

- Reduce engine speed to idle and shift to N (Neutral).



**NOTE:** Engines having smoke controls and throttle-delay mechanisms require the following stall test procedure. Put the transmission in the first range hold position. Operate the vehicle at maximum speed in first range. Apply the vehicle brakes while maintaining full throttle. As soon as the vehicle is completely stopped, read the engine rpm (stall speed) from the tachometer. Reduce engine speed to idle and shift to N (Neutral). Increase engine speed to cool the torque converter.

### c. Neutral Cool-Down Check Procedure

The neutral cool-down check determines if the transmission fluid cools following an engine load condition. Perform this check immediately after the engine speed has been recorded in the stall test.

- Record the converter-out fluid temperature.
- With the transmission remaining in N (Neutral), run the engine at 1200–1500 rpm for two minutes to cool the fluid.
- At the end of two minutes, record the converter-out fluid temperature.

### d. Results



**NOTE:** Environmental conditions, such as ambient temperature, altitude, engine accessory loss variations, etc., affect the power input to the converter. Under such conditions, a stall speed deviation up to  $\pm 150$  rpm from specification can be accepted as within normal range.

If the engine stall speed is more than 150 rpm below the stall speed specified by the engine manufacturer, an engine problem is indicated, such as the need for a tune-up.

If the engine stall speed is more than 150 rpm above specification, a transmission problem is indicated, such as slipping clutches, cavitation, or torque converter failure.

An extremely low stall speed, such as 33 percent of the specified engine stall rpm, during which the engine does not smoke, could indicate a free-wheeling torque converter stator.

If the engine stall speed conforms to specification, but the transmission fluid overheats, refer to the Neutral Cool-Down Check Procedure. If the fluid does not cool during the two minute cool-down check, a stuck torque converter stator could be indicated.

If the engine stall speed conforms to specification and the cool-down check shows that the transmission fluid cools properly, refer to the applicable MT Service Manual SM1317EN or SM1546EN (latest revision) for troubleshooting procedures.



## 2-1. DRAINING TRANSMISSION

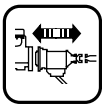
- Remove the drain plug from the pan. For earlier models, disconnect the transmission fill tube from the pan. Remove the fill tube completely if it interferes with transmission removal.
- Examine the drained fluid for evidence of contamination (refer to Paragraph 1-9).
- Install the drain plug and tighten it to 15–20 lb ft (20–27 N·m).



**NOTE:** A significant amount of fluid may drain from the hydraulic lines when they are disconnected from the transmission.

- Disconnect all hydraulic lines from the transmission. Remove the lines from the vehicle if they interfere with transmission removal. Cap or plug all hydraulic lines and openings to prevent dirt from entering the hydraulic system.

## 2-2. DISCONNECTING CONTROLS

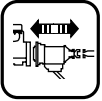


Disconnect the controls from the transmission and position them so they do not interfere with transmission removal.

- Disconnect all linkage or cables for shifting, shift modulation, parking brake, and speedometer. Remove the mechanical or electrical modulator control and plug the opening in the transmission.
- Disconnect the vacuum hose from the vacuum modulator (if used). Remove the vacuum modulator and plug the opening in the transmission.
- Disconnect the air hose from the air modulator or air-operated retarder valve (if used). Remove the air modulator and plug the opening in the transmission.

- Disconnect the power takeoff from its driven equipment. Disconnect the PTO controls. Remove the PTO completely if it will interfere with transmission removal. Cover the PTO opening.
- Disconnect any electrical leads to sensors or other equipment on the transmission.

### 2-3. UNCOUPLING FROM ENGINE AND DRIVELINE



- Chock the wheels to prevent the vehicle from rolling.
- Disconnect the vehicle driveline from the transmission output flange or yoke. Position the drive shaft to avoid interference with transmission removal.
- Figures 2-1 and 2-2 show typical methods of coupling the engine and transmission. Remove the drive cover nuts (Figure 2-1) or drive bolts (Figures 2-1, 2-2).

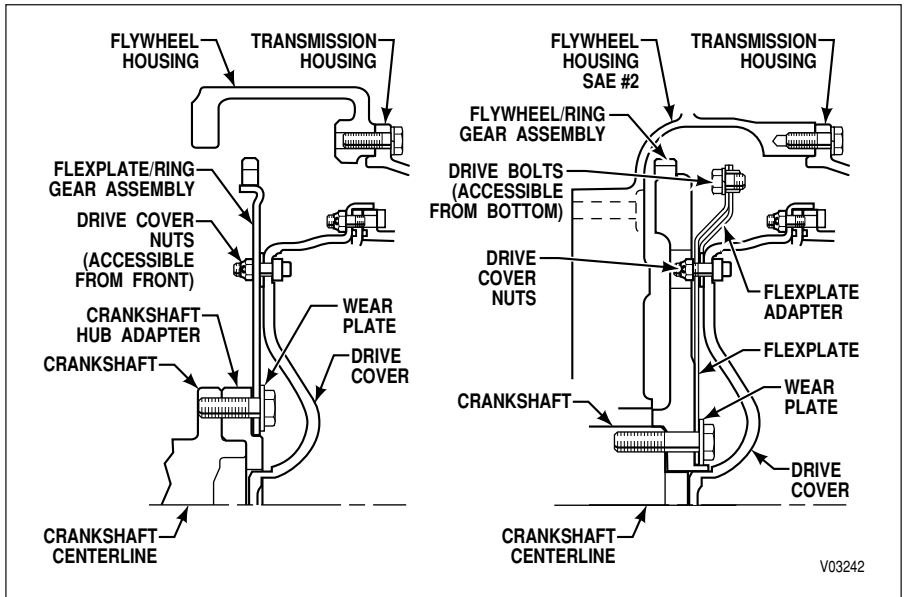
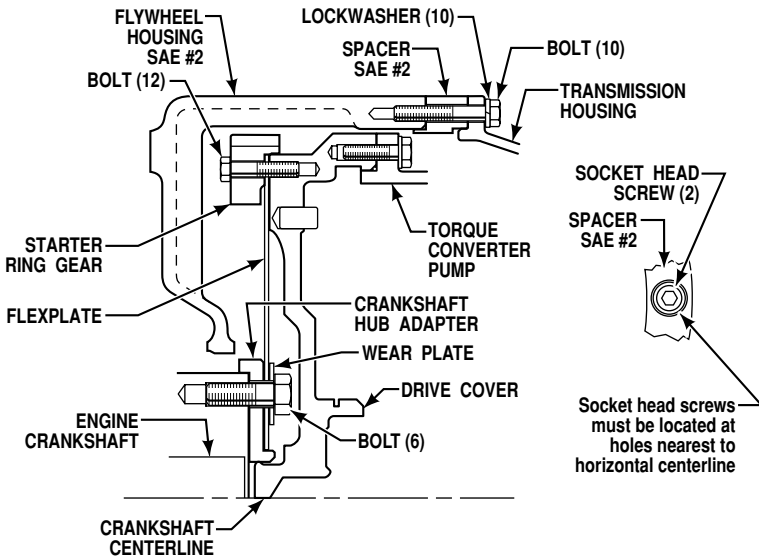
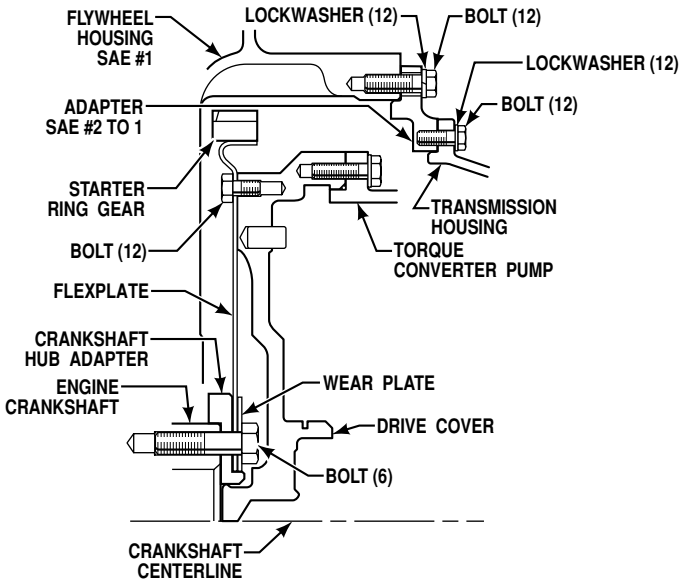


Figure 2-1. Typical Coupling Methods — MT(B) 640, 643, 650, 653 (TC 300 Converter)



V03243

Figure 2-2. Typical Coupling Methods — MT(B) 644, 647, 654CR (TC 400 Converter)



## 2-4. REMOVING MOUNTING BOLTS

- If transmission mountings support the rear of the engine, place a jack or other support under the engine.
- Support the transmission securely on a jack, hoist, or other removal support equipment.
- Remove all bolts and supports that attach the transmission to the vehicle. Refer to Figures 2-1 and 2-2 for bolts and nuts within the flywheel housing.



**NOTE:** To remove the transmission from the flywheel housing, do the following.

- When an adapter is used to adapt the transmission to a larger engine flywheel housing (Figure 2-2), remove only the transmission-to-adapter bolts.
- When a spacer is used, the transmission is fastened to the flywheel housing in one of two ways.
  - Remove the ten bolts that pass through the spacer and hold the transmission to the flywheel housing. To remove the spacer, remove the two bolts that hold the spacer to the flywheel housing.
  - Remove the ten bolts and two studs that pass through the spacer and hold the transmission to the flywheel housing.

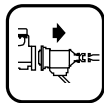
## 2-5. REMOVING TRANSMISSION



**CAUTION:** Do not pull the transmission away from the torque converter assembly. The torque converter drive cover must be entirely free of any restraint by the flexplate drive or crankshaft pilot when the transmission separates from the engine.



**CAUTION:** If the spacer is not independently bolted to the engine (Figure 2-2), prevent the spacer from falling during transmission removal.

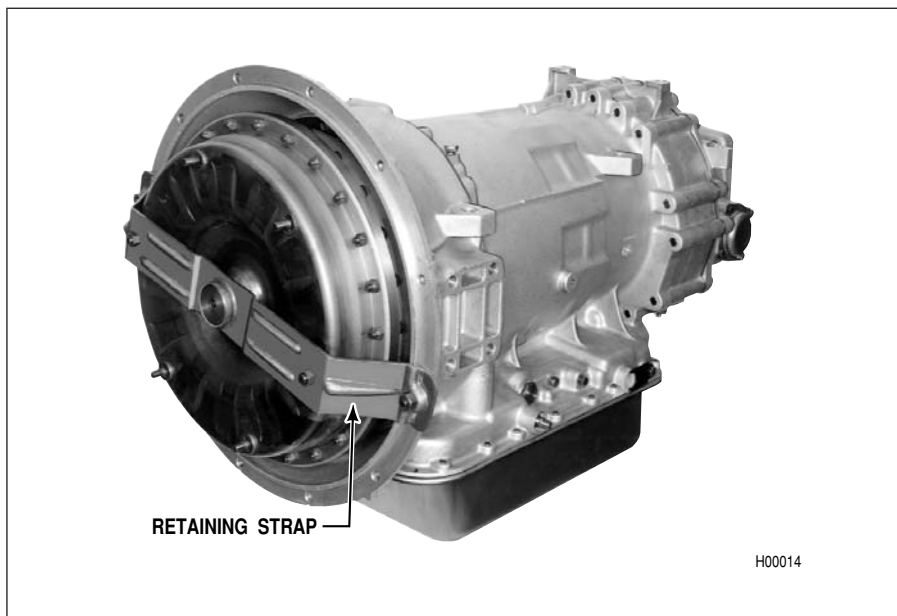


- Move the transmission rearward until it is clear of the engine. Use care to prevent the torque converter from separating from the transmission. Keep the transmission level or the rear slightly low to prevent the torque converter from slipping forward.

- Attach a retaining strap (Figure 2–3) across the converter drive cover and transmission housing at the earliest opportunity.
- Remove the spacer if used (Figure 2–2) from the engine flywheel housing.

## 2–6. REPAIR INSTRUCTIONS

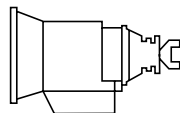
- Refer to the applicable Allison Transmission Service Manual SM1317EN or SM1546EN (latest revision) to repair the transmission.



**Figure 2–3. Location of Torque Converter Retaining Strap**

**SECTION  
III**

**PREPARING  
TRANSMISSION FOR  
INSTALLATION**



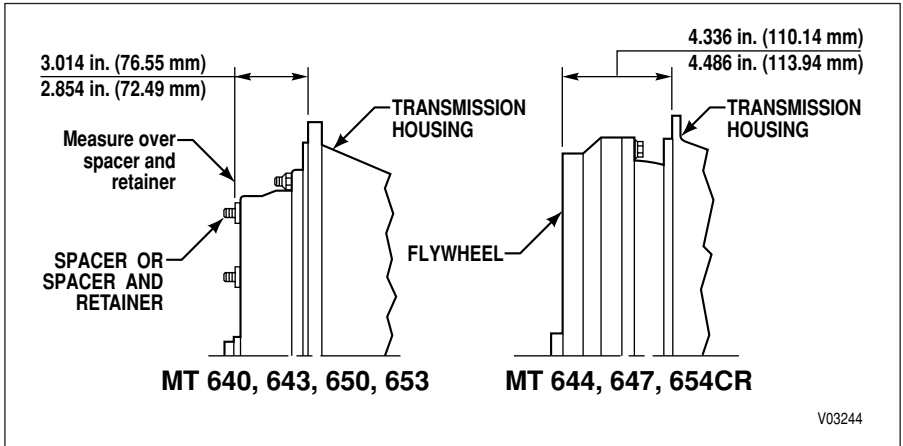
### **3-1. CHECKING INPUT COMPONENTS**

- Check all bolt holes on the front of the flywheel/converter cover/flexplate adapter. The threads must be undamaged, and the holes free of chips or foreign material.
- Check the pilot boss (at center of flywheel) for damage or raised metal that would prevent free entry into the flexplate hub (adapter).
- Check the starter ring gear for excessive wear or damage. Check welds that retain the ring gear (where applicable).
- Check the transmission mounting flange for gasket remnants, raised metal, or dirt.
- Inspect the transmission-to-engine mounting flange for raised metal, burrs, and pieces of gasket material. Remove any of these defects. Inspect the threaded holes for damaged threads.

### **3-2. CHECKING TORQUE CONVERTER POSITION**

When the transmission is installed, the torque converter is axially positioned by the flexplate. When properly positioned, the torque converter assembly is free of all restraints against fore and aft movement except for that of the flexplate.

- To determine that there will be ample clearance for positioning the torque converter, measure as indicated in Figure 3-1. Check the results against the following dimensions:
  - MT 640, 643, 650, 653: 2.854–3.014 inch (72.49–76.55 mm)
  - MT 644, 647, 654CR: 4.336–4.486 inch (110.14–113.94 mm)
- A measurement outside these dimensions indicates the torque converter is not installed properly. Refer to the applicable Allison Transmission Service Manual SM1317EN or SM1546EN (latest revision).



**Figure 3-1. Converter Position Measurements**

- If not previously installed (on transmissions coupled as in Figure 2-1), install the flexplate adapter over the spacers and retainers on the drive cover studs. Secure the adapter with six nuts, tightened to 34–40 lb ft (46–54 N·m).



**NOTE:** The nuts must be self-locking and capable of producing a tensile load of 8000 lbs (36 kN). A nut that meets these requirements is Allison P/N 23014107.

### 3-3. INSTALLING PARKING BRAKE AND OUTPUT FLANGE



**CAUTION:** Do not attempt to polish the oil seal contact surface on the flange or yoke. Scratches or machine-type lead can cause seal leakage.

- Check the output flange rear oil seal to ensure that it has not been damaged and is free of defects. For replacement instructions, refer to the applicable Allison Transmission Service Manual SM1317EN or SM1546EN (latest revision).
- Lubricate the oil seal with petrolatum or transmission fluid.
- Check the oil drip tube below the rear cover to ensure it is clean and unobstructed.
- Check the output flange or yoke for damage or wear. Check the oil seal contact surface to ensure it is smooth and free of surface irregularities to prevent fluid leaking past the seal. Rotate the flange during installation to avoid seal lip damage.
- Install the parking brake (if so equipped).



**CAUTION:** Do not use a hammer or similar tool to install the output flange or yoke onto the transmission output shaft. Internal damage can result.

- Lubricate the splines of the shaft and output flange and install the output flange. Ensure the flange hub is seated against the transmission rear bearing.
- The MT 640, 643, or 644, 647 output flange is retained by a 1/2-20 x 1 1/2 inch bolt and a washer. Replace the bolt and washer each time they are removed. Tighten the bolt to 102–121 lb ft (138–164 N·m).



**NOTE:** Bolt P/N 29510838 with improved torque retention should be used. This bolt has five grade identification slots in the bolt head rather than the six slots of P/N 23014159. Reference SIL 1-TR-94 (latest revision). The torque value is the same for both bolts.

- The MT(B) 650, 653, or 654CR output flange is retained by a self-locking nut. Clean the threads of the nut and the output shaft. Apply molybdenum disulfide grease to the output shaft and nut threads. Install the nut on the output shaft. Tighten the nut to 600–800 lb ft (813–1085 N·m).



**NOTE:** The self-locking ability of the nut is reduced with each usage. Each time the nut is reused, scribe a deep mark on one of the flats on the nut. Discard the nut after it has been reused five times.

### 3-4. INSTALLING SHIFT SELECTOR LEVER



**CAUTION:** Manual selector shafts that are center drilled at their outer ends require an M10 x 1.5-6G nut (metric thread). Shafts that are undrilled require a 3/8-16 nut (standard inch series). Use of the wrong nut will damage both the shaft and nut. Torque for either nut is 15–20 lb ft (20–27 N·m). Excessive torque applied to the nut without holding the lever can damage the internal lever. Do not use an impact wrench.

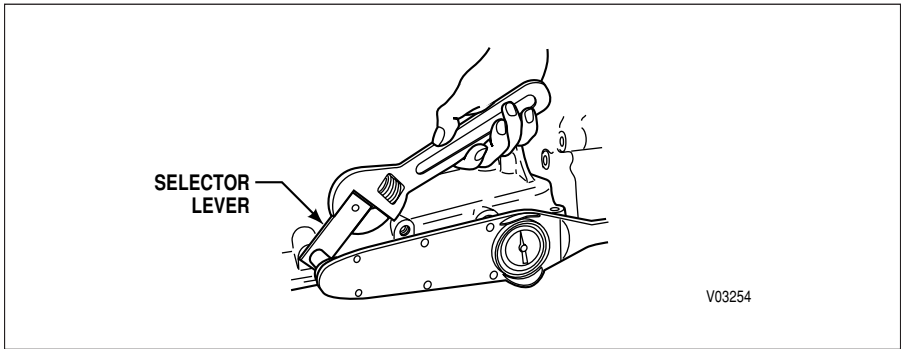
- Install the selector lever onto the selector shaft. The flats in the lever slot interfere slightly with the tapered flats on the selector shaft before the lever seats against the shaft shoulder. If such an interference fit is not present, replace the selector lever.



**CAUTION:** Overtightening the lever retaining nut can damage the shaft thread.

- Install the lever retaining nut, finger tight, against the lever.

- Shift the selector shaft to a position away from either end position. Two detent “clicks” from either end position is recommended.
- Hold the lever and tighten the nut to 15–20 lb ft (20–27 N·m) (Figure 3–2). The lever must be seated fully against the shaft shoulder.



**Figure 3–2. Tightening Selector Lever Nut**

### 3–5. INSTALLING POWER TAKEOFF (PTO)



**CAUTION:** Cork or other soft gaskets must never be used to mount the PTO. Use only shims or gaskets recommended by the PTO manufacturer.

Space limitations will determine whether the PTO should be installed before or after the transmission is installed.

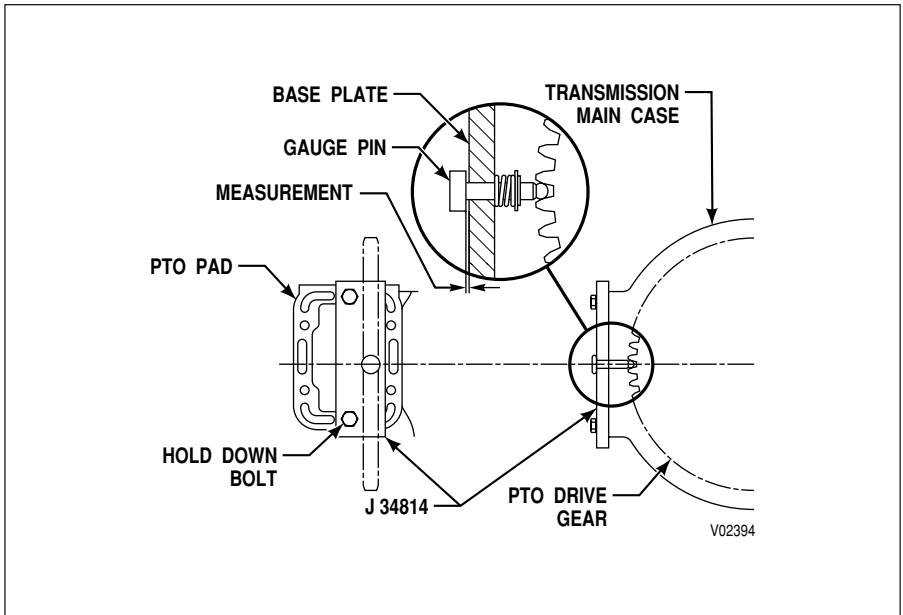
- The prescribed backlash between the drive gear (in transmission) and driven gear (in PTO) is 0.006–0.029 inch (0.15–0.73 mm) or as specified by the PTO manufacturer.
- Early model transmissions have a 6/8 pitch drive gear while later models have a 6 pitch gear. A 6 pitch or a 6/8 pitch PTO may be used with either gear, but the backlash must be maintained.
- If the PTO has a manual disconnect, ensure that the disconnect lever is in the disconnect position before installation. The PTO must be installed on the mounting pad with its driven gear to the rear of the PTO drive gear in the transmission.
- Determining PTO Backlash
  - PTO not installed: backlash can be measured with special tool J 34814 (Figure 3–3). Reference SIL 50-TR-83 and Service Manuals SM1317EN and SM1546EN (latest revisions).

- PTO installed: measure through the inspection port (if provided) with a dial indicator. On PTO units with no inspection port, rotate the PTO shaft back and forth. Rattling gears indicate too much backlash and require the removal of one or more gaskets from beneath the PTO housing. Difficult engagement or whining gears indicate a tight fit and require the addition of one or more gaskets.



**NOTE:** Do not remove all gaskets from beneath the PTO housing. One gasket (minimum) is required to prevent fluid leakage.

- Install the PTO unit and gasket(s) flush to the mounting pad; do not force. Avoid bumping the snapping (Figure 3-4), which could be displaced. Secure the PTO with six mounting bolts; tighten to 26–32 lb ft (35–43 N·m).



| Measurement                    | Correction                                  |
|--------------------------------|---|
| 0.011–0.045 in. (0.27–1.16 mm) | One–0.030 in. Gasket (one 0.76 mm Gasket)   |
| 0.047–0.070 in. (1.19–1.78 mm) | Two–0.030 in. Gaskets (two 0.76 mm Gaskets) |

**Figure 3-3. Measuring Turbine-Driven PTO Backlash**

- On PTO assemblies that require pressure lubrication, install the lubrication tube and fittings. The lubricating fluid comes from the line returning to the transmission from the cooler. Fluid should be directed to the PTO lubrication

circuit after passing through a 0.032 inch (0.81 mm) restriction. (Usually, the restriction is already located in the PTO.)

### 3-6. INSTALLING SHIFT MODULATION CONTROL

- Install the modulation control after the transmission is put into the vehicle. Refer to Paragraphs 5-8 and 5-9.

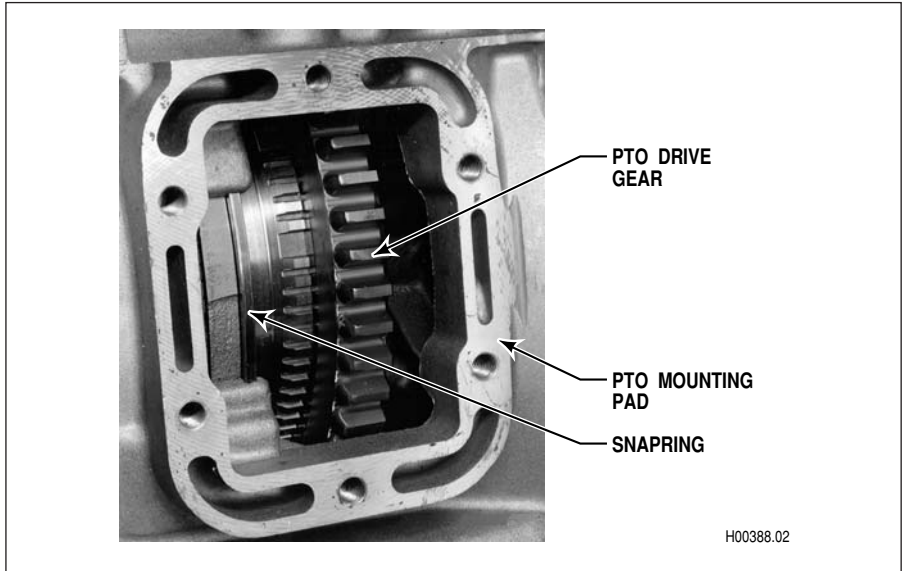


Figure 3-4. View at PTO Opening

### 3-7. INSTALLING FILL TUBE AND DRAIN PLUG

The fill tube may be installed before the transmission is put into the vehicle, unless its presence will interfere with transmission installation.

- Install the fill tube and tighten the fitting in the pan boss to 65-75 lb ft (88-102 N·m).



**NOTE:** Torque was increased to 90-100 lb ft (122-136 N·m) beginning with S/N 2410501058 where the oil pan boss length was changed from 0.575 to 0.675 inch. Reference SIL 30-TR-94.



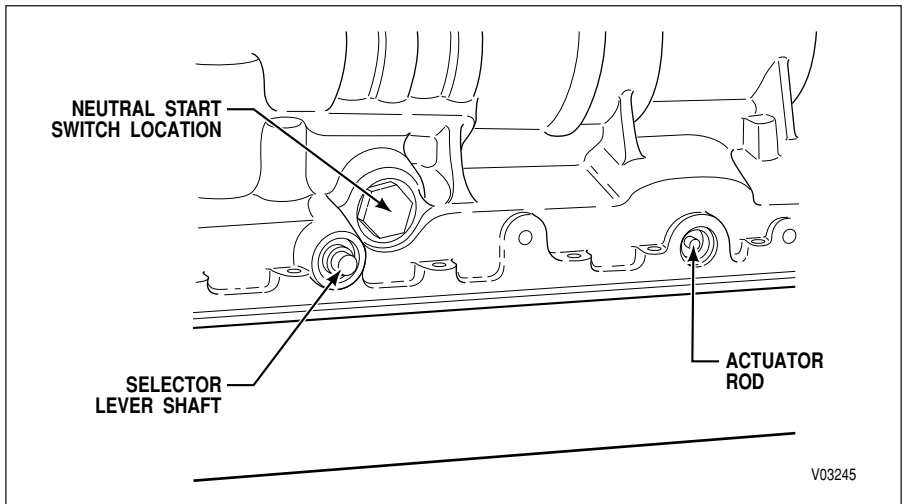
- Fasten the upper end of the fill tube to the engine or transmission with brackets and bolts as required. Do not attach the fill tube to the vehicle cab or frame.
- Ensure the drain plug is in place and tightened to 15–20 lb ft (20–27 N·m).

### 3-8. INSTALLING NEUTRAL START AND REVERSE SIGNAL SWITCHES



**NOTE:** The type and location of the Neutral Start Switch is optional. A functional Neutral Start Switch is required to avoid starting the engine in range.

- Connect any wiring required for sensors, signals, switches, or other electrical components.
- Install the Neutral Start Switch (if so equipped) into the tapped opening above the selector shaft (Figure 3-5). The switch must include an aluminum washer (gasket) approximately 0.090 inch (2.29 mm) thick. The washer on some switches has indentations on one side. Install the washer onto the switch with the indentations facing away from the switch. Make sure all mating surfaces are clean and free of contamination. Apply a light coat of Loctite® pipe sealant with Teflon®, or equivalent, to the threads of the switch. Install the switch assembly and tighten it to 50–60 lb ft (68–81 N·m) using installation wrench J 33410.



**Figure 3-5. Provision for Neutral Start Switch**

- If the Neutral Start Switch is not mounted at this location, plug the opening with a  $\frac{3}{4}$ -16 plug with its head seated on a rubber-coated washer.
- Apply a light coat of thread sealant onto the threads of the reverse signal switch. Install the switch into the  $\frac{1}{8}$  inch pipe-threaded opening near the nameplate, at the right side of the transmission. Tighten the switch to 4–5 lb ft (5–7 N·m). Connect the wire leads.



**NOTE:** An enhanced reverse pressure switch P/N 29503665 became available in November 1994. The improved switch is stamped with the 3-digit code 484. See SIL 7-TR-95.

### 3-9. CHECKING BREATHER

Ensure the breather is clean and free of obstructions. Also, the breather cap must be loose and free to rattle. Figure 3-6 shows the breather configurations.

- The earlier breathers should be equipped with a neoprene shroud (P/N 6883025). Later models have a breather with an integral shroud. If the breather shroud is damaged, install a new shroud.

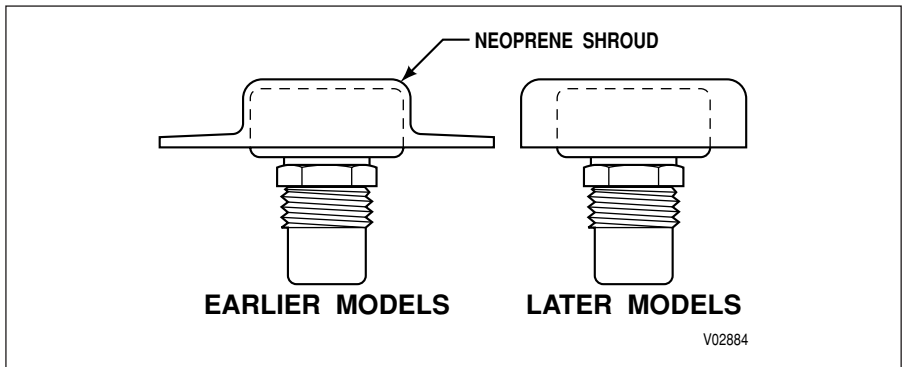
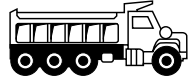


Figure 3-6. Breather Configurations

**SECTION  
IV**

**PREPARING VEHICLE  
FOR TRANSMISSION  
INSTALLATION**

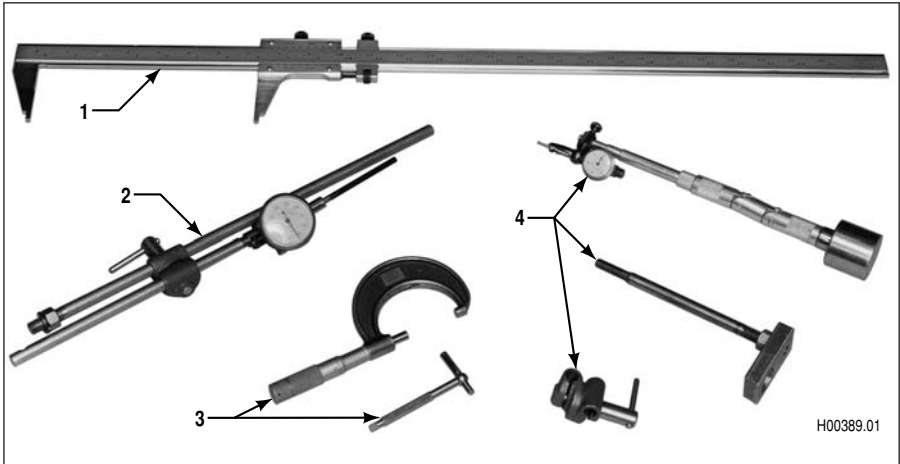


**4-1. CHECKING FLEXPLATE, ENGINE FEATURES**

Transmission performance may be adversely affected by improper tolerances existing between engine-to-transmission mating components. The drive connection between the engine and transmission converter must transmit engine power, properly locate and pilot the torque converter, and aid in controlling the forward thrust of the converter.

Vibration, converter section fluid leaks, a worn front bushing or bearing, and/or a worn engine crankshaft thrust bearing are frequently the result of exceeding recommended tolerances in engine-to-transmission mating components. When these conditions are encountered, certain important measurements should be investigated before installing a repaired or new transmission.

These measurements are summarized in Table 4-1. Figure 4-1 illustrates the tooling required for these measurements. Refer to SIL 60-TR-81 (latest revision).



**Figure 4-1. Tooling Used to Determine the Adaptation Measurements of an MT(B) 600 Series Transmission**

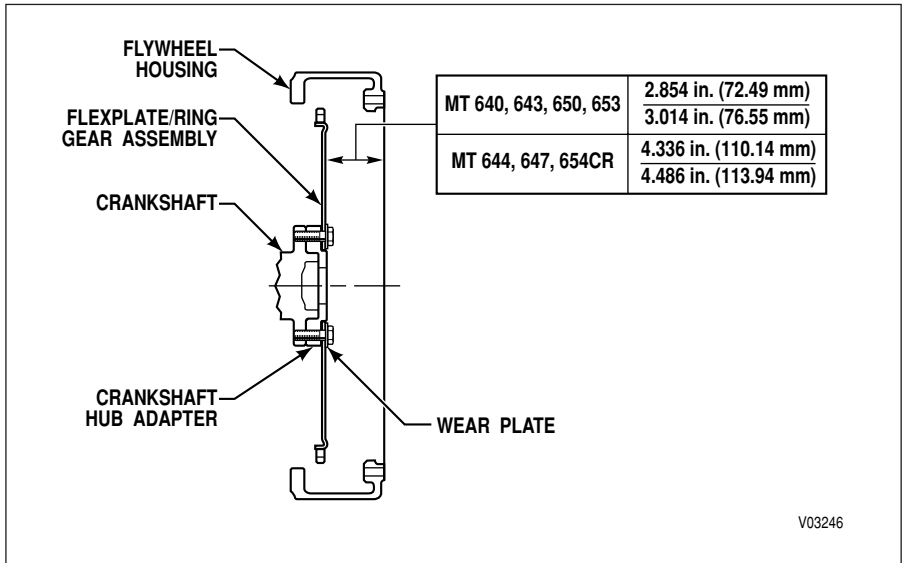
| Tool Description  | Kent-Moore No. |
|---|----------------|
| 1. 24 inch (610 mm) Vernier caliper*  | J 26900-25     |
| 2. 1.5-2 inch (38-50 mm) telescoping gauge  | J 26900-23     |
| 3. 1-2 inch (25-50 mm) outside and inside micrometers   | J 26900-2      |
| 4. Dial indicator and attachments (base and posts)  | J 5959-01      |
| NI. 0-6 inch (0-150 mm) depth micrometer set  | Not offered    |
| * The 24 inch caliper can also be used as a precision straight edge.<br>NI = Not illustrated. |                |

**Table 4–1. Measurements**

| <b>Component or Subassembly</b>     | <b>Required Inspections</b>  | <b>Limits</b>  |
|-------------------------------------|--|--|
| Flywheel Housing                    | Bore Diameter  | 17.625–17.630 in.<br>(447.68–447.81 mm)  |
|                                     | Bore Eccentricity*<br><br>MT(B) 640, 643, 650, 653 S/N 33458 and later or models updated with converter pump hub bushing P/N 6881926 or roller bearing P/N 7455739; all MT(B) 644, 647, 654CR<br><br>MT(B) 640, 643, 650, 653 prior to S/N 33458 | 0.020 in. (0.51 mm) T.I.R.<br><br><br><br><br><br><br><br>0.008 in. (0.20 mm) T.I.R. |
|                                     | Face Squareness*<br><br>MT(B) 640, 643, 650, 653 S/N 33458 and later or models updated with converter pump hub bushing P/N 6881926 or roller bearing P/N 7455739; all MT(B) 644, 647, 654CR<br><br>MT(B) 640, 643, 650, 653 prior to S/N 33458   | 0.020 in. (0.51 mm) T.I.R.<br><br><br><br><br><br><br><br>0.008 in. (0.20 mm) T.I.R. |
|                                     |  |  |
| * Limits are for installed engines. |  |  |

**Table 4–1. Measurements (Cont'd)**

| <b>Component or Subassembly</b>   | <b>Required Inspections</b>   | <b>Limits</b>   |
|---|---|---|
| Crankshaft Hub and/or Adapter   | Crankshaft Hub or Hub Adapter Pilot Diameter  | 1.703–1.705 in.<br>(43.26–43.31 mm)   |
|   | Converter Pilot Hub Diameter  | 1.699–1.702 in.<br>(43.16–43.23 mm)   |
|   | Face Squareness   | 0.0005 in. (0.013 mm) T.I.R.**  |
|   | Pilot Eccentricity†<br><br>MT(B) 640, 643, 650, 653 S/N 33458 and later or models updated with converter pump hub bushing P/N 6881926 or roller bearing P/N 7455739; all MT(B) 644, 647, 654CR<br><br>MT(B) 640, 643, 650, 653 prior to S/N 33458 | 0.010 in. (0.25 mm) T.I.R.<br><br><br><br><br><br><br><br>0.005 in. (0.13 mm) |
| Flexplate   | Check for Radial Cracks   | None permitted  |
|   | Check for Elongated Mounting Holes  | None permitted  |
|   | Check for Any Signs of Distress and/or Wear   | None permitted  |
| Mounted Flexplate (refer to Figure 4–2)   | Converter Axial Location  |   |
|   | MT(B) 640, 643, 650, 653 Series   | 2.854–3.014 in.<br>(72.49–76.56 mm)   |
|   | MT(B) 644, 647, 654CR Series  | 4.336–4.486 in.<br>(110.14–113.94 mm)   |
|   | Flatness  |   |
|   | Formed Plates ††  | 0.039 in. (0.99 mm)   |
|   | Flat Plates   | 0.157 in. (3.99 mm)   |
| <p>** T.I.R. per inch of diameter.<br/> † Eccentricity with respect to crankshaft center of rotation.<br/> †† A formed flexplate will not be flat, but may have raised areas at the bolt holes and/or have offset bends in the plate.</p> |   |   |



**Figure 4–2. Flexplate Location Dimensions**

## 4–2. CHECKING CHASSIS, DRIVELINE

Inspect the chassis and driveline and correct any faulty conditions.

- Broken or worn transmission mounts.
- Missing, cracked, or swollen isolators (rubber mounts).
- Improper or damaged bolts or other hardware.
- Permanent deformation of springs in rear transmission support.
- Damaged or worn cross-frame members.
- Lack of lubrication, excessive end play or wear, or deformation of driveline midship or hanger bearings.
- Inadequate freedom of movement, wear, excessive backlash, or lack of lubrication of driveline yoke slip joints.
- Inadequate freedom of movement, wear, lack of lubrication, or damaged needle bearings in universal joints.
- Nonconformance to manufacturer’s recommendations for driveline angles and universal joint phasing.
- Condition of alignment, flanges, yokes, backlash, fluid leaks, or torque tightness of mounting bolts for auxiliary transmission or transfer case mountings.

- Excessive backlash in vehicle differential ring gear and pinion (refer to the vehicle manufacturer’s specifications).
- Damaged condition or improper alignment of PTO-driven equipment, shafts, and couplings.

### 4-3. CHECKING COOLER, TUBES, HOSES, FITTINGS

Inspect chassis and transmission-related plumbing and correct any faulty conditions.

- Transmission hydraulic system cooler (heat exchanger) — clean and flush, or replace if cleaning and flushing are not satisfactory.
- Cooler connecting lines — clean and flush; inspect for deterioration, leaks, faulty connectors, kinks. Minimum tube size required for cooler circuit is 0.625 inch (15.9 mm) or No. 12 hose size. However, a larger hose may be required to meet flow and pressure drop requirements. Pay particular attention to any hose with a Teflon® liner for inner tube kinks or “bubbles.”
- If the hydraulic system has been contaminated with debris, install an auxiliary filter between the cooler and transmission (in cooler-return line). Refer to Paragraph 1-10 for filter recommendation and installation details.
- Vacuum or air modulator line and/or hose — inspect for deterioration, bad connections, loose or missing clamps, or improper routing that causes kinks.

### 4-4. CHECKING CONTROLS

Inspect transmission control components on vehicle and correct any faulty conditions.

- Shift selector control — inadequate freedom of movement, frayed or kinked cables, lack of lubrication, worn rod ends or clevis pins, damaged threads, or improper routing.
- Mechanical modulator control — inadequate freedom of movement, frayed or kinked cables, lack of lubrication, worn rod ends or clevis pins, damaged threads, or improper routing.
- Air modulator control — inadequate freedom of movement, incorrect pressure calibration (engine throttle must go to full throttle position when treadle is fully depressed), damaged hoses or fittings, or improper routing.



**NOTE:** Air pressure input required for pneumatic control is 55–65 psi (379–448 kPa).



- Parking brake control — cracks, bends, damaged threads, worn rod ends or clevis pins.
- PTO control — damage, wear, improper operation, lack of lubrication, or improper routing.
- Speedometer drive cable — wear, damage, kinks, lack of lubrication, improper routing, or incorrect drive torque.
- Wiring and related electrical components, sensors, and switches — poor connections, frayed wiring, or other damage.

## 4-5. MOUNTING ADAPTER OR SPACER

- When a mounting adapter (Figure 2-2) is used to adapt the transmission to an SAE 1 flywheel housing, install the adapter onto the engine. Retain it with the twelve SAE Grade 8 bolts and lockwashers supplied with the vehicle. Tighten the bolts to 54–65 lb ft (73–88 N·m).
- When a mounting spacer is used (Figure 2-2), install the spacer onto the engine. Retain with the two bolts and washers supplied with the vehicle.



**CAUTION:** Bolt heads must be below the rear surface of the spacer before installing the transmission.



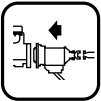
### 5-1. HANDLING



**CAUTION:** The transmission must be handled very carefully after the torque converter retaining strap is removed to avoid separating the torque converter from the transmission. Keep the transmission level or the rear slightly lower than the front at all times.

- Remove the torque converter retaining strap when the transmission is in position for installation.

### 5-2. COUPLING TO ENGINE



- Align the flexplate and torque converter so that the converter drive studs will enter the bolt holes in the flexplate (Figure 2-1), or so that the drive bolts can be installed (Figures 2-1 and 2-2).



**NOTE:** When the starter ring gear is separate from the flexplate (Figure 2-2), the ring gear must also be aligned.

- Lubricate the center pilot bore and converter nose pilot with molybdenum disulfide grease.
- Push the transmission toward the engine while guiding the pilot boss on the drive cover into the flexplate center bore and the drive studs into the flexplate outer holes.
- Engage the pilot diameter of the transmission housing into the flywheel housing bore. If interference is encountered, move the transmission away from the engine and investigate the cause.
- Install the SAE Grade 8 bolts that secure the transmission housing to the engine flywheel housing or adapter. Tighten the bolts to 36–43 lb ft (49–58 N·m)
- Install the six drive cover nuts (Figure 2-1) or drive bolts (Figures 2-1 or 2-2). Tighten each nut or bolt finger-tight.



**NOTE:** The drive cover nuts must be self-locking and capable of producing a tensile load of 8000 lbs (36 kN). A nut that meets these requirements is Allison P/N 23014107.

- Tighten the drive cover nuts to 34–40 lb ft (46–54 N·m).
- Tighten the drive cover bolts to 41–49 lb ft (56–66 N·m).
- Check crankshaft end play against engine manufacturer's specifications.

### 5-3. MOUNTING OUTPUT RETARDER

Transmissions with the integral output retarder require special attention when mounting. The additional weight of the retarder makes it necessary to support the transmission behind the engine using the rear support pads on the top of the retarder housing or the vertical pads on the rear face of the retarder case. The converter housing side-mount pads cannot be used with MTB 653 direct-mount units. Only remote-mount units and MTB 643 direct-mount units may be installed using the side-mount pad on the converter housing with a rear support.

### 5-4. INSTALLING TRANSMISSION MOUNTING COMPONENTS



**CAUTION:**

- Bolts must not penetrate the two rear holes of the converter side mounting pad more than 1.125 inch (28.6 mm). Tighten mounting pad bolts to 81–97 lb ft (110–132 N·m).
- Bolts must not penetrate the two front holes of the converter side mounting pad more than 1.25 inch (31.8 mm) to avoid interference with the converter. Tighten mounting pad bolts to 81–97 lb ft (110–132 N·m).

- Install all bolts, washers, cross-members, supports, and isolators required to support the transmission in the vehicle frame.

### 5-5. COUPLING TO DRIVELINE

- Couple the driveline companion flange or universal joint yoke to the transmission output flange or yoke.
- Use the bolts, nuts, and torque specified by the vehicle manufacturer.

### 5-6. CONNECTING COOLER, VACUUM LINES, AIR LINES

- Connect the lines from the transmission to the cooler forming a transmission fluid-to-water counterflow in the cooler. Vertical-mounted coolers require the transmission-to-cooler line to be connected to the bottom port in the cooler to avoid air-locking the cooler.

- Keep the cooler lines away from exhaust pipes and components that cause chafing. Avoid kinks and sharp bends. The fittings that thread into the transmission housing should be tightened to 25–34 lb ft (34–47 N·m).
- If a vacuum modulator is used, connect the vacuum modulator line at the intake manifold.
- If an air modulator is used, connect the air line from the junction of the accelerator-to-engine fuel control air line to the air modulator control. Keep the line away from exhaust pipes and components that cause chafing. Avoid kinks and sharp bends.

## 5-7. CONNECTING SHIFT SELECTOR CONTROL

- Place the operator's shift selector control at the **N** (Neutral) position. Place the selector lever (on the transmission) in the **N** (Neutral) position (Figure 5-1).
- Adjust the linkage so that it matches full movement of the selector lever on the transmission. Connect the linkage to the selector lever.
- Shift through and check all selector positions to ensure the valve body detent positions correspond to the respective selector positions and the selector lever is freely positioned by the transmission detent.

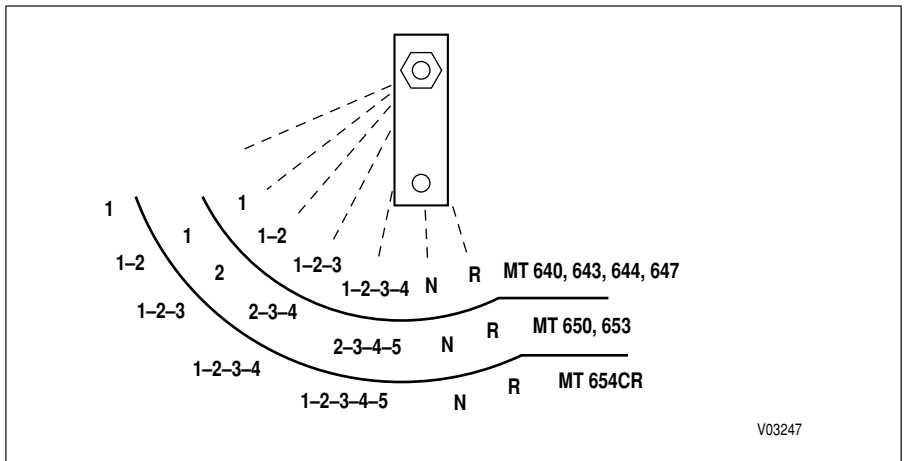


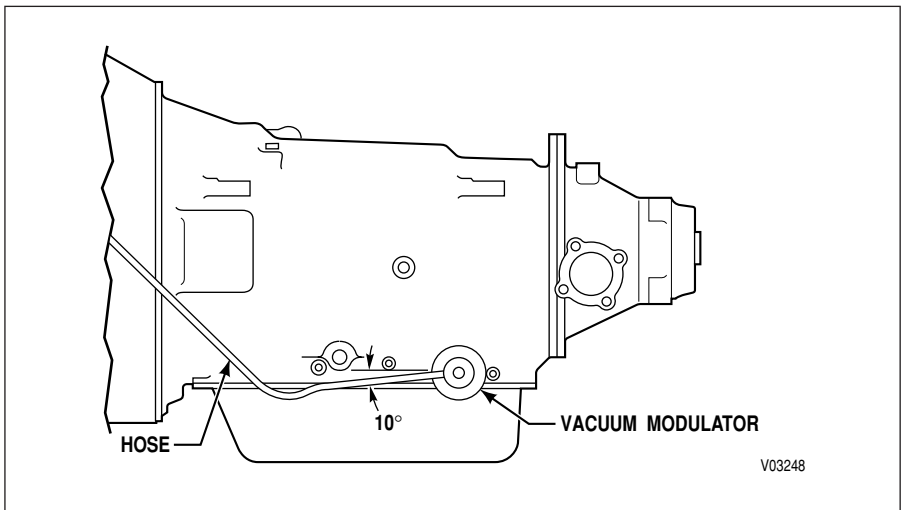
Figure 5-1. Shift Selector Positions

## 5-8. INSTALLING VACUUM OR AIR MODULATOR CONTROL



**NOTE:** There are 12V and 24V electric modulators available as of June, 1994. Refer to SIL 27-TR-94.

- Make sure the original sealing has been removed from the modulator can or from the counterbore of the transmission housing.
- Install the sealing onto the modulator. Coat the sealing with oil soluble grease.
- Install the modulator control into the transmission housing. Seat the sealing in the counterbore in the housing.
- Install the modulator retainer so that the convex side of the curved ends are toward the transmission. Secure the retainer with a  $\frac{5}{16}$ -18 x  $\frac{3}{4}$  inch bolt. (Earlier models use a  $\frac{5}{16}$ -18 x  $\frac{9}{16}$  inch bolt.) Tighten the bolt to 10–16 lb ft (14–22 N·m).
- Connect the vacuum or air line to the modulator. The tube connection at the vacuum modulator should face toward the engine. The routing should be approximately 10 degrees below horizontal and include a condensate trap (goose neck) as shown in Figure 5-2.



**Figure 5-2. Proper Relation of Vacuum Hose to Modulator Control**

## 5-9. INSTALLING, ADJUSTING MECHANICAL MODULATOR CONTROL



**NOTE:** There are 12V and 24V electric modulators available as of June, 1994. See SIL 27-TR-94.

- Connect the engine (throttle) end of the modulator cable housing to its mounting.
- Open the engine throttle fully and check whether the throttle linkage will push or pull the cable core when the throttle linkage is moving toward full throttle position. If it will push the cable core, then push the cable core until it reaches the end of its travel. If movement of the throttle linkage toward full throttle position will pull the cable, then pull the cable to the end of its travel.
- Adjust the clevis or rod end on the cable core until it registers with the hole in the throttle linkage lever and the connecting pin can be freely inserted. With the pin removed, rotate the clevis or rod end one additional turn counter-clockwise (viewing cable core from its end) for pull-type arrangement, or one additional turn clockwise for push-type arrangement. Install the clevis pin or rod end to connect the throttle linkage and cable. Tighten the lock nut against the clevis or rod end. This adjustment assures the ability to achieve full throttle on the engine without interference from the modulator control.
- Check the travel of the cable core when the throttle is moved from fully open to fully closed position. The system is designed to provide a travel of 1.187–1.560 inches (30.15–39.62 mm).
- The most common type of mechanical control is the cable-operated actuator with a lever to vary the force on the modulator valve. This type of control is convertible; either push or pull force can be used on the cable when the throttle is opened. Ensure the modulator control, when connected to the throttle linkage, provides an increasing force against the modulator actuator rod in the transmission when the engine throttle is moved toward the open throttle position.
- Later model actuators include a lever marked PUSH on one side and PULL on the opposite side. When the modulator control cover is removed, the word PUSH or PULL can be seen and indicates how the device is assembled.
- Conversion to the opposite mode of operation is only a matter of reassembling the internal parts. Reverse the positions of the lever, spring, and thimble to convert it.
- Be sure the modulator control action is as required.
- Install the O-ring seal onto the modulator control. Coat the O-ring with oil-soluble grease.

- Install the modulator control into the transmission. Install the control housing, and secure it with the retainer and the  $\frac{5}{16}$ -18 x  $\frac{3}{4}$  inch bolt provided. The convex side of the curved ends of the retainer must be toward the transmission end against the shoulder of the actuator stem. Tighten the bolt to 10–16 lb ft (14–22 N·m).
- Some mechanical controls include a support bracket, also secured by the retainer bolt.
- Check the cable routing. Bends must not be of less than 8 inches (20 cm) radius. The cable should not be nearer than 6 inches (15 cm) to the engine exhaust pipe or manifold. The cable must follow the movements of the throttle linkage; it may be necessary to add a spring to ensure the movement occurs smoothly.
- Adjust other types of mechanical controls as outlined in the vehicle manufacturer's instructions.

## **5-10. CONNECTING POWER TAKEOFF CONTROLS**

- If not previously installed, mount the PTO on the transmission. Refer to Paragraph 3–5 for instructions.
- Connect controls to the PTO. Check for proper operation of the controls.

## **5-11. CONNECTING PARKING BRAKE CONTROL**

- Install the bellcrank support bracket and cable support brackets onto the transmission housing. Tighten the bolts to 42–50 lb ft (57–68 N·m).
- Connect and properly adjust the parking brake linkage.
- Adjust the brake shoe-to-drum clearance as specified by the manufacturer.

## **5-12. CONNECTING SPEEDOMETER DRIVE**

- Install the speedometer driven gear assembly into the transmission. Tighten the body in the transmission rear cover to 45–50 lb ft (61–68 N·m). If no speedometer drive is provided, be sure a steel plug is installed to close the hole in the housing (torque is the same as for the driven gear body). Do not operate transmission with the plastic shipping plug in this hole.
- Install the speedometer drive cable onto the driven gear assembly. Tighten the cable nut to 50–55 lb in. (5.6–6.2 N·m). Avoid sharp bends in the cable. All bends must have a radius of at least 6 inches (152 mm) and no more than one 90 degree bend is allowed. The torque required to drive the cable and all associated equipment should not exceed 25 oz in. (0.17 N·m).

## **5-13. FILLING THE TRANSMISSION**

- Be sure the transmission hydraulic system is properly filled with fluid before starting the engine. Refer to Paragraph 1–4.

|   |                                 |                     |
|---|---------------------------------|---------------------|
|  | <h2>CHECKS AND ADJUSTMENTS</h2> | <h2>SECTION VI</h2> |
|---|---------------------------------|---------------------|

### 6-1. INSTALLATION CHECKLIST



- **PROPER TORQUE**

- Flexplate to drive cover bolts — 41–49 lb ft (56–66 N·m)
- Flexplate/adapter to drive cover nuts — 34–40 lb ft (46–54 N·m)
- Transmission-to-frame mounting bolts
  - Models without retarder — 164–192 lb ft (222–260 N·m)
  - Models with retarder — 67–81 lb ft (90–110 N·m)
- Converter side mount bolts — 81–97 lb ft (110–132 N·m)
- Output flange retaining bolt (MT 640, 643, 644, 647) — 102–121 lb ft (138–164 N·m)
- Output flange nut (MT 650, 653, 654CR) — 600–800 lb ft (813–1085 N·m)
- Companion flange or universal joints bolts\*
- Converter housing adapter to engine housing — 54–65 lb ft (73–88 N·m)
- Transmission housing to engine housing or adapter — 36–43 lb ft (49–58 N·m)
- Manual selector lever nut — 15–20 lb ft (20–27 N·m)
- PTO mounting bolts — 26–32 lb ft (35–43 N·m)
- Modulator control retaining bolt — 10–16 lb ft (14–22 N·m)
- Bellcrank and cable support brackets to transmission — 42–50 lb ft (57–68 N·m)
- Cooler lines to transmission — 25–34 lb ft (34–47 N·m)
- Temperature sensor plug or temperature sending unit — 16–20 lb ft (22–27 N·m)
- Fill tube fitting — 65–75 lb ft (88–102 N·m) or 90–100 lb ft (122–136 N·m) with 0.675 inch long oil pan boss

\* Tighten to vehicle manufacturer's specifications.



- **PROPER TORQUE (cont'd)**

- Drain plug — 15–20 lb ft (20–27 N·m)
- Speedometer driven gear assembly to rear cover — 45–50 lb ft (61–68 N·m)
- Neutral start switch to transmission housing — 50–60 lb ft (68–81 N·m)
- Reverse signal switch to transmission housing — 4–5 lb ft (5–7 N·m)

- **COOLER, AIR, AND VACUUM LINES**

- Check for leaks
- Check for tightness of connections
- Check routing

- **LINKAGE**

- Shift selector
  - Adjustment (at all positions)
  - Ease of movement
  - Neutral safety switch (start only in neutral)
  - Shift tower (for freedom of operation)
- Mechanical modulator control
  - Adjustment (proper shift points)
  - Ease of operation
  - Routing
- Parking brake
  - Adjust for proper clearance
  - Adjust for full apply
  - Check for full release

- **DRIVELINE**

- Check for proper indexing of universal joints
- Check for proper drive shaft angles
- Check driveline backlash
- Lubricate universals and slip-joints

- **HYDRAULIC SYSTEM**

- Recommended fluid (refer to Paragraph 1–4)
- Sufficient fluid in transmission
- Dipstick properly marked
- Fill cap tight
- Fill tube tight at pan
- Vent hole in fill tube
- Breather clean, free of restriction
- Filter differential pressure switch and alarm circuit

- **POWER TAKEOFF**

- Backlash properly established
- Controls connected and operative
- Properly coupled to driven equipment
- Lubrication line properly routed and connected

- **INSTRUMENTS, ELECTRIC COMPONENTS**

- Speedometer
- Oil temperature gauge
- Wiring and electrical connections, especially retarder or electric modulator
- Check neutral start switch

- **MOUNTING**

- No interference between engine/transmission components and frame on acceleration
- Rubber mounts free and in good condition
- Tail support preload correct
- Engine/transmission properly aligned
- Linkages and hoses do not restrain engine “roll” on acceleration

## 6-2. ROAD TEST AND VEHICLE OPERATION CHECKLIST



- **NEUTRAL START**

- Check the position of the operator's selector lever in each drive range and N (Neutral). The lever should align with the mark indicating a range (or N (Neutral)) when the transmission is in that range (or N (Neutral)).
- Check the neutral safety switch by trying to actuate the starter in every selector position. The starter should operate only when the selector lever is in N (Neutral) position.

- **INSTRUMENTS**

- Check the instruments associated with the transmission. These include the speedometer and the transmission fluid temperature gauge.

- **PARKING BRAKE**

- Check application and release of the parking brake. (Retarder models do not use a transmission-mounted parking brake.)
- Ensure the brake is not dragging or heating up while released.
- Ensure the brake is fully applied before the lever reaches full travel.

- **POWER TAKEOFF (PTO)**

- Check operation of the PTO. Refer to the Operator's Manual (OM1334EN) for general operating instructions, or to the vehicle manufacturer's specific instructions.

- **NO-LOAD GOVERNED SPEED**

- Check the no-load governed speed of the engine.
- Adjust the governor, if necessary, to meet the no-load governed speed specified for your particular engine-transmission match (available from the vehicle manufacturer).

• **SHIFT SEQUENCE**

- Check the full-load governed speed of the engine. Subtract 200 rpm from this speed and record the remainder as the desired speed for all automatic upshifts, except the 1–2 shift for the MT 640, 643, or 654CR and the 2–3 shift for the MT 650, 653. The latter two shifts should occur at full-load governed speed less 600 rpm. The 1–2 shift in MT 650, 653 models is a manual shift and not subject to adjustment.
- Drive the vehicle and check the wide-open throttle upshift points. If adjustment of the shift points is required, refer to the applicable MT Service Manual.

• **RETARDER**

- Check that the retarder responds correctly.
- Check that the retarder enable switch turns off the retarder.
- Check that retarder only applies at closed throttle.
- Check that the retarder temperature indicator increases rapidly when the retarder is applied.
- Check that the brake lights come on when the retarder is applied.

• **TRANSMISSION FLUID**

- Fluid level meets specification (transmission in **N** (Neutral)).
- Check for leaks.
- Warm up transmission and perform a fluid level “hot” check (transmission in **N** (Neutral) and vehicle on a level surface).

• **OTHER CHECKS**

- Stall check
- Shift quality
- Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SECTION  
VII**

**CUSTOMER  
SERVICE**



## **7-1. OWNER ASSISTANCE**

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

As an owner of an Allison transmission, you have 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 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.)

Reference the Sales and Service Directory (SA2229EN) for the current listing of Allison Transmission authorized distributors and service dealers.

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 equipped with electronic controls, also provide the ECU assembly number)
- 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:**

Manager Warranty Administration — PF9, Allison Transmission  
P.O. Box 894, Indianapolis, Indiana 46206-0894  
Phone: (317) 242-2052

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.

## 7-2. SERVICE LITERATURE



Additional service literature is available. This service literature provides fully illustrated instructions for the operation, maintenance, service, overhaul, and parts support of your transmission. To ensure that you get maximum performance and service life from your unit, see your dealer or distributor for the following publications. Check the telephone directory for the Allison Transmission service outlet nearest you.

**Table 7-1. Service Literature**

| <b>Literature Title</b>  | <b>MT(B) 640, 643,<br/>650, 653DR</b> | <b>MT(B) 644, 647,<br/>654CR</b> |
|--|---------------------------------------|----------------------------------|
| Service Manual   | SM1317EN                              | SM1546EN                         |
| Parts Catalog  | PC1316EN                              | PC1551EN                         |
| Operator's Manual  | OM1334EN*                             | OM1334EN*                        |
| Troubleshooting Manual   | TS1838EN                              | TS1838EN                         |
| Automatic Transmission Fluid<br>Technician's Guide   | GN2055EN                              | GN2055EN                         |
| Output Retarder Inspection/<br>Analysis  | GN2009EN                              | GN2009EN                         |
| * Also Available On The Internet At <a href="http://www.allisontransmission.com">www.allisontransmission.com</a> |                                       |                                  |

