

Manual Transmission

The S6-650 ZF transmission is a six-speed synchronized unit. The ZF six speed has the following features:

- An integral clutch housing
- An aluminum main case, extension housing, and intermediate housing
- The mainshaft has two tapered roller bearings. Mainshaft end play is controlled by a selective shim located under the bearing cup
- The countershaft has two tapered roller bearings. The countershaft end play is controlled by a selective shim located under the bearing cup
- The countershaft is serviced as an assembly
- Synchronized in all gears
- All gears are helical
- All gears, including reverse, turn on needle roller bearings
- Single-piece shift forks with moly coated pads
- Internal oil pump, driven by the countershaft, to supply transmission fluid to an external cooler
- Provisions for mounting a power take-off unit
- A reverse idler gear that does not need to be removed during disassembly
- The mainshaft and countershaft are assembled under preload. If the ZF transmission is disassembled, a preload measurement must be taken

The S6-650 ZF has six forward speeds that feature a LOW gear for take-off under heavy loads and a OVERDRIVE gear for highway driving conditions. The gear ratios are as follows:

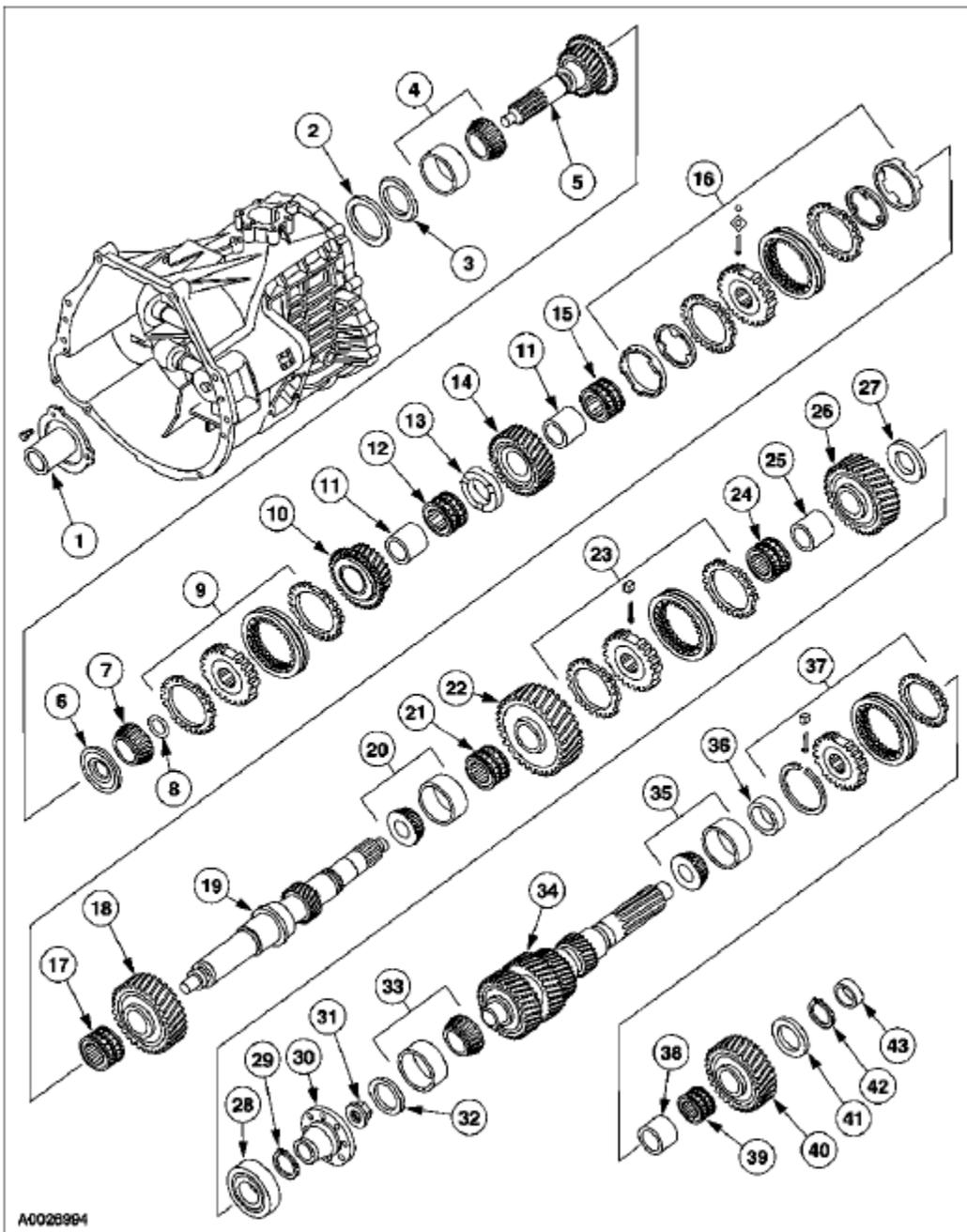
- Low 5.79:1
- First 3.30:1
- Second 2.10:1
- Third 1.31:1
- Fourth 1.00:1
- Overdrive 0.72:1
- Reverse 5.23:1

Transmission Identification

All ZF transmissions are identified by the model and serial number. This information is on the transmission identification tag and affixed to the transmission case. Do not remove or destroy the transmission identification tag.

- "S" means a synchronized transmission.
- "6" is the number of gears.
- 650 Nm (530 lb-ft) is the maximum input torque capacity.

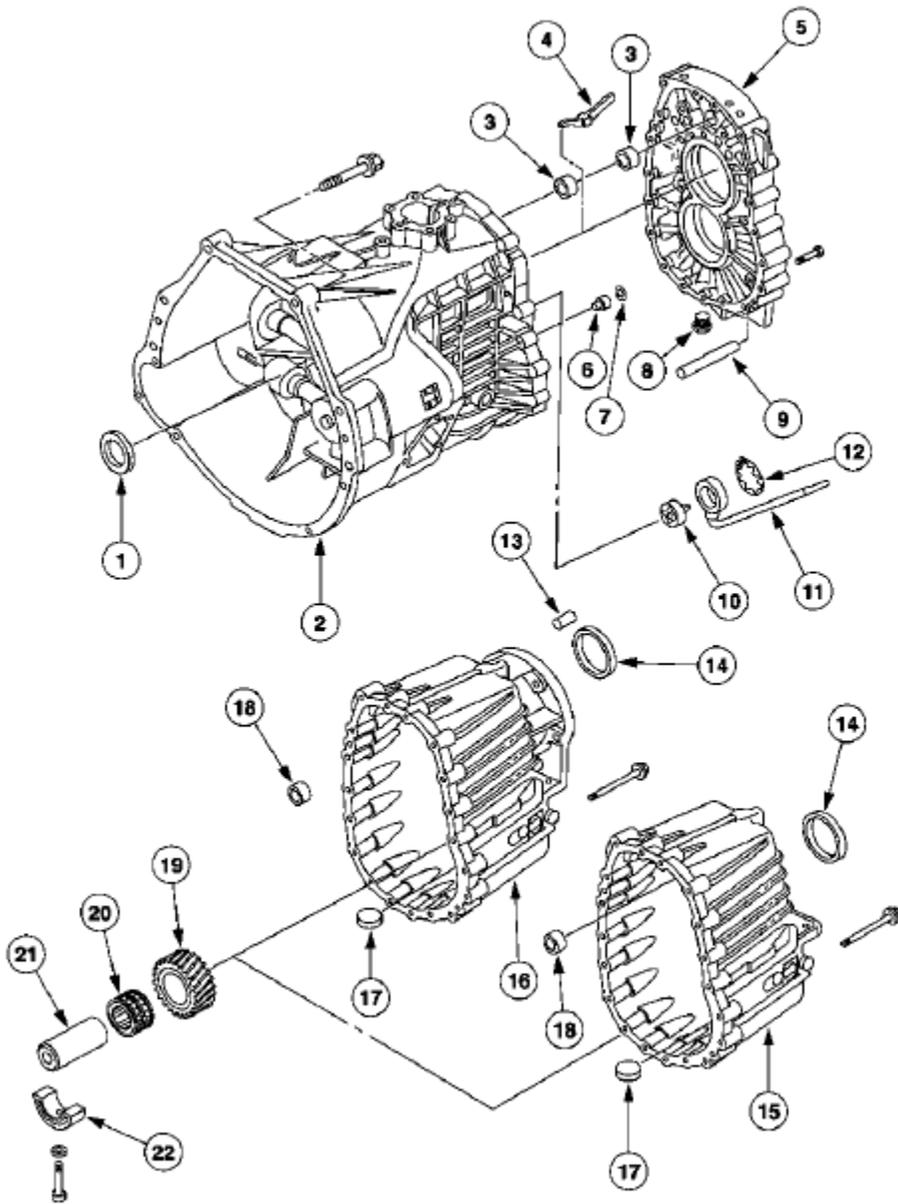
Transmission Internal Components—Disassembled View



Item	Part Number	Description
1	7050	Guide tube
2	7029	Input shaft shim (selective fit)
3	7046	Input shaft oil dam bearing ring
4	7025	Input shaft bearing and bearing cup
5	7017	Input shaft
6	7046	Input shaft rear oil dam
7	7120	Input shaft pocket bearing
8	7B331	Snap ring kit
9	7124	Synchronizer assembly, third and fourth gear
10	7196	Mainshaft third gear
11	7N318	Mainshaft second and third gear bushing
12	7K169	Mainshaft needle bearing
13	7056	Mainshaft second gear thrust ring

14	7103	Mainshaft second gear
15	7K169	Mainshaft needle bearing
16	7124	Synchronizer assembly, first and second gear
17	7K169	Mainshaft needle bearing
18	7100	Mainshaft first gear
19	7061	Mainshaft
20	7N430	Mainshaft middle bearing and bearing cup
21	7K322	Mainshaft needle bearing
22	7Z451	Mainshaft low gear
23	7124	Synchronizer assembly, low and reverse gear
24	7K322	Mainshaft reverse and low gear bearing
25	7D305	Mainshaft reverse gear bushing
26	7142	Mainshaft reverse gear
27	7E254	Output bearing thrust washer
28	7R205	Mainshaft rear bearing
29	7B331	Snap ring kit
30	7089	Transmission flange (4x2 vehicles)
31	7045	Transmission flange lock nut (4x2 vehicles)
32	7029	Countershaft shim (selective fit)
33	7065	Countershaft front bearing and bearing cup
34	7113	Countershaft
35	7065	Countershaft middle bearing and bearing cup
36	7115	Countershaft rear bearing spacer
37	7124	Synchronizer assembly, countershaft fifth gear
38	7069	Countershaft bushing
39	7K335	Countershaft needle bearing
40	7158	Countershaft fifth gear
41	7A385	Countershaft rear thrust washer
42	7B331	Snap ring kit
43	7065	Countershaft rear bearing

Transmission Internal Components—Disassembled View

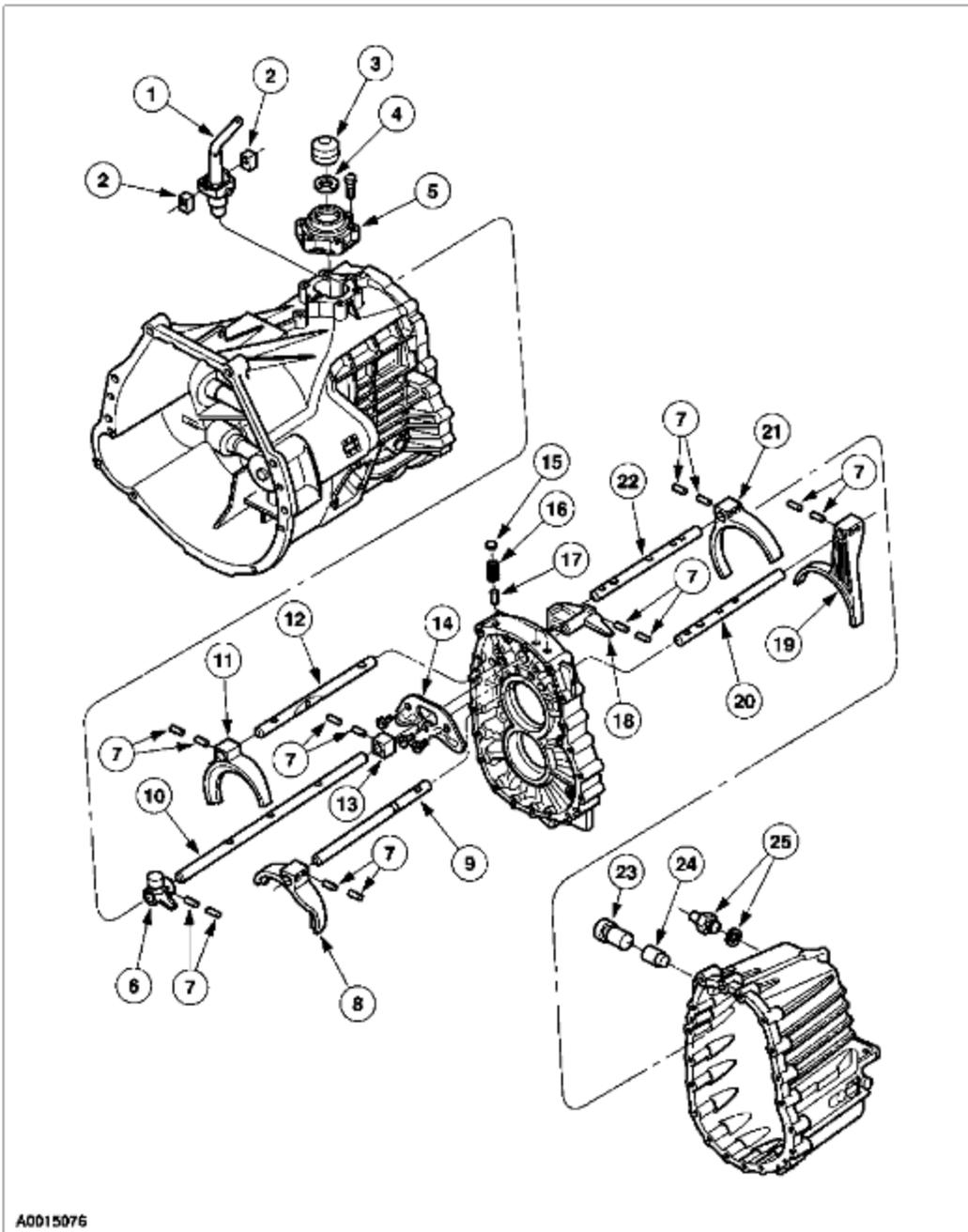


A0026995

Item	Part Number	Description
1	7052	Input oil seal
2	7005	Main case
3	7D362	Shift rail bearing
4	7005	Oil trough
5	7006	Middle case
6	7E213	Check valve
7	7917	Check valve snap ring
8	7A010	Drain plug
9	7B362	Dowel pin
10	7A103	Oil pump body
11	7B150	Oil pump housing
12	7R194	Oil pump snap ring
13	7B362	Dowel pin

14	7052	Output seal
15	7A039	Extension housing (4x2 vehicles)
16	7A039	Extension housing (4x4 vehicles)
17	7E290	Magnet
18	7D362	Shift rail bearing
19	7141	Reverse idler gear
20	7E139	Reverse idler bearing
21	7140	Reverse idler shaft
22	7723	Reverse idler shaft support

Transmission Shift Components — Disassembled View



A0015076

Item	Part Number	Description
1	7210	Shift lever (lower)
2	7C371	Shift lever blocks

3	7277	Shift lever boot
4	7D152	Inner shift lever boot ring
5	7203	Shift housing
6	7811	Shift finger
7	7B096	Roll pin (double)
8	7289	Shift fork (first and second)
9	7240	Shift rail
10	7R359	Main shift rail
11	7289	Shift fork (third and fourth)
12	7C113	Shift rail
13	7229	Shift position block
14	7K201	Shift interlock plate
15	7L013	Detent plugs
16	7N120	Detent springs
17	7247	Shift rail detents
18	7243	Main shift rail driver
19	7H419	Shift fork (fifth)
20	7682	Shift rail
21	7244	Shift fork (low and reverse)
22	7H418	Shift rail
23	7Z415	Main shift detent
24	7E218	Detent plunger
25	15520	Reverse lamp switch

Lubrication

 **CAUTION: Additives and friction modifiers are not recommended for use in ZF transmissions.**

ZF transmissions are designed so that the internal parts operate in an oil bath circulated by the motion of the gears and shafts. All parts are amply lubricated if these procedures are followed:

- Maintain the correct fluid level by inspecting it regularly.
- Change the fluid regularly. Refer to the Owners Literature for the recommended intervals.
- Use MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.

High operating temperatures increase the lubricant's rate of oxidation and shorten its effective life. When the average operating temperature is high, the transmission may require more frequent fluid changes or external cooling. External oil coolers are used to reduce high operating temperatures. The following conditions in any combination can cause high operating temperatures:

- Operating consistently at slow speeds.
 - High ambient temperatures.
 - Restricted air flow around the transmission.
 - Exhaust system too close to the transmission.
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General Specifications

Item	Specifications
Transmission w/o oil cooler fluid capacity	5.5 L (5.81 qts)
Transmission oil cooler fluid capacity	0.5 L (0.53 qts)
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (Type II)
Threadlock 262 E2FZ-19544-B	WSK-M2G351-A6
Silicone Lubricant F7AZ-19G208-BA	ESR-M13P4-A
Gasket and Trim Adhesive F3AZ-19B508-AA	—
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Mainshaft and countershaft preload	0.02-0.09 mm (0.00079-0.0035 in)
First and second synchronizer with new gear and synchronizer ring clearance	1.5-1.85 mm (0.059-0.073 in)
Third, fourth, fifth, reverse and low with new gear and synchronizer ring clearance	1.4-1.7 mm (0.055-0.066 in)
First and second service limit	1.0 mm (0.04 in)
Third, fourth, fifth, reverse and low service limit	1.0 mm (0.04 in)

Mounting Temperatures

Description	Temperature
Taper roller bearing inner race	150°C (300°F)
Synchronizer assemblies	150°C (300°F)
Thrust washers	150°C (300°F)
Shaft bushings	150°C (300°F)
Top roller bearing outer race	150°C (300°F)
Output ball bearing	150°C (300°F)

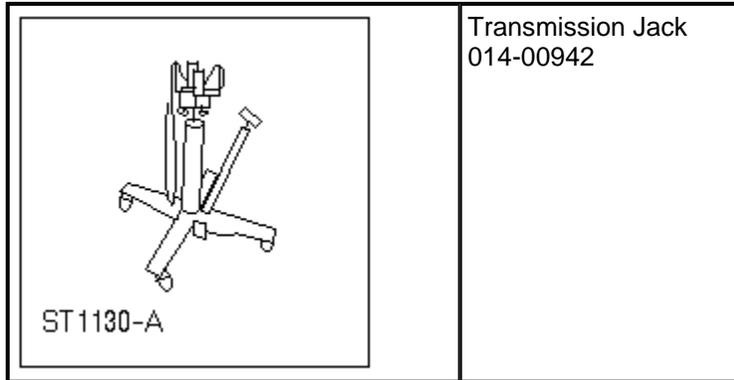
Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Transmission output flange lock nut	330	244	—
Shift housing-to-case bolts	23	17	—
PTO cover plate bolts	38	28	—
Idler shaft retention bolt	23	17	—
Shift plate interlock plate bolts	10	—	89
Detent plunger assembly	65	48	—
Engine plate-to-transmission bolts	28	21	—
Backup lamp switch	20	15	—
Upper gearshift lever bolts	28	21	—
Guide tube bolts	23	17	—

Transmission-to-engine bolts	63	46	—
Intermediate housing-to-case bolts	23	17	
Extension housing-to-case bolts	23	17	—
Fill plug	35	26	—
Drain plug	35	26	—
Transmission fluid cooler tubes	27	20	—
Transmission support crossmember bolts	70	52	—
Transmission mount nuts	81	60	—
Driveshaft-to-transmission flange bolts	102	75	—

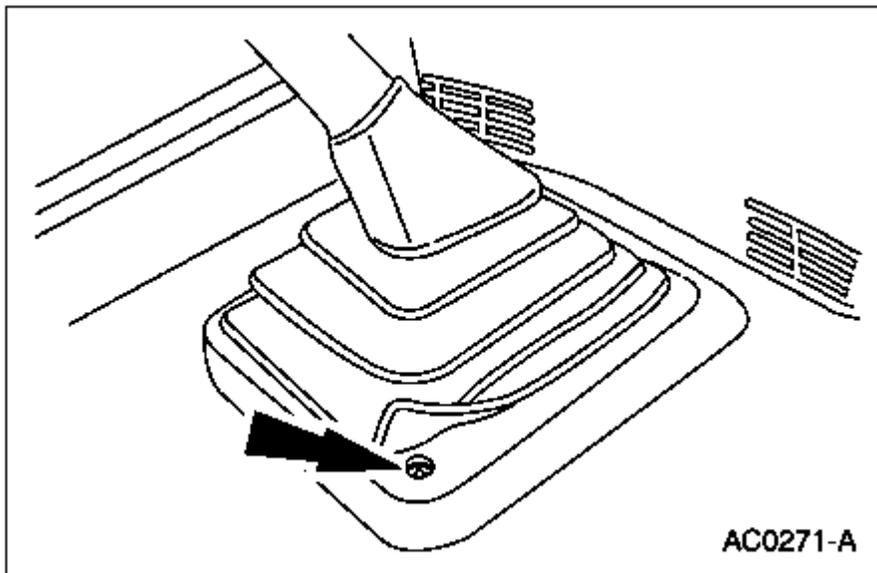
Transmission

Special Tool(s)

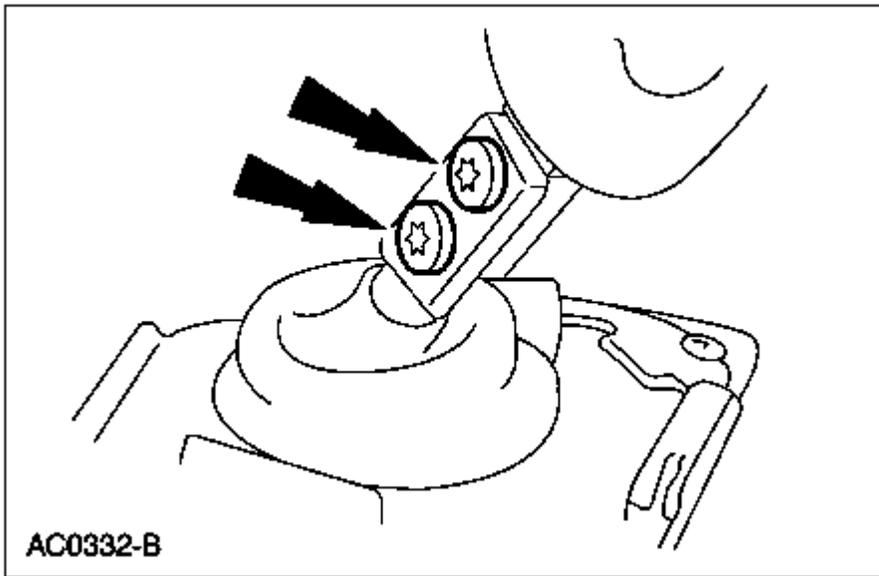


All vehicles

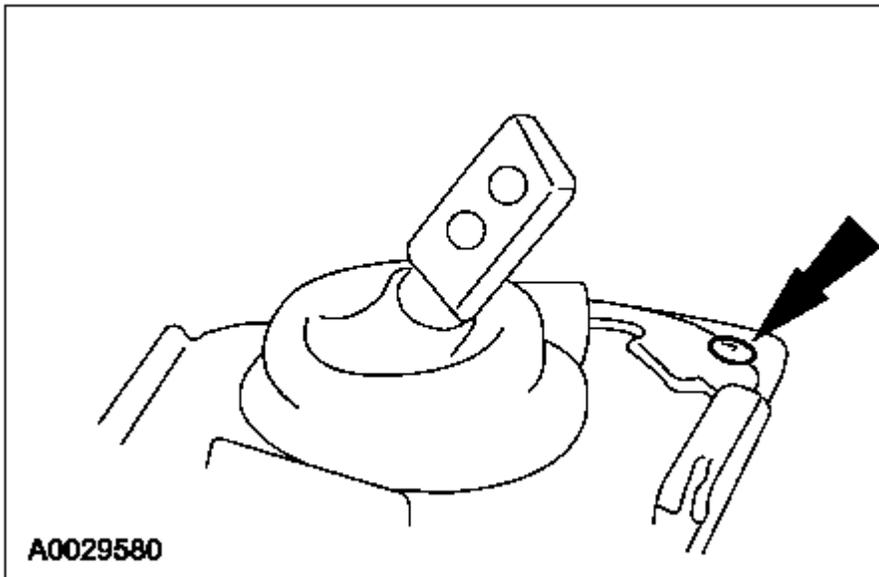
1. Remove the four screws and the outer shift lever boot.



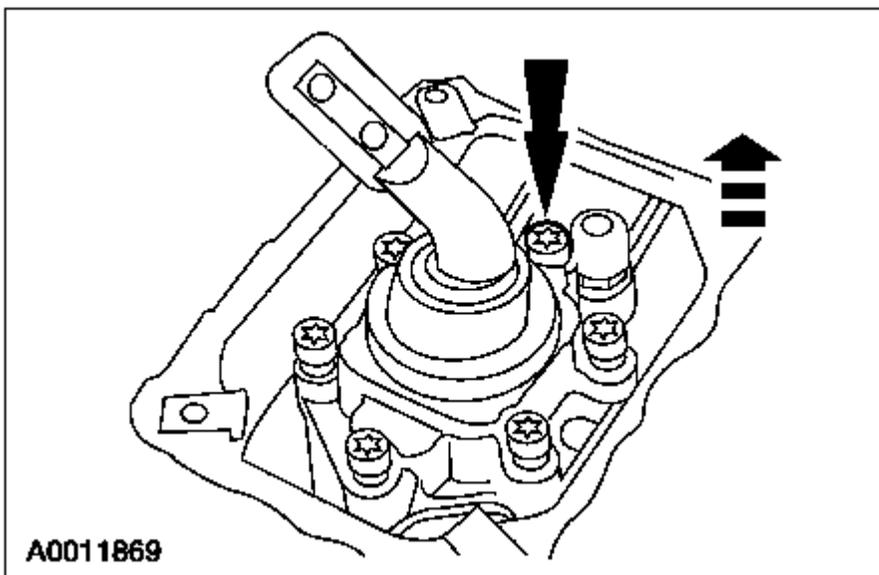
2. Remove the upper gearshift lever.



3. Remove the lower shift lever boot.

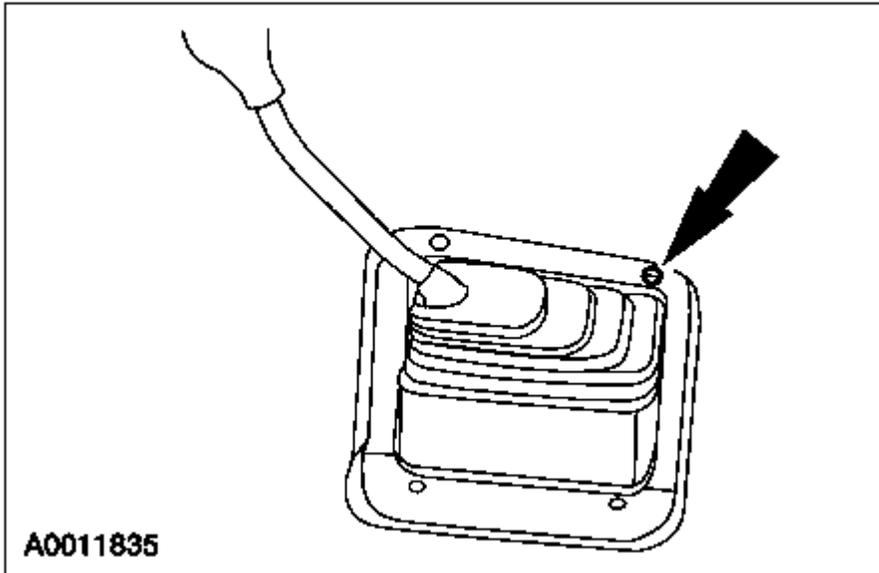


4. Remove the lower gearshift and shift housing.

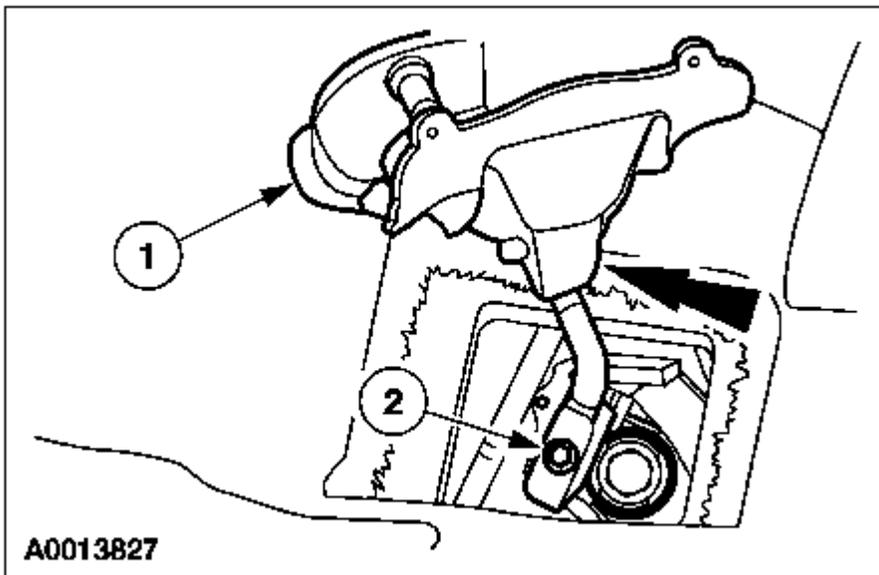


Vehicles with a manual shift lever

5. Shift the transfer case into 4H.
6. Remove the screws that attach the bezel and boot assembly to the floor.



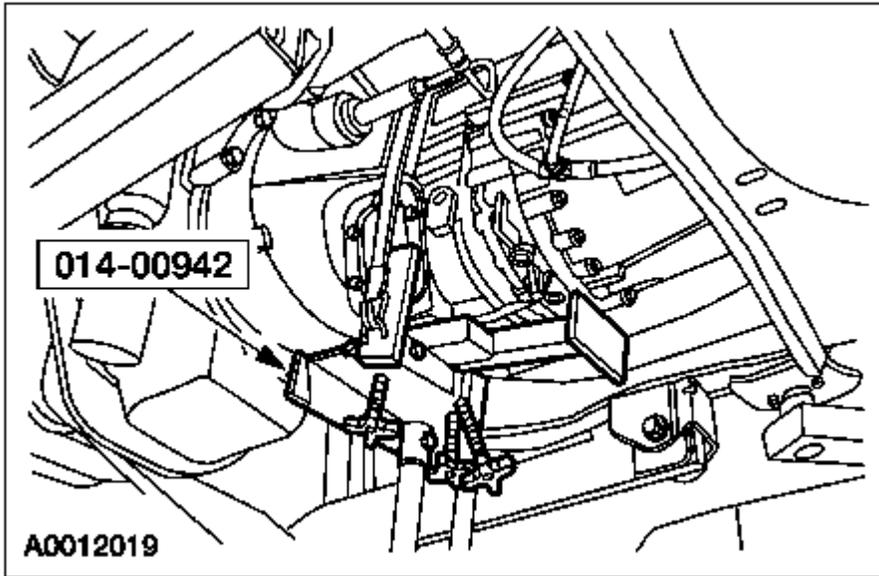
7. Remove the bolt that attaches the shift lever to the transfer case control lever assembly, and remove the shift lever, and the bezel and boot assembly.
 1. Slide the bezel and boot assembly upward on the shift lever.
 2. Remove the bolt, the shift lever, and the bezel and boot assembly.



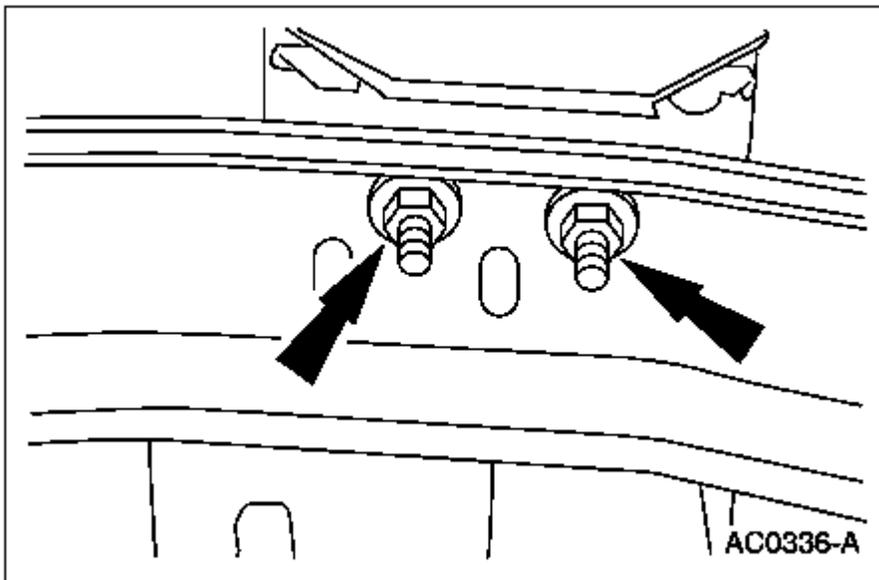
All vehicles

8. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
9. If the transmission is being disassembled, drain the transmission fluid.
10. Remove the starter. For additional information, refer to [Section 303-06B](#).
11. Disconnect the rear driveshaft and position it aside. For additional information, refer to [Section 205-01](#).
12. Remove the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).

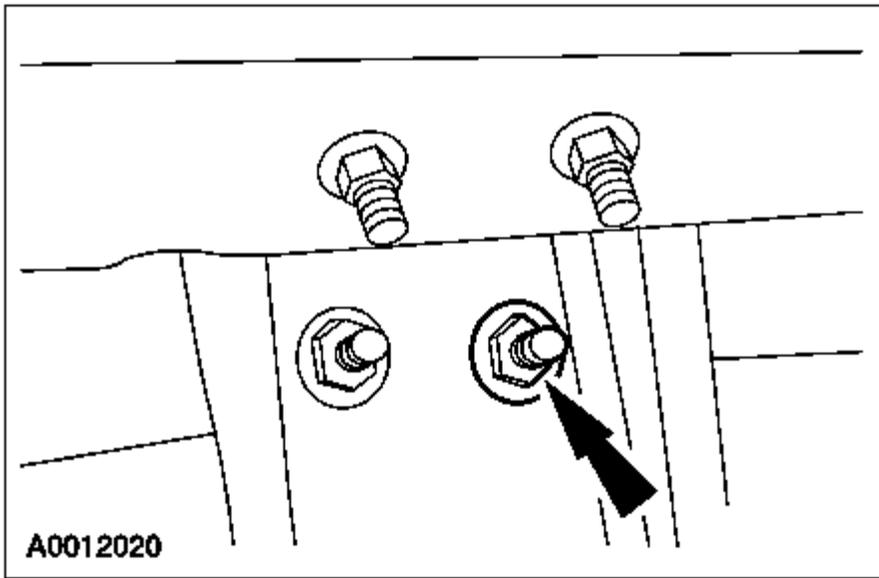
13. Remove any power take-off (PTO) equipment, if equipped.
14. Using the special tool, support the transmission.
 - Securely strap the jack to the transmission.



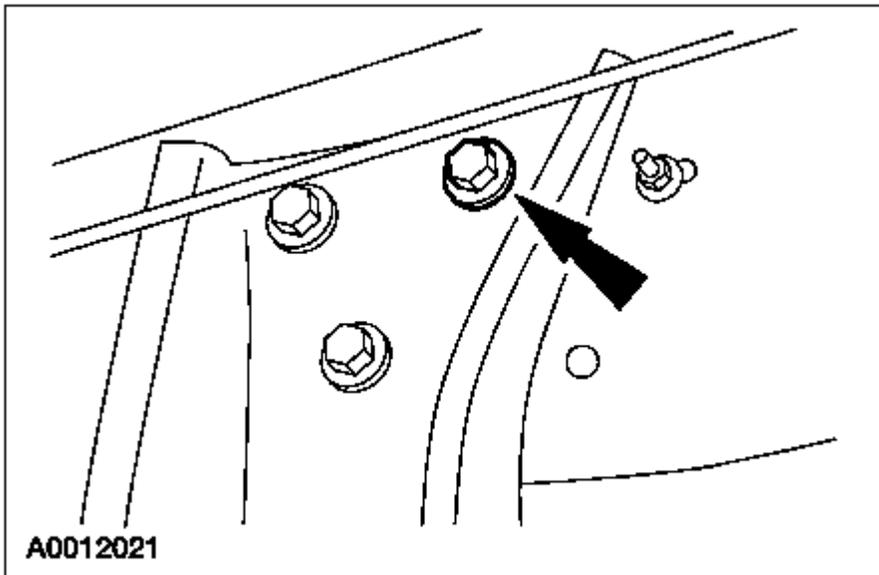
15. Remove the transmission mount nuts.



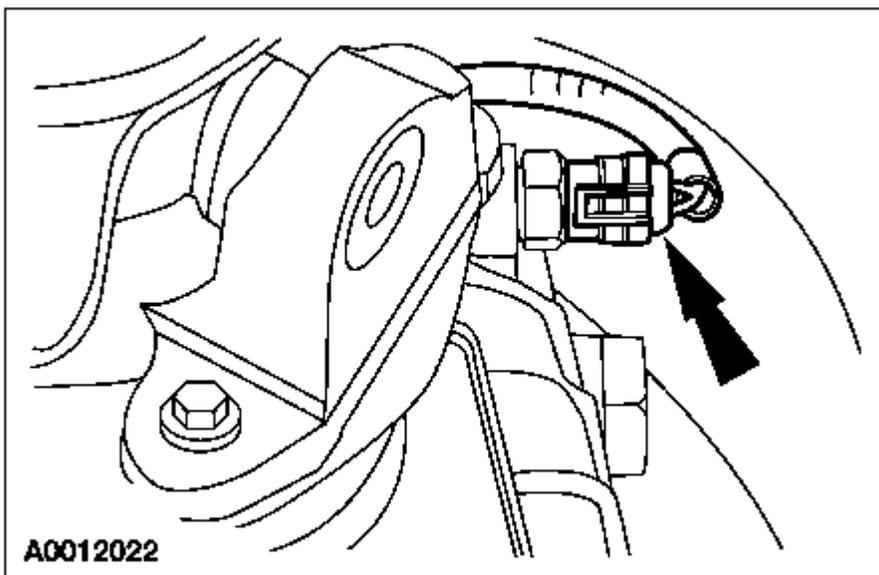
16. Remove the RH crossmember nuts.



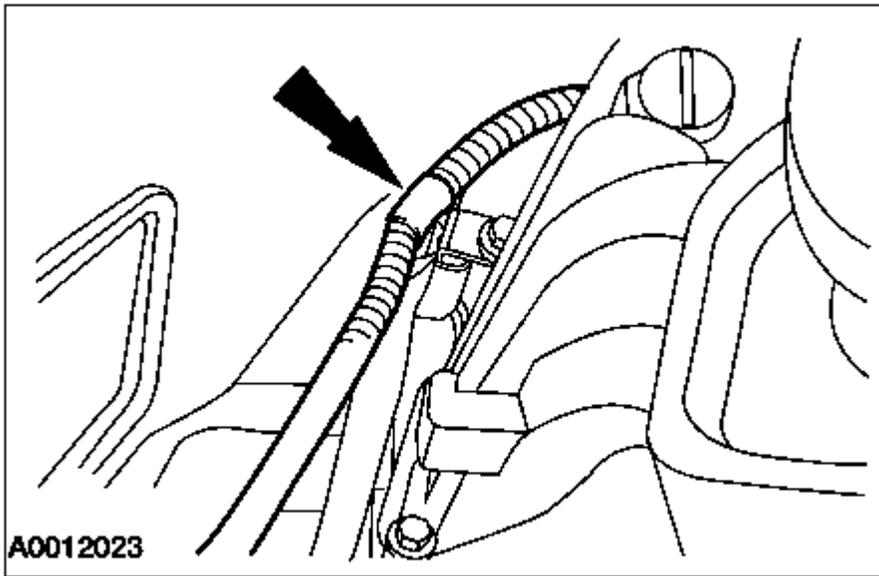
17. Remove the LH crossmember bolts.



18. Disconnect the reverse lamp switch electrical connector.

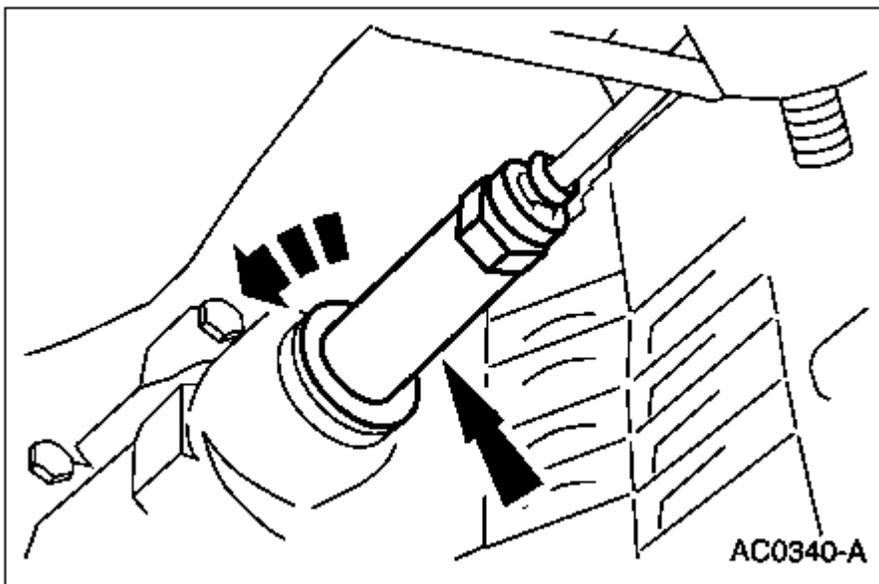


19. Disconnect wiring harness from the transmission.

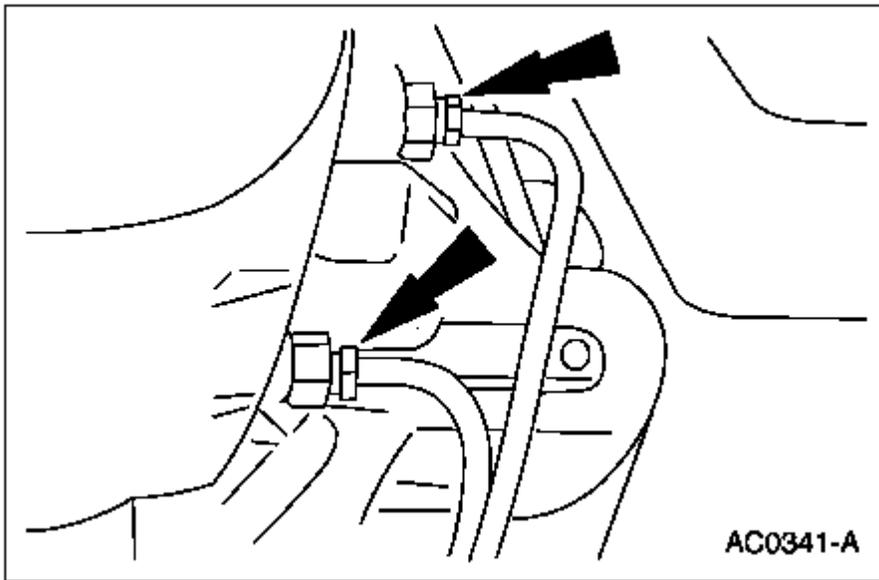


20. Remove the clutch slave cylinder and position it aside.

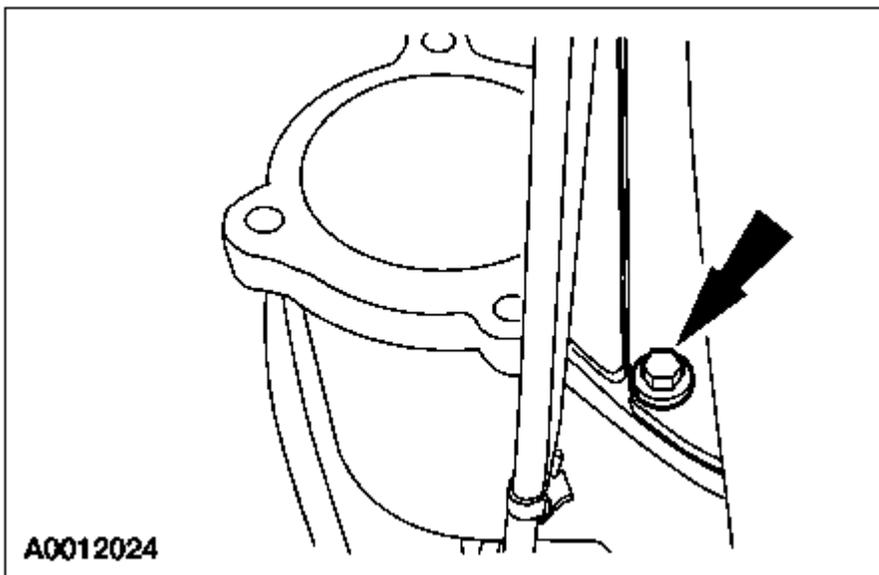
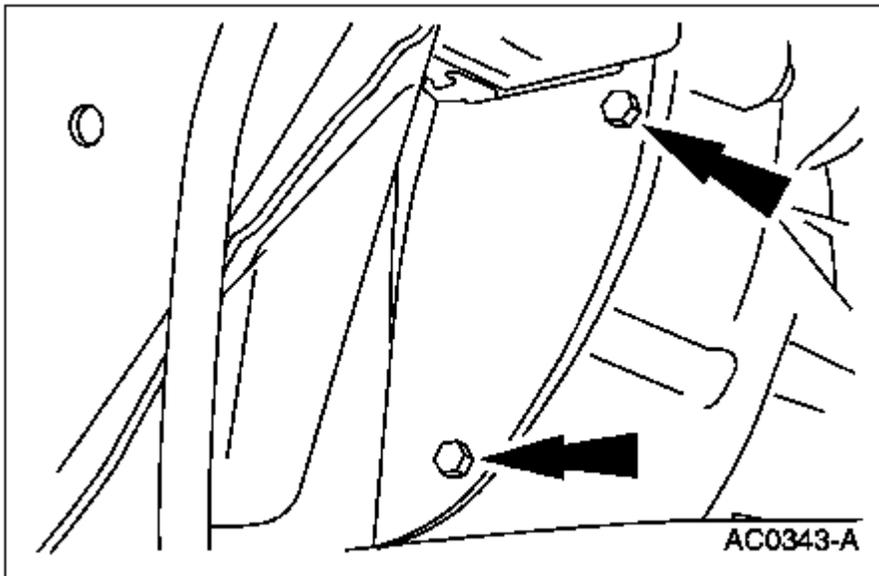
- Push the clutch slave cylinder inward, then rotate counterclockwise 45 degrees to remove.



21. Disconnect the transmission cooling tubes.

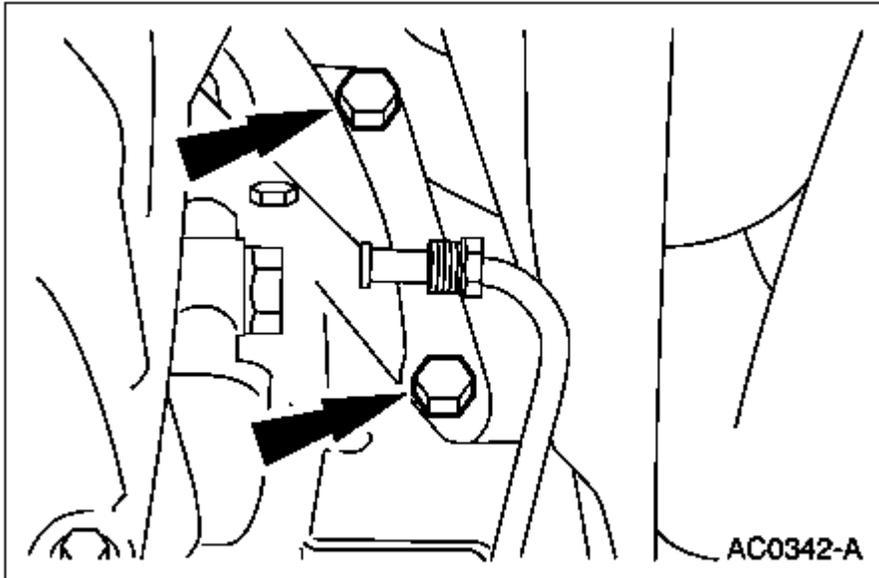


22. Remove the dust cover bolts.



23. Remove the transmission-to-engine bolts.

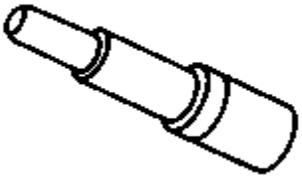
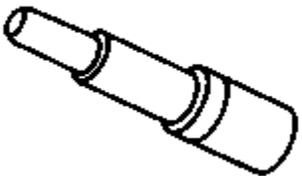
- For vehicles equipped with diesel engines, remove six bolts.
- For vehicles equipped with gasoline engines, remove seven bolts.



24. Remove the transmission.
- Move the transmission rearward until the input shaft is clear of the clutch, then lower from the vehicle.
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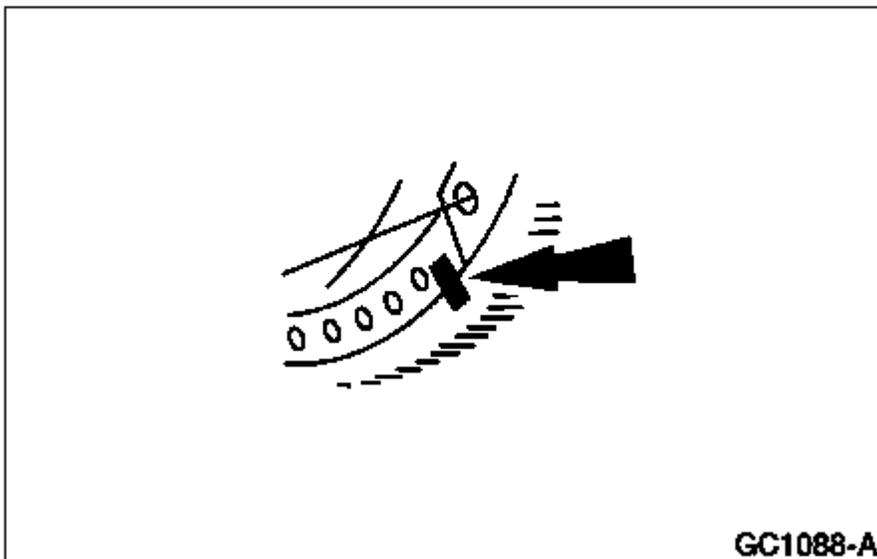
Clutch Disc And Pressure Plate

Special Tool(s)

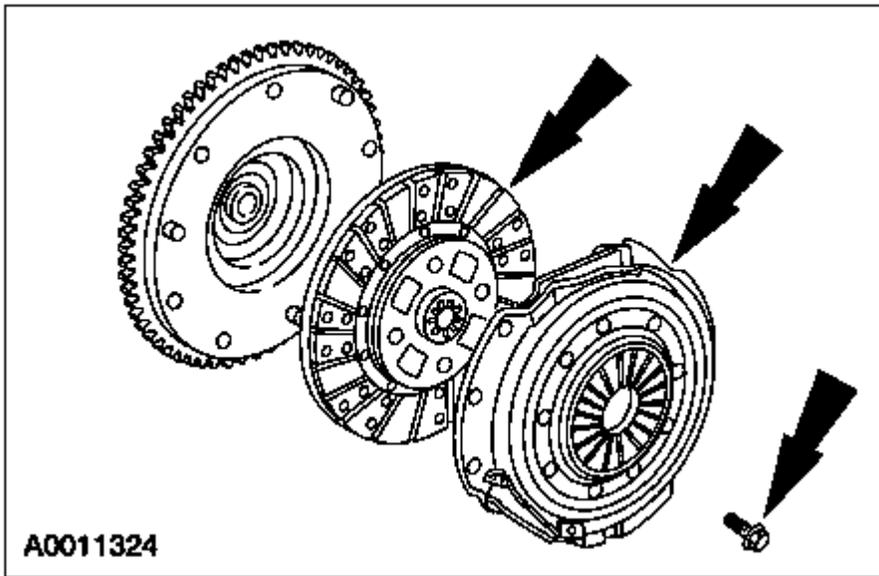
 <p>ST1469-A</p>	Clutch Aligner (5-Speed) 308-090 (T83T-7137-A)
 <p>ST1469-A</p>	Clutch Aligner (6-Speed) 308-421

Removal

1. Remove the transmission. For additional information, refer to [Section 308-03](#).
2. Index-mark the clutch pressure plate (7563) and the flywheel (6375), if reinstalling these parts.



3. Remove the bolts, the clutch pressure plate, and the clutch disc (7550).



4. Inspect the transmission input shaft pilot bearing (7120):
 - for misalignment and looseness in the crankshaft (gasoline engine) or flywheel (diesel engine).
 - needle rollers for scoring, discoloration, wear, and broken rollers.
 - seal for damage and lubricant leakage.
 - Install a new transmission input shaft pilot bearing if any of these conditions are present. For additional information, refer to [Pilot Bearing](#) in this section.

Installation

1.  **CAUTION:** Sometimes, when removing the transmission, the input shaft will remove a considerable amount of lubricant from the transmission input shaft pilot bearing.

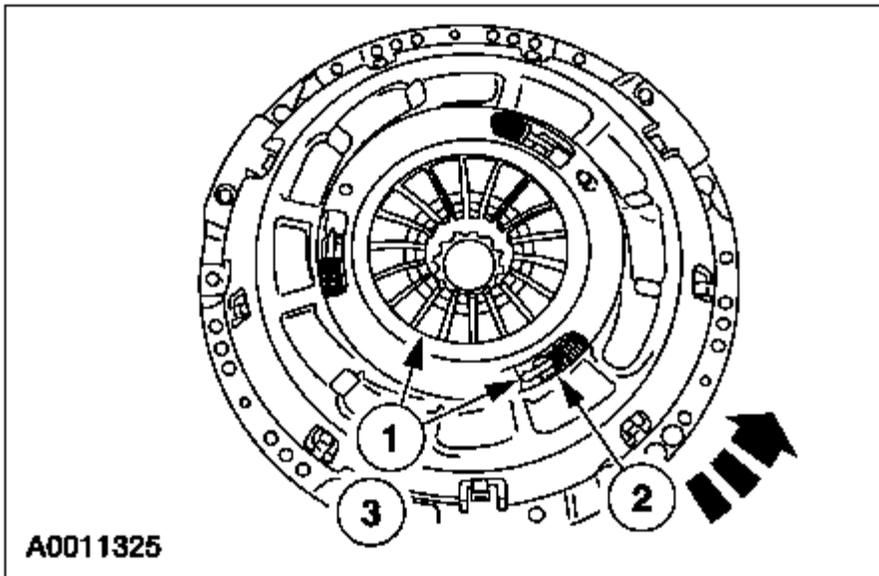
Lubricate the transmission input shaft pilot bearing, as necessary.

- Use High-Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A.

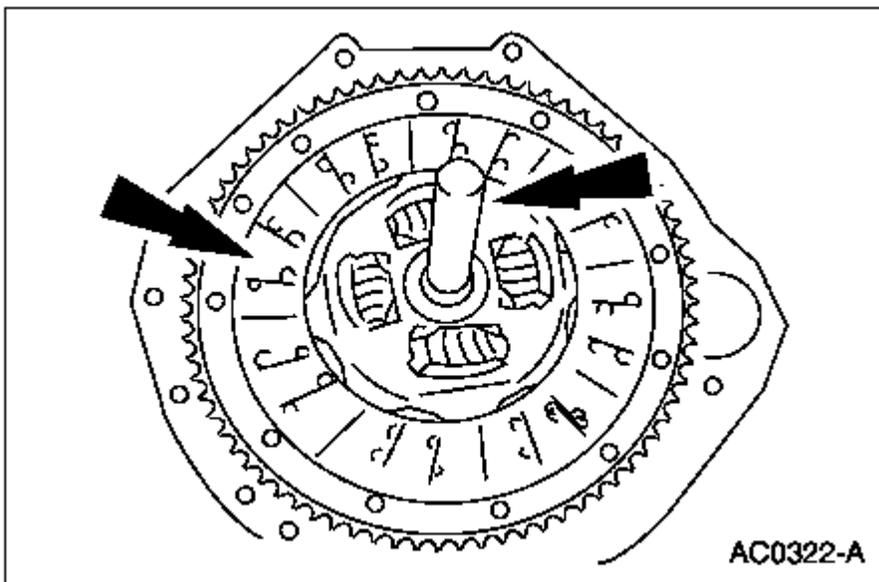
2.  **CAUTION:** When installing the original clutch pressure plate on 5.4L and 6.8L applications, reset the wear indicator before installing the clutch pressure plate on the flywheel.

Reset the wear indicator.

1. Using a suitable press and adapter, press downward on the fingers until the adjusting ring moves freely.
2. Rotate the adjusting ring counterclockwise to compress the tension springs. Hold the adjusting ring in this position.
3. Release the pressure on the fingers. The adjusting ring will now stay in the reset position.



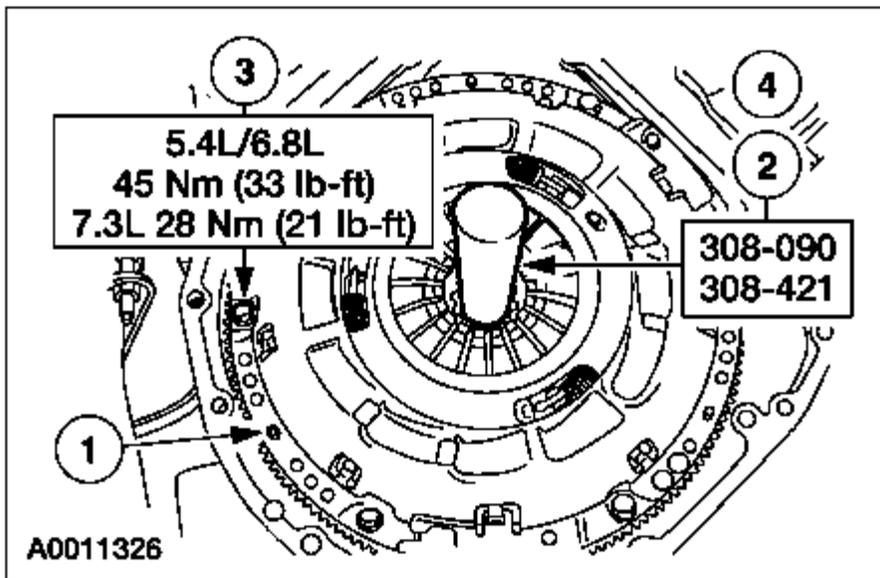
3. Position the clutch disc on the flywheel and the special tool in pilot bearing to align the clutch disc.
 - Use tool 308-090 for 5-speed applications, and tool 308-421 for 6-speed applications.
 - The 5.4L/6.8L engines accept a 1 1/4" input shaft.
 - The 7.3L engines accept a 1 3/8" input shaft.



4. **NOTE:** Align the index marks if installing the original clutch pressure plate and flywheel.

Install the clutch pressure plate.

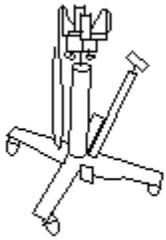
1. Position the clutch pressure plate on the dowels.
 - The diesel engine flywheel has two dowels. The gasoline engine flywheel has three dowels.
2. Using the special tool, align the clutch disc and the pressure plate.
3. Install the bolts and tighten in a star pattern sequence.
4. Remove the special tool.



5. Install the transmission. For additional information, refer to [Section 308-03](#).
 6. Test the system for normal operation.
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Transmission

Special Tool(s)

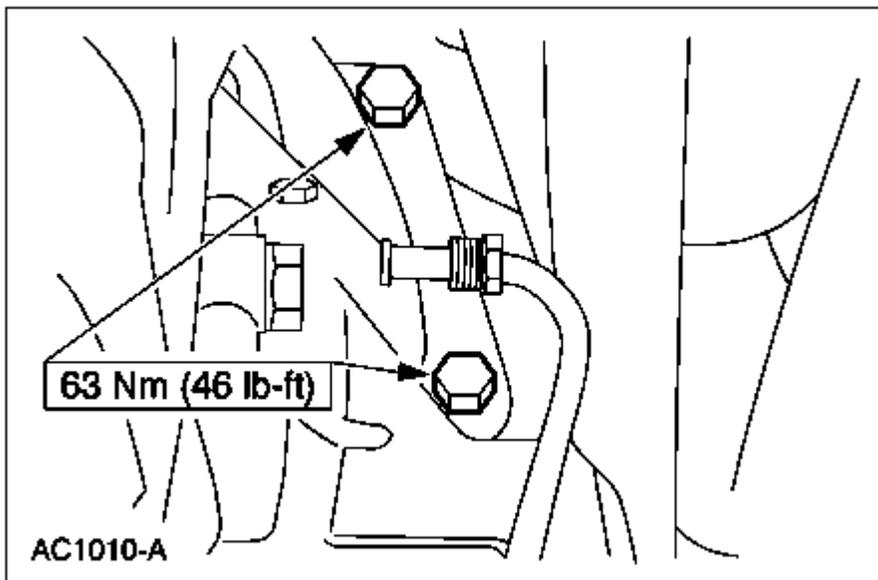
 ST1130-A	High Lift Transmission Jack 014-00942
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Material

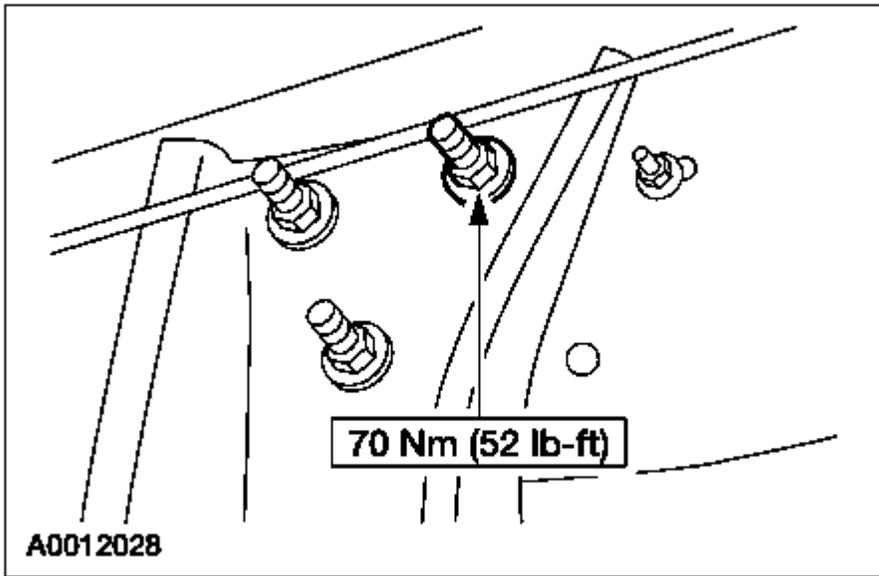
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (type II)

All vehicles

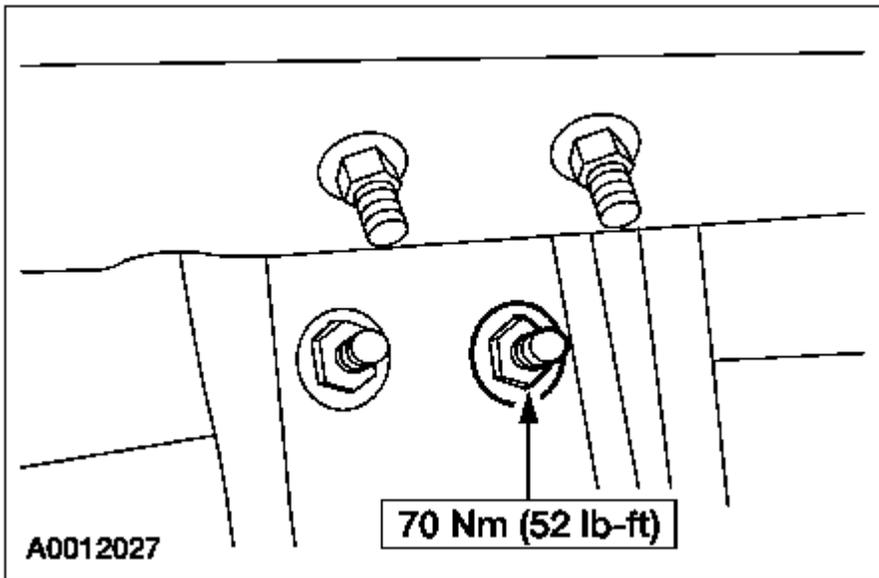
1. Using the transmission jack, raise and position the transmission to the engine and clutch.
2. Install the transmission-to-engine bolts.
 - For vehicles equipped with diesel engines, install six bolts.
 - For vehicles equipped with gasoline engines, install seven bolts.



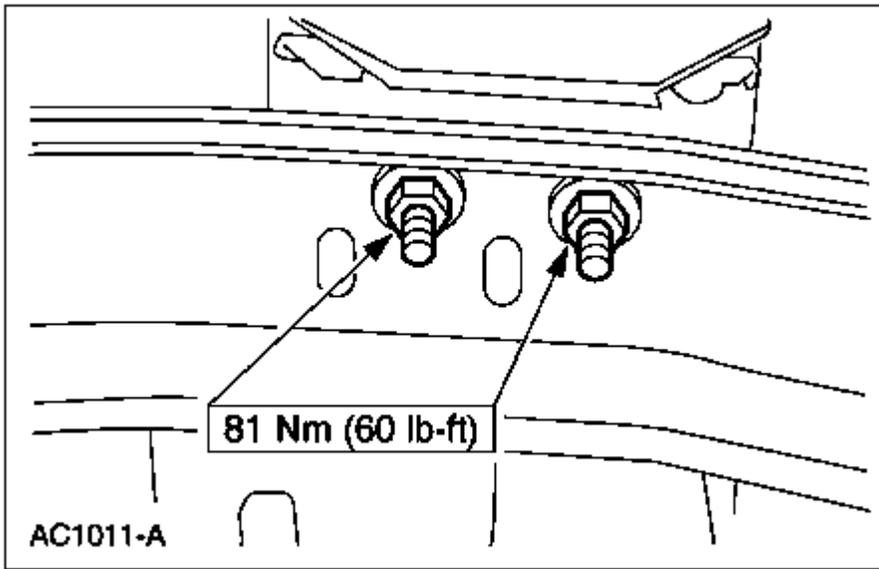
3. Install the LH crossmember bolts.



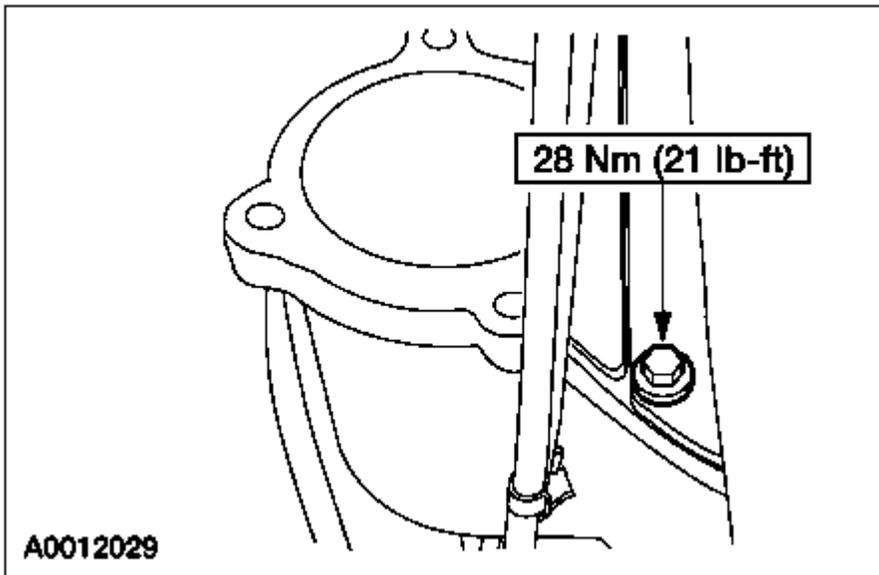
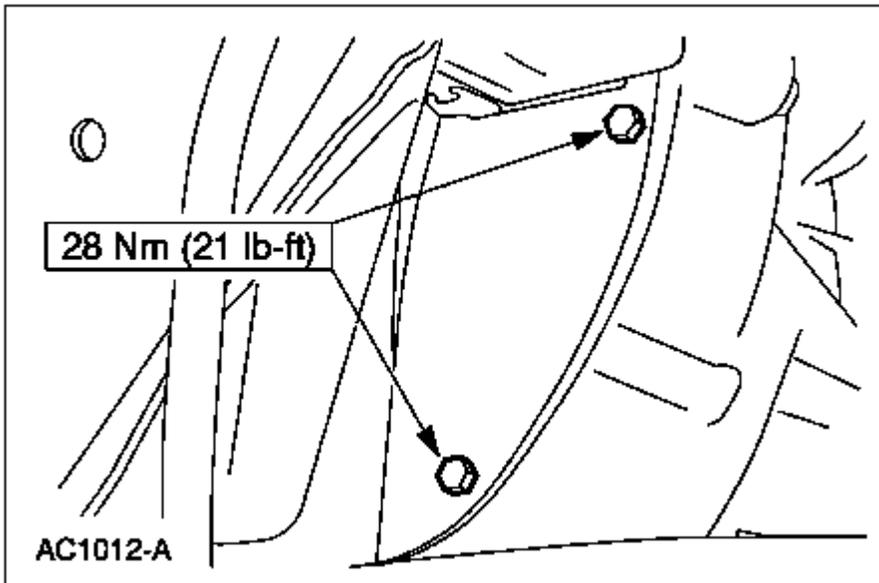
4. Install the RH crossmember nuts.



5. Install the transmission mount nuts.

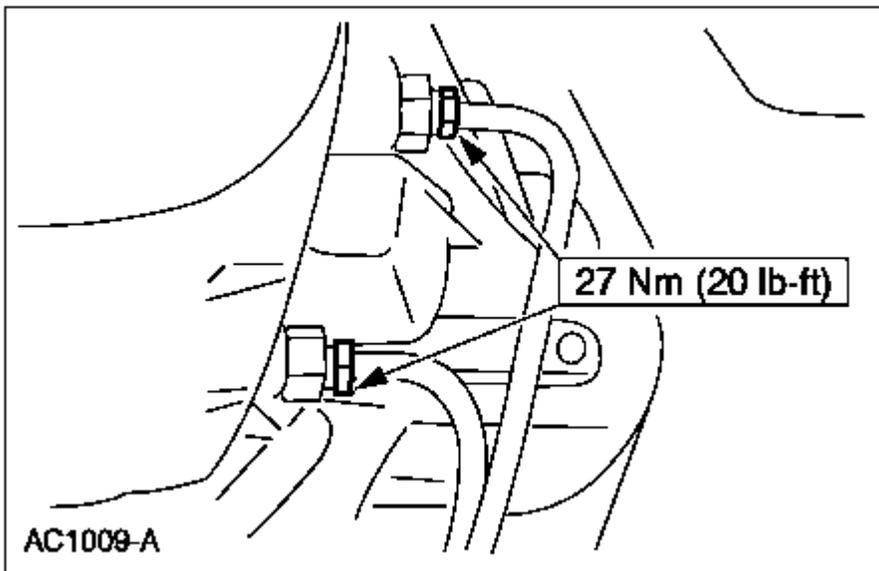


6. Install the engine plate bolts.

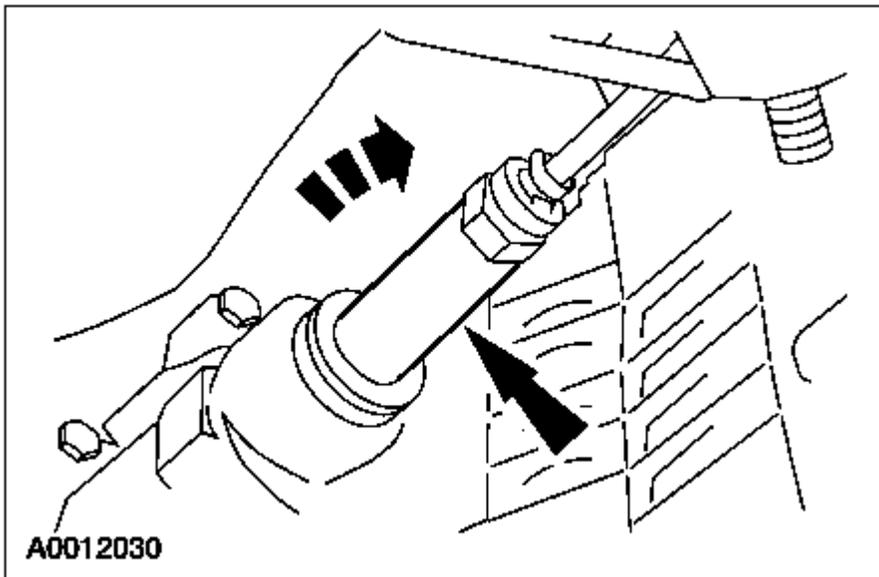


7. Remove the transmission jack.

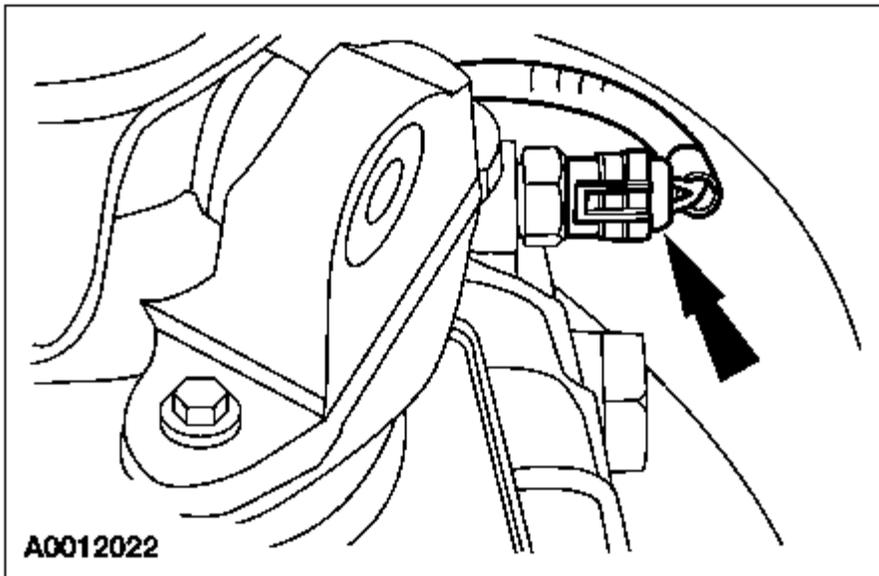
8. Connect the transmission cooler tubes.



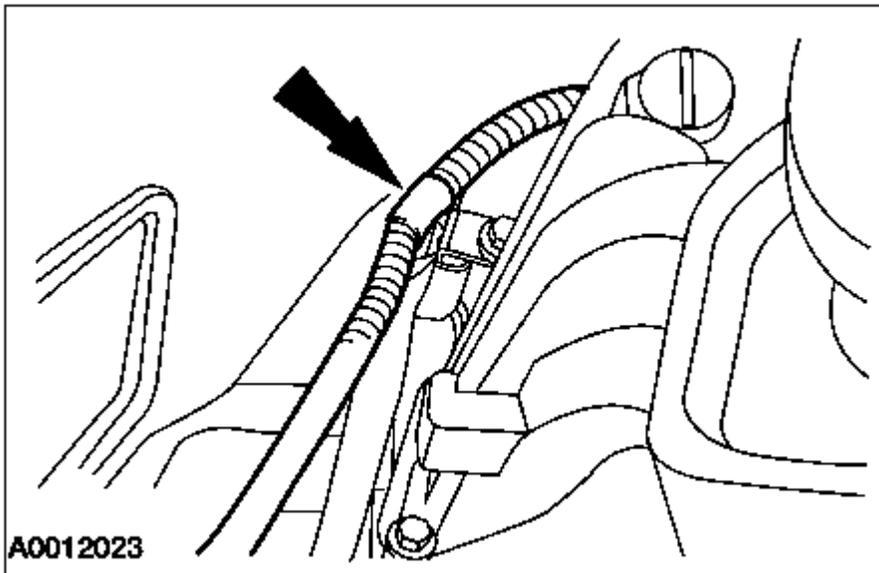
9. Install the clutch slave cylinder.
 - Rotate the clutch slave cylinder clockwise 45 degrees to lock in position.



10. Install the starter. For additional information, refer to [Section 303-06B](#).
11. Install the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).
 - If the transfer case control lever assembly was removed from the transmission, it must be correctly aligned.
12. Connect the driveshaft. For additional information, refer to [Section 205-01](#).
13. Install any power take-off (PTO) equipment, if equipped.
14. Connect the reverse lamp switch electrical connector.



15. Connect the wiring harness to the transmission.



16. Refill the transmission to specification.
 - Refill the transmission with clean transmission fluid.

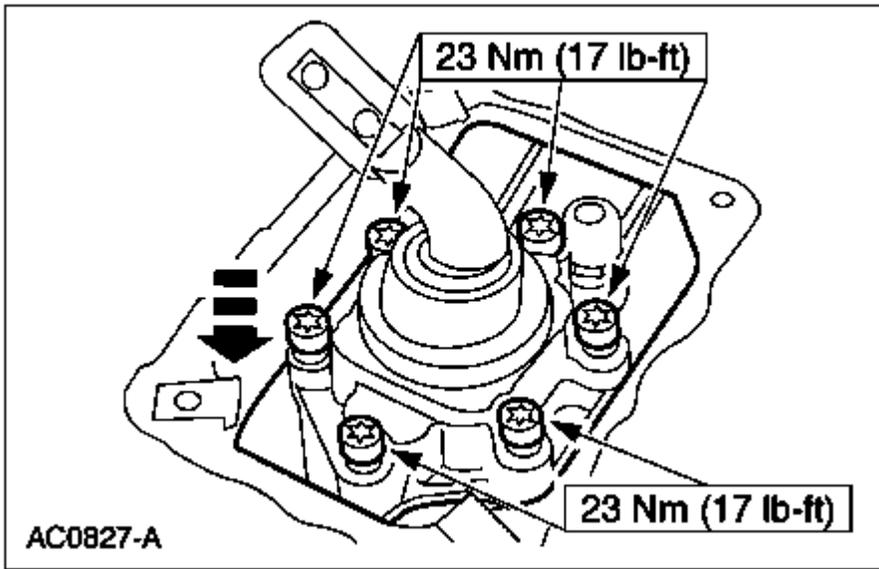
17. Lower the vehicle.

18.  **CAUTION: Do not use a silicone sealing compound.**

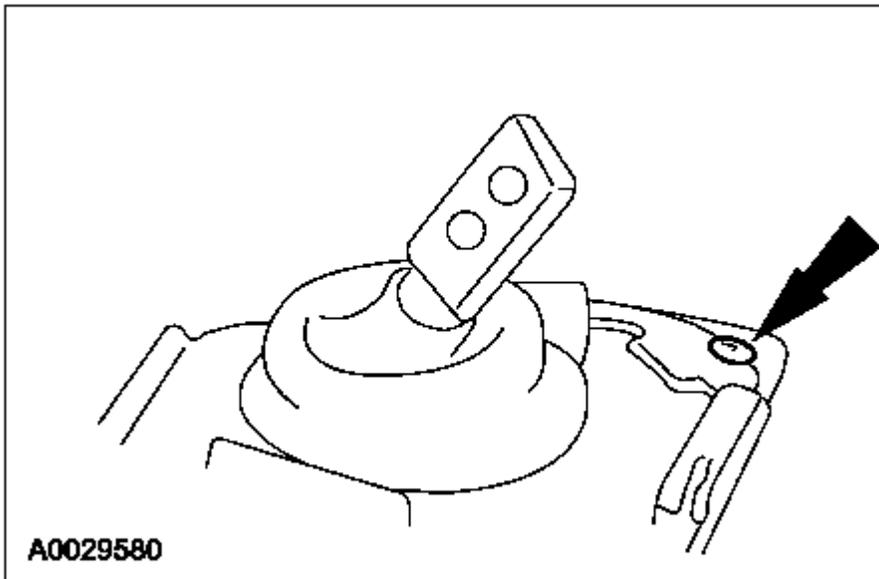
NOTE: Do not wait longer than ten minutes to tighten the six bolts due to the rapid cure time of the sealant.

Install the lower gearshift lever and shift housing assembly.

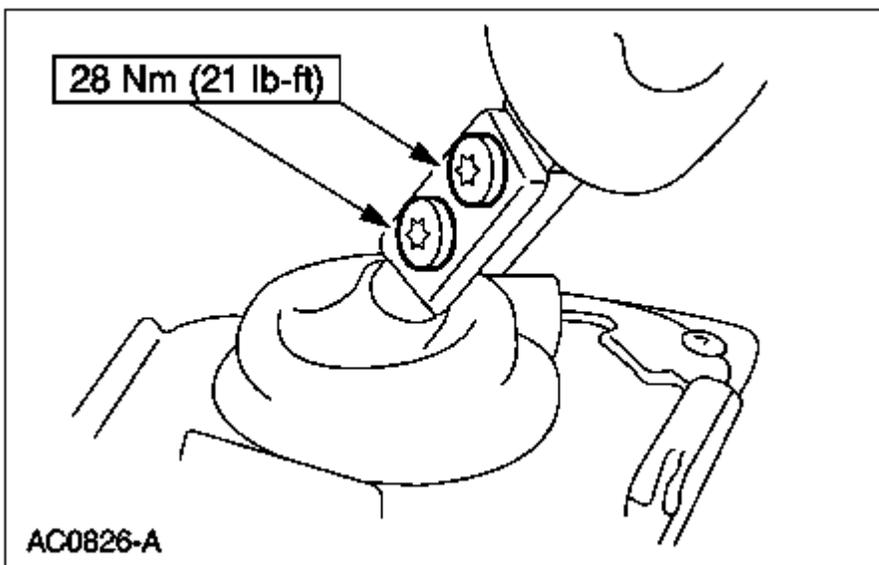
- Apply gasket maker to the shift housing and the main case.



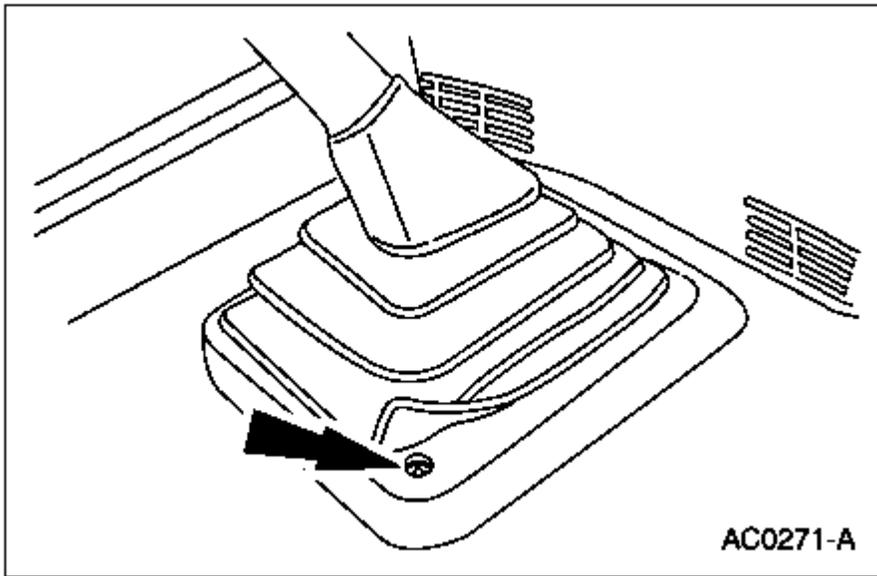
19. Install the lower shift lever boot.



20. Apply threadlock and sealer to the gearshift lever bolts. Install the upper gearshift lever.

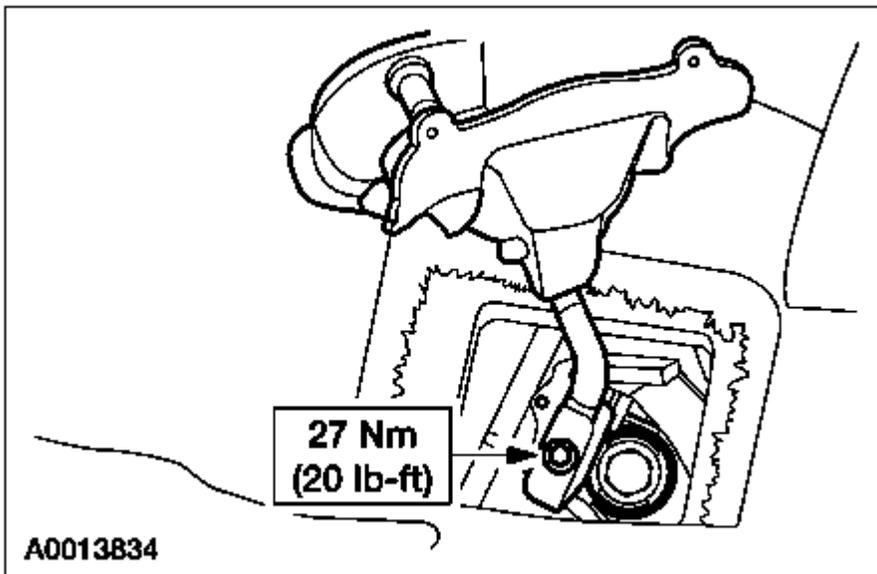


21. Install the screws.

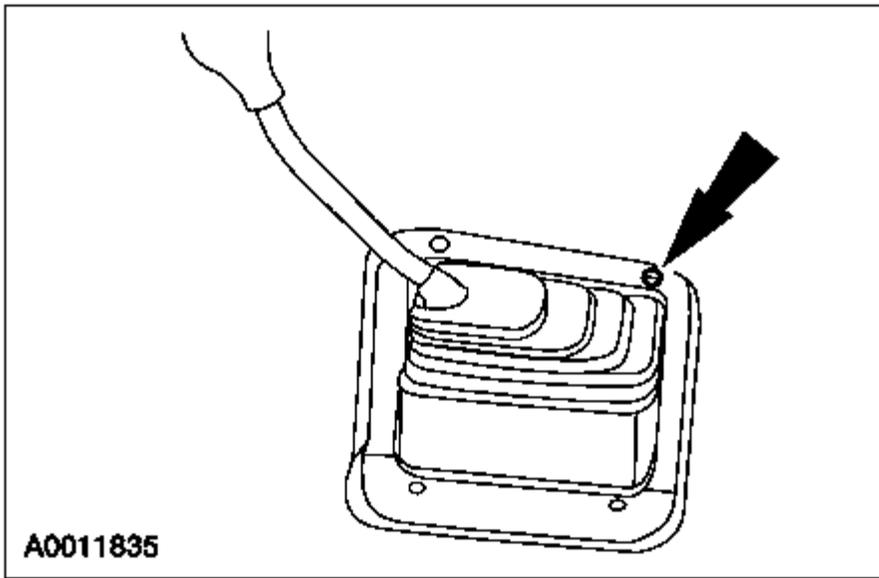


Vehicles with a manual shift lever

22. Position the shift lever with the bezel and boot assembly and install the bolt.



23. Position the bezel and boot assembly and install the screws.



24. Verify the shift sequence from 2H to 4L to 2H.
