
Workshop Manual

1999

F-Super Duty 250-550



3: Powertrain

[08: Manual Transmission, Clutch and Transfer Case](#)

[09: Exhaust System](#)

[10: Fuel System](#)

[1999 F-Super Duty 250-550 Contents/Index](#)

GROUP 08: Manual Transmission, Clutch and Transfer Case

[SECTION 308-00: Manual Transaxle/Transmission and Clutch — General Information](#)

[SECTION 308-01: Clutch](#)

[SECTION 308-02: Clutch Controls](#)

[SECTION 308-03A: Manual Transmission — Model S5-47 ZF](#)

[SECTION 308-03B: Manual Transaxle/Transmission — ZF 6-Speed](#)

[SECTION 308-07A: Transfer Case — General Information](#)

[SECTION 308-07B: Transfer Case](#)

SECTION 308-00:
Manual Transaxle/Transmission and Clutch — General Information

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Manual Transmission and Clutch](#)

DIAGNOSIS AND TESTING

[Manual Transmission and Clutch](#)

[Symptom Chart](#)

GENERAL PROCEDURES

[Clutch Disc Check](#)

[Clutch Pressure Plate Check](#)

[Flywheel Check](#)

[Flywheel Runout Check](#)

[Pilot Bearing Check](#)

[Clutch Cylinder Bench Bleeding](#)

[Clutch System Bleeding—In-Vehicle](#)

REMOVAL AND INSTALLATION

[Clutch Pressure Plate Locating Dowels](#)

[Clutch Housing Locating Dowels](#)

SECTION 308-00: Manual Transaxle/Transmission and
Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

SPECIFICATIONS

Procedure revision date:
01/26/2000

General Specifications	
Item	Specification
Pressure Plate	
Pressure spring	Belleville
Sensor spring	Belleville
Total plate pressure Kg (lbs) 5.4L and 6.8L	1305 (2878)
Total plate pressure Kg (lbs) 6.0L diesel	1478 (3260)
Total plate pressure Kg (lbs) 7.3L diesel	1071 (2361)
Clutch Disc	
Lining material 5.4L, 6.0L (for F250-350) and 6.8L	F808 woven non-asbestos
Lining material 6.0L (for F450-550) and 7.3L diesel	F808 MCC woven non-asbestos
O.S. diameter (approx) mm (in) 5.4L	303 (11.9)
I.S. diameter (approx) mm (in) 5.4L	213 (8.3)
O.S. diameter (approx) mm (in) 6.8L	303 (11.9)
I.S. diameter (approx) mm (in) 6.8L	174 (6.85)
O.S. diameter (approx) mm (in) 6.0L and 7.3L diesel	330 (12.9)
I.S. diameter (approx) mm (in) 6.0L and 7.3L diesel	210 (8.2)
Facing area sq. cm (sq. in) 5.4L	730 (112)
Facing area sq. cm (sq. in) 6.8L	967 (149)
Facing area sq. cm (sq. in) 6.0L and 7.3L diesel	1018 (158)
Compressed thickness mm (in) 5.4L	9.1 (0.36)
Compressed thickness mm (in) 6.0L	9.2 (0.36)
Compressed thickness mm (in) 6.8L	8.9 (0.35)
Compressed thickness mm (in) 7.3L diesel	8.4 (0.33)
Flywheel	
Flywheel TIR	0.203 mm (0.008 in)
Flywheel ring gear TIR	0.56 mm (0.022 in)
Lubricant (Spec and Capacity) Fluid	
High Performance	ESA-M6C25-A

DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB	
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Transmission w/o oil cooler fluid capacity	5.5 L (5.81 qts)
Transmission oil cooler fluid capacity	0.5 L (0.53 qts)

SECTION 308-00: Manual Transaxle/Transmission and
Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

DESCRIPTION AND OPERATION

[Procedure revision date:](#)
[01/26/2000](#)

Manual Transmission and Clutch

This section contains symptom based diagnosis and testing procedures. The symptom chart, and the inspection and verification procedures aid in the accurate diagnosis of transmission and clutch system related concerns.

SECTION 308-00: Manual Transaxle/Transmission and
Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

DIAGNOSIS AND TESTING

[Procedure revision date:](#)
[01/26/2000](#)

Manual Transmission and Clutch

Inspection and Verification

To guarantee an accurate diagnosis:

- get an accurate description of the condition.
- identify when the condition occurs; when hot or cold, during shifting, driving at a particular speed or in a particular gear.
- have the customer demonstrate the concern, if possible.

- refer to the Symptom Chart in this section for additional source information and suggested test procedures.
- carry out the following Noise Evaluation procedures, as necessary.

Noise Evaluation

NOTE: Carry out this evaluation with the transmission cold and at normal operating temperature to listen for any change in noise as the transmission warms up.

1. Start the engine.
2. Evaluate the noise in NEUTRAL with the vehicle is parked.
3. Listen for any change in noise while depressing and releasing the clutch pedal.
4. Listen for any change in noise while changing the engine rpm.
5. Drive the vehicle and shift through all of the gear ranges, including reverse. Listen for any change in noise in a particular gear.
6. Drive the vehicle in the gear in which the noise is most noticeable. Depress the clutch pedal and leave the gear engaged. Listen for any change in noise. The vibration of the engine may be amplifying the noise.
7. Drive the vehicle under the same conditions identified in the previous step. Depress the clutch pedal and shift the transmission into NEUTRAL. Release the clutch pedal and allow the vehicle to coast. Evaluate the noise as the rear axle assembly turns the mainshaft.

Noise Evaluation for 4x4 Applications

- With the vehicle at a complete stop and the transfer case in NEUTRAL, shift the transmission through all of the gear ranges and evaluate the noise at different engine rpm. Check for any noise in NEUTRAL at different engine rpm.
- Check for any noise change when shifting the transfer case between 2H, 4H, 4L and NEUTRAL.
- Refer to [Section 308-07A](#) for 4x4 system concerns.

Clutch Slippage Inspection and Verification

1. Chock the wheels.
2. Apply the parking brake.
3. Depress and release the clutch pedal slowly to check if the pedal is binding.
 - If the clutch pedal is not binding, proceed to the next step in this procedure.
 - If the clutch pedal is binding, inspect, and install a new clutch pedal and support bracket assembly as necessary. Refer to [Section 308-02](#). Test the system for normal operation. Proceed to the next step in this procedure, if necessary.

4. Depress the clutch pedal.
5. Start the engine.
6. Shift the transmission to fourth gear.
7. Increase the engine rpm to 2000 and slowly release the clutch pedal. If the engine stalls within five seconds, the clutch is not slipping.
 - If the clutch is slipping, remove the clutch disc (7550) and pressure plate (7563). Refer to [Section 308-01](#). Inspect the clutch disc and pressure plate for wear and damage. Refer to [Clutch Pressure Plate Check](#) and to [Clutch Disc Check](#) in this section. Inspect the flywheel (6375) for glazing and damage. Check the clutch release hub and bearing for binding, and inspect the guide tube. Inspect the input shaft for wear and damage. Repair all components as necessary. Test the system for normal operation.

Clutch Chatter or Shudder Inspection and Verification

1. Raise and support the vehicle. Refer to [Section 100-02](#).
2. Inspect the engine and transmission mounts for looseness and damage.
 - If the mounts are OK, proceed to the next step in this procedure.
 - If the mounts are loose or damaged, tighten, or install new mounts as necessary. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Check for loose bolts that retain the clutch pressure plate to the flywheel.
 - If the bolts are tightened to specification, proceed to the next step in this procedure.
 - If the bolts are loose, tighten the bolts to specification. Refer to [Section 308-01](#). Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
4. Remove the clutch disc and pressure plate. Refer to [Section 308-01](#). Inspect the clutch disc and pressure plate for wear and damage, and check the clutch disc runout. Refer to [Clutch Pressure Plate Check](#) and to [Clutch Disc Check](#) in this section. Inspect the flywheel for glazing and damage. Check the flywheel runout. Refer to [Flywheel Runout Check](#) in this section. Inspect the input shaft for wear, damage and eccentricity. Repair all components as necessary. Test the system for normal operation.

Clutch Drag Inspection and Verification

1. Verify that the clutch hydraulic fluid reservoir is filled to the correct level.
 - If the fluid level is correct, proceed to the next step in this procedure.
 - If the fluid level is low, add fluid as necessary. Inspect the clutch hydraulic system for leaks, and repair as necessary. Refer to [Section 308-02](#). Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
2. Depress and release the clutch pedal to check for a spongy pedal.

- If the pedal feels OK, proceed to the next step in this procedure.
 - If the pedal feels spongy, bleed the clutch hydraulic system. Refer to [Clutch System Bleeding—In-Vehicle](#) in this section. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Remove the clutch disc and pressure plate. Refer to [Section 308-01](#). Inspect the clutch disc and pressure plate for wear and damage, and check the clutch disc runout. Refer to [Clutch Pressure Plate Check](#) and to [Clutch Disc Check](#) in this section. Repair all components as necessary. Test the system for normal operation.

Hard Shifting Inspection and Verification

1. Verify that the clutch hydraulic fluid reservoir is filled to the correct level.
 - If the fluid level is correct, proceed to the next step in this procedure.
 - If the fluid level is low, add fluid as necessary. Check the clutch hydraulic system for leaks, and repair as necessary. Refer to [Section 308-02](#). Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
2. Depress and release the clutch pedal to check for a spongy pedal.
 - If the pedal feels OK, proceed to the next step in this procedure.
 - If the pedal feels spongy, bleed the clutch hydraulic system. Refer to [Clutch System Bleeding—In-Vehicle](#) in this section. Test the system for normal operation. Proceed to the next step in this procedure, if necessary.
3. Remove the clutch disc and pressure plate. Refer to [Section 308-01](#). Inspect the clutch disc and pressure plate for wear and damage. Refer to [Clutch Pressure Plate Check](#) and to [Clutch Disc Check](#) in this section. Check the clutch release hub and bearing for binding, and inspect the guide tube. Inspect the input shaft for wear and damage. If all of the components are OK, proceed to the next step in this procedure. Otherwise, repair all components as necessary. Test the system for normal operation.
4. Inspect the transmission housing, shafts, forks and synchronizer assemblies. Refer to [Section 308-03A](#) (Model S5-47ZF Transmission) or [Section 308-03B](#) (ZF 6 Speed Transmission). Repair all components as necessary. Test the system for normal operation.

Transmission Component Inspection

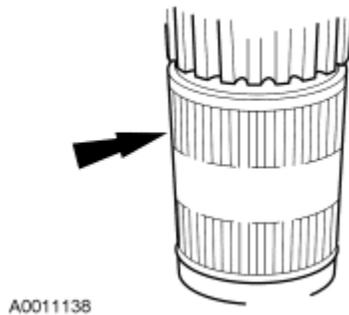
NOTE: Refer to Symptom Chart—Transmission Component Wear and Damage in this section for additional information relating to the following conditions.

Case Surface Roughness



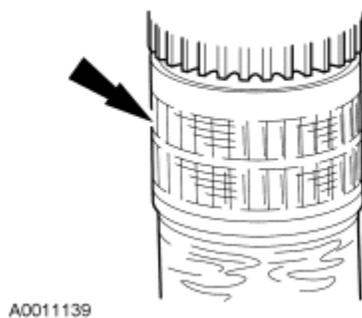
- The term describes areas of roughness on the case. The condition occurs in production, when even after a thorough cleaning, a tough, adhesive crust of sand remains on the surface. Normally, the visual impression is misleading and the housing is usable.

Shaft Damaged by Fine Brinelling



- The term describes a brightly polished race surface with signs of consecutive depressions. The damage is a combination of brinelling and wear.

Shaft Damaged by Severe Brinelling



- The term describes indentations in the race circumferential face, spaced identically to the roller bodies. The damage affects the individual gear's bore and race, and the roller bodies. This type of damage is serious due to a very high increase in radial play on helically-cut gears. It can result in contact pattern displacement on the mating gears and can culminate in tooth failure.

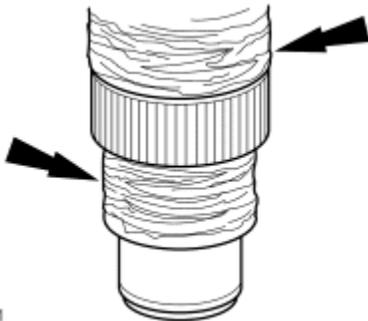
Shaft Damaged by Tribological Oxidation (Infinitely Brinelled Surface)



A0011140

- The term describes a highly polished, uniform radial wear in the race surface. Material wear resulting from fretting corrosion causes this type of damage.

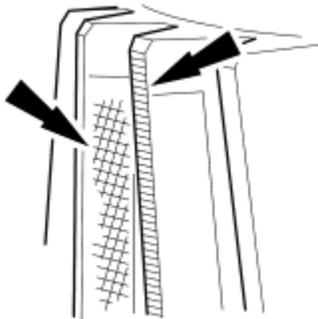
Shaft Damaged by Fretting



A0011141

- The term describes gnawing marks in the race surface. When combining high differential speeds with high uniformity of rotation, (such as towing the vehicle with the driveshaft connected), the contact between the roller bodies and the race may develop a high proportion of slip. If cooling or lubrication in the needle bearing is no longer sufficient, this can lead to overheating and cause fretting corrosion or bearing seizure.

Gear Teeth Break-In Wear



A0011142

- The term describes grinding and shaving marks in the gear teeth. Rough peaks, formed during production, wearing away or, to some extent, rolling into the surface cause break-in wear. This type of wear normally ceases after the running-in period has expired, without damaging the components.

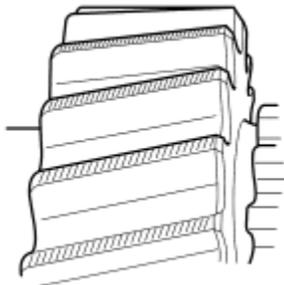
Gear Teeth Damaged by Scratches



A0011143

- The term describes shallow linear indentations on the flank, running in the direction of sliding. Assess scratches as damage.

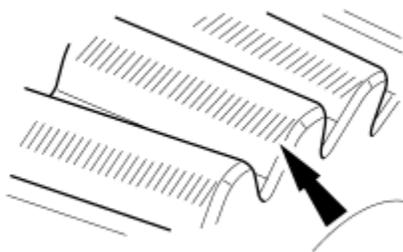
Gear Teeth Damaged by Abrasive Wear



A0011144

- The term describes a matte gray appearance on the entire flank. The abrasive wear erases the machining process marks. When abrasive wear reaches an advanced stage, substantial changes in the tooth profile and clearance occur. This type of damage increases the noise level and can also cause secondary damage.

Gear Teeth Damaged by Scoring



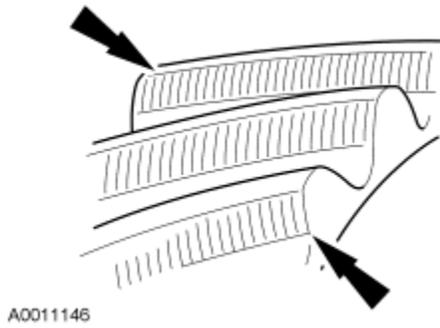
A0011145

- The term describes extensive linear indentations in the gear teeth, running in the direction of sliding. Unlike scratching, these marks extend from the start or end of the meshing zone. These marks are particularly deep at the root or tip, where maximum sliding speeds impact the most. Unlike scuffing, the score base is smooth. Scoring wear, which may have a

detrimental effect on the gear's performance, can occur if scoring develops over a longer period of time.

- This type of damage indicates the affected flank zone was subject to high sliding and rolling pressures. Fine local cold welding of the flanks and rough peaks are pressed into the mating flank where, as a result of this sliding action, they produce groove-like indentations, which, in turn, cause additional scoring on the original mating flank.

Gear Teeth Damaged by Light Scoring



- The term describes rough, partially porous lines in the gear teeth, aligned in the direction of sliding. The damage initially occurs in areas subjected to high Hertzian stresses and high sliding speeds, (predominantly along the tooth root and tooth tip). This type of damage either covers a part of the entire flank surface, or is not strongly developed and causes only insignificant wear after smoothing.
- This type of damage is due to the combined effect of contact pressure and high relative contact speeds. Followed by a localized increase in temperature, the film or lubricant is torn away between the flanks, permitting direct metal-to-metal contact. This may lead to seizure (welding). Because of the relative movement, these welded zones are immediately torn apart again, producing the associated damage.

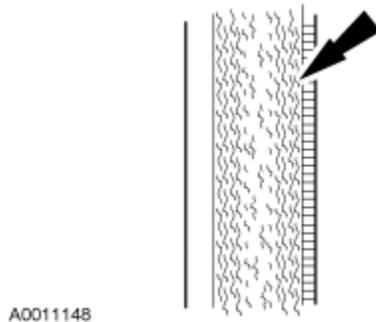
Gear Teeth Damaged by Severe Scoring



- The term describes rough, partially porous lines in the gear teeth, aligned in the direction of sliding. The damage initially occurs in areas subjected to high Hertzian stresses and high sliding speeds, (predominantly along the tooth root and tooth tip). This type of damage affects large areas of the tooth flank. At an advanced stage, the flank may heat up to such an extent that localized discoloring occurs.
- This type of damage is due to the combined effect of contact pressure and high relative contact speeds. Followed by a localized increase in temperature, the film of lubricant is torn

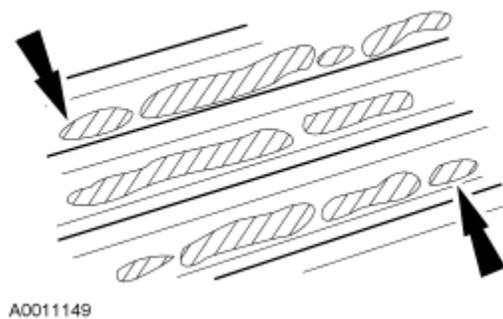
away between the flanks, permitting direct metal-to-metal contact. This may lead to seizure (welding). Because of the relative movement, these welded zones are immediately torn apart again, producing the associated damage.

Brinelling in Gear Teeth



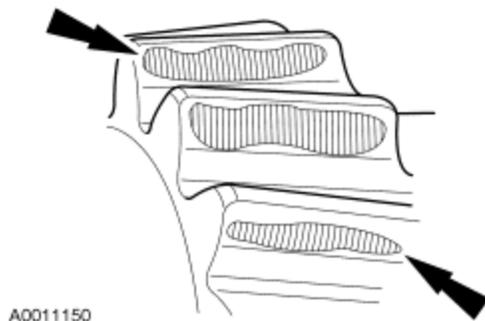
- The term describes ripple-like alterations in the surface structure, which run perpendicular to the direction of sliding. These marks resemble a washboard with differences in height of 1 micron. Do not assess these marks as damage.

Flank Fatigue



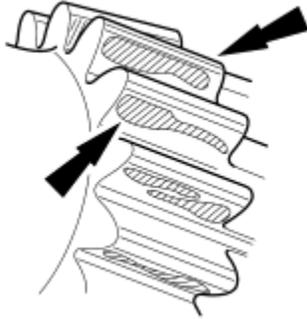
- The term describes extremely fine, localized pittings in the load-bearing flanks, visible as gray spots, or as a matte gray staining when found in clusters. Material fatigue resulting from a combination of contact pressure, sliding movement, and composite friction leads to the formation of this kind of microscopic surface cracking. Pittings originating from these cracks may create the appearance of local flank wear.

Slight Pittings in Gear Teeth



- The term describes individual, small, localized pittings that cover up to approximately 0.5 % of the flank face, and pore-like areas of pitting that usually are only present in the root zone of the flank. High local contact pressures on gears, which have not yet been run-in, may lead to individual pittings. Running-in wear relieves these zones and the pitting may stop as a result. A change in operating conditions may also stop continued development of slight pittings in the same way.

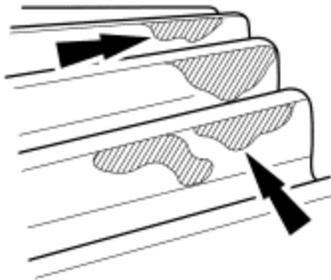
Gear Teeth with Heavy Pitting Damage



A0011151

- The term describes extensive flank pittings, which usually appear as pitting zones. The pit bases are usually shell-shaped. The total pitting surface may become so large that either smooth running is considerably impaired, or the remaining flank face, still bearing load, will soon be destroyed by wear. The pittings, attributed to material fatigue, result from a combination of contact pressure and sliding stress. The pittings occur if the local sliding and rolling stresses exceed material specification.

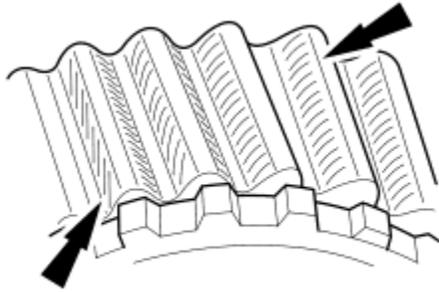
Gear Teeth Damaged by Spalling



A0011152

- The term describes localized pittings on the flank caused by material fatigue, and extensive triangular pits on the flank, generating from a zone of gray spots or a fine line of pits at the root. The depth of the exposed surface is relatively constant throughout. Additional cracks may extend from the pits at an angle. In some cases, the damage may even progress into the tip zone, causing tip damage.

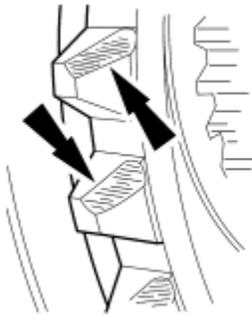
Overheating and Thermal Gear Deformation



A0011153

- The term describes a gray to blue black discoloration of the gear. Overheating reduces the surface hardness, allowing scoring or grooving to the flank, in the direction of sliding, particularly in the tip and the root zones. If there is extreme overheating, the material softens, causing gear tooth distortion.

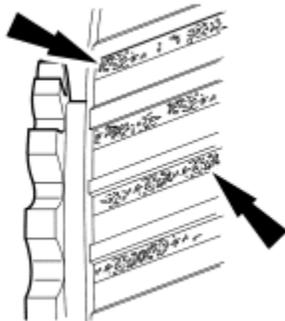
Gear Change Damage



A0011285

- The term describes worn and chipped, and in some cases, ragged tooth edges. The spline flanks may also show signs of wear resembling fretting corrosion. Obstructed gear change operation occurs in cases of severe selector tooth edge deformation.

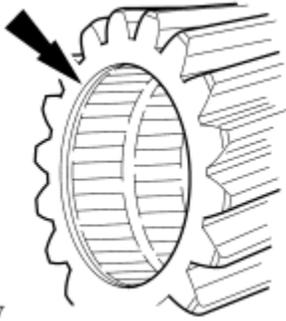
Gear Tooth Corrosion



A0011286

- The term describes brownish red to black spots, sometimes in conjunction with local material loss on the flank.

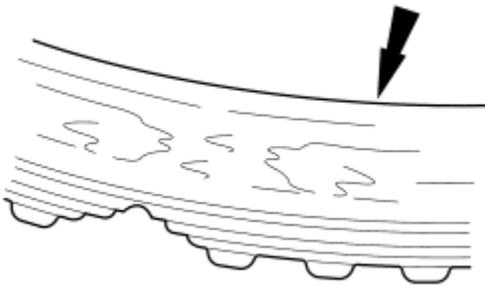
Idler Gear Damaged by Brinelling



A0011287

- The term describes the appearance of bearing element impressions on the roller race. If the bearing only carries out a supporting function over a long period of time, (there is no relative movement between the gear and the supporting shaft), the bearing contact areas may show signs of wearing away.

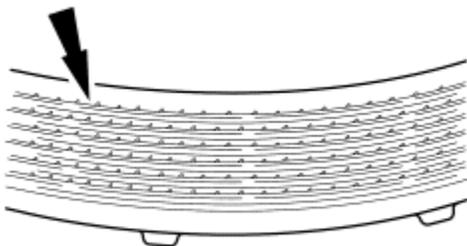
Synchronizer Ring Molybdenum Corrosion



A0011288

- The term describes a blackened friction lining, even in the worn area. The corrosion results from contact with water. This chemical process causes substantial wear, which results in removal of the friction lining.

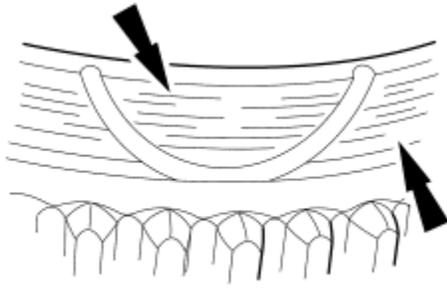
Synchronizer Ring Molybdenum Coat Destruction



A0011289

- The term describes flaking of the molybdenum coat. The destruction begins from the outer threads. The disintegrated areas have a coarse, grainy structure. This condition also applies to synchronizer rings with axial grooves.

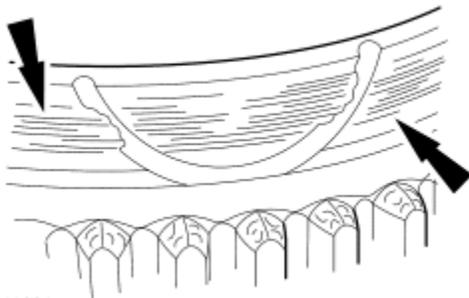
Synchronizer Friction Cone Slightly Worn



A0011290

- The term describes slight scoring in the friction cone. The scores are too light to feel and do not obstruct synchronizer unit (friction coefficient) function. Do not assess this type of wear as damage. If friction cone wear is only slight, but a severe, permanent grating condition exists, inspect the engage teeth for wear.

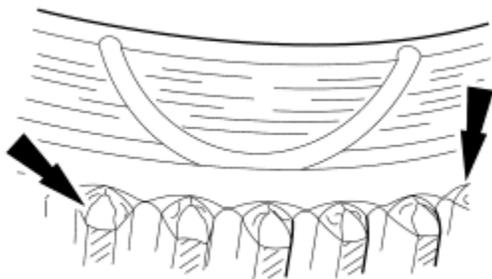
Synchronizer Friction Cone Worn with Material Displaced



A0011291

- The term describes pronounced groove-shaped wear with material displacement around the friction cone circumference. The material displacement is clearly visible in the area of any oil grooves.

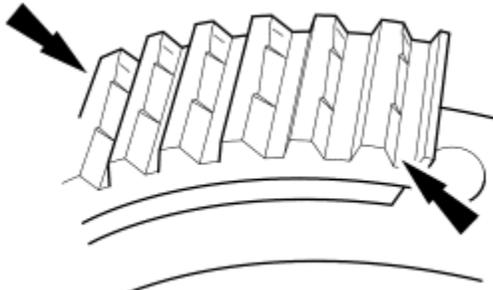
Synchronizer Gear Shift Teeth Worn



A0011292

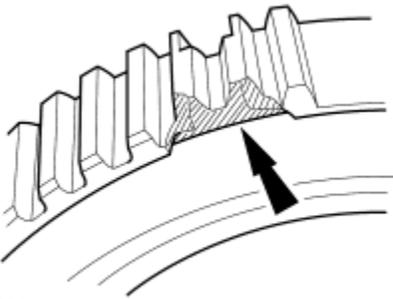
- The term describes severe flaking or blunting of the gear shift teeth. This condition causes shift concerns.

Synchronizer Body External Tooth Splines Worn



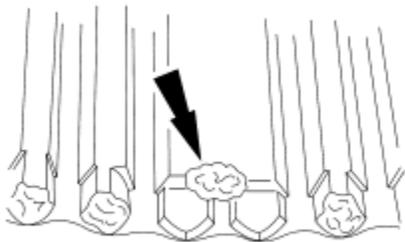
- The term describes a stepped effect on the tooth flanks. This condition causes shift concerns.

Synchronizer Body Stops Broken



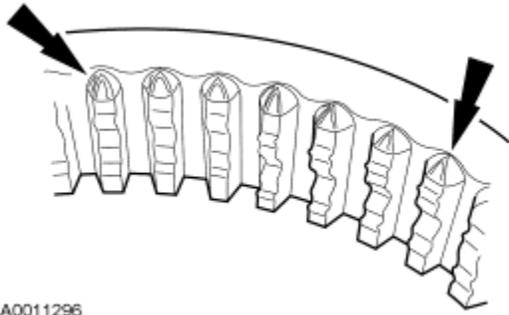
- The broken and chipped synchronizer body stops are clearly visible.

Synchronizer Sliding Sleeve Stop Deformed



- The term describes a deformed/chipped-off detent stop on the sliding sleeve. This condition causes shift concerns.

Synchronizer Gear Shift Teeth Worn



A0011296

- The term describes grated, chipped-off, or blunted front edges of the gear shift teeth. This condition causes shift concerns.

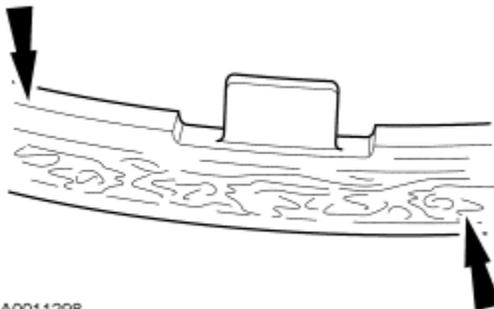
Synchronizer Inner Ring Heat Discolored with Slight Material Displacement



A0011297

- The term describes heat discoloration and slight material displacement that is visible on the taper of the inner ring. The intensity of the heat discoloration does not have a significant bearing on whether the component is reusable. Isolated heat discoloration occurs after just a few shifts with high shift effort and does not impair function. Only assess possible re-use of the inner ring in conjunction with the intermediate ring.

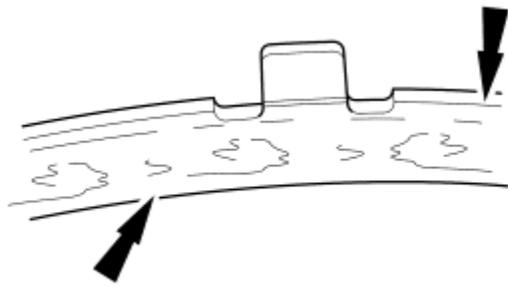
Synchronizer Inner Ring Material Displaced



A0011298

- The term describes heat discoloration and slight material displacement that is visible on the cone of the inner ring.

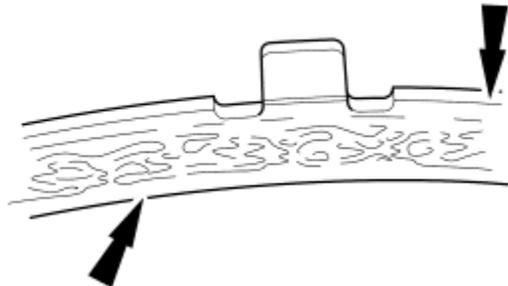
Synchronizer Outer Ring Heat Discolored



A0011299

- The term describes heat discoloration and slight material displacement that is visible on the cone of the outer ring. The intensity of the heat discoloration does not have a significant bearing on whether the component is reusable. Isolated heat discoloration occurs after just a few shifts with high shift effort and does not impair function.

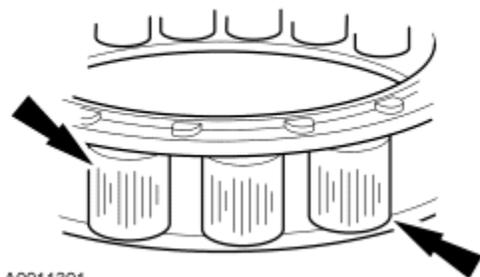
Synchronizer Outer Ring Material Displaced



A0011300

- The term describes heat discoloration and material displacement that is visible on the cone of the outer ring.

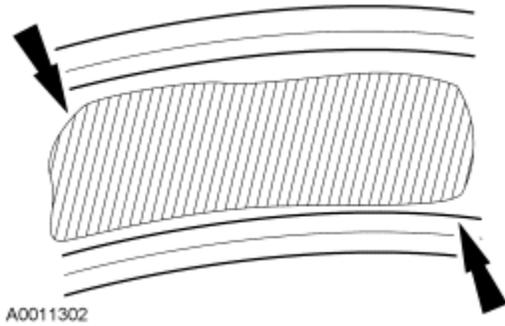
Bearing Worn with Subsequent Damage



A0011301

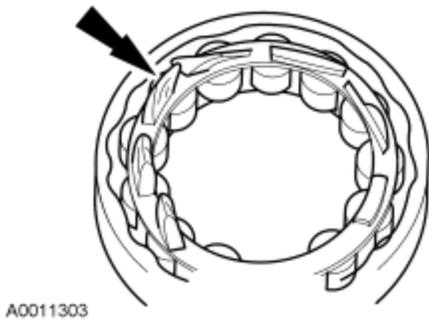
- The term describes grinding burrs on the races and the bearing components undergoing plastic deformation and some clip-off. The metallic particles this process creates give rise to abrasive wear. Additional consequences include the development of scoring and scratches, through to micro-pitting. The wear process develops rapidly as the bearing play continues to increase. Finally, this leads to power rubbing or peeling of the surface layers and severe subsequent damage.

Bearing Fatigue



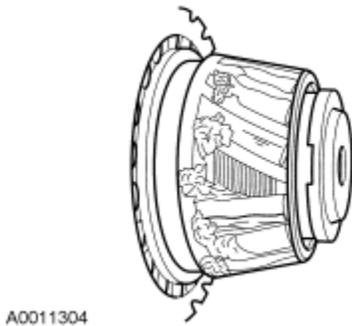
- The term describes a matte gray appearance to the race surface.

Bearing Collar Broken



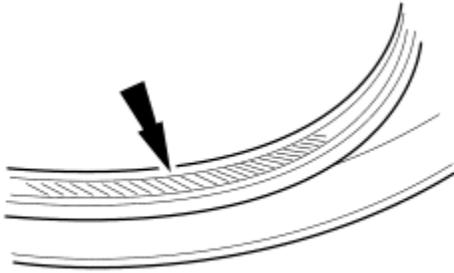
- The broken bearing collar is clearly visible.

Bearing Damaged by Fretting or Seizure



- The term describes gnawing marks on the cylinder ends of the rollers or on the contact edges, and the possibility of blue discoloration. In the case of tapered roller bearings, this can lead to roller misalignment and seizure of the bearing.

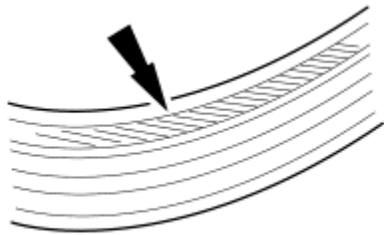
Sealing Element Radial Shaft Sealing Ring Damaged



A0011305

- The term describes a sealing lip that has undergone plastic deformation. In some cases, it may have hardened and heat cracked, and contain carbonized oil deposits.

Sealing Element Sealing Lip Worn



A0011306

- The term describes when the contact surface width of the sealing edge has worn evenly along the entire circumference. A normal, gradual degree of wear on a sealing edge is due to various friction conditions between the edge of the seal and the shaft race. Contact surface widths of up to 0.5 mm (0.02 in) are acceptable in transmissions with high mileage.

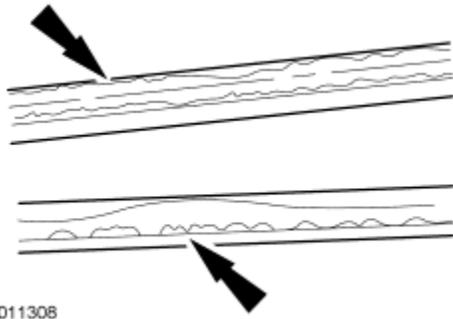
Sealing Element Rectangular/Lipped Sealing Ring Sheared



A0011307

- A slit is clearly visible in the sealing ring.

Sealing Element Worn/Hardened



A0011308

- The term describes hardening and chipping of the sealing ring.

Symptom Chart

SYMPTOM CHART—CLUTCH AND TRANSMISSION OPERATION		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> • Clutch Slippage 	<ul style="list-style-type: none"> • Clutch pedal binding. • Clutch pressure plate diaphragm spring weakened/damaged. • Clutch pressure plate worn/damaged. • Clutch disc facing worn excessively/damaged • Clutch disc facing surface hardened or oil coated. • Clutch release hub and bearing binding. • Flywheel glazed/damaged. 	<ul style="list-style-type: none"> • CARRY OUT the Clutch Slippage Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> • Clutch Chatter or Shudder 	<ul style="list-style-type: none"> • Engine/transmission mount loose/damaged. • Bolts retaining clutch pressure plate to flywheel loose. • Clutch pressure plate worn/damaged. • Clutch disc facing oil coated. 	<ul style="list-style-type: none"> • CARRY OUT the Clutch Chatter or Shudder Inspection and Verification procedure in this section.

	<ul style="list-style-type: none"> • Clutch disc facing hardened/damaged. • Clutch disc runout excessive. • Flywheel surface glazed/damaged. • Flywheel runout excessive. • Transmission input shaft eccentric/not perpendicular. 	
<ul style="list-style-type: none"> • Clutch Drag 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<ul style="list-style-type: none"> • CARRY OUT the Clutch Drag Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> • Clutch Pedal Pulsation 	<ul style="list-style-type: none"> • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc runout excessive. • Flywheel runout excessive. 	<ul style="list-style-type: none"> • REMOVE the clutch disc and pressure plate. REFER to Section 308-01. INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. CHECK the flywheel runout. REFER to Flywheel Runout Check in this section. REPAIR all

		components as necessary. TEST the system for normal operation.
<ul style="list-style-type: none"> • Clutch Related Vibrations 	<ul style="list-style-type: none"> • Engine component grounding against frame. • Accessory drive belt loose/damaged. • Clutch release bearing worn/damaged. • Bolts retaining clutch pressure plate to flywheel loose. • Bolts retaining flywheel to engine loose. • Flywheel runout excessive. • Clutch pressure plate imbalance. 	<ul style="list-style-type: none"> • CARRY OUT the Clutch Chatter or Shudder Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> • Hard Shifting 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch not releasing. • Transmission concern. 	<ul style="list-style-type: none"> • CARRY OUT the Hard Shifting Inspection and Verification procedure in this section.
<ul style="list-style-type: none"> • Excessive Noise 	<ul style="list-style-type: none"> • Clutch disc damper damaged. • Transmission input shaft pilot bearing (7120) worn/damaged. • Crankshaft end play excessive. • Release bearing worn/damaged. 	<ul style="list-style-type: none"> • REMOVE the clutch disc and pressure plate. REFER to Section 308-01. INSPECT the clutch disc for damage. REFER to Clutch Disc Check in this section. INSPECT the transmission input shaft pilot bearing for wear and

		<p>damage. REFER to Pilot Bearing Check in this section. CHECK the crankshaft end play. Refer to the appropriate section in Group 303 for the procedure. CHECK the clutch release hub and bearing, and guide tube for wear and damage. REPAIR all components as necessary. TEST the system for normal operation.</p>
<ul style="list-style-type: none"> • NOTE: While verifying the condition, determine whether the noise is gear roll-over noise, release bearing rub or some other transmission-related noise. Gear roll-over noise, inherent in manual transmission, is caused by the constant mesh gears turning at engine idle speed while the clutch is engaged and the transmission is in NEUTRAL. Release bearing rub is sometimes mistaken for mainshaft bearing noise. Gear roll-over noise will disappear when the clutch is disengaged or when the transmission is engaged in gear. Release bearing rub will disappear when 	<ul style="list-style-type: none"> • Lubricant level low/incorrect type. 	<ul style="list-style-type: none"> • ADD or REFILL with the specified lubricant. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B(ZF 6-Speed Transmission).

<p>the clutch is engaged. In the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in NEUTRAL.</p> <p>Noisy in Forward Gears</p>		
	<ul style="list-style-type: none"> • Components grounding out on transmission. 	<ul style="list-style-type: none"> • CHECK for screws, bolts, etc., of cab or other components grounding out. CORRECT as necessary.
	<ul style="list-style-type: none"> • Bolts retaining transmission to engine loose. 	<ul style="list-style-type: none"> • VERIFY that the bolts are tightened to specification. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Bearings/gears worn/damaged. 	<ul style="list-style-type: none"> • INSPECT the bearings, the gears, and the gear teeth for wear and damage. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Gears Clash When Shifting From One Forward Gear to Another 	<ul style="list-style-type: none"> • Transmission input shaft pilot bearing worn/damaged. 	<ul style="list-style-type: none"> • INSPECT the transmission input shaft pilot bearing for wear and damage. REFER to

		<p>Pilot Bearing Check in this section. REPAIR as necessary.</p>
	<ul style="list-style-type: none"> • Gear teeth/synchronizer damaged. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B(ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Engine idle speed too high. 	<ul style="list-style-type: none"> • REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.
<ul style="list-style-type: none"> • Transmission Jumps Out of Gear 	<ul style="list-style-type: none"> • Gearshift lever boot installed incorrectly. 	<ul style="list-style-type: none"> • CHECK gearshift lever boot installation. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Bolts retaining transmission to engine loose. 	<ul style="list-style-type: none"> • TIGHTEN the bolts to specification. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Transmission input shaft pilot bearing. 	<ul style="list-style-type: none"> • INSTALL a new transmission input shaft pilot bearing. REFER to Section 308-01.

	<ul style="list-style-type: none"> • Axial clearance incorrect. • Internal components damaged. 	<ul style="list-style-type: none"> • CHECK axial clearance. INSPECT the synchronizer sleeves for free movement on their hubs. INSPECT the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surface. CHECK the countershaft cluster gear for excessive end play. INSPECT the shift forks for wear. CHECK for loose shift forks on the shift rails. INSPECT the synchronizer sliding sleeve and the gear clutch teeth for wear and damage. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Gear teeth worn/damaged. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Transmission Will Not Shift Into One Gear — All Others OK 	<ul style="list-style-type: none"> • Reversing switch ball frozen in extended position. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary.

	<ul style="list-style-type: none"> Internal components. 	<ul style="list-style-type: none"> For the gear in question, INSPECT the shift rail and fork, the synchronizer, and the gear clutch teeth for restricted travel. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> Transmission is Locked in One Gear and Will Not Shift Out of That Gear 	<ul style="list-style-type: none"> Internal components. 	<ul style="list-style-type: none"> INSPECT the gears, the shift rails, and the forks and the synchronizer for wear and damage. REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B(ZF 6-Speed Transmission).
<ul style="list-style-type: none"> Fluid Leaks 	<ul style="list-style-type: none"> Engine, power steering, transmission, clutch. 	<ul style="list-style-type: none"> REMOVE all traces of lubricant on the exposed transmission surfaces. VERIFY that the transmission vent is clear of foreign material. OPERATE the transmission. INSPECT for new leakage. REFER to the appropriate section for repair procedures. REFER to Section 211-02,Section 303-01A,

		<p>Section 303-01B, Section 303-01C, Section 308-02, Section 308-03A, or Section 308-03B.</p>
	<ul style="list-style-type: none"> • Input shaft bearing retainer seal. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Shift rail detent plug. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Top cover gasket. 	<ul style="list-style-type: none"> • INSPECT, and REPAIR as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Sand holes/cracks in case. 	<ul style="list-style-type: none"> • INSPECT, and INSTALL a new case as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).

	<ul style="list-style-type: none"> • Fill and drain plugs. 	<ul style="list-style-type: none"> • INSPECT the plug, the O-ring, and the threads in the case. REPAIR as necessary. TIGHTEN the plug to specification. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Noise Occurs During Transfer Case Operation 	<ul style="list-style-type: none"> • 4x4 system. 	<ul style="list-style-type: none"> • REFER to Section 308-07A for diagnosis and testing procedures.
<ul style="list-style-type: none"> • Transfer Case Jumps Out of Gear 	<ul style="list-style-type: none"> • 4x4 system. 	<ul style="list-style-type: none"> • REFER to Section 308-07A for diagnosis and testing procedures.

SYMPTOM CHART—TRANSMISSION COMPONENT WEAR AND DAMAGE

Condition	Possible Sources	Action
<ul style="list-style-type: none"> • Case Breakage 	<ul style="list-style-type: none"> • Shock loads/alternating loads. • Jerky release of clutch. 	<ul style="list-style-type: none"> • INSTALL a new case. REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission). DISCUSS vehicle operation with the customer.
	<ul style="list-style-type: none"> • Bolt size/length incorrect. • Bolt threaded into hole incorrectly. • Bolt not tightened to specification. 	<ul style="list-style-type: none"> • INSTALL a new case. REPAIR the transmission as necessary. REVIEW the transmission installation procedure. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).

<ul style="list-style-type: none"> • Shaft Damaged by Brinelling 	<ul style="list-style-type: none"> • Vibration. 	<ul style="list-style-type: none"> • CORRECT the condition causing the vibration. REFER to Section 100-04 for NVH diagnosis.
	<ul style="list-style-type: none"> • Driving at low road speed in a high gear. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
	<ul style="list-style-type: none"> • Engine related factors (such as crankshaft vibration damper damaged). 	<ul style="list-style-type: none"> • CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure..
	<ul style="list-style-type: none"> • Driveshaft imbalance. 	<ul style="list-style-type: none"> • CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> • Shaft Damaged by Fretting 	<ul style="list-style-type: none"> • Lubricant thermally aged. • Inadequate lubrication. • Lubricant not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
	<ul style="list-style-type: none"> • Towing vehicle with driveshaft connected. 	<ul style="list-style-type: none"> • DISCUSS vehicle towing procedure with the customer.
<ul style="list-style-type: none"> • Gear Teeth Damaged by Scratches 	<ul style="list-style-type: none"> • Dust and abrasive particles in lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Gear Teeth Damaged by Abrasive Wear 	<ul style="list-style-type: none"> • Lubricant contamination resulting from wear or surface fatigue in other areas of transmission. • Foreign material entering 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.

	transmission.	
<ul style="list-style-type: none"> • Gear Teeth Damaged by Scoring 	<ul style="list-style-type: none"> • Lubricant not meeting manufacturer's specification. • Temporary lack of lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Brinelling in Gear Teeth 	<ul style="list-style-type: none"> • Combination of inadequate lubrication, high flank loads and low peripheral speeds. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Slight Pittings in Gear Teeth 	<ul style="list-style-type: none"> • High local contact pressures on gears not completely run-in. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer. Continued run-in wear and a change in operating conditions may stop this type of pitting.
<ul style="list-style-type: none"> • Gear Teeth with Heavy Pitting Damage 	<ul style="list-style-type: none"> • Lubricant viscosity not meeting manufacturer's specification. • Lubricant temperature run too high. • Local sliding and rolling stresses exceed material specification. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance and vehicle operation with the customer.
<ul style="list-style-type: none"> • Gear Teeth Damaged by Spalling 	<ul style="list-style-type: none"> • Lubricant not meeting manufacturer's specification. • Lubricant temperature run too high. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation and transmission maintenance with the customer.
<ul style="list-style-type: none"> • Overheating and Thermal Gear 	<ul style="list-style-type: none"> • Temporary or complete lack of 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the

Deformation	lubrication.	customer.
<ul style="list-style-type: none"> • Gear Change Damage 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Gear Tooth Corrosion 	<ul style="list-style-type: none"> • Water in lubricant. • Condensation forming due to unfavorable operating conditions. • Lubricant aging. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Idler Gear Damaged by Brinelling 	<ul style="list-style-type: none"> • Transmission rebuilt with bearing not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • INSTALL a new anti-friction bearing meeting manufacture specification.
<ul style="list-style-type: none"> • Synchronizer Ring Molybdenum Corrosion 	<ul style="list-style-type: none"> • Water in lubricant. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
<ul style="list-style-type: none"> • Synchronizer Ring Molybdenum Coat Destruction 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. • Driving at low road speed in a high gear. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
	<ul style="list-style-type: none"> • Engine related factors (such as crankshaft vibration damper damaged). 	<ul style="list-style-type: none"> • CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure..
	<ul style="list-style-type: none"> • Driveshaft imbalance. 	<ul style="list-style-type: none"> • CORRECT the driveshaft imbalance. REFER to Section 205-00.

<ul style="list-style-type: none"> • Synchronizer Ring Broken 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. • Driving at low road speed in a high gear. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
	<ul style="list-style-type: none"> • Engine related factors (such as crankshaft vibration damper damaged). 	<ul style="list-style-type: none"> • CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure.
	<ul style="list-style-type: none"> • Driveshaft imbalance. 	<ul style="list-style-type: none"> • CORRECT the driveshaft imbalance. REFER to Section 205-00.
<ul style="list-style-type: none"> • Synchronizer Friction Cone Slightly Worn 	<ul style="list-style-type: none"> • Normal run-in wear. 	<ul style="list-style-type: none"> • INSPECT the engaging teeth for wear if a severe, permanent grating condition exists.
<ul style="list-style-type: none"> • Synchronizer 	<ul style="list-style-type: none"> • Insufficient clutch 	<ul style="list-style-type: none"> • INSPECT the clutch disc and

<p>Friction Cone Worn with Material Displaced</p>	<p>hydraulic system fluid.</p> <ul style="list-style-type: none"> • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<p>pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.</p>
	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Synchronizer Gear Shift Teeth Worn 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Synchronizer Body External Tooth Splines Worn 	<ul style="list-style-type: none"> • Driving at low road speed in a high gear. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
	<ul style="list-style-type: none"> • Engine related factors (such as crankshaft vibration damper damaged). 	<ul style="list-style-type: none"> • CORRECT as necessary. Refer to the appropriate section in Group 303 for the procedure.
	<ul style="list-style-type: none"> • Driveshaft imbalance. 	<ul style="list-style-type: none"> • CORRECT the driveshaft imbalance. REFER to Section 205-00.

<ul style="list-style-type: none"> • Synchronizer Body Stops Broken 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Synchronizer Sliding Sleeve Stop Deformed 	<ul style="list-style-type: none"> • Shift unit set incorrectly. 	<ul style="list-style-type: none"> • INSPECT for interference between the shift unit and the vehicle. REPAIR as necessary.
<ul style="list-style-type: none"> • Synchronizer Gear Shift Teeth Worn 	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Synchronizer Inner Ring Heat Discolored with Slight Material Displacement 	<ul style="list-style-type: none"> • Normal synchronizer operation with high shift effort. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. CHECK the clutch release hub and bearing for binding, and INSPECT the guide tube. INSPECT the

		<p>input shaft for wear and damage. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.</p>
<ul style="list-style-type: none"> • Synchronizer Inner Ring Material Displaced 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Clutching and shifting transmission incorrectly. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Synchronizer Outer Ring Heat Discolored with 	<ul style="list-style-type: none"> • Normal synchronizer operation with 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage. REFER to Clutch

<p>Slight Material Displacement</p>	<p>high shift effort.</p>	<p>Pressure Plate Check and to Clutch Disc Check in this section. CHECK the clutch release hub and bearing for binding, and INSPECT the guide tube. INSPECT the input shaft for wear and damage. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.</p>
<ul style="list-style-type: none"> • Synchronizer Outer Ring Material Displaced 	<ul style="list-style-type: none"> • Insufficient clutch hydraulic system fluid. • Clutch hydraulic system fluid leakage. • Air in clutch hydraulic system. • Clutch pressure plate worn/damaged. • Clutch disc damaged. • Clutch disc splines rusted/worn. • Clutch disc runout excessive. 	<ul style="list-style-type: none"> • INSPECT the clutch disc and pressure plate for wear and damage, and CHECK the clutch disc runout. REFER to Clutch Pressure Plate Check and to Clutch Disc Check in this section. VERIFY that the clutch hydraulic fluid reservoir is filled to the correct level. ADD fluid as necessary. INSPECT the clutch hydraulic system for leaks, and REPAIR as necessary. REFER to Section 308-02. BLEED the clutch hydraulic system as necessary. REFER to Clutch System Bleeding—In-Vehicle in this section. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Clutching and shifting 	<ul style="list-style-type: none"> • DISCUSS vehicle operation

	transmission incorrectly.	with the customer.
<ul style="list-style-type: none"> • General Bearing Wear 	<ul style="list-style-type: none"> • Lubricant contaminated. • Lubricant thermally aged. • Lubricant not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
	<ul style="list-style-type: none"> • High mileage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Bearing Worn with Subsequent Damage 	<ul style="list-style-type: none"> • Lubricant contaminated. • Lubricant thermally aged. • Lubricant not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
	<ul style="list-style-type: none"> • High mileage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Vehicle overloading. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Bearing Fatigue 	<ul style="list-style-type: none"> • Lubricant contaminated. • Lubricant thermally aged. • Lubricant not meeting manufacturer's 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.

	specification.	
	<ul style="list-style-type: none"> • High mileage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Bearing Collar Broken 	<ul style="list-style-type: none"> • Seizure. • Other transmission or driveline components damaged broken. • Accident damage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Operator error. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation with the customer.
<ul style="list-style-type: none"> • Bearing Damaged by Fretting or Seizure 	<ul style="list-style-type: none"> • Inadequate lubrication. 	<ul style="list-style-type: none"> • DISCUSS transmission maintenance with the customer.
	<ul style="list-style-type: none"> • Towing vehicle with driveshaft connected. 	<ul style="list-style-type: none"> • DISCUSS vehicle towing procedure with the customer.
	<ul style="list-style-type: none"> • Incorrect driveline angles. 	<ul style="list-style-type: none"> • CHECK the driveline angles. REFER to Section 205-00.
<ul style="list-style-type: none"> • Sealing Element Radial Shaft Sealing Ring Damaged 	<ul style="list-style-type: none"> • Thermal Overload. • Lubricant not meeting manufacturer's specification. 	<ul style="list-style-type: none"> • Discuss vehicle operation and transmission maintenance with the customer.
<ul style="list-style-type: none"> • Sealing Element Sealing Lip Worn 	<ul style="list-style-type: none"> • Effect of dirt from outside. • Excessive temperatures. • Case vent blocked. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation and transmission maintenance with the customer.

	<ul style="list-style-type: none"> • Vibration. 	<ul style="list-style-type: none"> • CORRECT the condition causing the vibration. REFER to Section 100-04 for NVH diagnosis.
	<ul style="list-style-type: none"> • High mileage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
	<ul style="list-style-type: none"> • Radial shaft sealing ring not pushed in evenly during assembly. • Shaft race damaged. 	<ul style="list-style-type: none"> • REVIEW repair procedures. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Sealing Element Rectangular/Lipped Sealing Ring Sheared 	<ul style="list-style-type: none"> • Incorrect seal installation. • Damaged by assembly tool. • Incorrect repair. 	<ul style="list-style-type: none"> • INSPECT adjacent component contact surfaces, edges, insertion tapers, and REPAIR as necessary. REVIEW repair procedures. REFER to Section 308-03A (Model S5-47ZF Transmission) or Section 308-03B (ZF 6-Speed Transmission).
<ul style="list-style-type: none"> • Sealing Element Worn/Hardened 	<ul style="list-style-type: none"> • Clutch damage 	<ul style="list-style-type: none"> • INSPECT the clutch components, and REPAIR as necessary.
	<ul style="list-style-type: none"> • Vehicle overloading. • Inadequate cooling. • Contaminants. 	<ul style="list-style-type: none"> • DISCUSS vehicle operation and transmission maintenance with the customer.
	<ul style="list-style-type: none"> • Grooves on contact surfaces. 	<ul style="list-style-type: none"> • INSPECT component contact surfaces and REPAIR as necessary. REVIEW repair procedures. REFER to Section 308-03A (Model S5-47ZF Transmission) or

SECTION 308-00: Manual Transaxle/Transmission and Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

GENERAL PROCEDURES

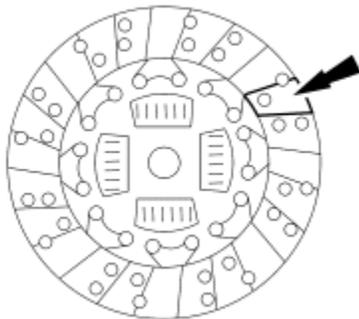
[Procedure revision date:](#)
[01/26/2000](#)

Clutch Disc Check

1. **NOTE:** Use emery cloth to remove minor imperfections in the clutch disc friction surface.

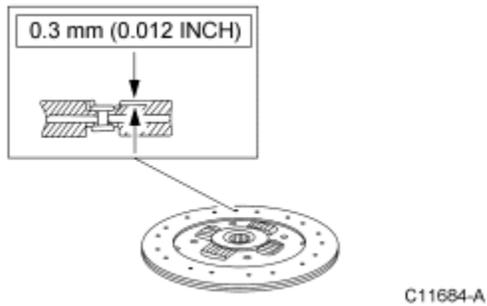
Inspect the clutch disc (7550) for:

- oil and grease saturation.
- worn and loose rivets at the hub.
- broken springs.
- wear and rust on the splines.
 - Install a new clutch disc if any of these conditions are present.

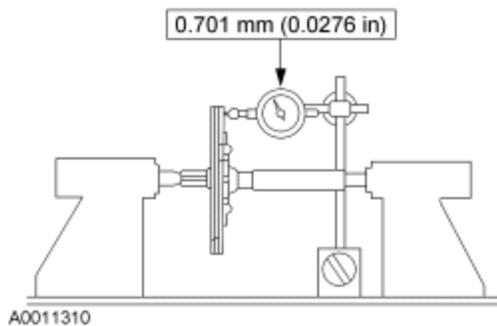


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2. Using a suitable slide caliper, measure the depth to the rivet heads.
 - Install a new clutch disc if the measurement is less than the specification.



3. Using a suitable dial indicator, measure the clutch disc runout.
 - Install a new clutch disc if the measurement is greater than the specification.



SECTION 308-00: Manual Transaxle/Transmission and Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

GENERAL PROCEDURES

[Procedure revision date:](#)
[01/26/2000](#)

Clutch Pressure Plate Check

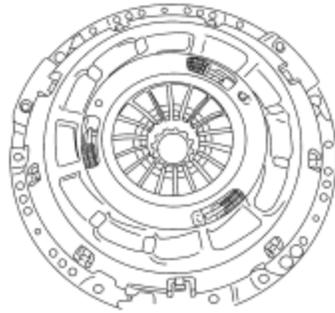
1.  **CAUTION: Do not use petroleum based cleaning solutions.**

 **CAUTION: Do not immerse the clutch pressure plate (7563) in the cleaning solution.**

If necessary, use a suitable cleaning solution to remove any oil film from the clutch pressure plate friction surface.

2. Inspect the clutch pressure plate levers for heavy wear associated with binding. Also, inspect for substantial difference in lever wear. Inspect the clutch pressure plate friction surface for scoring, burning, heat checking, distortion, warping, and dishing.

- Install a new clutch pressure plate if any of these conditions are present.



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SECTION 308-00: Manual Transaxle/Transmission and
Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

GENERAL PROCEDURES

[Procedure revision date:](#)
[09/09/2002](#)

Flywheel Check

1.  **CAUTION: Do not use petroleum based cleaning solutions.**

NOTE: Always inspect the flywheel whenever the clutch is removed or installed new.

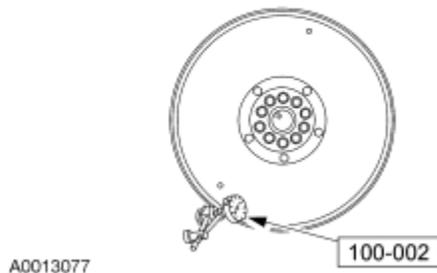
Using a suitable cleaning solution, clean the flywheel clutch surface.

2. Inspect the flywheel for:
 - surface cracks.
 - heat check.
 - glazing.
 - scoring.
 - scratches or grooves.
 - For minor damage, finish the flywheel surface with coarse emery cloth or with a fine grade (400 grit) sandpaper. To polish the surface, stroke parallel to the machine lines.
 3. Inspect the ring gear for:
 - worn, chopped or broken teeth.
-

Flywheel Runout Check

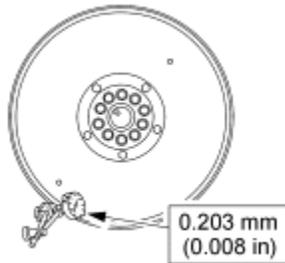
Special Tool(s)	
 ST1214-A	Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C) or equivalent

1. Push the flywheel forward.
2. Install the special tool against the flywheel face 25 mm (1 in) from the outer edge of the flywheel. Zero the dial indicator.



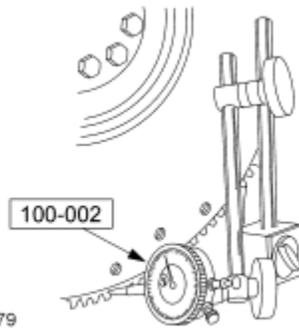
3. Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The flywheel TIR must not exceed the specification.
 - If the flywheel TIR does not exceed the specification, proceed to the next step in this procedure to check the ring gear runout.
 - If the flywheel TIR exceeds the specification, remove the flywheel. For additional information, refer to [Section 308-01](#). Check for burrs between the flywheel and the crankshaft mounting flange. If burrs exist, remove them. Check the crankshaft flange runout.
 - If the crankshaft flange TIR does not exceed specification, and no burrs were found between the flywheel and the crankshaft mounting flange, install a new flywheel.
 - If the crankshaft flange TIR does not exceed specification, but burrs were removed from between the flywheel and the crankshaft mounting flange, reinstall the flywheel. For additional information, refer to [Section 308-01](#). Recheck the flywheel runout. If the flywheel TIR exceeds the specification, install a new flywheel.

- If the crankshaft flange TIR exceeds specification, repair as necessary. Refer to the appropriate section in Group [303](#) for the procedure. Reinstall the flywheel. For additional information, refer to [Section 308-01](#). Recheck the flywheel runout. If the flywheel TIR exceeds the specification, install a new flywheel.



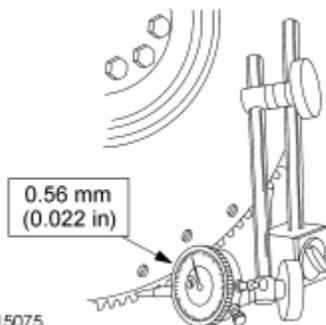
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4. Install the special tool against the ring gear face adjacent to the teeth. Zero the dial indicator.



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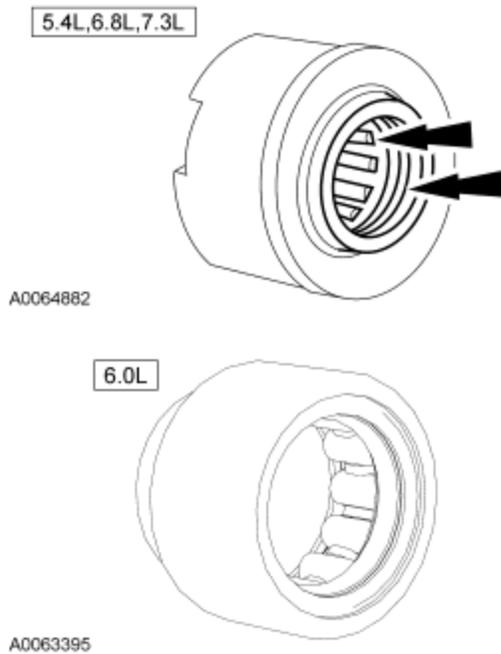
5. Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The ring gear TIR must not exceed the specification.
 - If the ring gear TIR exceeds the specification, install a new flywheel and ring gear assembly.



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Pilot Bearing Check

1. Inspect the transmission input shaft pilot bearing:
 - for misalignment and looseness in the crankshaft (gasoline engine) or the flywheel (diesel engine).
 - needle rollers for scoring, discoloration, wear, broken rollers, and inadequate lubricant.
 - seal for damage and lubricant leakage.
 - Install a new transmission input shaft pilot bearing if any of these conditions are present. Refer to [Section 308-01](#).

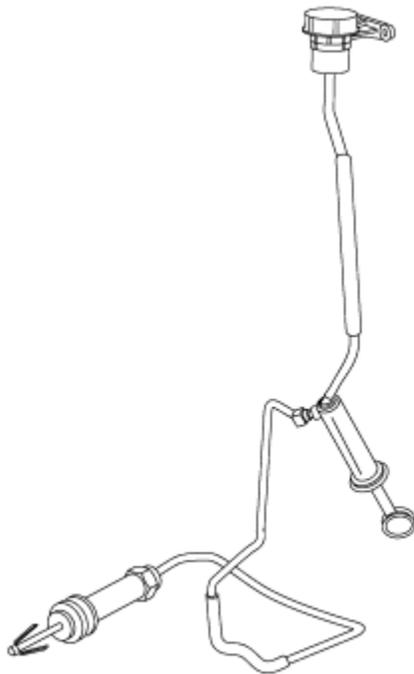


Clutch Cylinder Bench Bleeding

Material	
Item	Specification
High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB	ESA-M6C25-A, DOT 3

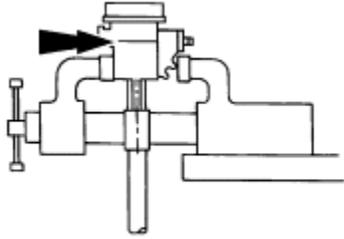
1.  **CAUTION:** So as not to trap air in the clutch hydraulic system, fill any disconnected component (such as master cylinder, slave cylinder) with the specified brake fluid before connecting it.

Support the clutch hydraulic system components so that the reservoir is above the master cylinder and the slave cylinder is below the master cylinder.



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2. Fill the clutch master cylinder reservoir to the full line with brake fluid.

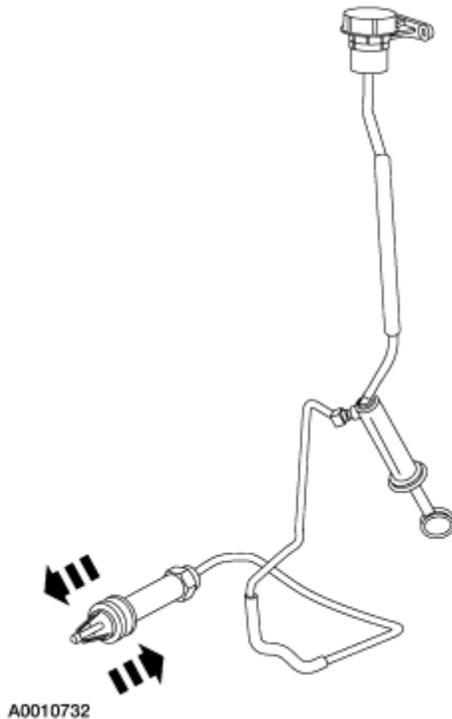


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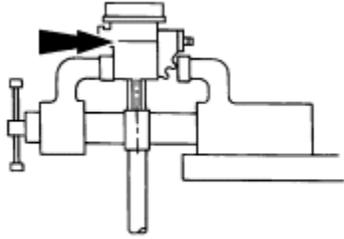
3.  **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**

Purge the air from the clutch hydraulic system.

- Push the push rod slowly into the slave cylinder until it bottoms out the piston. Hold the push rod in this position for five to ten seconds to allow all trapped air to rise through the system. Look for air bubbles in the fluid in the clutch hydraulic reservoir. Very slowly, so that air is not drawn back into the slave cylinder, release the pushrod (the spring in the slave cylinder will force the piston outward). Wait five to ten seconds for the air bubbles to rise. Repeat this process five to ten times to make sure that all air purged from the system.



4. Verify that the fluid level in the reservoir is correct, and install the cap.



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SECTION 308-00: Manual Transaxle/Transmission and Clutch — General Information

1999 F-Super Duty 250-550
Workshop Manual

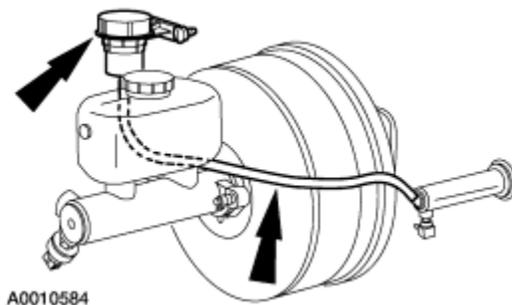
GENERAL PROCEDURES

Procedure revision date:
01/26/2000

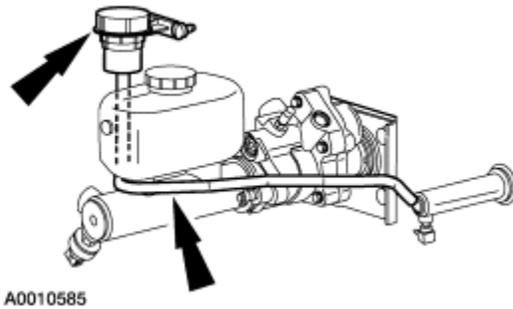
Clutch System Bleeding—In-Vehicle

Material	
Item	Specification
High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB	ESA-M6C25-A, DOT 3

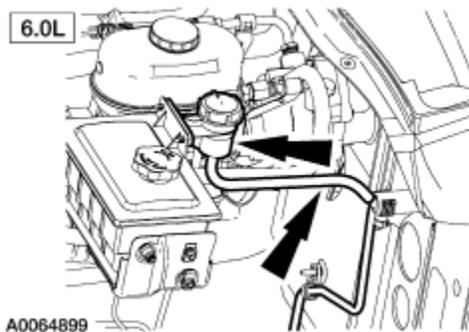
1. Fill the clutch master cylinder reservoir to the full line with DOT 3 Brake Fluid.
2. Verify that the reservoir-to-master cylinder tube routing is as shown so as not to trap air in the clutch hydraulic system. Correct the routing as necessary.
 - The routing for vacuum boost brakes and hydraboost brakes differ. Also, the reservoir location for 6.0L vehicles differ. Make sure the tube is routed correctly during installation.



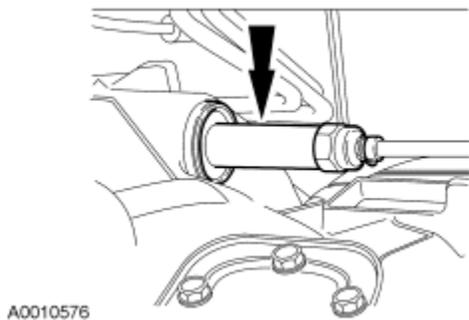
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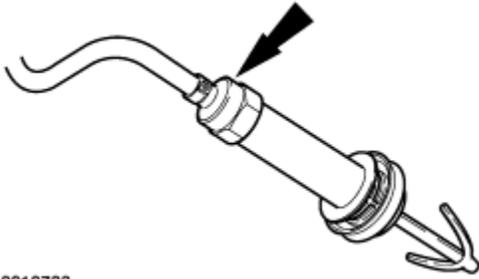
3. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).



4. Unlock, and remove the slave cylinder from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



5. Disconnect the clutch hydraulic tube from the floor pan clip.
6. Position the slave cylinder and the hydraulic tube so that there are no high points that could trap air in the system.
 - Position the slave cylinder push rod downward. Route the hydraulic tube upward as straight as possible toward the master cylinder so that the air can flow freely to the fluid reservoir.

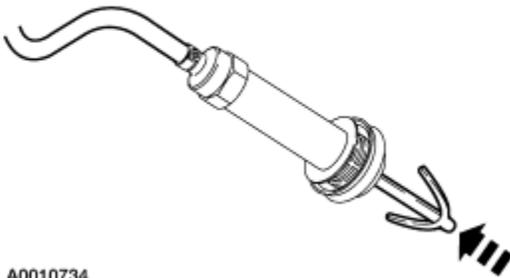


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7.  **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**

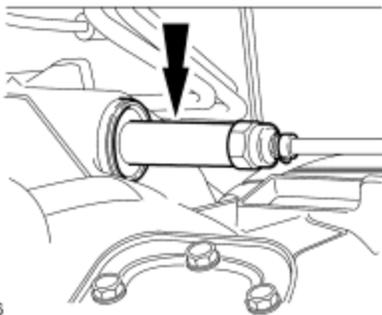
Purge the air from the clutch hydraulic system.

- Push the push rod slowly into the slave cylinder until it bottoms out the piston. Hold the push rod in this position for five to ten seconds to allow all trapped air to rise through the system. Very slowly, so that air is not drawn back into the slave cylinder, release the push rod (the spring in the slave cylinder will force the piston outward). Wait five to ten seconds for the air bubbles to rise. Repeat this process until all air purged from the system. Verify that the fluid in the reservoir is free of air bubbles.



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8. Install the slave cylinder.
- Compress and twist the slave cylinder to lock it onto the transmission.



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9. Connect the clutch hydraulic tube to the floor pan clip.

10. Lower the vehicle.
11. Slowly depress and release the clutch pedal 20 to 25 times to bleed any air still trapped in the system. Verify that the fluid in the reservoir is free of air bubbles.
12. Verify that the fluid level in the reservoir is correct, and install the cap.

SECTION 308-00: Manual Transaxle/Transmission and
Clutch — General Information
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550
Workshop Manual
Procedure revision date:
01/26/2000

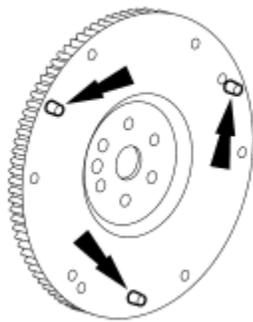
Clutch Pressure Plate Locating Dowels

Removal

1.  **CAUTION: Do not damage the bore or the surrounding surface area.**

When installed in an open hole, use a drift to remove the dowel. When installed in a blind hole, use locking pliers to remove the dowel.

- There are two dowels on the diesel engine flywheel, and three dowels on the gasoline engine flywheel.



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Installation

1.  **CAUTION: Do not damage the bore or the surrounding surface area.**

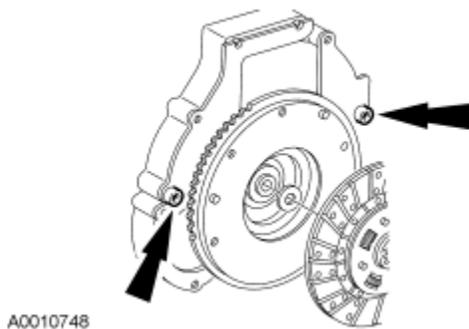
Using a brass or plastic mallet, drive the dowels squarely into place until fully seated in the bore.

Clutch Housing Locating Dowels

Removal

1.  **CAUTION: Do not damage the bore or the surrounding surface area.**

When installed in an open hole, use a drift to remove the dowel. When installed in a blind hole, use locking pliers to remove the dowel.



Installation

1.  **CAUTION: Do not damage the bore or the surrounding surface area.**

Using a brass or plastic mallet, drive the dowels squarely into place until fully seated in the bore.

**SECTION 308-01:
Clutch**

SPECIFICATIONS

DESCRIPTION AND OPERATION

Clutch

DIAGNOSIS AND TESTING

Clutch

REMOVAL AND INSTALLATION

Clutch Disc and Pressure Plate

Pilot Bearing

Flywheel

Flywheel Ring Gear

SECTION 308-01: Clutch
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop Manual
Procedure revision date: 01/26/2000

General Specifications	
Item	Specification
Clutch Disc	
O.S. diameter (approx) mm (in) (5.4L)	303 (11.9)
I.S. diameter (approx) mm (in) (5.4L)	213 (8.3)
O.S. diameter (approx) mm (in) (6.8L)	303 (11.9)
I.S. diameter (approx) mm (in) (6.8L)	174 (6.8)
O.S. diameter (approx) mm (in) (7.3L Diesel)	330 (12.9)
I.S. diameter (approx) mm (in) (7.3L Diesel)	210 (8.2)
Lining material (5.4L and 6.8L)	F808 woven non-asbestos

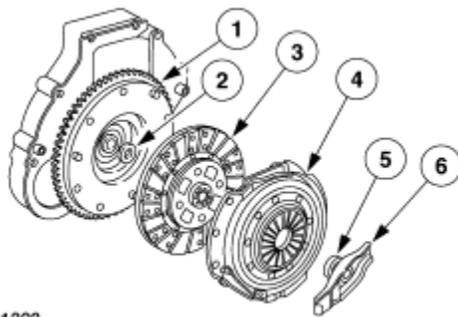
Lining material (7.3L Diesel)	F808 MCC woven non-asbestos
Lubricant	
High-Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A	ESA-M1C198-A

Torque Specifications		
Description	Nm	lb-ft
Clutch pressure plate bolt—5.4L, 6.8L	45	33
Clutch pressure plate bolt—7.3L	28	21
Flywheel bolt—5.4L and 6.8L	80	59
Flywheel bolt—7.3L	121	89

SECTION 308-01: Clutch
DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Clutch



A0011323

Item	Part Number	Description
1	6375	Flywheel
2	7120	Transmission input shaft pilot bearing
3	7550	Clutch disc
4	7563	Clutch pressure plate
5	7548	Release bearing
6	7515	Release lever

Clutch

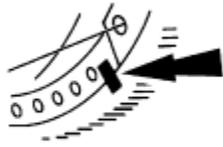
Refer to [Section 308-00](#).

Clutch Disc and Pressure Plate

Special Tool(s)	
 ST1469-A	Clutch Aligner (5-Speed) 308-090 (T83T-7137-A)
 ST1469-A	Clutch Aligner (6-Speed) 308-421

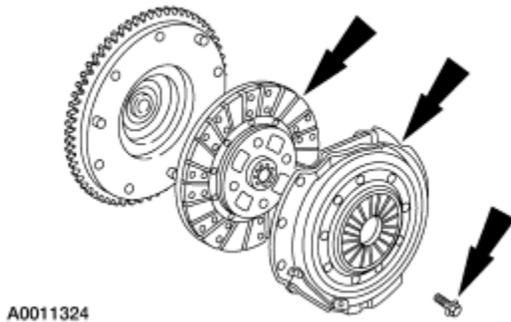
Removal

1. Remove the transmission. For additional information, refer to [Section 308-03A](#) (5-speed) or [Section 308-03B](#) (6-speed).
2. Index-mark the clutch pressure plate (7563) and the flywheel (6375), if reinstalling these parts.



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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.**

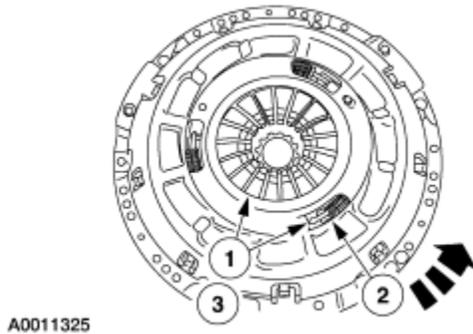
Lubricate the transmission input shaft pilot bearing, as necessary.

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

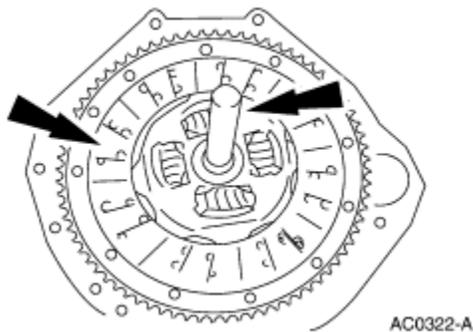
2.  **CAUTION: When installing the original clutch pressure plate on 5.4L and 6.8L applications, reset the wear indicator before installing the clutch pressure plate on the flywheel.**

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.

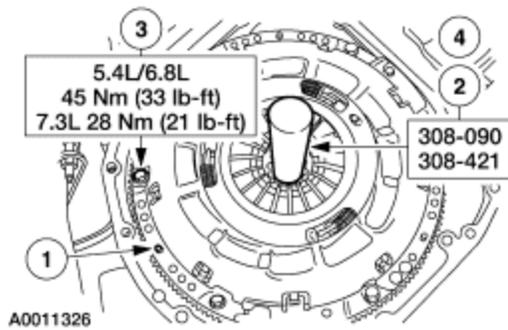


4. **NOTE:** Align the index marks if installing the original clutch pressure plate and flywheel.

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.

- Remove the special tool.



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

SECTION 308-01: Clutch
REMOVAL AND INSTALLATION

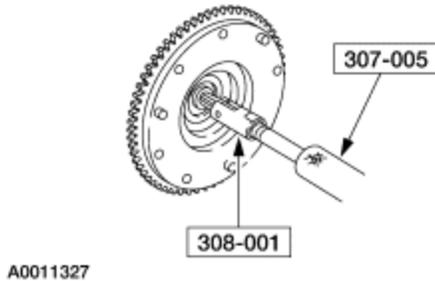
1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Pilot Bearing

Special Tool(s)	
 ST1187-A	Impact Slide Hammer 307-005 (T59L-100-B)
 ST1470-A	Pilot Bearing Replacer 308-105 (T85T-7137-A)
 ST1282-A	Puller 308-001 (T58L-101-B)

Removal

1. Using the special tools, remove the transmission input shaft pilot bearing (7120), and discard it.

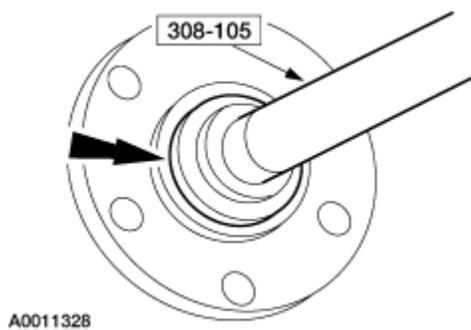


Installation

1. **⚠ CAUTION: Never install a used transmission input shaft pilot bearing.**

NOTE: The new transmission input shaft pilot bearing is pre-greased and does not require additional lubrication.

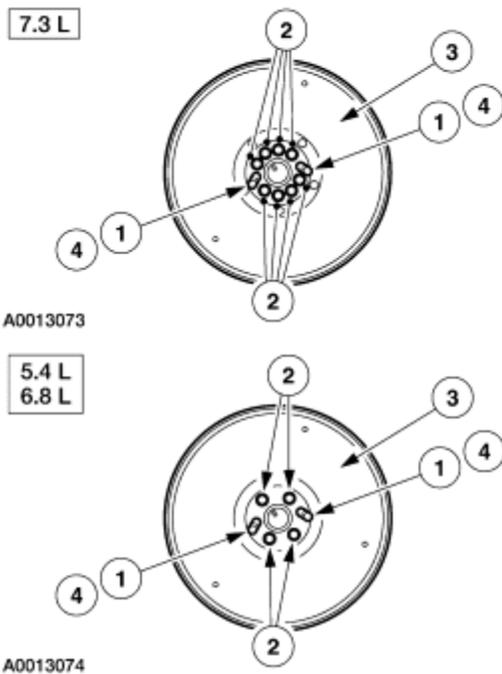
Using a soft-face hammer and the special tool, install the new transmission input shaft pilot bearing.



Flywheel

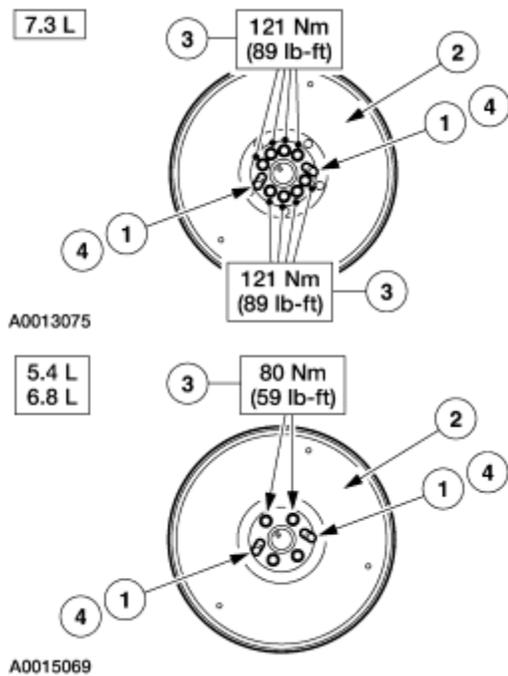
Removal

1. Prepare the vehicle for flywheel removal.
 1. Remove the Transmission. For additional information, refer to [Section 308-03A](#)(Model S5-47ZF Transmission) or [Section 308-03B](#)(ZF 6-Speed Transmission).
 2. Remove the clutch pressure plate and disc. For additional information, refer to [Clutch Disc and Pressure Plate](#) in this section.
2. Remove the flywheel.
 1. Remove the bolts. Install the guide studs.
 2. Remove the bolts.
 3. Remove the reinforcing ring (7.3L), and the flywheel and ring gear assembly.
 4. Remove the guide studs.



Installation

1. Install the flywheel.
 1. Install the guide studs.
 2. Install the flywheel and ring gear assembly, and the reinforcing ring (7.3L).
 3. Install the bolts.
 4. Remove the guide studs. Install and tighten the bolts to specification.



2. Restore the vehicle to operating condition.
 1. Install the clutch disc and pressure plate. For additional information, refer to [Clutch Disc and Pressure Plate](#) in this section.
 2. Install the transmission. For additional information, refer to [Section 308-03A](#)(Model S5-47ZF Transmission) or [Section 308-03B](#)(ZF 6-Speed Transmission).

Flywheel Ring Gear

Removal

⚠ WARNING: Carry out this procedure only if experienced with acetylene torches and equipped with the correct equipment. Failure to follow these instructions may result in personal injury.

1. Remove the clutch pressure plate (7563) and the clutch disc (7550). For additional information, refer to [Clutch Disc and Pressure Plate](#) in this section.

2. Remove the flywheel (6375). For additional information, refer to [Flywheel](#) in this section.

3. **⚠️ WARNING:** Wear asbestos gloves and use tongs when handling the hot flywheel and flywheel ring gear (6384). Failure to follow these instructions may result in personal injury.

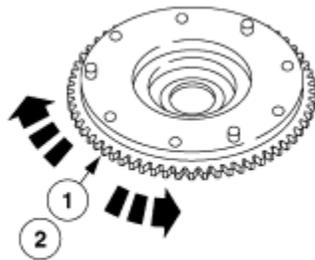
⚠️ CAUTION: Do not heat the flywheel ring gear above 278°C (500°F). Use heat indicating crayons to prevent overheating.

⚠️ CAUTION: Keep the torch moving to prevent hot spots.

⚠️ CAUTION: Tap evenly around the ring gear to prevent binding.

Remove the flywheel ring gear from the flywheel.

1. Heat the entire flywheel ring gear evenly.
2. Using a brass drift and a hammer, drive the flywheel ring gear from the flywheel.



A0011329

Installation

⚠️ WARNING: Carry out this procedure only if experienced with acetylene torches and equipped with the correct equipment. Failure to follow these instructions may result in personal injury.

1. **⚠️ WARNING:** Wear asbestos gloves and use tongs when handling the hot flywheel and ring gear. Failure to follow these instructions may result in personal injury.

⚠️ CAUTION: Do not heat the flywheel ring gear above 278°C (500°F). Use heat indicating crayons to prevent overheating.

⚠️ CAUTION: Keep the torch moving to prevent hot spots.

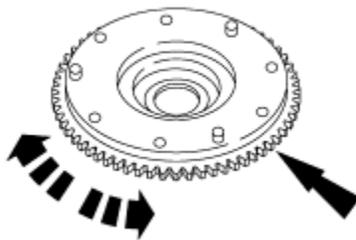
Heat the entire flywheel ring gear evenly.

2.  **WARNING: Wear asbestos gloves and use tongs when handling the hot flywheel and ring gear. Failure to follow these instructions may result in personal injury.**

 **CAUTION: The bevel on the ring gear must face the rear of the flywheel.**

 **CAUTION: Tap evenly around the ring gear to prevent binding.**

Using a brass drift and a hammer, install the flywheel ring gear.



A0011330

3. Install the flywheel (6375). For additional information, refer to [Flywheel](#) in this section.
 4. Install the clutch disc and pressure plate. For additional information, refer to [Clutch Disc and Pressure Plate](#) in this section.
-

**SECTION 308-02:
Clutch Controls**

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Clutch Controls](#)

DIAGNOSIS AND TESTING

[Clutch Controls](#)

REMOVAL AND INSTALLATION

[Clutch Pedal](#)

[Clutch Master Cylinder and Reservoir](#)

[Clutch Slave Cylinder](#)

[Clutch Hydraulic Fluid Tubes—Clutch Master Cylinder-to-Slave Cylinder](#)

SECTION 308-02: Clutch Controls
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

General Specifications	
Item	Specification
Clutch System	
Clutch Control	Hydraulic
System Adjustment	Automatic
Clutch Pedal Type	Suspended
Clutch Pedal Travel mm (in) (5.4L/6.8L)	166-177 (6.5-7)
Clutch Pedal Travel mm (in) (7.3L)	201-203 (7.9-8.0)
Fluid	
Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB	ESA-M6C25-A
Lubricant	

Premium Long-Life Grease
XG-1-C, XG-1-K

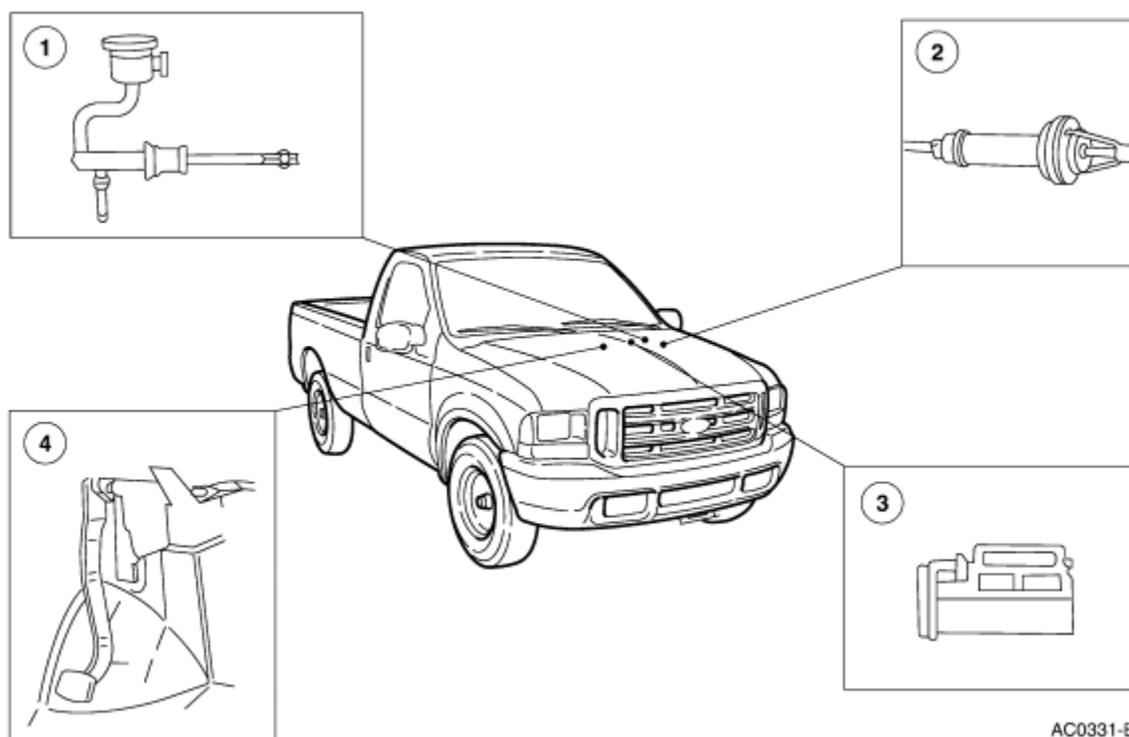
ESA-M1C75-B

Torque Specifications		
Description	Nm	lb-ft
Clutch Pedal Support Bracket Nut	25	18

SECTION 308-02: Clutch Controls
DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Clutch Controls



AC0331-B

Item	Part Number	Description
1	7C522	Clutch master cylinder assembly
2	7A564	Slave cylinder
3	7C534	Clutch pedal position switch
4	7B633	Clutch pedal and support bracket

The hydraulic clutch system adjusts automatically to compensate for clutch disc wear.

SECTION 308-02: Clutch Controls
DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Clutch Controls

Refer to [Section 308-00](#).

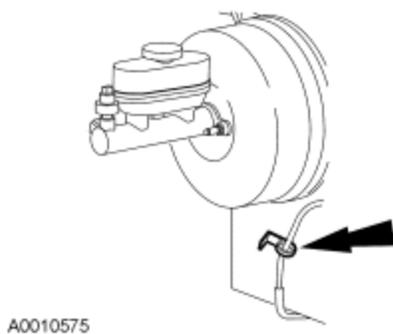
SECTION 308-02: Clutch Controls
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

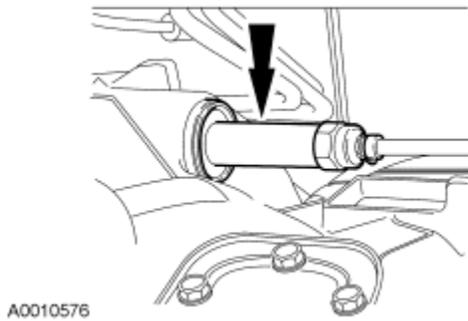
Clutch Pedal

Removal and Installation

1. Disconnect the clutch hydraulic tube from the dash clip.



2. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
3. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.

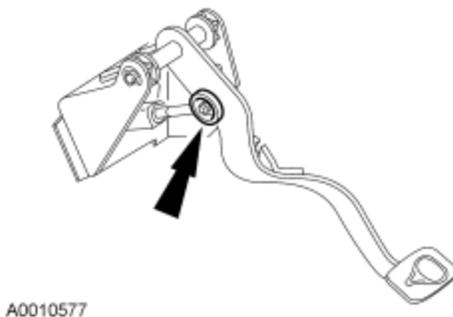


4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.

5. Lower the vehicle.

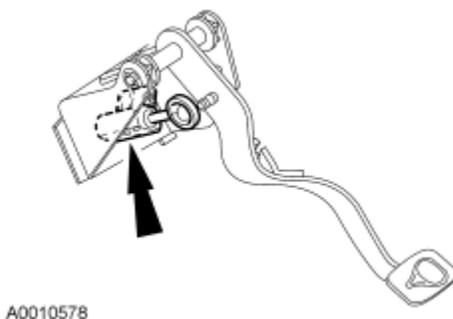
6.  **WARNING: The clutch pedal is under spring tension.**

Unlock the push rod bushing retaining clips and separate the clutch master cylinder push rod from the clutch pedal.

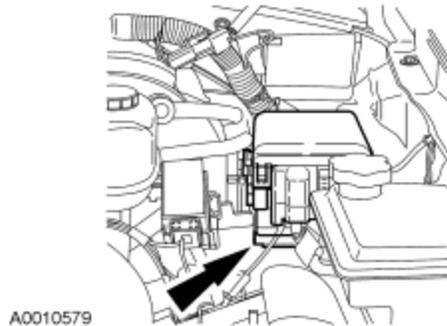


7. Remove and discard the push rod bushing (7526).

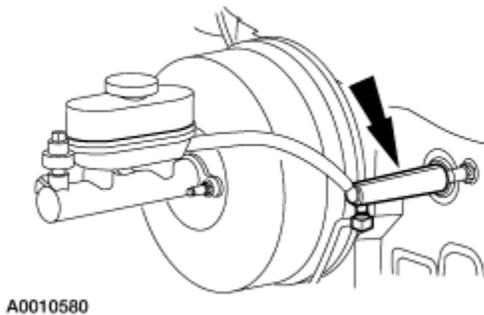
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



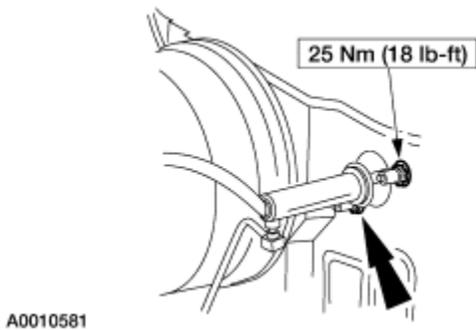
9. Separate the power distribution box from the bracket to gain access to the clutch master cylinder.



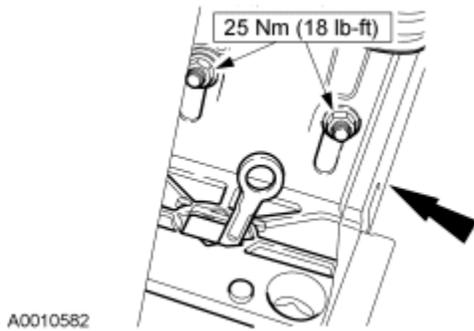
10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
- Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.



11. Remove the nuts.



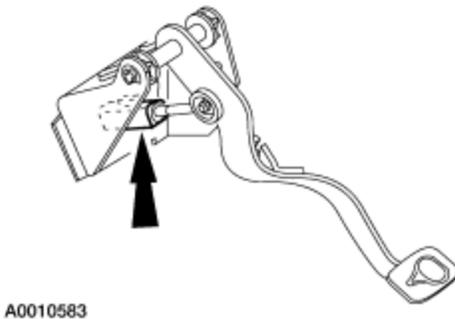
12. Remove the nuts and the clutch pedal and support bracket.



13. To install, reverse the removal procedure noting the following:
- Seat the clutch master cylinder rubber seal to the bulkhead after locking the clutch master cylinder in the clutch pedal and support bracket.
 - Route the clutch master cylinder-to-slave cylinder hydraulic tube under the brake booster after installing the clutch master cylinder.

14.  **CAUTION:** When installed correctly, the clutch pedal position switch wiring connector must be in the 1 o'clock position for pre-February 1998 production vehicles and in the 12 o'clock position for vehicles produced after January 1998. Incorrect installation will damage the clutch pedal position switch and cause insufficient clutch pedal travel.

Correctly position the clutch pedal position switch when installing it on the clutch master cylinder push rod.

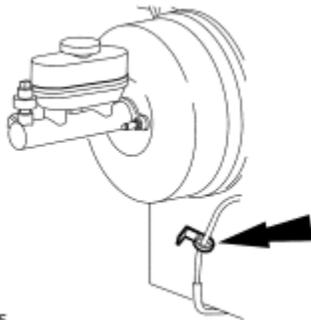


Clutch Master Cylinder and Reservoir

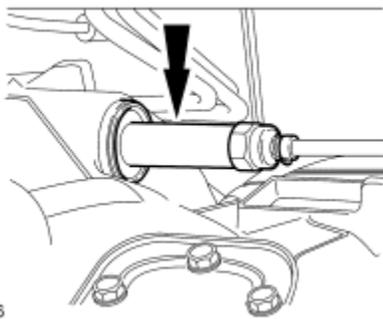
Removal

⚠ CAUTION: Remove the entire clutch hydraulic system from the vehicle as an assembly when installing a new clutch master cylinder assembly (7C522).

1. Disconnect the clutch hydraulic tube from the dash clip.

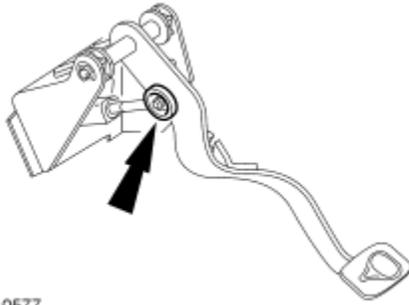


2. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
3. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



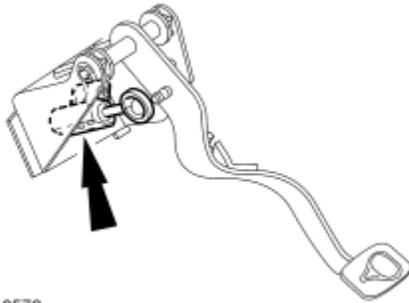
4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.
5. Lower the vehicle.
6. **⚠ WARNING: The clutch pedal is under spring tension.**

Unlock the push rod bushing retaining clips and separate the clutch master cylinder push rod from the clutch pedal.



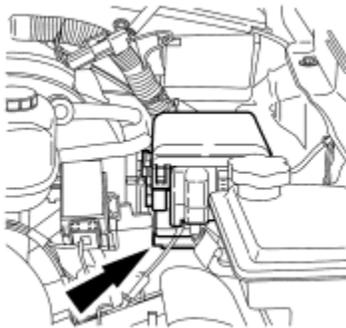
A0010577

7. Remove and discard the push rod bushing (7526).
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



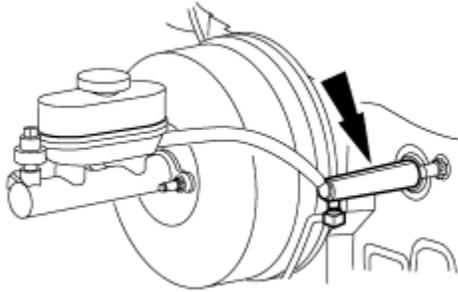
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9. Separate the power distribution box from the bracket to gain access to the clutch master cylinder.



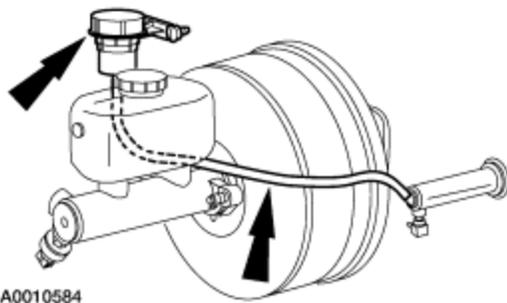
A0010579

10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
 - Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.

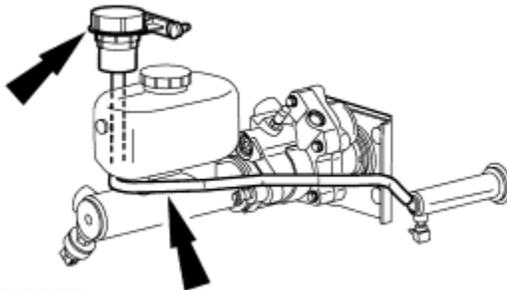


A0010580

11. Remove the clutch hydraulic reservoir from the wiring tray and separate the clutch hydraulic tube from the brake master cylinder assembly. Position the clutch hydraulic reservoir aside.



A0010584



A0010585

12.  **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash the surface with water immediately.**

Remove the clutch hydraulic system from the vehicle.



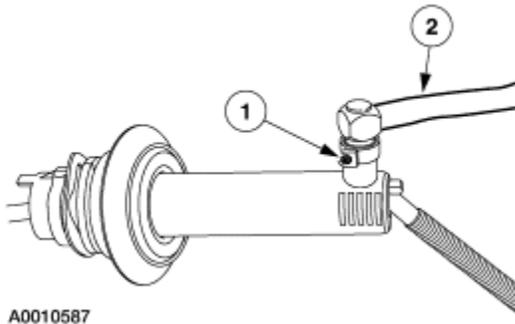
A0010586

13. Clean the clutch hydraulic system components to prevent contaminants from entering the hydraulic system.

14.  **CAUTION: Place a suitable container under the clutch master cylinder.**

Disconnect the hydraulic tube from the clutch master cylinder.

1. Using a 3/32-inch punch and a hammer, drive out the roll pin, and discard it.
2. Disconnect the hydraulic tube from the clutch master cylinder.



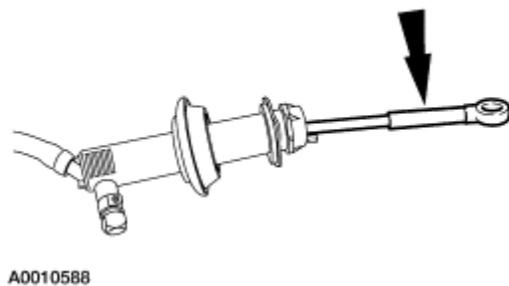
15. **NOTE:** Sometimes the O-ring seal will remain inside the clutch master cylinder.

Remove the O-ring seal from the end of the hydraulic tube, and discard it. Cap the open end of the hydraulic tube.

Installation

1.  **CAUTION: The push rod is not removable after installing it in the clutch master cylinder.**

Install the new push rod in the clutch master cylinder.



2.  **CAUTION: Place a suitable container under the clutch master cylinder.**

Support the hydraulic components so that the reservoir is above the master cylinder.

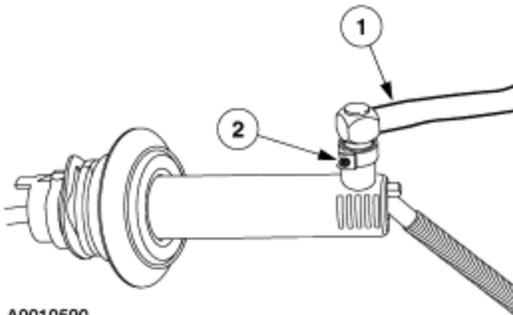


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3.  **CAUTION: Do not let the reservoir run dry.**

Purge the air from the clutch master cylinder assembly (7C522). Install the reservoir cap, and cap the port in the master cylinder after purging the system of air.

- Fill the reservoir with Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A. Allow the fluid to flow through the master cylinder and run out into the container. Do not let the reservoir run dry. Repeat this process, refilling the reservoir 2 to 3 times, to ensure that all air purged from the assembly. Install the reservoir cap, and cap the port in the master cylinder after purging the system of air.
4. Remove the cap from the opening in the hydraulic tube. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.
5. Remove the cap from the port in the clutch master cylinder. Connect and secure the hydraulic tube to the clutch master cylinder.
1. Connect the hydraulic tube to the clutch master cylinder.
 2. Install the new roll pin.

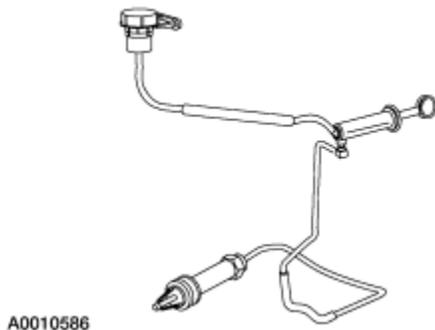


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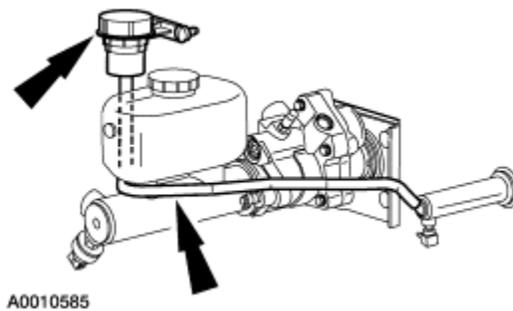
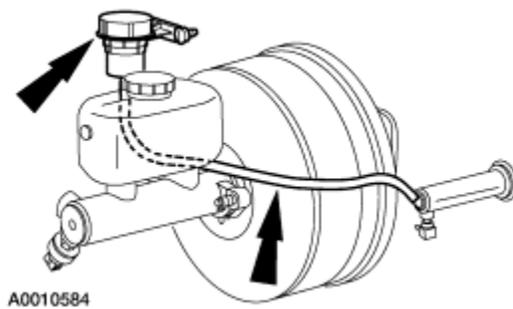
6. Bench bleed the clutch hydraulic system. For additional information, refer to [Section 308-00](#).

7.  **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash the surface with water immediately.**

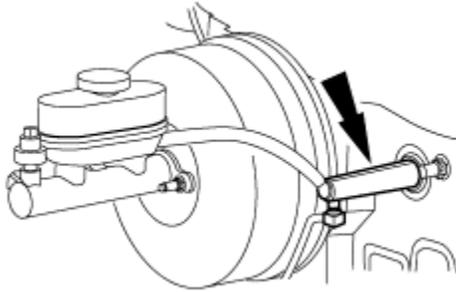
Position the clutch hydraulic system in the vehicle.



8. Correctly route the clutch hydraulic tube and attach the clutch hydraulic reservoir to the wiring tray.

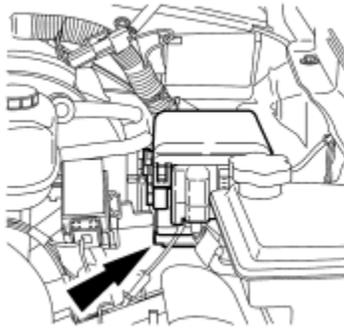


9. Install the clutch master cylinder.
- Compress and twist the clutch master cylinder counterclockwise 45 degrees to lock it to the clutch pedal and support bracket.



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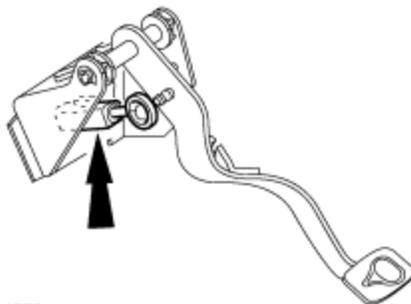
10. Seat the clutch master cylinder rubber seal to the bulkhead.
11. Route the clutch master cylinder-to-slave cylinder hydraulic tube under the brake booster reservoir.
12. Connect the power distribution box to the bracket.



A0010579

13. **⚠ CAUTION:** When installed correctly, the clutch pedal position switch wiring connector must be in the 1 o'clock position for pre-February 1998 production vehicles and in the 12 o'clock position for vehicles produced after January 1998. Incorrect installation will damage the clutch pedal position switch and cause insufficient clutch pedal travel.

Install the clutch pedal position switch on the clutch master cylinder push rod, and secure it with the switch cover.

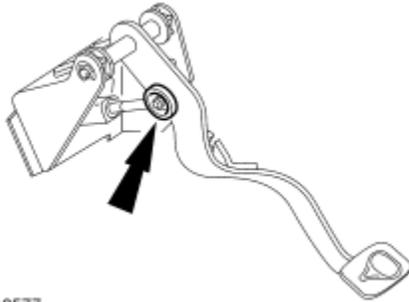


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14. Install the new push rod bushing.

15.  **WARNING: The clutch pedal is under spring tension.**

Connect the clutch master cylinder push rod to the clutch pedal.



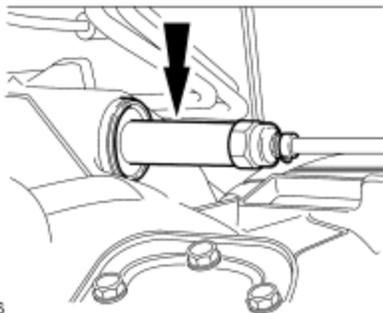
A0010577

16. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).

17. Correctly route the hydraulic tube and slave cylinder (7A564) to the transmission.

18. Install the slave cylinder (7A564).

- Compress and twist the slave cylinder to lock it onto the transmission.

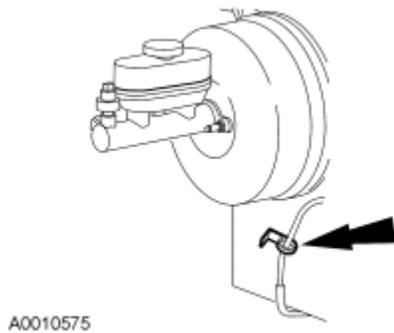


A0010576

19. Connect the clutch hydraulic tube to the floor pan clip.

20. Lower the vehicle.

21. Connect the clutch hydraulic tube to the dash clip.



22. Press the clutch pedal to seat the push rod in the clutch master cylinder.
23. Test the system for normal operation.

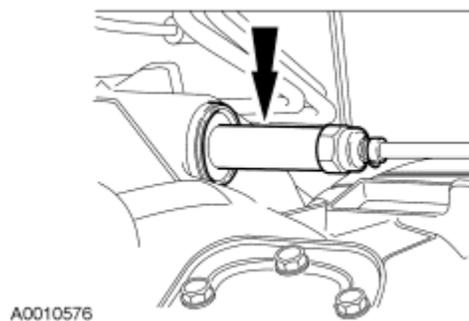
SECTION 308-02: Clutch Controls
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Clutch Slave Cylinder

Removal

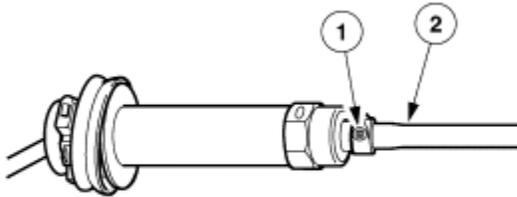
1. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



3. Clean the slave cylinder and the hydraulic tube to prevent contaminants from entering the hydraulic system.
4.  **CAUTION: Place a suitable container under the slave cylinder.**

Disconnect the slave cylinder from the hydraulic tube.

1. Using a 3/32-inch punch and a hammer, drive out the roll pin, and discard it.
2. Disconnect the slave cylinder from the hydraulic tube.



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5. **NOTE:** Sometimes the O-ring seal will remain inside the slave cylinder.

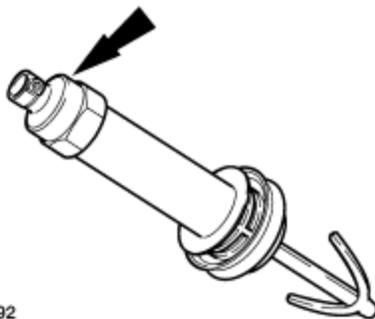
Remove the O-ring seal from the end of the hydraulic tube, and discard it. Cap the open end of the hydraulic tube.

Installation

1.  **CAUTION: Hold the slave cylinder over a suitable container.**

Angle the slave cylinder so that the hydraulic tube connection port is above the push rod. Fill the slave cylinder with DOT 3 brake fluid.

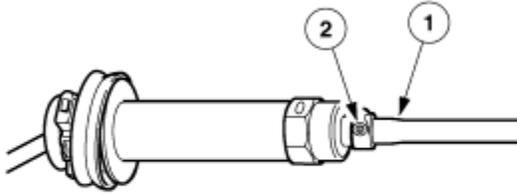
- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.



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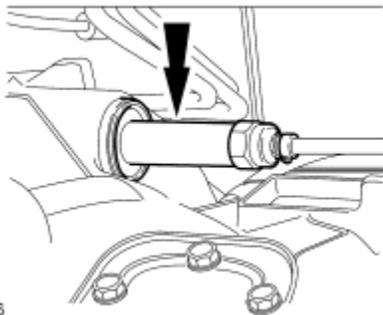
2. Remove the cap from the opening in the hydraulic tube. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
 - Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.
3. Connect and secure the slave cylinder to the hydraulic tube.

1. Connect the hydraulic tube to the slave cylinder.
2. Install the new roll pin.



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4. Bleed the clutch hydraulic system. For additional information, refer to [Section 308-00](#).
5. Install the slave cylinder (7A564).
 - Compress and twist the slave cylinder to lock it onto the transmission.



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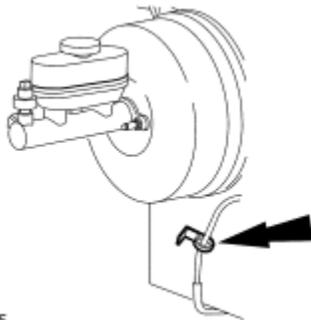
6. Lower the vehicle.
7. Test the system for normal operation.

Clutch Hydraulic Fluid Tubes—Clutch Master Cylinder-to-Slave Cylinder

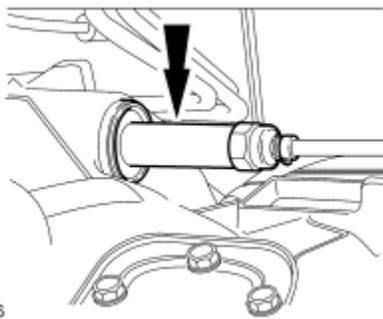
Removal

⚠ CAUTION: Remove the entire clutch hydraulic system from the vehicle as an assembly when installing a new clutch master cylinder-to-slave cylinder hydraulic tube.

1. Disconnect the clutch hydraulic tube from the dash clip.

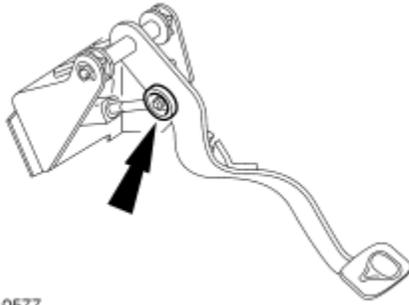


2. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
3. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



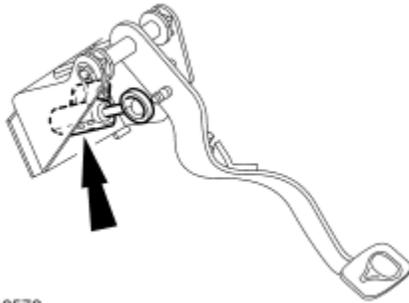
4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.
5. Lower the vehicle.
6. **⚠ WARNING: The clutch pedal is under spring tension.**

Unlock the push rod bushing retaining clips and separate the clutch master cylinder push rod from the clutch pedal.



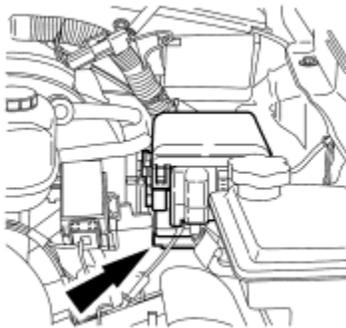
A0010577

7. Remove and discard the push rod bushing (7526).
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



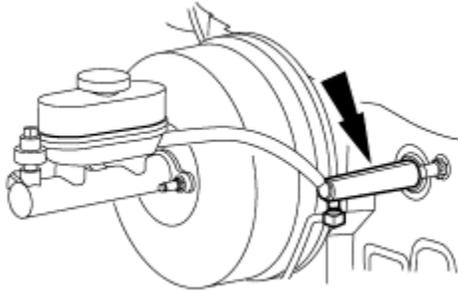
A0010578

9. Separate the power distribution box from the bracket to gain access to the clutch master cylinder.



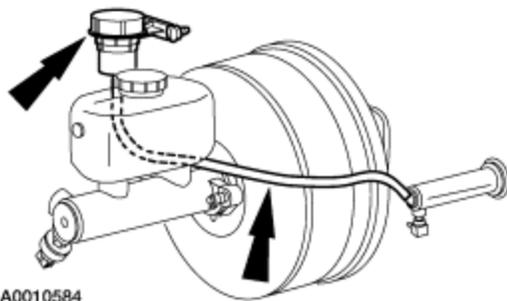
A0010579

10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
 - Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.

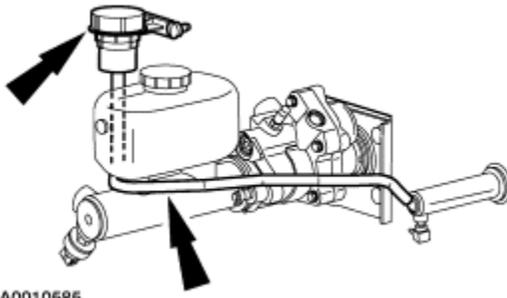


A0010580

11. Remove the clutch hydraulic reservoir from the wiring tray and separate the clutch hydraulic tube from the brake master cylinder assembly. Position the clutch hydraulic reservoir aside.



A0010584



A0010585

12.  **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash the surface with water immediately.**

Remove the clutch hydraulic system from the vehicle.



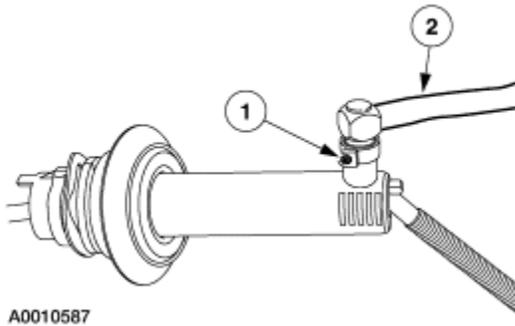
A0010586

13. Clean the clutch hydraulic system components to prevent contaminants from entering the hydraulic system.

14.  **CAUTION: Place a suitable container under the clutch master cylinder.**

Disconnect the hydraulic tube from the clutch master cylinder.

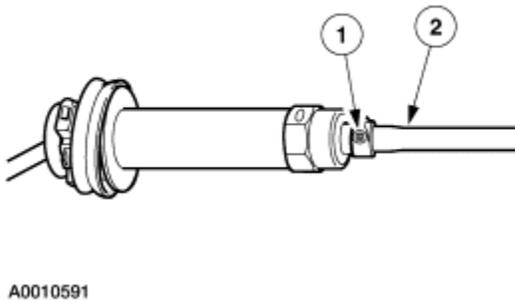
1. Using a 3/32-inch punch and a hammer, drive out the roll pin, and discard it.
2. Disconnect the hydraulic tube from the clutch master cylinder.



15.  **CAUTION: Place a suitable container under the slave cylinder.**

Disconnect the hydraulic tube from the slave cylinder.

1. Using a 3/32-inch punch and a hammer, drive out the roll pin, and discard it.
2. Disconnect the hydraulic tube from the slave cylinder.

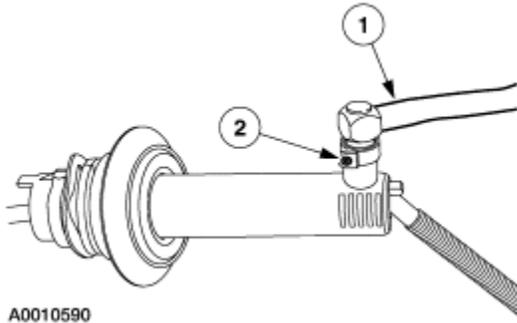


16. **NOTE:** Sometimes the O-ring seals will remain inside the clutch master cylinder and the slave cylinder.

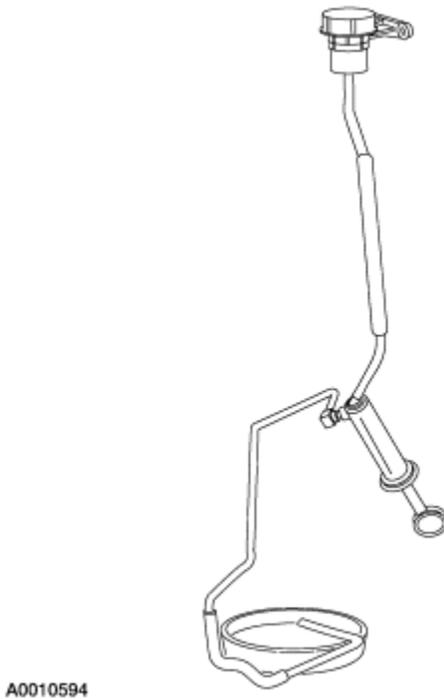
Remove and discard the O-ring seals.

Installation

1. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
 1. Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.
2. Connect and secure the hydraulic tube to the clutch master cylinder.
 1. Connect the hydraulic tube to the clutch master cylinder.
 2. Install the new roll pin.



3. Support the components so that the reservoir is above the master cylinder and the hydraulic tube is below the master cylinder. Place the open end of the tube in a suitable container.



4.  **CAUTION: Do not let the reservoir run dry.**

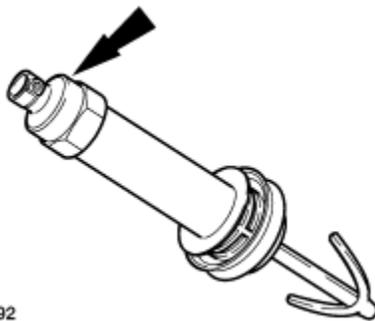
Purge the air from the clutch master cylinder assembly (7C522) and hydraulic tube. Cap the open end of the tube after purging the system of air.

- Fill the reservoir with Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A. Allow the fluid to flow through the master cylinder and run out of the end of the tube in the container. Do not let the reservoir run dry. Repeat this process, refilling the reservoir 2 to 3 times, to make sure that all air purged from the assembly. Cap the open end of the tube after purging the system of air.

5.  **CAUTION: Hold the slave cylinder over a suitable container.**

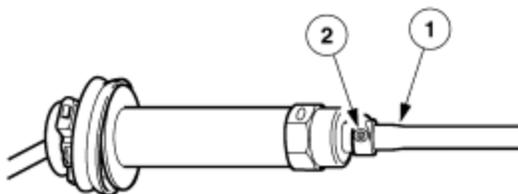
Angle the slave cylinder so that the hydraulic tube connection port is above the push rod. Fill the slave cylinder with DOT 3 brake fluid

- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.



6. Remove the cap from the opening in the hydraulic tube. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.

7. Connect and secure the hydraulic tube to the slave cylinder.
1. Connect the hydraulic tube to the slave cylinder.
 2. Install the new roll pin.

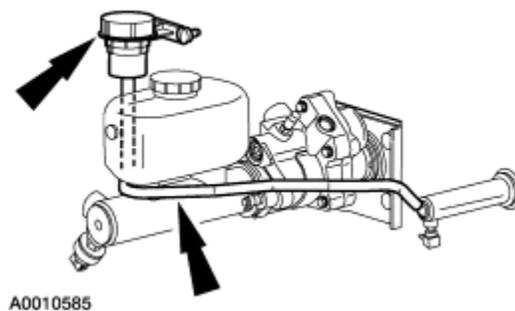
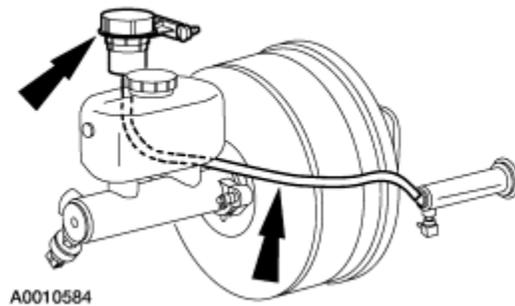


8. Bench bleed the clutch hydraulic system. For additional information, refer to [Section 308-00](#).
9.  **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash the surface with water immediately.**

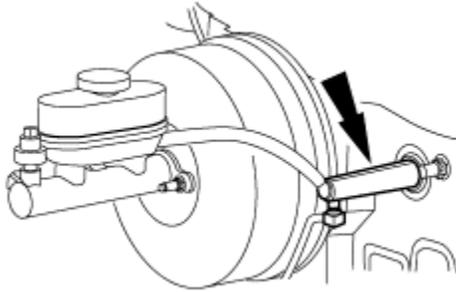
Position the clutch hydraulic system in the vehicle.



10. Correctly route the clutch hydraulic tube and attach the clutch hydraulic reservoir to the wiring tray.

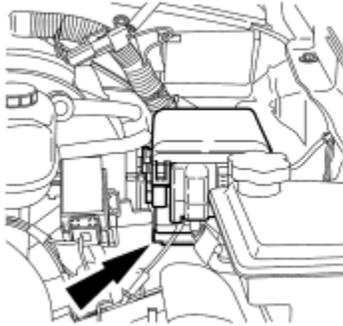


11. Install the clutch master cylinder.
 - Compress and twist the clutch master cylinder counterclockwise 45 degrees to lock it to the clutch pedal and support bracket.



A0010580

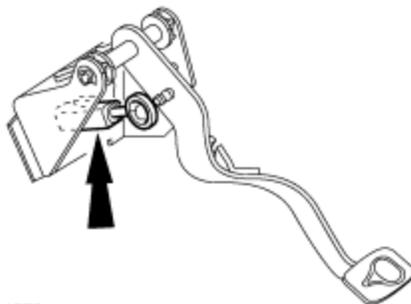
12. Seat the clutch master cylinder rubber seal to the bulkhead.
13. Route the clutch master cylinder-to-slave cylinder hydraulic tube under the brake booster reservoir.
14. Connect the power distribution box to the bracket.



A0010579

15. **⚠ CAUTION:** When installed correctly, the clutch pedal position switch wiring connector must be in the 1 o'clock position for pre-February 1998 production vehicles and in the 12 o'clock position for vehicles produced after January 1998 . Incorrect installation will damage the clutch pedal position switch and cause insufficient clutch pedal travel.

Install the clutch pedal position switch on the clutch master cylinder push rod, and secure it with the switch cover.

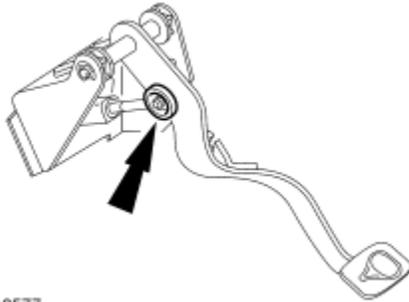


A0011873

16. Install the new the push rod bushing.

17.  **WARNING: The clutch pedal is under spring tension.**

Connect the clutch master cylinder push rod to the clutch pedal.



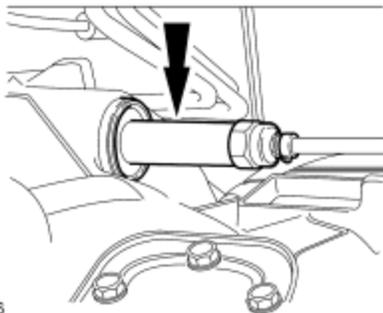
A0010577

18. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).

19. Correctly route the hydraulic tube and slave cylinder (7A564) to the transmission.

20. Install the slave cylinder (7A564).

- Compress and twist the slave cylinder to lock it onto the transmission.

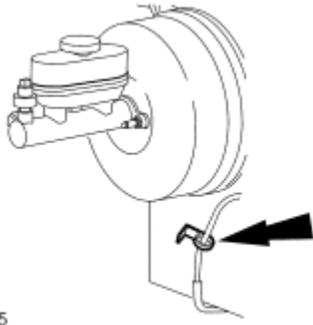


A0010576

21. Connect the clutch hydraulic tube to the floor pan clip.

22. Lower the vehicle.

23. Connect the clutch hydraulic tube to the dash clip.



A0010575

24. Test the system for normal operation.

SECTION 308-03A:
Manual Transmission — Model S5-47 ZF

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Manual Transmission](#)

[Powerflow in Neutral](#)

[Powerflow in 1st Gear](#)

[Powerflow in 2nd Gear](#)

[Powerflow in 3rd Gear](#)

[Powerflow in 4th Gear](#)

[Powerflow in 5th Gear](#)

[Powerflow in Reverse Gear](#)

DIAGNOSIS AND TESTING

[Manual Transmission](#)

GENERAL PROCEDURES

[Bearings—Inspection](#)

IN-VEHICLE REPAIR

[Seal—Rear](#)

[Shift Lever and Boot](#)

REMOVAL

[Transmission](#)

DISASSEMBLY

[Transmission](#)

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

[Counter Shaft Bearing](#)

[Input Shaft and Bearing](#)

[Main Shaft](#)

[Shift Control Housing](#)

[Extension Housing](#)

[Case](#)

[Bearing Preload—Main Shaft](#)

[Bearing Preload—Counter Shaft](#)

ASSEMBLY

[Transmission](#)

INSTALLATION

[Transmission](#)

SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

General Specifications	
Item	Specification
Countershaft (preload)	0.00-0.05 mm (0-0.00197 in)
Mainshaft (preload)	0.00-0.05 mm (0-0.00197 in)
Reverse gear clearance	0.15-0.35 mm (0.00591-0.01378 in)
First gear clearance	0.15-0.35 mm (0.00591-0.01378 in)
Second gear clearance	0.15-0.45 mm (0.00591-0.0177 in)
Third gear clearance	0.15-0.35 mm (0.00591-0.01378 in)
Fifth gear clearance	0.15-0.35 mm (0.00591-0.01378 in)
Component mounting temperatures	150° C (300° F)
Lubricants & Sealants	
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer EOAZ-19554-AA	WSK-M2G351-A5
Threadlock 262 E2FZ-19554-B	WSK-M2G351-A6
Gasket and Trim Adhesive F3AZ-19B508-AA	—
Silicone Lubricant F7AZ-19G208-BA	ESR-M13P4-A

SPRING SPECIFICATIONS		
Description	Length	Outer Diameter
Shift rail detent springs	44.1 mm (1.736 in)	7.880 mm (0.310 in)
Shifter interlock spring	35.5 mm (1.398 in)	9.040 mm (0.356 in)
Synchronizer springs	14.8 mm (0.583 in)	5.960 mm (0.235 in)

LUBRICANT REFILL CAPACITIES			
Description	Liters	U.S. Qts.	Imp. Qts.
Synthetic Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or MERCON® Equivalent	3.2	3.4	2.8

Torque Specifications			
Description	Nm	lb-ft	lb-in
Oil fill or drain plug	60	44	—
Pinion flange locknut	270	200	—
Shift housing bolts	23	17	—
PTO cover bolts	38	28	—
Reverse idler bolts	22	16	—
Shift interlock plate bolts	10	7	84
Shift cover-to-shift housing bolts	10	—	84
Reverse lamp switch	20	15	—
Upper shift lever bolts	28	21	—
Transmission-to-engine bolts	63	46	—
Extension housing-to-case bolts	23	17	—
Guide tube bolts	24	18	—
Crossmember bolts	70	52	—
Crossmember nuts	70	52	—
Transmission insulator nuts	81	60	—

SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop
 Manual

[Procedure revision date: 01/26/2000](#)

Manual Transmission

The S5-47 ZF transmission is a five-speed synchronized unit. The ZF five speed has the following features:

- An integral clutch housing.
- An aluminum main case.
- 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 bevel cut.
- All gears, including reverse, turn on needle roller bearings.
- Single-piece shaft forks with molly coated pads.
- Provisions for mounting a power take-off.
- The mainshaft and countershaft are assembled under preload. If the ZF transmission is disassembled, a preload measurement must be taken.

The S5-47 has five forward speeds and one reverse speed. The gear ratios are as follows:

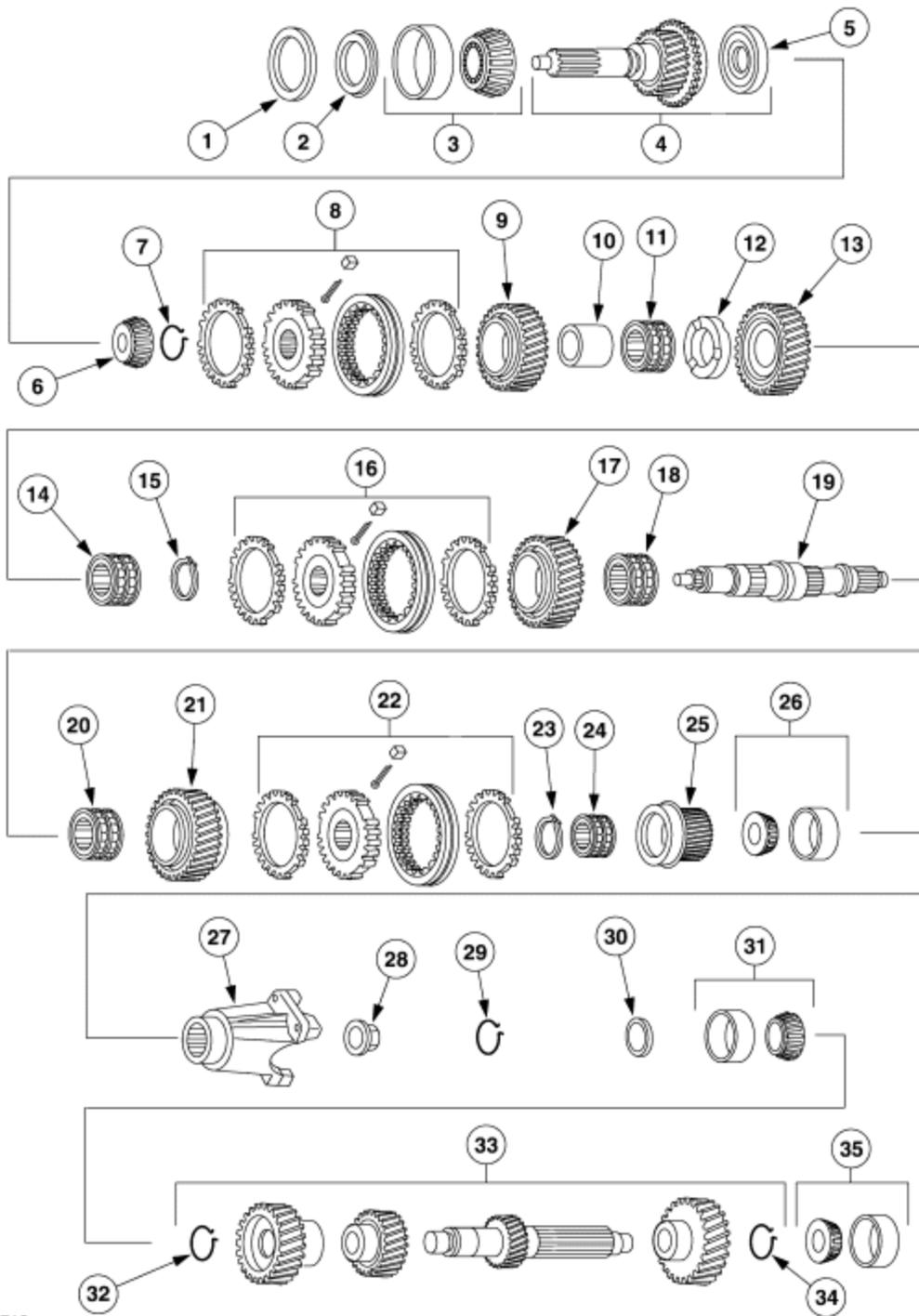
- First 5.72:1
- Second 2.94:1
- Third 1.61:1
- Fourth 1.00:1
- Fifth 0.76:1
- Reverse 5.24:1

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. The model number designations are:

- "S" means a synchronized transmission.
- "5" is the number of gears.
- 47 is the maximum input torque capacity in tens of lb-ft or 470 lb-ft of input torque capacity.

Transmission Internal Components—Disassembled View

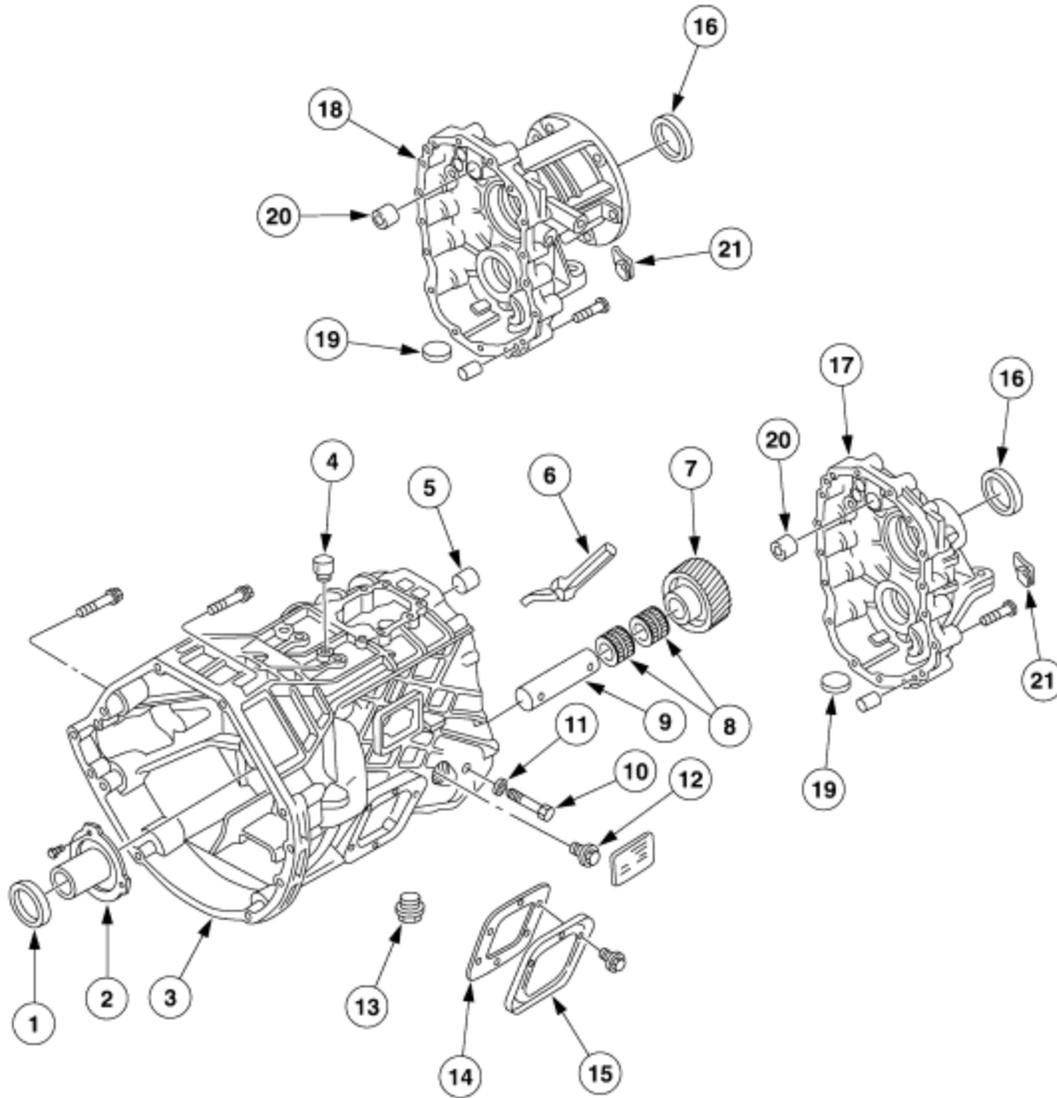


A0026710

Item	Part Number	Description
1	7029	Input shaft shim (selective fit)
2	7040	Input shaft oil baffle
3	7025	Input shaft bearing and bearing cup
4	7017	Input shaft
5	7046	Input shaft rear oil dam

6	7120	Input shaft pocket bearing
7	7B331	Snap ring kit
8	7124	Synchronizer assembly, third and fourth gear
9	7196	Mainshaft third gear
10	7173	Mainshaft third and fourth gear bushing
11	7133	Mainshaft needle bearing
12	7119	Mainshaft third gear thrust washer
13	7103	Mainshaft second gear
14	7133	Mainshaft needle bearing
15	7B331	Snap ring kit
16	7124	Synchronizer assembly, first and second gear
17	7100	Mainshaft first gear
18	7127	Mainshaft needle bearing
19	7061	Mainshaft
20	7127	Mainshaft needle bearing
21	7142	Mainshaft reverse gear
22	7124	Synchronizer assembly, fifth and reverse gear
23	7B331	Snap ring kit
24	7121	Mainshaft needle bearing
25	7158	Mainshaft fifth gear
26	7R205	Mainshaft rear bearing and bearing cup
27	7089	Pinion flange (4x2 vehicles)
28	7045	Pinion flange locknut (4x2 vehicles)
29	7B331	Snap ring kit (4x4 vehicles)
30	7119	Countershaft shim (selective fit)
31	7065	Countershaft front bearing and bearing cup
32	7064	Snap ring
33	7113	Countershaft
34	7064	Snap ring
35	7065	Countershaft rear bearing and bearing cup

Transmission Internal Components—Disassembled View

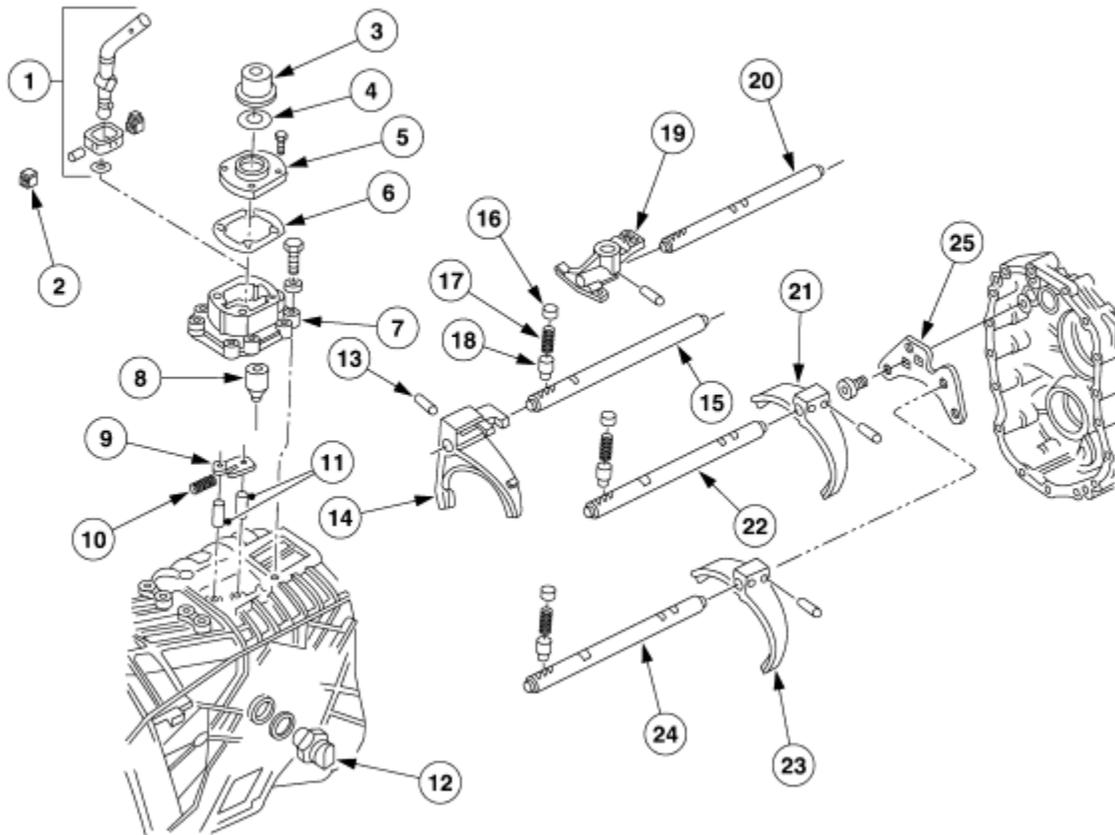


A0015363

Item	Part Number	Description
1	7052	Input oil seal
2	7050	Release bearing retainer
3	7005	Main case
4	7034	Vent
5	7D362	Shift rail bearing
6	7A174	Oil trough
7	7141	Reverse idler gear
8	7E139	Reverse idler bearing
9	7140	Reverse idler shaft
10	7214	Reverse idler bolt
11	7K267	Reverse idler seal

12	7A010	Fill plug
13	7A010	Drain plug
14	7166	PTO gasket
15	7165	PTO cover
16	7052	Output seal
17	7A039	Extension housing (4x2 vehicles)
18	7A039	Extension housing (4x4 vehicles)
19	7E290	Magnet
20	7D362	Shift rail bearing
21	14A163	Wire harness retainer

Transmission Shift Components — Disassembled View



Item	Part Number	Description
1	7210	Shift lever (lower)
2	7C371	Shift lever blocks
3	7E138	Shift lever boot (upper)
4	7D152	Inner shift lever boot ring
5	7262	Shift lever boot (lower)
6	7207	Shift lever boot gasket
7	7203	Shift housing
8	7E218	Shift detent plunger
9	7F194	Fifth and reverse interlock
10	7234	Interlock spring
11	7B096	Interlock roll pins
12	15520	Reverse lamp switch
13	7B096	Roll pin
14	7230	Shift fork (third and fourth)
15	7241	Shift rail
16	7L013	Shift rail detent plugs
17	7N120	Shift rail detent springs
18	7247	Shift rail detents
19	7243	Main shift rail driver
20	7240	Main shift rail
21	7231	Shift fork (fifth and reverse)
22	7242	Shift rail
23	7239	Shift fork (first and second
24	7358	Shift rail
25	7K201	Shift interlock plate

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:

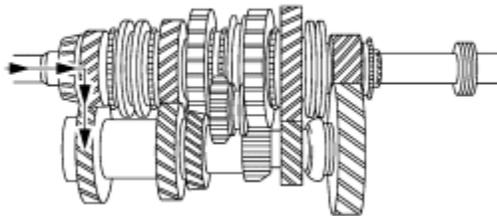
- Maintain the correct fluid level by inspecting it regularly.
- Change the fluid at recommended intervals. For additional information, refer to the Owners Literature for the recommended intervals.

- Use MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX 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. 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

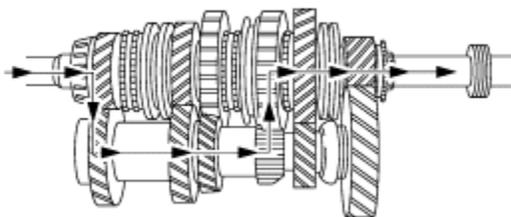
Powerflow in Neutral



AC0261-A

- The input gear drives the countershaft.
- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft.
- All synchronizers are centered (disengaged).
- No gears are engaged to the output shaft.
- The output shaft is not engaged to the input shaft.

Powerflow in 1st Gear

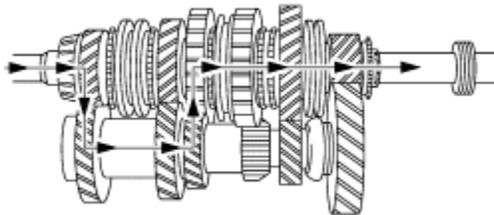


A0015364

- The input gear drives the countershaft.

- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft.
- The 1-2 synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted rearward, the 1st gear is engaged to the output shaft through the synchronizer hub.

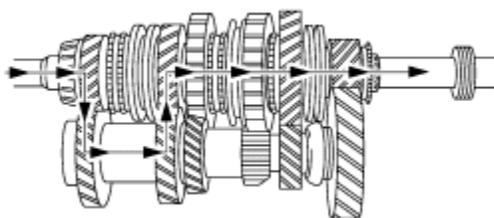
Powerflow in 2nd Gear



AC0263-A

- The input gear drives the countershaft.
- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft.
- The 1-2 synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted forward, the 2nd gear is engaged to the output shaft through the synchronizer hub.

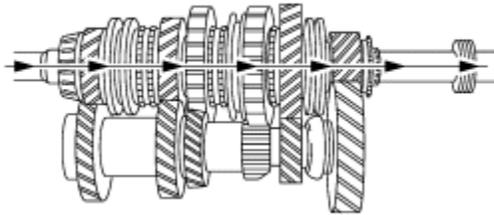
Powerflow in 3rd Gear



AC0264-A

- The input gear drives the countershaft.
- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft.
- The 3-4 synchronizer hub is splined to the output shaft.
- When the synchronizer sleeve is shifted rearward, the 3rd gear is engaged to the output shaft through the synchronizer hub.

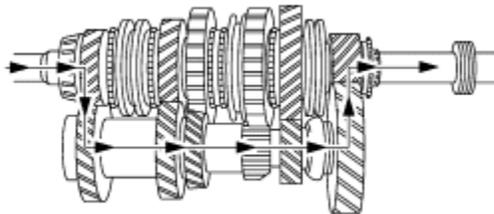
Powerflow in 4th Gear



AC0265-A

- The input gear drives the countershaft.
- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft.
- The 3-4 synchronizer hub is splined to the output shaft, but no gears are engaged to the output shaft.
- When the synchronizer sleeve is shifted forward, the input shaft is locked to the output shaft through the synchronizer hub.

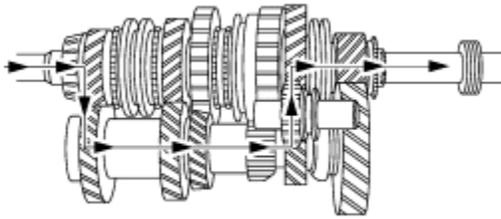
Powerflow in 5th Gear



AC0266-A

- The input gear drives the countershaft.
- The countershaft gears drive the 1st, 2nd and 3rd gears on the output shaft, and the 5th gear synchronizer.
- The 5th gear synchronizer is splined to the countershaft.
- When the synchronizer sleeve is shifted forward, the 5th gear is engaged to the countershaft.
- The countershaft 5th gear drives the output shaft 5th gear.

Powerflow in Reverse Gear



A0015365

- The input gear drives the countershaft.
- The countershaft gears drive the reverse idler gear, after the idler is slid into engagement.
- The reverse idler gear drives the teeth cut along the outside of the 1-2 synchronizer sleeve (which is splined to the output shaft through the hub), which reverses the rotation of the output shaft and drives it in reduction.

SECTION 308-03A: Manual Transmission — Model 1999 F-Super Duty 250-550 Workshop
S5-47 ZF Manual
DIAGNOSIS AND TESTING [Procedure revision date: 01/26/2000](#)

Manual Transmission

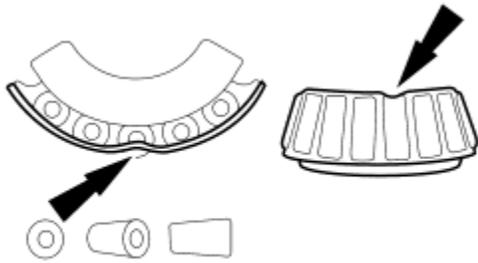
Refer to [Section 308-00](#).

SECTION 308-03A: Manual Transmission — Model 1999 F-Super Duty 250-550 Workshop
S5-47 ZF Manual
GENERAL PROCEDURES [Procedure revision date: 01/26/2000](#)

Bearings—Inspection

NOTE: If any of the following conditions exists, replace the bearing.

1. Inspect bearing for bent cage.



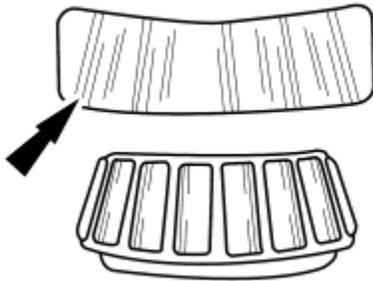
C11911-A

2. Inspect bearings for galling (metal smears on roller ends).
 - Galling is caused by overheating, poor lubrication or overload.
 - If galling is found, replace bearing and inspect seals.



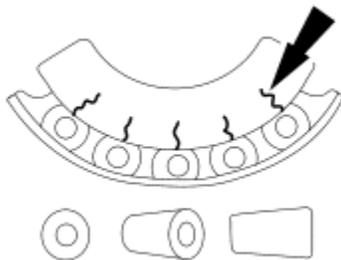
C11912-A

3. Inspect the bearing for brinelling (surface indentations in the raceway).



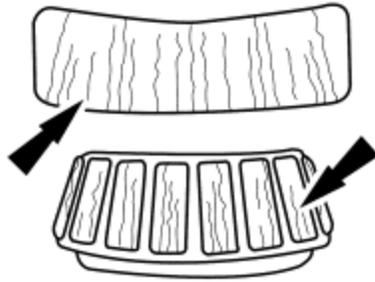
C11913-A

4. Inspect bearing for cracked inner race.



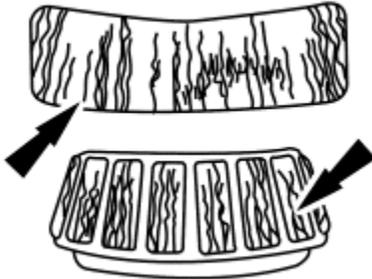
C11914-A

5. Inspect the bearing and raceway for etching.
- If etching is present inspect seals.



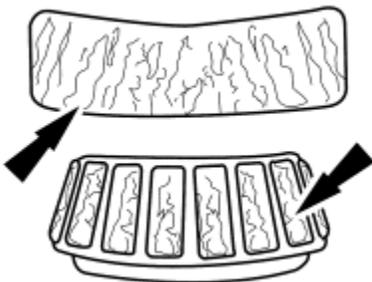
C11915-A

6. Inspect the bearing for heat discoloration (dark blue).
- If heat discoloration is evident, check bearing and race for loss of temper. Draw a file across the component. If the file cuts the metal, there is a loss of temper.



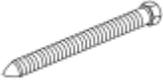
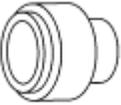
C11916-A

7. Inspect the bearing for fatigue spalling (metal flaking).



C11917-A

Seal—Rear

Special Tool(s)	
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 ST2141-A	Socket, Mainshaft Locknut (36 mm) 308-127 (T87T-7025-AH)
 ST2142-A	Remover, Output Shaft Oil Seal 308-129 (T87T-7025-CH)
 ST1304-A	Screw, Bearing Removal Tube 308-092 (T84T-7025-B)
 ST2371-A	Remover/Installer, Thrust Washer Bearing Cup 308-416
 ST2157-A	Installer, Output Shaft Oil Seal (4x4) 308-134 (T87T-7025-LH)
 ST2158-A	Installer, Output Shaft Oil Seal (4x2) 308-128 (T87T-7025-BH)

 <p>ST2166-A</p>	<p>Remover, Input Shaft Oil Seal 308-375</p>
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>

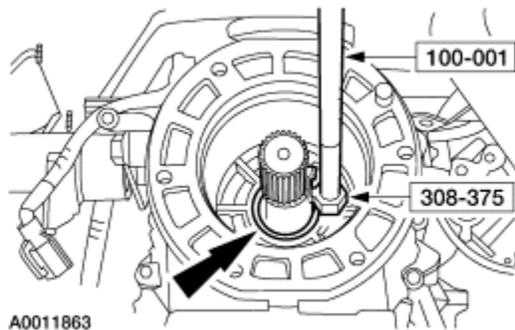
Removal

All vehicles

1. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. Remove and position the driveshaft aside. For additional information, refer to [Section 205-01](#).

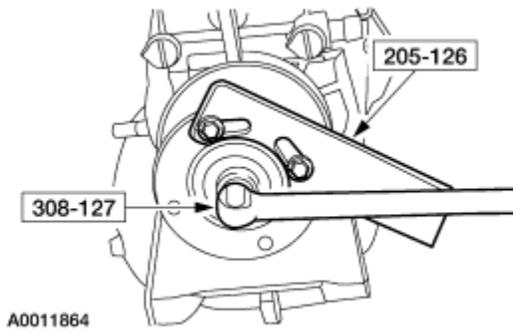
Vehicles with 4-wheel drive

3. Remove the transfer case. For additional information, refer to [Section 308-07B](#).
4. Using the special tools, remove and discard the output oil seal.

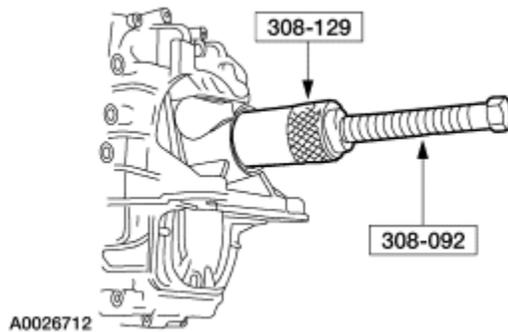


Vehicles with 2-wheel drive

5. Using the Rear Seal Remover and the Forcing Screw, remove the pinion flange.



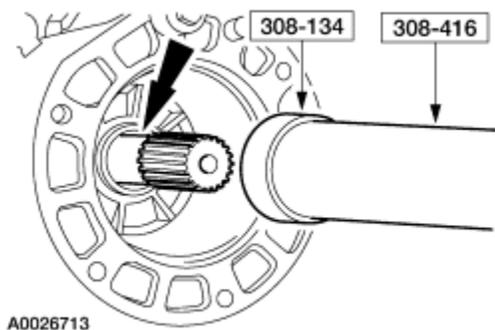
- Using the special tools, remove and discard the output oil seal.



Installation

Vehicles with 4-wheel drive

- Using the special tool, install a new output oil seal.
 - Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.
 - Coat the inner diameter of the new seal with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent Ford specification MERCON®.

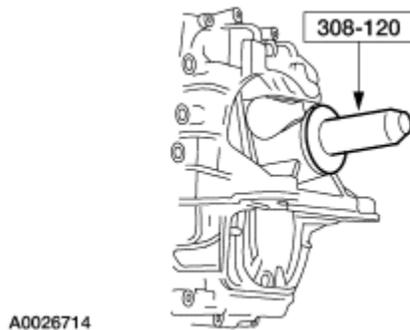


- Install the transfer case. For additional information, refer to [Section 308-07B](#).

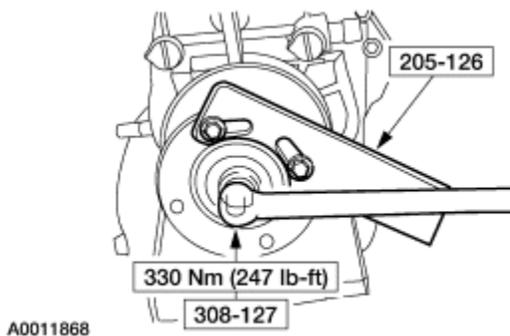
Vehicles with 2-wheel drive

- Using the Rear Seal Replacer, install a new output oil seal.

- Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.
- Coat the inner diameter of the new seal with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent Ford specification MERCON®.



- Using the special tools, install the pinion flange.
 - Apply Threadlock 262 E2FZ-19554-B or equivalent meeting Ford specification WSK-M2G351-A6 to the threads of the pinion flange locknut.



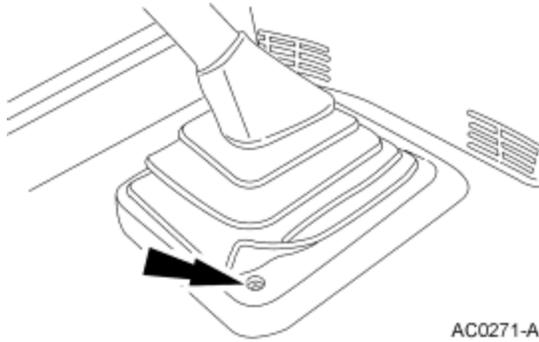
All vehicles

- Install the driveshaft. For additional information, refer to [Section 205-01](#).

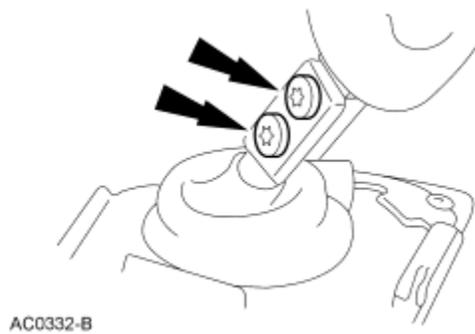
Shift Lever and Boot

Removal

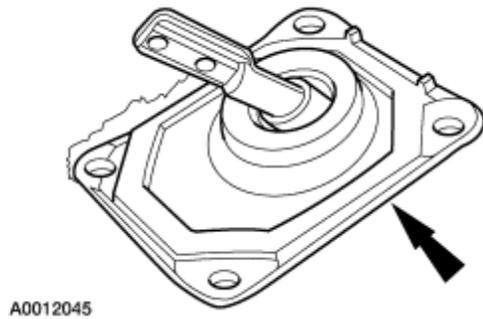
1. Remove the four screws and the gearshift lever boot.



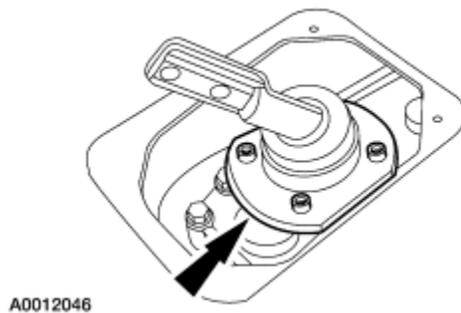
2. Remove the upper gearshift lever.



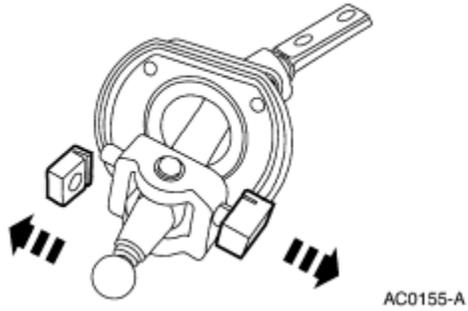
3. Remove the gearshift lever upper boot.



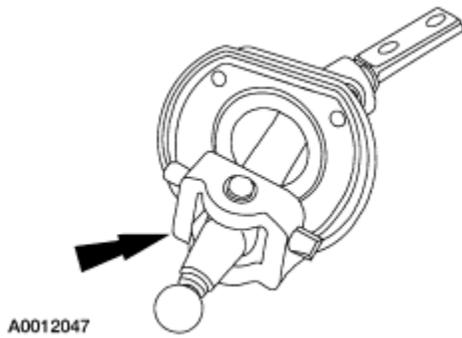
4. Remove the four bolts and the lower gearshift lever. Discard the gasket.



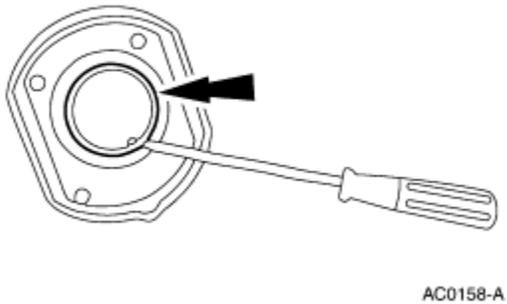
5. Remove the gearshift lever blocks.



6. Remove the gearshift lever retainer from the gearshift lever.

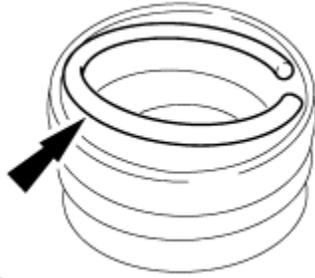


7. Remove the snap ring and the lower gearshift lever boot.



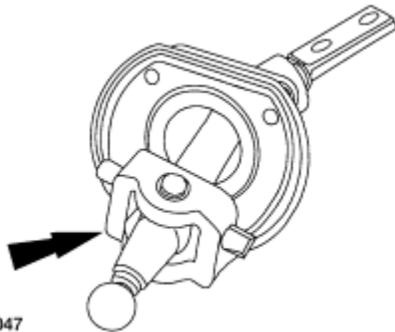
Installation

1. Install the inner gearshift lever boot ring into the gearshift lever boot.



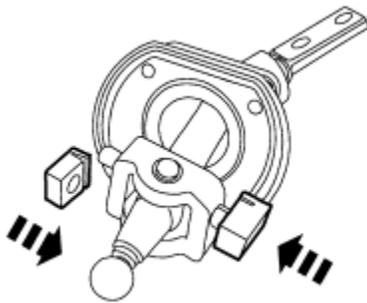
A0011870

2. Install the gearshift lever boot into the gearshift lever retainer.
3. Install the lower gearshift lever into the gearshift lever retainer.



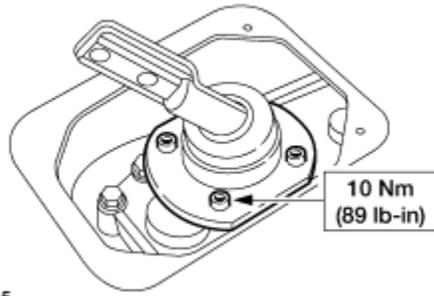
A0012047

4. Install the gearshift lever blocks.
 - Install the gearshift lever blocks with the notches facing upward.



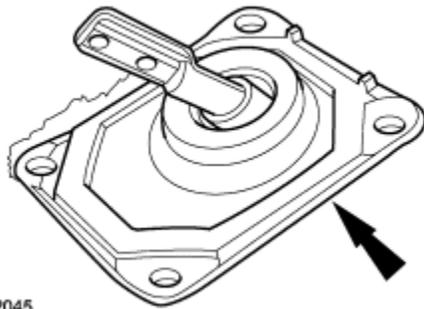
AC0159-A

5. Install a new gasket, the lower gearshift lever and the four bolts.



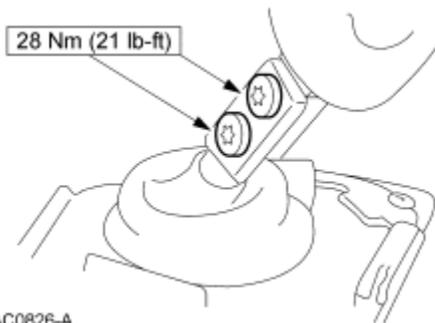
A0026715

6. Install the upper gearshift lever boot.



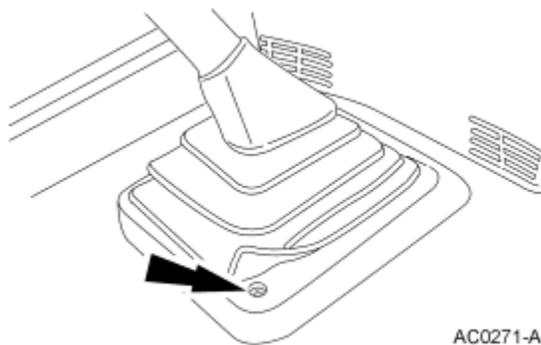
A0012045

7. Install the upper gearshift lever.



AC0826-A

8. Install the gearshift lever boot and the four screws.

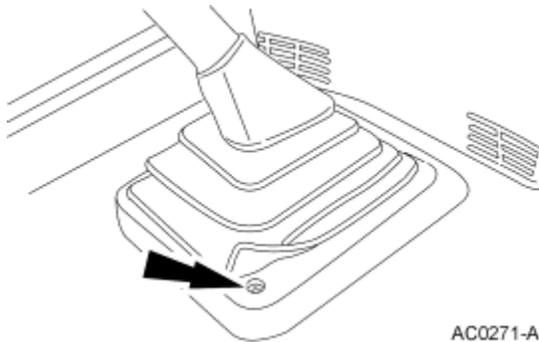


AC0271-A

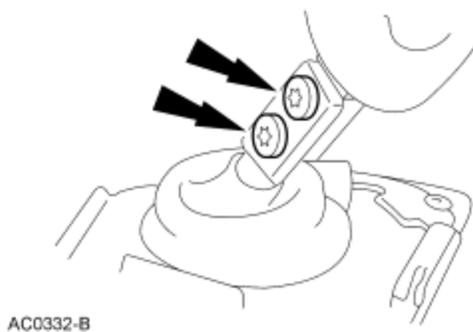
Transmission

Special Tool(s)	
 ST1130-A	High Lift Transmission Jack 014-00942

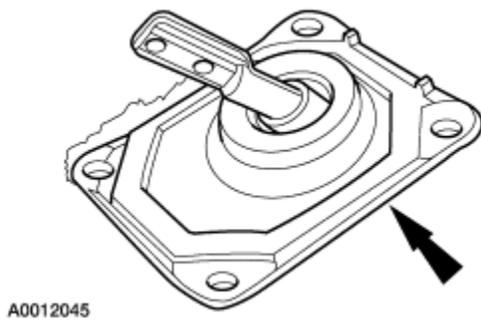
1. Disconnect the battery ground cable.
2. Remove the four screws and the shift lever boot.



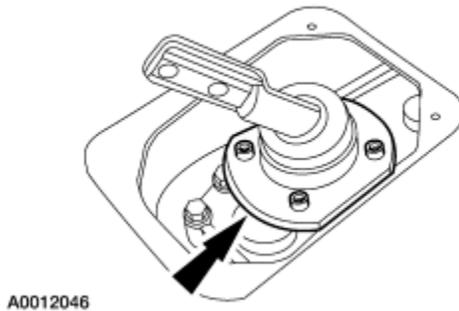
3. Remove the upper gearshift lever.



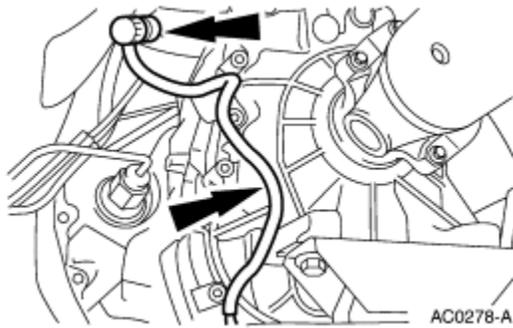
4. Remove the gearshift lever upper boot.



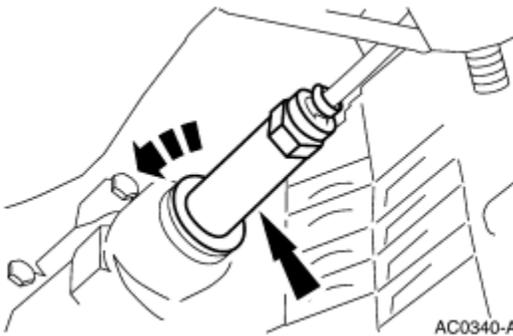
5. Remove the four bolts and the lower gearshift lever. Discard the gasket.



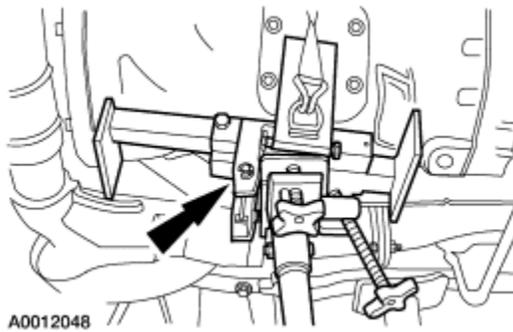
6. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
7. If the transmission is being disassembled, drain the transmission fluid.
8. Remove the starter. For additional information, refer to [Section 303-06B](#).
9. Disconnect the driveshaft and position it aside. For additional information, refer to [Section 205-01](#).
10. Remove the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).
11. Remove any power take-off (PTO) equipment, if equipped.
12. Disconnect the reverse lamp switch electrical connector.
13. Disconnect the wiring harness from the transmission and position it aside.



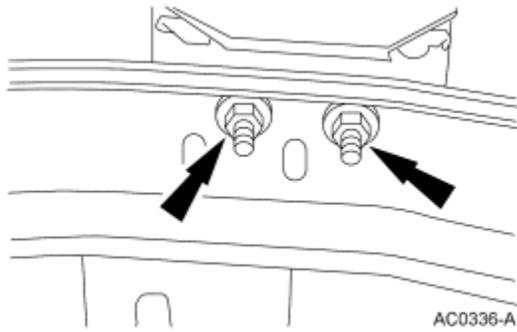
14. Remove the clutch slave cylinder and position it aside.
- Push inward then rotate the clutch slave cylinder counterclockwise 45 degrees to remove.



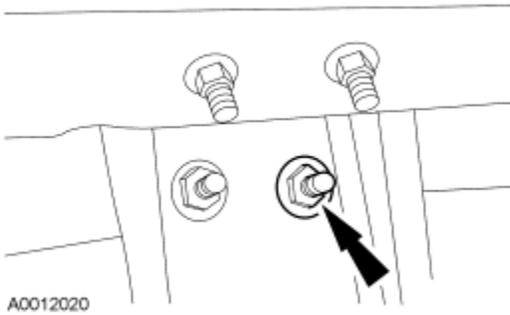
15. Using the special tool, support the transmission.
- Securely strap the jack to the transmission.



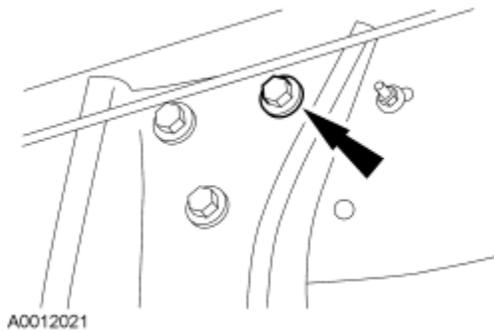
16. Remove the nuts.



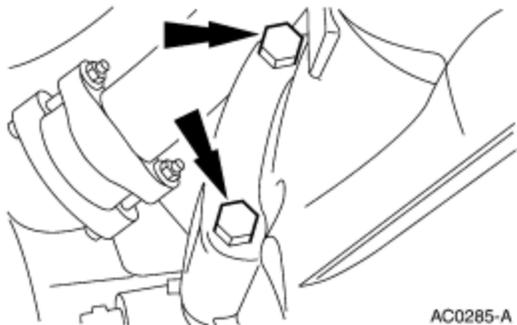
17. Remove the RH crossmember nuts.



18. Remove the LH crossmember bolts.



19. Remove the nine transmission-to-engine bolts.



20. Remove the transmission.

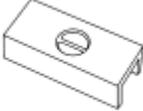
- Move the transmission rearward until the input shaft is clear of the clutch, then lower from the vehicle.

SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
DISASSEMBLY

1999 F-Super Duty 250-550 Workshop
Manual

[Procedure revision date: 01/26/2000](#)

Transmission

Special Tool(s)	
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 ST2141-A	Socket, Mainshaft Locknut (36 mm) 308-127 (T87T-7025-AH)
 ST1186-A	Holding Fixture, Transmission 307-003 (T57L-500-B)
 ST1254-A	Plate, Bearing/Oil Seal 205-090 (T75L-1165-B)
 ST1807-A	Remover, Jet Plug 310-005 (T77L-9533-B)

 <p>ST2154-A</p>	<p>Holding Fixture, Gear Pack 308-139 (T87T-7025-HH)</p>
 <p>ST2155-A</p>	<p>Aligner, Shift Rod Assemblies 308-133 (T87T-7025-JH)</p>
 <p>ST1110-A</p>	<p>Heat Gun 107-R0300</p>

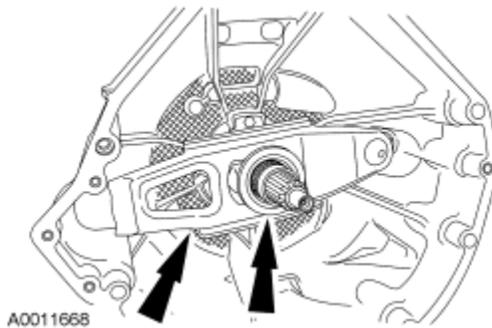
1.  **WARNING: Wear protective eyewear whenever using compressed air.**

Clean the transmission exterior with solvent, and dry with compressed air.

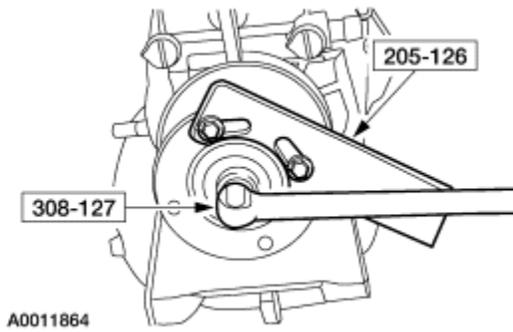
2.  **WARNING: Wear protective eyewear whenever using compressed air.**

Clean all parts removed with solvent, and dry with compressed air.

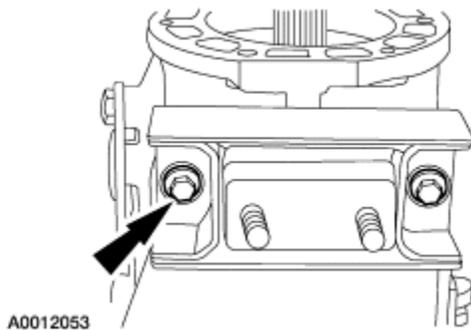
3. Remove the clutch release lever and the clutch release hub and bearing.



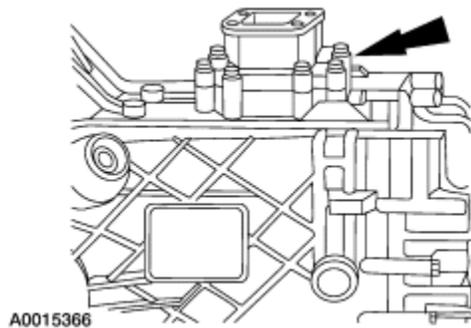
4. Using the special tools, remove the pinion flange on 2-wheel drive vehicles.



5. Remove the transmission mount.



6. Remove the eight bolts and the shift housing.

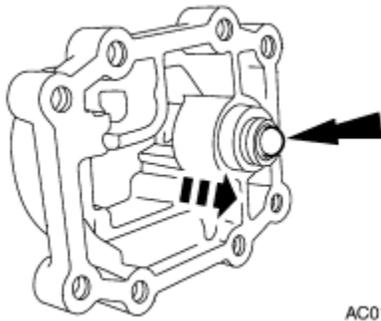


7.  **CAUTION:** To prevent damage, do not heat the shift housing higher than 150°C (300°F).

NOTE: Inspect the shift detent plunger for wear or damage. Check plunger operation.

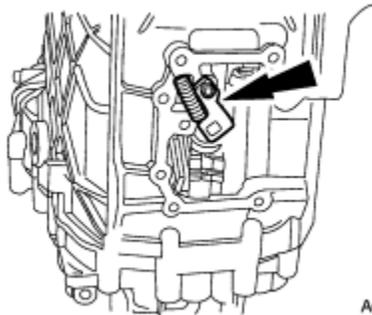
Using the Heat Gun, remove the shift detent plunger.

- Using a hammer and punch, tap the shift detent plunger from the housing.

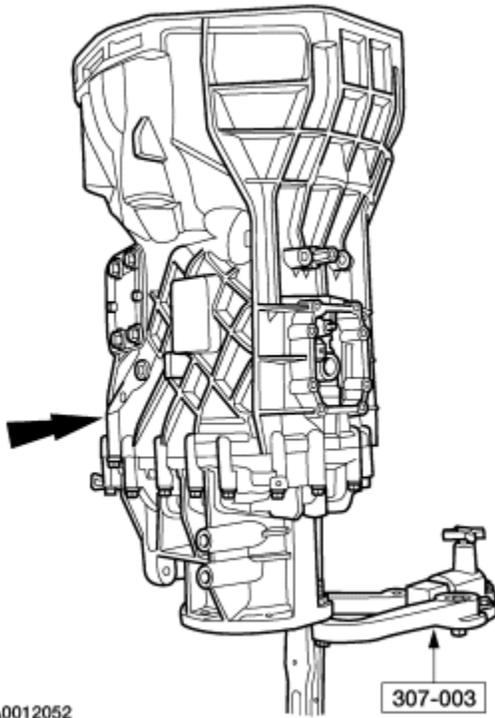


AC0183-A

8. Remove the fifth and reverse gear interlock and the interlock spring.



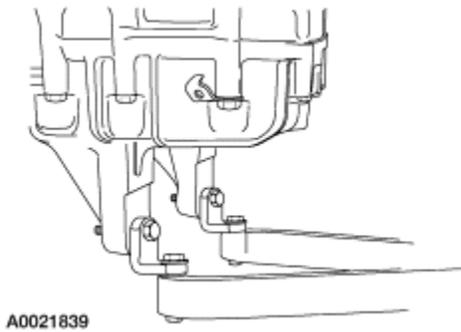
AC0164-A



A0012052

307-003

9. Using the special tool, secure the transmission to a suitable workbench.
 - Position the transmission with the input shaft facing upward.

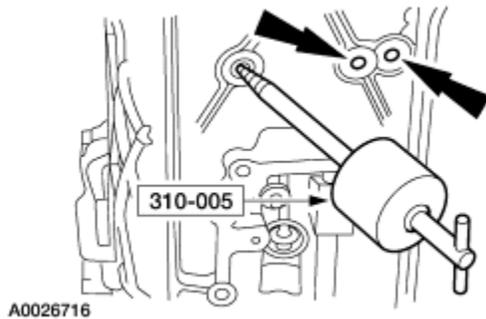


10. **⚠️ WARNING:** Shift rail detent plug is under spring pressure. Always wear protective eyeglasses when performing this procedure to make sure that shift rail detent plug does not strike eyes when it is forced out by spring pressure.

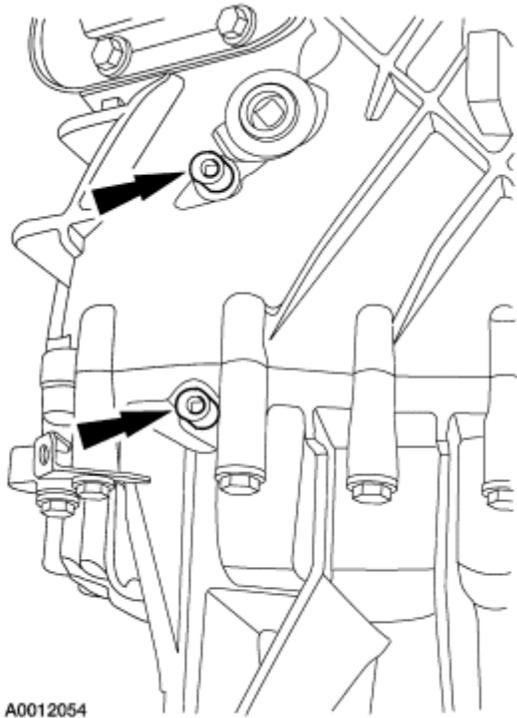
NOTE: Use a 1/8-inch center punch to create a pilot hole in the plug before installing the tool. Using the Jet Plug Remover to make the pilot hole will damage the tool.

Using the Jet Plug Remover, remove the shift rail detent plugs and springs. Discard the detent plugs.

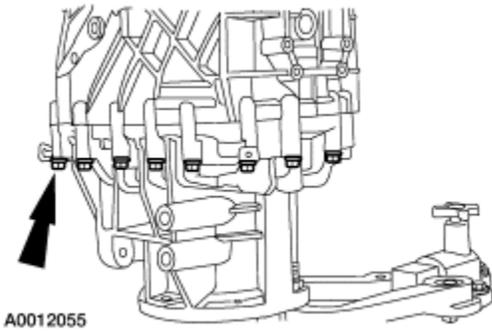
- Lightly thread in the Jet Plug Remover so as not to damage the springs.



11. Remove the upper reverse idler gear bolt, only loosen the lower reverse idler gear bolt.

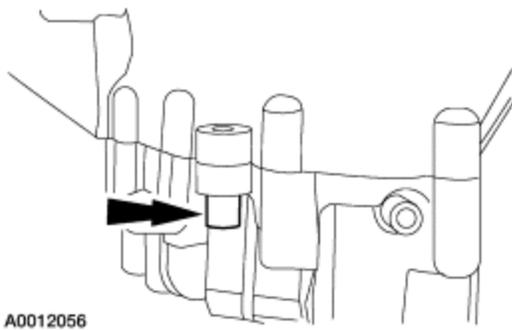


12. Remove the 17 bolts.



13. **NOTE:** The dowel pins do not have to be removed.

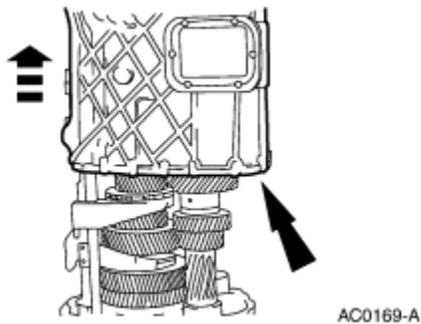
Using a hammer and punch, tap the two dowel pins down until they are past the main case.



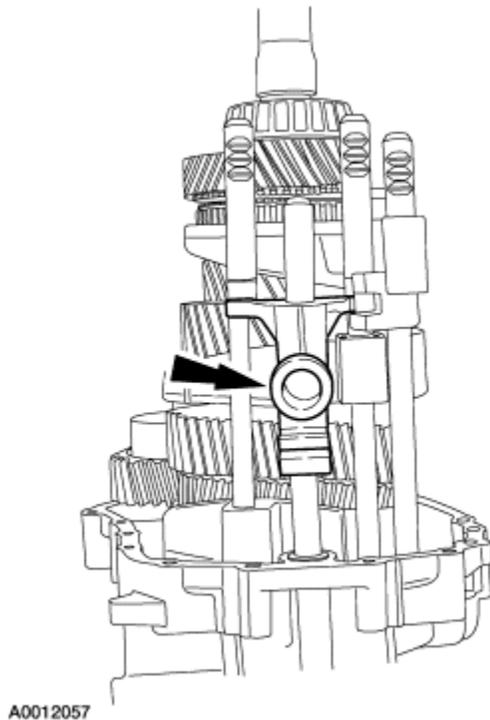
14.  **CAUTION: Do not use a pry bar or a screwdriver to force the main case and extension housing apart. This could damage the mating surfaces and cause leaks.**

Carefully lift the main case off the extension housing.

- Using a soft-faced hammer, tap the main case lightly to break the gasket seal.
- It may be necessary to push the main shift rail driver inwards to prevent it from hanging up on the case as it is being removed. Use care to make sure that the main shift rail is not lifted off with the case.

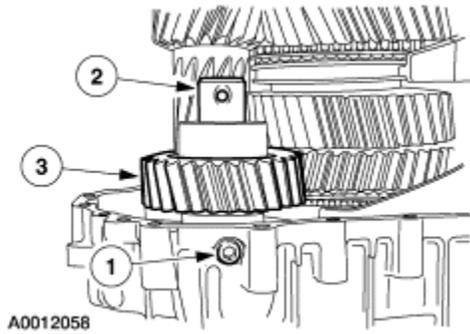


15. Remove the main shift rail and the main shift rail driver.

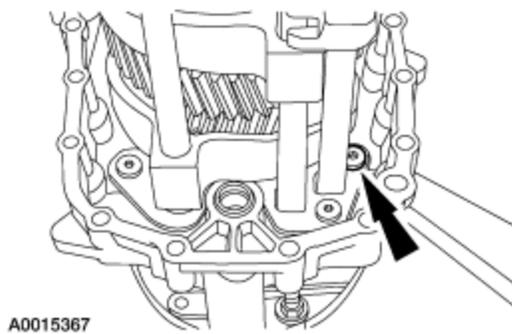


16. Remove the reverse idler gear assembly.
1. Remove the reverse idler gear bolt.
 2. Remove the reverse idler shaft.

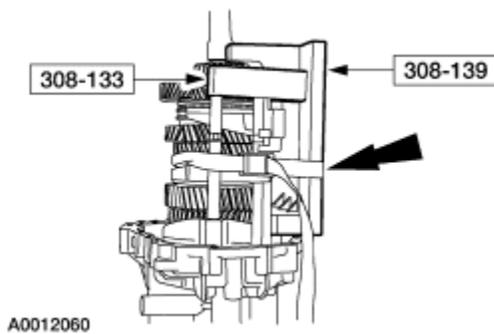
3. Remove the reverse idler gear and the two reverse idler gear bearings.
 - Inspect the idler shaft, gear and bearings for wear or damage. Install new components, as necessary.



17. Remove one bolt from the shift interlock plate.

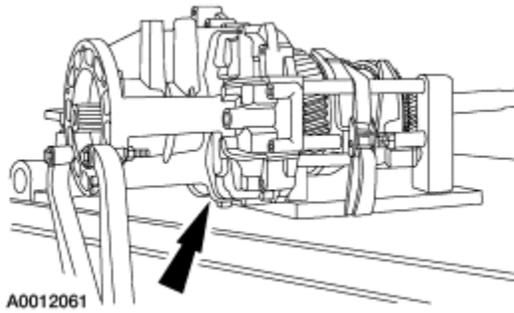


18. Position the special tools onto the gear assembly. Attach the tools to the gear assembly with a cargo strap.

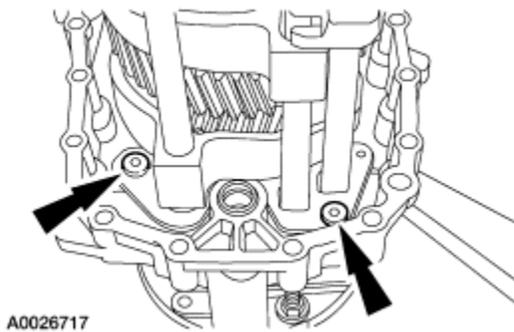


19. **NOTE:** An assistant will be needed to remove the gear assembly from the bench fixture.

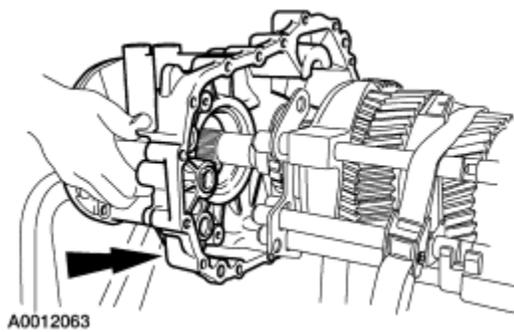
Firmly hold the gear assembly, release the Holding Fixture from the bench fixture, then remove the transmission. Place the gear assembly on a workbench.



20. Remove the remaining bolts from the shift interlock plate.

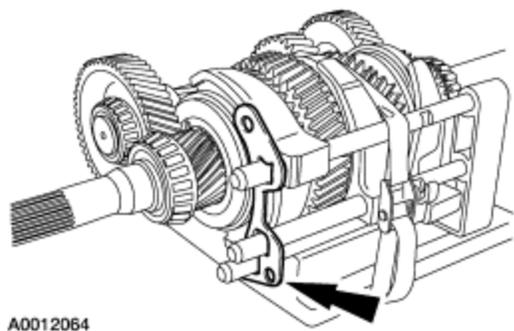


21. Separate the extension housing from the gear assembly.



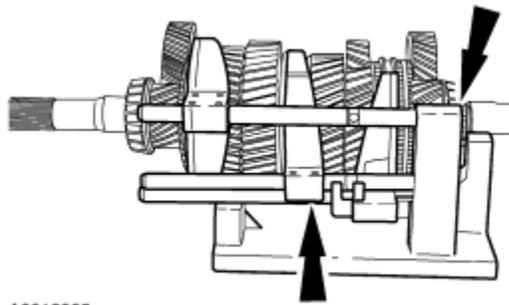
22. Remove the shift interlock plate.

- Remove the cargo strap from around the shift rails and gear assembly.



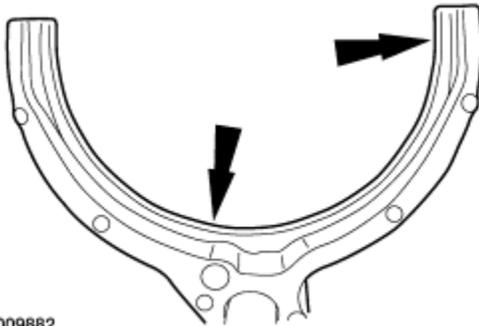
23. Remove the shift rail assembly with the Shift Rod Assemblies Aligner.

- Inspect the shift rails and shift forks for wear or damage. Disassemble and install new components as necessary.



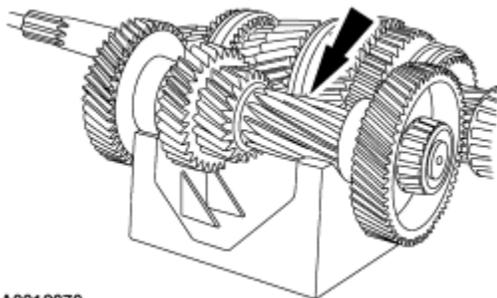
A0012065

24. Inspect the shift fork pads and centers for wear or damage. Install new shift forks as necessary.



A0009882

25. Remove the countershaft from the Gear Pack Holding Fixture and set it aside.

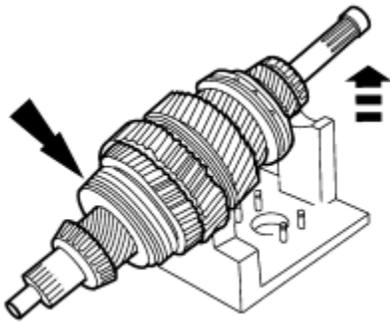


A0012070

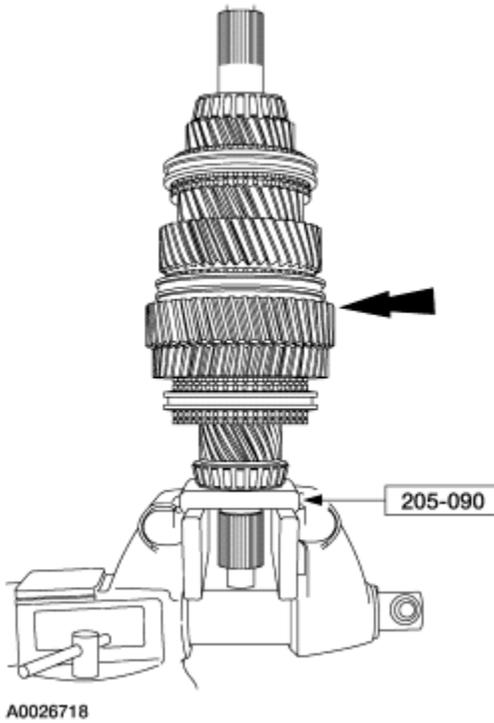
26. **NOTE:** Secure the Bearing/Oil Seal Plate in a vise.

Remove the mainshaft from the Gear Pack Holding Fixture and place it in the Axle Bearing Seal Plate.

- Place the mainshaft in the Axle Bearing Seal Plate with the input shaft facing upward.



AC0182-A



A0026718

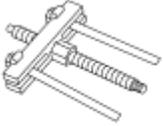
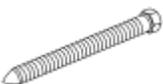
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
Manual

[Procedure revision date: 01/26/2000](#)

Counter Shaft Bearing

Special Tool(s)

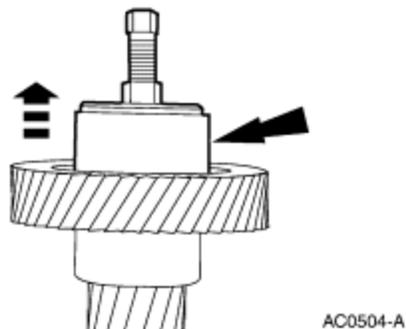
 <p>ST1516-A</p>	<p>Collet 5/8 to 3/4 303-D018 (D80L-1008-P)</p>
 <p>ST1304-A</p>	<p>TOD Forcing Screw T84T-7025-B</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164R-3900</p>

Disassembly

1. **NOTE:** With the exception of the bearings the countershaft is serviced as an assembly.

NOTE: This procedure is used for both countershaft bearings.

2. Use the Collets and Forcing Screw to remove the output shaft bearing.



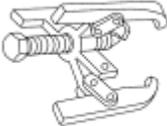
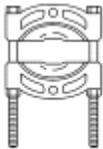
Assembly

1.  **CAUTION: Do not heat the countershaft shaft bearings for more than 15 minutes.**

Use a Gear/Bearing Heater to heat the countershaft bearing to 130°C (250°F).

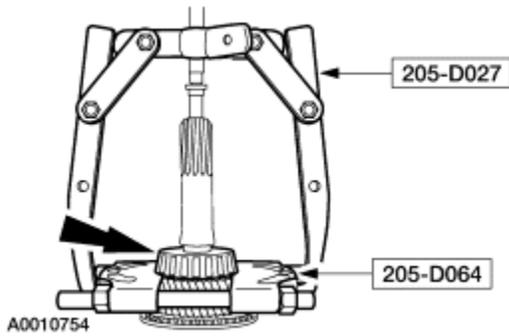
2. Install the output shaft bearing until it seats against its stop.
-

Input Shaft and Bearing

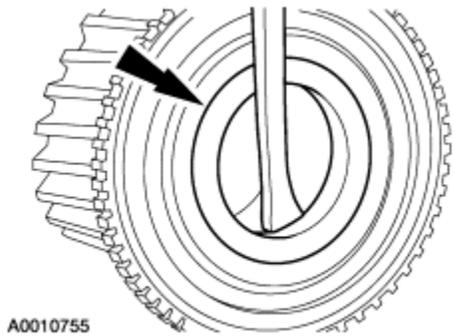
Special Tool(s)	
 ST2369-A	Hub Sensing Ring Replacer 205-059 (T94P-20202-B1)
 ST1585-A	2 or 3 Jaw Puller 205-D027 (D80L-1013-A)
 ST2143-A	Inner Pinion Bearing Cone Replacer 205-232 (T85T-4621-AH)
 ST1254-A	Axle Bearing/Seal Service Plate 205-090 (T75L-1165-B)
 ST2156-A	Gear/Bearing Heater 164-R3900
 ST1368-A	Bearing Pulling Attachment 205-D064 (D84L-1123-A)

Disassembly

1. Using the special tools, remove the input shaft bearing.

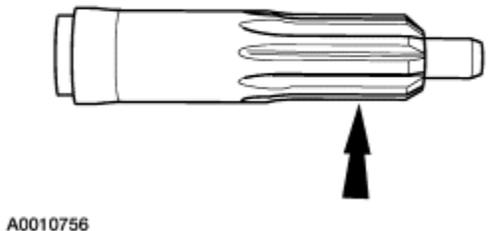


2. Remove the input shaft rear oil dam.



3. **⚠ CAUTION: To prevent damage, inspect the surface of the input shaft in the area of the bearing race to make sure it is smooth and free of burrs.**

Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



4. **⚠ CAUTION: To prevent damage, do not heat the bearing higher than 150°C (300°F).**

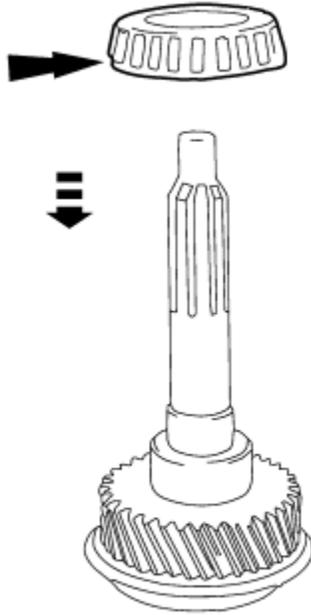
New or original components should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater.

Assembly

1.  **CAUTION: Do not drive against the bearing cone. Drive against the inner race only.**

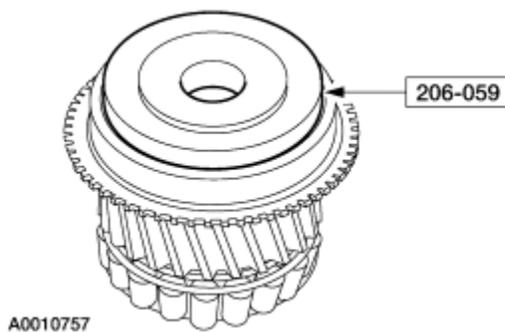
Install the input shaft bearing.

- Using a suitable driver, make sure the bearing is seated against its stop.

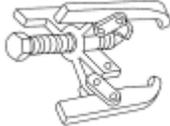
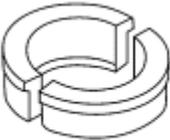


AC0206-A

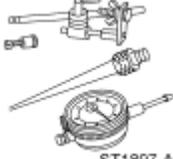
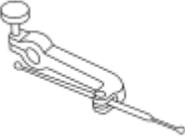
2. Using the special tool, install the input shaft rear oil dam.
 - Position the input shaft in the Gear Pack Assembly Fixture.



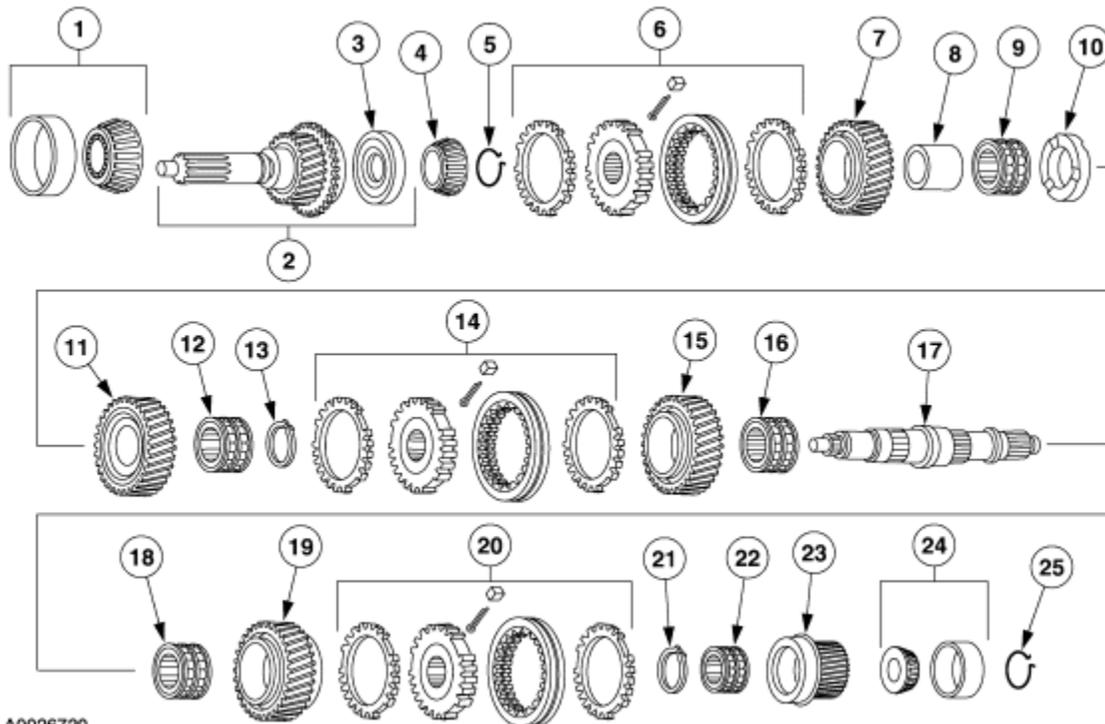
Main Shaft

Special Tool(s)	
 <p>ST2369-A</p>	Installer, Wheel Speed Sensor Ring 206-059 (T94P-20202-B1)
 <p>ST2143-A</p>	Installer, Drive Pinion Bearing 205-232 (T85T-4621-AH)
 <p>ST1368-A</p>	Puller, Bearing 205-D064 (D84L-1123-A)
 <p>ST2156-A</p>	Gear/Bearing Heater 164-R3900
 <p>ST1585-A</p>	2 or 3 Jaw Puller 205-D027 (D80L-1013-A)
 <p>ST2172-A</p>	Remover, Synchronizer 308-136 (T87T-7025-NH)

 <p>ST2511-A</p>	<p>Remover, Synchronizer 308-135 (T87T-7025-MH)</p>
 <p>ST2170-A</p>	<p>Remover, Synchronizer 308-137 (T87T-7025-OH)</p>
 <p>ST1835-A</p>	<p>Protector, Shaft 205-D008 (D80L-625-4)</p>
 <p>ST1347-A</p>	<p>Puller, Drive Pinion/Differential Carrier 205-D036 (D81L-4220-A)</p>
 <p>ST1254-A</p>	<p>Plate, Bearing/Oil Seal 205-090 (T75L-1165-B)</p>
 <p>ST2147-A</p>	<p>Remover/Installer, Bearing Tube 308-052 (T77J-7025-B)</p>
 <p>ST1304-A</p>	<p>Screw, Bearing Removal Tube 308-092 (T84T-7025-B)</p>
 <p>ST2146-A</p>	<p>Remover, Bearing Collet Sleeve 308-029 (T75L-7025-G)</p>

 <p>ST2144-A</p>	<p>Remover/Installer, Transmission Bearing Collet 308-132 (T87T-7025-FH)</p>
 <p>ST1897-A</p>	<p>Dial Indicator Gauge with Holding Fixture 100-002 (Tool-4201-A)</p>
 <p>ST1348-A</p>	<p>Gauge, Clutch Housing 308-021 (T75L-4201-A)</p>

Mainshaft-Disassembled View



A0026720

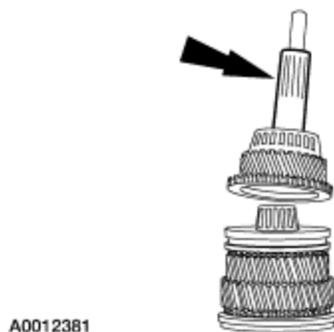
Item	Part Number	Description
1	7025	Input shaft bearing and bearing cup
2	7017	Input shaft
3	7046	Input shaft rear oil dam
4	7120	Input shaft pocket bearing

5	7B331	Snap ring kit
6	7124	Synchronizer assembly, third and fourth gear
7	7196	Mainshaft third gear
8	7173	Mainshaft third and fourth gear bushing
9	7133	Mainshaft needle bearing
10	7119	Mainshaft third gear thrust washer
11	7103	Mainshaft second gear
12	7133	Mainshaft needle bearing
13	7B331	Snap ring kit
14	7124	Synchronizer assembly, first and second gear
15	7100	Mainshaft first gear
16	7127	Mainshaft needle bearing
17	7061	Mainshaft
18	7127	Mainshaft needle bearing
19	7142	Mainshaft reverse gear
20	7124	Synchronizer assembly, fifth and reverse gear
21	7B331	Snap ring kit
22	7121	Mainshaft needle bearing
23	7158	Mainshaft fifth gear
24	7R205	Mainshaft rear bearing and bearing cup
25	7B331	Snap ring kit (4x4 vehicles)

Disassembly

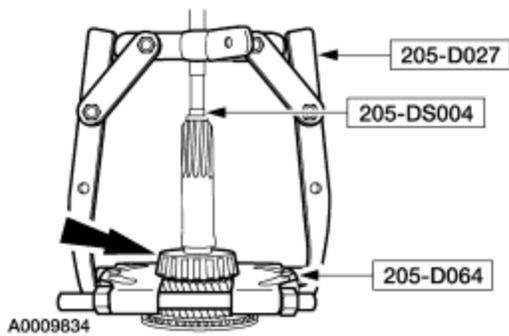
1. **NOTE:** Installing a new input shaft will affect mainshaft clearance. Carry out mainshaft clearance measurement.

Remove the input shaft.

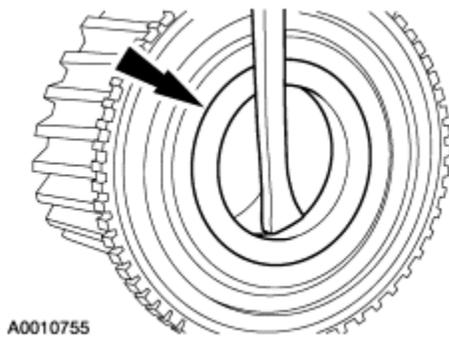


2. Using the special tools, remove and discard the input shaft bearing.

- Install new bearings and cups in a set only. Do not install one without the other.

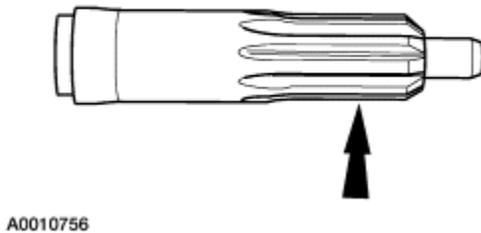


3. Remove and discard the input shaft rear oil dam.
 - Removing the oil dam will damage it, only remove as necessary.



4. **⚠ CAUTION: To prevent damage, inspect the surface of the input shaft in the area of the bearing race to make sure it is smooth and free of burrs.**

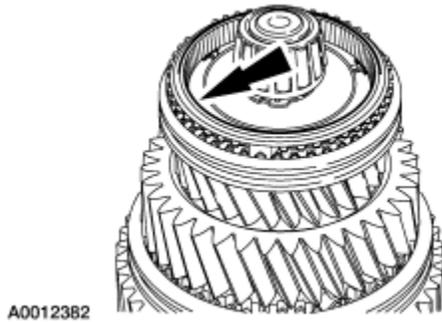
Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



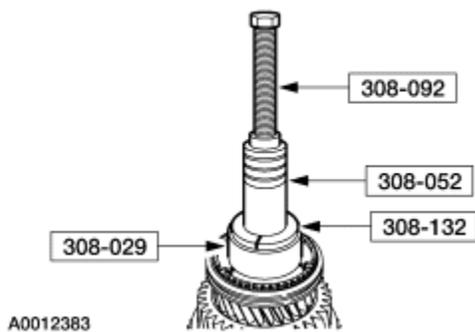
5. **⚠ CAUTION: To prevent damage, do not heat the bearing higher than 150°C (300°F).**

New or original components should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater.

6. Remove the synchronizer ring.
 - Inspect the internal surface of the synchronizer rings for a contact pattern.

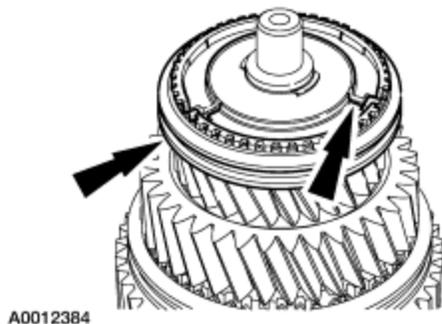


7. Using the special tools, remove the input shaft pocket bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary. Install new bearings and cups in a set only. Do not install one without the other.

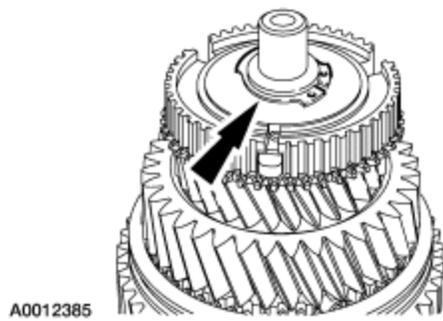


8.  **CAUTION: Place a cloth around the synchronizer to catch the detent springs and detents that will be released when the sliding sleeve is removed.**

Remove the synchronizer sliding sleeve, detents and detent springs.

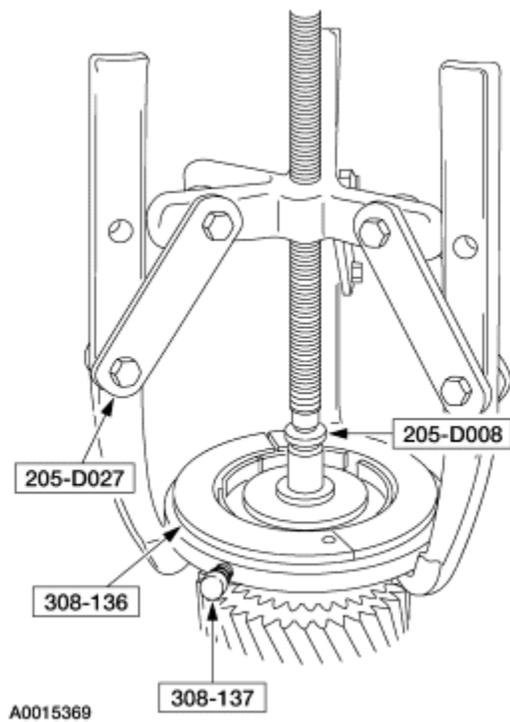


9. Remove and discard the snap ring.



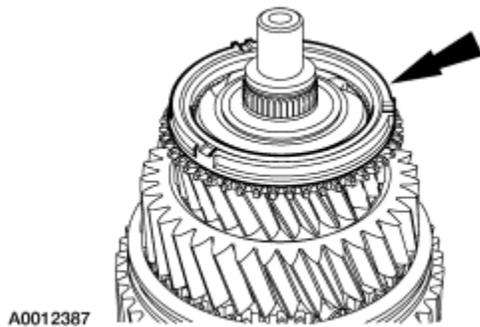
10. Using the special tools, remove the synchronizer body.

- Place the Synchronizer Remover under the third gear synchronizer ring



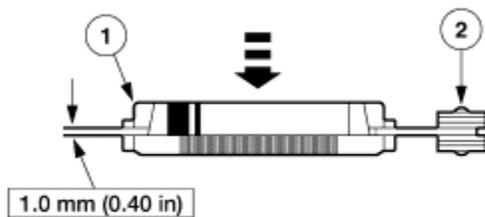
11. Remove the synchronizer ring.

- Inspect the internal surface of the synchronizer rings for a contact pattern.



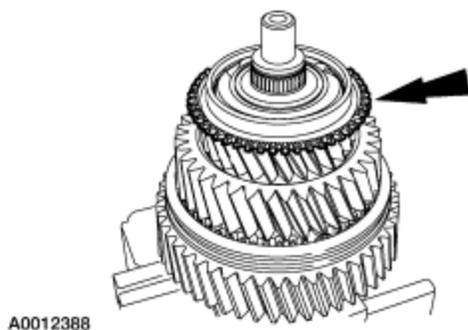
12. Check the clearance between the synchronizer rings and the gear.

1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference. Place the feeler gauge between the ring and gear clutching teeth. The ring has a raised section, inserting the feeler gauge past the teeth will give a wrong reading.
 - If the clearance is less than 1.0 mm (0.04 in), install a new synchronizer assembly, third or fourth gear to correct to specification.



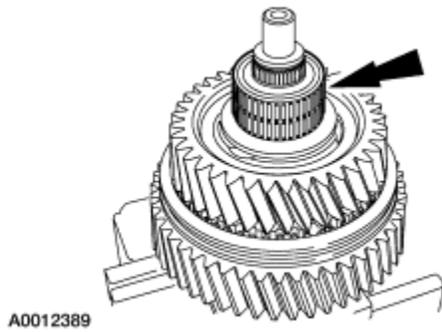
13. Remove third gear.

- Inspect the gear for wear or damage. Install a new gear as necessary.

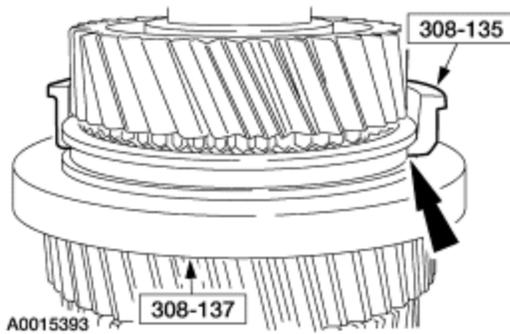


14. Remove mainshaft needle bearing.

- Inspect the bearing for wear or damage. Install a new bearing as necessary.



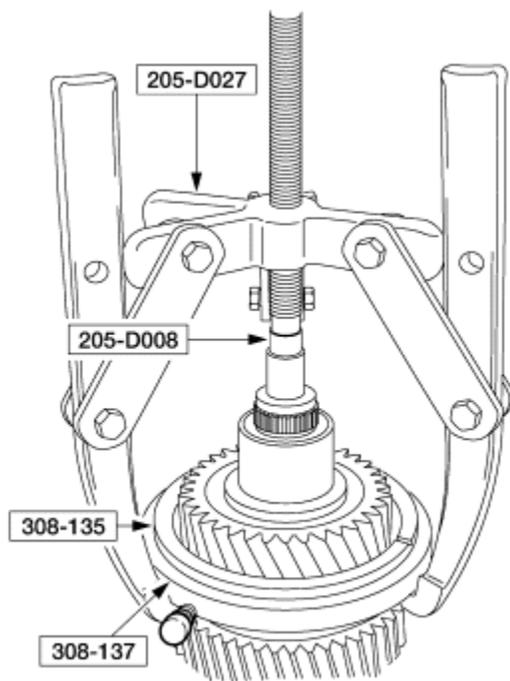
15. Engage second gear. Position the Collet Puller and Collet Ring into the first and second synchronizer sliding sleeve.



16.  **CAUTION: The detent springs and detents will be released when the synchronizer sliding sleeve is lifted off the synchronizer body.**

Using the special tools, remove the synchronizer sliding sleeve, the mainshaft third gear thrust washer, second gear and the mainshaft third gear bushing.

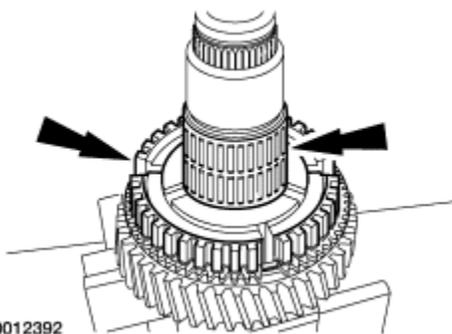
- Inspect the gear for wear or damage. Install a new gear as necessary.



A0015392

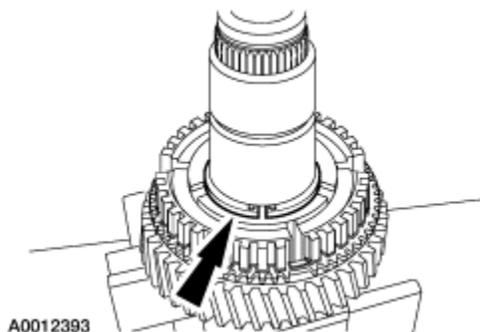
17. Remove the synchronizer ring and the mainshaft needle bearing.

- Inspect the bearing for wear or damage. Install a new bearing as necessary.
- Inspect the internal surface of the synchronizer rings for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.



A0012392

18. Remove and discard the snap ring.

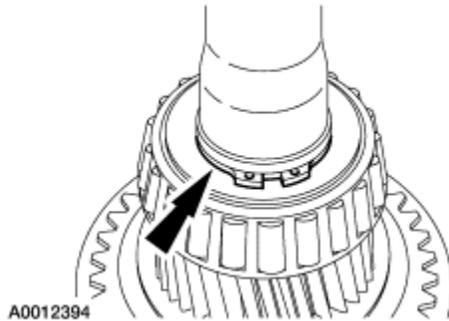


A0012393

19. Rotate the mainshaft in the Axle Bearing Seal Plate with the output end pointing upward.

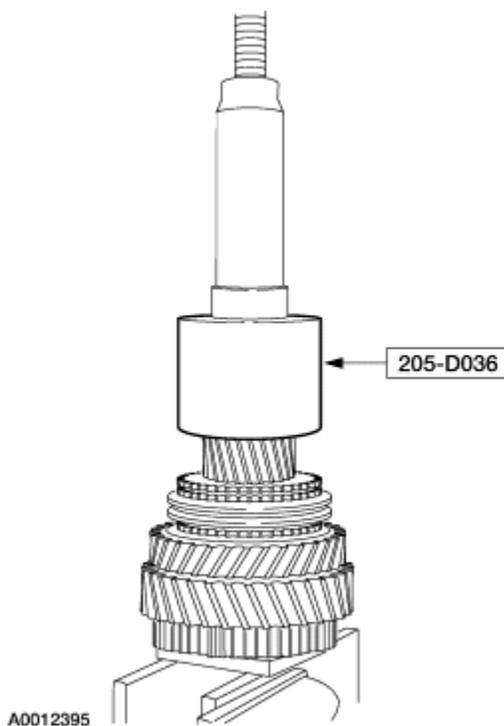
20. **NOTE:** The snap ring is used on 4-wheel drive vehicles only.

Remove and discard the snap ring.



21. Using the special tools, remove the output shaft rear bearing.

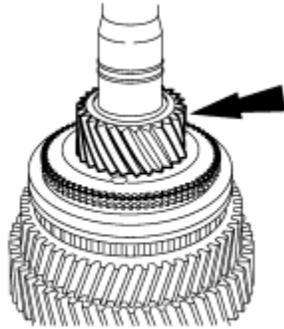
- Damage to the bearing can occur during removal. Inspect the bearing for wear or damage. Install a new bearing as necessary. Install new bearings and cups in a set only. Do not install one without the other.



22. Remove fifth gear.

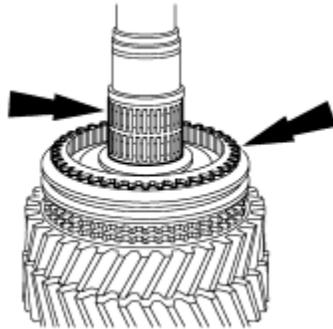
- Inspect the gear for wear or damage. Install a new gear as necessary.

A0012396



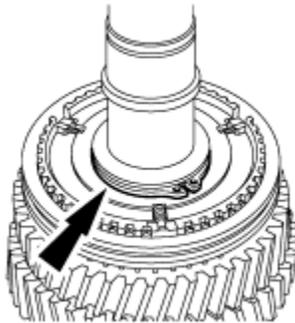
23. Remove the fifth gear mainshaft needle bearing and the synchronizer ring.
- The fifth gear mainshaft bearing is a split bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary.
 - Inspect the internal surface of the synchronizer rings for a contact pattern.

A0012397



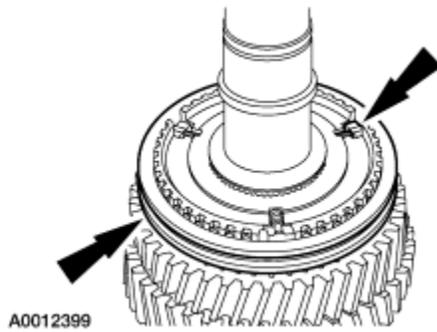
24. Remove and discard the snap ring.

A0012398

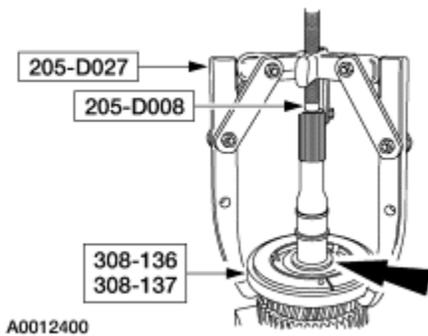


25.  **CAUTION:** The detent springs and detents will be released when the synchronizer sliding sleeve is lifted off the synchronizer body.

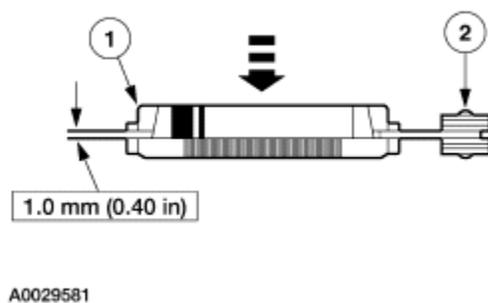
Remove the synchronizer sliding sleeve, the detent springs and the detents.



26. Using the special tools, remove the synchronizer body and synchronizer ring.
- Inspect the internal surface of the synchronizer ring for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.

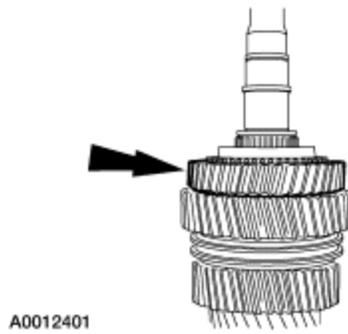


27. Check the clearance between the synchronizer rings and the gear.
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
 2. Insert a feeler gauge and measure the clearance while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference. Place the feeler gauge between the ring and gear clutching tee th. The ring has a raised section, inserting the feeler gauge past the teeth will give a wrong reading.
 - If the clearance is less than 1.0 mm (0.04 in), install a new synchronizer assembly, third or fourth gear to correct to specification.



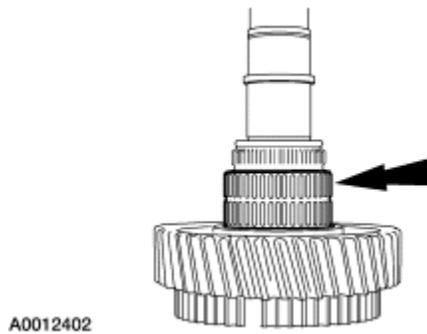
28. Remove reverse gear.

- Inspect the gear for wear or damage. Install a new gear as necessary.



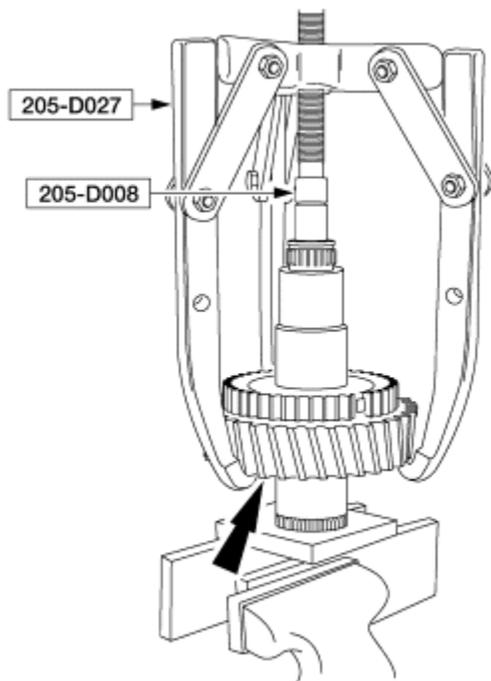
29. Remove the mainshaft needle bearing.

- Inspect the bearing for wear or damage. Install a new bearing as necessary.



30. Rotate the mainshaft with the input end facing upward.

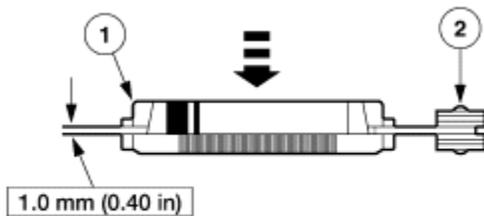
31. Using the special tools, remove the synchronizer body and first gear.



A0012420

32. Check the clearance between the synchronizer rings and the gear.

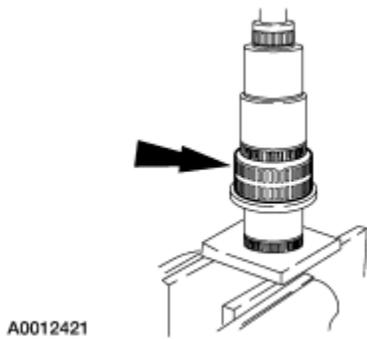
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference. Place the feeler gauge between the ring and gear clutching teeth. The ring has a raised section, inserting the feeler gauge past the teeth will give a wrong reading.
 - If the clearance is less than 1.0 mm (0.04 in), install a new synchronizer assembly, third or fourth gear to correct to specification.



A0029581

33. Remove the mainshaft needle bearing.

- Inspect the bearing for wear or damage. Install a new bearing as necessary.



34.  **CAUTION: To prevent damage, do not heat the rear mainshaft bearing, the output bearing thrust washer and the mainshaft low gear bushing higher than 150°C (300°F) maximum.**

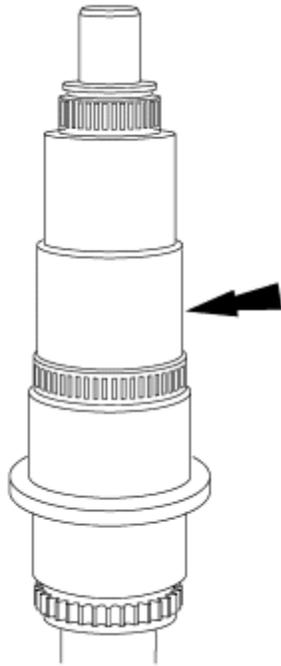
New or original components should be heated in advance of the assembly procedure. Heating will ease the assembly process. Place the input shaft pocket bearing, the synchronizer bodies, the mainshaft third gear thrust washer, the mainshaft third gear bushing and the output shaft rear bearing into the Gear/Bearing Heater. Allow 45 minutes for components to reach 150°C (300°F).

Assembly

1. Inspect the mainshaft and all mainshaft components for wear or damage. For additional information, refer to [Section 308-00](#).
2.  **CAUTION: Do not reassemble the mainshaft dry. Apply lubricant throughout the assembly procedure.**

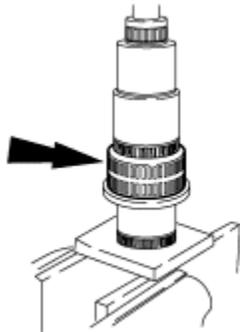
Lubricate all mainshaft components with the recommended transmission lubricant, MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.

3. Position the mainshaft in the Axle Bearing Seal Plate with the input end facing upward.



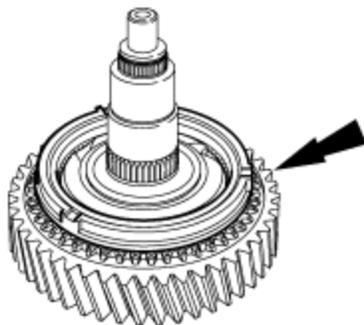
A0013134

4. Install the mainshaft first gear needle bearing.



A0012421

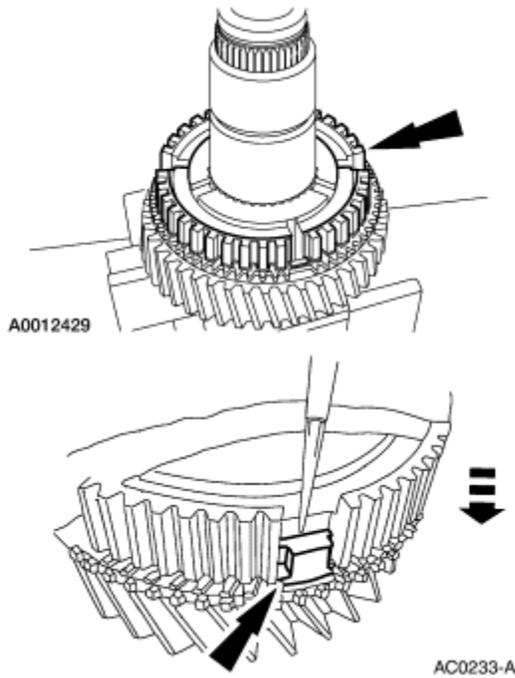
5. Install first gear and the first gear synchronizer ring.



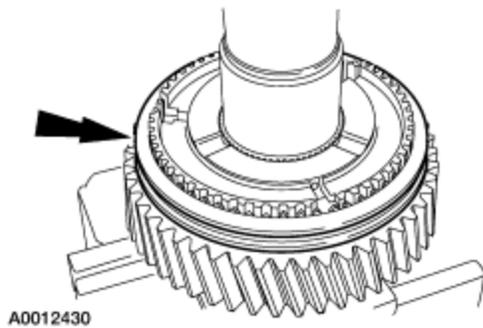
A0013135

6. Install the first and second synchronizer body.
 - The numbers on the synchronizer body must face upward.

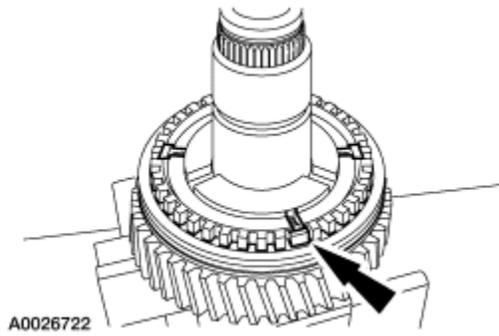
- Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.
- Use a suitable tube to fully seat the synchronizer body.



7. Install the synchronizer sliding sleeve, then pushing down on the sleeve, engage first gear.
 - Install the synchronizer sliding sleeve with the bevel edge against first gear.

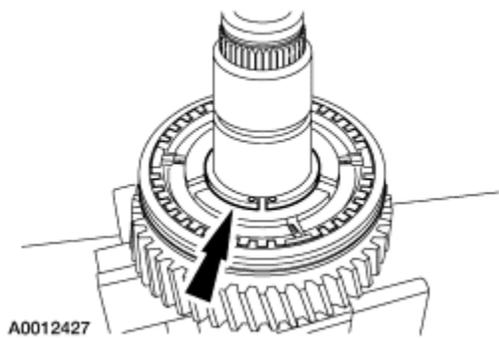


8. Install the detent springs and the detents.



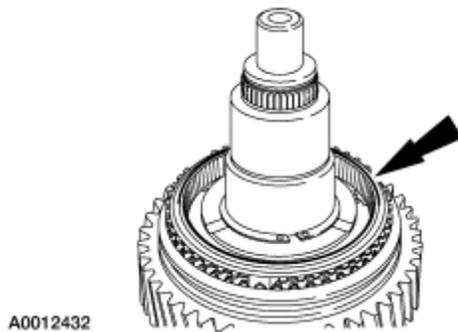
9. Install a new snap ring.

- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated. Using a feeler gauge, check the clearance between the snap ring and the synchronizer body. Clearance should not be greater than 0.1 mm (0.004 inch).

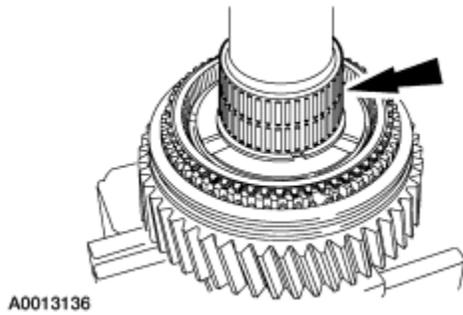


10. Install the second gear synchronizer ring.

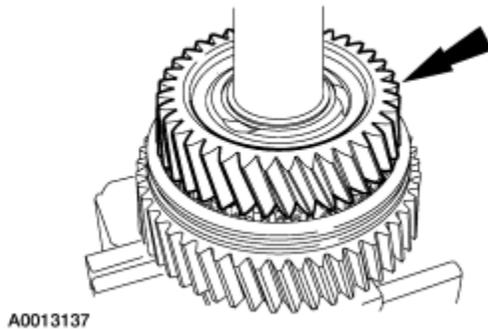
- Move the synchronizer sliding sleeve to the center position.



11. Install the mainshaft second gear needle bearing.

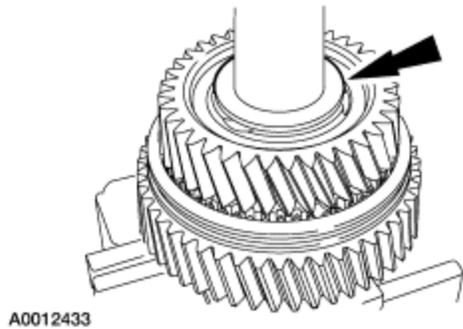


12. Install second gear.



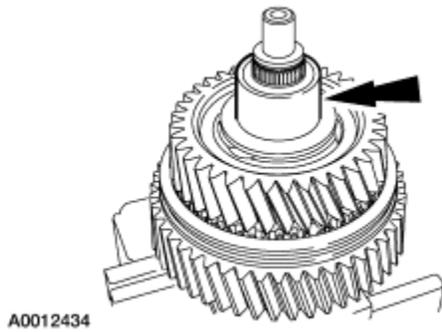
13. Remove the mainshaft third gear thrust washer from the Gear/Bearing Heater and install it on the mainshaft.

- Using a suitable driver, tap or press the thrust washer down until it is seated against the stop.



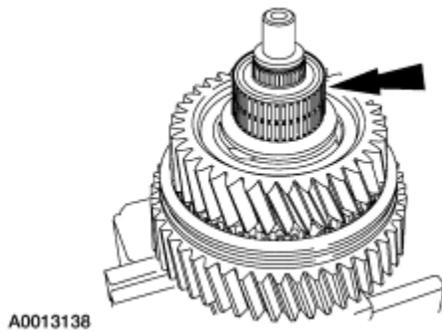
14. Remove the mainshaft third gear bushing from the Gear/Bearing Heater and install it on the mainshaft.

- Using a suitable driver, tap the spacer down until it is seated against the stop.

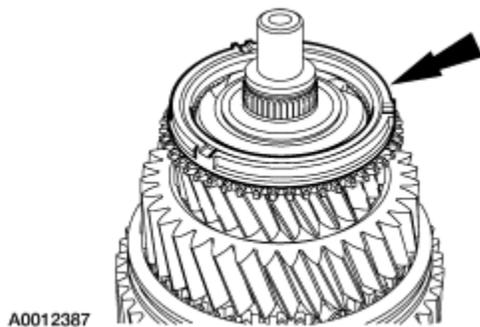


15. **NOTE:** Let the mainshaft third gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

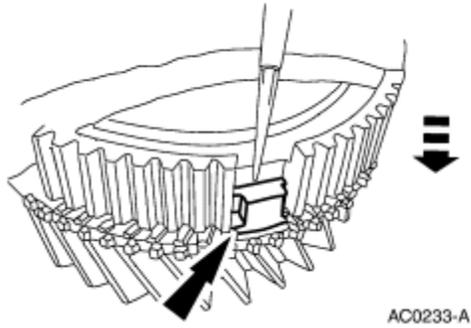
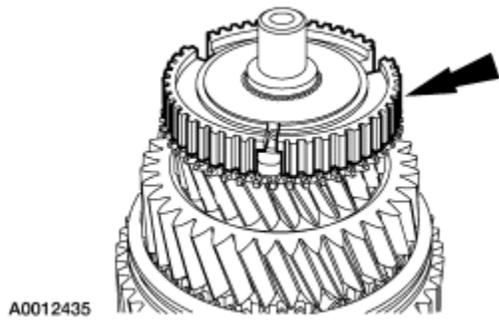
Install the mainshaft third gear needle bearing.



16. Install third gear and the third gear synchronizer ring.

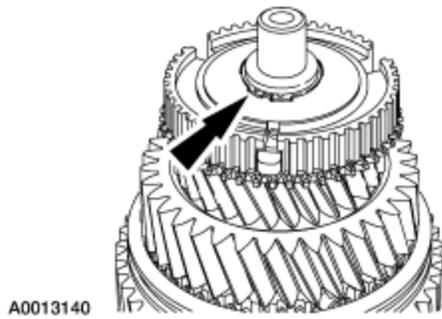


17. Remove the third and fourth gear synchronizer body from the Gear/Bearing Heater and install it on the mainshaft.
- Install the synchronizer body with the part numbers facing upward.
 - Use a suitable tube to fully seat the synchronizer body.

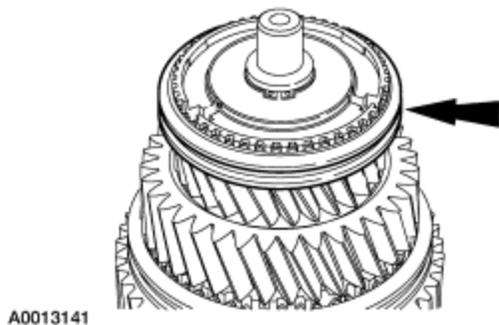


18. Install a new snap ring.

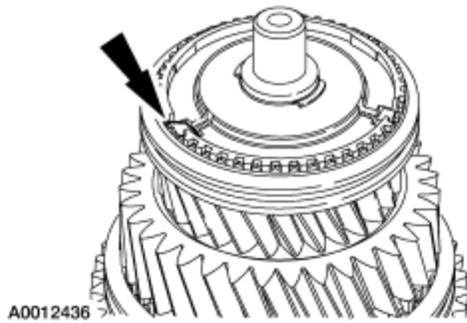
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



19. Install the synchronizer sliding sleeve with the part number facing upward, then push it downward to engage third gear.

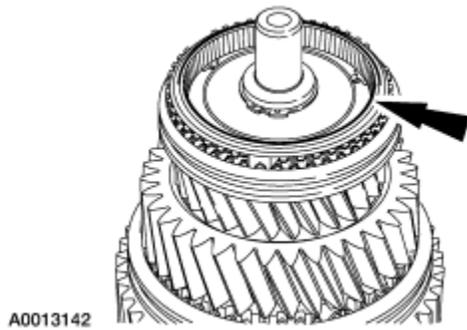


20. Install the detent springs and the detents.



21. Install the fourth gear synchronizer ring.

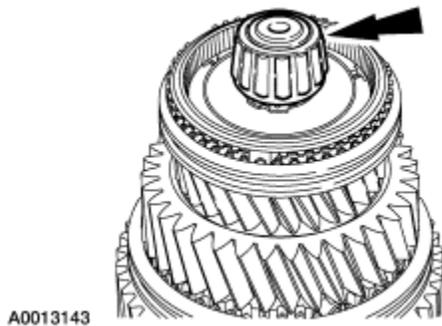
- Move the synchronizer sliding sleeve to the center position.

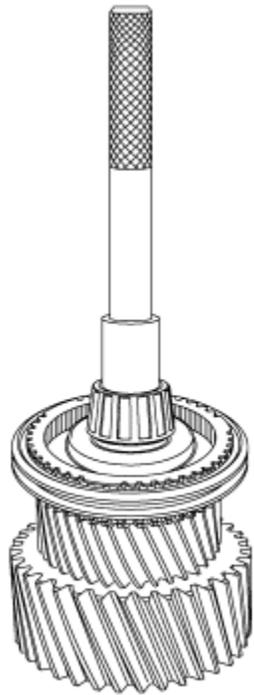


22.  **CAUTION: Drive the input shaft pocket bearing onto the mainshaft by the inner race only. Using the outer race will damage the bearing.**

Remove the input shaft pocket bearing from the Gear/Bearing Heater and install it on the mainshaft.

- Using a suitable driver, tap the bearing down until it is seated against its stop.

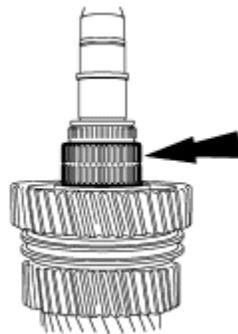




A0026723

23. Reposition the mainshaft in the Axle Bearing Seal Plate with the output end facing upward.

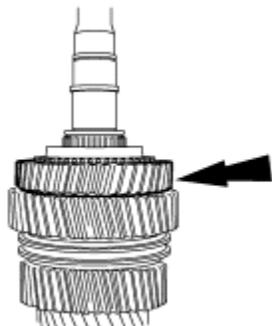
24. Install the mainshaft reverse gear needle bearing.



A0013144

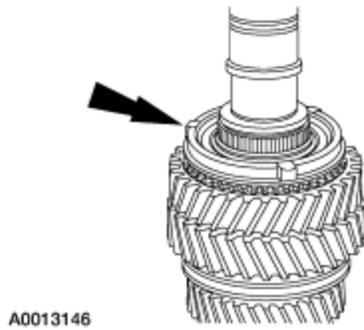
25. Install the reverse gear.

- The gear clutching teeth must face upward.



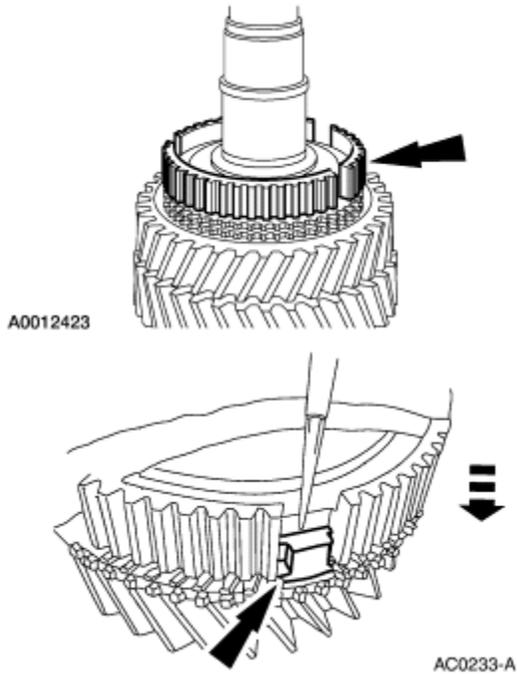
A0013145

26. Install the reverse gear synchronizer ring.



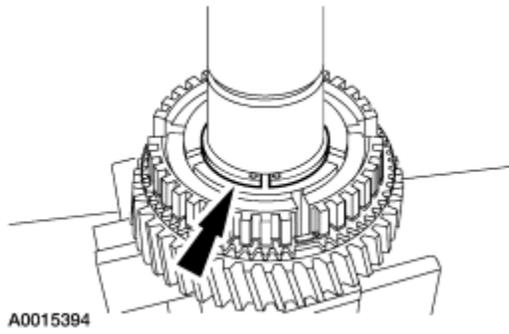
27. Remove the fifth and reverse synchronizer body from the Gear/Bearing Heater and install it on the mainshaft.

- The numbers on the synchronizer body must face upward.
- The side with the shoulder (deeper hub) faces downward. Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.

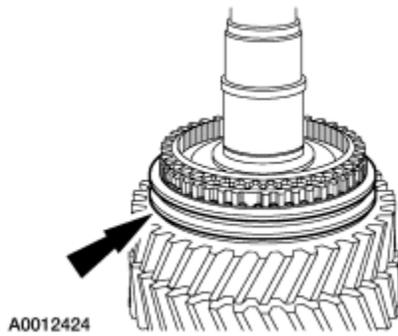


28. Install a new snap ring.

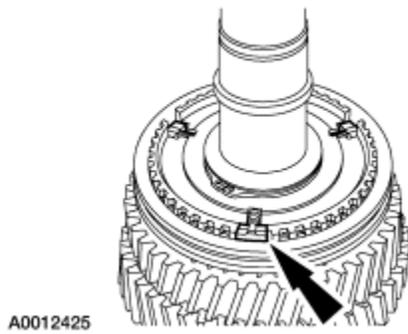
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



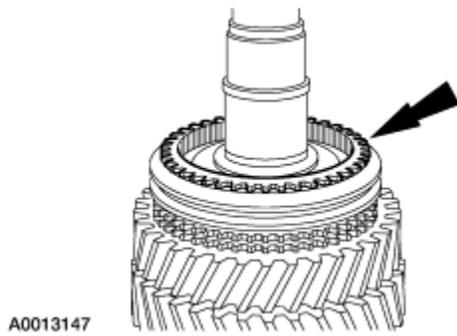
29. Install the synchronizer sliding sleeve, sliding the sleeve down to engage the clutching teeth of the reverse gear.



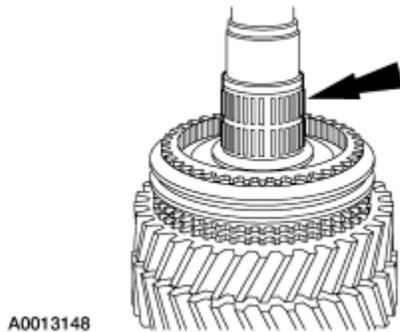
30. Install the detent springs and the detents.



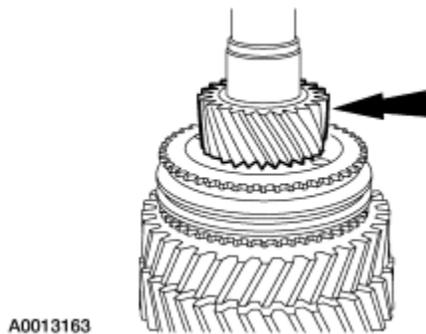
31. Install the fifth gear synchronizer ring.
- Pull the sliding sleeve into the neutral position.



32. Install the mainshaft fifth gear split needle bearing.



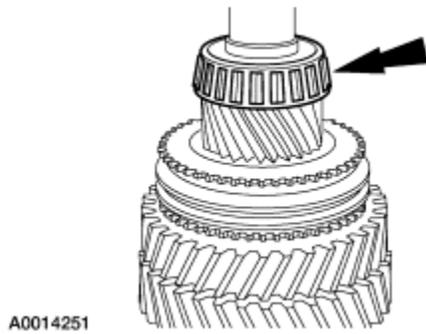
33. Install fifth gear.



34.  **CAUTION: Drive the output shaft rear bearing onto the mainshaft by the inner race only. Using the outer race will damage the bearing.**

Remove the output shaft rear bearing from the Gear/Bearing Heater and install it on the mainshaft.

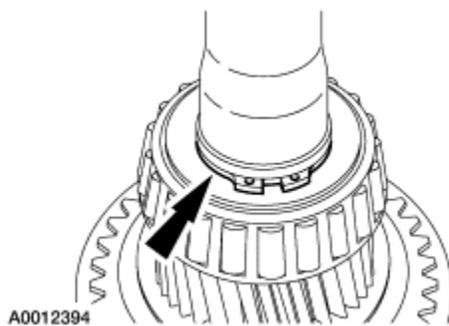
- Using a suitable tube, tap on the inside bearing race to make sure the bearing is seated against the stop.



35. **NOTE:** The snap ring is used on 4-wheel drive vehicles only.

Install a new snap ring.

- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



36. **NOTE:** The transmission must be in the neutral position before final assembly.

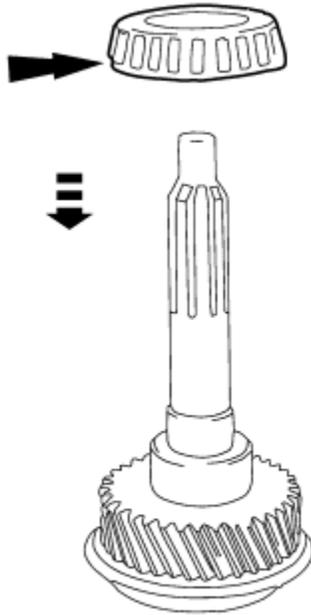
Place the mainshaft in the neutral position.

- Hold down the input shaft and pull up on the third and fourth synchronizer sliding sleeve to the neutral position.
- Lift up on the first and second synchronizer sliding sleeve to the neutral position.

37.  **CAUTION: Do not drive against the bearing cone. Drive against the inner race only.**

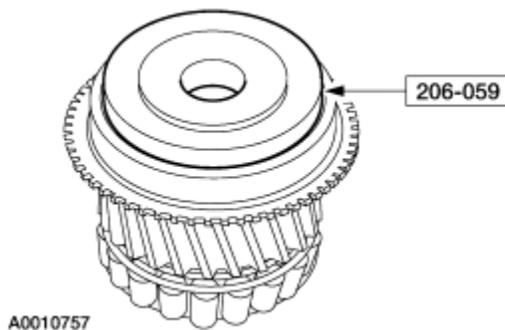
Remove the input shaft bearing from the Gear/Bearing Heater and install the bearing.

- Using a suitable driver, make sure the bearing is seated against its stop.



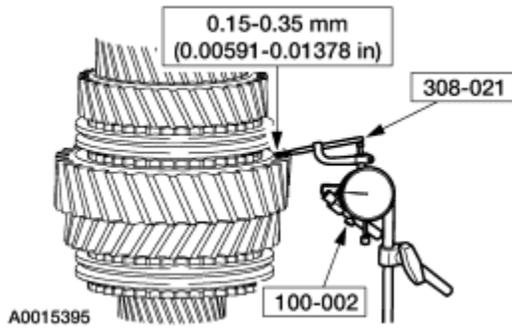
AC0206-A

38. Using the special tool, install the input shaft rear oil dam.
- Rotate the input shaft 360 degrees to make sure the input shaft rear oil dam is completely seated.

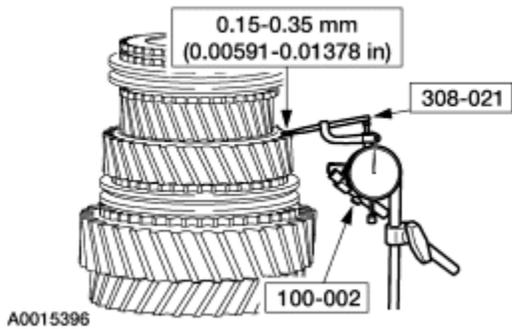


39. Install the input shaft.
- Fill the input shaft pocket with a suitable engine assembly white grease.
40. **NOTE:** If the following axial gear clearances are not within specification, it will be necessary to disassemble and reinspect.

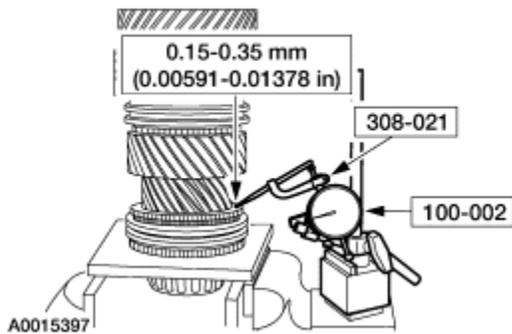
Using the special tools, check the axial gear clearance at the mainshaft first gear.



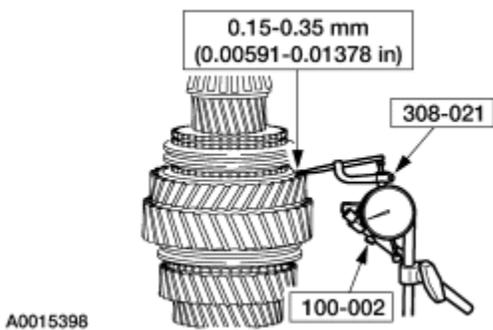
41. Using the special tools, check the axial gear clearance at the mainshaft second gear.



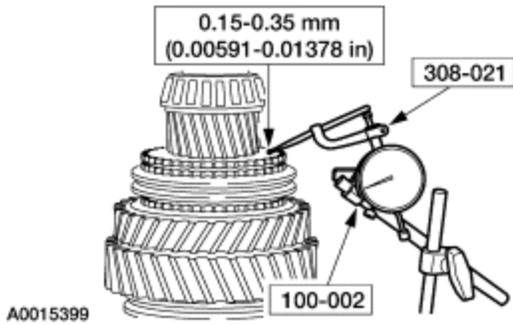
42. Rotate the mainshaft with the input shaft facing downward. Using the special tools, check the axial gear clearance at the mainshaft third gear.



43. Using the special tools, check the axial gear clearance at the mainshaft reverse gear.



44. Using the special tools, check the axial gear clearance at the mainshaft fifth gear.



SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
Manual

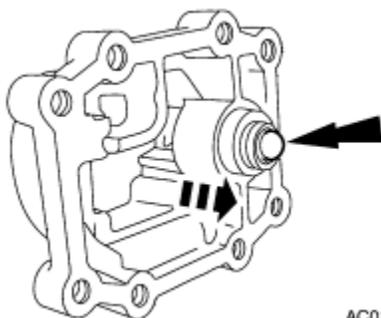
[Procedure revision date: 01/26/2000](#)

Shift Control Housing

Special Tool(s)	
	Rotunda Heat Gun 107-R0300

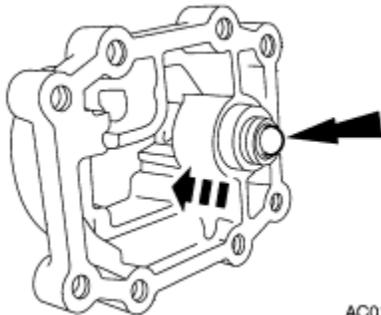
Disassembly

1. Remove the detent.
 - Use the Heat Gun to heat the shift lever housing to approximately 120°C (248°F).
 - Remove the detent.



Assembly

1. Install the detent.
 - Use the Heat Gun to heat the shift lever housing to approximately 120°C (248°F).
 - Press the detent into its mounting hole until it rests against its stop.



AC0184-A

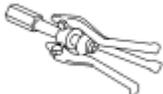
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF

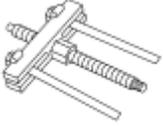
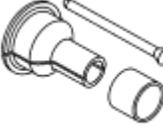
1999 F-Super Duty 250-550 Workshop
Manual

DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

[Procedure revision date: 01/26/2000](#)

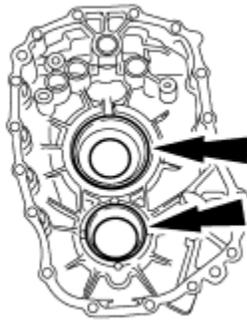
Extension Housing

Special Tool(s)	
 ST1200-A	Remover, Bearing Cup 308-047 (T77F-1102-A)
 ST2153-A	Collet, 3/4 in to 7/8 in 303-D019 (D80L100-Q)
 ST1616-A	Actuator Pin (Dia. 3/16 in) 303-D011 (D80L-100-G)

 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>
 <p>ST2576-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
 <p>ST1255-A</p>	<p>Adapter for 30-224 (Handle) 205-153 (T80T-4000-W)</p>
 <p>ST2150-A</p>	<p>Installer, Bearing Cup 308-016 (T73T-4222-A)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1110-A</p>	<p>Heat Gun 107-R0300</p>

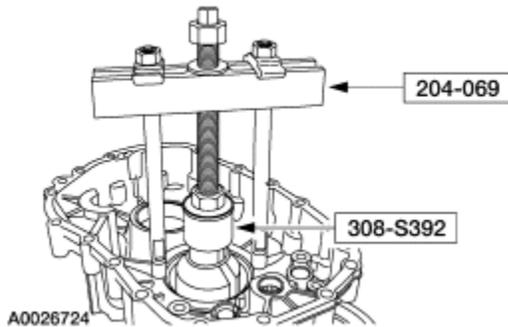
Disassembly

1. Inspect the bearing cups for wear or damage. Install new cups as necessary.
 - If new bearings were installed on the mainshaft or countershaft, install new bearing cups.



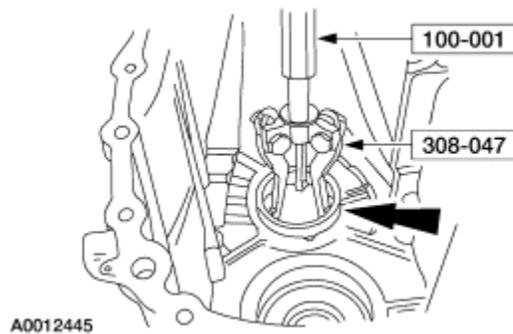
A0012437

2. Using the special tools, remove the mainshaft rear bearing cup.



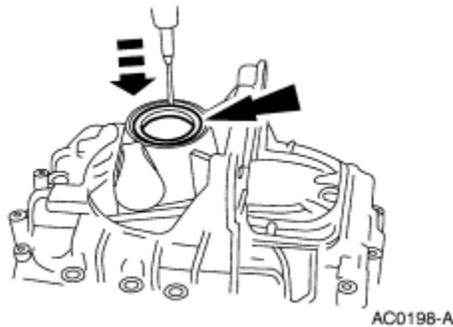
A0026724

3. Using the special tools, remove the countershaft rear bearing cup.



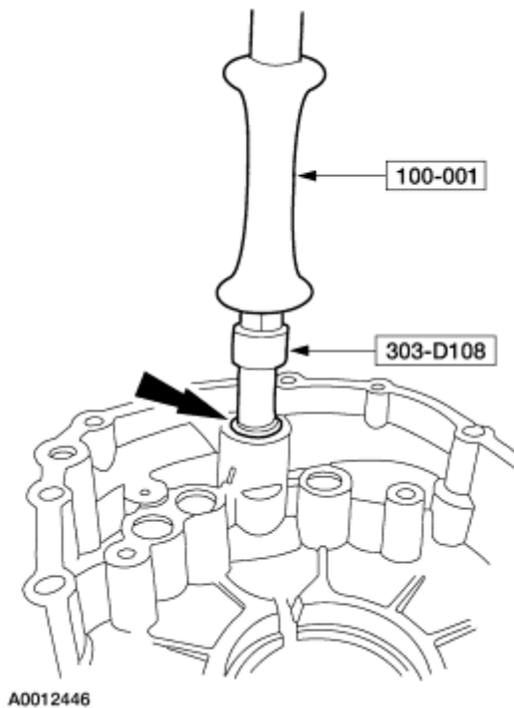
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4. Remove and discard the oil seal.



AC0198-A

5. Using the special tools, remove and discard the shift rail bearing.



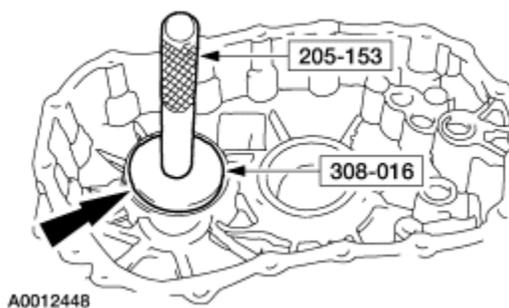
6. **NOTE:** Use care when cleaning the mating surfaces. Nicks and gouges can prevent sealing and cause leaks. Clean the mating surfaces with an oil stone.

Clean the mating surface of the extension housing.

Assembly

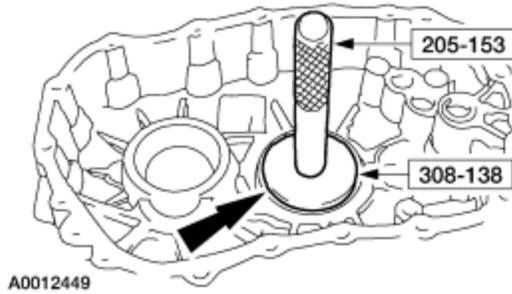
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

1. Using the Needle Bearing Replacer and the Handle, install the shift rail bearing.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).
2. Using the special tools, install the countershaft rear bearing cup.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).



3. Using the special tools, install the mainshaft bearing cup.

- Use the Heat Gun to heat the bearing bore to 150°C (300°F).



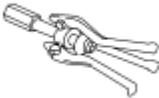
4. Install a new output oil seal after the bearing preload is completed during transmission assembly.

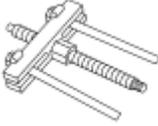
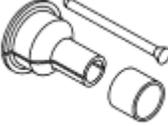
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
 Manual

[Procedure revision date: 01/26/2000](#)

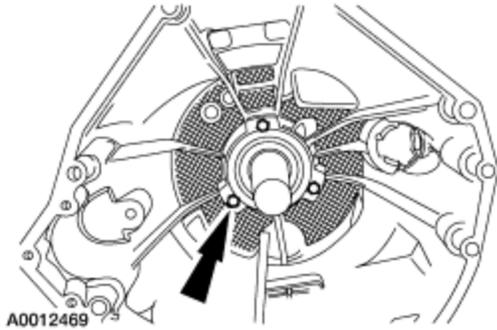
Case

Special Tool(s)	
 ST1185-A	Slide Hammer 100-001 (T50T-100-A)
 ST1200-A	Remover, Bearing Cup 308-047 (T77F-1102-A)
 ST2153-A	Collet, 3/4 in to 7/8 in 303-D019 (D80L-100-Q) or equivalent

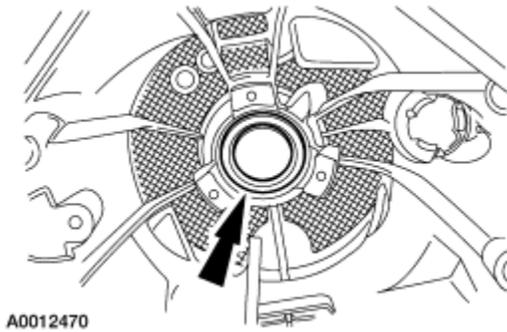
 <p>ST1616-A</p>	<p>Actuator Pin (Dia. 3/16 in) 303-D011 (D80L-100-G) or equivalent</p>
 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Cup 308-390</p>
 <p>ST1255-A</p>	<p>Handle 205-D055 (D81L-4000-A) or equivalent</p>
 <p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>
 <p>ST2576-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
 <p>ST1110-A</p>	<p>Heat Gun 107-R0300</p>

Disassembly

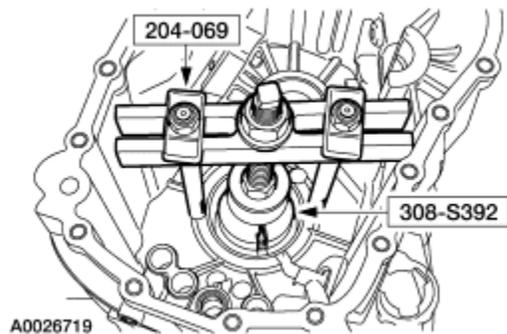
1. Remove the guide tube.
 - Inspect the guide tube for wear or damage. Install a new guide tube as necessary.



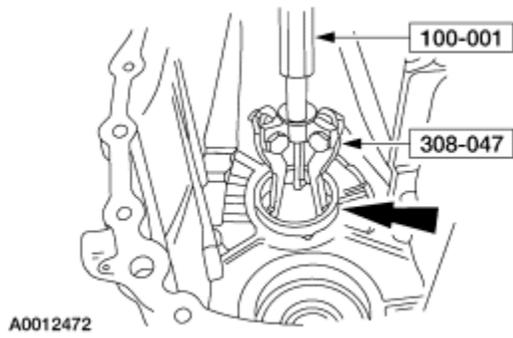
2. Remove and discard the input shaft oil seal.



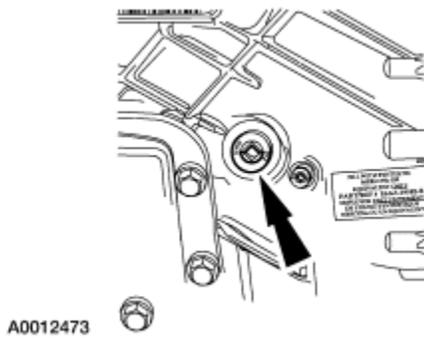
3. Using the special tools, remove the input shaft bearing cup, the oil dam and the shims.
 - Using a hammer and punch, tap down two areas on the oil dam, 180 degrees apart, to insert the puller under the cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the input shaft, install a new cup.



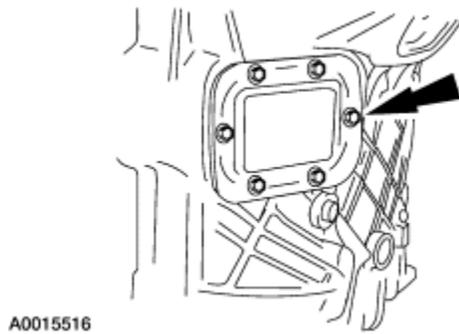
4. Use the special tools, remove the countershaft front bearing cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the countershaft, install a new cup.



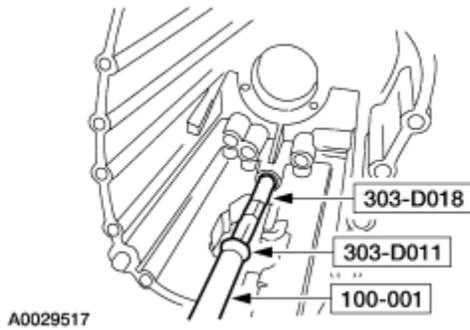
5. Remove the case plug and discard the seal.



6. Remove the reverse lamp switch and discard the seal.
7. Remove the power take-off (PTO) covers.



8. Using the special tools, remove and discard the shift rail bearing.



9. **NOTE:** Use care when cleaning the mating surfaces. Nicks and gouges can prevent sealing and cause leaks. Clean the mating surfaces with an oil stone.

Clean the mating surface of the case.

Assembly

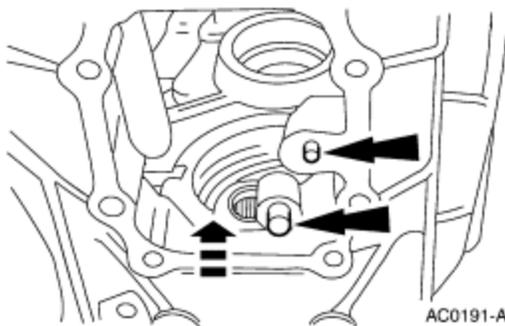
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

1. **NOTE:** If installing a new case, new interlock plate roll pins must be installed.

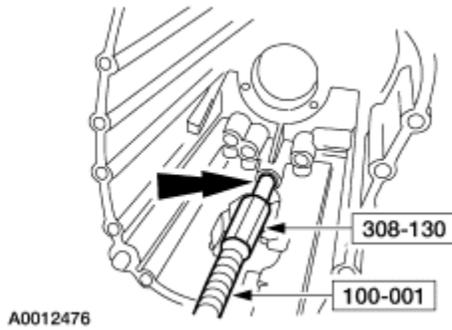
Install the interlock plate roll pins.

- Install the large pin until it bottoms out (will stick out approximately 8 mm [0.32 in]).
- **NOTE:** Do not allow the small pin to bottom out.

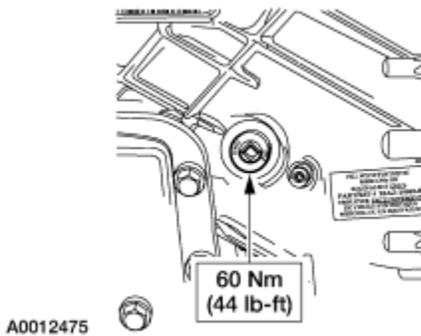
Install the small pin (will stick out 4-5 mm [0.158-0.197 in]).



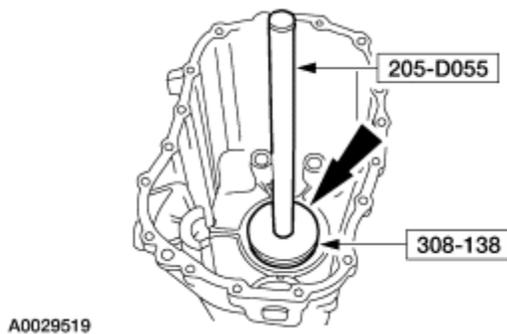
2. Using the special tools, install a new shift rail bearing.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).
 - Bearing should be flush with the surface of the bore.



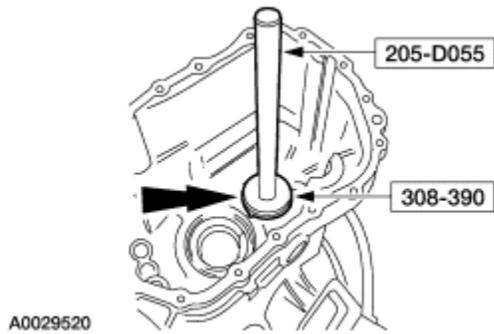
3. Install the case plug with a new seal.



4. Using the special tools, install the input shaft bearing cup.
 - Do not install the oil trough, shim or oil dam at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed. For additional information, refer to [Transmission](#) in this section.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).



5. Using the special tools, install the countershaft front bearing cup.
 - Do not install the shim at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed. For additional information, refer to [Transmission](#) in this section.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).



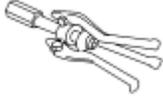
6. Install a new input shaft oil seal and the guide tube after the bearing preload is completed. For additional information, refer to [Transmission](#) in this section.

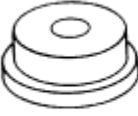
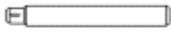
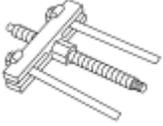
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
 Manual

[Procedure revision date: 01/26/2000](#)

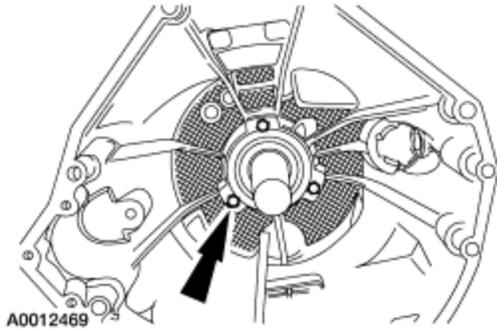
Case

Special Tool(s)	
 ST1185-A	Slide Hammer 100-001 (T50T-100-A)
 ST1200-A	Remover, Bearing Cup 308-047 (T77F-1102-A)
 ST2153-A	Collet, 3/4 in to 7/8 in 303-D019 (D80L-100-Q) or equivalent

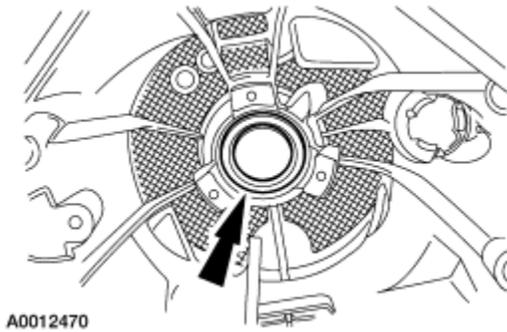
 <p>ST1616-A</p>	<p>Actuator Pin (Dia. 3/16 in) 303-D011 (D80L-100-G) or equivalent</p>
 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Cup 308-390</p>
 <p>ST1255-A</p>	<p>Handle 205-D055 (D81L-4000-A) or equivalent</p>
 <p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>
 <p>ST2576-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
 <p>ST1110-A</p>	<p>Heat Gun 107-R0300</p>

Disassembly

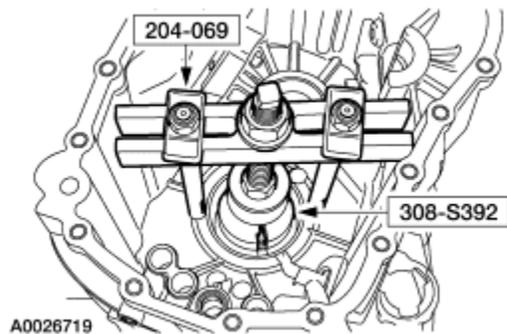
1. Remove the guide tube.
 - Inspect the guide tube for wear or damage. Install a new guide tube as necessary.



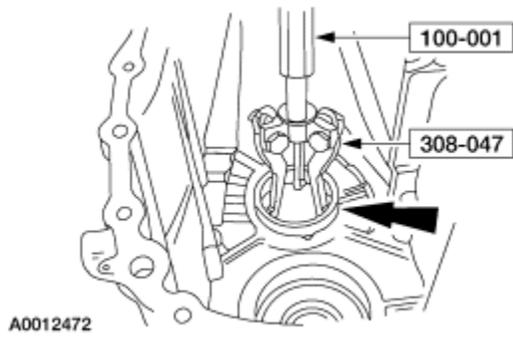
2. Remove and discard the input shaft oil seal.



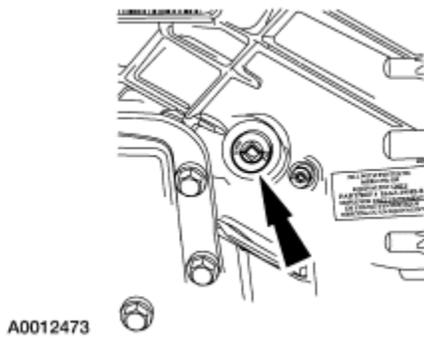
3. Using the special tools, remove the input shaft bearing cup, the oil dam and the shims.
 - Using a hammer and punch, tap down two areas on the oil dam, 180 degrees apart, to insert the puller under the cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the input shaft, install a new cup.



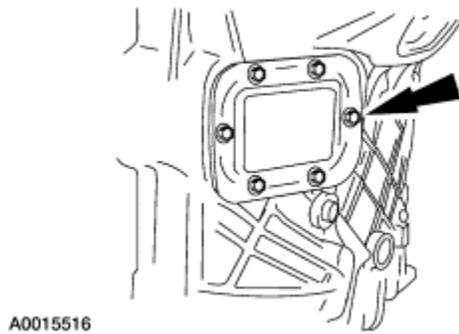
4. Use the special tools, remove the countershaft front bearing cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the countershaft, install a new cup.



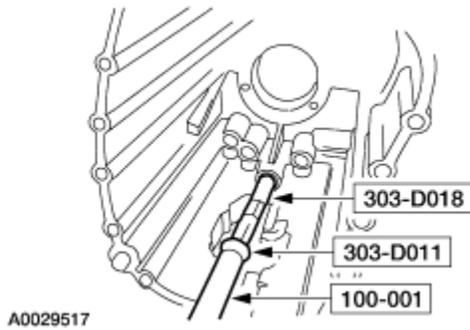
5. Remove the case plug and discard the seal.



6. Remove the reverse lamp switch and discard the seal.
7. Remove the power take-off (PTO) covers.



8. Using the special tools, remove and discard the shift rail bearing.



9. **NOTE:** Use care when cleaning the mating surfaces. Nicks and gouges can prevent sealing and cause leaks. Clean the mating surfaces with an oil stone.

Clean the mating surface of the case.

Assembly

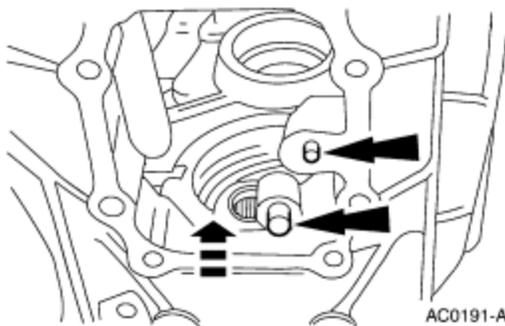
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

1. **NOTE:** If installing a new case, new interlock plate roll pins must be installed.

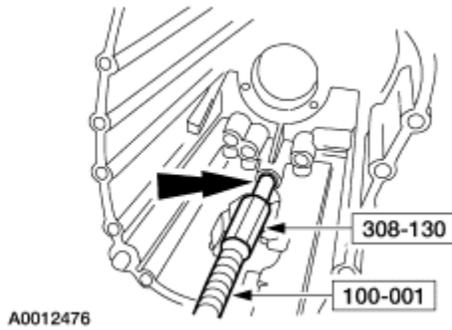
Install the interlock plate roll pins.

- Install the large pin until it bottoms out (will stick out approximately 8 mm [0.32 in]).
- **NOTE:** Do not allow the small pin to bottom out.

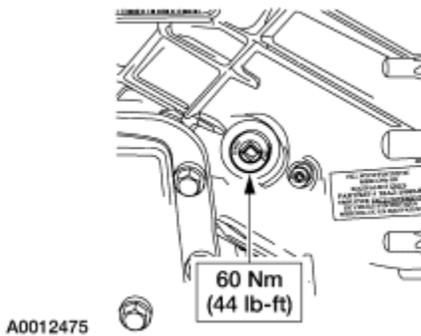
Install the small pin (will stick out 4-5 mm [0.158-0.197 in]).



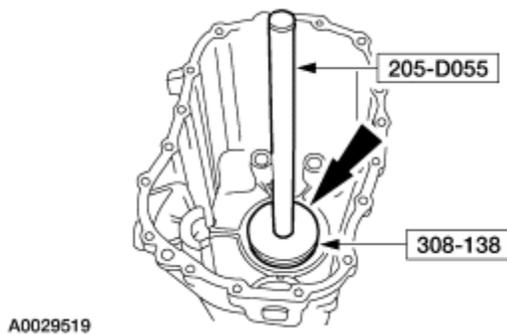
2. Using the special tools, install a new shift rail bearing.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).
 - Bearing should be flush with the surface of the bore.



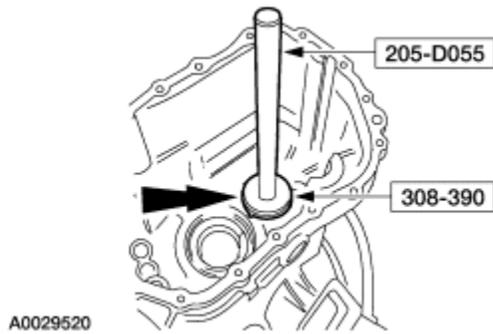
3. Install the case plug with a new seal.



4. Using the special tools, install the input shaft bearing cup.
 - Do not install the oil trough, shim or oil dam at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed. For additional information, refer to [Transmission](#) in this section.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).



5. Using the special tools, install the countershaft front bearing cup.
 - Do not install the shim at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed. For additional information, refer to [Transmission](#) in this section.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).



6. Install a new input shaft oil seal and the guide tube after the bearing preload is completed. For additional information, refer to [Transmission](#) in this section.

SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

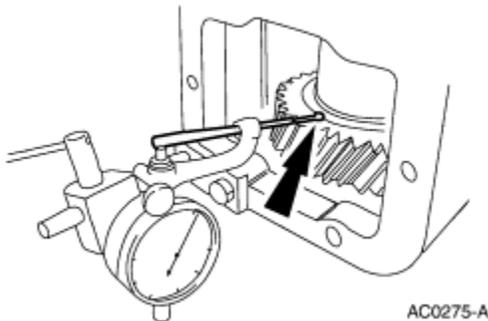
1999 F-Super Duty 250-550 Workshop
 Manual

[Procedure revision date: 01/26/2000](#)

Bearing Preload—Counter Shaft

NOTE: The countershaft thrust washer must be removed prior to the bearing preload measurement.

1. Remove the two power take off covers.
2. Attach a dial indicator/magnetic base and a Clutch Housing Alignment Adapter to the transmission case.
3. Position the stem of the alignment adapter so that it contacts the 4th speed gear of the countershaft.



4. Zero the dial indicator.

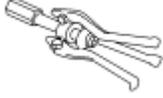
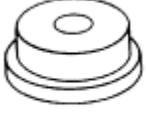
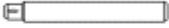
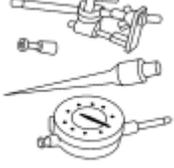
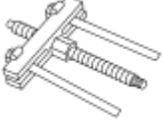
5. Inspect the pry bar through the PTO opening and position them beneath the 4th speed gear on the counter shaft. Pry up on the counter shaft.
6. Record the dial indicator reading.
7. The thrust washer should have a thickness of the recorded reading plus 0.02-0.11 mm (0.00079-0.00434 inch).
8. After completing the bearing preload measurement, position the transmission with the input shaft pointing up.
9. Remove the case from the extension housing; refer to Case in this section.
10. Remove the front bearing outer race; refer to Case in this section.
11. Install the shim and the front bearing outer race; refer to Case in this section.

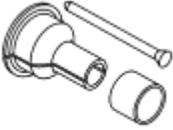
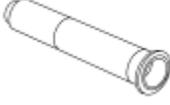
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 ASSEMBLY

1999 F-Super Duty 250-550 Workshop
 Manual
[Procedure revision date: 01/26/2000](#)

Transmission

Special Tool(s)	
 ST2154-A	Holding Fixture, Gear Pack 308-139 (T87T-7025-HH)
 ST2155-A	Aligner, Shift Rod Assemblies 308-133 (T87T-7025-JH)
 ST1186-A	Holding Fixture, Transmission 307-003 (T57L-500-B)

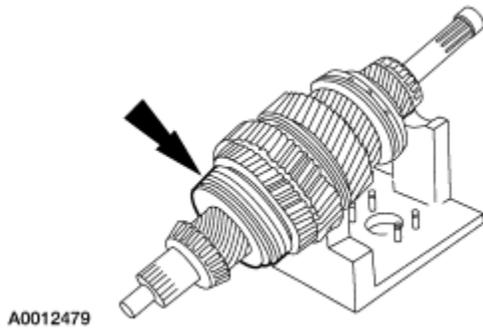
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>
 <p>ST1200-A</p>	<p>Remover, Bearing Cup 308-047 (T77F-1102-A)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Bearing Cup 308-390</p>
 <p>ST1255-A</p>	<p>Handle 205-D055 (D81L-4000-A) or equivalent. (Part of 205-DS050)</p>
 <p>ST1110-A</p>	<p>Heat Gun 107-R0300</p>
 <p>ST1214-A</p>	<p>Dial Indicator Gauge with Holding Fixture 100-002 (Tool-4201-C)</p>
 <p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>

 <p>ST2576-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
 <p>ST1348-A</p>	<p>Gauge, Clutch Housing 308-021 (T75L-4201-A)</p>
 <p>ST2157-A</p>	<p>Installer, Output Shaft Oil Seal (4x4) 308-134 (T87T-7025-LH)</p>
 <p>ST2158-A</p>	<p>Installer, Output Shaft Oil Seal (4x2) 308-128 (T87T-7025-BH)</p>
 <p>ST2371-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</p>
 <p>ST2475-A</p>	<p>Installer, Input Shaft Oil Seal 308-374</p>

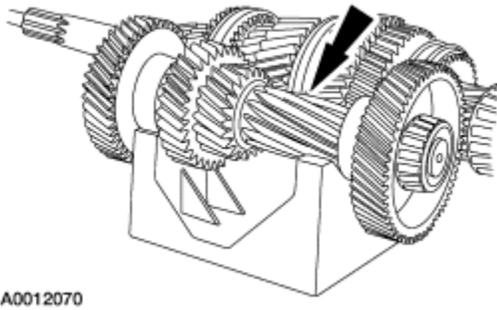
1.  **CAUTION: Do not reassemble the transmission dry. Apply lubricant throughout the assembly procedure.**

Lubricate all bearings, gears and synchronizers with the recommended transmission lubricant, MERCON® Multi-Purpose ATF Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.

2. Position the mainshaft assembly in the Gear Pack Holding Fixture.

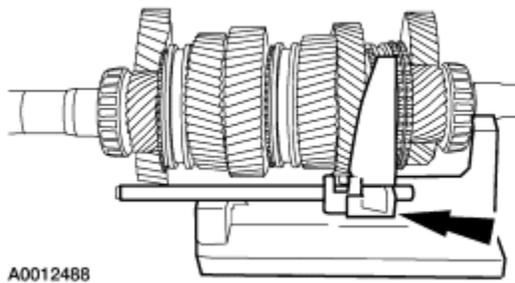


3. Position the countershaft assembly on the Holding Fixture.



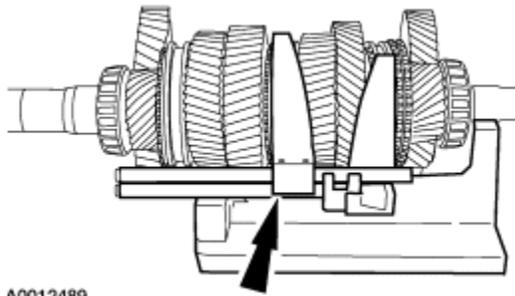
4. **NOTE:** If new components were installed, use new roll pins to assemble the shift fork to the shift rail.

Install the third and fourth shift fork and shift rail.



5. **NOTE:** If new components were installed, use new roll pins to assemble the shift fork to the shift rail.

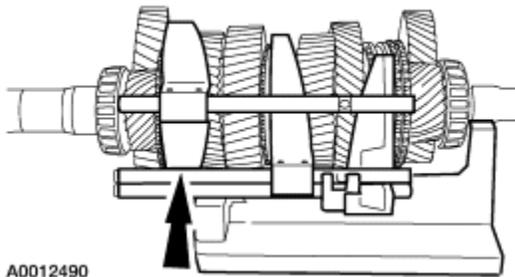
Install the first and second shift fork and shift rail.



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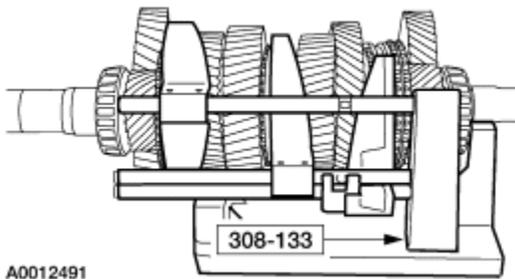
6. **NOTE:** If new components were installed, use new roll pins to assemble the shift fork to the shift rail.

Install the fifth and reverse shift fork and shift rail.



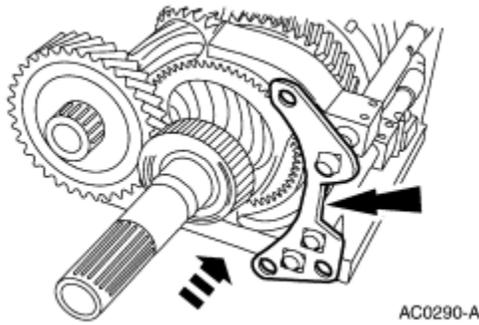
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7. Install the Shift Rod Support.



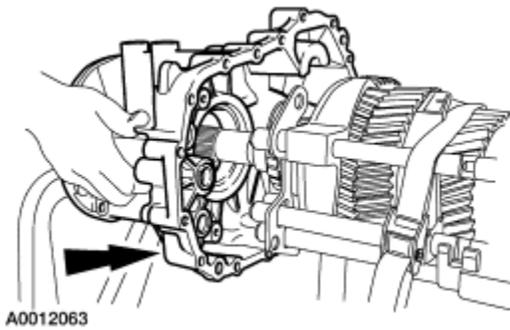
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8. Install the shift interlock plate, then position the plate in the grooves on the main shift rail.
 - The part numbers on the shift interlock plate face toward the input shaft.

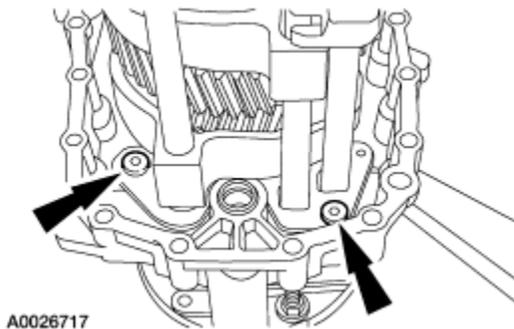


9. **NOTE:** Attach the Holding Fixture to the extension housing.

Install the extension housing.

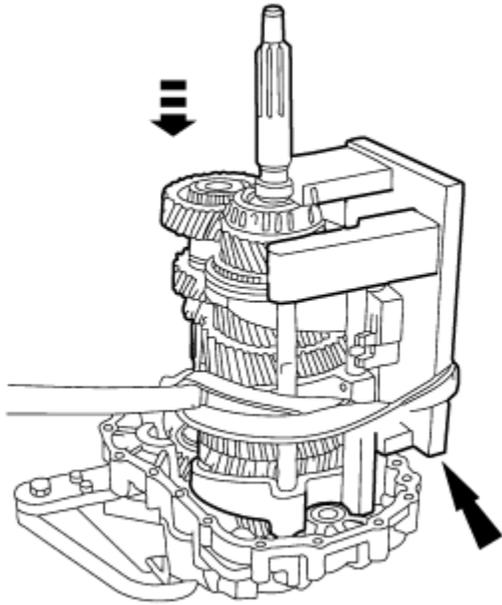


10. Install two shift interlock plate bolts. Do not tighten at this time.



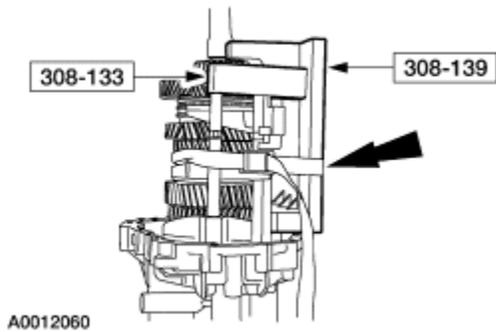
11. **NOTE:** An assistant will be needed to install the gear assembly into the bench fixture.

Secure the gear assembly to the Gear Pack Holding Fixture with a cargo strap, then install into the bench fixture.



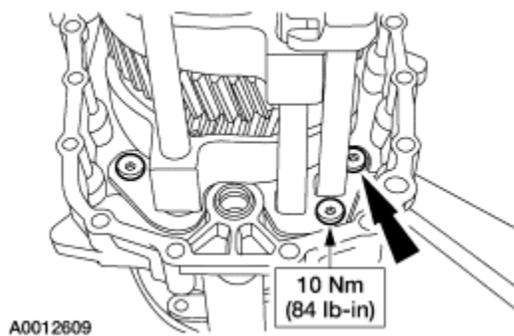
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12. Remove the special tools.



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13. Install the remaining shift interlock plate bolt, then tighten all three bolts to specification.

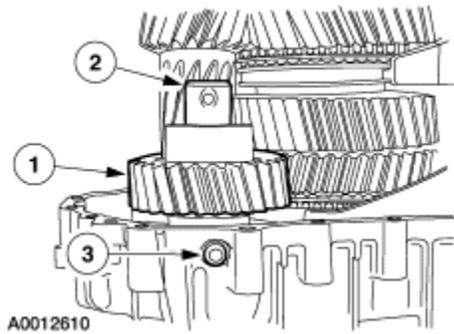


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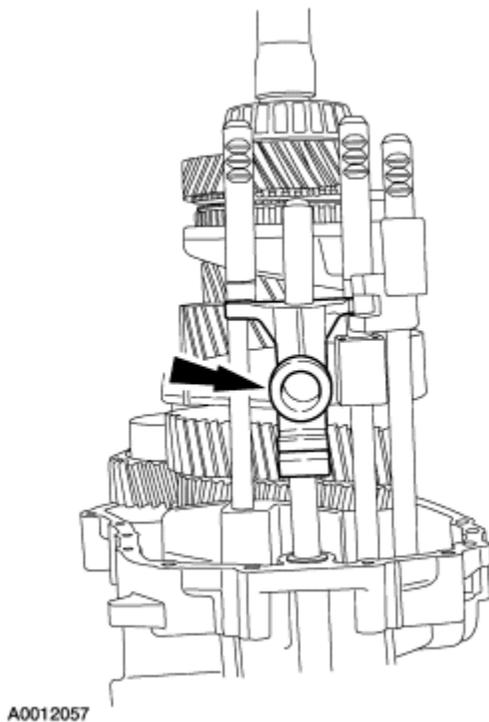
14. Install the reverse idler gear assembly.

1. Install the reverse gear on the extension housing.

- Assemble the reverse idler gear bearings into the reverse idler gear.
2. Install the reverse idler shaft. Align the threaded holes in the reverse idler shaft with the holes in the extension housing.
 3. Install a new seal and the reverse idler gear bolt. Do not tighten the bolt at this time.

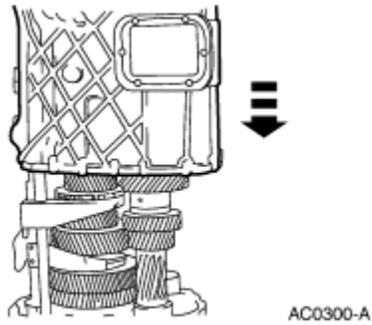


15. Install the main shift rail and main shift rail driver.

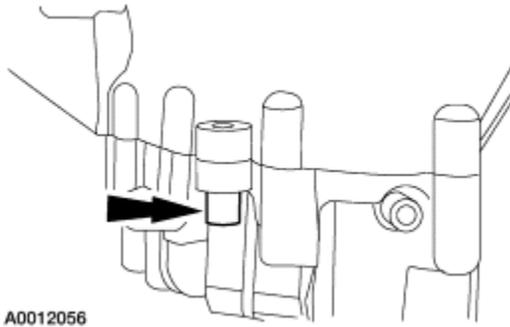


16.  **CAUTION: Make sure that the shift rail detents do not obstruct entry of the shift rails.**

Carefully install the case onto the extension housing, then install two bolts.



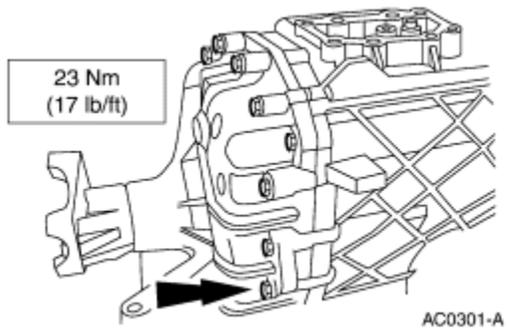
17. Tap the dowel pins into the upper case.



18. Rotate the transmission 180°.

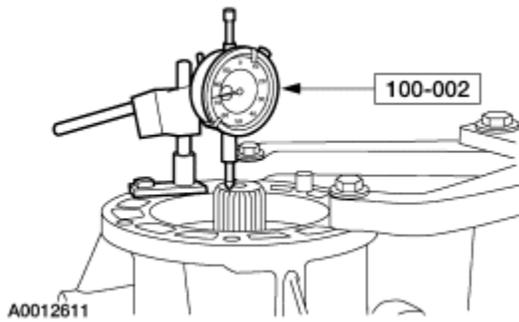
- The input shaft is pointing down.

19. Install the remaining 15 bolts.

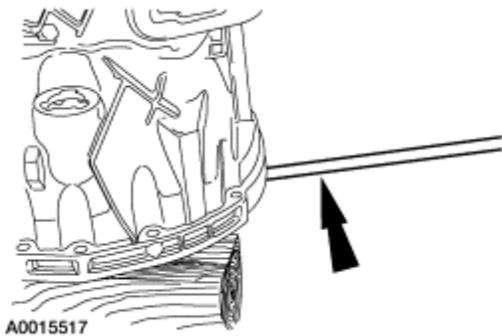


20. Install the special tool to measure mainshaft clearance.

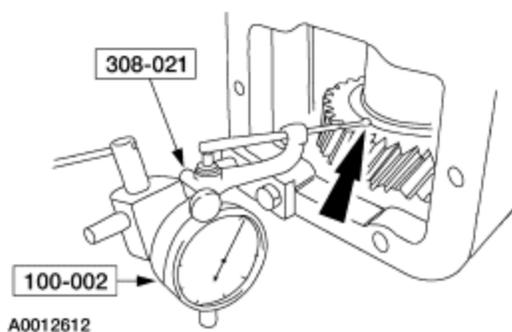
- Mount the indicator stand to the extension housing.
- Position the indicator on the end of the mainshaft.
- Zero the dial indicator.



21. Place the transmission on the floor. Wooden blocks will be needed to elevate the transmission.
22. Lifting up on the mainshaft, measure the mainshaft clearance.
 - Using a pry bar, lift up on the input shaft.
 - Observe the dial indicator reading.
 - Add preload specification 0.0 mm (0 in) to 0.05 mm (0.002 in) to the dial indicator reading to determine shim thickness. Measure the thickness of the input shaft oil dam bearing ring at three places and subtract the highest dimension. Use the higher measurement to allow for break in. Mainshaft clearance (-) the thickness of the oil dam + preload = shim range.

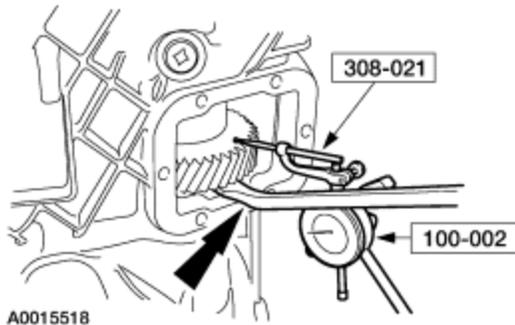


23. Install the special tool to measure countershaft clearance.
 - Mount the indicator stand to the case.
 - Position the indicator on the fourth gear of the countershaft.
 - Zero the dial indicator.



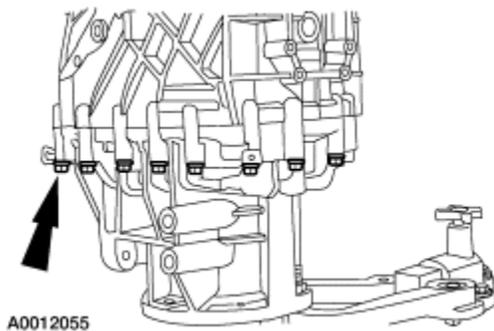
24. Measure countershaft clearance.

- Insert a pry bar through the PTO opening, and position it under the fourth gear on the countershaft. Lift up on the countershaft.
- Observe the dial indicator reading.
- Add preload specification 0.0 mm (0.0 in) and 0.05 mm (0.002 in) to the dial indicator reading to determine shim thickness range. Use the higher measurement to allow for break in. Countershaft clearance + preload = shim range.



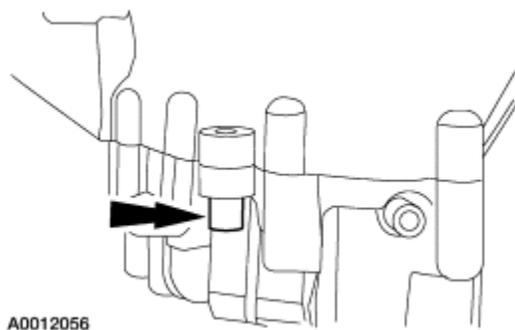
25. Reinstall the transmission into the bench fixture. Rotate the transmission so the input shaft is pointing upward.

26. Remove the 17 bolts.

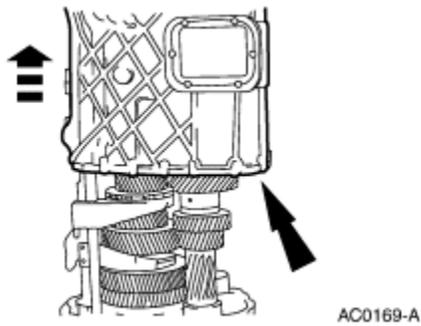


27. **NOTE:** The dowel pins do not have to be removed.

Using a hammer and punch, tap the two dowel pins down until they are past the main case.

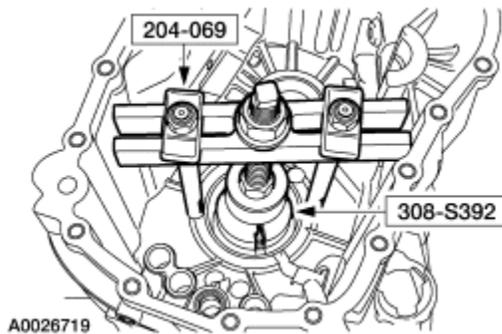


28. Carefully lift the main case off the extension housing. Set the case on the floor.



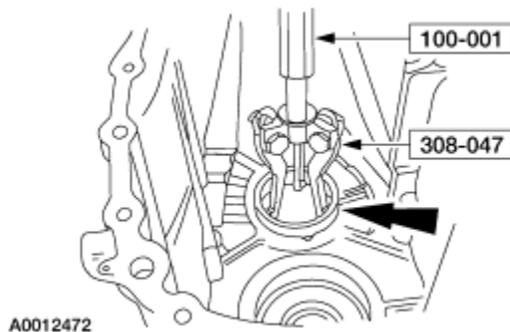
29. Using the special tools, remove the input shaft bearing cup.

- If a new bearing was installed on the input shaft, install a new cup.



30. Use the special tools, remove the countershaft front bearing cup.

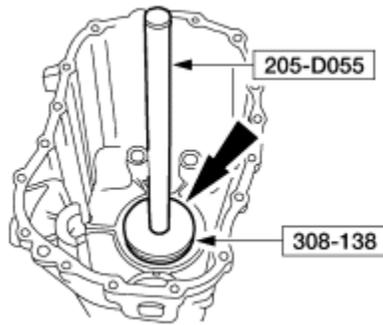
- If a new bearing was installed on the countershaft, install a new cup.



31. **NOTE:** Using the Heat Gun, heat the case bearing cup area to aid installation.

Install the oil trough, the new shim and the new input shaft oil dam into the bearing cup bore, then using the special tools, install the input shaft bearing cup.

- Using the clearance measurement, select the appropriate shim and input shaft oil dam.

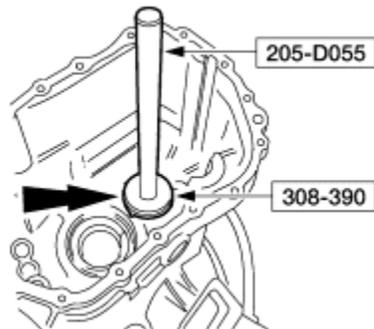


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32. **NOTE:** Using the Heat Gun, heat the case bearing cup area to aid installation.

Install the new shim, then using the special tools, install the countershaft bearing cup.

- Using the clearance measurement, select the appropriate shim.



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33. **⚠ CAUTION:** Make sure that the shift rail detents do not obstruct entry of the shift rails.

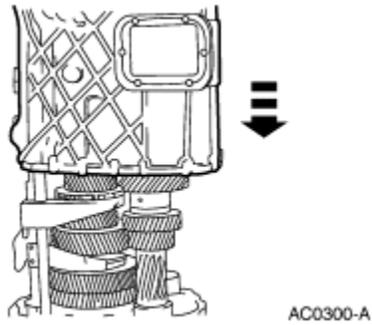
⚠ CAUTION: Use an oil stone or sanding block to clean the mating surfaces.

⚠ CAUTION: Do not use a silicone sealing compound.

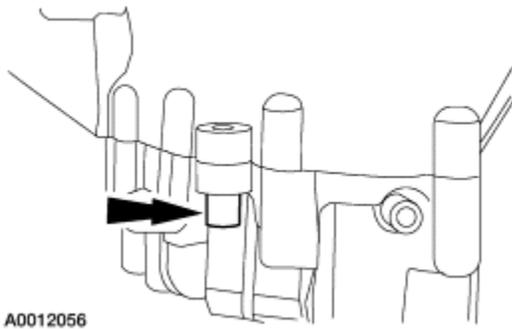
NOTE: Do not wait longer than ten minutes to tighten the bolts due to the rapid cure time of the sealant.

Carefully install the case onto the extension housing.

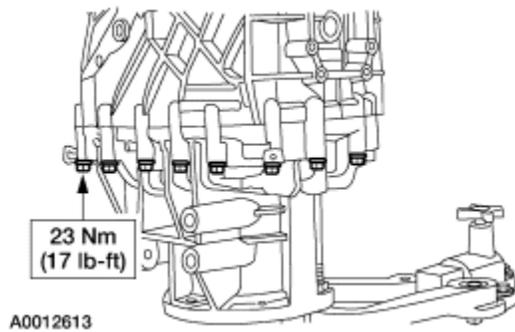
- Using Gasket Maker F8AZ-19B508-AB or equivalent meeting Ford specification WSK-M2G348-A5, apply a thin coat to the sealing surface of the case and the extension housing.



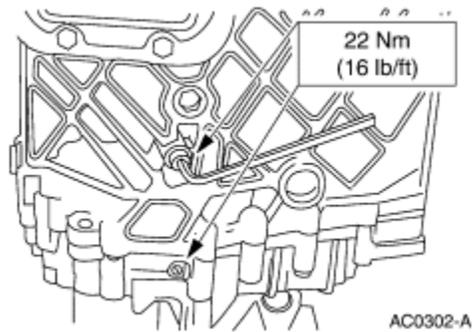
34. Tap the dowel pins into the upper case.



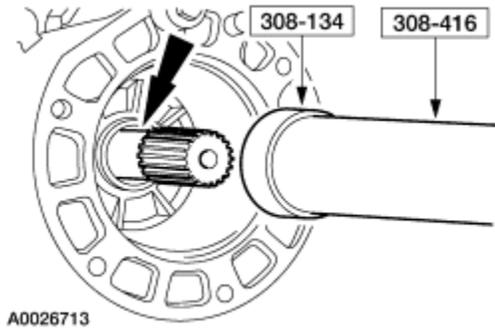
35. Install the 17 bolts.



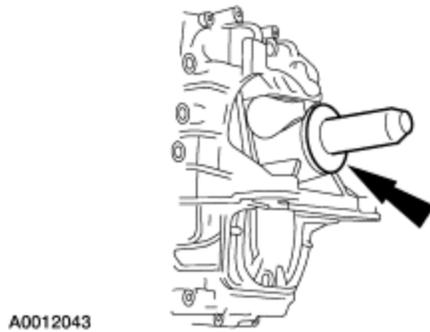
36. Install a new seal and the upper reverse idler bolt. Tighten both the upper and lower bolts.



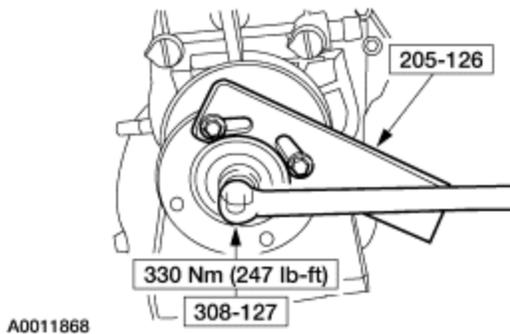
37. On 4-wheel drive vehicles, use the special tool and install a new output oil seal.
- Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.



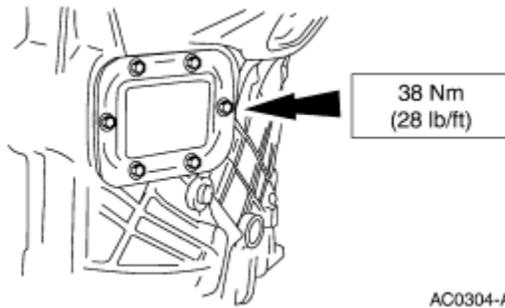
38. On 2-wheel drive vehicles, use the special tool and install a new output oil seal.
- Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.



39. On 2-wheel drive vehicles, use the special tools and install the pinion flange.
- Apply Threadlock 262 E2FZ-19554-B or equivalent meeting Ford specification WSK-M2G351-A6 to the threads of the pinion flange locknut.



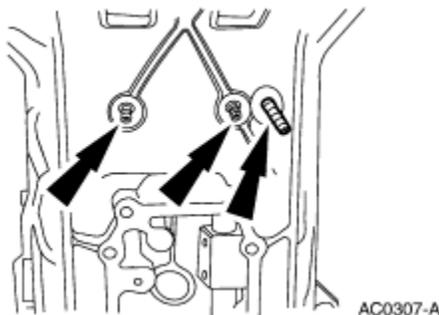
40. On all vehicles, install the PTO covers with new gaskets.
- Apply Threadlock and Sealer EOAZ-19554-AA or equivalent meeting Ford specification WSK-M2G351-A5 to the threads of the PTO cover bolts.



41. **⚠ CAUTION: Do not strike the detent plugs in the center. This will damage the detent plug, which will result in a leak.**

Install the detents, the detent springs, then tap in new detent plugs. Tap the plugs until they rest against the case stops.

- Apply Gasket Maker F8AZ-19B508-AB or equivalent meeting Ford specifications WSK-M2G348-A5 to the detent plugs before installing.

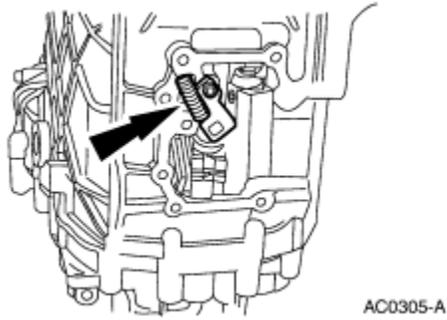


42. **⚠ CAUTION: The procedure must be followed exactly to make sure that the interlock function operates correctly.**

NOTE: Make sure that the interlock plate and shifter interlock spring do not drop into the case.

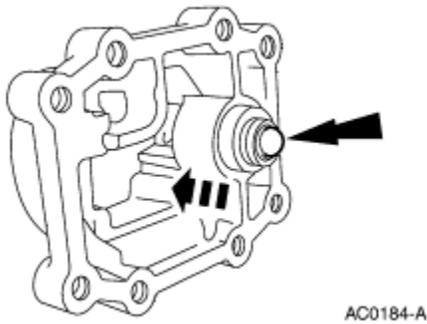
Position the fifth-reverse gear interlock plate into its installed position. Using Gasket Maker F8AZ-19B508-AB or equivalent meeting Ford specification WSK-M2G348-A5, apply a thin coat to the sealing surface of the shift control housing on the case.

Place the shifter interlock spring above the nose in the interlock plate and move both parts into their installed positions.



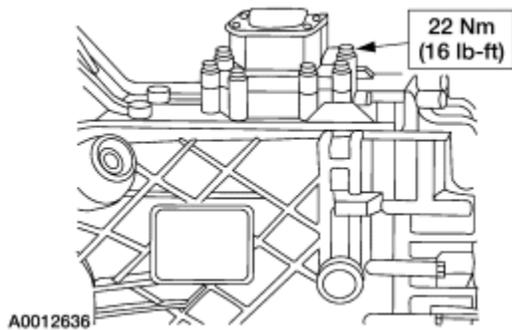
43. Install the detent.

- Using the Heat Gun, heat the shift lever housing to approximately 120°C (248°F).
- Press the detent into its mounting hole until it rests against its stop.

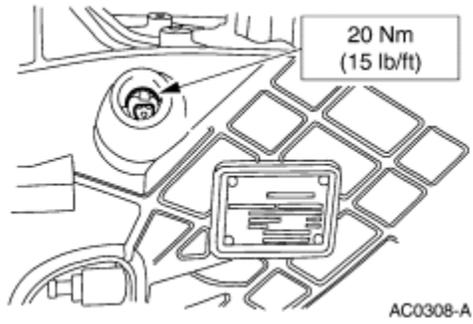


44. Install the shift housing.

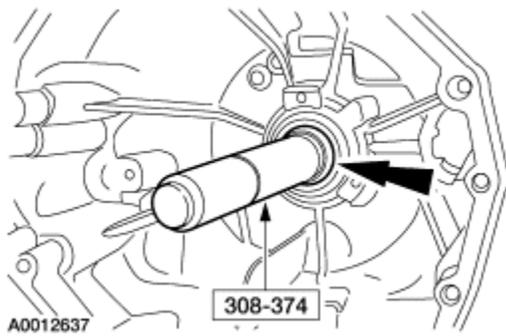
- Rotate the transmission to the horizontal position.
- Check the functioning of the interlock. Temporarily install the shift lever. The nose on the shift lever located just above the ball must point toward the interlock plate.



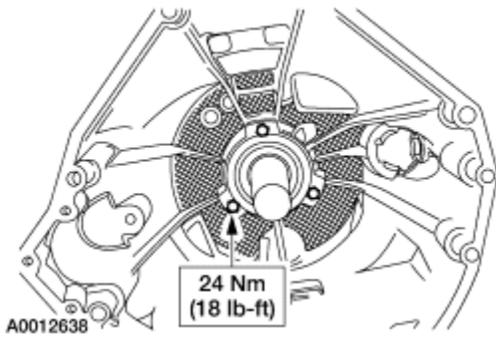
45. Install the reverse lamp switch with a new seal.



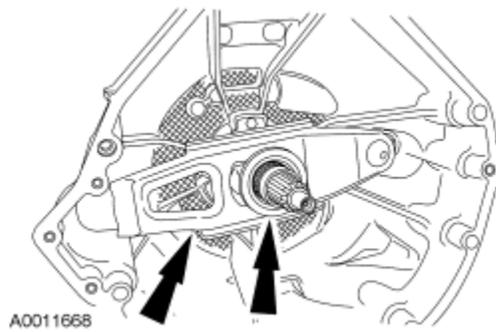
46. Using the special tool, install the input shaft seal.



47. Install the guide tube.

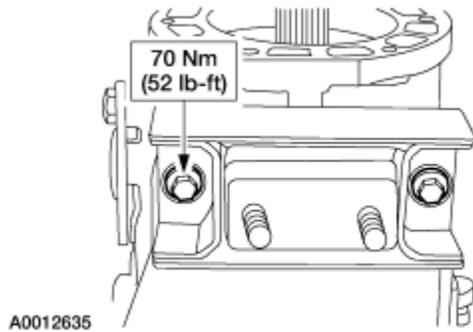


48. Install the clutch release lever and the clutch release hub and bearing.



49. Remove the transmission from the Holding Fixture.

50. Install the transmission mount.



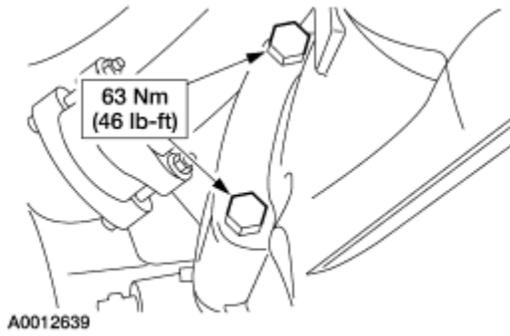
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
INSTALLATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

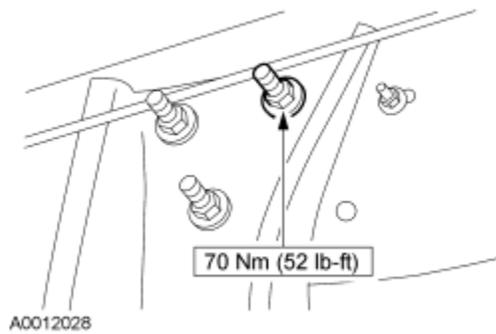
Transmission

Special Tool(s)	
 ST1130-A	High Lift Transmission Jack 014-00942

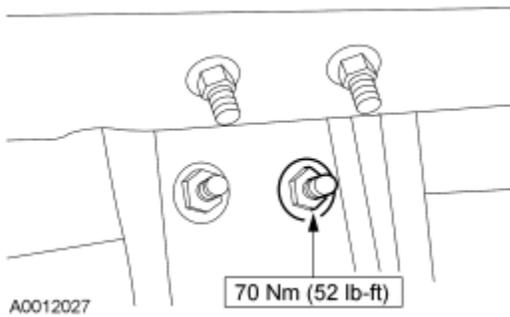
1. Using the High Lift Transmission Jack, raise and position the transmission to the engine and clutch.
 - Use a suitable clutch aligner to align the clutch disc.
2. Install the nine bolts.



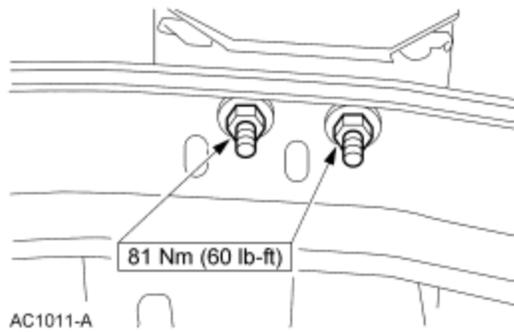
3. Install the crossmember bolts.



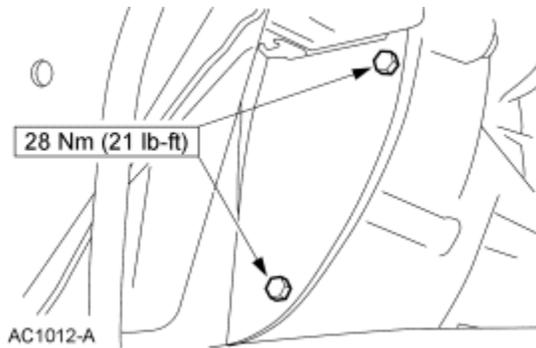
4. Install the nuts.



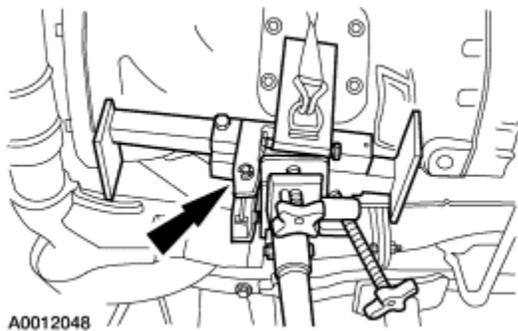
5. Install the nuts.



6. Install the bolts.

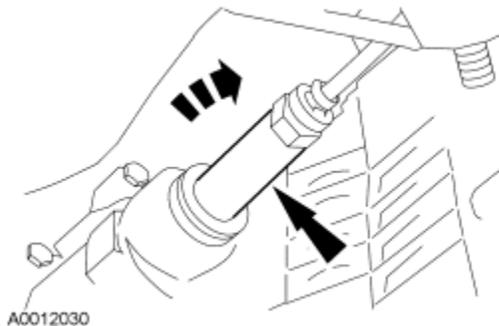


7. Remove the transmission jack.



8. Install the clutch slave cylinder.

- Push in and rotate the clutch slave cylinder clockwise 45 degrees to install.



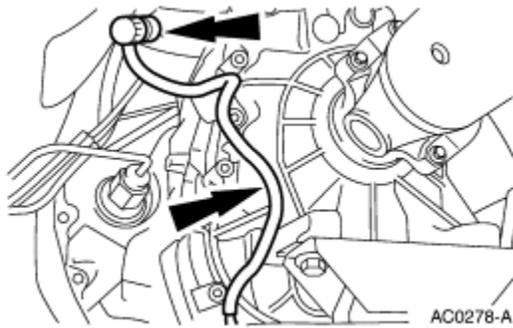
9. Install the starter. For additional information, refer to [Section 303-06B](#).

10. Install the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).

11. Connect the rear driveshaft. For additional information, refer to [Section 205-01](#).

12. Install any power take-off (PTO) equipment, if equipped.

13. Connect the reverse lamp switch electrical connector then attach the harness to the transmission.

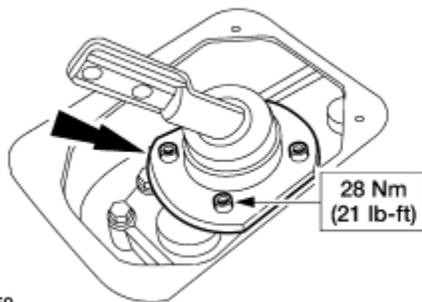


14. Refill the transmission with the specified amount.

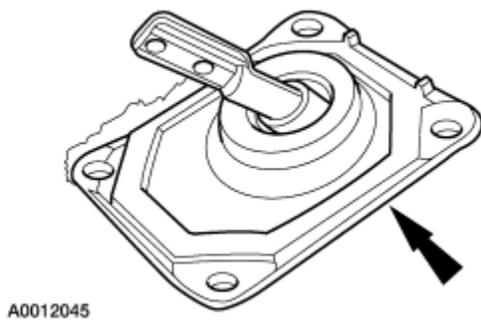
- Refill the transmission with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.

15. Lower the vehicle.

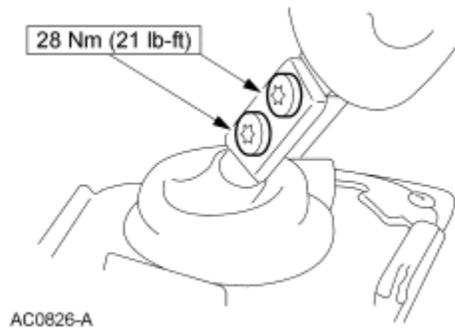
16. Install a new gasket and the lower gear shift lever.



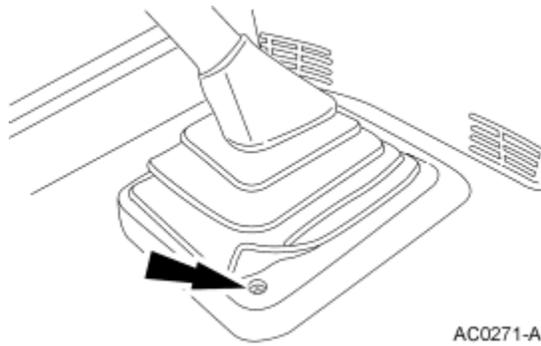
17. Install the gearshift lever upper boot.



18. Install the upper gearshift lever.



19. Install the four screws and the gearshift lever boot.



20. Connect the battery ground cable.

**SECTION 308-03B:
Manual Transaxle/Transmission — ZF 6-Speed**

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Manual Transmission](#)

DIAGNOSIS AND TESTING

[Manual Transmission](#)

IN-VEHICLE REPAIR

[Seal—Output Oil](#)

[Shift Lever and Boot](#)

REMOVAL

[Transmission](#)

DISASSEMBLY

[Transmission](#)

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

[Extension Housing](#)

[Input Shaft and Bearing](#)

[Main Shaft](#)

[Countershaft and Bearing](#)

[Case](#)

[Case—Intermediate Housing](#)

ASSEMBLY

[Transmission](#)

INSTALLATION

[Transmission](#)

General Specifications	
Item	Specification
Lubricants and Sealants	
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
Preload	
Mainshaft and countershaft	0.02-0.09 mm (0.00079-0.0035 in)
Component Mounting Temperatures	
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)
Fluid	
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Synchronizer	
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)

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	—

SECTION 308-03B: Manual Transaxle/Transmission
— ZF 6-Speed

1999 F-Super Duty 250-550
Workshop Manual

DESCRIPTION AND OPERATION

[Procedure revision date: 01/26/2000](#)

Manual Transmission

The S6-650 and the M6HD transmissions are six-speed synchronized units. 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

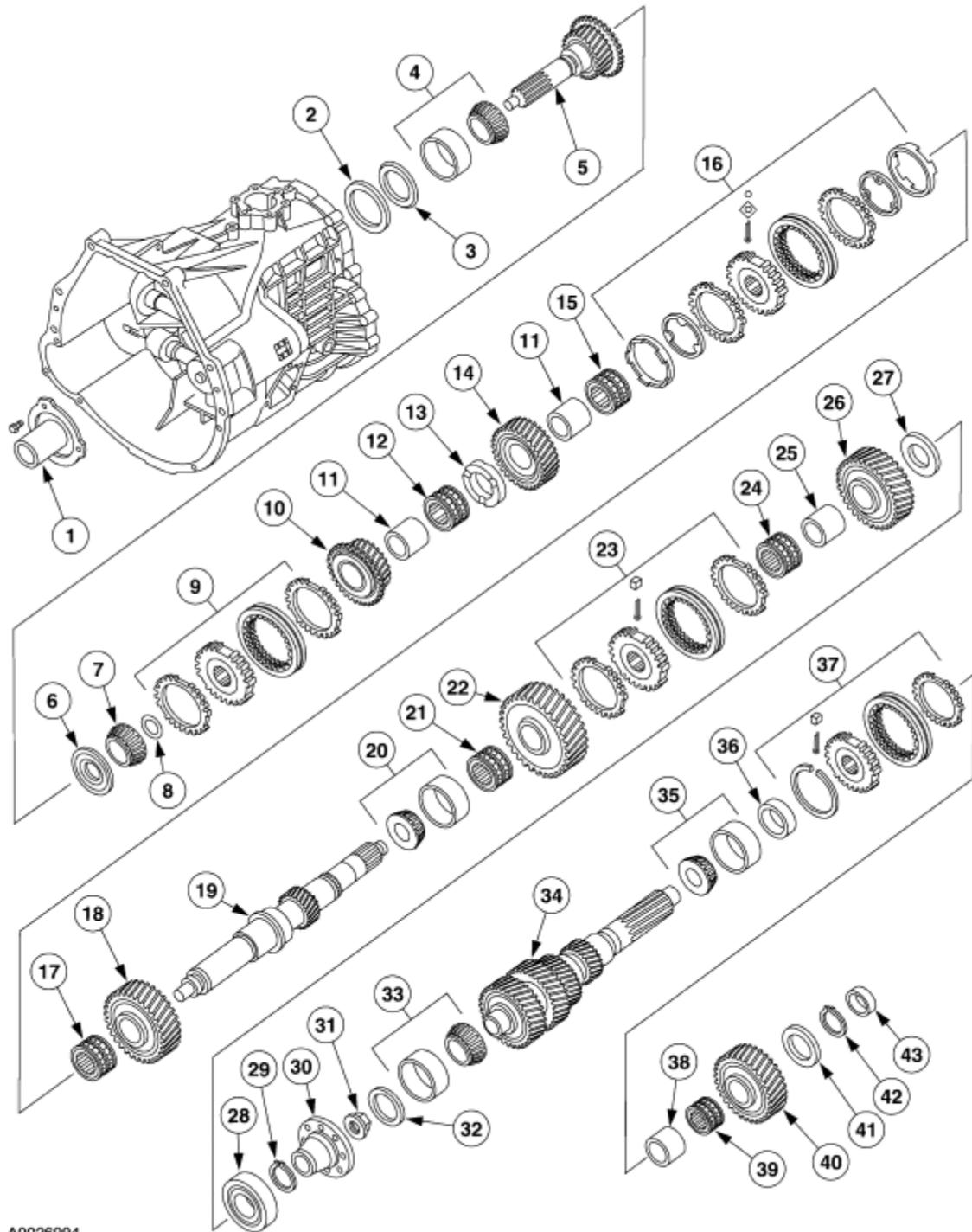
The S6-650 and the M6HD have six forward speeds that feature a LOW gear for take-off under heavy loads and a OVERDRIVE gear for highway driving conditions. The gear ratios are as follows:

- 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.

Transmission Internal Components—Disassembled View



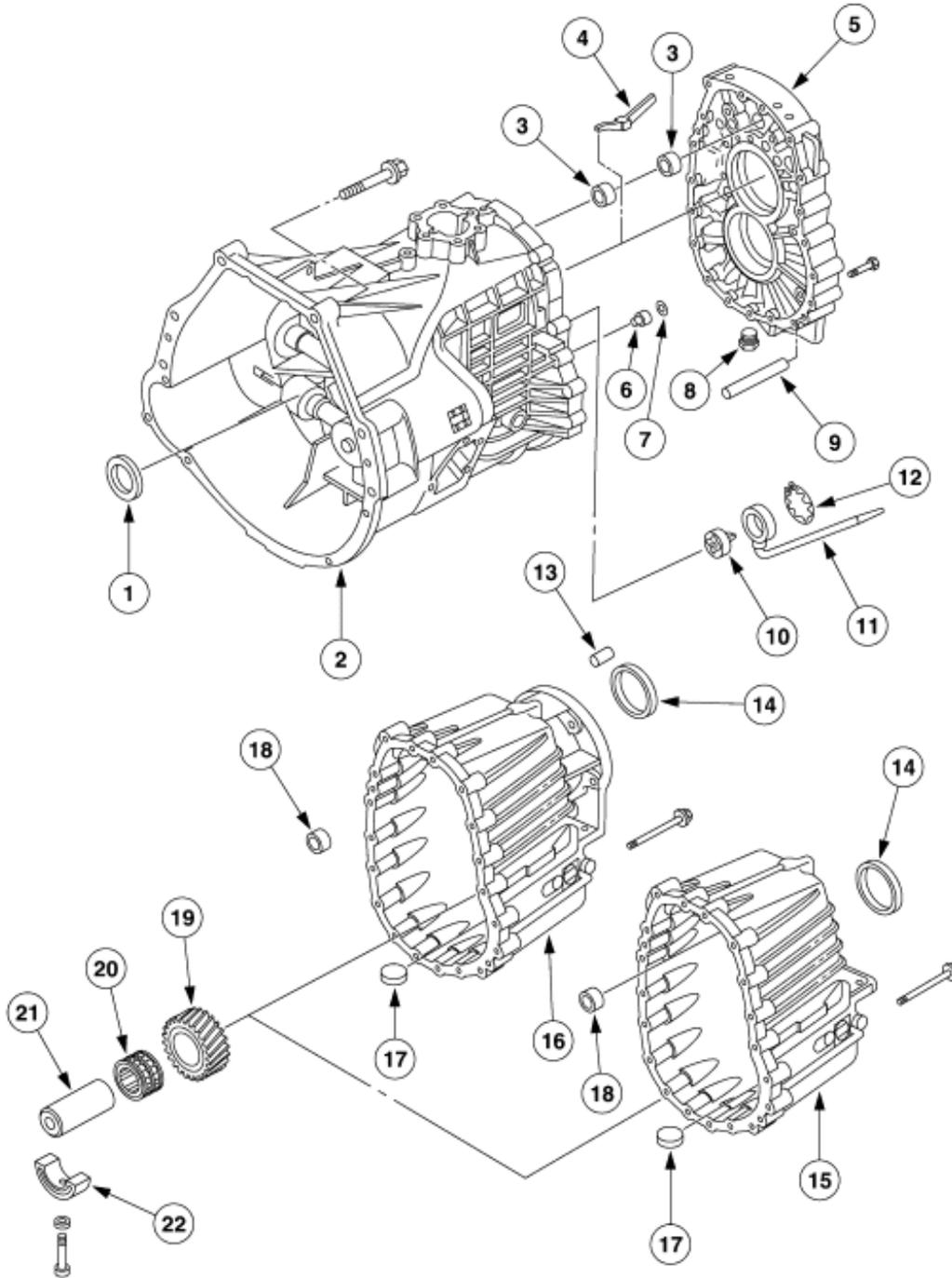
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Item	Part Number	Description
1	7050	Guide tube
2	7029	Input shaft shim (selective fit)
3	7046	Input shaft oil dam bearing ring
4	7025	Input shaft bearing and bearing cup
5	7017	Input shaft

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

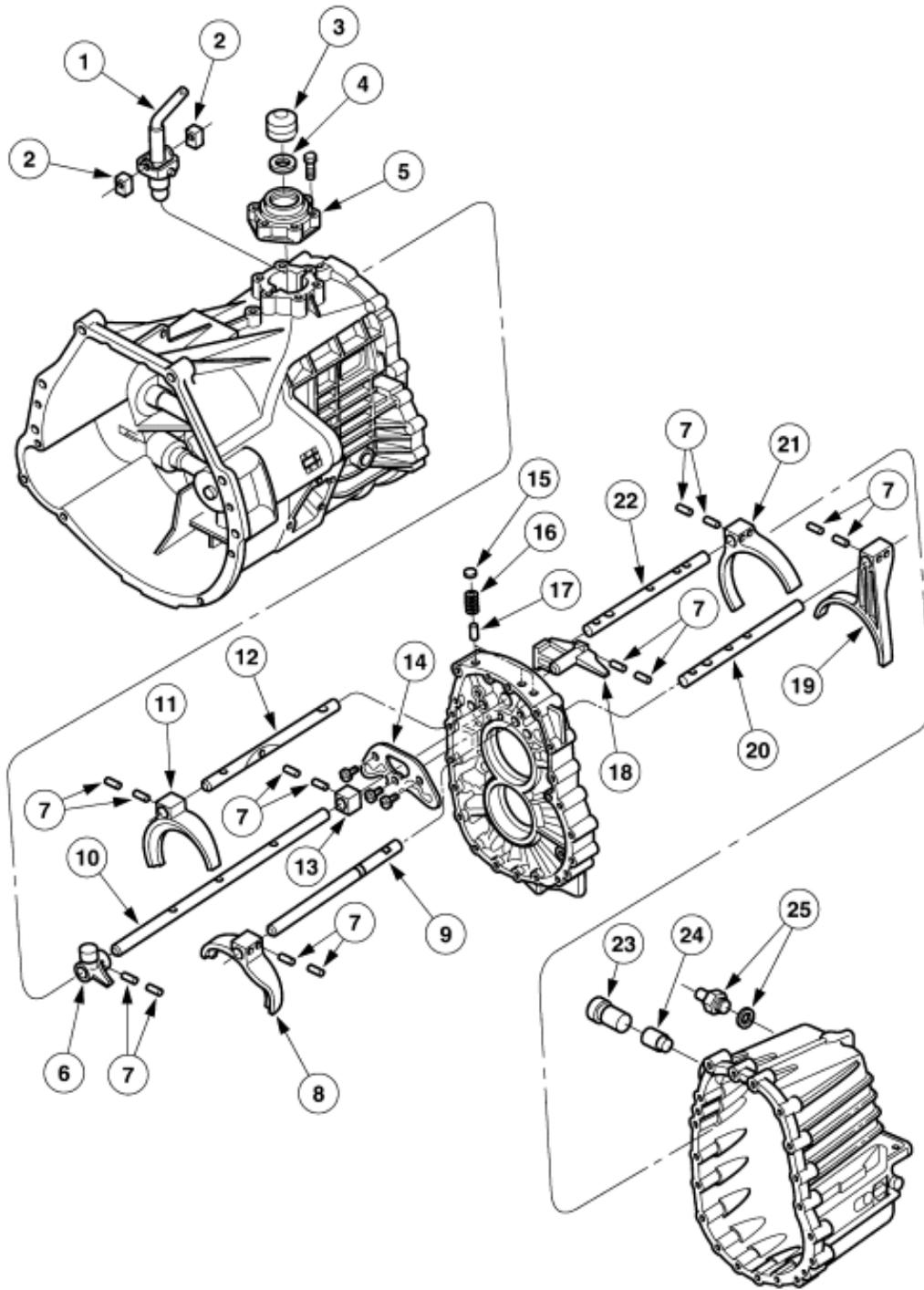
41	7A385	Countershaft rear thrust washer
42	7B331	Snap ring kit
43	7065	Countershaft rear bearing

Transmission Internal Components—Disassembled View



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.

SECTION 308-03B: Manual Transaxle/Transmission —
 ZF 6-Speed
 DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550
 Workshop Manual
[Procedure revision date: 01/26/2000](#)

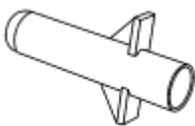
Manual Transmission

Refer to [Section 308-00](#).

SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 IN-VEHICLE REPAIR

1999 F-Super Duty 250-550
 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Seal—Output Oil

Special Tool(s)	
 <p>ST2165-A</p>	Installer, Output Shaft Oil Seal (4x4) 308-383
 <p>ST2164-A</p>	Installer, Output Shaft Oil Seal (4x2) 308-382

 <p>ST1257-A</p>	<p>Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)</p>
 <p>ST2141-A</p>	<p>Socket, Mainshaft Locknut (36 mm) 308-127 (T87T-7025-AH)</p>
 <p>ST2166-A</p>	<p>Remover, Input Shaft Oil Seal 308-375</p>
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>

Material	
Item	Specification
Gasket and Trim Adhesive F3AZ-19B508-AA	N/A
Threadlock 262 E2FZ-19554-B	WSK-M2G351-A6

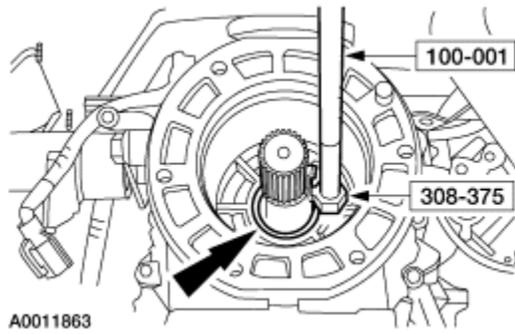
Removal

All vehicles

1. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. Disconnect the rear driveshaft from the transmission and position it aside. For additional information, refer to [Section 205-01](#).

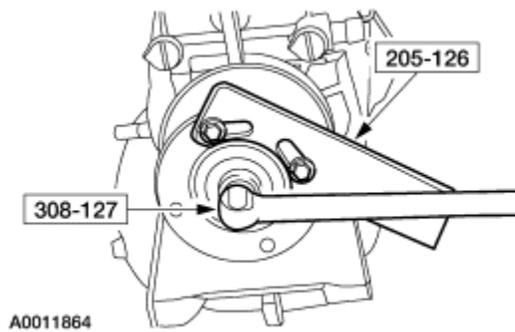
Vehicles with 4-wheel drive

3. Remove the transfer case. For additional information, refer to [Section 308-07B](#).
4. Using the special tools, remove and discard the output oil seal.

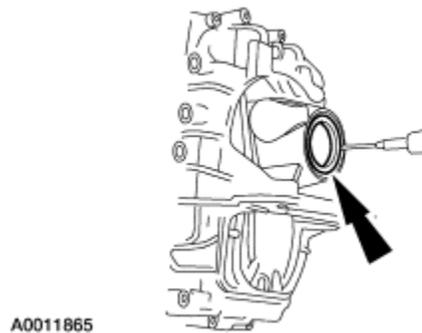


Vehicles with 2-wheel drive

5. Using the special tools, remove the transmission flange.



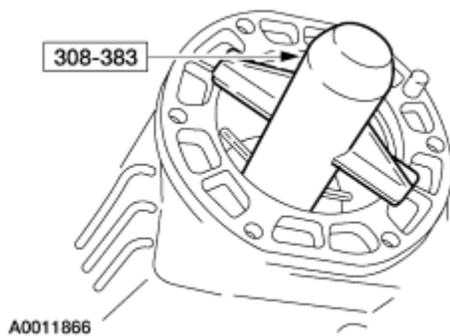
6. Remove and discard the output oil seal.



Installation

Vehicles with 4-wheel drive

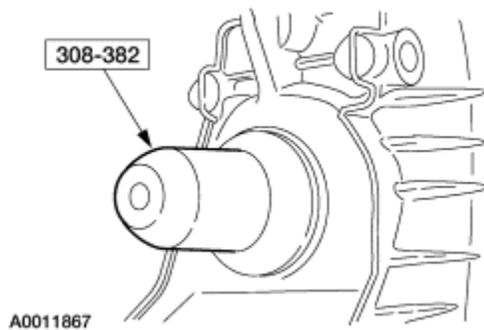
1. Using the special tool, install a new output oil seal.
 - Coat the outer diameter of the new seal with gasket and trim adhesive.



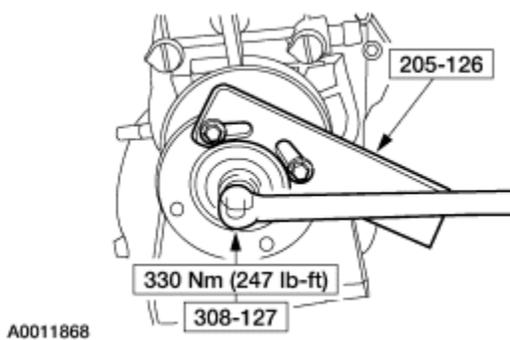
2. Install the transfer case. For additional information, refer to [Section 308-07B](#).

Vehicles with 2-wheel drive

3. Using the special tool, install a new output oil seal.
 - Coat the outer diameter of the new seal with gasket and trim adhesive.



4. Apply Threadlock 262 to the threads of the transmission flange locknut. Using the special tools, install the transmission flange.



All vehicles

5. Connect the rear driveshaft. For additional information, refer to [Section 205-01](#).
-

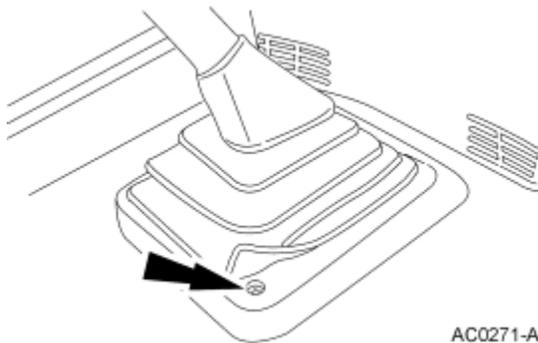
Shift Lever and Boot

Special Tool(s)	
 ST2372-A	Installer, Shifter Boot 308-S385

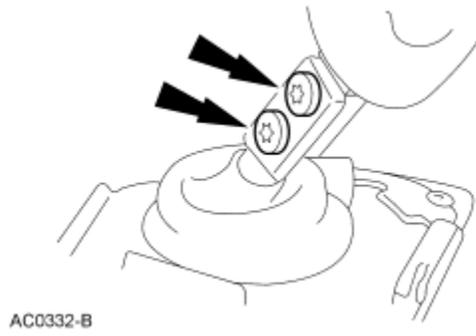
Material	
Item	Specification
Silicone Lubricant F7AZ-19G208-BA	ESR-M13P4-A
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (type II)

Removal

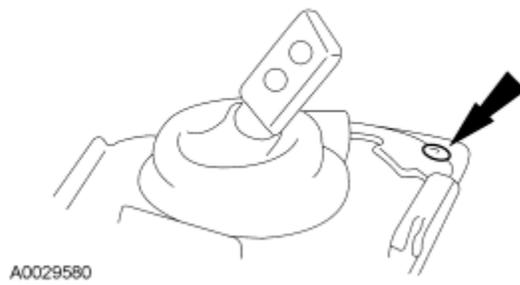
1. Remove the four screws and the shift lever boot.



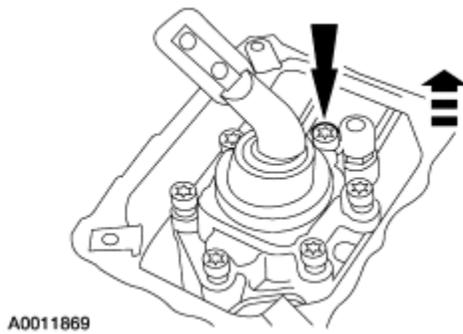
2. Remove the upper gearshift lever.



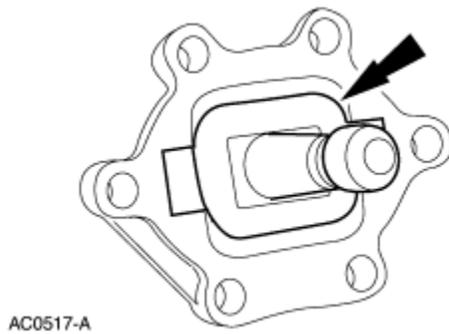
3. Remove the lower shift lever boot.



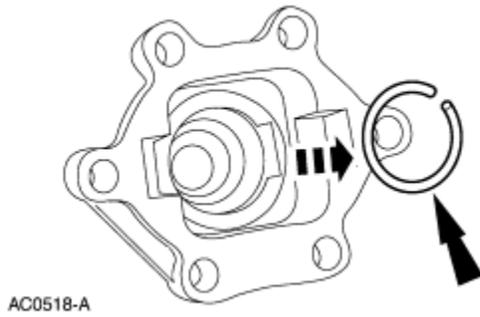
4. Remove the lower gearshift lever and the shift housing.



5. Separate the lower shift lever and gearshift lever blocks from the shift housing.

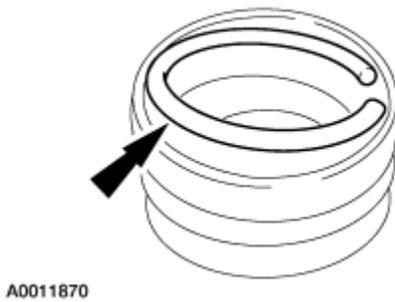


6. Remove the inner shift lever boot ring, then the shift lever boot.

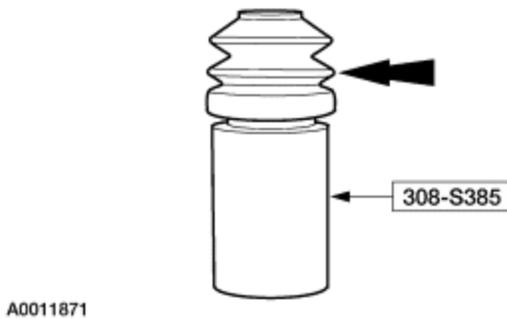


Installation

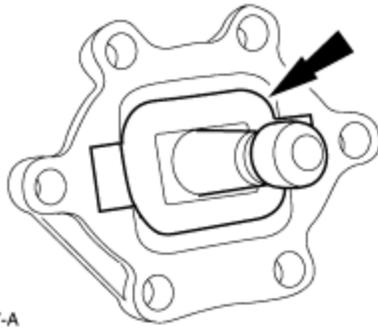
1. Install the inner shift lever boot ring into the shift lever boot.



2. Install the shift lever boot into the special tool.
 - Apply silicone lubricant to the shift lever boot.



3. Position the shift housing on a vice. Using the special tools, install the shift lever boot into the shift housing.
4. Install the lower gearshift lever and gearshift lever blocks into the shift housing.
 - Install the gearshift lever blocks with the notches facing downward.



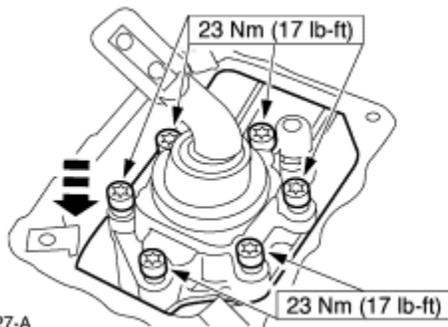
AC0517-A

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

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

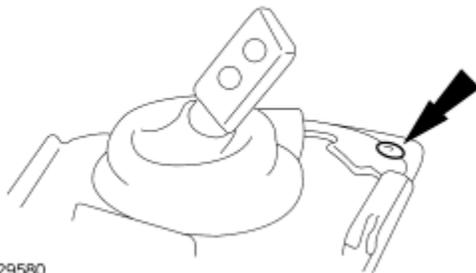
Install the shift housing.

- Apply gasket maker to the sealing surfaces.



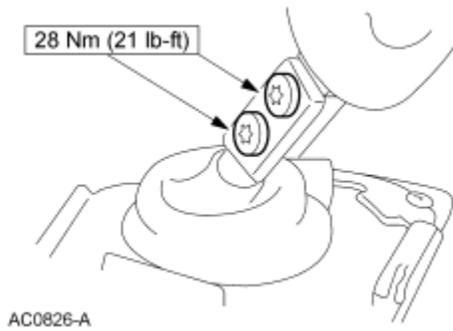
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6. Install the lower shift lever boot.

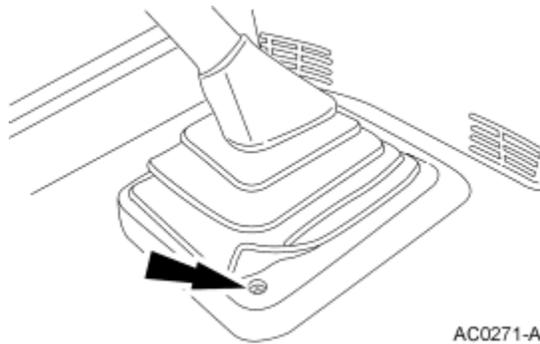


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7. Apply threadlock and sealer to the gearshift lever bolts, and install the upper gearshift lever.



8. Install the shift lever boot.



SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 REMOVAL

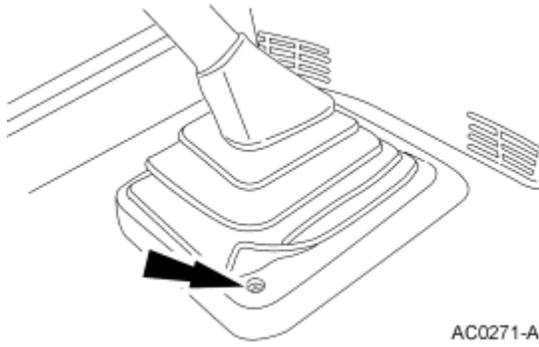
1999 F-Super Duty 250-550
 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transmission

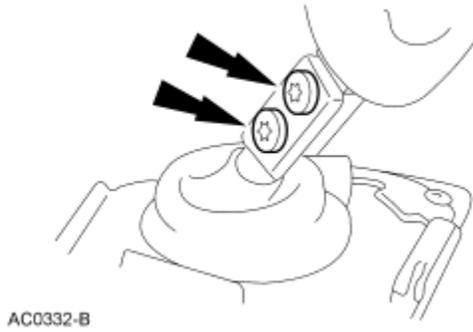
Special Tool(s)	
 <p>ST1130-A</p>	<p>Transmission Jack 014-00942</p>

All vehicles

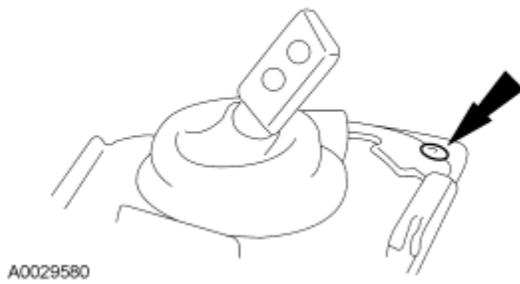
1. Remove the four screws and the outer shift lever boot.



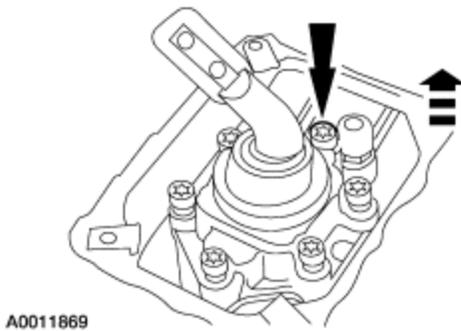
2. Remove the upper gearshift lever.



3. Remove the lower shift lever boot.

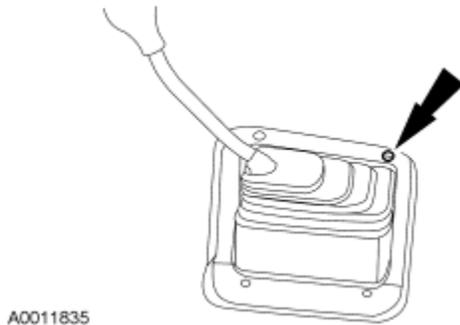


4. Remove the lower gearshift and shift housing.



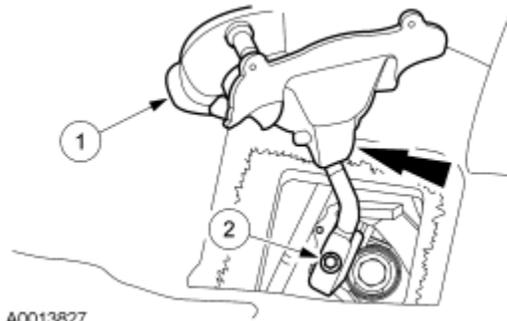
Vehicles with a manual shift lever

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



A0011835

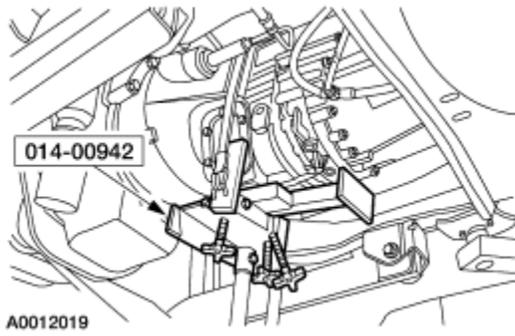
7. Remove the bolt that attaches the shift lever to the transfer case control lever assembly, and remove the shift lever, and the bezel and boot assembly.
 1. Slide the bezel and boot assembly upward on the shift lever.
 2. Remove the bolt, the shift lever, and the bezel and boot assembly.



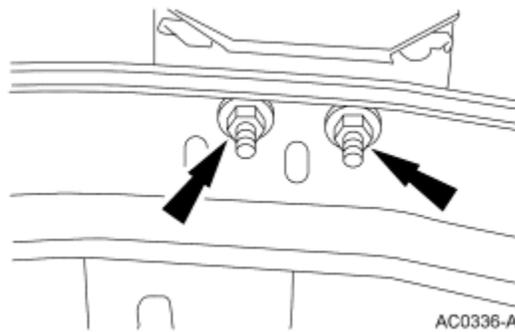
A0013827

All vehicles

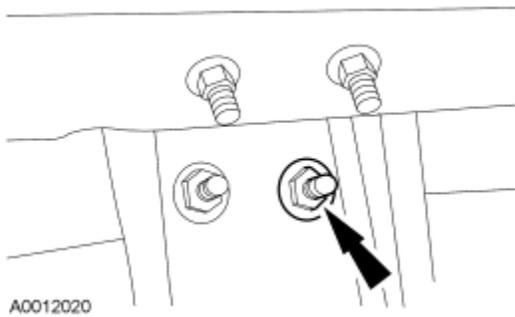
8. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
9. If the transmission is being disassembled, drain the transmission fluid.
10. Remove the starter. For additional information, refer to [Section 303-06B](#).
11. Disconnect the rear driveshaft and position it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



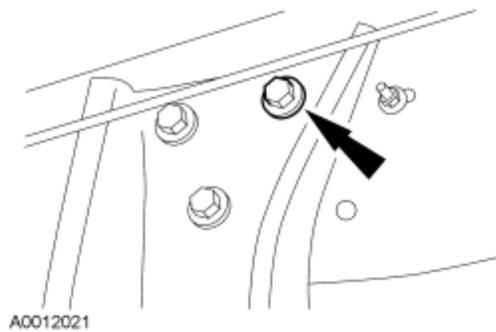
15. Remove the transmission mount nuts.



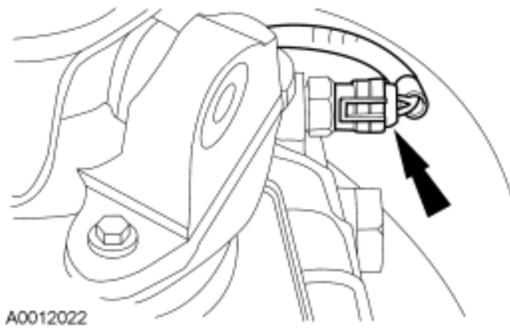
16. Remove the RH crossmember nuts.



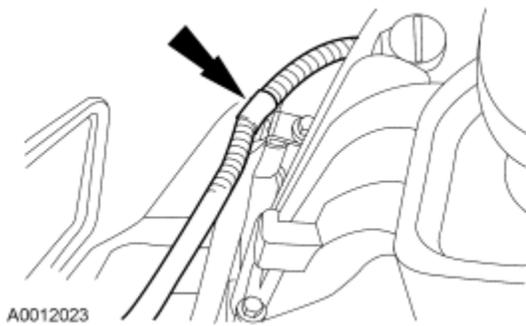
17. Remove the LH crossmember bolts.



18. Disconnect the reverse lamp switch electrical connector.

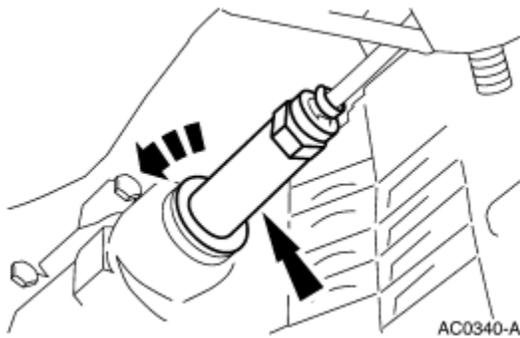


19. Disconnect wiring harness from the transmission.

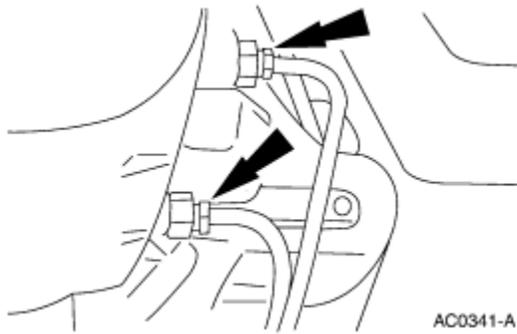


20. Remove the clutch slave cylinder and position it aside.

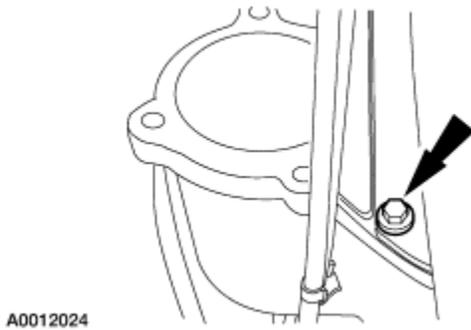
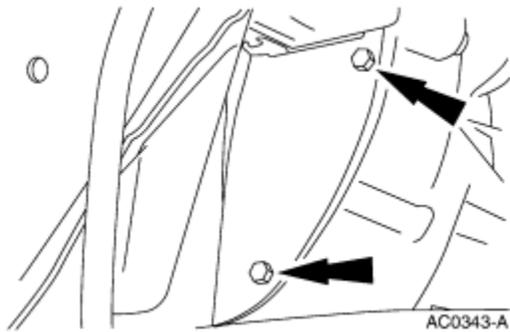
- Push the clutch slave cylinder inward, then rotate counterclockwise 45 degrees to remove.



21. Disconnect the transmission cooling tubes.

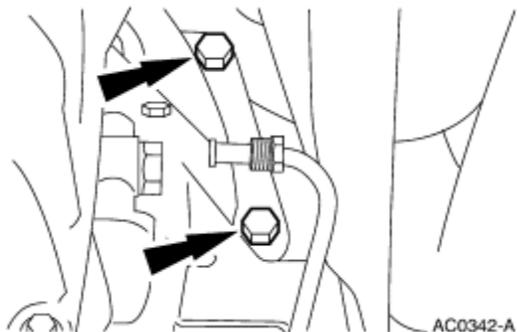


22. Remove the dust cover bolts.



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.

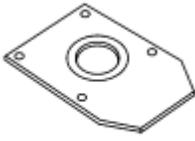
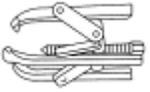
- Move the transmission rearward until the input shaft is clear of the clutch, then lower from the vehicle.

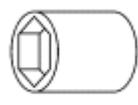
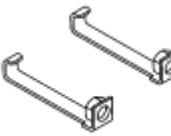
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY

1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 01/26/2000](#)

Transmission

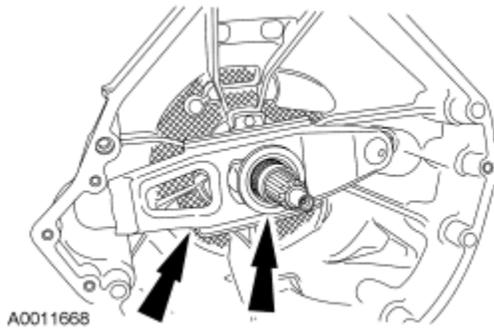
Special Tool(s)	
 <p>ST2168-A</p>	Fixture, Gear Pack 308-381
 <p>ST1257-A</p>	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 <p>ST1184-A</p>	2 or 3 Jaw Puller 205-D027 (D80L-1013-A)
 <p>ST2111-A</p>	Remover, Jet Plug 310-005 (T77L-9533-B)
 <p>ST1835-A</p>	Shaft Protector Set 205-DS004 (D80L-625-A)

 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164R-3900</p>
 <p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>
 <p>ST2141-A</p>	<p>Socket, Mainshaft Locknut (36 mm) 308-127 (T87P-7025-AH)</p>
 <p>ST2364-A</p>	<p>Centerplate Legs 308-380</p>

Material	
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX

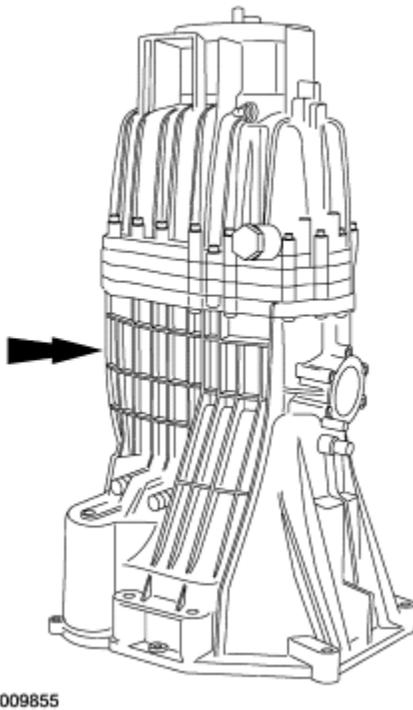
All vehicles

1.  **WARNING: Wear protective eyewear whenever using compressed air.**
Clean the transmission exterior with solvent, and dry with compressed air.
2.  **WARNING: Wear protective eyewear whenever using compressed air.**
Clean all parts removed with solvent, and dry with compressed air.
3. Remove the clutch release lever and the clutch release hub and bearing.



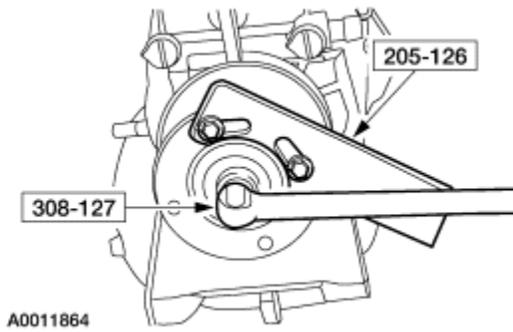
4. **NOTE:** For vehicles equipped with gasoline engines, the transmission must be elevated, 50-101 mm (2-4 inches), to prevent damage to the input shaft.

Position the transmission on the floor with the output flange pointing upward.



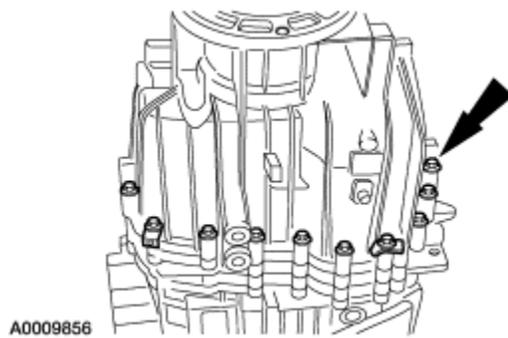
4x2 vehicles

5. Using the special tools, remove the pinion flange.



All vehicles

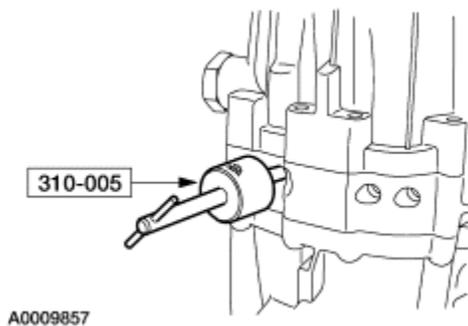
6. Remove the 19 bolts.



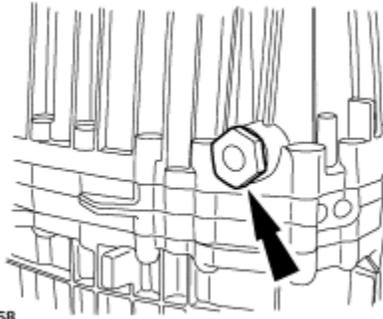
7. **NOTE:** Use a 1/8 inch center punch to create a pilot hole in the plug before installing the tool. Using the Jet Plug Remover to make the pilot hole will damage the tool.

Using the special tool, remove the detent plugs and shift detent springs. Discard the detent plugs.

- Lightly thread in the Jet Plug Remover so as not to damage the springs.

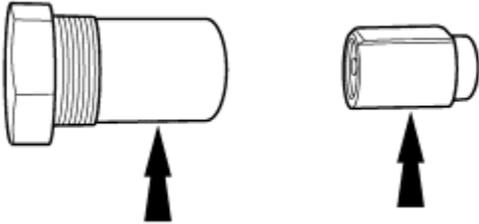


8. Remove the main shift detent.



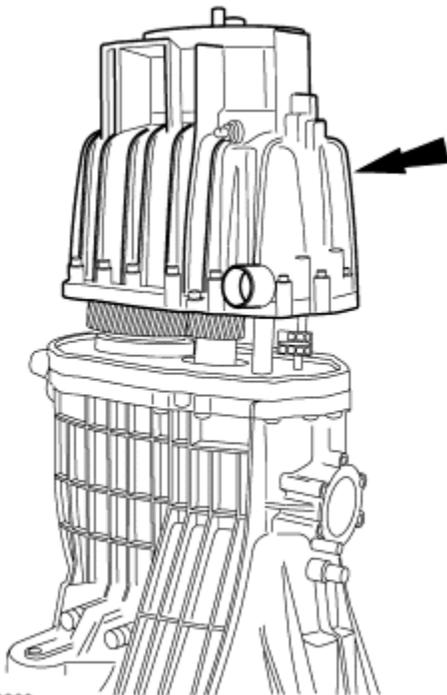
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9. Separate the main shift detent from the detent plunger.
 - Inspect the detent plunger for wear or damage. Install a new detent plunger as necessary.



A0009859

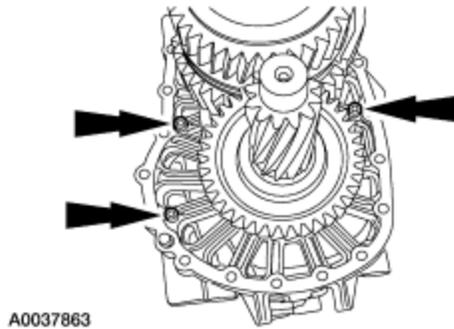
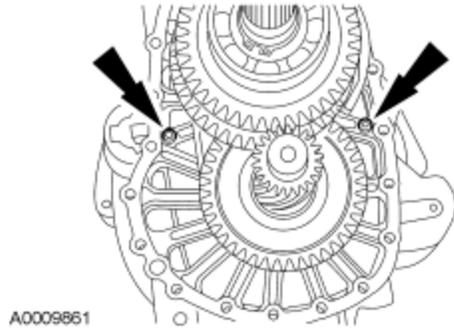
10. Remove the extension housing from the intermediate housing.
 - Using a soft-faced hammer, tap the extension housing lightly to break the gasket seal.



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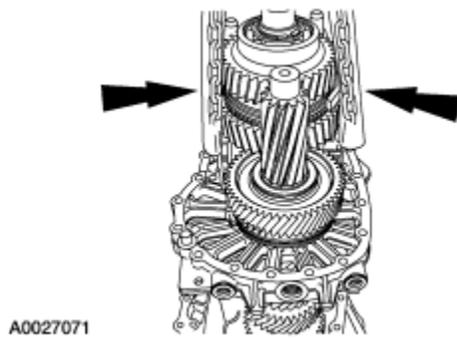
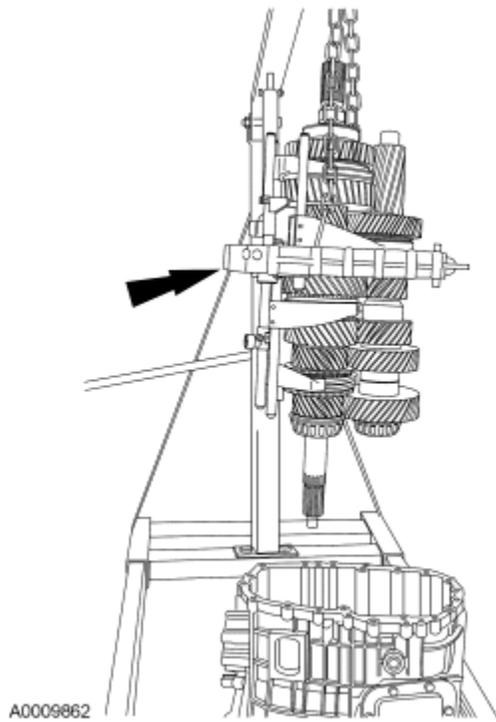
11. Remove the intermediate housing to case bolts.

- Early production vehicles will have three bolts.

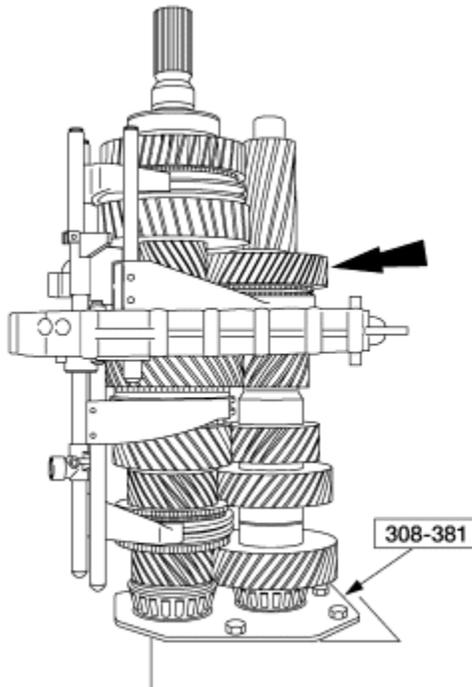


12. Using a suitable lifting device, a suitable chain and two S-hooks, lift the intermediate housing and gear assembly out of the main case.

- Place the S-hooks in the intermediate housing where the two bolts were removed.
- Place a protective cover or rag around the chain. This will ensure the low and reverse gears are not damaged during removal.
- Lift the transmission 1 inch (25 mm) off the ground. Using a soft faced hammer, lightly tap the main housing to break the gasket seal.

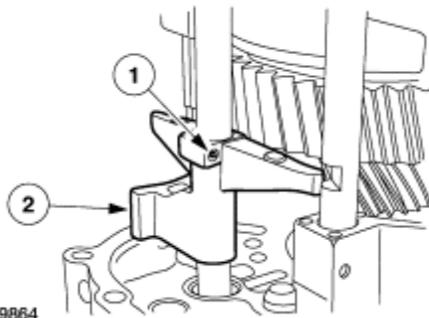


13. Position the intermediate housing and gear assembly on the special tool.
- Securely fasten the holding plate to a sturdy work bench.



A0027069

14. Remove the low/reverse/fifth gear main shift rail driver.
 1. Remove the two roll pins.
 - Use a hammer and punch or an air hammer and roll pin remover.
 2. Remove the main shift rail driver.

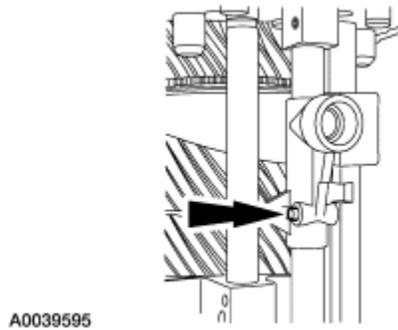
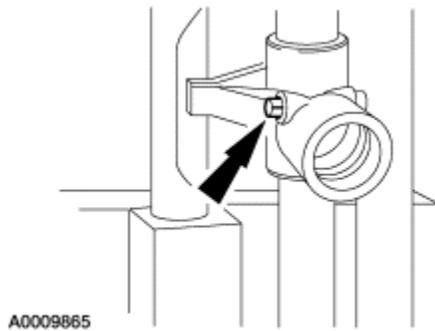


A0009864

15. **NOTE:** The shift finger is also the first/second and third/fourth rail driver.

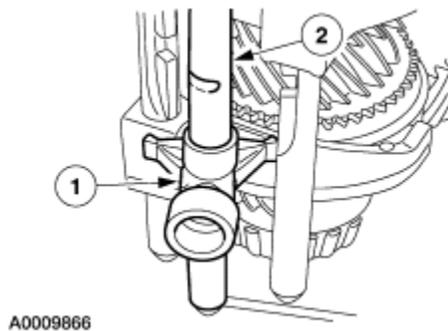
Remove the lower roll pins.

- Use a hammer and punch or an air hammer and roll pin remover to remove.
- For vehicles equipped with a diesel engine, the shift finger is short. For vehicles equipped with a gas engine, the shift finger is long.



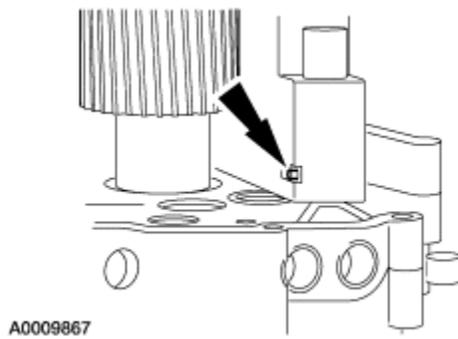
16. Remove the lower shift finger and the main shift rail.

1. Remove the lower shift finger.
 - Rotate the rail driver counterclockwise and pull outward to remove.
2. Remove the main shift rail.



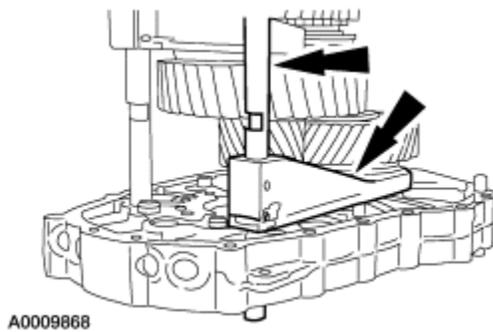
17. Align the interlock plate into second gear position, engage second gear, then remove the two fifth gear shift fork roll pins.

- Use a hammer and punch or an air hammer and roll pin remover to remove.



18. Remove the fifth gear shift fork and shift rail.

- Align the interlock plate into the fifth gear position. Remove the shift rail by tapping the shift fork with a soft faced hammer while pulling on the shift rail.



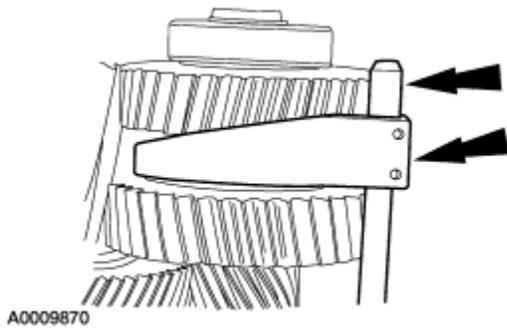
19. Remove the low and reverse gear shift fork roll pin.

- Use a hammer and punch or an air hammer and roll pin remover to remove.

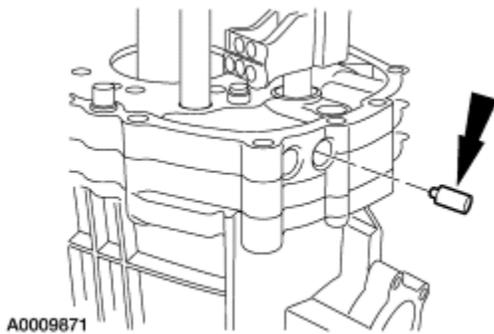


20. Remove the low/reverse gear shift fork and shift rail.

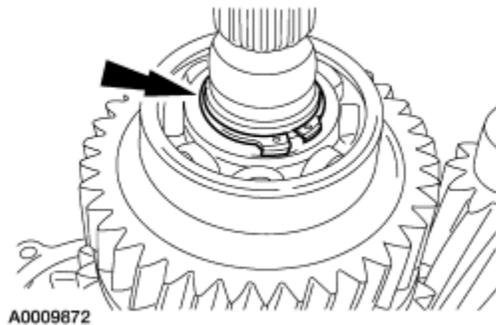
- Align the interlock plate into the low/reverse gear position. Remove the shift rail by tapping the shift fork with a soft faced hammer while pulling up on the shift rail and fork.



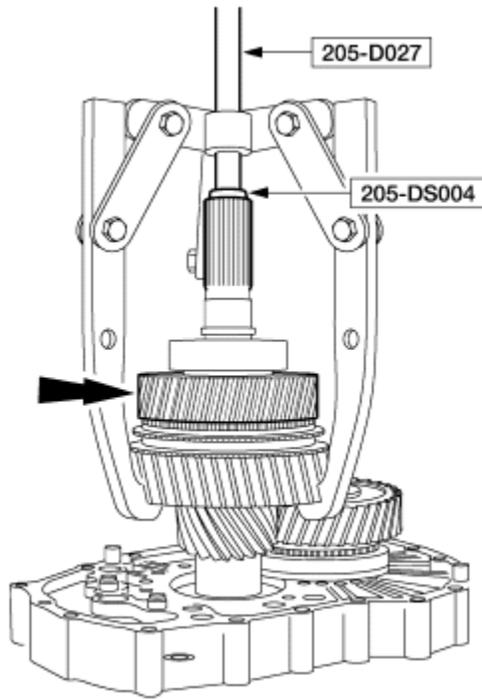
21. Remove the shift rail detents, if necessary.
- The shift rail detents can be difficult to remove. Using a heat gun, apply heat to the intermediate plate to ease removal.



22. On 4-wheel drive vehicles, remove and discard the snap ring.



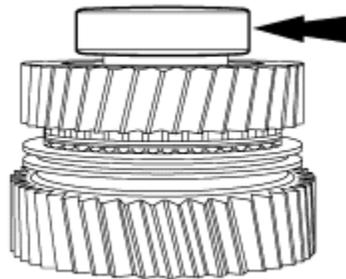
23. Using the special tools, remove the mainshaft rear bearing, the output bearing thrust washer, mainshaft low gear, the mainshaft low gear bushing, the synchronizer assembly (low and reverse) and the mainshaft reverse gear.



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24. Remove the mainshaft rear bearing and the output bearing thrust washer from the low and reverse assembly.

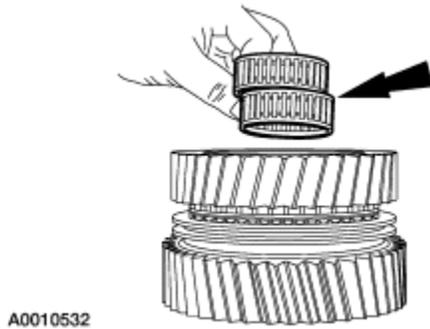
- Inspect the bearing for wear or damage. Install a new bearing as necessary.
- Always install new bearings and cups as a set. Do not install one without the other.



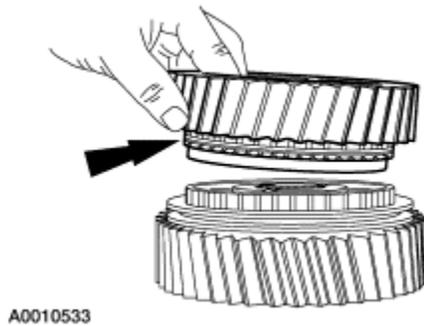
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25. Remove the mainshaft needle bearings.

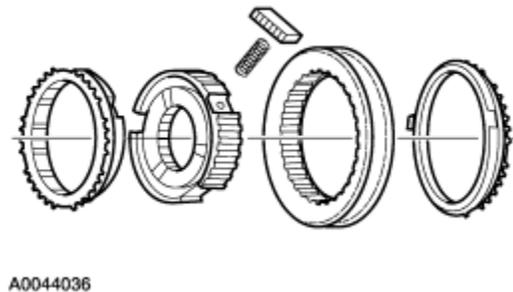
- Inspect the bearings for wear or damage. Install new bearings as necessary.



26. Remove the low gear from the low and reverse synchronizer assembly.
- Inspect the low and reverse gears for wear or damage. Install new gears as necessary.

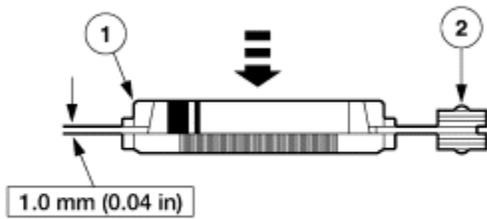


27. Disassemble the low and reverse synchronizer assembly.
- Inspect the components for wear or damage. Inspect the internal surface of the synchronizer rings for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.



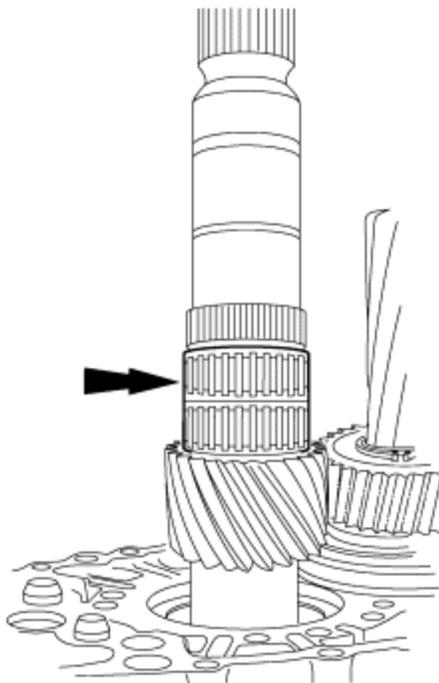
28. Check the clearance between the synchronizer ring and the gear.
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
 2. Insert a feeler gauge and measure the clearance, while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference.
 - Place the feeler gauge between the ring and gear. The ring has a raised section, inserting the feeler gauge past the teeth will give a incorrect reading.

- If the clearance is less than 1.0 mm (0.04 in.) for low or reverse gear, install a new synchronizer assembly, low gear or reverse gear to obtain correct specification.



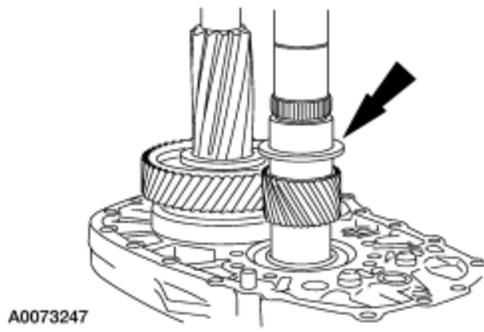
A0044032

29. Remove the mainshaft needle bearing.

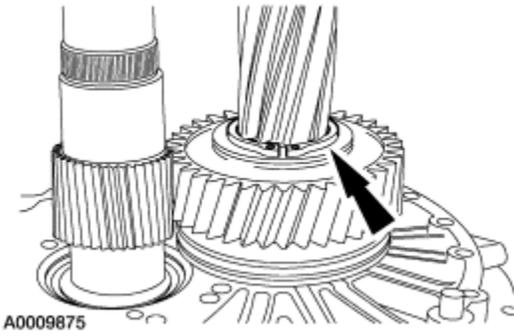


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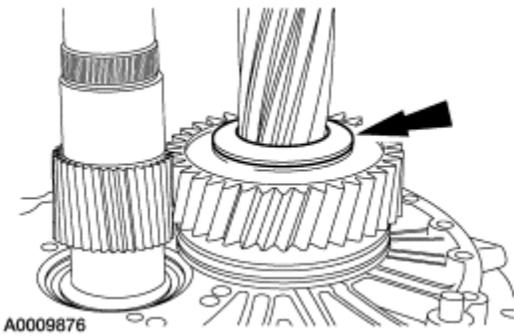
30. For vehicles equipped with a 6.0L engine, remove the low gear thrust washer.



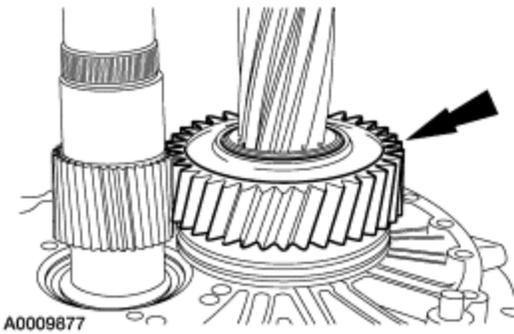
31. Remove and discard the snap ring.



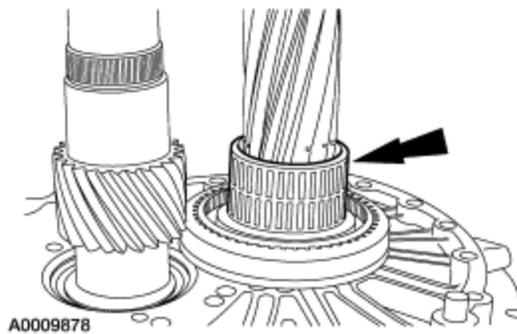
32. Remove the countershaft rear thrust washer.



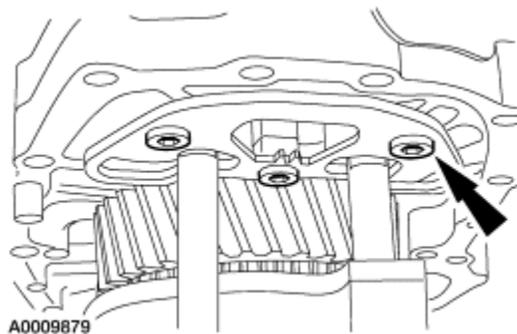
33. Remove fifth gear.



34. Remove the countershaft needle bearing.



35. Remove the interlock plate bolts.

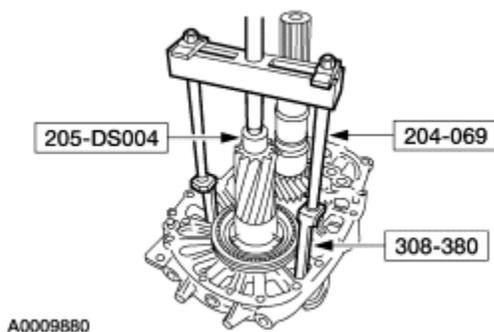


36. **NOTE:** Do not use power tools to remove.

NOTE: Make sure the shift rails are not binding while pulling up on the intermediate housing.

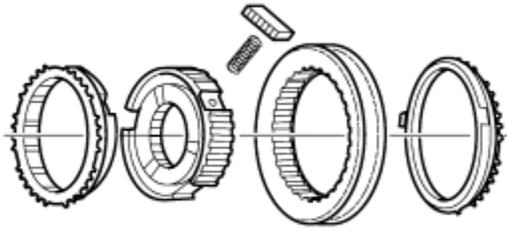
Using the special tools, remove the countershaft bushing, the countershaft fifth gear synchronizer assembly and the intermediate housing.

- When installing the Centerplate Legs, position them opposing one another.
- Inspect the countershaft fifth gear synchronizer, countershaft bushing and the intermediate plate for wear or damage. Install new components as necessary.



37. Disassemble the countershaft fifth gear synchronizer assembly.

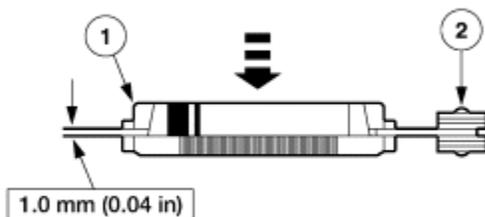
- Inspect the components for wear or damage. Inspect the internal surface of the synchronizer ring for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.



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38. Check the clearance between the synchronizer ring and the gear.

1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance, while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference.
 - Place the feeler gauge between the ring and gear. The ring has a raised section. Inserting the feeler gauge past the teeth will give an incorrect reading.
 - If the clearance is less than 1.0 mm (0.04 in.) for fifth gear, install a new synchronizer assembly or fifth gear to obtain correct specification.



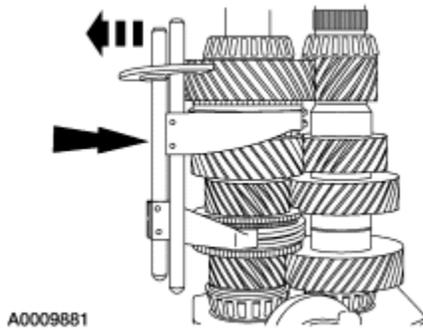
A0044032

39. **⚠ CAUTION: To prevent damage, do not heat the mainshaft rear bearing, the countershaft or mainshaft rear thrust washer, the mainshaft bushing or the countershaft bushing higher than 150°C (300°F) maximum.**

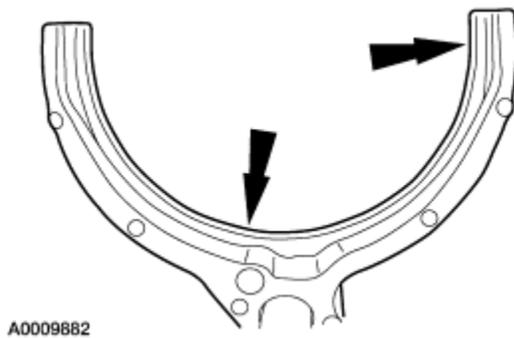
NOTE: Make sure the components are heated to 150°C (300°F) for reassembly.

New or original components should be heated in advance of the assembly procedure. Heating will ease the assembly process. Place the mainshaft rear bearing, the countershaft rear thrust washer, the countershaft bushing, the rear mainshaft bearing, the and the mainshaft low gear bushing into the Gear/Bearing Heater.

40. Remove the interlock plate, the first/second and third/fourth shift fork and shift rail assemblies.



41. Inspect all the shift fork pads and centers for wear or damage. Install new shift forks as necessary.

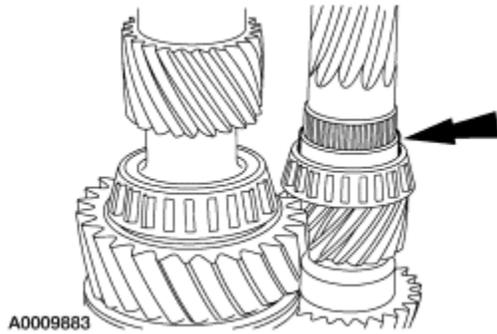


42.  **CAUTION: To prevent damage, do not heat the bearings higher than 150°C (300°F) maximum.**

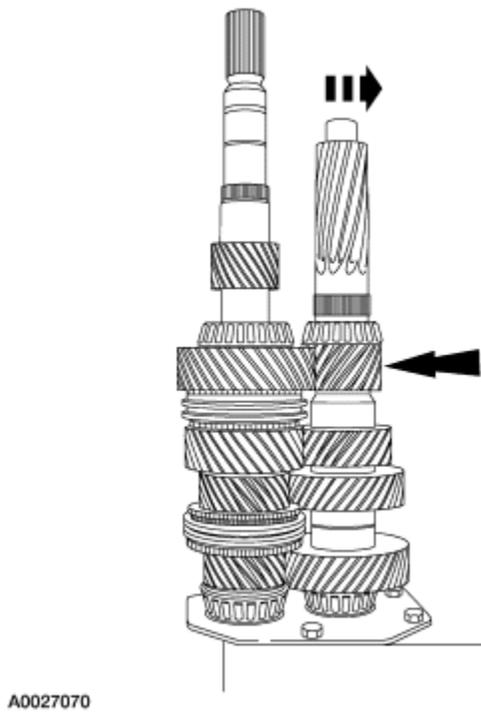
Inspect the mainshaft middle bearing, the countershaft middle bearing and the bearing cups in the intermediate housing for wear or damage. Install new components as necessary.

- Always install new bearings and cups as a set. Do not install one without the other.
- The bearings should be heated to install. Place the bearings in the Gear/Bearing Heater.

43. Remove the countershaft rear bearing spacer.



44. Remove the countershaft from the Gear Pack Assembly Fixture and set it aside.



SECTION 308-03B: Manual Transaxle/Transmission
— ZF 6-Speed

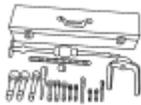
1999 F-Super Duty 250-550
Workshop Manual

DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

[Procedure revision date: 01/26/2000](#)

Extension Housing

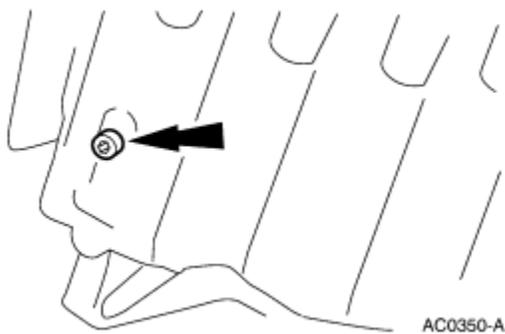
Special Tool(s)

 <p>ST1144-A</p>	<p>Universal Puller Set 303-DS005 (D80L-100-A)</p>
 <p>ST2366-A</p>	<p>Installer, Countershaft Rear Bearing 308-384</p>
 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST1416-A</p>	<p>Handle 205-D055 (D81L-4000-A)</p>
 <p>ST1073-A</p>	<p>Heat Gun 107-R0300</p>

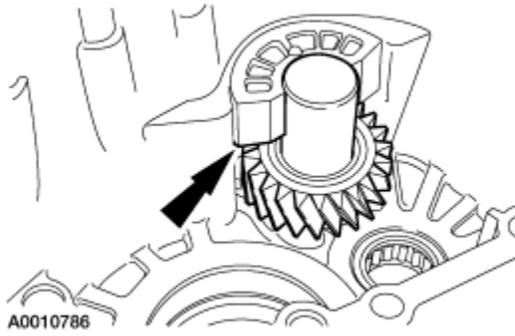
Disassembly

1. **NOTE:** To aid installation, index-mark the bolt hole position on the reverse idler shaft.

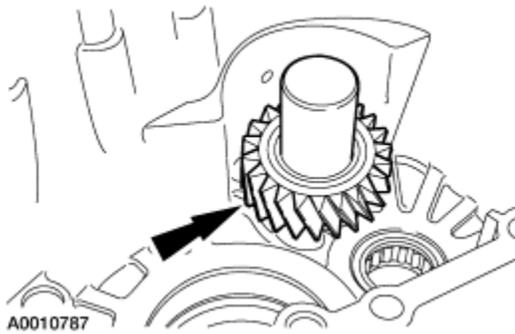
Remove the bolt and seal. Discard the seal.



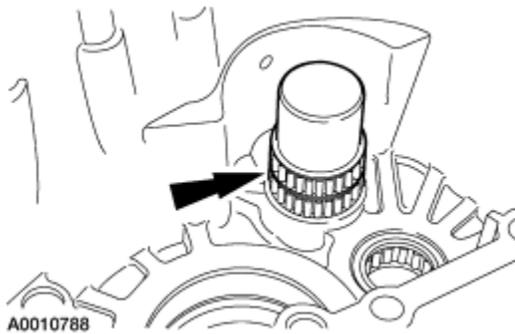
2. Remove the reverse idler shaft support.



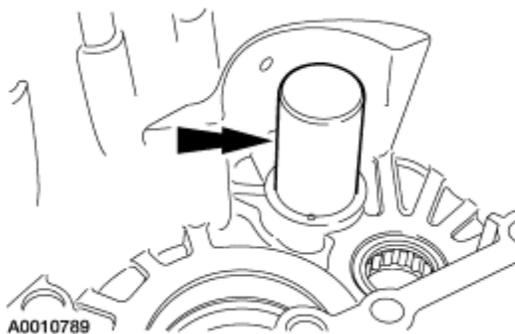
3. Remove the reverse idler gear.



4. Remove the reverse idler gear bearing.

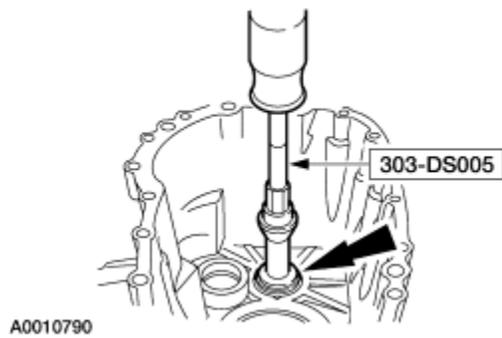


5. Remove the reverse idler shaft.



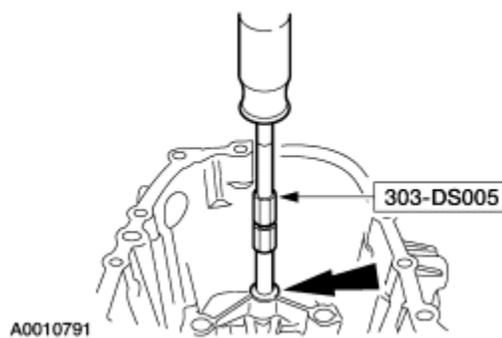
6. **NOTE:** Inspect the countershaft front bearing for wear or damage before removing.

Using the special tools, remove and discard the countershaft front bearing.

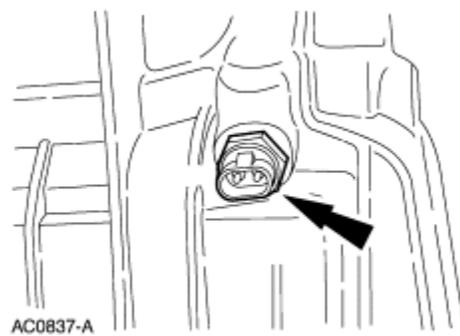


7. **NOTE:** Inspect the bearing for wear or damage before removing.

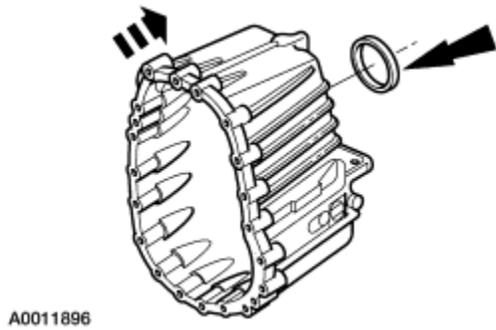
Using the special tools, remove and discard the shift rail bearing.



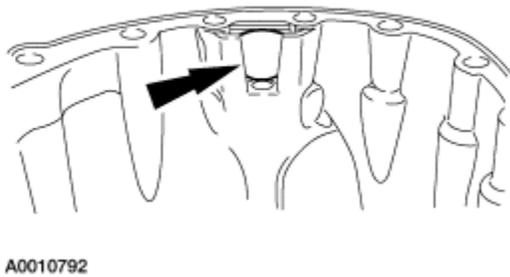
8. Remove the reverse lamp switch and seal. Discard the seal.



9. Remove and discard the output oil seal.



10. Inspect the magnet. Make sure it is securely attached in the extension housing.

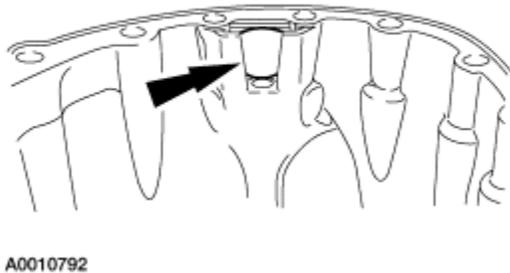


Assembly

1. **NOTE:** A new extension housing will not have a magnet. A new magnet must be installed.

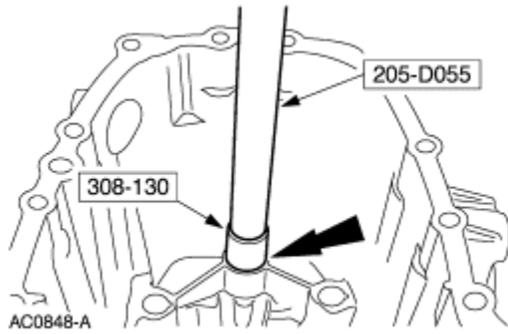
Apply adhesive to the magnet and install.

- Only apply adhesive to the housing side of the magnet.

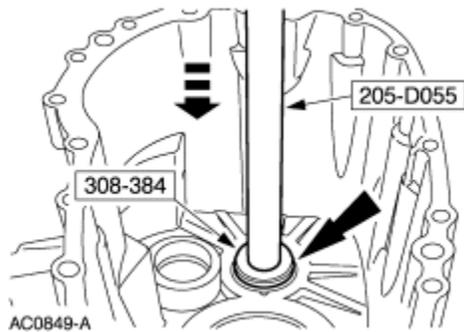


2. Using the special tools, install a new shift rail bearing.

- Using a Heat Gun, heat the bearing area of the housing to ease installation.



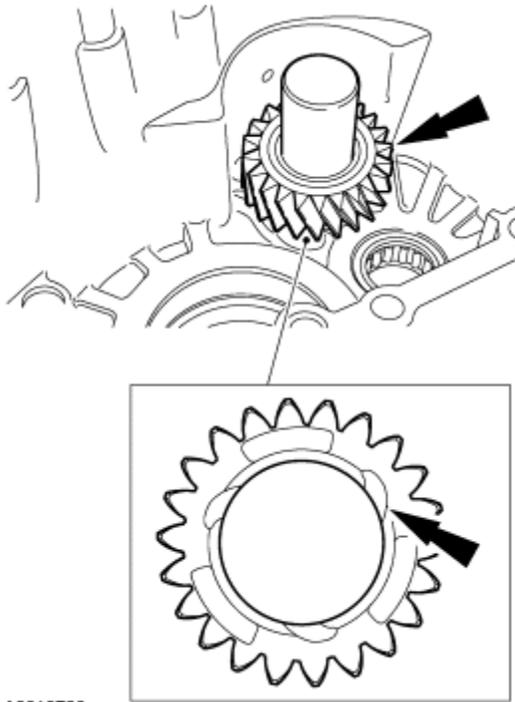
3. Using the special tool, install a new countershaft bearing.
 - Using a Heat Gun, heat the bearing area of the housing to ease installation.



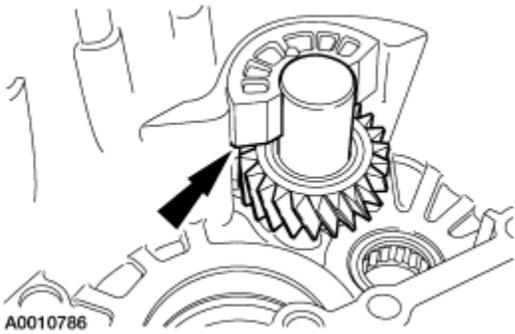
4. **NOTE:** Make sure the hole in the shaft aligns with the hole in the extension housing.

NOTE: The oil grooves on the gear, face the output side of the extension housing.

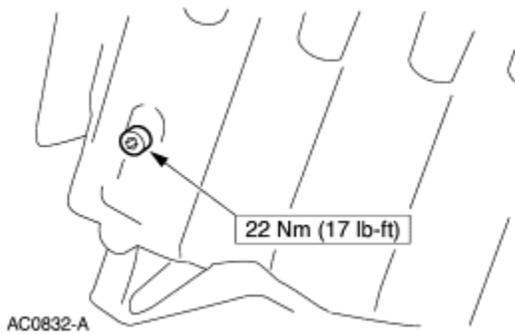
Install the reverse idler shaft, reverse idler gear bearings and reverse idler gear.



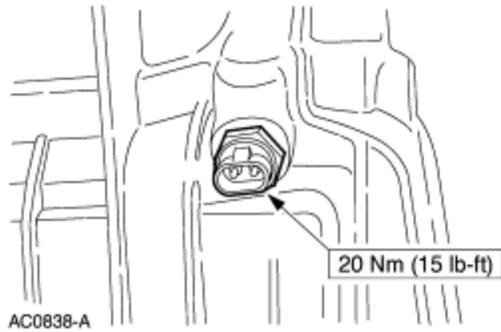
5. Install the reverse idler shaft support.
 - The ribs on the reverse idler shaft support face upward.



6. Install the reverse idler shaft bolt with a new seal.



7. Install the reverse lamp switch with a new seal.



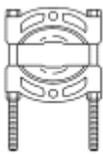
8. Install the new output oil seal after the bearing preload is completed during transmission assembly.

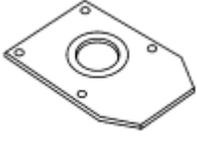
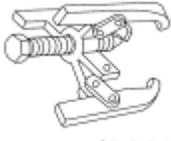
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 01/26/2000](#)

Input Shaft and Bearing

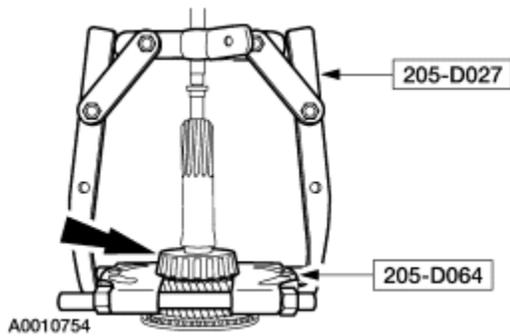
Special Tool(s)	
 <p>ST1368-A</p>	<p>Bearing Puller 205-D064 (D84L-1123-A) or equivalent</p>
 <p>ST2369-A</p>	<p>Hub Sensing Ring Replacer 205-059 (T94P-20202-B1)</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164R-3900</p>

 <p>ST2168-A</p>	<p>Gear Pack Assembly Fixture 308-381</p>
 <p>ST1585-A</p>	<p>2 or 3 Jaw Puller 205-D027 (D80L-1013-A)</p>

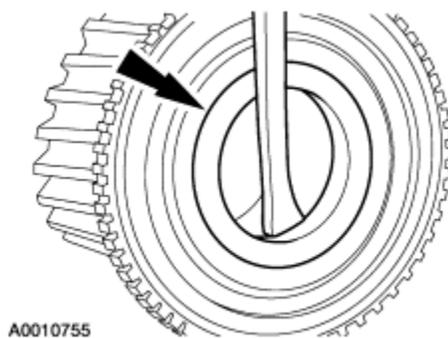
Disassembly

NOTE: Installing a new input shaft will affect mainshaft clearance. Carry out a mainshaft clearance measurement. Refer to the transmission assembly procedures in this section.

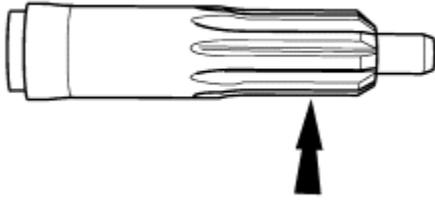
1. Using the special tools, remove the input shaft bearing.



2. Remove the input shaft rear oil dam.



3. Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



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4.  **CAUTION: To prevent damage, do not heat the bearing higher than 150°C (300°F).**

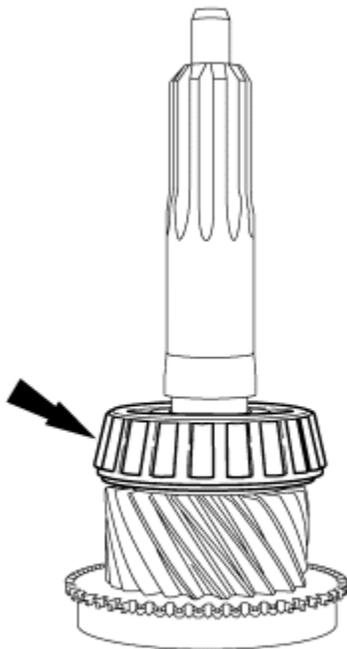
New or original components should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater.

Assembly

1.  **CAUTION: Do not drive against the bearing cone. Drive against the inner race only.**

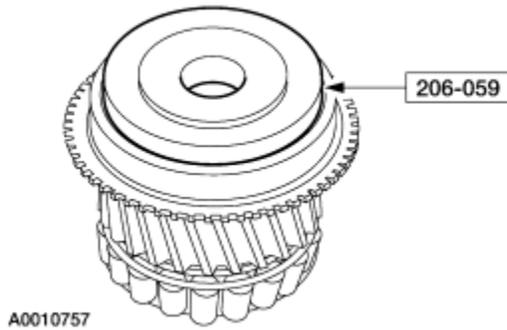
Using a suitable driver, install the input shaft bearing.

- Seat the bearing against its stop.



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2. Using the special tool, install the input shaft rear oil dam.
 - Position the input shaft in the Gear Pack Assembly Fixture.



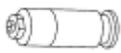
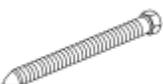
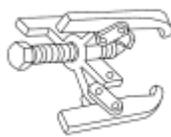
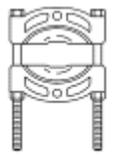
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

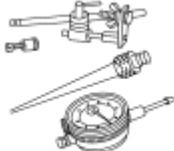
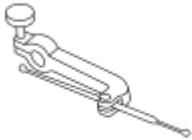
1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 01/26/2000](#)

Main Shaft

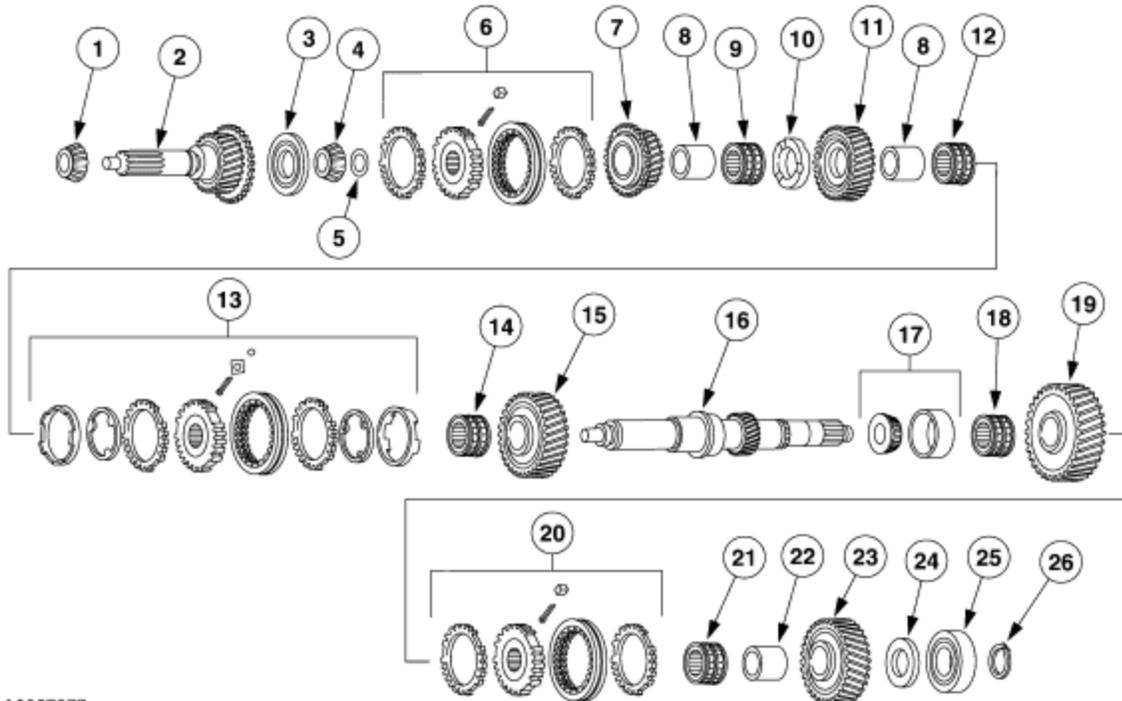
Special Tool(s)	
<p>ST2168-A</p>	Fixture, Gear Pack 308-381
<p>ST2144-A</p>	Remover/Installer, Transmission Bearing Collet 308-132 (T87T-7025-FH)
<p>ST2370-A</p>	Guide, Thrust Washer 308-415

 <p>ST2371-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</p>
 <p>ST2147-A</p>	<p>Remover/Installer, Bearing Tube 308-052 (T77J-7025-B)</p>
 <p>ST2146-A</p>	<p>Remover, Bearing Collet Sleeve 308-029 (T75L-7025-G)</p>
 <p>ST1304-A</p>	<p>Screw, Bearing Removal Tube 308-092 (T84T-7025-B)</p>
 <p>ST1585-A</p>	<p>2 or 3 Jaw Puller 205-D027 (D80L-1013-A)</p>
 <p>ST1835-A</p>	<p>Shaft Protector Set 205-DS004 (D80L-625-A)</p>
 <p>ST1368-A</p>	<p>Puller, Bearing 205-D064 (D84L-1123-A) or equivalent</p>
 <p>ST2369-A</p>	<p>Installer, Wheel Speed Sensor Ring 206-059 (T94P-20202-B1)</p>

 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164-R3900</p>
 <p>ST2008-A</p>	<p>17.5 Ton Press 014-00021</p>
 <p>ST1897-A</p>	<p>Dial Indicator Gauge With Holding Fixture 100-002 (TOOL-4201-A)</p>
 <p>ST1348-A</p>	<p>Gauge, Clutch Housing 308-021 (T75L-4201-A)</p>

Disassembly

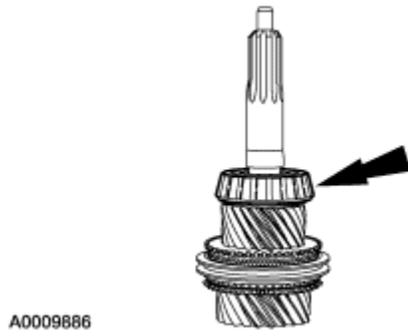
Mainshaft Components—Disassembled View



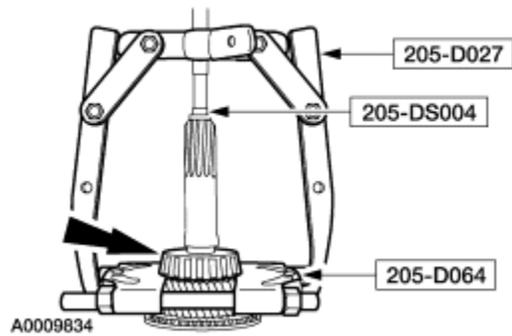
Item	Part Number	Description
1	7025	Input shaft bearing
2	7017	Input shaft
3	7046	Input shaft rear oil dam
4	7120	Input shaft pocket bearing
5	7B331	Snap ring (kit)
6	7124	Synchronizer assembly, third and fourth
7	7196	Mainshaft third gear
8	7N318	Mainshaft second and third gear bushing
9	7K169	Mainshaft needle bearing (third gear)
10	7056	Mainshaft second gear thrust washer
11	7103	Mainshaft second gear
12	7K169	Mainshaft needle bearing (second gear)
13	7124	Synchronizer assembly, first and second
14	7K169	Mainshaft needle bearing (first gear)
15	7100	Mainshaft first gear
16	7061	Mainshaft
17	7N430	Mainshaft center bearing and bearing cup
18	7K322	Mainshaft needle bearing (reverse gear)
19	7142	Mainshaft reverse gear
20	7124	Synchronizer assembly, low and reverse
21	7K322	Mainshaft needle bearing (low gear)
22	7D305	Mainshaft low gear bushing
23	7Z451	Mainshaft low gear
24	7E254	Output bearing thrust washer
25	7R205	Mainshaft rear bearing
26	7B331	Snap ring (kit)

1. Rotate the mainshaft. Position the mainshaft in the Gear Pack Assembly Fixture with the input shaft pointing upward.
2. **NOTE:** Installing a new input shaft will affect mainshaft clearance. Carry out a mainshaft clearance measurement. Refer to the transmission assembly procedures in this section.

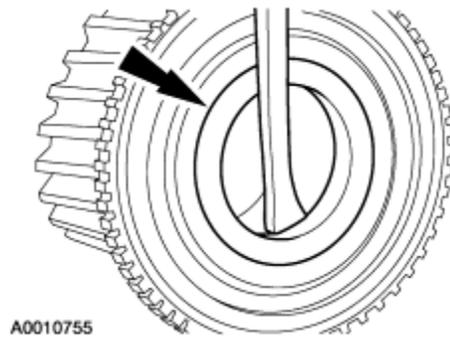
Remove the input shaft.



3. Using the special tools, remove and discard the input shaft bearing.



4. Remove and discard the input shaft rear oil dam.



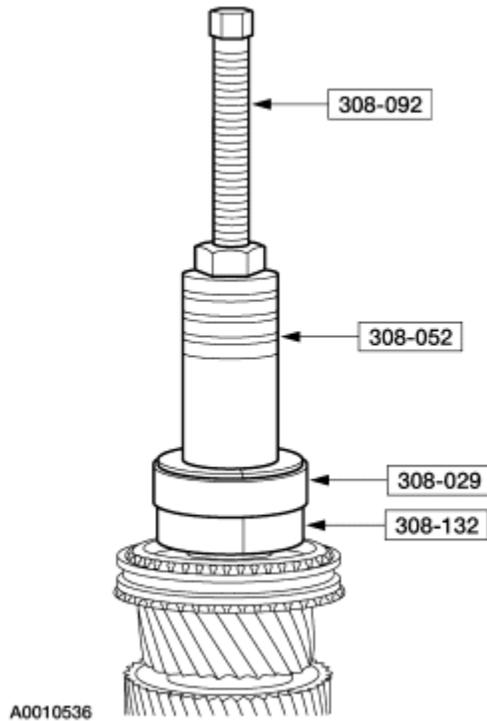
5. Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



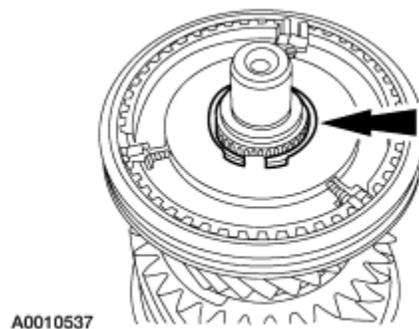
6.  **CAUTION: To prevent damage, do not heat the bearing higher than 150°C (300°F).**

A new input shaft bearing should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater. Make sure the bearing is heated to 150°C (300°F).

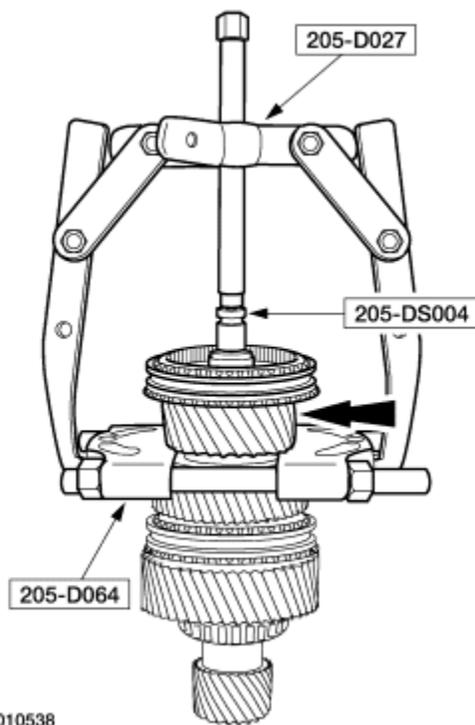
7. Using the special tools, remove the input shaft pocket bearing.
- Inspect the bearing for wear or damage. Install a new bearing as necessary.



8. Remove and discard the snap ring.

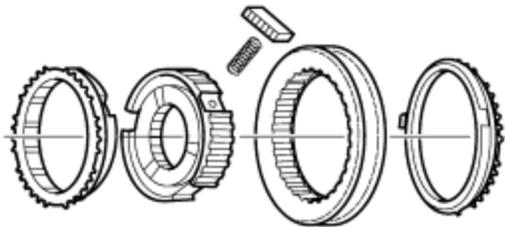


9. Using the special tools, remove the third and fourth synchronizer assembly and third gear.
- Inspect third gear for wear or damage. Install a new gear as necessary.



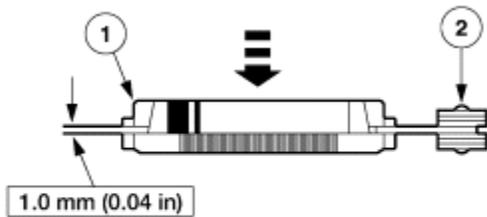
10. Disassemble the third and fourth synchronizer assembly.

- Inspect the components for wear or damage. Install new components as necessary.



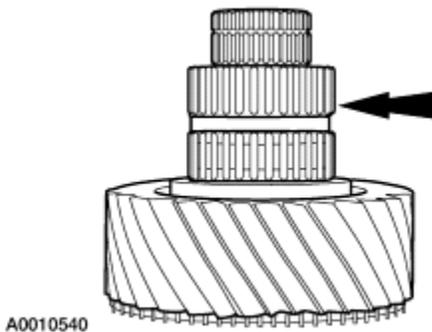
11. Check the clearance between the synchronizer ring and the gear.

1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance, while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference.
 - Place the feeler gauge between the ring and gear clutching teeth. The ring has a raised section, inserting the feeler gauge past the teeth will give an incorrect reading.
 - If the clearance is less than 1.0 mm (0.04 in), install a new synchronizer assembly.



A0044032

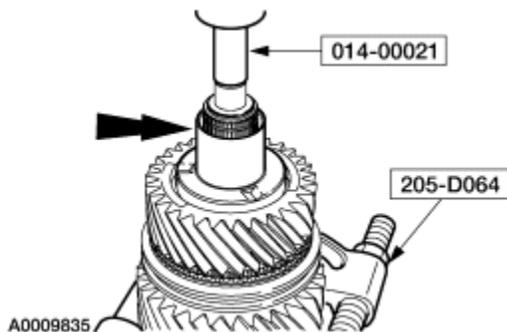
12. Remove the mainshaft needle bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary.



A0010540

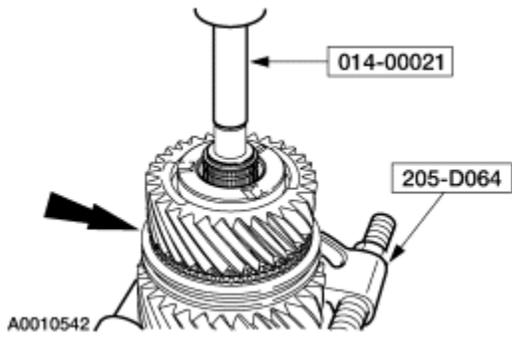
13. **NOTE:** When installing the Bearing Puller, make sure it is installed above the mainshaft bearing race.

Using the special tool, press the mainshaft gear bushing off the mainshaft.

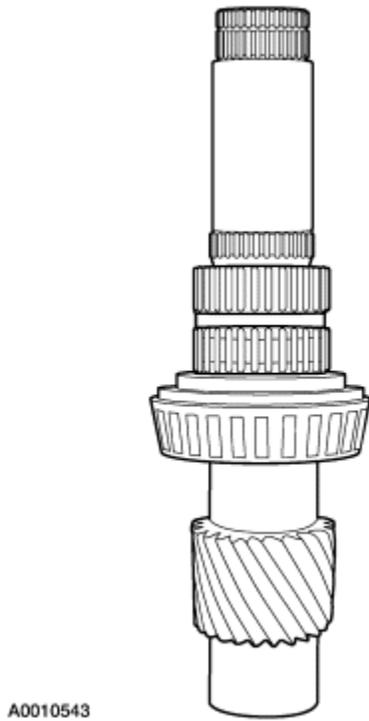


A0009835

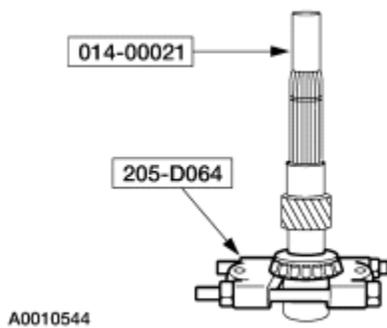
14. Using the special tool, press the mainshaft second gear thrust washer, the mainshaft second gear, the mainshaft needle bearing, the mainshaft gear bushing, first and second synchronizer assembly and mainshaft first gear.
 - Inspect the gears and bearing for wear or damage. Install new components as necessary.



15. Remove the mainshaft first gear needle bearing.
- Inspect the bearing for wear or damage. Install a new bearing as necessary.



16. Using the special tools, remove the mainshaft center bearing.
- Inspect the bearing for wear or damage. Install a new bearing as necessary.



17. Disassemble the first and second synchronizer assembly.

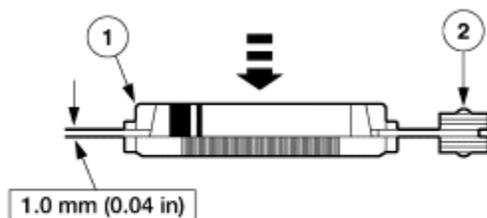
- Inspect the components for wear or damage. Install a new synchronizer assembly as necessary.



A0010545

18. Check the clearance between the synchronizer ring and the gear clutching teeth.

1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance, while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference.
 - Place the feeler gauge between the ring and gear clutching teeth. The ring has a raised section, inserting the feeler gauge past the teeth will give a wrong reading.
 - If the clearance is less than 1.0 mm (0.04 in), install a new synchronizer assembly.



A0044032

19. **⚠ CAUTION: To prevent damage, do not heat bearings, thrust washers, bushings or the synchronizer bodies higher than 150°C (300°F).**

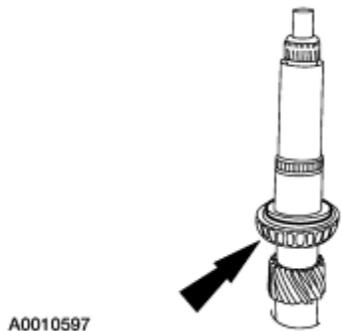
New or original components should be heated in advance of the assembly procedure. Heating the specified components will ease the assembly process. Place the input shaft pocket bearing, the mainshaft second gear thrust washer, the mainshaft center bearing, the synchronizer bodies and the mainshaft gear bushings into the Gear/Bearing Heater.

Assembly

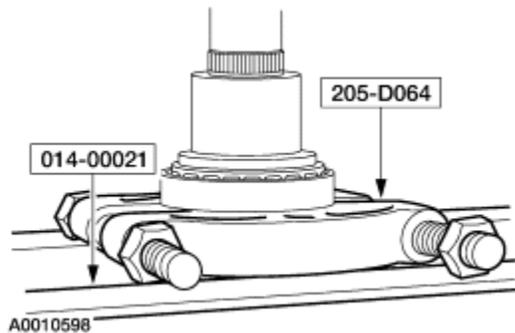
1. Inspect the mainshaft and all mainshaft components for wear or damage. For additional information, refer to [Section 308-00](#).
2.  **CAUTION: Do not reassembly the mainshaft dry. Apply lubricant throughout the assembly procedure.**

Lubricate all mainshaft components with the recommended transmission lubricant during reassembly.

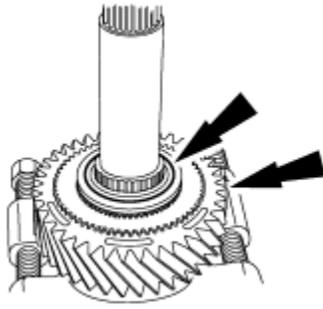
3. Install the center mainshaft bearing.
 - Make sure the bearing is installed against the stop on the mainshaft.



4. Using the special tool, position the mainshaft on the press with the input end facing upward.
 - Using a hammer and punch, remove the bearing cup from the intermediate housing, then install it on the bearing. This will prevent any damage to the bearing during installation.

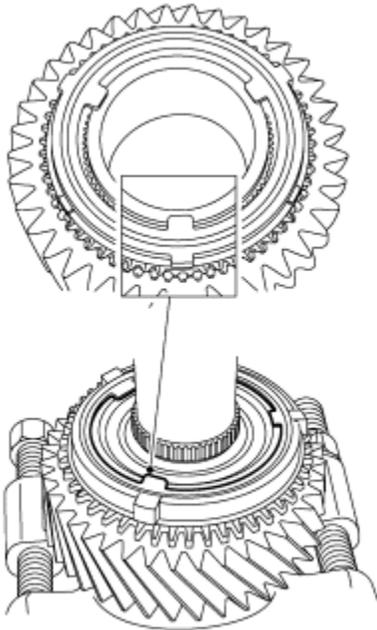


5. Install the first gear bearing and first gear.



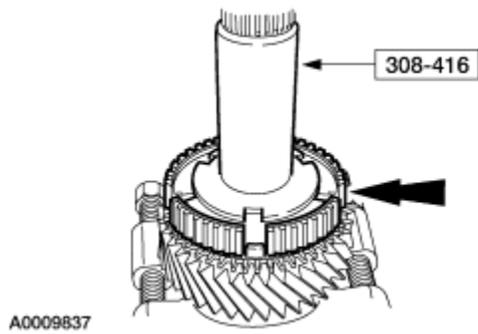
A0010599

6. Install the three synchronizer rings for first gear.
 - Make sure the tabs on the synchronizer ring are in the slots on the gear.
 - Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.



A0009836

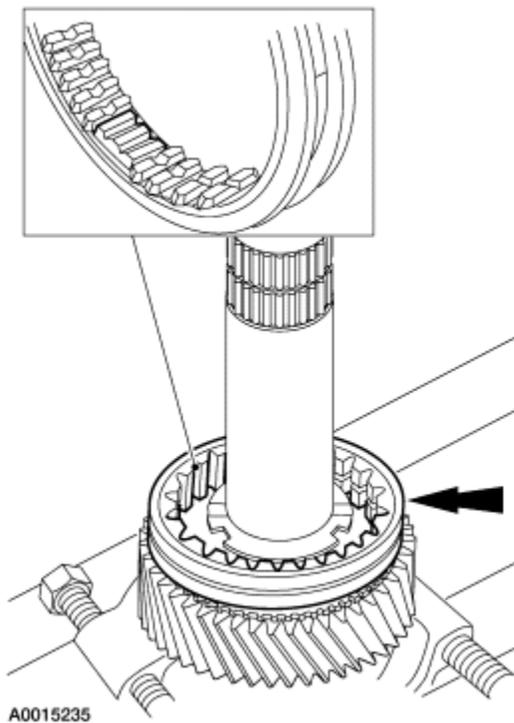
7. Using the special tools, press the first and second gear synchronizer body into place.
 - The numbers on the synchronizer hub must face upward.
 - Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.



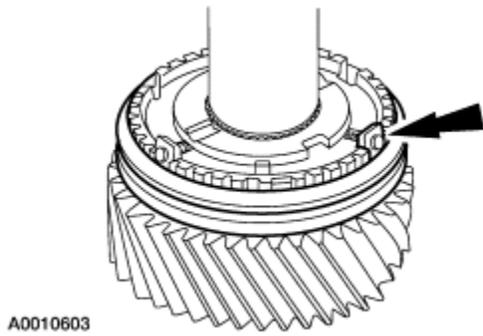
8. **NOTE:** Install the synchronizer sliding sleeve with the flats aligned with the detent notches.

Install the synchronizer sliding sleeve.

- The sliding sleeve has three flat areas which need to line up with the detent area of the synchronizer body.



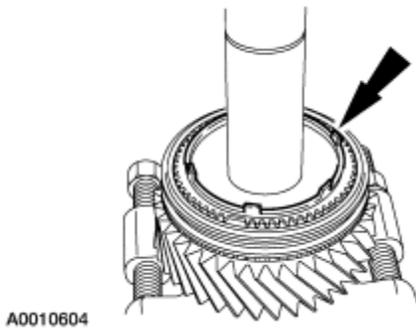
9. Install the synchronizer spring and plate, then tilt the plate up and install the detent ball.
- If the springs are difficult to install, check the alignment of the synchronizer sliding sleeve flat areas.



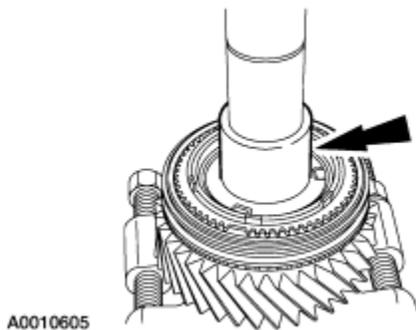
10. **NOTE:** Position the synchronizer into the neutral position.

Install the synchronizer rings for second gear.

- Align the tabs on the synchronizer rings with the slots in the synchronizer body.

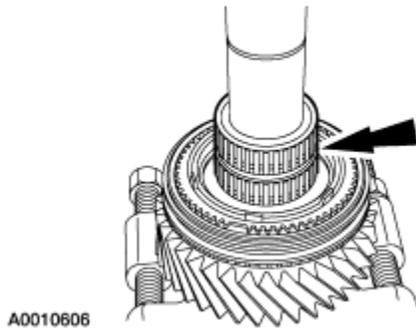


11. Install the mainshaft second gear bushing.



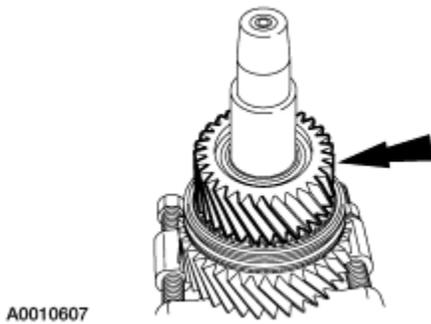
12. **NOTE:** Let the mainshaft second gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

Install the mainshaft needle bearing.

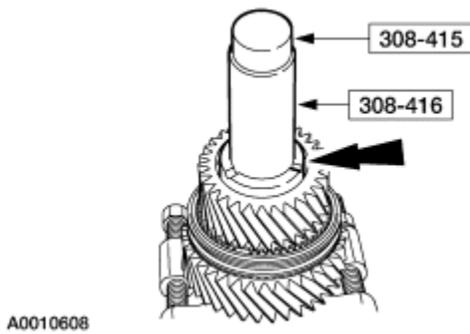


13. Install second gear.

- Make sure to align the tabs on the synchronizer ring with the slots on the gear.

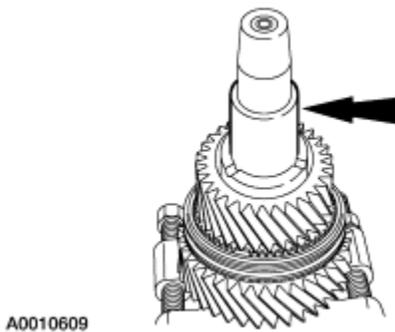


14. Using the special tools, press the mainshaft second gear thrust washer into place.



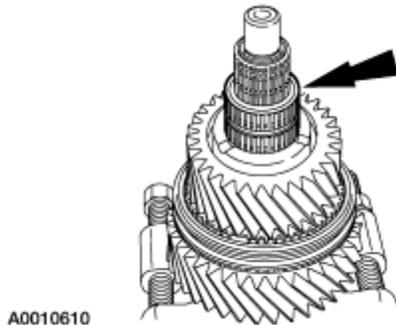
15. Using the special tool, install the mainshaft third gear bushing on the mainshaft.

- Pull the first/second gear sliding sleeve into the neutral position.

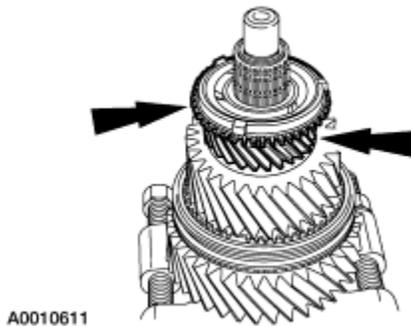


16. **NOTE:** Let the mainshaft third gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

Install the mainshaft needle bearing.

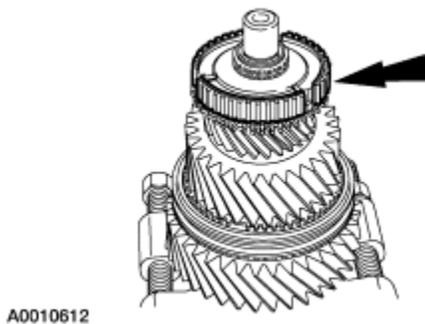


17. Install the mainshaft third gear and synchronizer ring.



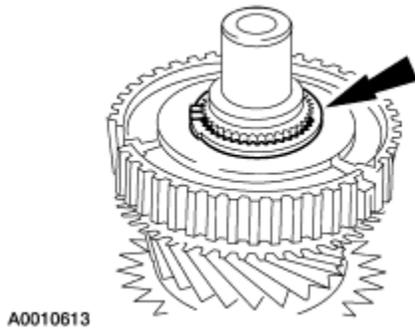
18. Install the third and fourth gear synchronizer body.

- The numbers on the synchronizer body must face upward.
- Make sure to align the synchronizer body notches with the tabs on the synchronizer ring.



19. Install a new snap ring.

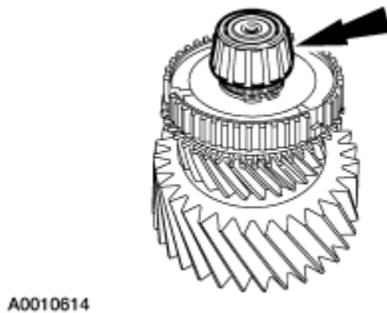
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



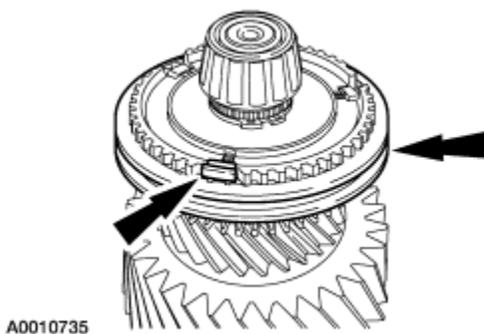
20. **⚠ CAUTION: Press the input shaft pocket bearing onto the mainshaft by the inner race only. Pressing on the outer race will damage the bearing.**

Press the input shaft pocket bearing into place.

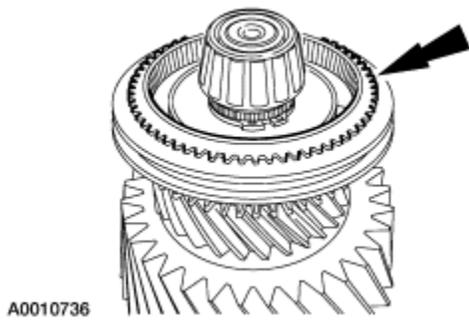
- Make sure the bearing is correctly seated. At the bottom of the bearing, there should be no gap. At the top of the bearing, check for a small amount of the mainshaft to be above the inner bearing race.



21. Remove the mainshaft from the press and reinstall it in the Gear Pack Assembly Fixture.
22. Install and position the synchronizer sliding sleeve down on the synchronizer body, install the springs and detents.



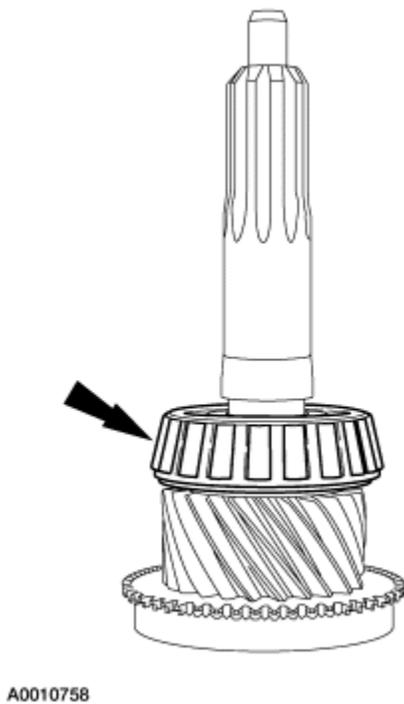
23. Install the synchronizer ring, then move the synchronizer sliding sleeve up on the synchronizer body.



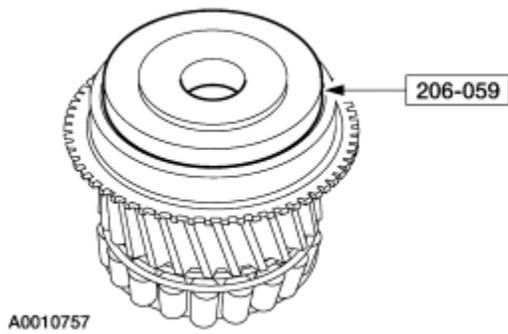
24.  **CAUTION: Do not drive against the bearing cone. Drive against the inner race only.**

Using a suitable driver, install a new input shaft bearing.

- Seat the bearing against its stop.

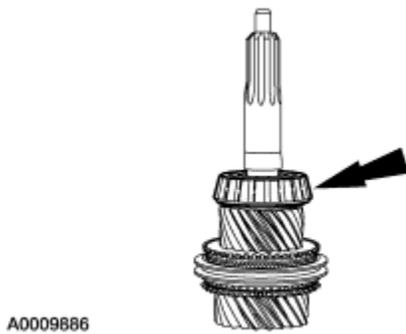


25. Using the special tool, install the input shaft rear oil dam.
- Rotate the input shaft to make sure the input shaft rear oil dam is completely seated.



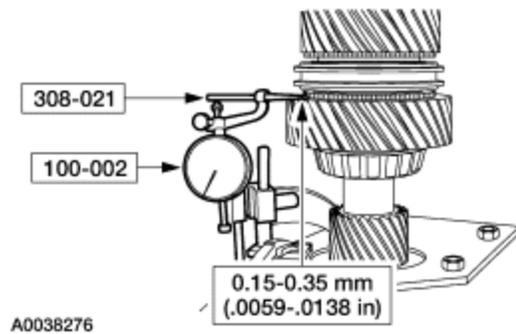
26. Install the input shaft.

- Fill the input shaft pocket with a suitable engine assembly white grease.

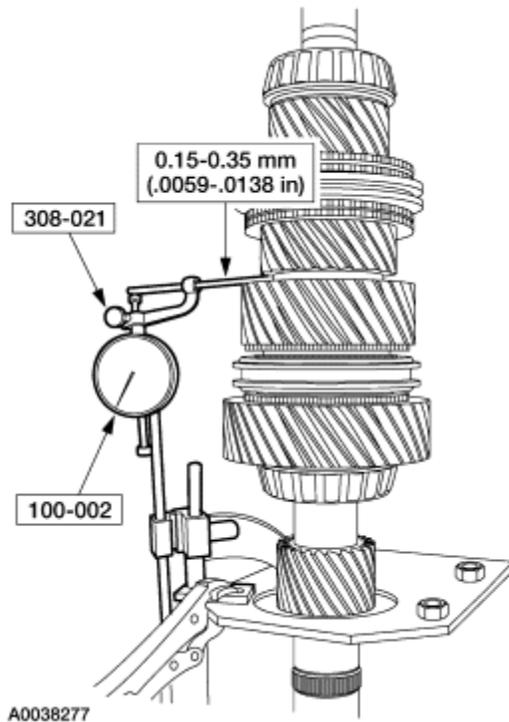


27. **NOTE:** If the following axial gear clearances are not within specification, it will be necessary to disassemble and reinspect.

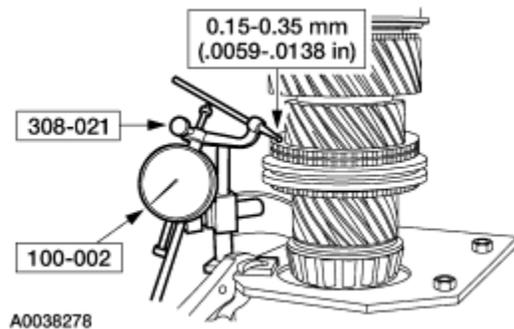
Using the special tool, check the axial gear clearance at the mainshaft first gear.



28. Using the special tool, check the axial gear clearance at the mainshaft second gear.



29. Rotate the mainshaft with the input shaft facing downward. Using the special tool, check the axial gear clearance at the mainshaft third gear.



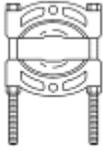
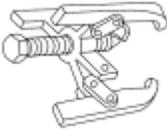
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 01/26/2000](#)

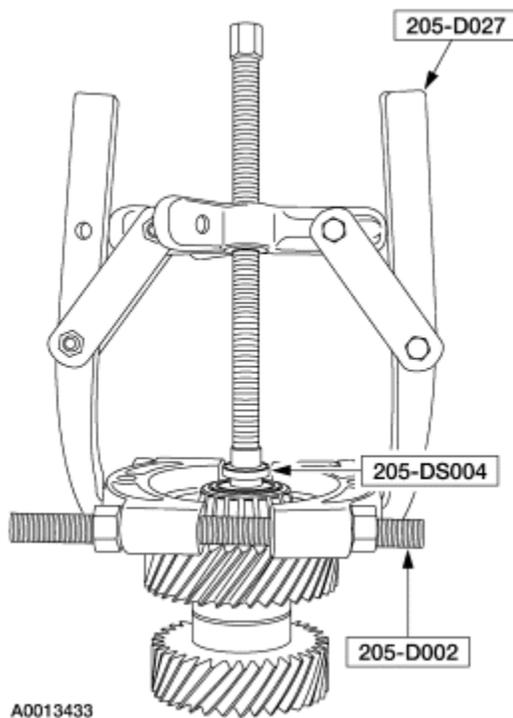
Countershaft and Bearing

Special Tool(s)

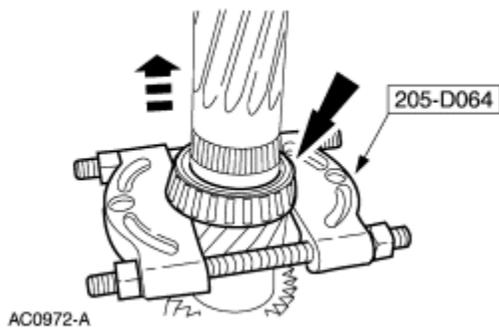
 <p>ST1368-A</p>	<p>Puller, Bearing 205-D064 (D84L-1123-A) or equivalent</p>
 <p>ST1585-A</p>	<p>2 or 3 Jaw Puller 205-D027 (D80L-1013-A) or equivalent</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164-R3900</p>
 <p>ST2474-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</p>

Disassembly

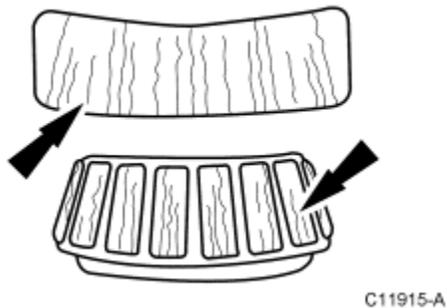
1. Using the special tools, remove the front countershaft bearing.



- Using the special tools, remove the rear countershaft bearing.



- Inspect the countershaft and bearings for wear or damage. Install new components as necessary. For additional information, refer to [Section 308-00](#).
 - Always install new bearings and cups as a set. Do not install one without the other.

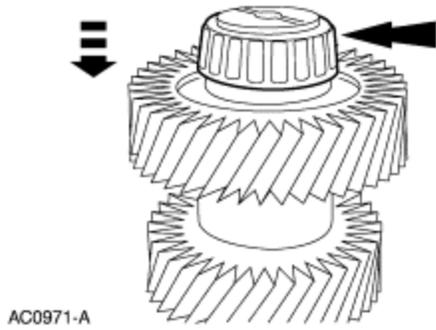


- ⚠ CAUTION: To prevent damage, do not heat the countershaft middle bearing or the countershaft front bearing higher than 150°C (300°F) maximum.**

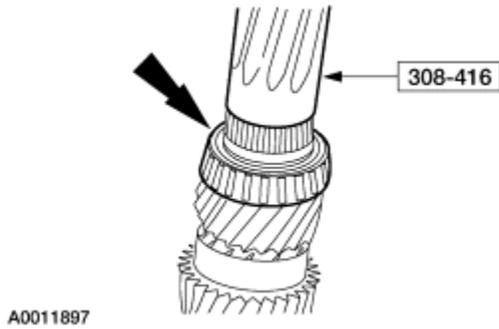
New or original components should be heated in advance of the assembly procedure. Heating the specified components will ease the assembly process. Place the countershaft middle bearing and the countershaft front bearing into the Gear/Bearing Heater.

Assembly

- Remove the bearing from the Gear/Bearing Heater, then install the countershaft bearing.
 - If necessary, use the Thrust Washer Bearing Race Driver to seat the bearing.



2. Remove the bearing from the Gear/Bearing Heater, then install the rear countershaft bearing.
 - If necessary, use the Thrust Washer Bearing Race Driver to seat the bearing.

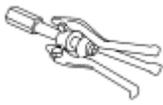


SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 01/26/2000](#)

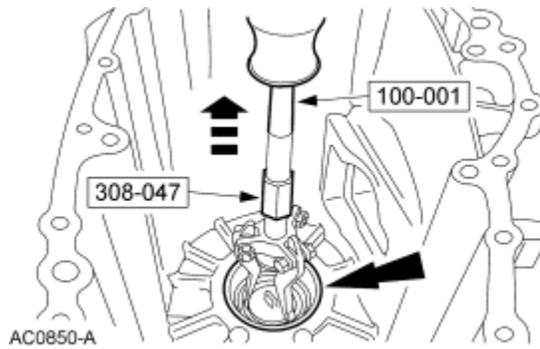
Case

Special Tool(s)	
 <p>ST1200-A</p>	<p>Remover, Bearing Cup 308-047 (T77F-1102-A)</p>

<p>ST1144-A</p>	<p>Universal Puller Set 303-DS005 (D80L-100-A)</p>
<p>ST1516-A</p>	<p>Remover/Installer, Front Wheel Hub 204-069 (T81P-1104-C)</p>
<p>ST2367-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
<p>ST1416-A</p>	<p>Handle 205-D055 (D81L-4000-A)</p>
<p>ST1555-A</p>	<p>Installer, Countershaft Front Bearing Cup 308-390</p>
<p>ST2368-A</p>	<p>Installer, Input Shaft Bearing Cup 308-391</p>

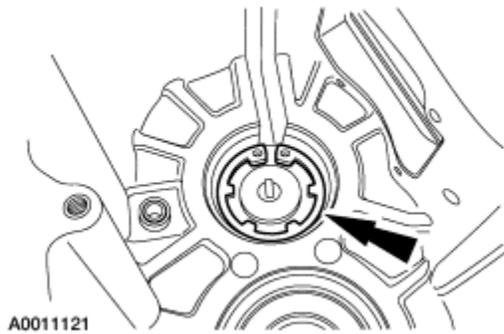
Disassembly

1. Using the special tools, remove the countershaft bearing cup and shim. Discard the shim.
 - Inspect the countershaft bearing cup for wear or damage. Install a new cup as necessary.
 - Install a new cup if the countershaft front bearing was installed new.

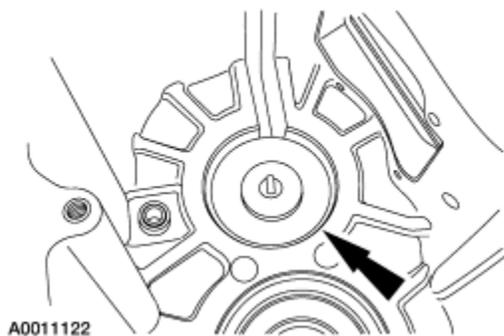


2. **NOTE:** Oil pump removal is only necessary if a large amount of particles were in the transmission during disassembly.

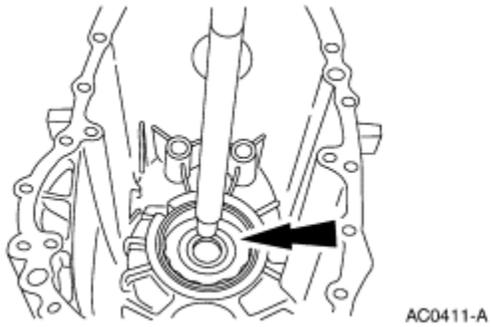
Remove the oil pump snap ring.



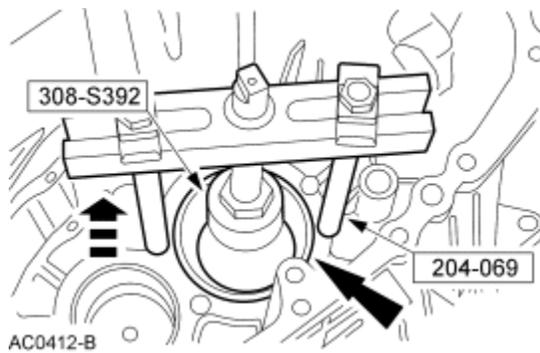
3. Remove the oil pump assembly.
 - Using vise-grips, pull upward on the center shaft.
 - Thoroughly clean the oil pump housing. Inspect the oil pump for wear or damage. Install a new oil pump assembly as necessary.



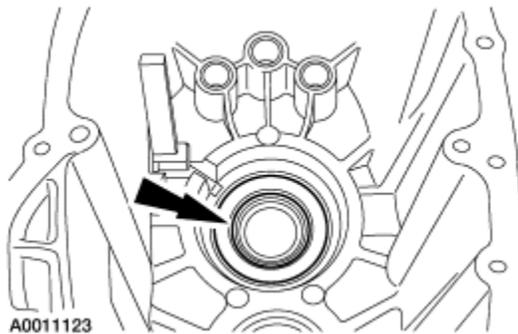
4. Using a brass drift, dent the input shaft oil baffle for puller tool clearance.



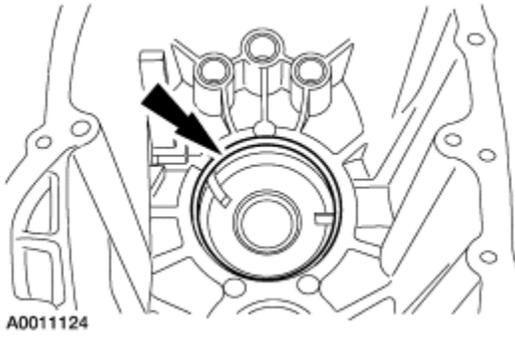
5. Using the special tools, remove the input shaft bearing cup.
 - Inspect the input shaft bearing cup for wear or damage. Install a new cup as necessary.
 - Install a new cup if the input shaft bearing was installed new.



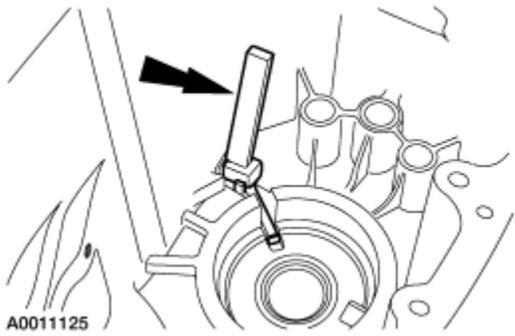
6. Remove the input shaft oil dam bearing ring.



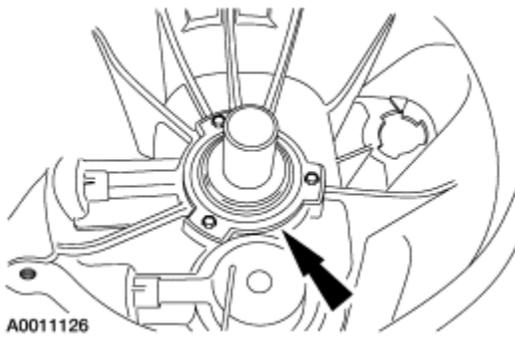
7. Remove the input shaft shim. Discard the shim.



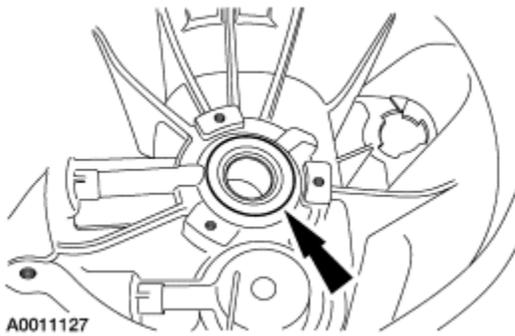
8. Remove the oil trough.



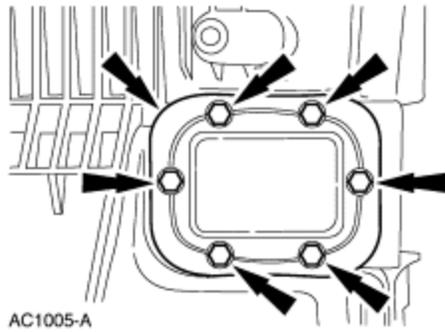
9. Remove the guide tube.



10. Remove the input shaft oil seal.

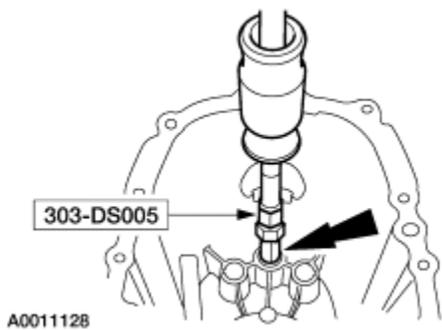


11. Remove the PTO cover.



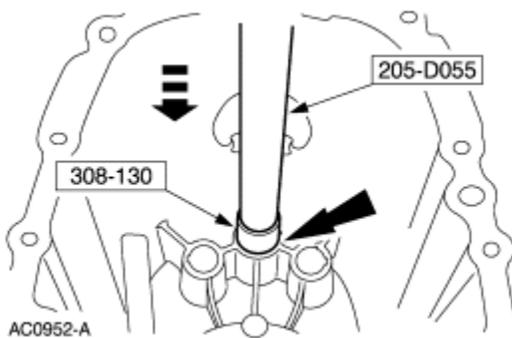
12. **NOTE:** Inspect the bearing for wear or damage before removing.

Using the special tools, remove and discard the shift rail bearing.



Assembly

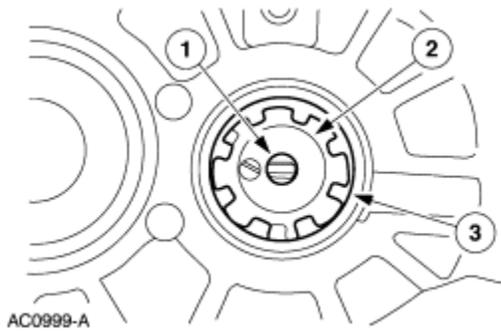
1. Using the special tools, install a new shift rail bearing.



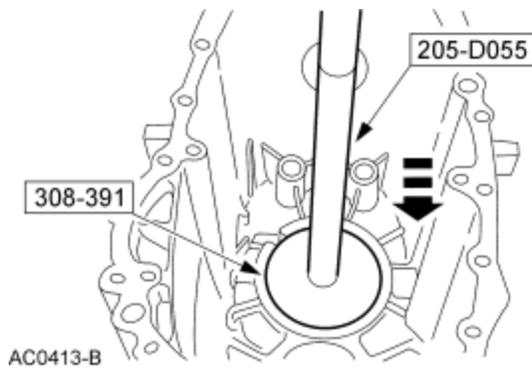
2. **NOTE:** Fill the oil pump housing with a suitable engine assembly white grease.

Install the oil pump assembly.

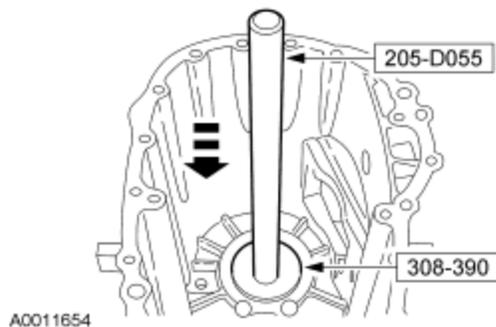
1. Install the rotor into the pump housing.
2. Install the oil pump body.
3. Install the oil pump snap ring.



3. Using the special tools, install the input shaft bearing cup.
 - Do not install the oil trough, input shaft shim, or the input shaft oil dam bearing ring at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed.



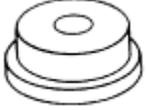
4. Using the special tools, install the countershaft bearing cup.
 - Do not install the shim at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed.



5. The case assembly will be completed during the assembly procedure. For additional information, refer to [Transmission](#) assembly in this section.
-

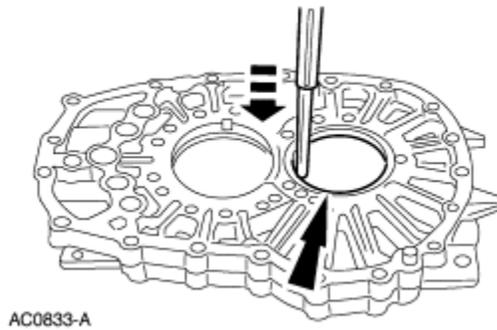
Case—Intermediate Housing

Special Tool(s)	
 ST1255-A	Adapter for 303-224 (Handle) 205-153 (T80T-4000-W)
 ST1185-A	Slide Hammer 100-001 (T50T-100-A)
 ST1615-A	Collet, 3/4" to 7/8" 303-D019 (D80L-100-Q) or equivalent
 ST2149-A	Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)
 ST1616-A	Actuator Pin (Dia 3/16") 303-D011 (D80L-100-G)
 ST1555-A	Installer, Countershaft Bearing Cup 308-388

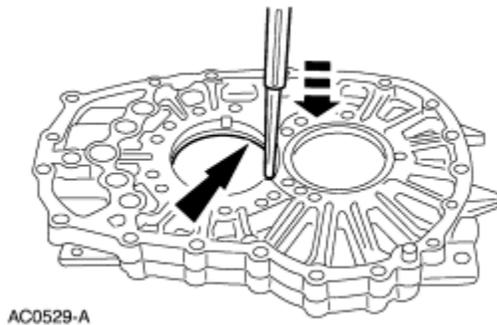
 <p>ST1555-A</p>	<p>Installer, Centerplate Mainshaft Bearing Cup 308-389</p>
 <p>ST1073-A</p>	<p>Heat Gun 107-R0300</p>

Disassembly

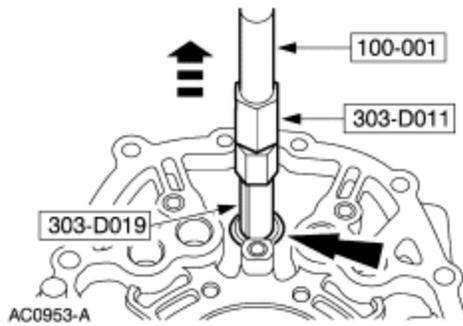
1. Using a brass drift, remove the intermediate housing countershaft bearing race.



2. Using a brass drift, remove the intermediate housing mainshaft bearing race.

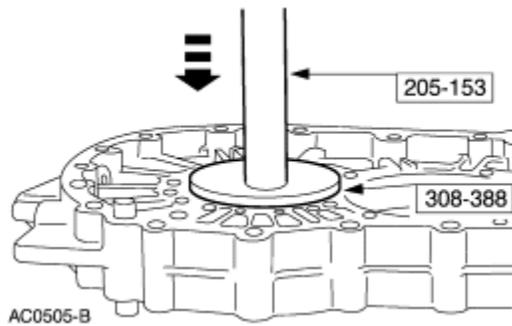


3. Using the special tools, remove and discard the center shift rail bearing.

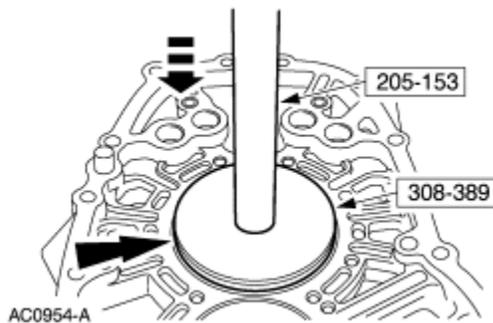


Assembly

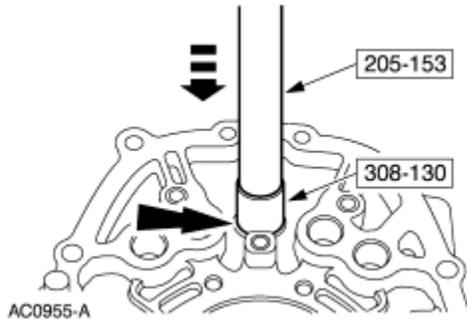
- Using the special tools, install the intermediate housing countershaft bearing race.
 - Using the Heat Gun, heat the bearing area of the housing.



- Using the special tools, install the intermediate housing mainshaft bearing race.
 - Using the Heat Gun, heat the bearing area of the housing.



- Using the special tools, install the center rail shift bearing.
 - Using the Heat Gun, heat the bearing area of the housing.

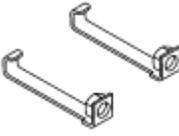
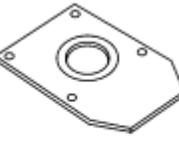


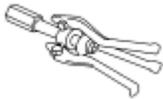
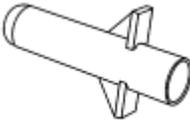
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 ASSEMBLY

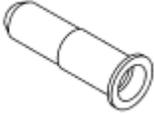
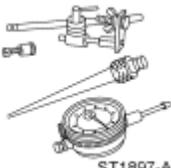
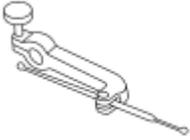
1999 F-Super Duty 250-550
 Workshop Manual

[Procedure revision date: 02/21/2003](#)

Transmission

Special Tool(s)	
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164-R3900</p>
 <p>ST2364-A</p>	<p>Centerplate Legs 308-380</p>
 <p>ST1073-A</p>	<p>Heat Gun 107-R0300</p>
 <p>ST2168-A</p>	<p>Fixture, Gear Pack 308-381</p>

 <p>ST1200-A</p>	<p>Remover, Bearing Cup 308-047 (T77F-1102-A)</p>
 <p>ST1555-A</p>	<p>Installer, Countershaft Front Bearing Cup 308-390</p>
 <p>ST1416-A</p>	<p>Handle 205-D055 (D81L-4000-A)</p>
 <p>ST2368-A</p>	<p>Installer, Input Shaft Bearing Cup 308-391</p>
 <p>ST2367-A</p>	<p>Remover, Input Shaft Bearing Cup 308-S392</p>
 <p>ST2474-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</p>
 <p>ST2165-A</p>	<p>Installer, Output Shaft Oil Seal (4x4) 308-383</p>
 <p>ST2164-A</p>	<p>Installer, Output Shaft Oil Seal (4x2) 308-382</p>

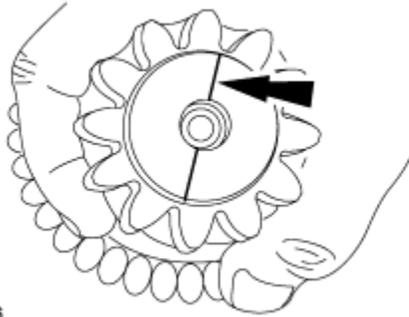
 ST2365-A	Installer, Input Shaft Oil Seal 308-379
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 ST2141-A	Socket, Mainshaft Locknut (36mm) 308-127 (T87T-7025-AH)
 ST1897-A	Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C)
 ST1348-A	Gauge, Clutch Housing 308-021 (T75L-4201-A)

Material	
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid NA	MERCON®
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5
Gasket and Trim Adhesive F3AZ-19B508-AA	NA
Threadlock 262 E2FZ-19554-B	WSK-M2G351-A6
Premium Long Life Grease XG-1-C	ESA-M1C75-B

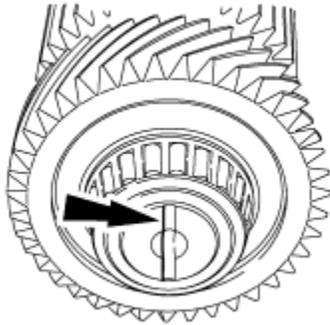
1.  **CAUTION: Do not reassembly the transmission dry. Apply lubricant throughout the assembly procedure.**

Lubricate all bearings, gears and synchronizers with the recommended transmission lubricant during reassembly.

2. Index-mark the countershaft in relation to the oil pump slot.

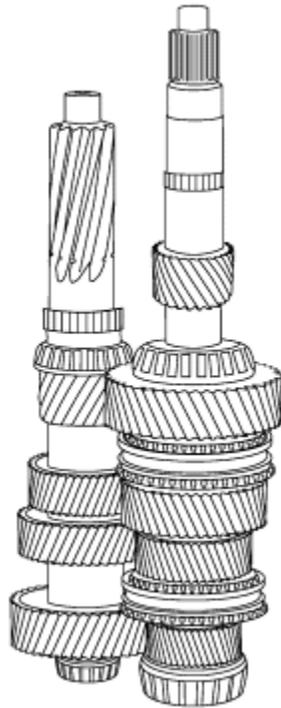


A0011576



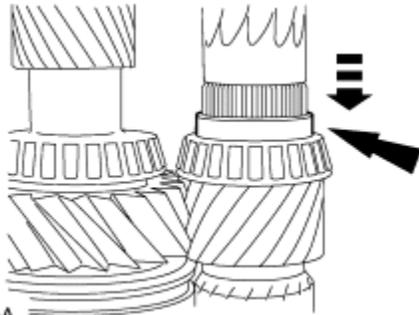
A0011577

3. Position the countershaft to the mainshaft on the Gear Pack Assembly Fixture.



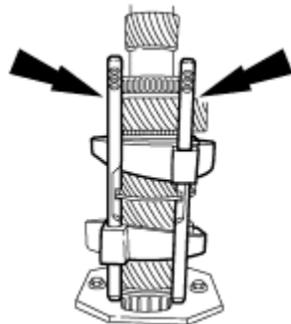
AC0394-B

4. Install the countershaft rear bearing spacer.
 - The countershaft rear bearing spacer can be installed either way.



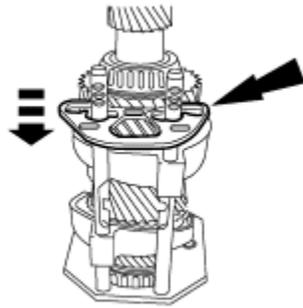
AC0974-A

5. Install the first/second and third/fourth shift fork and shift rail assemblies.
 - The detent groove on the rail faces upward or to the output shaft.
 - All shift forks and rails use double roll pins.



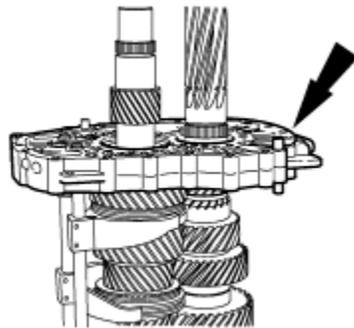
A0038251

6. Install the interlock plate.
- The stamped part numbers on the interlock plate must face toward the input shaft.



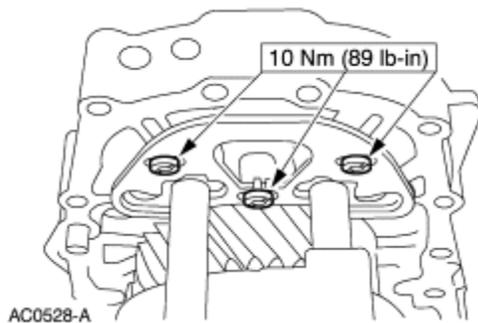
AC0545-A

7. Install and position the intermediate housing on the mainshaft, the countershaft, and the shift rails.
- Make sure the detents are clear of the bore area on the intermediate housing.



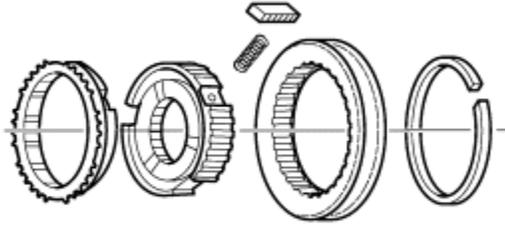
A0011578

8. Install the interlock plate bolts.



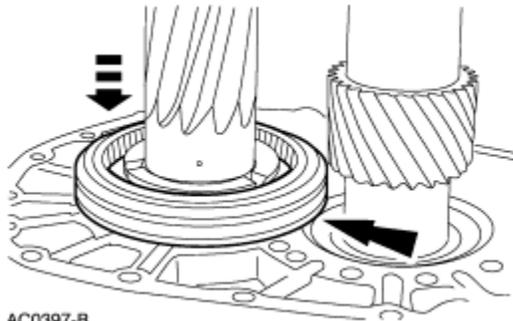
AC0528-A

9. Assemble the fifth gear synchronizer assembly.



A0038237

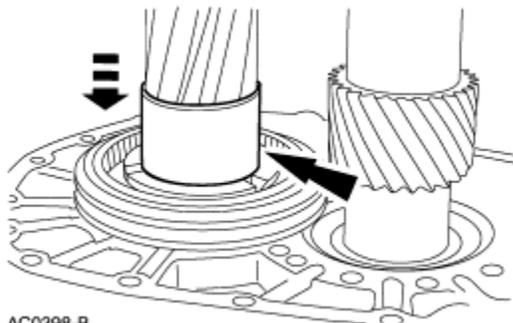
10. Install the fifth gear synchronizer assembly.
 - Install the fifth gear synchronizer with the snap ring on the synchronizer body facing down against the intermediate housing.
 - The fifth gear synchronizer will slide into place and does not require heat to install.



AC0397-B

11.  **CAUTION:** To prevent damage, do not heat the countershaft bushing higher than 150°C (300°F) maximum.

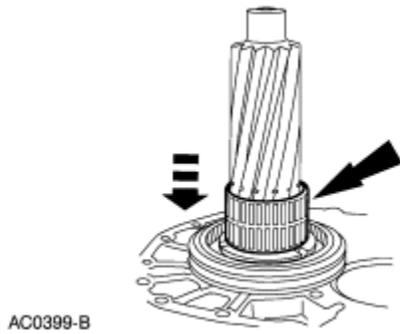
Remove the countershaft bushing from the Gear/Bearing Heater, then install the countershaft bushing.



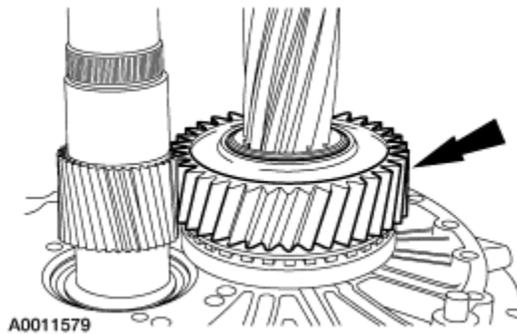
AC0398-B

12. **NOTE:** Allow the countershaft bushing to cool for 2-4 minutes before installing the countershaft needle bearing.

Install the countershaft needle bearing.

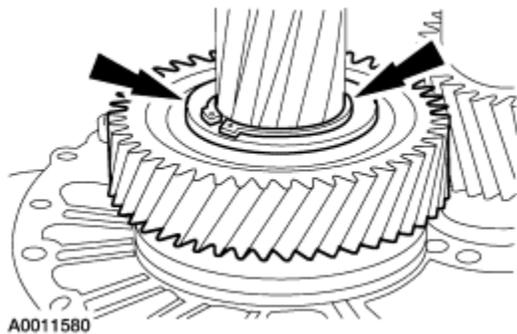


13. Install the fifth gear.

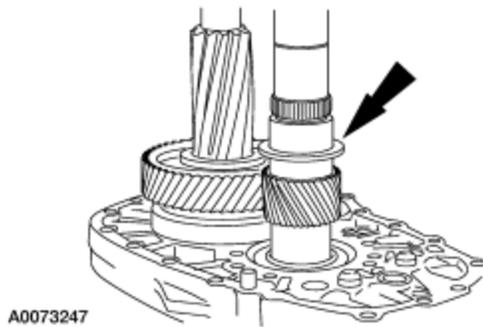


14. Install the countershaft rear thrust washer and a new snap ring.

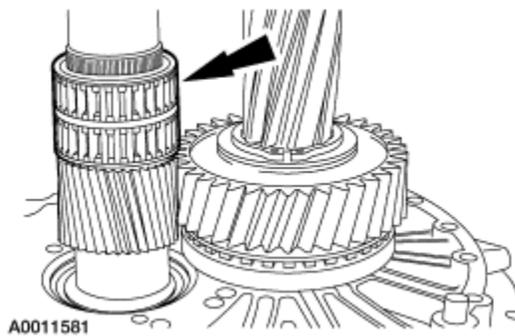
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.
- Install the snap ring with the small holes upward.
- Make sure the snap ring is completely seated, with one tab of the snap ring under the gear tooth.



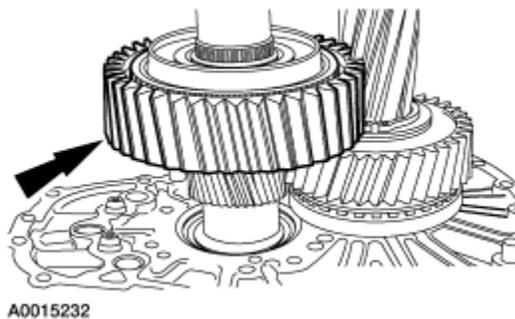
15. For vehicles equipped with a 6.0L engine, install the low gear thrust washer.



16. Install the two mainshaft low gear needle bearings.

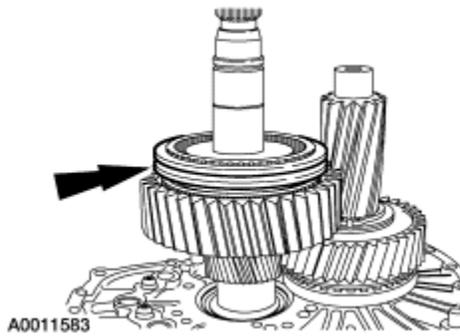


17. Install low gear.



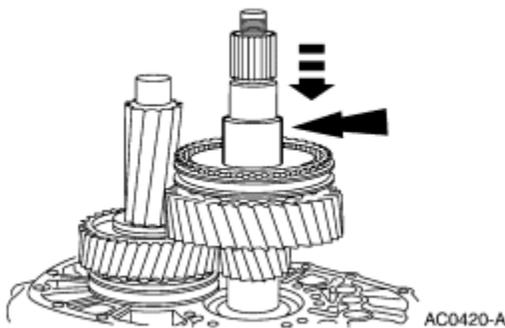
18. Install the low and reverse synchronizer assembly and synchronizer ring.

- Install the low/reverse gear synchronizer with the shoulder of the sliding sleeve facing down to the low gear.
- The low/reverse synchronizer body will slide into place and does not require heat to install.



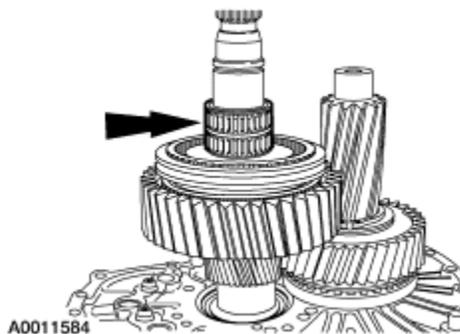
19.  **CAUTION:** To prevent damage, do not heat the reverse gear bushing higher than **150°C (300°F) maximum.**

Remove the mainshaft reverse gear bushing from the Gear/Bearing Heater, then install the mainshaft bushing.

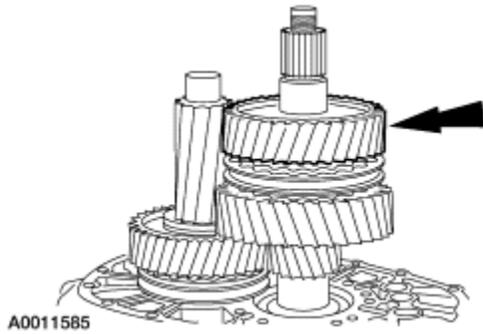


20. **NOTE:** Allow the mainshaft reverse gear bushing to cool for 2-4 minutes before installing mainshaft needle bearing.

Install the mainshaft needle bearing.

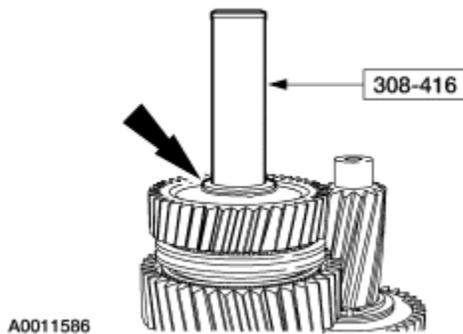


21. Install the reverse gear. Pull the synchronizer sliding sleeve into the neutral position.



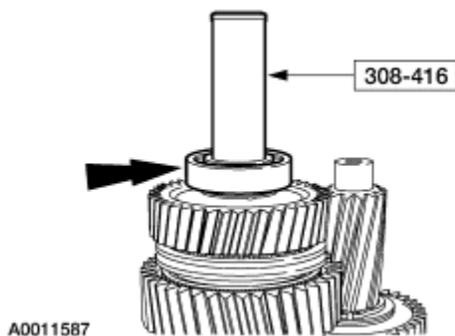
22. **⚠ CAUTION: To prevent damage, do not heat the output bearing thrust washer higher than 150°C (300°F) maximum.**

Remove the output bearing thrust washer from the Gear/Bearing Heater, then using the special tools, install the output bearing thrust washer.

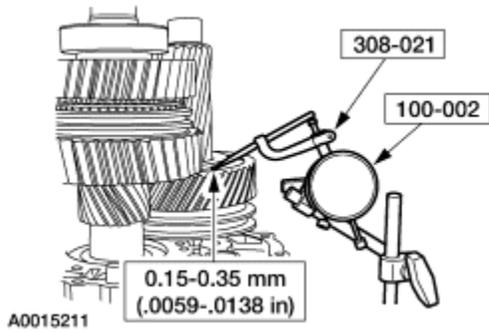


23. **⚠ CAUTION: To prevent damage, do not heat the rear mainshaft output bearing higher than 150°C (300°F) maximum.**

Remove the mainshaft output bearing from the Gear/Bearing Heater, then using the special tools, install the rear mainshaft output bearing.

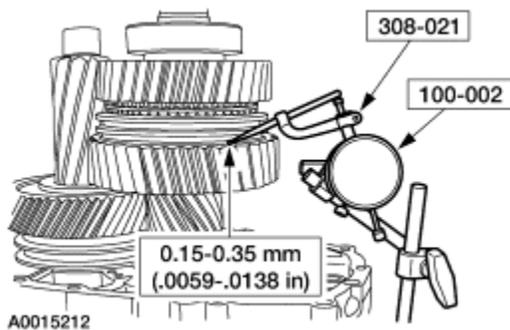


24. Using the Dial Indicator with Bracketry and the Clutch Housing Gauge, check the axial gear clearance at fifth gear.
- If not within specifications, disassemble and reinspect.



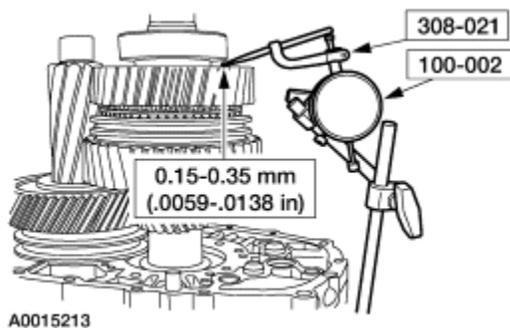
25. Using the Dial Indicator with Bracketry and the Clutch Housing Gauge, check the axial gear clearance at low gear.

- If not within specifications, disassemble and reinspect.



26. Using the Dial Indicator with Bracketry and the Clutch Housing Gauge, check the axial gear clearance at reverse gear.

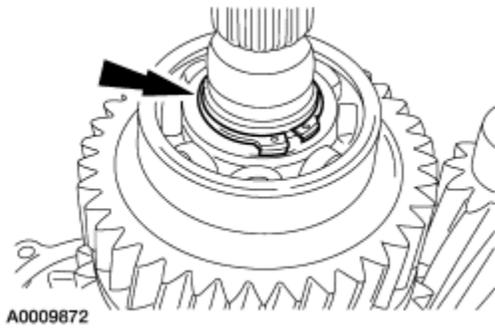
- If not within specifications, disassemble and reinspect.



27. **NOTE:** The snap ring is used on 4-wheel drive vehicles only.

Install a new snap ring.

- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.
- Install the snap ring with the small holes upward.



A0009872

28. **NOTE:** Using an oil stone or emery cloth, lightly condition the shift rails and clean them with transmission fluid before installing the shift forks and shift rails.

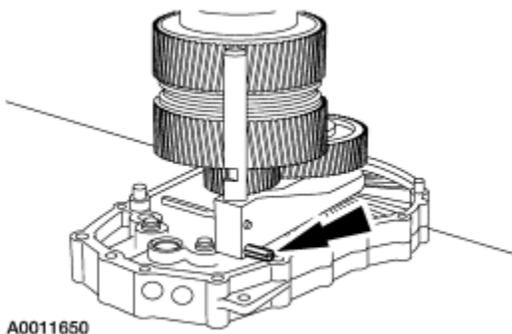
NOTE: Move the interlock plate into the fifth gear position.

Install the fifth gear shift fork and the shift rail.



A0011588

29. Using a 5 mm (3/16 in) punch, align the roll pin hole with the top hole of the shift fork.
- Do not hit the sealing surface of the intermediate plate.
 - Make sure the slot of the roll pin is facing away from the shift rail.

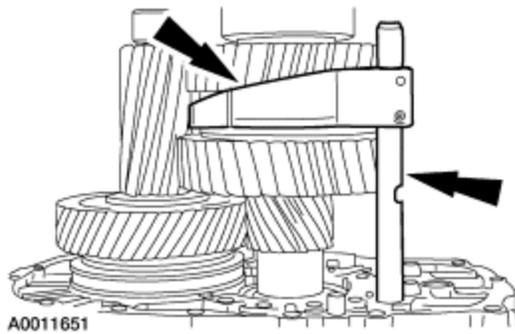


A0011650

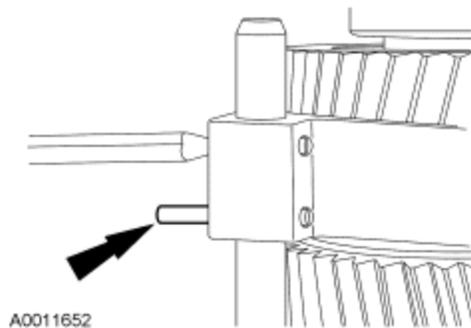
30. **NOTE:** Using an oil stone or emery cloth, lightly condition the shift rails and clean them with transmission fluid before installing the shift forks and rails.

NOTE: Move the interlock plate into the low/reverse position.

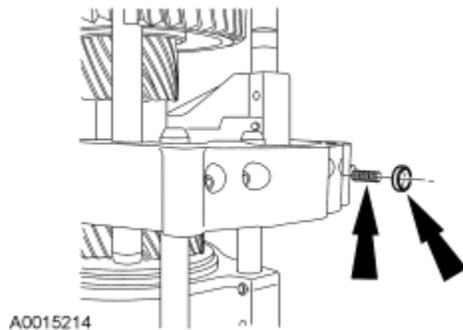
Install the low/reverse gear shift fork and the shift rail.



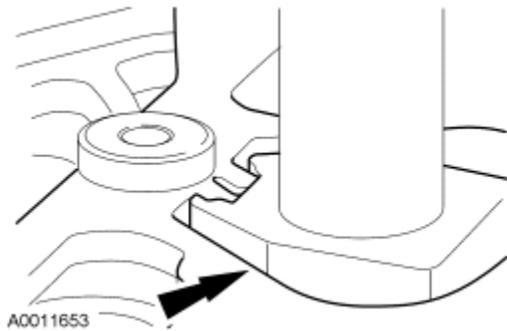
31. Using a 5 mm (3/16 in) punch, align the roll pin hole with the top hole of the shift fork.
- Install the double roll pin in the lower hole, then install a roll pin in the upper hole.
 - Make sure the slot of the roll pin is facing away from the shift rail.



32. Install the four shift detent springs and four new detent plugs.
- Apply gasket maker to the detent plugs before installing.

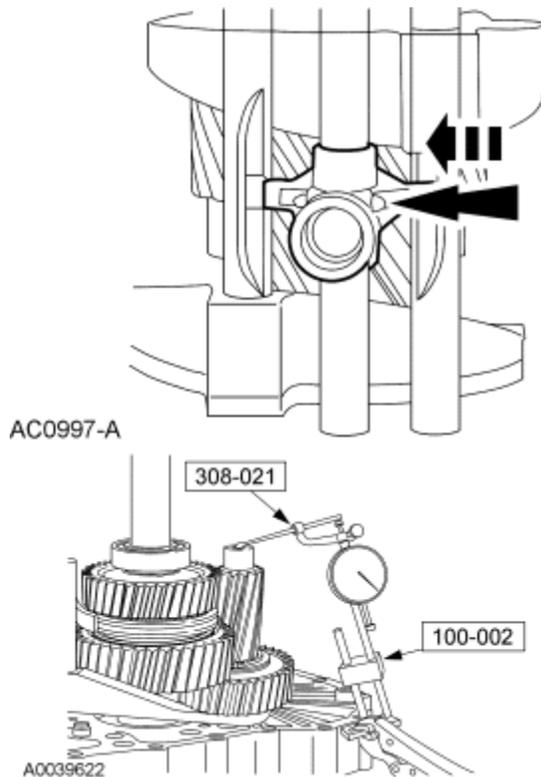


33. Install the main shift rail, aligning the center of the interlock driver with the center of the interlock plate.
- The part numbers on the main shift rail, shift position block and shift finger face the output side of the transmission. The roll pin groove on the main shift rail with the shorter distance from the end faces the output end.



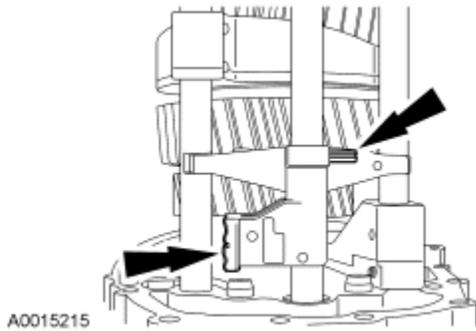
34. Install the lower shift finger and a new large roll pin, then install a new small roll pin.

- Make sure the lower shift finger cup is down.
- Install the large roll pin with the opening away from the gearset.
- Make sure the center of the interlock driver is aligned with the center of the interlock plate before installing the small pin.
- Install the small roll pin with the opening 180 degrees from the opening in the large roll pin. The roll pin should extend equally from both sides when properly installed.



35. Install the main shift rail driver and a new large roll pin, then install a new small roll pin.

- Install the large roll pin with the opening away from the gearset.
- Install the small roll pin with the opening 180 degrees from the opening in the large roll pin.



36. **NOTE:** Only install the bearing cups in the main case. The following bearing preload adjustment procedure will determine the thickness of the shim to be used.

NOTE: For vehicles equipped with gasoline engines, the transmission must be elevated, 50-101 mm (2-4 inches), to prevent damage to the input shaft.

Place the main case on the floor. Align the oil pump center shaft with the slot in the countershaft.

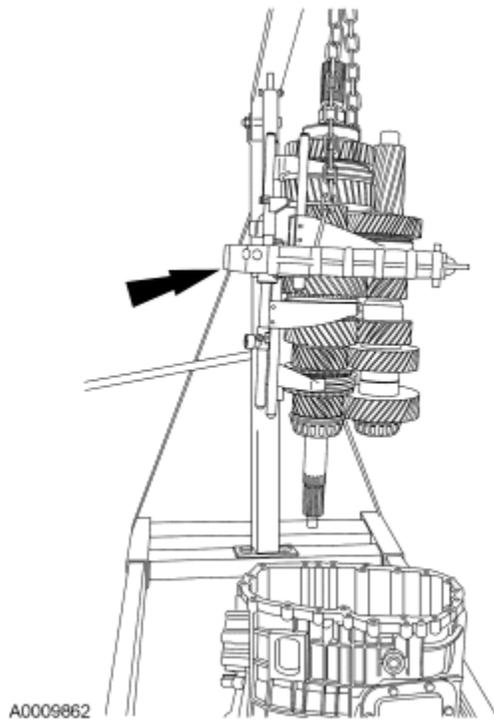
37. **NOTE:** Do not apply sealer at this time.

NOTE: Do not damage the input shaft when removing it from the Gear Pack Assembly Fixture.

NOTE: To aid installation, have an assistant lower the assembly while another guides the assembly into the main case.

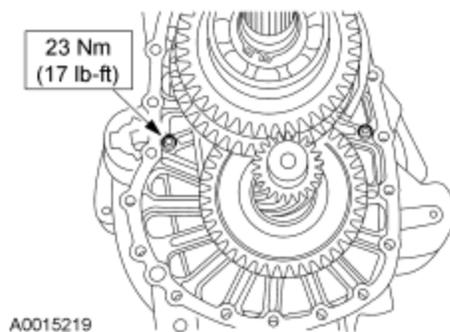
Using a suitable lifting device, a suitable chain and two S-hooks, lift the intermediate housing and gear assembly into the case.

- Using the index mark made on the countershaft, make sure the oil pump center shaft is aligned with the slot on the countershaft.
- Lightly tap the intermediate housing onto the transmission case.



38. Install the bolts.

- Early production vehicles will have three bolts.



39. Install the special tools to measure countershaft clearance.

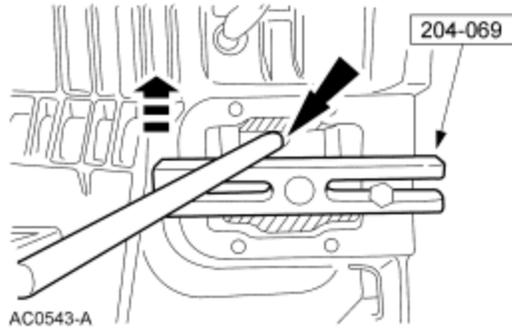
- Mount the indicator stand to the intermediate housing.
- Install the Dial Indicator Gauge. Make sure the indicator is off center on the end of the countershaft.
- Zero the dial indicator.

40. **NOTE:** The tool is installed on the PTO opening.

Using the special tool, measure for countershaft clearance.

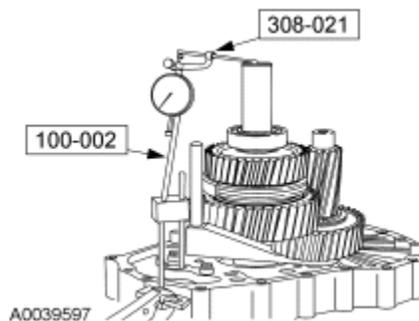
- Lift up on the third gear counter.
- Observe the dial indicator reading.
- Add preload specification 0.02 mm (0.00079 in) and 0.09 mm (0.0035 in) to the dial indicator reading to determine shim thickness range. Countershaft clearance + 0.02

mm (0.00079 in) Preload = Shim size. Countershaft clearance + 0.09 mm (0.0035 in)
Preload = Shim size.



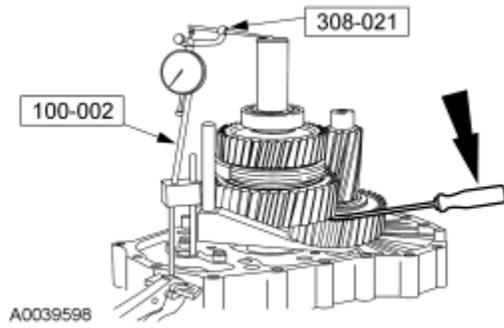
41. Install the special tools to measure mainshaft clearance.

- Mount the indicator stand to the intermediate housing.
- Install the Dial Indicator Gauge. Make sure the indicator is off center on the end of the mainshaft.
- Zero the dial indicator.

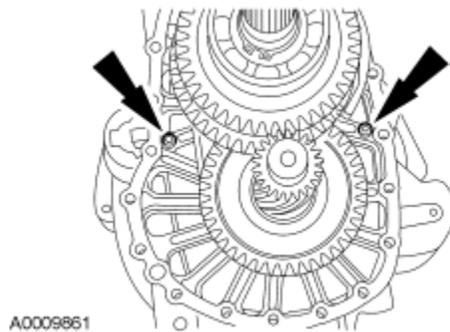


42. Lifting up on the mainshaft, measure the mainshaft clearance.

- Lift up on low gear.
- Observe the dial indicator reading.
- Add preload specification 0.02 mm (0.00079 in) and 0.09 mm (0.0035 in) to the dial indicator reading to determine shim thickness. Measure the thickness of the input shaft oil dam bearing ring at three places and subtract the highest dimension.
Mainshaft clearance (-) the thickness of the oil dam + 0.02 mm (0.00079 in) Preload = Shim size. Mainshaft clearance (-) the thickness of the oil dam + 0.09 mm (0.0035 in) Preload = Shim size.

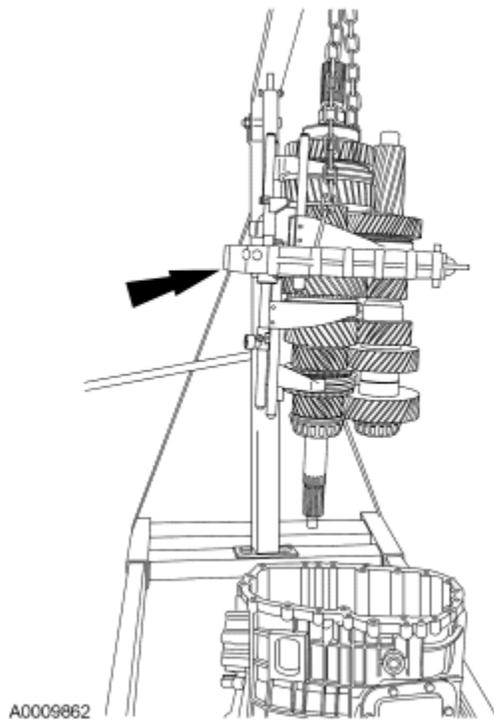


43. Remove the special tools, then remove the bolts.

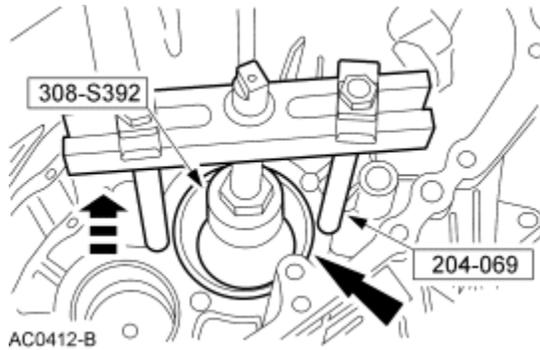


44. Using a suitable lifting device, a suitable chain and two S-hooks, lift the intermediate housing and gear assembly out of the case.

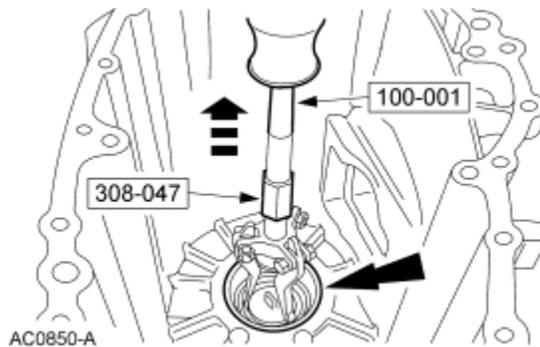
- Place the S-hooks in the area where the bolts were removed.



45. Using the special tools, remove the input shaft bearing cup.



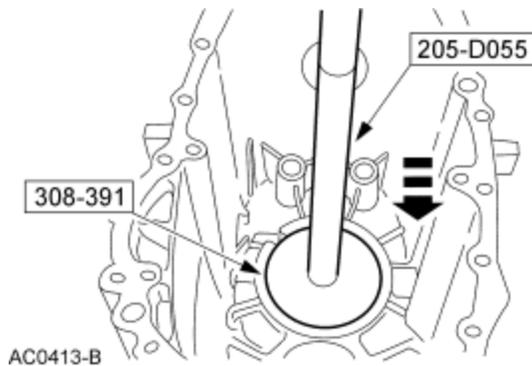
46. Using the special tools, remove the countershaft bearing cup.



47. **NOTE:** Use a Heat Gun on the case bearing cup area to aid installation.

Install the new shim, the new input shaft oil dam bearing ring and the oil trough into the bearing cup bore, then using the special tools, install the input shaft bearing cup.

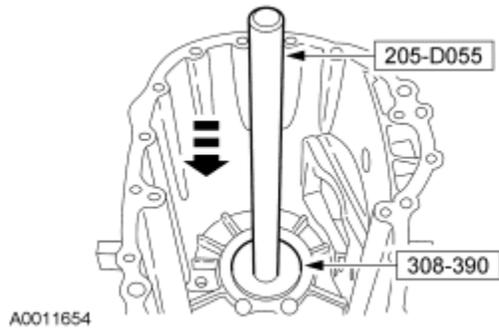
- Using the clearance measurement plus the preload, select the appropriate shim and input shaft oil dam bearing ring.



48. **NOTE:** Use a Heat Gun on the case bearing cup area to aid installation.

Install the new shim, then using the special tools, install the countershaft bearing cup.

- Using the clearance measurement plus the preload, select the appropriate shim.



49. **⚠ CAUTION:** Use an oil stone or sanding block to clean the intermediate plate and main case mating surfaces.

⚠ CAUTION: Do not use a silicone sealing compound.

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

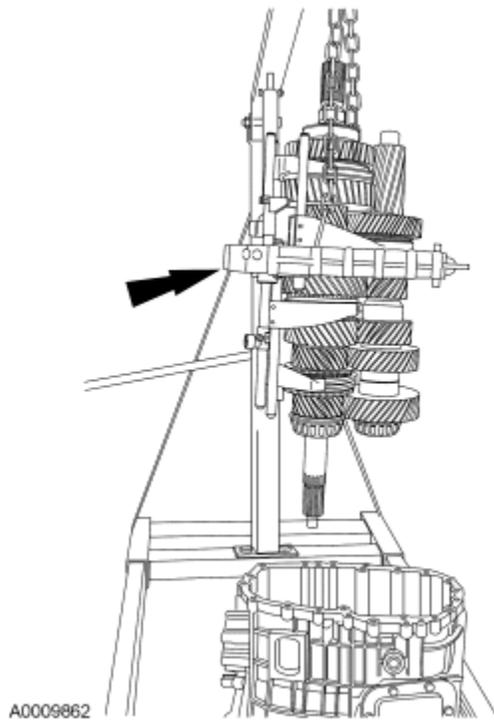
Thinly coat the rear sealing surface of the case and the front sealing surface of the intermediate housing with gasket maker.

50. **NOTE:** For vehicles equipped with gasoline engines, the transmission must be elevated, 50-101 mm (2-4 inches), to prevent damage to the input shaft.

NOTE: To aid installation, have an assistant lower the assembly while another guides the assembly into the case.

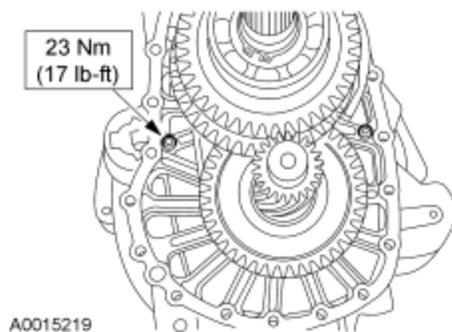
Install the intermediate housing and gear assembly into the case.

- Using the index mark made on the countershaft, make sure the oil pump center shaft is aligned with the slot on the countershaft.
- Lightly tap the intermediate housing onto the transmission case.



51. Install the bolts.

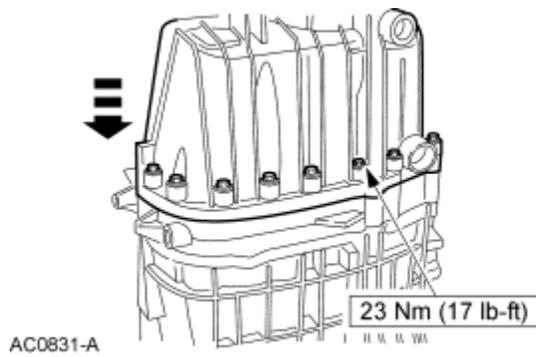
- Apply threadlock and sealer to the intermediate housing bolts.



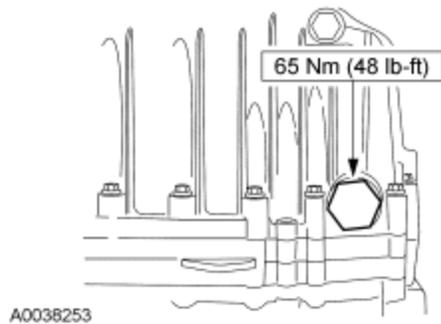
52.  **CAUTION: Do not use a silicone sealing compound.**

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

Thinly coat the rear sealing surface of the intermediate housing and the extension housing with gasket maker. Install the extension housing.

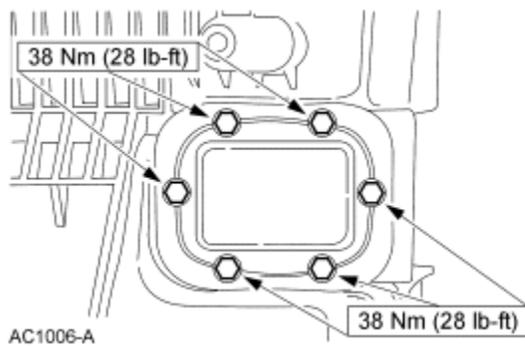


53. Apply threadlock and sealer to the threads of the main shift detent. Install the detent plunger and the main shift detent.

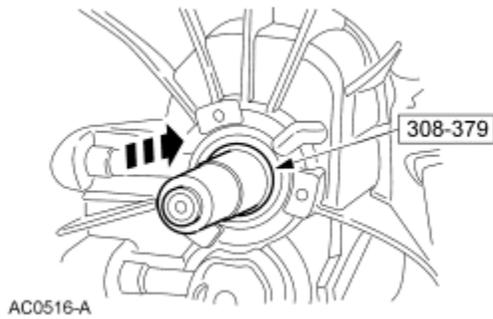


54. **NOTE:** Cross tighten the bolts.

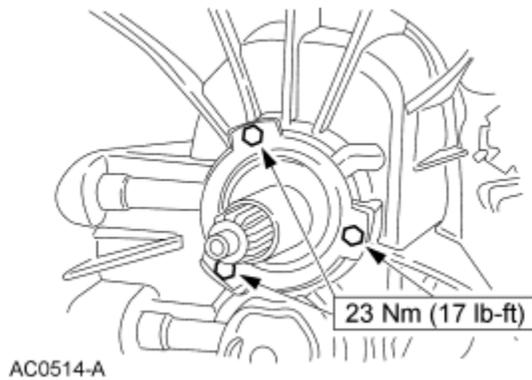
Apply threadlock and sealer to the threads of the PTO cover bolts. Install a new gasket and the PTO cover.



55. Using the special tool, install a new input oil seal.
- Coat the outer diameter of the new input oil seal with gasket and trim adhesive.
 - Coat the inner diameter of the new input oil seal with MERCON®.

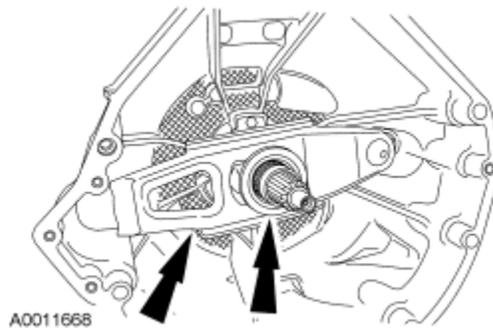


56. Apply threadlock and sealer to the threads of the guide tube bolts. Install the guide tube.

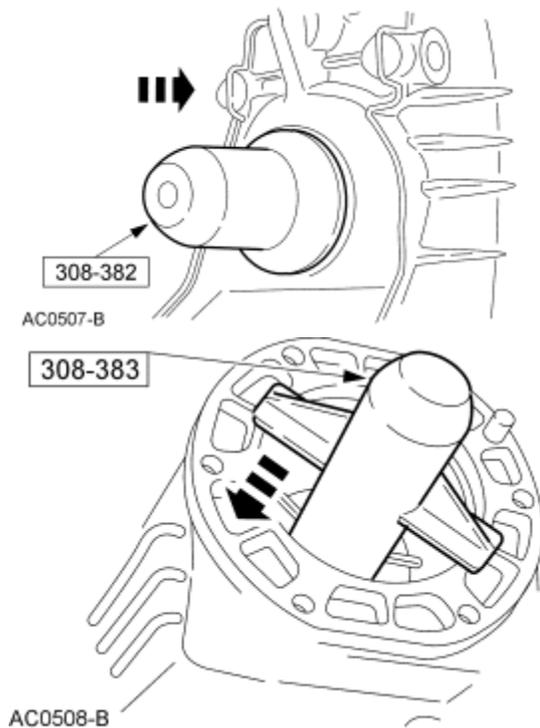


57. Install the release lever and clutch release hub and bearing.

- Lubricate the ball stud and the clutch release lever. Only apply grease where the clutch release lever comes in contact with the pivot and the release hub and bearing.

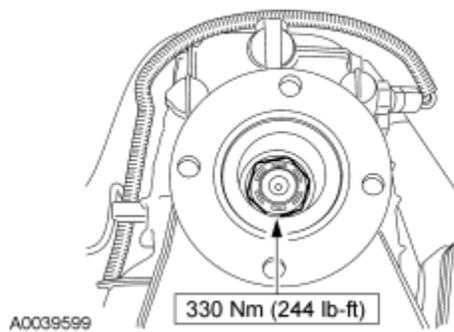


58. Coat the outer diameter of the new output oil seal with gasket and trim adhesive. Using the special tool, install a new output oil seal.



59. **NOTE:** This step is for 2-wheel drive vehicles only.

Apply Threadlock 262 to the threads of the transmission flange lock nut. Using the special tool, install the transmission flange and a new pinion flange lock nut.



60. Install the shifter.

- Shift the transmission through all gears to make sure gears shift correctly.

61. Check transmission preload. Shift the transmission into reverse and rotate the mainshaft.

- Drag torque should be 2-8 Nm.

62. Remove the shifter for installation.

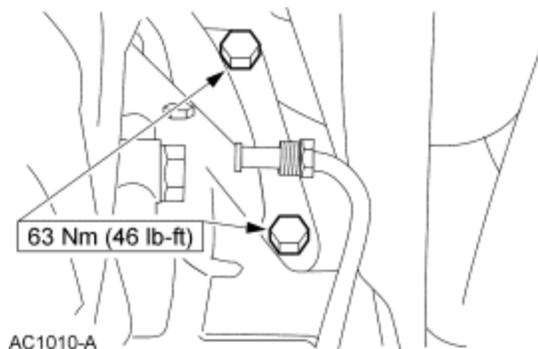
Transmission

Special Tool(s)	
	High Lift Transmission Jack 014-00942

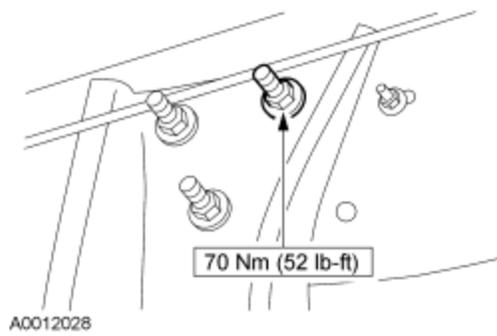
Material	
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (type II)

All vehicles

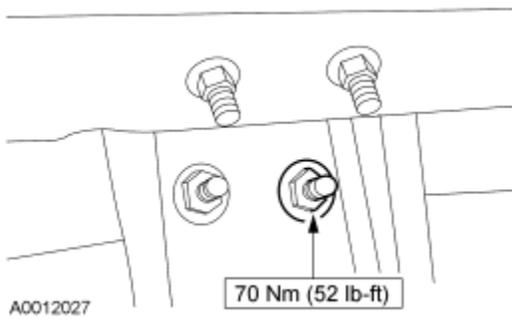
1. Using the transmission jack, raise and position the transmission to the engine and clutch.
2. Install the transmission-to-engine bolts.
 - For vehicles equipped with diesel engines, install six bolts.
 - For vehicles equipped with gasoline engines, install seven bolts.



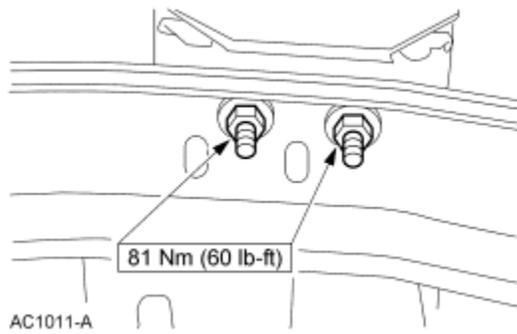
3. Install the LH crossmember bolts.



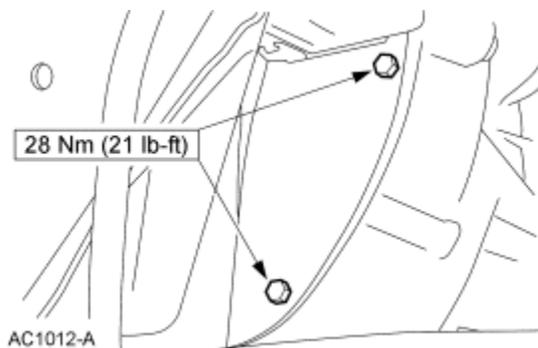
4. Install the RH crossmember nuts.

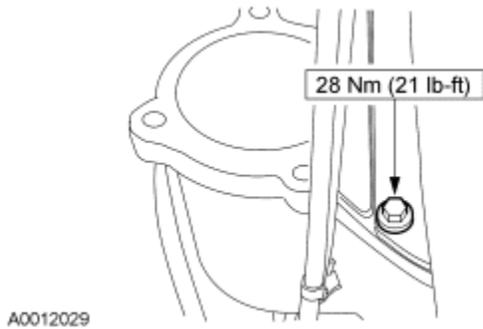


5. Install the transmission mount nuts.

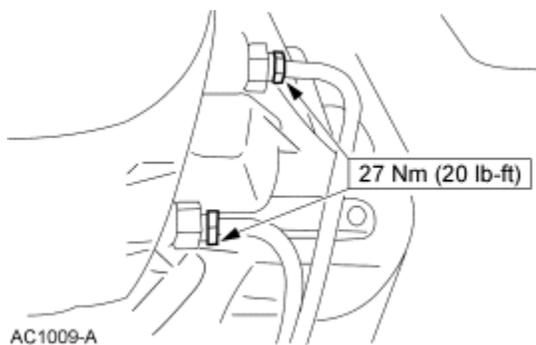


6. Install the engine plate bolts.

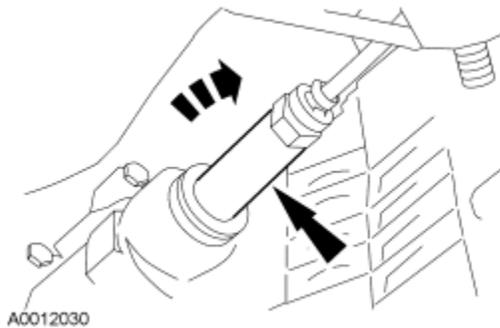




7. Remove the transmission jack.
8. Connect the transmission cooler tubes.

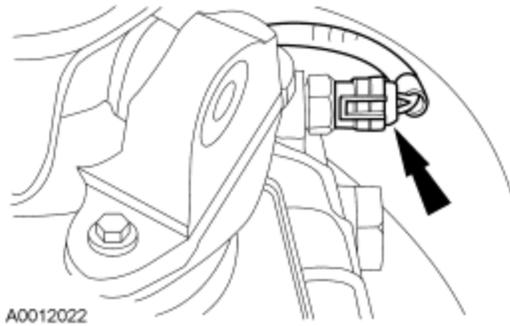


9. Install the clutch slave cylinder.
 - Rotate the clutch slave cylinder clockwise 45 degrees to lock in position.

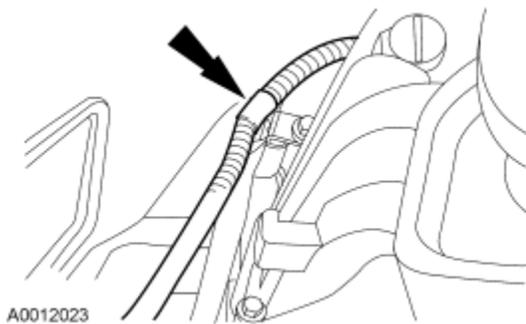


10. Install the starter. For additional information, refer to [Section 303-06B](#).
11. Install the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).
 - If the transfer case control lever assembly was removed from the transmission, it must be correctly aligned.
12. 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.

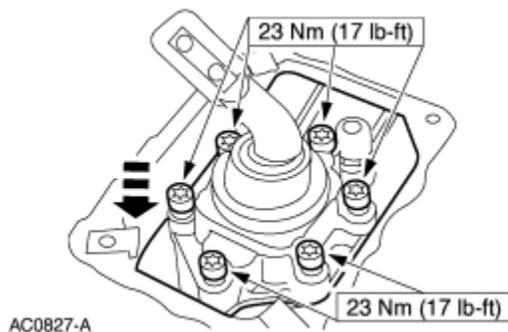
17. Lower the vehicle.

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

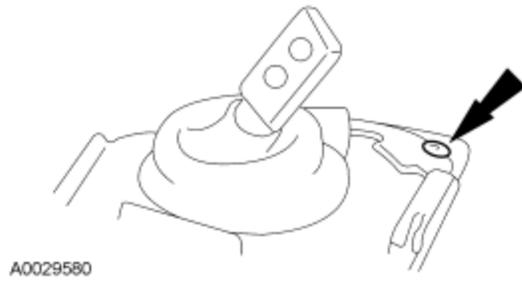
NOTE: Do not wait longer than ten minutes to tighten the six bolts due to the rapid cure time of the sealant.

Install the lower gearshift lever and shift housing assembly.

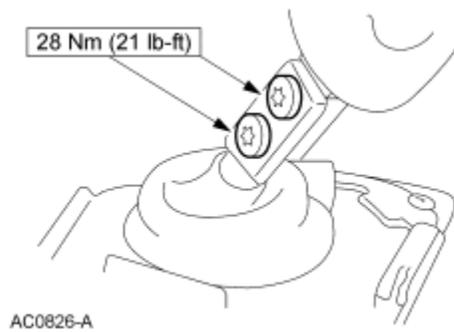
- Apply gasket maker to the shift housing and the main case.



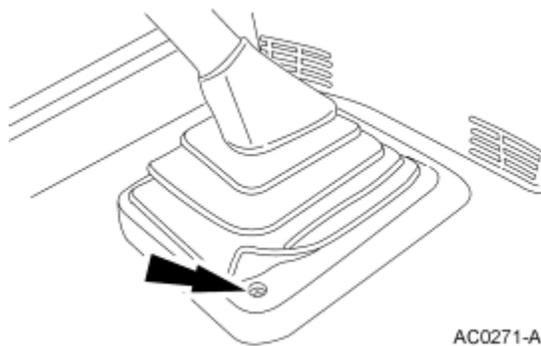
19. Install the lower shift lever boot.



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

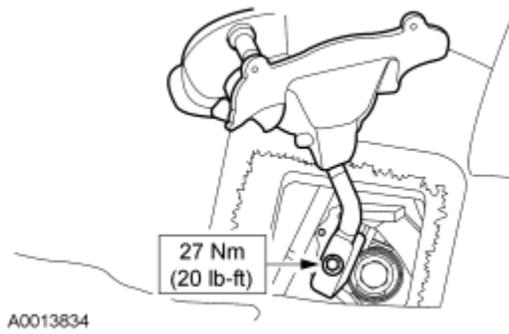


21. Install the screws.

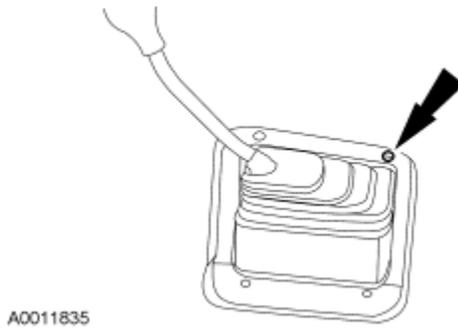


Vehicles with a manual shift lever

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.

**SECTION 308-07A:
Transfer Case — General Information**

DESCRIPTION AND OPERATION

[Transfer Case](#)

DIAGNOSIS AND TESTING

[Transfer Case—Manual Shift](#)

[Principles of Operation — Manual Shift](#)

[Symptom Chart — Manual Shift](#)

[Transfer Case—Electronic Shift on the Fly \(ESOF\)](#)

[Principles of Operation — Electronic Shift on the Fly](#)

[Inspection and Verification — Electronic Shift on the Fly \(ESOF\)](#)

[GEM Diagnostic Trouble Code \(DTC\) Index](#)

[GEM Parameter Identification \(PID\) Index](#)

[GEM Active Command Index](#)

[Symptom Chart — Electronic Shift on the Fly \(ESOF\)](#)

[Pinpoint Tests — Electronic Shift on the Fly \(ESOF\)](#)

[Component Test](#)

[Relay — Micro ISO](#)

SECTION 308-07A: Transfer Case — General
Information

1999 F-Super Duty 250-550 Workshop
Manual

DESCRIPTION AND OPERATION

[Procedure revision date: 01/26/2000](#)

Transfer Case

Refer to [Section 308-07B](#).

SECTION 308-07A: Transfer Case — General
Information

1999 F-Super Duty 250-550 Workshop
Manual

DIAGNOSIS AND TESTING

[Procedure revision date: 01/26/2000](#)

Transfer Case—Manual Shift

Principles of Operation — Manual Shift

Mechanical Shift System

The New Venture NV 271 is a manual shift, part time three piece transfer case. The case is aluminum. The unit is lubricated by a positive-displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft, and allows towing of the vehicle without disconnecting the rear driveshaft.

The input shaft, front output shaft, 4WD indicator switch, breather barb and shift lever are located on the front part of the case. The drain and fill plugs are located on the rear part of the case. The rear output shaft is located in the rear extension housing.

Mechanical Operation

In the 2WD mode, torque from the transmission is transferred to the front input shaft, which in turn drives the output shaft and fifth gear drive shaft that drives the rear axle.

The 2WD to 4X4 HIGH shift is accomplished when the 2WD to 4X4 HIGH shift fork moves the lockup collar to engage the drive sprocket to the rear output shaft. The drive sprocket turns the chain which turns the front output shaft driven sprocket on the front output shaft and the front driveshaft.

The 4X4 HIGH to 4X4 LOW shift is accomplished when the 4X4 HIGH to 4X4 LOW shift fork moves the shift collar to engage the planet carrier to the main shaft. Torque for the input shaft is then transmitted through the sun gear, which then turns the planets. The planets, which are now engaged to the output shaft, provides a reduction.

Neutral

With the shift selector in neutral, no power is transmitted to either the front or the rear. All the planetary gears turn freely with the input shaft, and the chain sprocket floats freely on the output and fifth gear drive shaft.

2-Wheel Drive

When 2WD is selected, the shift collar hub at the center of the front planet slides forward, putting the transfer case into the high speed range (direct drive). The input shaft and the rear output shaft are locked together. This results in direct drive, straight through to the rear drive shaft. In addition, the 4-wheel drive lockup collar is disengaged so none of the 4-wheel drive components turn.

4-Wheel Drive — 4X4 HIGH

In 4X4 HIGH, the front planet remains in the same position as it was in 2WD. The action of the shift lever causes the 4-wheel drive lockup hub to move rearward, locking the chain sprocket to the rear output shaft. This causes both the front and rear wheels to be driven in the high range.

4-Wheel Drive — 4X4 LOW

4X4 LOW allows for maximum pulling capacity. Shifting into 4X4 LOW causes the shift collar hub to move rearward and allows the front planet to lock to the output and fifth gear drive shaft. With the ring gear unable to turn, the planetary gears "walk" around the inside. The result is that the front planet now turns more slowly than the input shaft. Because the front planet is now locked to the output and fifth gear driveshaft, the output shaft now rotates at a slower speed than the input shaft. This action increases the pulling capacity available to the wheels.

Symptom Chart — Manual Shift

Symptom Chart — Manual Shift		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> Transfer Case Makes Noise 	<ul style="list-style-type: none"> Tire or wheel size. 	<ul style="list-style-type: none"> VERIFY all tires and wheels are the same size and tire pressure is correct.
	<ul style="list-style-type: none"> Excessive tire tread wear. 	<ul style="list-style-type: none"> CHECK tire tread wear to see if there is more than 0.06 inch difference in tread wear between front and rear. EXCHANGE one front and one rear wheel. RE-INFLATE tires to proper specifications.
	<ul style="list-style-type: none"> Internal components. 	<ul style="list-style-type: none"> CYCLE the transmission through all gear positions with the transfer case in 2WD and 4X4 HIGH. If there is noise in the neutral position or in some gears but not others, DIAGNOSE the transmission. If there is noise in all transmission gear positions, OPERATE the transfer case in all positions. If the noise is only present in 4X4 HIGH,

		<p>DISASSEMBLE the transfer case; REFER to Section 308-07B. CHECK the input gear, intermediate, and front output shaft gear for damage. REPAIR or REPLACE as required. If the noise is only present in 4X4 LOW, INSPECT the planet gears and sliding gears for damage. REPAIR or REPLACE as required.</p>
<ul style="list-style-type: none"> Transfer Case Jumps Out of Gear 	<ul style="list-style-type: none"> Shift linkage. 	<ul style="list-style-type: none"> CHECK shift linkage travel. ADJUST linkage to provide complete gear engagement. ADJUST gearshift lever boot.
	<ul style="list-style-type: none"> Loose mounting bolts. 	<ul style="list-style-type: none"> TIGHTEN mounting bolts.
	<ul style="list-style-type: none"> Front and rear driveshaft slip yokes. 	<ul style="list-style-type: none"> LUBRICATE and REPAIR slip yoke as required. TIGHTEN flange yoke attaching nuts to specifications.
	<ul style="list-style-type: none"> Internal components. 	<ul style="list-style-type: none"> DISASSEMBLE the transfer case; REFER to Section 308-07B. INSPECT the sliding clutch hub and gear clutch teeth. REPAIR or REPLACE as required.
<ul style="list-style-type: none"> Locking Hubs Will Not Release 	<ul style="list-style-type: none"> Driveline/vehicle torsional lockup. 	<ul style="list-style-type: none"> DRIVE vehicle in reverse for 10 feet.
	<ul style="list-style-type: none"> Cold ambient temperatures. 	<ul style="list-style-type: none"> DRIVE vehicle for 16 km (10 mi) to warm the axle; then ATTEMPT to disengage the hub locks.

<ul style="list-style-type: none"> • Driveline/Torsional Windup (Vehicle Hop, Wheel/Tire Bounce, Vehicle Skip) 	<ul style="list-style-type: none"> • Tire inflation pressure. • Tire and wheel size. 	<ul style="list-style-type: none"> • VERIFY all tires and wheels are the correct size and that inflation pressures are correct.
<ul style="list-style-type: none"> • Delayed Shifts to 2WD 	<ul style="list-style-type: none"> • Driveline/torsional windup. 	<ul style="list-style-type: none"> • PLACE the transmission in neutral. RAISE and SUPPORT the vehicle; REFER to Section 100-02. Torsional windup will be released when the wheels are free to rotate and transfer case will complete the shift.
	<ul style="list-style-type: none"> • Cold ambient temperatures. 	<ul style="list-style-type: none"> • DRIVE vehicle for 16 km (10 mi) to warm the axle; then ATTEMPT to disengage the hub locks.
<ul style="list-style-type: none"> • Buzz/Rattle Noise in Transfer Case Shift Lever When the Engine Is Above 1500 RPM 	<ul style="list-style-type: none"> • Powertrain vibration transferred to shift lever. 	<ul style="list-style-type: none"> • CHECK attaching nuts and bolts. TIGHTEN to proper specifications. If buzz/rattle still persists, REMOVE the transfer case shift lever. CHECK the vehicle for buzz/rattle noise with shifter removed. If buzz/rattle persists, CHECK elsewhere for the source of noise. If buzz/rattle is no longer present, REPLACE the transfer case shift lever and control rod connecting the shifter to the transfer case.

Transfer Case—Electronic Shift on the Fly (ESOF)

Refer to Wiring Diagrams Cell 34 ([F-53 Motorhome Chassis](#), [F-Super Duty 250-550](#)), Electric Shift Control for schematic and connector information.

Refer to Wiring Diagrams Cell 59 ([F-53 Motorhome Chassis](#), [F-Super Duty 250-550](#)), Generic Electronic Module for schematic and connector information.

Special Tool(s)	
 ST1137-A	73 Digital Multimeter 105-R0051 or equivalent
 ST1217-A	New Generation STAR (NGS) Tester 418-F048 (007-00500) or equivalent
 ST1176-A	Vacuum Pump 014-R1054 or equivalent

Principles of Operation — Electronic Shift on the Fly

Transfer Case — Electronic Shift on the Fly

The four-wheel drive electronic shift on the fly feature electrically shifts the vehicle transfer case between 2WD, 4X4 HIGH, and 4X4 LOW. The system mode is selected by the operator through a three-position rotary switch on the instrument panel. The operator is informed which mode the system is in by two cluster indicator lamps, one for 4WD HIGH, and one for 4WD LOW (in 4WD LOW, both the lamps are on). Shifts into 4X4 HIGH can be made at any speed. When shifting into or out of LOW range, the generic electronic module (GEM) requires that the vehicle speed be less than 5 km/h (3 mph), the brake applied, and the transmission in NEUTRAL (A/T) or the clutch pedal

be depressed (M/T). (The digital transmission range (TR) sensor informs the GEM when the transmission is in the NEUTRAL range position.)

The electronic shift motor is mounted externally on the transfer case. It drives a rotary cam which moves the mode fork and the range fork within the transfer case between the 4X4 HIGH, 4X4 LOW, and 2WD range positions.

The 4X4 shift motor uses two relays which, under control of the GEM, shift the transfer case shift motor between 4X4 HIGH, 4X4 LOW, and 2WD modes.

The GEM accomplishes shifts system modes by interpreting inputs from:

- 4X4 selector switch.
- Vehicle speed signal (transmitted from the ABS system).
- Transfer case.
- Brake switch.
- Digital transmission range (TR) sensor (automatic transmission).
- Clutch pedal position switch (manual transmission).
- Ignition switch.

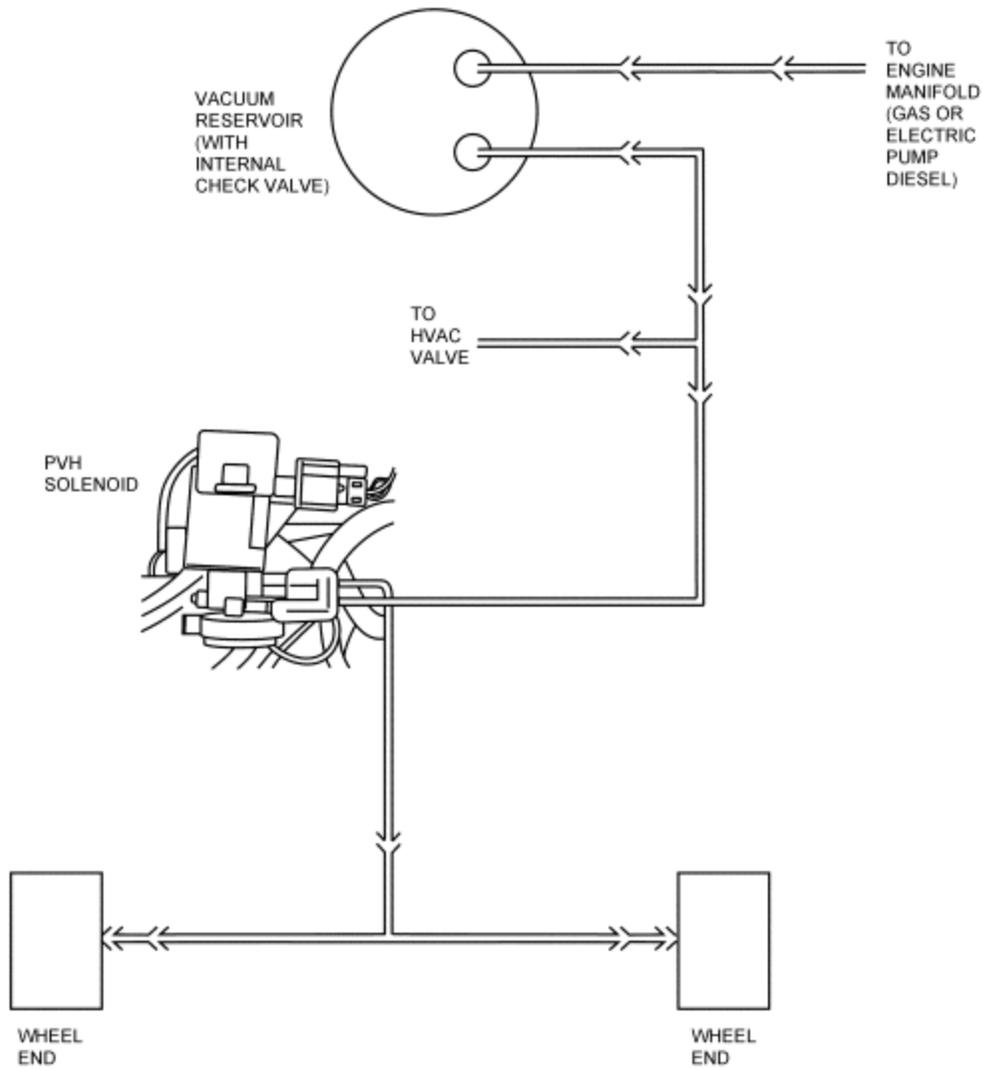
Based on these inputs, the GEM controls the shifts into 2WD, 4X4 HIGH, or 4X4 LOW with the following outputs:

- Low to high relay.
- High to low relay.
- Vacuum hub lock solenoid.
- Transfer case shift motor.

The ESOF system has a feature which allows the driver to override the vacuum operated hubs. When the front hubs are manually turned to the LOCK position, the hubs are locked at all times, overriding the vacuum operated system. If the front hubs are manually turned to the AUTO FREE position, the hubs can only be locked by turning the 4WD mode switch to one of the 4WD positions.

If the front hubs are unable to be unlocked by use of the 4WD mode switch, the hubs may be unlocked by turning the manual locking hub from the AUTO FREE position to the LOCK position and back to AUTO FREE.

Electrical Shift on the Fly (ESOF) Vacuum Schematic



GC1828-B

Inspection and Verification — Electronic Shift on the Fly (ESOF)

1. Verify the customer concern by operating the 2WD/4WD engagement.
2. Visually inspect for the following obvious signs of mechanical and electrical damage.

Visual Inspection Chart	
Mechanical	Electrical
<ul style="list-style-type: none"> • Switch(es) • Transfer case • Hub • Front driveshaft 	<ul style="list-style-type: none"> • Generic electronic module (GEM) • Fuse(s) • PVH solenoid • Damaged wiring harness

<ul style="list-style-type: none"> • Vacuum lines 	<ul style="list-style-type: none"> • Loose or corroded connector(s) • Relay(s) • Circuitry
--	---

3. If the concern remains after the inspection, connect the New Generation STAR (NGS) Tester to the data link connector (DLC) located beneath the instrument panel and select the vehicle to be tested from the NGS menu. If the NGS does not communicate with the vehicle:

- check that the program card is properly installed.
- check the connections to the vehicle.
- check the ignition switch position.

4. If the NGS still does not communicate with the vehicle, refer to the New Generation STAR Tester manual.

5. Perform the DATA LINK DIAGNOSTIC TEST. If the NGS responds with:

- CKT914, CKT915 or CKT70 = ALL ECUS NO RESP/NOT EQUIP, refer to [Section 418-00](#).
- NO RESP/NOT EQUIP for GEM, go to Pinpoint Test E.
- **NOTE:** For vehicles built prior to February 5, 1998, the following criteria must be met when performing the GEM On-Demand Self-Test: headlamps and parklamps must be off and the power windows must be completely up. Failure to meet this criteria will result in DTCs B1577 and B2357 being set. For vehicles built after February 5, 1998, the following criteria must be met when performing the GEM On-Demand Self-Test: headlamps and parklamps must be on. Failure to meet this criteria will result in DTC B1575 being set.

SYSTEM PASSED, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the continuous DTCs and perform self-test diagnostics for the GEM.

6. If the DTCs retrieved are related to the concern, go to the GEM Diagnostic Trouble Code (DTC) Index to continue diagnostics.

7. If no DTCs related to the concern are retrieved, proceed to Symptom Chart to continue diagnostics.

GEM Diagnostic Trouble Code (DTC) Index

GEM Diagnostic Trouble Code (DTC) Index			
DTC	Description	DTC Caused By	Action
B1217	Horn Relay Coil Circuit	GEM	REFER to Section 501-14B .

	Failure		
B1218	Horn Relay Coil Circuit Short to Battery	GEM	REFER to Section 501-14B.
B1243	Express Window Down Switch Circuit Short to Battery	GEM	REFER to Section 501-11.
B1300	Power Door Lock Circuit Failure	GEM	REFER to Section 501-14B.
B1302	Accessory Delay Relay Coil Circuit Failure	GEM	REFER to Section 501-11.
B1304	Accessory Delay Relay Coil Circuit Short to Battery	GEM	REFER to Section 501-11.
B1310	Power Door Unlock Circuit Failure	GEM	REFER to Section 501-14B.
B1317	Battery Voltage High	GEM	REFER to Section 414-00.
B1318	Battery Voltage Low	GEM	REFER to Section 414-00.
B1322	Driver Door Ajar Circuit Short to Ground	GEM	REFER to Section 417-02.
B1323	Door Ajar Lamp Circuit Failure	GEM	REFER to Section 413-01.
B1325	Door Ajar Lamp Circuit Short to Battery	GEM	REFER to Section 413-01.
B1330	Passenger Door Ajar Circuit Short to Ground	GEM	REFER to Section 417-02.
B1338	Door Ajar RR Circuit Short to Ground	GEM	REFER to Section 417-02.
B1340	Chime Input Request Circuit Short to Ground	GEM	REFER to Section 413-09.
B1342	ECU is Defective, RAM/ROM Checksum Failure	GEM	CLEAR the DTCs. RETRIEVE the DTCs. If DTC B1342 is retrieved, REPLACE the GEM. REFER to Section 419-10. TEST the system for normal operation.
B1352	Ignition Key-In Circuit Failure	GEM	REFER to Section 413-09.
B1355	Ignition Run Circuit Failure	GEM	REFER to Section 211-05.
B1359	Ignition Run/ACC Circuit Failure	GEM	REFER to Section 211-05.
B1366	Ignition Start Circuit Short to Ground	GEM	REFER to Section 211-05.
B1371	Illuminated Entry Relay	GEM	REFER to Section 417-02.

	Circuit Failure		
B1373	Illuminated Entry Relay Short to Battery	GEM	REFER to Section 417-02.
B1396	Power Door Lock Circuit Short to Battery	GEM	REFER to Section 501-14B.
B1397	Power Door Unlock Circuit Short to Battery	GEM	REFER to Section 501-14B.
B1398	Driver Power Window One Touch Window Relay Circuit Failure	GEM	REFER to Section 501-11.
B1400	Driver Power Window One Touch Relay Circuit Short to Battery	GEM	REFER to Section 501-11.
B1405	Driver Power Window Down Circuit Short to Battery	GEM	REFER to Section 501-11.
B1410	Driver Power Window Motor Circuit Failure	GEM	REFER to Section 501-11.
B1426	Lamp Seat Belt Circuit Short to Battery	GEM	REFER to Section 413-01.
B1428	Lamp Seat Belt Circuit Failure	GEM	REFER to Section 413-01.
B1431	Wiper Brake/Run Relay Circuit Failure	GEM	REFER to Section 501-16.
B1432	Wiper Brake/Run Relay Circuit Short to Battery	GEM	REFER to Section 501-16.
B1434	Wiper Hi/Low Speed Relay Coil Circuit Failure	GEM	REFER to Section 501-16.
B1436	Wiper Hi/Low Speed Relay Coil Circuit Short to Battery	GEM	REFER to Section 501-16.
B1438	Wiper Mode Select Switch Circuit Failure	GEM	REFER to Section 501-16.
B1441	Wiper Mode Select Switch Circuit Short to Ground	GEM	REFER to Section 501-16.
B1446	Wiper Park Sense Circuit Failure	GEM	REFER to Section 501-16.
B1450	Wiper Wash/Delay Switch Circuit Failure	GEM	REFER to Section 501-16.
B1453	Wiper Wash/Delay Switch Circuit Short to Ground	GEM	REFER to Section 501-16.

B1458	Wiper Washer Pump Motor Relay Circuit Failure	GEM	REFER to Section 501-16 .
B1460	Wiper Washer Pump Motor Relay Coil Circuit Short to Battery	GEM	REFER to Section 501-16 .
B1462	Seat Belt Switch Circuit Failure	GEM	REFER to Section 413-09 .
B1473	Wiper Low Speed Circuit Motor Failure	GEM	REFER to Section 501-16 .
B1475	Accessory Delay Relay Contact Short to Battery	GEM	REFER to Section 501-11 .
B1476	Wiper High Speed Circuit Motor Failure	GEM	REFER to Section 501-16 .
B1483	Brake Pedal Input Circuit Failure	GEM	GO to Pinpoint Test B .
B1485	Brake Pedal Input Battery Short	GEM	GO to Pinpoint Test B .
B1574	Door Ajar LR Circuit Short to Ground	GEM	REFER to Section 417-02 .
B1577	Lamp Park Input Circuit Short to Battery	GEM	REFER to Section 413-09 .
B1840	Wiper Front Power Circuit Failure	GEM	REFER to Section 501-16 .
B1982	Driver Door Unlock Relay Circuit Failure	GEM	REFER to Section 501-14B .
B1983	Driver Door Unlock Relay Circuit Short to Battery	GEM	REFER to Section 501-14B .
B2132	Dimmer Switch Circuit Short to Ground	GEM	REFER to Section 417-02 .
B2141	NVM Configuration Failure	GEM	CHECK the module configuration. REFER to the NGS Ford Service Function (FSF) card to verify proper module configuration. CLEAR the DTCs. RETRIEVE the DTCs. If DTC B2141 is still present, REPLACE the GEM. REFER to Section 419-10 . TEST the system for normal operation.
B2357	Driver Window Down Current Sense Low Circuit Failure	GEM	REFER to Section 501-11 .
B2425	Remote Keyless Entry Out of Synchronization	GEM	REFER to Section 501-14B .
C1125	Brake Fluid Level Sensor Input Circuit Failure	GEM	REFER to Section 413-01 .

C1182	Park Lamp Flash Relay Circuit Failure	GEM	REFER to Section 501-14B.
C1183	Park Lamp Flash Relay Circuit Short to Battery	GEM	REFER to Section 501-14B.
C1189	Brake Fluid Level Sensor Input Circuit Short to Ground	GEM	REFER to Section 413-01.
C1223	Lamp Brake Warning Output Circuit Failure	GEM	REFER to Section 413-01.
C1225	Lamp Brake Warning Output Circuit Short to Battery	GEM	REFER to Section 413-01.
C1230	Speed Wheel Sensor Rear Center Input Circuit Failure	GEM	REFER to Section 413-01.
C1446	Brake Switch Circuit Failure	GEM	REFER to Section 413-01.
C1728	Transfer Case Unable to Transition Between 2H and 4H	GEM	GO to Pinpoint Test A.
C1729	Transfer Case Unable to Transition Between 4H and 4L	GEM	GO to Pinpoint Test A.
C1751	Vehicle Speed Sensor Number 1 Output Circuit Short to Battery	GEM	REFER to Section 310-03.
C1752	Vehicle Speed Sensor Number 1 Output Circuit Short to Ground	GEM	REFER to Section 310-03.
P0500	Vehicle Speed Sensor (VSS) Malfunction	GEM	GO to Pinpoint Test B.
P1804	Transmission 4-Wheel Drive High Indicator Circuit Failure	GEM	GO to Pinpoint Test D.
P1806	Transmission 4-Wheel Drive High Indicator Short Circuit to Battery	GEM	GO to Pinpoint Test D.
P1808	Transmission 4-Wheel Drive Low Indicator Circuit Failure	GEM	GO to Pinpoint Test D.
P1810	Transmission 4-Wheel Drive Low Indicator Short Circuit to Battery	GEM	GO to Pinpoint Test D.

P1812	Transmission 4-Wheel Drive Mode Select Circuit Failure	GEM	GO to Pinpoint Test A.
P1815	Transmission 4-Wheel Drive Mode Select Short Circuit to Ground	GEM	GO to Pinpoint Test A.
P1819	Transmission Neutral Safety Switch Short Circuit to Ground	GEM	GO to Pinpoint Test B.
P1820	Transmission Transfer Case Clockwise Shift Relay Coil Circuit Failure	GEM	GO to Pinpoint Test A.
P1822	Transmission Transfer Case Clockwise Shift Relay Coil Short to Battery	GEM	GO to Pinpoint Test A.
P1828	Transfer Case Counterclockwise Shift Relay Coil Circuit Failure	GEM	GO to Pinpoint Test A.
P1830	Transmission Transfer Case Counterclockwise Shift Relay Coil Short Circuit to Battery	GEM	GO to Pinpoint Test A.
P1832	Transmission Transfer Case Differential Lockup Solenoid Circuit Failure	GEM	GO to Pinpoint Test C.
P1834	Transmission Transfer Case Differential Lockup Solenoid Short Circuit to Battery	GEM	GO to Pinpoint Test C.
P1838	Transmission Transfer Case Shift Motor Circuit Failure	GEM	GO to Pinpoint Test A.
P1865	Transmission Transfer Case Contact Plate Power Short to Ground	GEM	GO to Pinpoint Test A.
P1866	Transmission Transfer Case System Concern — Servicing Required	GEM	GO to Pinpoint Test A.
P1867	Transmission Transfer Case Contact Plate General Circuit Failure	GEM	GO to Pinpoint Test A.
P1876	Transmission Transfer Case 2-Wheel Drive	GEM	GO to Pinpoint Test C.

	Solenoid Circuit Failure		
P1877	Transmission Transfer Case 2-Wheel Drive Solenoid Circuit Short to Battery	GEM	GO to Pinpoint Test C.

GEM Parameter Identification (PID) Index

GEM Parameter Identification (PID) Index		
PID	Description	Expected Values
ACCDLY	Accessory Delay Relay Circuit	ON, OFF
BOO_GEM	Brake Input Switch Status	ON, OFF
CLTCHSW	Transmission Clutch Interlock Switch	notEGD, ENGAGD
D_DN_SW	Driver Window Down Switch	OFF, DOWN
D_PWRLY	Driver Power Window Status	ON---, OFF---
D_PWAMP	Driver Power Window Motor Current	0.25 to 63.75 amps
DRAJR_L	Door Ajar Warning Lamp Status	ON---, OFF---
D_DR_SW	Left External Access Ajar Switch Status	CLOSED, AJAR
D_SBELT	Driver Seat Belt Status	IN, OUT
IGN_GEM	Ignition Switch Status	START, RUN, OFF, ACCY
IGN_KEY	Ignition Key In/Out	IN, OUT
MTR_CCW	Transmission Transfer Counter CW Motor Output	ON---, OFF---
MTR_CW	Transmission Transfer Clockwise Motor Output	ON---, OFF---
NTRL_SW	Neutral Safety Switch Input	NTRL, notNTRL
OTD_SW	Left Front Power Window One Touch Down Status	OFF, DOWN
P_DR_SW	Right External Access Ajar Switch Status	CLOSED, AJAR
RRDR_SW	Right Rear Door Ajar Switch	CLOSED, AJAR
LRDR_SW	Left Rear Door Ajar Switch	CLOSED, AJAR
PRK_BRK	Park Brake Switch Status	ON, OFF
BRKLAMP	Brake Warning Lamp Status	ON---, OFF---
FLUID_1	Brake Fluid Level Switch #1 Status	ON, OFF
FLUID_2	Brake Fluid Level Switch #2 Status	ON, OFF

PLATE_A	Transmission Transfer Case Contact Plate A	OPEN, CLOSED
PLATE_B	Transmission Transfer Case Contact Plate B	OPEN, CLOSED
PLATE_C	Transmission Transfer Case Contact Plate C	OPEN, CLOSED
PLATE_D	Transmission Transfer Case Contact Plate D	OPEN, CLOSED
PLATEPW	Transmission Transfer Case Contact Plate Pull	ON---, OFF---
SBLTLMP	Seat Belt Lamp Circuit	ON---, OFF---
VBATGEM	Battery Voltage	0.0 VDC-25.5 VDC
VSS_GEM	Vehicle Speed Input	0-255 MPH
WASH_SW	Washer Pump Switch	ON, OFF
WPHISP	Windshield Wiper HI/LO Speed Relay	ON---, OFF---
WPMODE	Windshield Wiper Control Mode Select	WASH, OPEN, OFF, INTVL 1-7, LOW, HIGH
WPRUN	Wiper Motor Run Relay Driver State	ON---, OFF---
2WDSOL	2WD Hub Lock Solenoid Output Status	ON---, OFF---
4WDHIGH	4WD High Output State	ON---, OFF---
4WDLOW	4WD Low Output State	ON---, OFF---
4WD_SW	4WD Input Switch Status	2WD, 4WD LOW, 4WD HIGH, OPEN, GSHORT
4WDSOL	4WD Hub Lock Solenoid Output Status	ON---, OFF---
IPCHIME	External Chime Request	ON, OFF
PARK_SW	Exterior Lamp Control Input Park Lamps Switch Status	ON, OFF
HDL_DIM	Headlamp Dimmer Switch	ON---, OFF---
PRKFRLY	Park Lamp Flash Relay	ON, OFF
HORNRLY	Horn Control Relay Output Status	ON---, OFF---
DR_UNLK	All Doors Unlock Output Status	ON---, OFF---
DD_UNLK	Driver Door Unlock Output Status	ON---, OFF---
ALL_RLY	All Door Lock Output Status	ON, OFF
INTLMP	Illuminated Entry Relay Circuit	ON---, OFF---
CCNTGEM	Number of Continuous DTCs In GEM	One count per bit

GEM Active Command Index

GEM Active Command		
Active Command	Display	Action

FRONT WINDSHIELD WIPER	WIPER RLY	ON, OFF
FRONT WINDSHIELD WIPER	SPEED RLY	ON, OFF
FRONT WINDSHIELD WIPER	WASH RLY	ON, OFF
WARNING LAMPS AND CHIME	SBLT LAMP	ON, OFF
WARNING LAMPS AND CHIME	CHIME	ON, OFF
WARNING LAMPS AND CHIME	AJAR LAMP	ON, OFF
BATTERY SAVER & COURTESY ENTRY	INT LAMPS	ON, OFF
ONE TOUCH WINDOW DOWN & ACCY DELAY	ACCY RLY	ON, OFF
ONE TOUCH WINDOW DOWN & ACCY DELAY	ONE TOUCH	ON, OFF
DOOR LOCK CONTROL	ALL LOCK	ON, OFF
DOOR LOCK CONTROL	UNLOCK	ON, OFF
DOOR LOCK CONTROL	DD UNLOCK	ON, OFF
TURN SIGNAL AND MARKER LAMPS	PARK LAMPS	ON, OFF
HORN CONTROL	HORN	ON, OFF
4-WHEEL ELECTRONIC SHIFT	CW/CCW	ON, OFF
4-WHEEL ELECTRONIC SHIFT	HIGH LAMP	ON, OFF
4-WHEEL ELECTRONIC SHIFT	LOW LAMP	ON, OFF
INDICATOR LAMP CONTROL	BRK LAMP	ON, OFF
MODULE OPTION CONTENT	SPD WARN	ON, OFF
MODULE OPTION CONTENT	SPD WIPER	ACTIVE, notACT
4WD TRANSFR CASE & INDICATORS	NUBLOCK_L	ON, OFF
4WD TRANSFER CASE & INDICATOR	NUBLOCK_H	ON, OFF

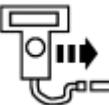
Symptom Chart — Electronic Shift on the Fly (ESOF)

Symptom Chart		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> The Vehicle Does Not Shift Between 2WD and 4WD Modes Correctly 	<ul style="list-style-type: none"> 4WD mode switch. Transfer case shift relays. Contact plate A, B, C, or D. Transfer case shift motor. Circuitry. GEM. Transfer case 	<ul style="list-style-type: none"> GO to Pinpoint Test A.

	mechanism.	
<ul style="list-style-type: none"> The Vehicle Does Not Shift Between 4WD High and 4WD Low Modes Correctly 	<ul style="list-style-type: none"> 4WD mode switch. Neutral safety switch. Brake pedal position (BPP) switch. GEM. Transfer case. Digital transmission range (TR) sensor. Circuitry. 	<ul style="list-style-type: none"> GO to Pinpoint Test B.
<ul style="list-style-type: none"> The Front Axle Is Not Engaging Correctly (Transfer Case Motor Movement and Front Driveshaft OK) 	<ul style="list-style-type: none"> Pulse vacuum hublock (PVH) solenoid. GEM. Circuitry. Vacuum lines. Hub and bearing. 	<ul style="list-style-type: none"> GO to Pinpoint Test C.
<ul style="list-style-type: none"> The 4x4 HIGH or 4x4 LOW Range Indicator Do/Does Not Operate Properly 	<ul style="list-style-type: none"> Bulb. Digital TR sensor. Circuitry. Instrument cluster. GEM. 	<ul style="list-style-type: none"> GO to Pinpoint Test D.
<ul style="list-style-type: none"> No Communication With the Module — Generic Electronic Module 	<ul style="list-style-type: none"> Fuse(s). Circuitry. GEM. Fuse junction panel. 	<ul style="list-style-type: none"> GO to Pinpoint Test E.
<ul style="list-style-type: none"> The Front Axle Engages With the 4 Wheel Drive Hubs in Manual But Not in Automatic 	<ul style="list-style-type: none"> Pulse vacuum hublock (PVH) solenoid. GEM. Circuitry. Vacuum lines. Hub and bearing. 	<ul style="list-style-type: none"> GO to Pinpoint Test D.

Pinpoint Tests — Electronic Shift on the Fly (ESOF)

PINPOINT TEST A: THE VEHICLE DOES NOT SHIFT BETWEEN 2WD AND 4WD MODES CORRECTLY

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE IGNITION STATES — MONITOR THE GEM PID IGN_GEM	
1. 	
2.  NGS	
3. 	3 NOTE: If the vehicle is equipped with a manual transmission, depress the clutch pedal while turning the ignition switch to the START position. Monitor the GEM PID IGN_GEM and rotate the ignition switch (11572) through the START, RUN, OFF, and ACC positions.
	<ul style="list-style-type: none"> • Do the PID values agree with the ignition switch positions? <p>→ Yes GO to A2.</p> <p>→ No REFER to Section 417-02.</p>
A2 RETRIEVE THE DIAGNOSTIC TROUBLE CODES (DTCS)	
NOTE: DTC P1838 and DTC P1866 require the GEM keep alive memory (KAM) to be cleared after repairs are completed.	
1. 	1 Retrieve and document continuous DTCs.
2. 	

Clear Continuous DTCs



GEM On-Demand Self-Test

- **Are any DTCs recorded?**

→ **Yes**

If DTC B1342, REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

If DTC P1812, GO to [A3](#) .

If DTC P1815, GO to [A3](#) .

If DTC P1820, GO to [A9](#) .

If DTC P1822, GO to [A9](#) .

If DTC P1828, GO to [A9](#) .

If DTC P1830, GO to [A9](#) .

If DTC P1838, GO to [A33](#) .

If DTC P1865, GO to [A33](#) .

If DTC P1866, GO to [A33](#) .

If DTC P1867, GO to [A33](#) .

If DTC C1728, GO to [A33](#) .

If DTC C1729, GO to [A33](#) .

If DTC P1820, P1828 and P1838 are all retrieved together, GO to [A33](#) .

→ **No**

GO to [A23](#).

A3 CHECK THE 4WD MODE SWITCH — MONITOR THE GEM PID 4WD_SW

1



2



2 Monitor the GEM PID 4WD_SW while cycling the 4WD mode switch through 2WD, 4X4 HIGH, and 4X4 LOW.

- **Do the GEM PID values agree with the 4WD mode switch positions?**

→ **Yes**
GO to [A9](#).

→ **No**
GO to [A4](#).

A4 CHECK THE 4WD MODE SWITCH — ALL POSITIONS

1

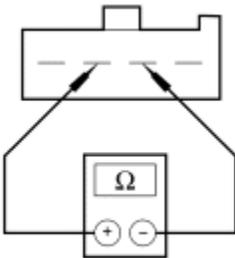


2



4WD Mode Switch 246

3

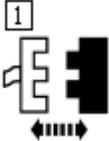
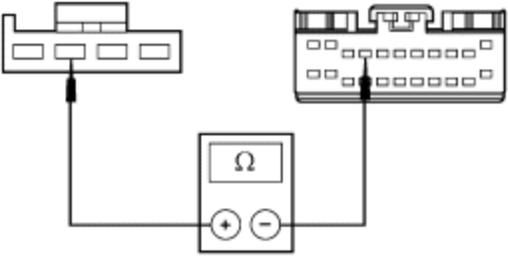


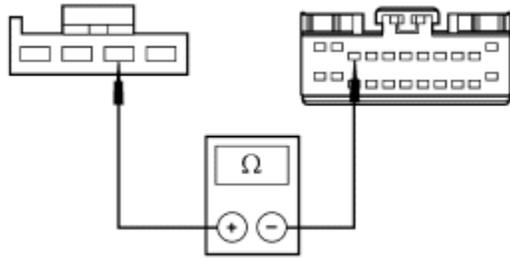
C11929-B

3 Measure the resistance between the 4WD mode switch terminal 2 and terminal 3. Refer to the following chart:

Mode Switch Position	Resistance
2WD	3,700-4,100 Ohms
4X4 HIGH	1,050-1,150 Ohms
4X4 LOW	340-380 Ohms

- **Are the resistances within the specified**

	<p>values?</p> <p>→ Yes GO to A5.</p> <p>→ No REPLACE the 4WD mode switch; REFER to Section 308-07B. CLEAR the DTCs. TEST the system for normal operation.</p>
<p>A5 CHECK CIRCUIT 465 (W/LB) FOR OPEN</p>	
<p>1</p>  <p>GEM C247</p>	
<p>2</p>  <p>GC1785-A</p>	<p>2 Measure the resistance between 4WD mode switch C246-2, circuit 465 (W/LB), and GEM C247-4, circuit 465 (W/LB).</p>
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to A6.</p> <p>→ No REPAIR circuit 465 (W/LB). CLEAR the DTCs. TEST the system for normal operation.</p>
<p>A6 CHECK CIRCUIT 780 (DB) FOR OPEN</p>	
<p>1</p>	<p>1 Measure the resistance between 4WD mode switch C246-3, circuit 780 (DB), and GEM C247-3, circuit 780 (DB).</p>



GC1784-A

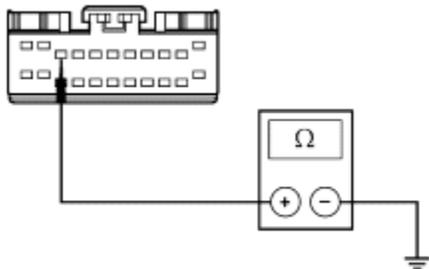
- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [A7](#).

→ **No**
REPAIR circuit 780 (DB). CLEAR the DTCs. TEST the system for normal operation.

A7 CHECK CIRCUIT 780 (DB) FOR SHORT TO GROUND

1



GC1843-A

1 Measure the resistance between GEM C247-3, circuit 780 (DB), and ground.

- **Is the resistance greater than 10,000 ohms?**

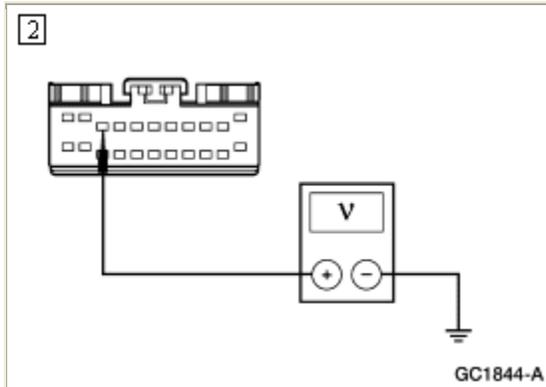
→ **Yes**
GO to [A8](#).

→ **No**
REPAIR circuit 780 (DB). CLEAR the DTCs. TEST the system for normal operation.

A8 CHECK CIRCUIT 780 (DB) FOR SHORT TO POWER

1





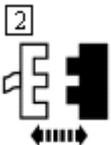
2 Measure the voltage between GEM C247-3, circuit 780 (DB), and ground.

- **Is any voltage indicated?**

→ **Yes**
REPAIR circuit 780 (DB). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

A9 CHECK THE VOLTAGE TO THE ELECTRIC SHIFT MOTOR — GEM ACTIVE COMMAND CW/CCW ON



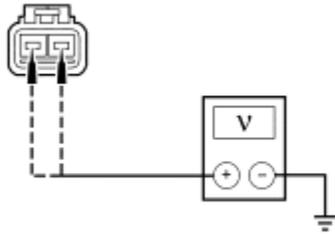
Transfer Case Assembly C284



4

4 **NOTE:** Voltage is only applied to the transfer case assembly for six seconds while the GEM active command CW/CCW is ON.

Measure the voltage between transfer case assembly C284, circuit 778 (O), and ground while triggering the GEM active command CW/CCW to ON; and between transfer case



GC1788-A

assembly C284, circuit 777 (Y), and ground while triggering the GEM active command CW/CCW to ON.

- **Are the voltages greater than 10 volts?**

→ **Yes**

GO to [A10](#).

→ **No**

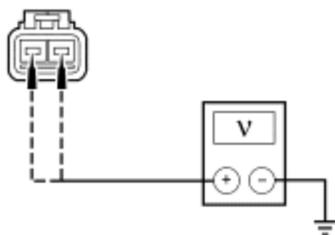
If there is no voltage on circuits 777 (Y) and 778 (O), GO to [A23](#) .

If there is no voltage on circuit 777 (Y) only, GO to [A11](#) .

If there is no voltage on circuit 778 (O) only, GO to [A15](#) .

A10 CHECK THE VOLTAGE TO THE ELECTRIC SHIFT MOTOR — GEM ACTIVE COMMAND CW/CCW OFF

1



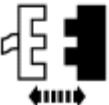
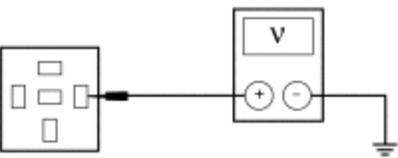
GC1788-A

1 Measure the voltage between transfer case assembly C284, circuit 777 (Y), and ground while triggering the GEM active command CW/CCW to OFF; and between transfer case assembly C284, circuit 778 (O), and ground while triggering the GEM active command CW/CCW to OFF.

- **Are the voltages greater than 10 volts?**

→ **Yes**

If there is voltage on circuit 777 (Y) only, GO to [A19](#) .

	<p>If there is voltage on circuit 778 (O) only, GO to A21.</p> <p>→ No GO to A23.</p>
<p>A11 CHECK THE VOLTAGE TO THE TRANSFER CASE HIGH TO LOW SHIFT RELAY — CIRCUIT 704 (DG/LG)</p>	
<p>1</p> 	
<p>2</p>  <p>Transfer Case High to Low Shift Relay C254</p>	
<p>3</p> 	
<p>4</p>  <p>GN1438-A</p>	<p>4 Measure the voltage between transfer case high to low shift relays C254-86, circuit 704 (DG/LG), and ground.</p>
	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to A12.</p> <p>→ No REPAIR circuit 704 (DG/LG). CLEAR the DTCs. TEST the system for normal operation.</p>
<p>A12 CHECK THE TRANSFER CASE HIGH TO LOW RELAY</p>	
<p>1</p>	



2 Check the transfer case high to low shift relay; refer to Component Test.

- **Is the relay OK?**

→ **Yes**
GO to [A13](#).

→ **No**
REPLACE the transfer case high to low relay. TEST the system for normal operation.

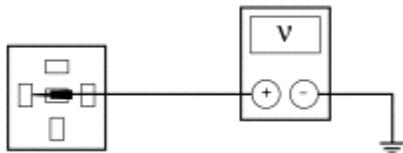
A13 CHECK CIRCUIT 782 (BR/W) FOR SHORT TO POWER



GEM C247



3



GN1436-A

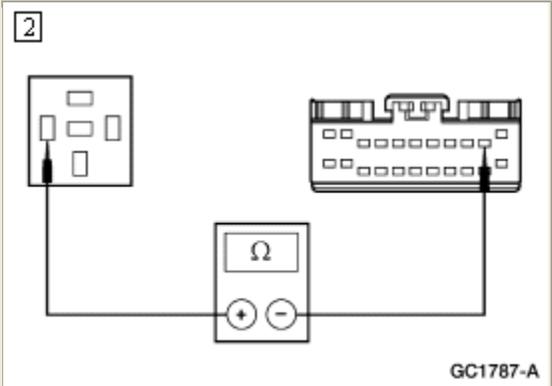
3 Measure the voltage between transfer case low to high shift relay C255-85, circuit 782 (BR/W), and ground.

- **Is any voltage indicated?**

→ **Yes**
REPAIR circuit 782 (BR/W). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
GO to [A14](#).

A14 CHECK CIRCUIT 782 (BR/W) FOR OPEN



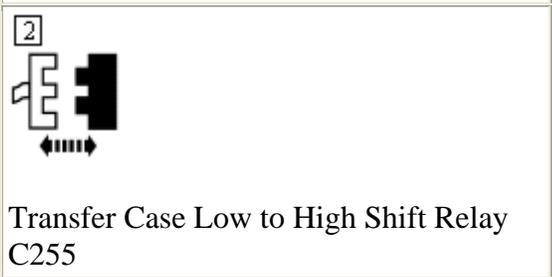
2 Measure the resistance between transfer case low to high shift relay C255-85, circuit 782 (BR/W), and GEM C247-10, circuit 782 (BR/W).

- **Is the resistance less than 5 ohms?**

→ **Yes**
REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
REPAIR circuit 782 (BR/W). CLEAR the DTCs. TEST the system for normal operation.

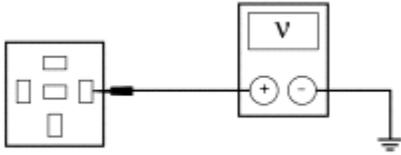
A15 CHECK THE VOLTAGE TO THE TRANSFER CASE LOW TO HIGH SHIFT RELAY — CIRCUIT 704 (DG/LG)



3



4



GN1438-A

4 Measure the voltage between transfer case low to high shift relay C285-86, circuit 704 (DG/LG), and ground.

- Is the voltage greater than 10 volts?

→ Yes
GO to [A16](#).

→ No
REPAIR circuit 704 (DG/LG). CLEAR the DTCs.
TEST the system for normal operation.

A16 CHECK THE TRANSFER CASE LOW TO HIGH SHIFT RELAY

1



2 Check the transfer case low to high shift relay; refer to Component Test.

- Is the relay OK?

→ Yes
GO to [A17](#).

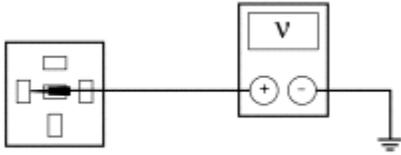
→ No
REPLACE the transfer case low to high shift relay.
TEST the system for normal operation.

A17 CHECK CIRCUIT 781 (O/LB) FOR SHORT TO POWER

1



2



GN1436-A

2 Measure the voltage between transfer case high to low shift relay connector C254-85, circuit 781 (O/LB), and ground.

- **Is any voltage indicated?**

→ **Yes**

REPAIR circuit 781 (O/LB). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

GO to [A18](#).

A18 CHECK CIRCUIT 781 (O/LB) FOR OPEN

1

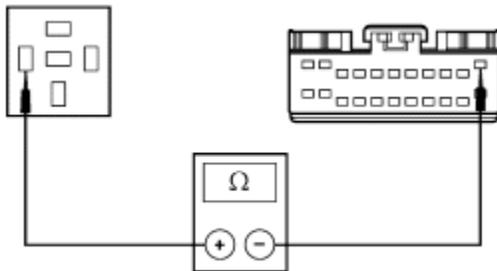


2



GEM C247

3

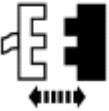


GC1786-A

3 Measure the resistance between transfer case shift high to low relay C254-85, circuit 781 (O/LB), and GEM C247-11, circuit 781 (O/LB).

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes REPLACE the GEM; REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 781 (O/LB). CLEAR the DTCs. TEST the system for normal operation.</p>
--	--

A19 CHECK THE TRANSFER CASE HIGH TO LOW SHIFT RELAY

<p>1</p> 	
<p>2</p>  <p>Transfer Case High to Low Shift Relay C254</p>	

	<p>3 Check the transfer case high to low relay; refer to Component Test.</p>
--	--

	<ul style="list-style-type: none"> • Is the relay OK? <p>→ Yes GO to A20.</p> <p>→ No REPLACE the transfer case high to low relay. TEST the system for normal operation.</p>
--	--

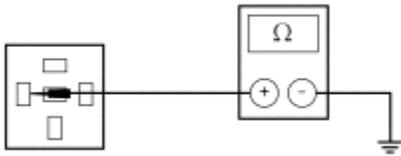
A20 CHECK CIRCUIT 782 (BR/W) FOR SHORT TO GROUND

<p>1</p>  <p>GEM C247</p>	
<p>2</p>	



Transfer Case High to Low Relay

3



GN1431-A

3 Measure the resistance between transfer case high to low shift relay C254-85, circuit 782 (BR/W), and ground.

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**

REPAIR circuit 782 (BR/W). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

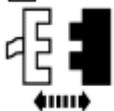
REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

A21 CHECK THE TRANSFER CASE LOW TO HIGH SHIFT RELAY

1



2



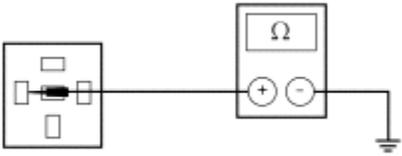
Transfer Case Low to High Shift Relay C255

2 Check the transfer case low to high shift relay; refer to Component Test.

- **Is the relay OK?**

→ **Yes**

GO to [A22](#).

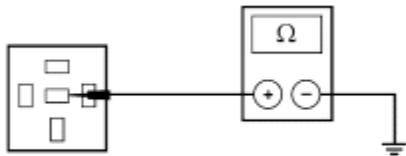
	<p>→ No REPLACE the transfer case low to high shift relay. TEST the system for normal operation.</p>
<p>A22 CHECK CIRCUIT 781 (O/LB) FOR SHORT TO GROUND</p>	
<p>1</p>  <p>GEM C247</p>	
<p>2</p>  <p>GN1431-A</p>	<p>2 Measure the resistance between transfer case high to low shift relay C254-85, circuit 781 (O/LB), and ground.</p>
	<ul style="list-style-type: none"> • Is the resistance greater than 10,000 ohms? <p>→ Yes REPAIR circuit 781 (O/LB). CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPLACE the GEM; REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p>
<p>A23 CHECK THE GROUND TO THE CW AND CCW RELAYS — CIRCUITS 57 (BK)</p>	
<p>1</p> 	
<p>2</p>  <p>Transfer Case High to Low Shift Relay</p>	

C254



Transfer Case Low to High Shift Relay
C255

4



GN1430-A

4 Measure the resistance between transfer case low to high shift relay C255-87A, circuit 57 (BK), and ground; and between transfer case high to low shift relay C254-87A, circuit 57 (BK), and ground.

- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [A24](#).

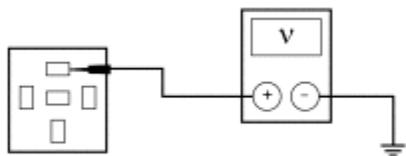
→ **No**
REPAIR circuit 57 (BK). CLEAR the DTCs. TEST the system for normal operation.

A24 CHECK THE VOLTAGE TO THE CW AND CCW RELAYS — CIRCUITS 704 (DG/LG)

1



2



GN1439-A

2 Measure the voltage between transfer case low to high shift relay C255-87, circuit 704 (DG/LG), and ground; and between transfer case high to low shift relay C284-87, circuit 704 (DG/LG), and ground.

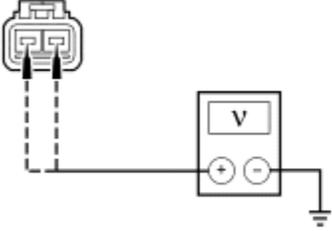
	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to A25.</p> <p>→ No REPAIR circuit 704 (DG/LG). CLEAR the DTCs. TEST the system for normal operation.</p> <p>If both circuits have no voltage, GO to A53 .</p>
--	---

A25 CHECK THE FRONT DRIVESHAFT ENGAGEMENT

<p>1</p> 	
	<p>2</p> <p>Place the 4WD mode switch in 4X4 HIGH and drive a short distance.</p>
	<p>3</p> <p>Raise and support the vehicle; refer to Section 100-02.</p>
<p>4</p> 	
	<p>5</p> <p>NOTE: The front and rear driveshafts should both spin. Observe the front and rear driveshafts.</p>
	<ul style="list-style-type: none"> • Does the transfer case lock the front driveshaft to the rear driveshaft? <p>→ Yes GO to A26.</p> <p>→ No GO to A27.</p>

A26 CHECK THE FRONT DRIVE SHAFT DISENGAGEMENT

	<p>1</p> <p>Place the 4WD mode switch in the 2WD position.</p>
<p>2</p>	

	
	<p>3 Observe the front and rear driveshaft.</p>
	<ul style="list-style-type: none"> • Does only the rear driveshaft spin? <p>→ Yes GO to Pinpoint Test C.</p> <p>→ No GO to A27.</p>
<p>A27 CHECK THE VOLTAGE TO THE ELECTRIC SHIFT MOTOR — MOTOR ON</p>	
<p>1</p> 	
<p>2</p>  <p>Transfer Case Assembly C284</p>	
<p>3</p> 	
<p>4</p>  <p style="text-align: right;">GC1788-A</p>	<p>4 NOTE: Voltage is only applied to the transfer case shift motor for six seconds while the GEM active command CW/CCW is ON.</p> <p>Measure the voltage between transfer case assembly C284, circuit 778 (O), and ground while triggering the GEM active command CW/CCW to ON; and between transfer case assembly C284, circuit 777 (Y), and ground while triggering the GEM active command CW/CCW to ON.</p>
	<ul style="list-style-type: none"> • Are the voltages greater than 10 volts? <p>→ Yes GO to A29.</p>

→ **No**
GO to [A28](#).

A28 CHECK THE TRANSFER CASE SHIFT RELAYS

1



2



Transfer Case Low to High Shift Relay

3



Transfer Case High to Low Shift Relay

4 Check the transfer case shift relays; refer to Component Test.

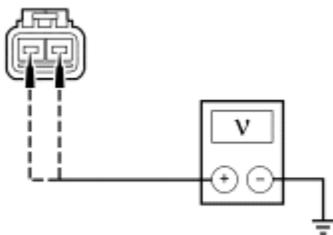
- **Are the relays OK?**

→ **Yes**
GO to [A31](#).

→ **No**
REPLACE the relay in question. CLEAR the DTCs.
TEST the system for normal operation.

A29 CHECK THE VOLTAGE TO THE ELECTRIC SHIFT MOTOR — MOTOR OFF

1



GC1788-A

1 Measure the voltage between transfer case assembly C284, circuit 778 (O), and ground while triggering the GEM active command CW/CCW to OFF; and between transfer case assembly C284, circuit 777 (Y), and ground while triggering the GEM active command CW/CCW to OFF.

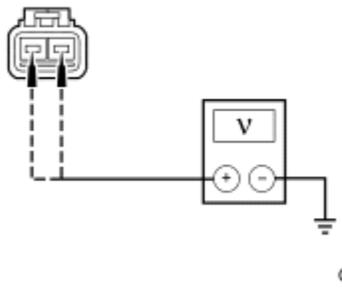
	<ul style="list-style-type: none"> • Are the voltages greater than 10 volts? <p>→ Yes GO to A30.</p> <p>→ No GO to A33.</p>
--	---

A30 CHECK CIRCUITS 777 (Y) AND 778 (O) FOR SHORT(S) TO POWER

<p>1</p> 	
--	--

<p>2</p>  <p>GEM C247</p>	
--	--

<p>3</p> 	
---	--

<p>4</p> 	<p>4 Measure the voltage between transfer case assembly C284, circuit 778 (O), and ground; and between transfer case assembly C284, circuit 777 (Y), and ground.</p>
--	--

	<ul style="list-style-type: none"> • Is any voltage indicated? <p>→ Yes REPAIR circuit 778 (O) or circuit 777 (Y). CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPLACE the transfer case shift relay in question.</p>
--	---

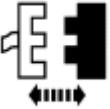
CLEAR the DTCs. TEST the system for normal operation.

A31 CHECK CIRCUIT 777 (Y) FOR OPEN

1

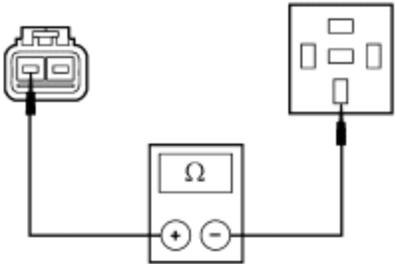


2



Transfer Case Low to High Shift Relay C255

3



GC1789-A

3 Measure the resistance between transfer case low to high shift relay C255-30, circuit 777 (Y), and transfer case assembly C284, circuit 777 (Y).

- Is the resistance less than 5 ohms?

→ Yes
GO to [A32](#).

→ No
REPAIR circuit 777 (Y). CLEAR the DTCs. TEST the system for normal operation.

A32 CHECK CIRCUIT 778 (O) FOR OPEN

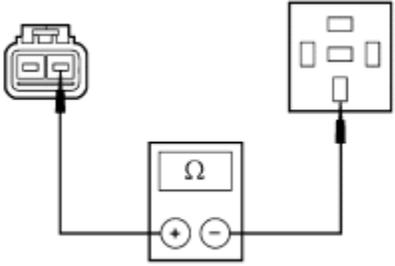
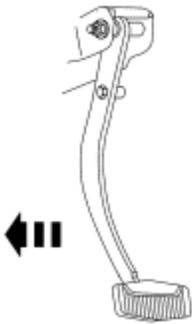
1



Transfer Case High to Low Shift Relay C254

2

2 Measure the resistance between transfer case high to low shift relay C254-30, circuit 778 (O), and

 <p style="text-align: right;">GC1790-A</p>	<p>transfer case assembly C284, circuit 778 (O).</p>
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes REPLACE the transfer case motor and sensor assembly. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 778 (O). CLEAR the DTCs. TEST the system for normal operation.</p>
<p>A33 CHECK THE CONTACT PLATE SWITCHES — MONITOR THE GEM PLATE PIDS</p>	
<p>1</p> 	<p>1 Monitor the GEM PIDs PLATE_A, PLATE_B, PLATE_C, and PLATE_D.</p>
	<p>2 Place the 4WD mode switch in 2WD and record the GEM PIDs.</p>
	<p>3 Place the 4WD mode switch in 4X4 HIGH and record the PID values.</p>
<p>4</p> 	
<p>5</p>  <p style="text-align: right;">H9589-A</p>	<p>5 Depress the brake pedal and depress the clutch (M/T) or place the shift lever into NEUTRAL (A/T).</p>

6 Place the 4WD mode switch in 4X4 LOW and record the PID values.

7 Compare the PID values with the following table.

PID	2WD	4HIGH	4LOW
PLATE_A	CLOSED	OPEN	OPEN
PLATE_B	CLOSED	CLOSED	OPEN
PLATE_C	OPEN	OPEN	CLOSED
PLATE_D	CLOSED	CLOSED	CLOSED

- **Do the PID values agree with the table?**

→ **Yes**

REPAIR the transfer case (7A195) or shift motor assembly; REFER to [Section 308-07B](#). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

GO to [A34](#).

A34 CHECK CIRCUIT 676 (PK/O) FOR OPEN

1

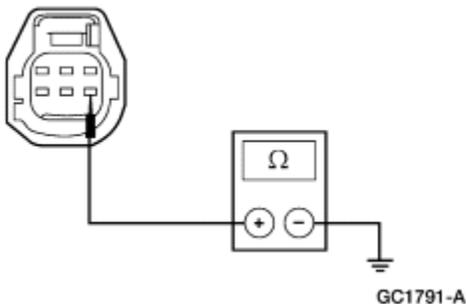


2



Transfer Case Assembly C285

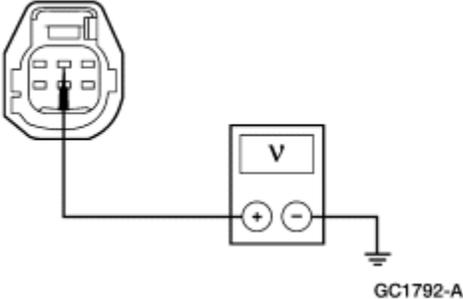
3



3 Measure the resistance between transfer case assembly C285-4, circuit 676 (PK/O), and ground.

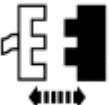
	<ul style="list-style-type: none"> • Is the resistance less than 10 ohms? <p>→ Yes GO to A35.</p> <p>→ No REPAIR circuit 676 (PK/O). CLEAR the DTCs. TEST the system for normal operation.</p>
--	--

A35 CHECK CIRCUIT 976 (O) FOR BATTERY VOLTAGE

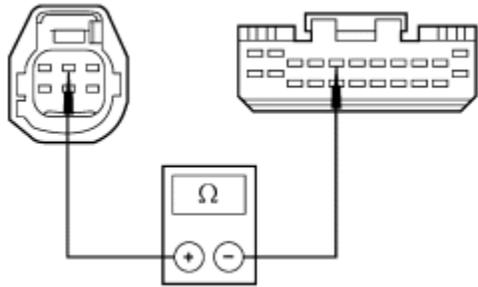
<p>1</p> 	
<p>2</p>  <p style="text-align: right;">GC1792-A</p>	<p>2 Measure the voltage between transfer case assembly C285-2, circuit 976 (O), and ground.</p>

	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to A37.</p> <p>→ No GO to A36.</p>
--	---

A36 CHECK CIRCUIT 976 (O) FOR OPEN

<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	

3



GC1793-A

3 Measure the resistance between transfer case assembly C285-2, circuit 976 (O) and GEM C247-5, circuit 976 (O).

- **Is the resistance less than 5 ohms?**

→ **Yes**

REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

REPAIR circuit 976 (O). CLEAR the DTCs. TEST the system for normal operation.

A37 CHECK THE CIRCUIT 771 (P/Y) TO THE CONTACT PLATE SWITCH A — MONITOR THE GEM PID PLATE_A

1

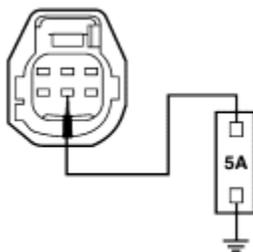


1 Monitor the GEM PID PLATE_A.

2



3

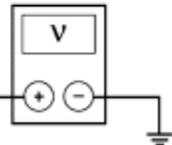


GC1796-B

3 Connect a fused (5A) jumper wire between transfer case assembly C285-5, circuit 771 (P/Y), and ground.

4

	
	 <p>5 Monitor the GEM PID PLATE_A.</p>
	<ul style="list-style-type: none"> • Does the GEM PID PLATE_A indicate CLOSED when the jumper wire is connected and OPEN when the jumper wire is not connected? <p>→ Yes REMOVE the jumper wire; GO to A41 .</p> <p>→ No If the fuse opens or the PID value does not change, GO to A38 .</p>
<p>A38 CHECK CIRCUIT 771 (P/Y) FOR SHORT TO POWER</p>	
	
 <p>GEM C247</p>	
	
	 <p>4 Measure the voltage between transfer case assembly C285-5, circuit 771 (P/Y), and ground.</p>



GC1795-A

- **Is any voltage indicated?**

→ **Yes**

REPAIR circuit 771 (P/Y). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

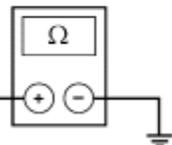
GO to [A39](#).

A39 CHECK CIRCUIT 771 (P/Y) FOR SHORT TO GROUND

1



2



GC1797-A

2 Measure the resistance between transfer case assembly C285-5, circuit 771 (P/Y), and ground.

- **Is the resistance greater than 10,000 ohms?**

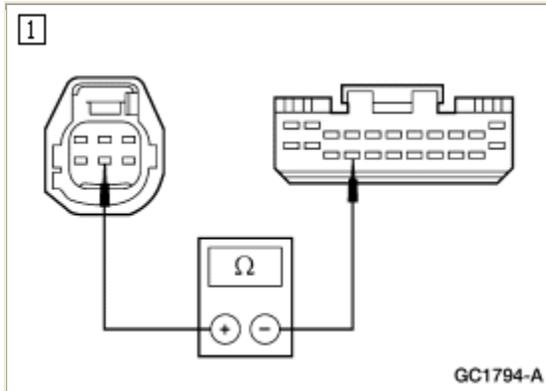
→ **Yes**

GO to [A40](#).

→ **No**

REPAIR circuit 771 (P/Y). CLEAR the DTCs. TEST the system for normal operation.

A40 CHECK CIRCUIT 771 (P/Y) FOR OPEN



1 Measure the resistance between transfer case assembly C285-5, circuit 771 (P/Y), and GEM C247-15, circuit 771 (P/Y).

- Is the resistance less than 5 ohms?

→ Yes

REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

→ No

REPAIR circuit 771 (P/Y). CLEAR the DTCs. TEST the system for normal operation.

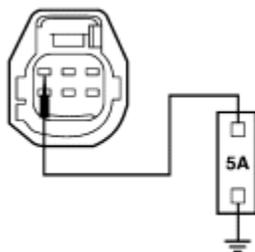
A41 CHECK THE CIRCUIT 764 (BR/W) TO THE CONTACT PLATE SWITCH B — MONITOR THE GEM PID PLATE_B



1 Monitor the GEM PID PLATE_B.



3

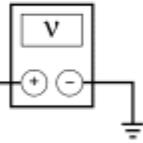


3 Connect a fused (5A) jumper wire between transfer case assembly, C285-3, circuit 764 (BR/W), and ground.

GC1798-B

4

	
	<p>5 Monitor the GEM PID PLATE_B.</p>
	<ul style="list-style-type: none"> • Does the GEM PID PLATE_B indicate CLOSED when the jumper wire is connected and OPEN when the jumper wire is not connected? <p>→ Yes GO to A45.</p> <p>→ No If the fuse opens or the PID value does not change, GO to A42 .</p>
<p>A42 CHECK CIRCUIT 764 (BR/W) FOR SHORT TO POWER</p>	
<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p> 	
<p>4</p>	<p>4 Measure the voltage between transfer case assembly C285-3, circuit 764 (BR/W), and ground.</p>



GC1801-A

- **Is the voltage greater than 10 volts?**

→ **Yes**

REPAIR circuit 764 (BR/W). CLEAR the DTCs.
TEST the system for normal operation.

→ **No**

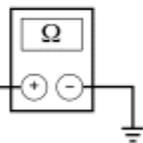
GO to [A43](#).

A43 CHECK CIRCUIT 764 (BR/W) FOR SHORT TO GROUND

1



2



GC1799-A

- 2 Measure the resistance between transfer case assembly C285-3, circuit 764 (BR/W), and ground.

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**

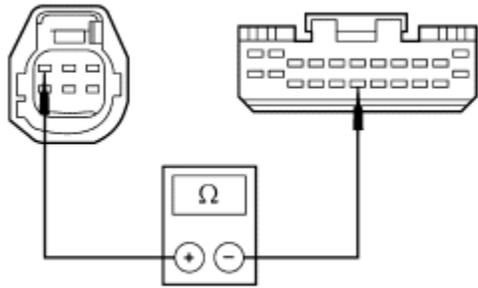
GO to [A44](#).

→ **No**

REPAIR circuit 764 (BR/W). CLEAR the DTCs.
TEST the system for normal operation.

A44 CHECK CIRCUIT 764 (BR/W) FOR OPEN

1



GC1800-A

1 Measure the resistance between transfer case assembly C285-3, circuit 764 (BR/W), and GEM C247-17, circuit 764 (BR/W).

- **Is the resistance less than 5 ohms?**

→ **Yes**
REPLACE the GEM; REFER to [Section 419-10](#).
CLEAR the DTCs. TEST the system for normal operation.

→ **No**
REPAIR circuit 764 (BR/W). CLEAR the DTCs.
TEST the system for normal operation.

A45 CHECK THE CIRCUIT 770 (W) TO THE CONTACT PLATE SWITCH C — MONITOR THE GEM PID PLATE_C

1

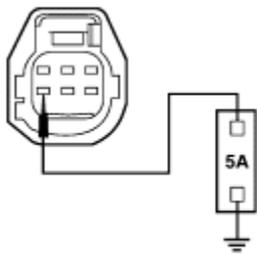


1 Monitor the GEM PID PLATE_C.

2



3

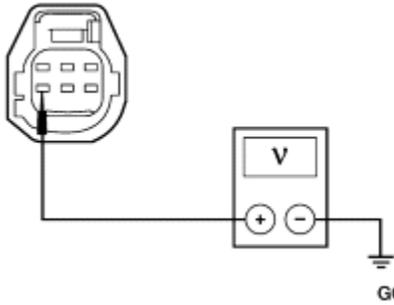


GC1802-B

3 Connect a fused (5A) jumper wire between transfer case assembly C285-6, circuit 770 (W), and ground.

4

	
	<p>5 Monitor the GEM PID PLATE_C.</p>
	<ul style="list-style-type: none"> • Does the GEM PID PLATE_C indicate CLOSED when the jumper wire is connected and OPEN when the jumper wire is not connected? <p>→ Yes GO to A49.</p> <p>→ No If the fuse opens or the PID does not change, GO to A46 .</p>
<p>A46 CHECK CIRCUIT 770 (W) FOR SHORT TO POWER</p>	
<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p> 	
<p>4</p>	<p>4 Measure the voltage between transfer case assembly C285-6, circuit 770 (W), and ground.</p>



- **Is any voltage indicated?**

→ **Yes**

REPAIR circuit 770 (W). CLEAR the DTCs. TEST the system for normal operation.

→ **No**

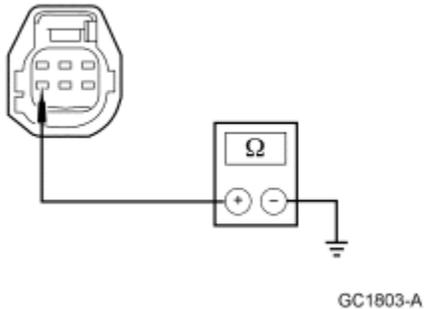
GO to [A47](#).

A47 CHECK CIRCUIT 770 (W) FOR SHORT TO GROUND

1



2



2 Measure the resistance between transfer case assembly C285-6, circuit 770 (W), and ground.

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**

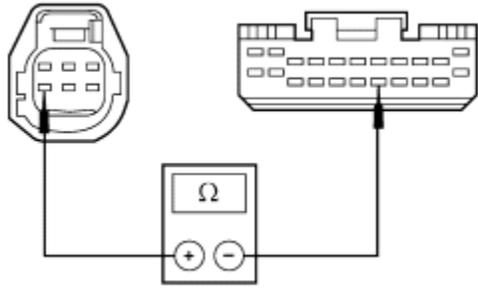
GO to [A48](#).

→ **No**

REPAIR circuit 770 (W). CLEAR the DTCs. TEST the system for normal operation.

A48 CHECK CIRCUIT 770 (W) FOR OPEN

1



GC1804-A

1 Measure the resistance between transfer case assembly C285-6, circuit 770 (W), and GEM C247-18, circuit 770 (W).

- **Is the resistance less than 5 ohms?**

→ **Yes**
REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
REPAIR circuit 770 (W). CLEAR the DTCs. TEST the system for normal operation.

A49 CHECK CIRCUIT 763 (O/W) TO THE CONTACT PLATE SWITCH D — MONITOR THE GEM PID PLATE_D

1

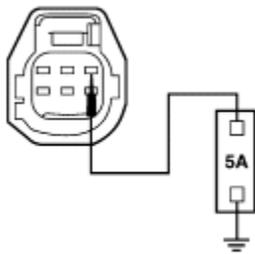


1 Monitor the GEM PID PLATE_D.

2



3

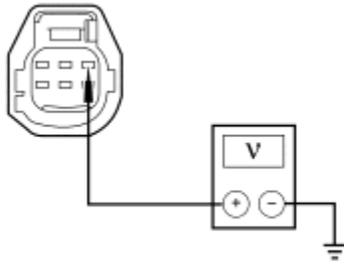


GC1806-B

3 Connect a fused (5A) jumper wire between transfer case assembly C285-1, circuit 763 (O/W), and ground.

4

	
	<p>5 Monitor the GEM PID PLATE_D.</p>
	<ul style="list-style-type: none"> • Does the PID PLATE_D indicate CLOSED when the jumper wire is connected and OPEN when the jumper wire is not connected? <p>→ Yes REPLACE the transfer case shift motor (7G360); REFER to Section 308-07B. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No GO to A50.</p>
<p>A50 CHECK CIRCUIT 763 (O/W) FOR SHORT TO POWER</p>	
<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p> 	
<p>4</p>	<p>4 Measure the voltage between transfer case assembly C285-1, circuit 763 (O/W), and ground.</p>



GC1809-A

- **Is the voltage greater than 10 volts?**

→ **Yes**

REPAIR circuit 763 (O/W). CLEAR the DTCs.
TEST the system for normal operation.

→ **No**

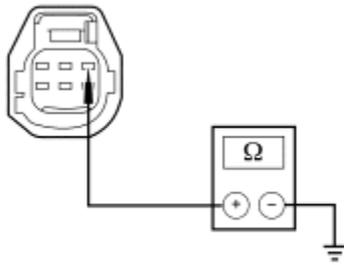
GO to [A51](#).

A51 CHECK CIRCUIT 763 (O/W) FOR SHORT TO GROUND

1



2



GC1807-A

- 2 Measure the resistance between transfer case assembly C285-1, circuit 763 (O/W), and ground.

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**

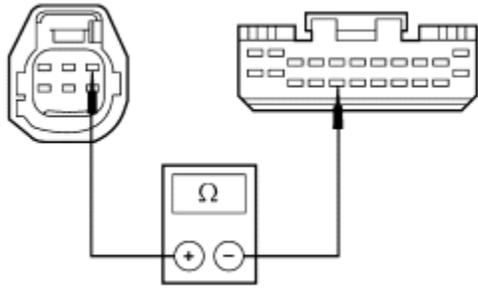
GO to [A52](#).

→ **No**

REPAIR circuit 763 (O/W). CLEAR the DTCs.
TEST the system for normal operation.

A52 CHECK CIRCUIT 763 (O/W) FOR OPEN

1



GC1808-A

1 Measure the resistance between transfer case assembly C285-1, circuit 763 (O/W), and GEM C247-16, circuit 763 (O/W).

- **Is the resistance less than 5 ohms?**

→ **Yes**
REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

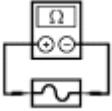
→ **No**
REPAIR circuit 763 (O/W). CLEAR the DTCs. TEST the system for normal operation.

A53 CHECK POWER DISTRIBUTION BOX FUSE 17 (30A)

1



2



Fuse 17 (30A)

- **Is the fuse OK?**

→ **Yes**
GO to [A54](#).

→ **No**
GO to [A55](#).

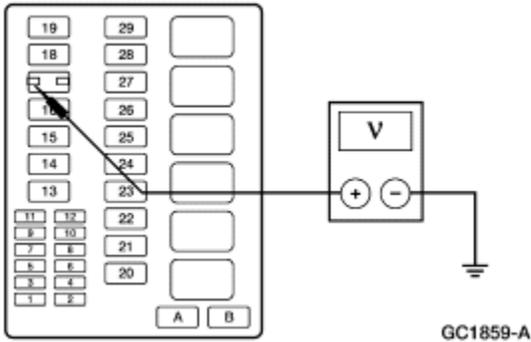
A54 CHECK VOLTAGE AT POWER DISTRIBUTION BOX FUSE 17 (30A)

1



Fuse 17 (30A)

2



2 Measure the voltage between power distribution box fuse 17 (30A) and ground.

- Is the voltage greater than 10 volts?

→ Yes

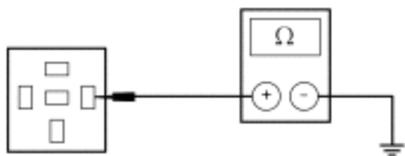
REPAIR circuit 704 (DG/LG). TEST the system for normal operation.

→ No

REPAIR/REPLACE the power distribution box. TEST the system for normal operation.

A55 CHECK CIRCUIT 704 (DG/LG) FOR SHORT TO GROUND

1



1 Measure the resistance between transfer case high to low relay C254-86, circuit 704 (DG/LB), and ground.

- Is the resistance less than 5 ohms?

→ Yes

REPAIR circuit 704 (DG/LG). TEST the system for normal operation.

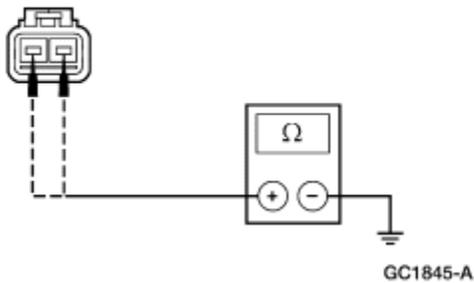
→ **No**
GO to [A56](#).

A56 CHECK CIRCUITS 777 (Y) AND 778 (O) FOR SHORT TO GROUND



Transfer Case Assembly C284

2



2 Measure the resistance between transfer case assembly C284, circuit 777 (Y), and ground; and between transfer case assembly C284, circuit 778 (O), and ground.

- **Are the resistances less than 5 ohms?**

→ **Yes**
REPAIR circuits 777 (Y) or 778 (O). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
GO to [A57](#).

A57 CHECK THE TRANSFER CASE SHIFT RELAYS

1 Check the transfer case shift relays; refer to Component Test.

- **Are the relays OK?**

→ **Yes**
REPLACE the transfer case assembly. CLEAR the DTCs. TEST the system for normal operation.

→ **No**
REPLACE the transfer case shift relay(s). CLEAR the DTCs. TEST the system for normal operation.

PINPOINT TEST B: THE VEHICLE DOES NOT SHIFT BETWEEN 4WD HIGH AND 4WD LOW MODES CORRECTLY

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK THE IGNITION STATES — MONITOR THE GEM PID IGN_GEM	
<p>1</p> 	
<p>2</p>  <p>NGS</p>	
<p>3</p> 	<p>3 NOTE: If the vehicle is equipped with a manual transmission, depress the clutch pedal while turning the ignition switch to START.</p> <p>Monitor the GEM PID IGN_GEM and rotate the ignition switch through the START, RUN, OFF, and ACC positions.</p>
	<ul style="list-style-type: none"> • Do the PID values agree with the ignition switch positions? <p>→ Yes GO to B2.</p> <p>→ No REFER to Section 417-02.</p>
B2 RETRIEVE THE DIAGNOSTIC TROUBLE CODES (DTCS)	
<p>1</p> 	<p>1 Retrieve and document continuous DTCs.</p>
<p>2</p>  <p>Clear Continuous DTCs</p>	
<p>3</p>	



GEM On-Demand Self-Test

- **Are any DTCs recorded?**

→ **Yes**

If DTC B1342, REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

If DTC P0500, GO to [B16](#) .

If DTC B1483, GO to [B9](#) .

If DTC B1485, GO to [B21](#) .

If DTC P1812, GO to [B4](#) .

If DTC P1815, GO to [B4](#) .

If DTC P1819, GO to [B13](#) .

→ **No**

GO to [B3](#).

B3 CHECK THE 4WD MODE SWITCH — MONITOR THE GEM PID 4WD_SW



1 Monitor the GEM PID 4WD_SW while cycling the 4WD mode switch through 2WD, 4X4 HIGH, and 4X4 LOW.

- **Do the GEM PID values agree with the switch positions?**

→ **Yes**

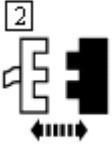
GO to [B9](#).

→ **No**

GO to [B4](#).

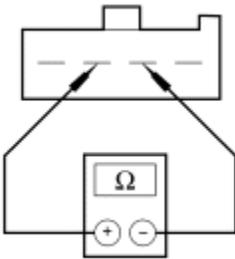
B4 CHECK THE 4WD MODE SWITCH — ALL POSITIONS

1



4WD Mode Switch C246

3



C11929-B

3 Measure the resistance between the 4WD mode switch terminal 2 and terminal 3. Refer to the following chart:

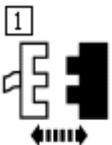
Mode Switch Position	Resistance
2WD	3700-4100 Ohms
4X4 HIGH	1050-1150 Ohms
4X4 LOW	340-480 Ohms

- Are the resistances within the specified values?

→ Yes
GO to [B5](#).

→ No
REPLACE the 4WD mode switch. REFER to [Section 308-07B](#). CLEAR the DTCs. TEST the system for normal operation.

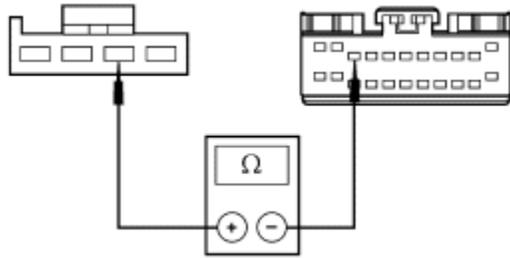
B5 CHECK CIRCUIT 780 (DB) FOR OPEN



GEM C247

2

2 Measure the resistance between 4WD mode switch C246-3, circuit 780 (DB), and GEM C247-3, circuit 780 (DB).



GC1784-A

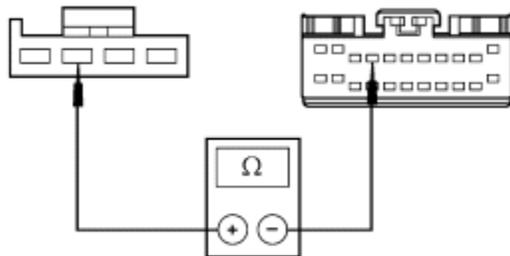
- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [B6](#).

→ **No**
REPAIR circuit 780 (DB). CLEAR the DTCs. TEST the system for normal operation.

B6 CHECK CIRCUIT 465 (W/LB) FOR OPEN

1



GC1785-A

1 Measure the resistance between 4WD mode switch C246-2, circuit 465 (W/LB), and GEM C247-4, circuit 465 (W/LB).

- **Is the resistance less than 5 ohms?**

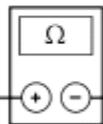
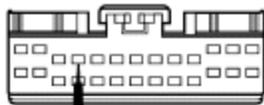
→ **Yes**
GO to [B7](#).

→ **No**
REPAIR circuit 465 (W/LB). CLEAR the DTCs. TEST the system for normal operation.

B7 CHECK CIRCUIT 465 (W/LB) FOR SHORT TO GROUND

1

1 Measure the resistance between GEM C247-4, circuit 465 (W/LB), and ground.



GC1856-A

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**
GO to [B8](#).

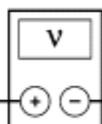
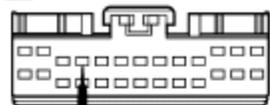
→ **No**
REPAIR circuit 465 (W/LB). CLEAR the DTCs.
TEST the system for normal operation.

B8 CHECK CIRCUIT 465 (W/LB) FOR SHORT TO POWER

1



2



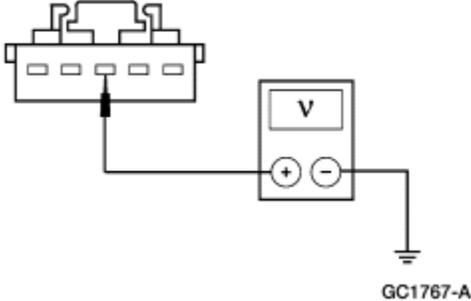
GC1857-A

2 Measure the voltage between GEM C247-4, circuit 465 (W/LB), and ground.

- **Is any voltage indicated?**

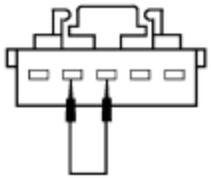
→ **Yes**
REPAIR circuit 465 (W/LB). CLEAR the DTCs.
TEST the system for normal operation.

→ **No**
REPLACE the GEM; REFER to [Section 419-10](#).
CLEAR the DTCs. TEST the system for normal

	operation.
B9 CHECK BRAKE PEDAL POSITION (BPP) SWITCH INPUT — MONITOR THE GEM PID BOO_GEM	
	 <p>1 Monitor the GEM PID BOO_GEM.</p>
	<p>2 Depress the brake pedal.</p>
	<ul style="list-style-type: none"> • Does the GEM PID BOO_GEM change states? <p>→ Yes If the vehicle is a manual transmission, GO to B12 .</p> <p>If the vehicle is an automatic transmission, GO to B13 .</p> <p>→ No GO to B10.</p>
B10 CHECK THE VOLTAGE TO THE BPP SWITCH — CIRCUIT 22 (LB/BK)	
	
 <p>BPP Switch C279</p>	
 <p>GC1767-A</p>	<p>3 Measure the voltage between BPP switch C279-3, circuit 22 (LB/BK), and ground.</p>

	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to B11.</p> <p>→ No CHECK fuse junction panel 15 (5A). REPLACE if necessary. If fuse junction panel 15 (5A) is OK, REPAIR circuit 22 (LB/BK). CLEAR the DTCs. TEST the system for normal operation.</p>
--	--

B11 CHECK THE BPP SWITCH — MONITOR THE GEM PID BOO_GEM

	<p>1 Verify the GEM PID BOO_GEM displays OFF.</p>
 <p style="text-align: right;">GC1768-A</p>	<p>2 Connect a jumper wire between BPP switch C279-3, circuit 22 (LB/BK), and BPP switch C279-2, circuit 810 (R/LG).</p>
	<p>3 Monitor the GEM PID BOO_GEM.</p>

	<ul style="list-style-type: none"> • Does the GEM PID display ON? <p>→ Yes REPLACE the BPP switch; REFER to Section 417-01. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 810 (R/LG). TEST the system for normal operation. If the concern remains, REPLACE the GEM. REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p>
--	--

B12 CHECK THE CLUTCH INTERLOCK — MONITOR THE GEM PID CLTCHSW

	<p>1 Monitor the GEM PID CLTCHSW while depressing the clutch pedal.</p>
	<p>2 Verify the GEM PID CLTCHSW displays ENGAGD.</p>
	<p>3 Release the clutch pedal.</p>
	<p>4 Verify the GEM PID CLTCHSW displays NOT ENGAGD.</p>
	<ul style="list-style-type: none"> • Do the GEM PIDs display correctly? <p>→ Yes GO to B16.</p> <p>→ No DIAGNOSE the starter interrupt circuit; REFER to Section 303-06A or Section 303-06B. CLEAR the DTCs. TEST the system for normal operation.</p>
<p>B13 CHECK THE DIGITAL TR SENSOR — MONITOR THE GEM PID NTRL_SW</p>	
	<p>1 Monitor the GEM PID NTRL_SW.</p>
	
	<p>3 Verify the GEM PID NTRL_SW displays NTRL.</p>
	<p>4 Place the gear selector in every position except neutral.</p>
	<p>5 Verify the GEM PID NTRL_SW displays notNTRL when the transmission is in any position other than NEUTRAL.</p>
	<ul style="list-style-type: none"> • Do the GEM PIDs indicate correctly? <p>→ Yes</p>

GO to [B16](#).

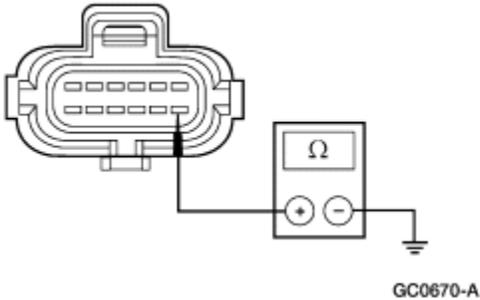
→ **No**
GO to [B14](#).

B14 CHECK THE GROUND TO THE DIGITAL TRANSMISSION RANGE (TR) SENSOR — CIRCUIT 676 (PK/O)



Digital TR Sensor

2



2 Measure the resistance between digital TR sensor C1012-7, circuit 676 (PK/O), and ground.

- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [B15](#).

→ **No**
REPAIR circuit 676 (PK/O). CLEAR the DTCs.
TEST the system for normal operation.

B15 CHECK THE DIGITAL TR SENSOR — MONITOR THE GEM PID NTRL_SW



2 Monitor the GEM PID NTRL_SW.

- **Does the GEM PID NTRL_SW indicate**

	<p style="text-align: center;">NTRL?</p> <p>→ Yes REPAIR circuit 463 (R/W). CLEAR the DTCs. TEST the system for normal operation. If the concern remains, REPLACE the GEM. REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 463 (R/W). TEST the system for normal operation. If the concern remains, REPLACE the digital TR sensor. REFER to Section 307-01. CLEAR the DTCs. TEST the system for normal operation.</p>
--	--

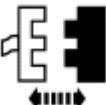
B16 CHECK THE VEHICLE SPEED SIGNAL — MONITOR THE GEM PID VSS_GEM

	<p>1 Monitor the GEM PID VSS_GEM while driving the vehicle from 0 to 88.5 km/h (55 mph).</p>
---	--

	<ul style="list-style-type: none"> • Does the GEM PID VSS_GEM agree with the speedometer? <p>→ Yes REPLACE the GEM; REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No GO to B17.</p>
--	---

B17 CHECK CIRCUIT 679 (GY/BK) FOR OPEN

<p>1</p> 	
--	--

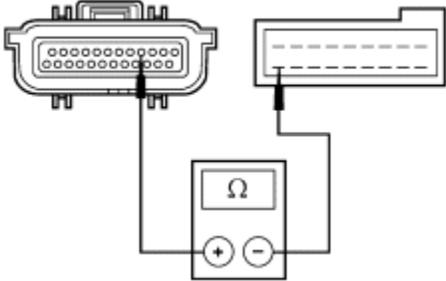
<p>2</p>  <p>4WABS Control Module C1040</p>	
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<p>3</p>	
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GEM C241

4



GC1810-A

4 Measure the resistance between 4WABS control module C1040-16, circuit 679 (GY/BK), and fuse junction panel C241 terminal 18.

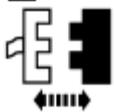
- Is the resistance less than 5 ohms?

→ Yes
GO to [B18](#).

→ No
REPAIR circuit 679 (GY/BK). CLEAR the DTCs.
TEST the system for normal operation.

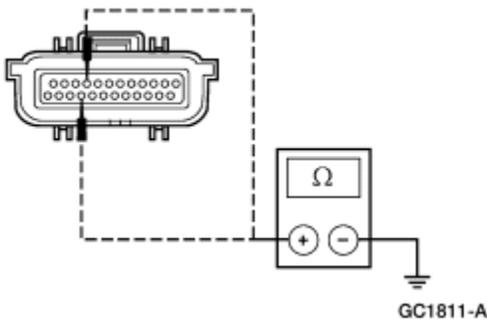
B18 CHECK CIRCUITS 523 (R/PK) AND 519 (LG/BK) FOR SHORT TO GROUND

1



Rear Anti-Lock Brake Sensor C404

2



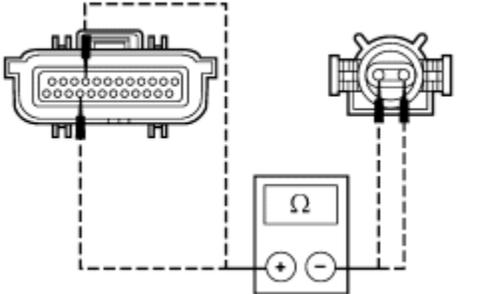
GC1811-A

2 Measure the resistance between 4WABS control module C1040-9, circuit 523 (R/PK), and ground; and between 4WABS control module C1040-21, circuit 519 (LG/BK), and ground.

- Are the resistances greater than 10,000

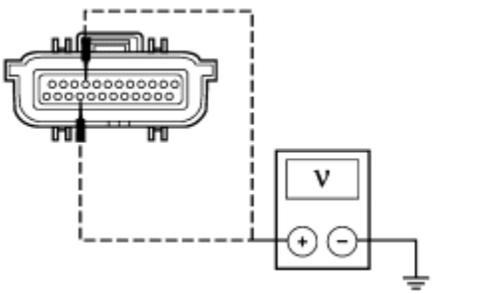
	<p>ohms?</p> <p>→ Yes GO to B19.</p> <p>→ No REPAIR circuit 523 (R/PK) or 519 (LG/BK). CLEAR the DTCs. TEST the system for normal operation.</p>
--	---

B19 CHECK CIRCUITS 523 (R/PK) AND 519 (LG/BK) FOR OPEN

<p>1</p>  <p>GC1812-A</p>	<p>1 Measure the resistance between rear anti-lock brake sensor C404, circuit 523 (R/PK) and 4WABS control module C1040-9, circuit 523 (R/PK); and between rear anti-lock brake sensor C404, circuit 519 (LG/BK), and 4WABS control module C1040-21, circuit 519 (LG/BK).</p>
--	---

	<ul style="list-style-type: none"> • Are the resistances less than 5 ohms? <p>→ Yes GO to B20.</p> <p>→ No REPAIR circuit 523 (R/PK) or 519 (LG/BK). TEST the system for normal operation.</p>
--	--

B20 CHECK CIRCUITS 523 (R/PK) AND 519 (LG/BK) FOR SHORT TO POWER

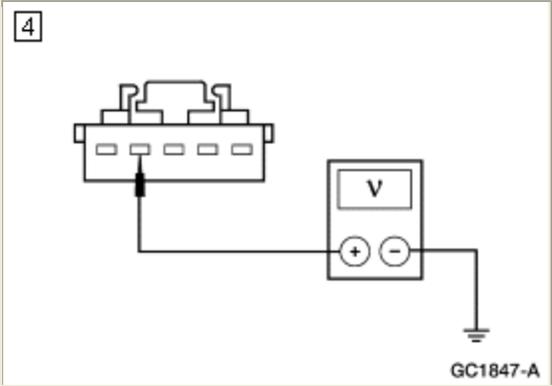
<p>1</p>  <p>GC1813-A</p>	<p>1 Measure the voltage between 4WABS control module C1040-9, circuit 523 (R/PK), and ground; and between 4WABS control module C1040-21, circuit 519 (LG/BK), and ground.</p>
--	--

	<ul style="list-style-type: none"> • Is any voltage indicated?
--	--

→ **Yes**
 REPAIR circuit 523 (R/PK) or 519 (LG/BK). TEST the system for normal operation.

→ **No**
 DIAGNOSE the 4WABS system; REFER to [Section 206-09B](#).

B21 CHECK CIRCUIT 810 (R/LG) FOR SHORT TO POWER



4 Measure the voltage between BPP switch C279-2, circuit 810 (R/LG), and ground.

• **Is any voltage indicated?**

→ **Yes**
 REPAIR circuit 810 (R/LG). CLEAR the DTCs. TEST the system for normal operation.

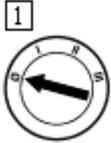
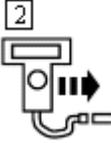
→ **No**
 REPLACE the BPP switch; REFER to [Section 417-01](#). CLEAR the DTCs. TEST the system for normal operation.

• **Is any voltage indicated?**

→ **Yes**
 REPAIR circuit 810 (R/LG). CLEAR the DTCs. TEST the system for normal operation.

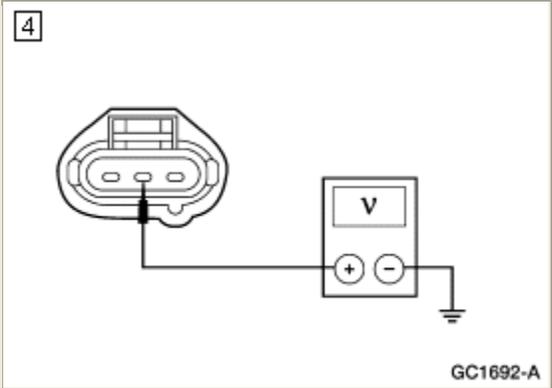
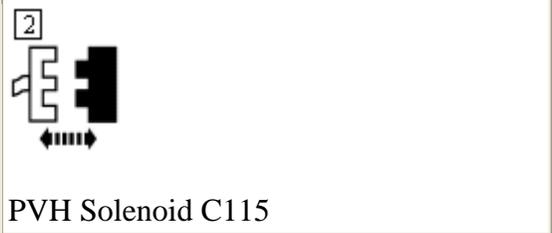
→ **No**
 REPLACE the BPP switch; REFER to [Section 417-01](#). CLEAR the DTCs. TEST the system for normal operation.

**PINPOINT TEST C: THE FRONT AXLE IS NOT ENGAGING PROPERLY
(TRANSFER CASE MOTOR MOVEMENT OK)**

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 RETRIEVE THE DIAGNOSTIC TROUBLE CODES (DTCS)	
	
 <p>NGS</p>	
	 Retrieve and document continuous DTCs.
 <p>Clear Continuous DTCs</p>	
 <p>GEM On-Demand Self-Test</p>	
	<ul style="list-style-type: none"> • Are any DTCs retrieved? <p>→ Yes If DTC P1832, GO to C3 . If DTC P1834, GO to C5 . If DTC P1876, GO to C3 . If DTC P1877, GO to C5 . If DTC P1832 and DTC P1876 are retrieved together,</p>

GO to [C2](#) .
 → **No**
 GO to [C7](#).

C2 CHECK FOR VOLTAGE TO THE PVH SOLENOID — CIRCUIT 295 (LB/BK)



4 Measure the voltage between PVH solenoid C115-2, circuit 295 (LB/BK), and ground.

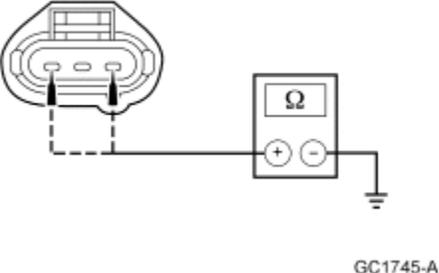
• **Is the voltage greater than 10 volts?**

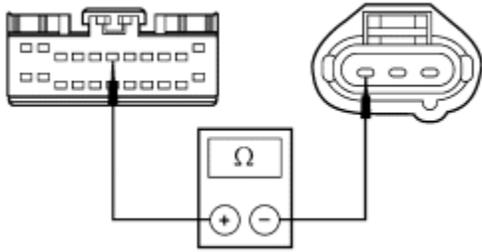
→ **Yes**
 REPLACE the PVH solenoid; REFER to [Section 204-01B](#). CLEAR the DTCs. TEST the system for normal operation.

→ **No**
 REPAIR circuit 295 (LB/BK). TEST the system for normal operation.

C3 CHECK CIRCUITS 605 (R) AND 145 (GY/BK) FOR SHORT TO GROUND

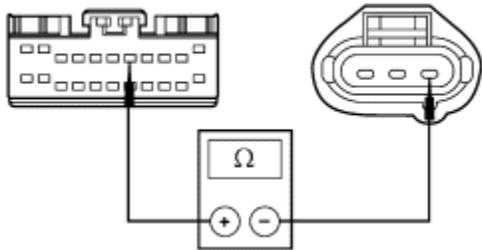


	
<p>2</p>  <p>PVH Solenoid C115</p>	
<p>3</p>  <p>GEM C247</p>	
<p>4</p>  <p>GC1745-A</p>	<p>4 Measure the resistance between PVH solenoid C115-1, circuit 605 (R), and ground; and between PVH solenoid C115-3, circuit 145 (GY/BK), and ground.</p>
	<ul style="list-style-type: none"> • Are the resistances greater than 10,000 ohms? <p>→ Yes GO to C4.</p> <p>→ No REPAIR circuit 605 (R) or 145 (GY/BK). CLEAR the DTCs. TEST the system for normal operation.</p>
<p>C4 CHECK CIRCUITS 605 (R) AND 145 (GY/BK) FOR OPEN</p>	
<p>1</p>	<p>1 Measure the resistance between GEM C247-6, circuit 605 (R), and PVH solenoid C115-1, circuit 605 (R).</p>



GC1858-A

2



GC1697-A

2 Measure the resistance between GEM C247-7, circuit 145 (GY/BK), and PVH solenoid C115-3, circuit 145 (GY/BK).

- Are the resistances less than 5 ohms?

→ **Yes**
GO to [C6](#).

→ **No**
REPAIR circuit 605 (R) or 145 (GY/BK). CLEAR the DTCs. TEST the system for normal operation.

C5 CHECK CIRCUITS 605 (R) AND 145 (GY/BK) FOR SHORTS TO POWER

1

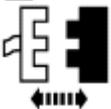


2



PVH Solenoid C115

3

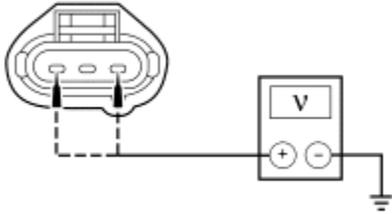


GEM C247

4



5



GC1746-A

5 Measure the voltage between PVH solenoid C115-1, circuit 605 (R), and ground; and between PVH solenoid C115-3, circuit 145 (GY/BK), and ground.

- Is the voltage greater than 10 volts?

→ Yes

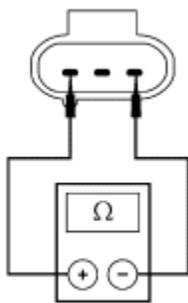
REPAIR circuit 605 (R) or 145 (GY/BK). CLEAR the DTCs. TEST the system for normal operation.

→ No

REPLACE the GEM; REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

C6 CHECK THE PVH SOLENOID COILS

1



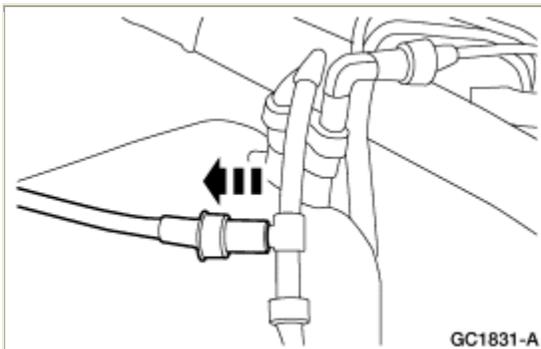
GC1698-A

1 Measure the resistance between the PVH solenoid terminal 1 and terminal 3.

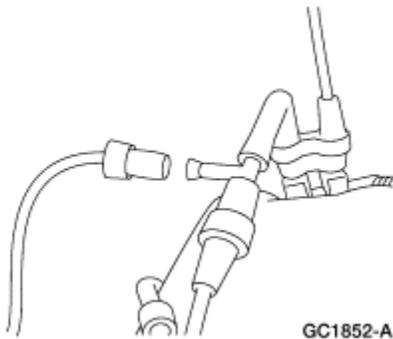
- Is the resistance between 90 and 115 ohms?

→ Yes

	<p>REPLACE the GEM; REFER to Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p> <p>→ No REPLACE the PVH solenoid; REFER to Section 204-01B. TEST the system for normal operation.</p>
C7 CHECK THE HUB LOCKS MANUALLY	
	<p>1 Raise and support the vehicle; refer to Section 100-02.</p>
	<p>2 Cycle both manual hub lock switches from LOCK to AUTO/FREE.</p>
	<p>3 Observe the front driveshaft while spinning both front wheels.</p>
	<p>4 Cycle both manual hub lock switches from AUTO/FREE to LOCK.</p>
	<p>5 Observe the front driveshaft while spinning both front wheels.</p>
	<ul style="list-style-type: none"> • Does the driveshaft rotate when the manual hub lock switches are in LOCK and remain stationary when the manual hub lock switches are in AUTO/FREE? <p>→ Yes GO to C8.</p> <p>→ No REPLACE the hublock. REFER to Section 204-01B. TEST the system for normal operation.</p>
C8 CHECK THE PVH SYSTEM FOR LEAKS — A/C SYSTEM DISCONNECTED	
<p>1</p> 	
<p>2</p>	<p>2 Disconnect the A/C vacuum input line.</p>

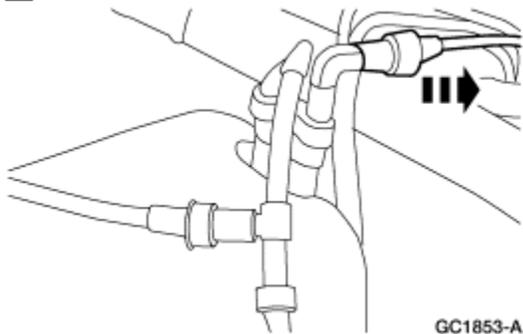


3



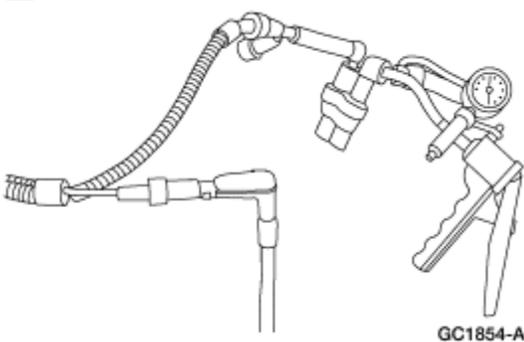
3 Plug the A/C vacuum line tee fitting.

4



4 Disconnect the vacuum reservoir input connector.

5



5 Connect a hand vacuum pump to the vacuum reservoir input connector and try to pull a vacuum to 15 in/Hg.

- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ Yes

RECONNECT the A/C vacuum input line and vacuum reservoir input line. GO to [C9](#) .

→ **No**

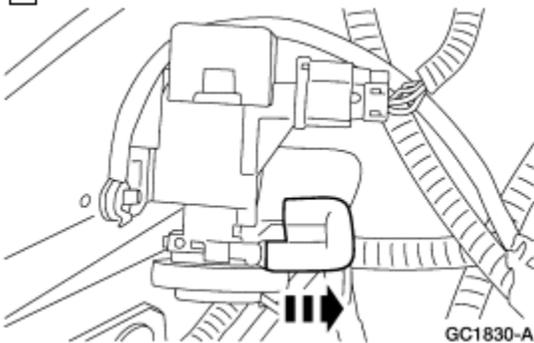
DIAGNOSE the A/C system. REFER to [Section 412-00](#). TEST the system for normal operation.

C9 LEAK TEST THE WHEEL ENDS AND LOWER VACUUM SYSTEM — SOLENOID OUTPUT

1

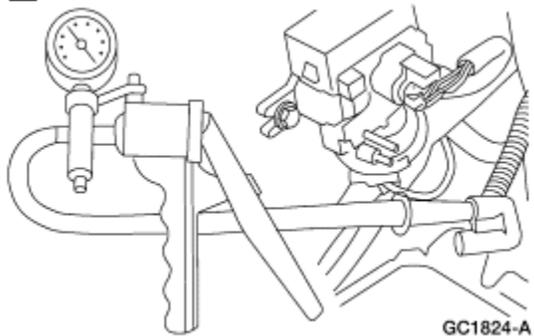


2



2 Disconnect the PVH solenoid vacuum connector.

3



3 **NOTE:** This step may require rapid pumping for up to 20 seconds.

Connect a hand vacuum pump to the PVH solenoid upper port hose connector and try to pull a vacuum to 15 in/Hg.

- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ **Yes**

GO to [C15](#).

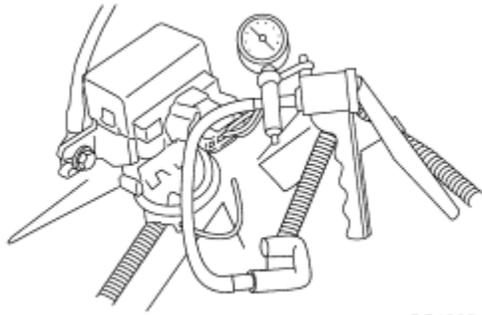
→ **No**

GO to [C10](#).

C10 LEAK TEST THE UPPER VACUUM SYSTEM — SOLENOID INPUT

1

1 Connect a hand vacuum pump to the PVH



GC1825-A

solenoid lower port hose connector and try to pull a vacuum to 15 in/Hg.

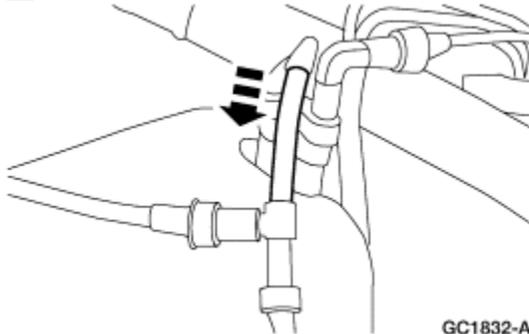
- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ Yes
GO to [C11](#).

→ No
GO to [C12](#).

C11 CHECK THE VACUUM SYSTEM RESERVOIR AND VACUUM LINES

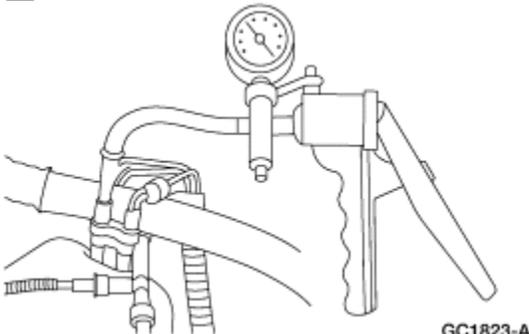
1



GC1832-A

1 Disconnect the vacuum reservoir output tee connector.

2



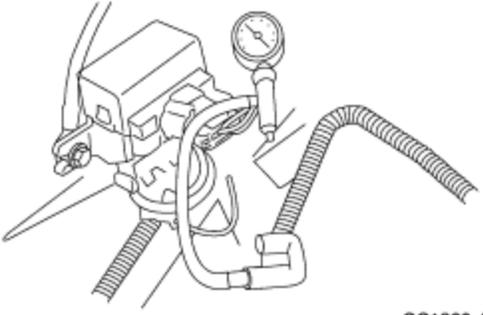
GC1823-A

2 Connect a hand vacuum pump to the vacuum reservoir output line connector and try to pull a vacuum to 15 in/Hg.

- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

	<p>→ Yes DIAGNOSE the engine vacuum system; REFER to Section 303-00.</p> <p>→ No REPAIR or REPLACE the vacuum reservoir output tee fitting or vacuum line between vacuum reservoir tee fitting and PVH vacuum solenoid. TEST the system for normal operation.</p>
--	---

C12 CHECK THE PVH VACUUM SYSTEM FOR ENGINE VACUUM

<p>1</p>  <p>GC1826-A</p>	<p>1 Connect a vacuum gauge to the PVH solenoid lower port hose connector and measure the vacuum level.</p>
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<p>2</p> 	
---	--

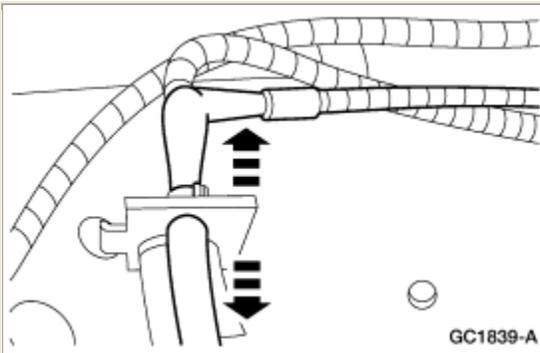
	<ul style="list-style-type: none"> • Is the vacuum level greater than 11 in/Hg? <p>→ Yes RECONNECT the PVH solenoid vacuum connector. GO to C13 .</p> <p>→ No GO to C14.</p>
--	--

C13 CHECK THE PVH SOLENOID FOR PROPER VACUUM OUTPUT LEVELS — 4X4 DISENGAGED

NOTE: This step requires the use of a calibrated vacuum gauge that is accurate to within a minimum of 0.1 in/Hg. It is recommended that Pressure/Vacuum Module 105-R0099 or equivalent be used for this check.

<p>1</p> 	
--	--

<p>2</p>	<p>2 Disconnect the RH wheel end vacuum line</p>
----------	--



connector from the crossmember vacuum line connector.

3



4 Connect a calibrated vacuum gauge to the crossmember vacuum line connector and measure the vacuum while switching the 4X4 mode switch from 4X4 HIGH to 2WD.

- **Does the vacuum gauge indicate between 5.85 and 7.1 in/Hg after six seconds but not longer than 60 seconds after switching the 4X4 mode switch to 2WD?**

→ **Yes**

REMOVE the vacuum gauge. RECONNECT all vacuum lines. TEST the system for normal operation. If the 4X4 system still does not operate properly, CLARIFY the customer concern and RETURN to Symptom Chart.

→ **No**

REPLACE the PVH solenoid; REFER to [Section 204-01B](#). TEST the system for normal operation.

C14 CHECK THE VACUUM RESERVOIR INPUT VACUUM LINE FOR VACUUM

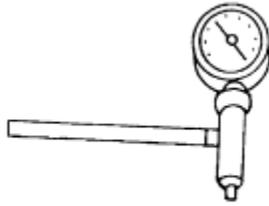
1



2 Disconnect the engine vacuum output connector (gas) or the vacuum pump output connector (diesel).

3

3 Connect a vacuum gauge to the engine vacuum output connector (gas) or the vacuum pump output connector (diesel) and measure the vacuum level.



GC1722-A

- **Is the vacuum level greater than 11 in/Hg?**

→ **Yes**

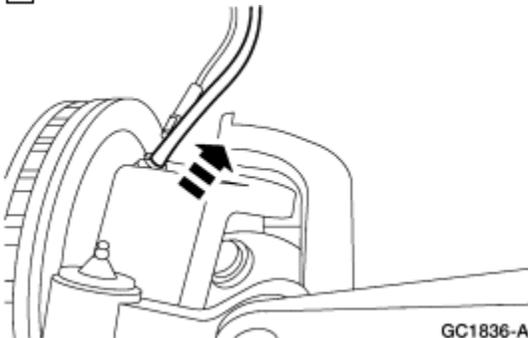
REPAIR or REPLACE the vacuum reservoir or vacuum lines between the PVH solenoid vacuum input line and vacuum reservoir input line. TEST the system for normal operation.

→ **No**

DIAGNOSE the engine vacuum system; REFER to [Section 303-00](#).

C15 CHECK THE RH SIDE WHEEL END FOR LEAKS

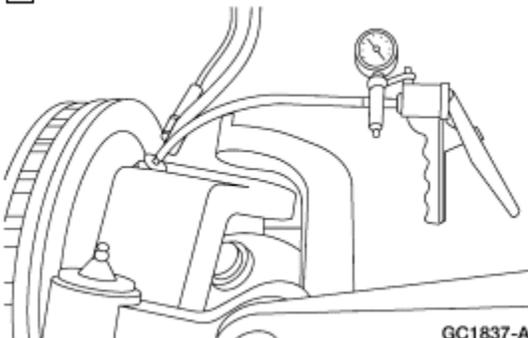
1



GC1836-A

- 1 Disconnect the RH wheel end vacuum line from the wheel end.

2



GC1837-A

- 2 **NOTE:** This step may require rapid pumping for up to 10 seconds.

Connect a hand vacuum pump to the RH wheel end vacuum line fitting and try to pull a vacuum to 15 in/Hg.

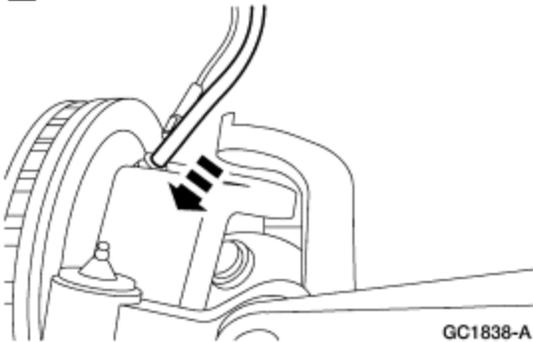
- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ Yes
GO to [C19](#).

→ No
GO to [C16](#).

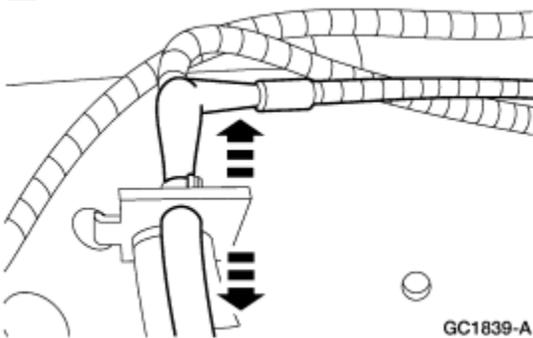
C16 CHECK THE RH WHEEL END VACUUM LINE FOR VACUUM LEAKS

1



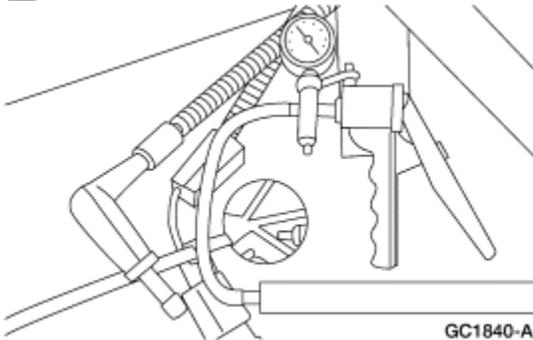
1 Reconnect the RH wheel end vacuum line to the wheel end.

2



2 Disconnect the RH wheel end vacuum line from the crossmember vacuum line connector.

3



3 **NOTE:** This step may require rapid pumping for up to 10 seconds.

Connect a hand vacuum pump to the RH wheel end vacuum line and try to pull a vacuum to 15 in/Hg.

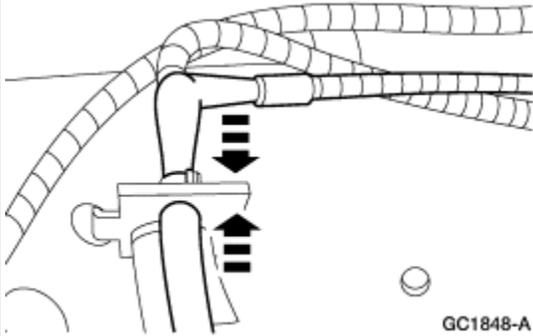
- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ **Yes**
REPAIR or REPLACE the RH wheel end vacuum line. TEST the system for normal operation.

→ **No**
GO to [C17](#).

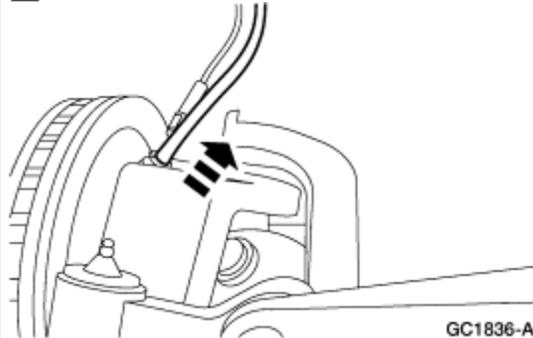
C17 CHECK THE LH SIDE WHEEL END FOR LEAKS

1



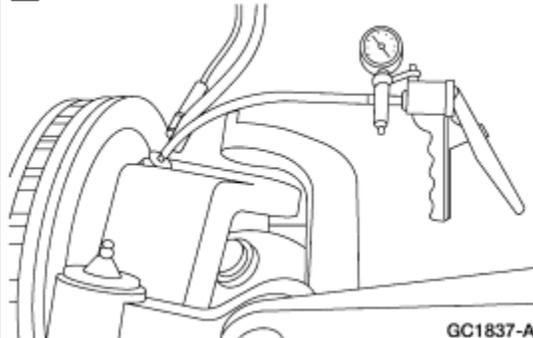
1 Reconnect the RH wheel end vacuum line to the crossmember vacuum line connector.

2



2 Disconnect the LH wheel end vacuum line from the wheel end.

3



3 **NOTE:** This step may require rapid pumping for up to 10 seconds.
Connect a hand vacuum pump to the LH wheel end vacuum line fitting and try to pull a vacuum to 15 in/Hg.

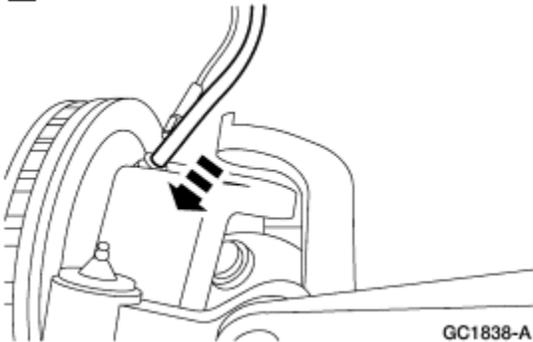
- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ **Yes**
GO to [C19](#).

→ **No**
GO to [C18](#).

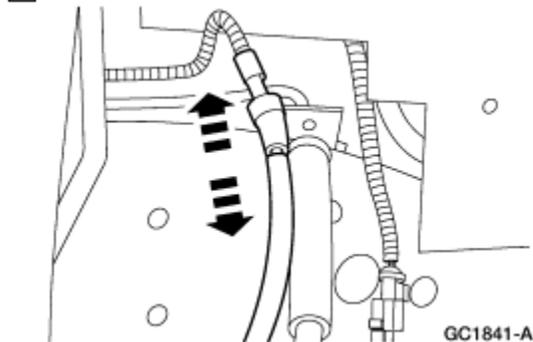
C18 CHECK THE LH WHEEL END VACUUM LINE FOR LEAKS

1



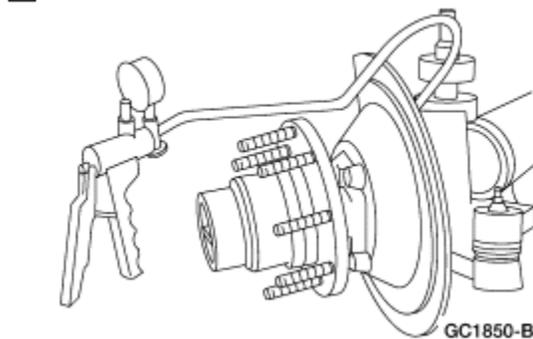
1 Reconnect the LH wheel end vacuum line to the wheel end.

2



2 Disconnect the LH wheel end vacuum line from the crossmember vacuum harness.

3



3 **NOTE:** This step may require rapid pumping for up to 10 seconds.
Connect a hand vacuum pump to the LH wheel end vacuum supply hose and try to pull a vacuum to 15 in/Hg.

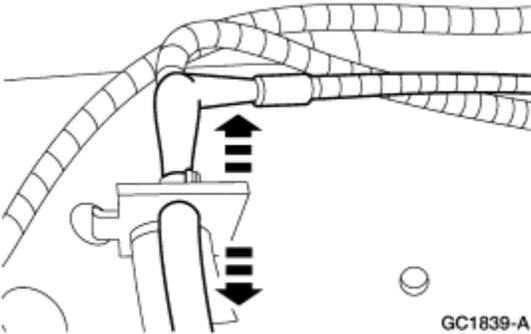
- **Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?**

→ **Yes**
REPAIR or REPLACE the LH wheel end vacuum line. TEST the system for normal operation.

→ **No**
REPAIR or REPLACE the crossmember vacuum harness. TEST the system for normal operation.

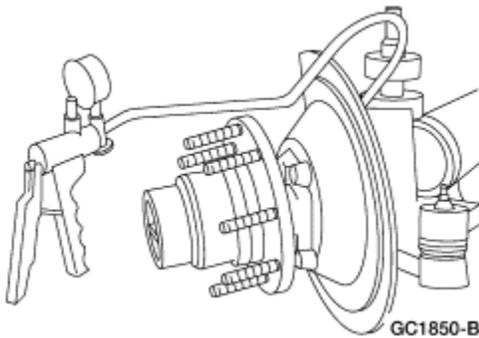
C19 CHECK THE WHEEL END FOR TYPE OF VACUUM LEAK — STATIC OR DYNAMIC

1



1 Disconnect the wheel end vacuum line connector from the crossmember vacuum line.

2



2 **NOTE:** This step may require rapid pumping for up to 20 seconds.

Connect a hand vacuum pump to the wheel end vacuum line and try to pull a vacuum to 15 in/Hg.

3 Observe the vacuum gauge for at least 60 seconds while the wheel is stationary.

4 Observe the vacuum gauge for at least 60 seconds while rotating the wheel.

- **Does the vacuum drop exceed 0.5 in/Hg in 60 seconds when the wheel is stationary?**

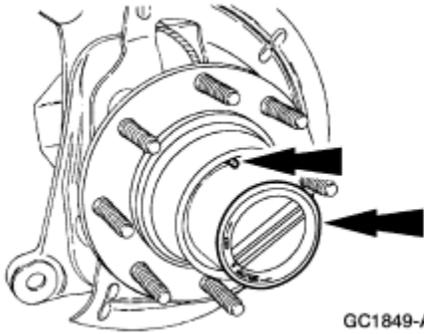
→ **Yes**
GO to [C20](#).

→ **No**
GO to [C21](#).

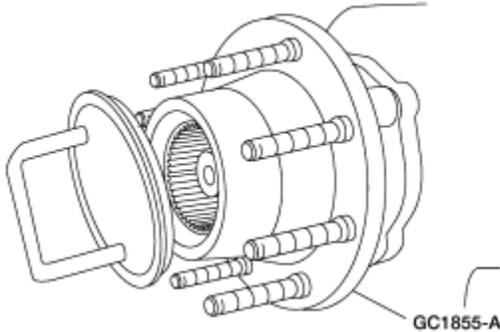
C20 CHECK THE HUBLOCK FOR VACUUM LEAKS

1

1 Remove the retainer ring and hublock assembly.

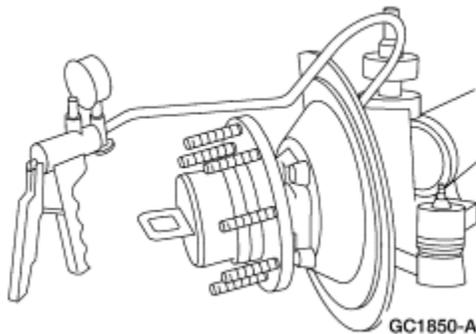


2



2 Connect a suitable vacuum cap (P/N 11A02) to the wheel end.

3



3 Connect a hand vacuum pump to the wheel end vacuum supply hose and try to pull a vacuum to 10-12 in/Hg.

- Does the vacuum drop exceed 0.5 in/Hg in 60 seconds?

→ **Yes**

REPLACE the wheel hub O-ring. TEST the system for normal operation. If the leak persists, REPLACE the RDS knuckle seal. TEST the system for normal operation. If the leak persists, REPLACE the wheel hub. REFER to [Section 204-01B](#). TEST the system for normal operation.

→ **No**

REINSTALL the hublock using a new hublock O-ring. TEST the system for normal operation. If the

	leak persists, REPLACE the hublock. TEST the system for normal operation.
C21 ISOLATE THE DYNAMIC VACUUM LEAK — RDS KNUCKLE SEAL OR WHEEL HUB SEAL	
	1 Verify the vehicle is in 2WD rotating the front wheel and ensuring the driveshaft does not spin.
	2 Connect a hand vacuum pump to the wheel end vacuum line and try to pull a vacuum to 15 in/Hg.
	3 Observe the vacuum gauge for at least 60 seconds while rotating the wheel.
	4 Cycle the manual hublock switch from AUTO/FREE to LOCK.
	5 Connect a hand vacuum pump to the wheel end vacuum line and try to pull a vacuum to 15 in/Hg.
	6 Observe the vacuum gauge for at least 60 seconds while rotating the wheel.
	<ul style="list-style-type: none"> • Does the vacuum drop exceed 0.5 in/Hg in 60 seconds only when the manual hublock switch is in the LOCK position? <p>→ Yes REPLACE the RDS knuckle seal. REFER to Section 204-01B. TEST the system for normal operation.</p> <p>→ No REPLACE the wheel hub; REFER to Section 204-01B. TEST the system for normal operation.</p>

PINPOINT TEST D: THE 4X4 HIGH or 4X4 LOW RANGE INDICATOR DO/DOES NOT OPERATE PROPERLY

CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK THE IGNITION STATES — MONITOR THE GEM PID IGN_GEM	
1 	
2	

 <p>NGS</p>	
	<p>3 NOTE: If the vehicle is equipped with a manual transmission, depress the clutch pedal while turning the ignition switch to START.</p> <p>Monitor the GEM PID IGN_GEM and rotate the ignition switch through the START, RUN, OFF, and ACC positions.</p>
	<ul style="list-style-type: none"> • Do the PID values agree with the ignition switch positions? <p>→ Yes GO to D2.</p> <p>→ No REFER to Section 417-02.</p>
<p>D2 RETRIEVE THE DIAGNOSTIC TROUBLE CODES (DTCs)</p>	
	<p>1 Retrieve and document continuous DTCs.</p>
 <p>Clear Continuous DTCs</p>	
 <p>GEM On-Demand Self-Test</p>	
	<ul style="list-style-type: none"> • Are any DTCs recorded? <p>→ Yes If DTC B1342, REPLACE the GEM; REFER to</p>

	<p>Section 419-10. CLEAR the DTCs. TEST the system for normal operation.</p> <p>If DTC P1804, GO to D4 .</p> <p>If DTC P1806, GO to D4 .</p> <p>If DTC P1808, GO to D5 .</p> <p>If DTC P1810, GO to D5 .</p> <p>→ No GO to D3.</p>
--	---

D3 VERIFY THE INOPERATIVE INDICATOR LAMP

<p>1</p> 	
	2 Place the 4WD mode switch in 4X4 HIGH.
	3 Verify the 4X4 HIGH indicator illuminates.
	4 Depress the brake pedal, depress the clutch (M/T) or place the shift lever into NEUTRAL (A/T) and place the 4WD mode switch in 4X4 LOW.
	5 Verify the 4X4 LOW indicator illuminates.
	<ul style="list-style-type: none"> • Is only the 4X4 HIGH indicator inoperative? <p>→ Yes GO to D4.</p> <p>→ No If only the 4X4 LOW indicator is inoperative, GO to D5 .</p> <p>If both the 4X4 HIGH and 4X4 LOW indicators are inoperative, REFER to Section 413-01.</p>

D4 CHECK THE 4x4 HIGH INDICATOR

<p>1</p> 	<p>1 Trigger the GEM active command HIGH LAMP ON then OFF.</p>
--	--

	<ul style="list-style-type: none"> • Does the 4X4 HIGH indicator illuminate then go off? <p>→ Yes GO to D5.</p> <p>→ No If the 4X4 HIGH indicator remains on, GO to D13 .</p> <p>If the 4X4 HIGH indicator does not illuminate, GO to D9 .</p>
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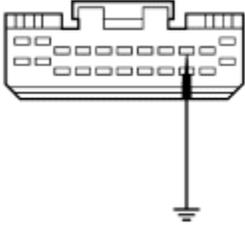
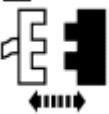
D5 CHECK THE 4x4 LOW INDICATOR

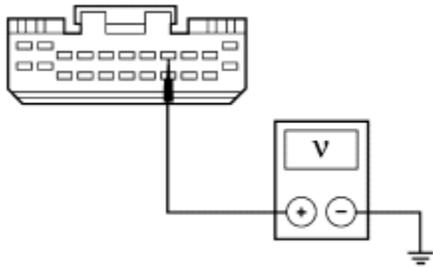
	<p>1 Trigger the GEM active command LOWLAMP ON then OFF.</p>
---	---

	<ul style="list-style-type: none"> • Does the 4X4 LOW indicator illuminate then go off? <p>→ Yes Indicators are OK. GO to Pinpoint Test A.</p> <p>→ No If the 4X4 LOW indicator remains on, GO to D12 .</p> <p>If the 4X4 LOW indicator does not illuminate, GO to D6 .</p>
--	---

D6 CHECK THE GEM OUTPUT TO THE INSTRUMENT CLUSTER

<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p>	

	
<p>4</p>  <p>GC1814-A</p>	<p>4 Connect a fused (3A) jumper wire between GEM C247-9, circuit 210 (LB), and ground.</p>
	<ul style="list-style-type: none"> • Does the 4X4 HIGH indicator illuminate? <p>→ Yes REPLACE the GEM; REFER to Section 419-10. TEST the system for normal operation.</p> <p>→ No If the fuse opens or the indicator does not illuminate, GO to D7.</p>
<p>D7 CHECK CIRCUIT 975 (BR/Y) FOR SHORT TO POWER</p>	
<p>1</p> 	
<p>2</p>  <p>Instrument Cluster C253</p>	
<p>3</p> 	
<p>4</p>	<p>4 Measure the voltage between GEM C247-8, circuit 975 (BR/Y), and ground.</p>



GC1815-A

- **Is the voltage greater than 10 volts?**

→ **Yes**

REPAIR circuit 975 (BR/Y). TEST the system for normal operation.

→ **No**

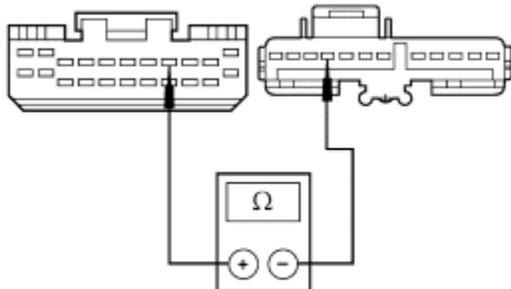
GO to [D8](#).

D8 CHECK CIRCUIT 975 (BR/Y) FOR OPEN

1



2



GC1816-A

- 2 Measure the resistance between GEM C247-8, circuit 975 (BR/Y), and instrument cluster C253-9, circuit 975 (BR/Y).

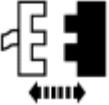
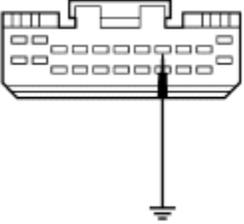
- **Is the resistance less than 5 ohms?**

→ **Yes**

CHECK the indicator bulbs. If OK, REPLACE the instrument cluster. TEST the system for normal operation.

→ **No**

REPAIR circuit 975 (BR/Y). TEST the system for

	normal operation.
D9 CHECK THE INSTRUMENT CLUSTER	
<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p> 	
<p>4</p>  <p>GC1817-A</p>	<p>4</p> <p>Connect a fused (3A) jumper wire between GEM C247-8, circuit 975 (BR/Y), and ground.</p>
	<ul style="list-style-type: none"> • Does the 4X4 LOW indicator illuminate? <p>→ Yes REPLACE the GEM; REFER to Section 419-10. TEST the system for normal operation.</p> <p>→ No If the fuse opens or the indicator does not illuminate, GO to D10 .</p>
D10 CHECK CIRCUIT 210 (LB) FOR SHORT TO POWER	
<p>1</p> 	
<p>2</p>	

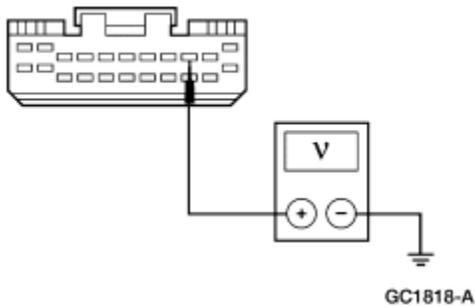


Instrument Cluster C253

3



4



4 Measure the voltage between GEM C247-9, circuit 210 (LB), and ground.

- **Is any voltage indicated?**

→ **Yes**
REPAIR circuit 210 (LB). TEST the system for normal operation.

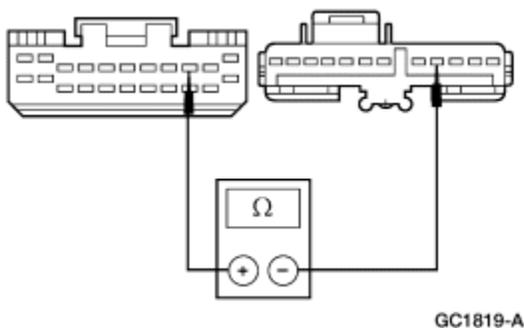
→ **No**
GO to [D11](#).

D11 CHECK CIRCUIT 210 (LB) FOR OPEN

1



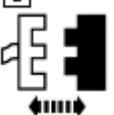
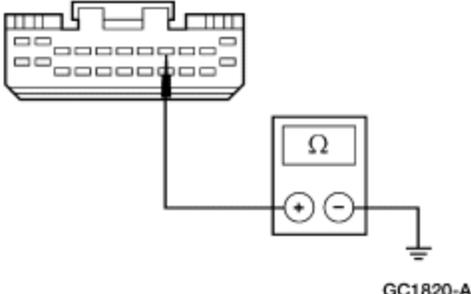
2



2 Measure the resistance between GEM C247-9, circuit 210 (LB), and instrument cluster C253-4, circuit 210 (LB).

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes CHECK the indicator bulbs. If OK, REPLACE the instrument cluster. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 210 (LB). TEST the system for normal operation.</p>
--	--

D12 CHECK CIRCUIT 975 (BR/Y) FOR SHORT TO GROUND

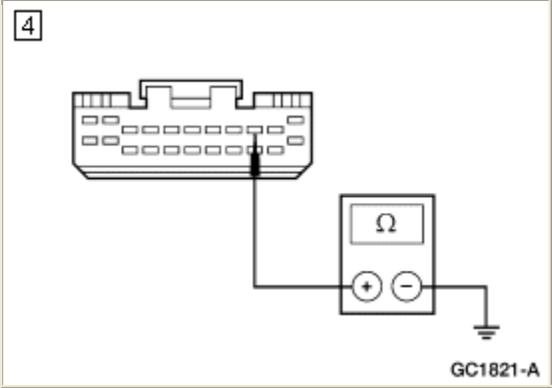
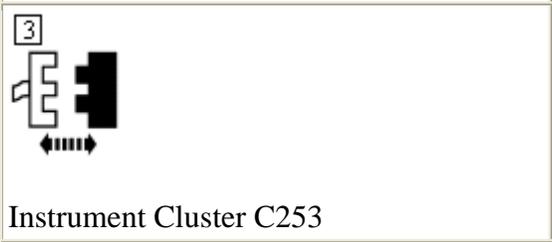
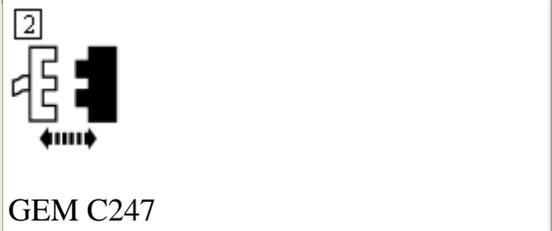
<p>1</p> 	
<p>2</p>  <p>GEM C247</p>	
<p>3</p>  <p>Instrument Cluster C253</p>	
<p>4</p>  <p>GC1820-A</p>	<p>4 Measure the resistance between GEM C247-9, circuit 975 (BR/Y), and ground.</p>

	<ul style="list-style-type: none"> • Is the resistance greater than 10,000 ohms? <p>→ Yes REPLACE the GEM. REFER to Section 419-10.</p>
--	--

TEST the system for normal operation.

→ **No**
 REPAIR circuit 975 (BR/Y). TEST the system for normal operation.

D13 CHECK CIRCUIT 210 (LB) FOR SHORT TO GROUND



4 Measure the resistance between GEM C247-9, circuit 210 (LB), and ground.

• **Is the resistance greater than 10,000 ohms?**

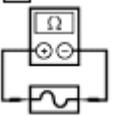
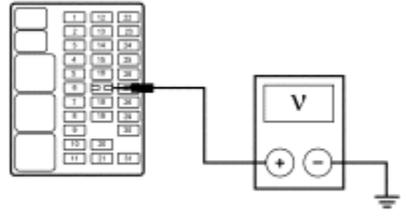
→ **Yes**
 REPLACE the GEM. REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**
 REPAIR circuit 210 (LB). TEST the system for normal operation.

→ **Yes**
 REPLACE the GEM. REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**
 REPAIR circuit 210 (LB). TEST the system for normal operation.

PINPOINT TEST E: NO COMMUNICATION WITH THE MODULE — GENERIC ELECTRONIC MODULE

CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CHECK FUSE JUNCTION PANEL FUSE 15 (5A)	
<p>1</p> 	
<p>2</p>  <p>Fuse 15 (5A)</p>	
	<ul style="list-style-type: none"> • Is the fuse OK? <p>→ Yes REINSTALL the fuse. GO to E2 .</p> <p>→ No GO to E3.</p>
E2 CHECK FOR VOLTAGE AT FUSE/JUNCTION PANEL FUSE 15 (5A)	
<p>1</p>  <p>GK7657-A</p>	<p>1 Measure the voltage between fuse junction panel fuse 15 (5A) and ground.</p>
	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to E4.</p> <p>→ No GO to E5.</p>

E3 CHECK FUSE JUNCTION PANEL FOR SHORT TO GROUND

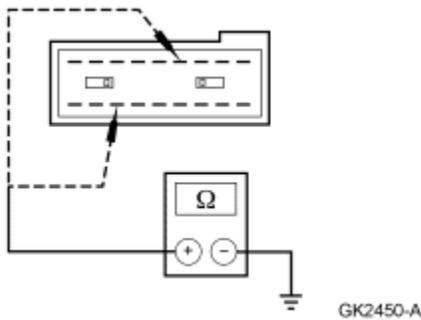


Fuse 15 (5A)



GEM C241

3



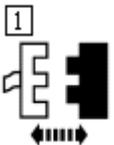
3 Measure the resistance between fuse junction panel C241, terminal 4, and ground; and between fuse junction panel C241, terminal 16, and ground.

- Are the resistances greater than 10,000 ohms?

→ Yes
GO to [E16](#).

→ No
REPLACE the fuse junction panel. TEST the system for normal operation.

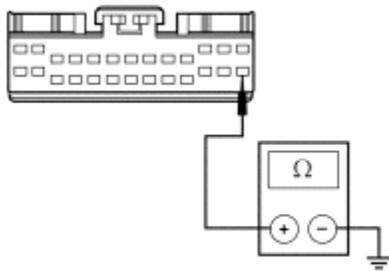
E4 CHECK CIRCUIT 676 (PK/O) FOR OPEN



GEM C239

2

2 Measure the resistance between GEM C239-26, circuit 676 (PK/O), and ground.



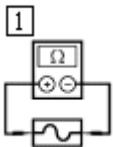
GK6309-A

- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [E7](#).

→ **No**
REPAIR circuit 676 (PK/O). TEST the system for normal operation.

E5 CHECK THE POWER DISTRIBUTION BOX FUSE 22 (50A)



Fuse 22 (50A)

2 Remove and inspect the fuse.

- **Is the fuse OK?**

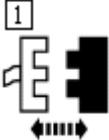
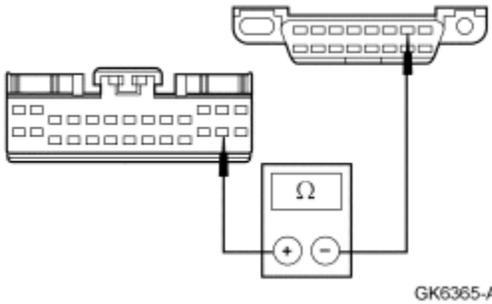
→ **Yes**
REINSTALL the fuse. GO to [E6](#) .

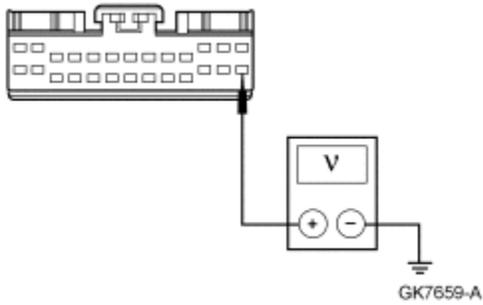
→ **No**
REPAIR circuit 1052 (T/BK). TEST the system for normal operation.

E6 CHECK CIRCUIT 1052 (T/BK) FOR OPEN

1 Measure the voltage between power distribution box fuse 22 (50A) and ground.

- **Is the voltage greater than 10 volts?**

	<p>→ Yes REPAIR circuit 1052 (T/BK). TEST the system for normal operation.</p> <p>→ No REPAIR/REPLACE the power distribution box. TEST the system for normal operation.</p>
<p>E7 CHECK CIRCUIT 70 (LB/W) FOR OPEN</p>	
<p>1</p>  <p>GEM C239</p>	
	<p>2 Verify the NGS is disconnected.</p>
<p>3</p> 	<p>3 Measure the resistance between GEM C239-25, circuit 70 (LB/W), and DLC C227-7, circuit 70 (LB/W).</p>
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to E8.</p> <p>→ No REPAIR circuit 70 (LB/W). TEST the system for normal operation.</p>
<p>E8 CHECK CIRCUIT 676 (PK/O) FOR SHORT TO POWER</p>	
<p>1</p>	<p>1 Measure the voltage between GEM C239-26, circuit 676 (PK/O), and ground.</p>



- **Is the voltage greater than 10 volts?**

→ **Yes**

REPAIR circuit 676 (PK/O). REPLACE the GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**

If equipped with ESOF, GO to [E9](#) .

If not equipped with ESOF, GO to [E11](#) .

E9 CHECK CIRCUIT 465 (W/LB)

1



2



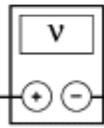
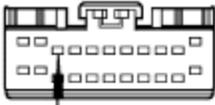
GEM C247

3



4

4 Measure the voltage between GEM C247-3, circuit 465 (W/LB), and ground.



GK7660-A

- Is the voltage greater than 10 volts?

→ Yes
GO to [E10](#).

→ No
GO to [E11](#).

E10 CHECK CIRCUIT 465 (W/LB) FOR SHORT TO POWER

1



2

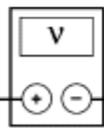
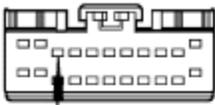


4WD Mode Switch C246

3



4

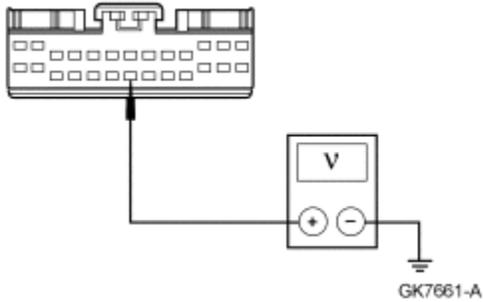


GK7660-A

4 Measure the voltage between GEM C247-3, circuit 465 (W/LB), and ground.

	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes REPAIR circuit 465 (W/LB). REPLACE the GEM; REFER to Section 419-10. TEST the system for normal operation.</p> <p>→ No REPLACE the 4WD mode select switch. REPLACE the GEM; REFER to Section 419-10. TEST the system for normal operation.</p>
--	--

E11 CHECK CIRCUIT 682 (DB) FOR SHORT TO POWER

<p>1</p> 	<p>1 Measure the voltage between GEM C239-20, circuit 682 (DB), and ground.</p>
---	---

	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to E12.</p> <p>→ No GO to E13.</p>
--	---

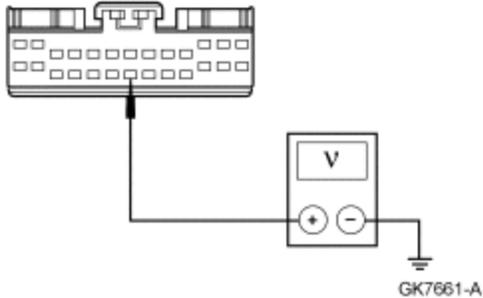
E12 CHECK CIRCUIT 682 (DB) FOR SHORT TO POWER (MULTI-FUNCTION SWITCH DISCONNECTED)

<p>1</p> 	
<p>2</p>  <p>Multi-Function Switch C230</p>	

3



4



4 Measure the voltage between GEM C239-20, circuit 682 (DB), and ground.

- **Is the voltage greater than 10 volts?**

→ **Yes**

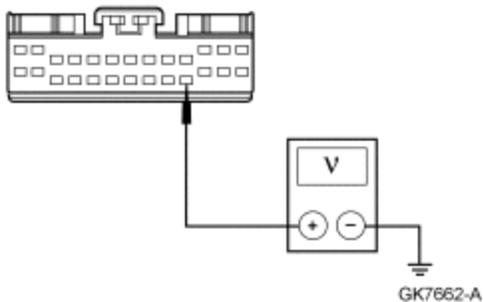
REPAIR circuit 682 (DB). REPLACE the GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**

REPLACE the wiper multi-function switch. REPLACE the GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

E13 CHECK CIRCUIT 684 (PK/Y) FOR SHORT TO POWER

1



1 Measure the voltage between GEM C239-23, circuit 684 (PK/Y), and ground.

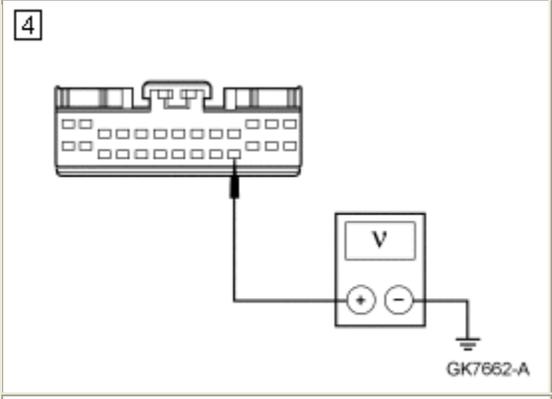
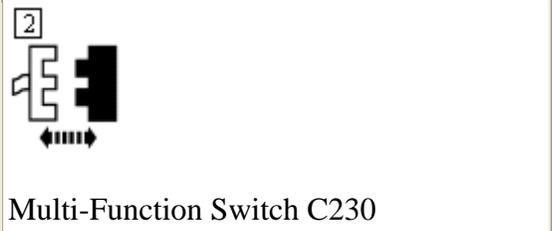
- **Is the voltage greater than 10 volts?**

→ **Yes**

GO to [E14](#).

→ **No**
 If the vehicle is not equipped with anti-lock brake control module, GO to [E15](#) .
 If the vehicle is equipped with anti-lock brake control module, REPLACE the GEM. REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

E14 CHECK CIRCUIT 684 (PK/Y) FOR SHORT TO POWER (MULTI-FUNCTION SWITCH DISCONNECTED)



4 Measure the voltage between GEM C239-23, circuit 684 (PK/Y), and ground.

• **Is the voltage greater than 10 volts?**

→ **Yes**
 REPAIR circuit 684 (PK/Y). REPLACE the GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**
 REPLACE the multi-function switch. REPLACE the

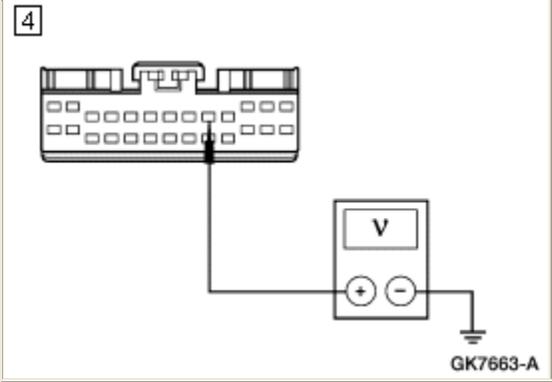
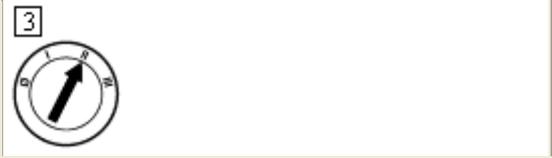
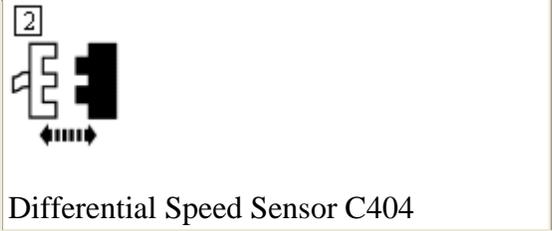
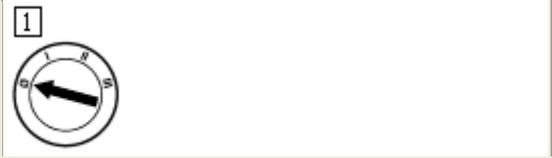
• **Is the voltage greater than 10 volts?**

→ **Yes**
 REPAIR circuit 684 (PK/Y). REPLACE the GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

→ **No**
 REPLACE the multi-function switch. REPLACE the

GEM; REFER to [Section 419-10](#). TEST the system for normal operation.

E15 CHECK CIRCUIT 519 (LG/BK) FOR SHORT TO POWER



4 Measure the voltage between GEM C239-9, circuit 519 (LG/BK), and ground.

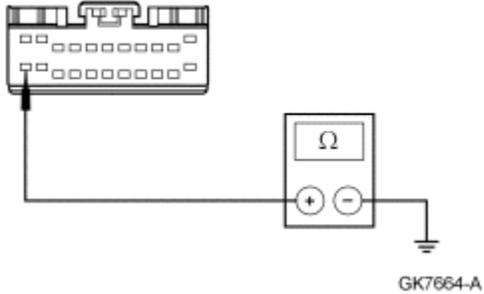
• Is the voltage greater than 10 volts?

→ Yes
REPAIR circuit 519 (LG/BK). REPLACE the GEM. TEST the system for normal operation.

→ No
REPLACE the GEM. REFER to [Section 419-10](#). CLEAR the DTCs. TEST the system for normal operation.

E16 CHECK THE HORN RELAY

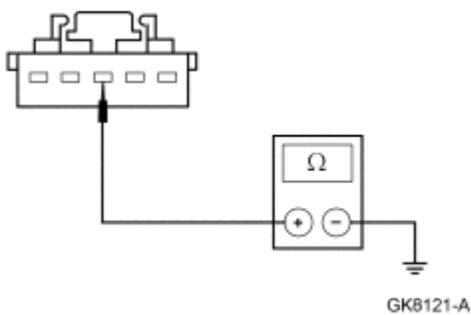


Horn Relay	
	<p>2 Check the horn relay; refer to Component Test.</p>
	<ul style="list-style-type: none"> • Is the horn relay OK? <p>→ Yes GO to E17.</p> <p>→ No REPLACE the horn relay. TEST the system for normal operation.</p>
<p>E17 CHECK CIRCUIT 810 (R/LG) FOR SHORT TO GROUND</p>	
<p>1</p>  <p>GEM C241</p>	
<p>2</p>  <p>GEM C247</p>	
<p>3</p>  <p>BPP Switch C279</p>	
<p>4</p>  <p>GK7664-A</p>	<p>4 Measure the resistance between GEM C247-12, circuit 810 (R/LG), and ground.</p>

	<ul style="list-style-type: none"> • Is the resistance greater than 10,000 ohms? <p>→ Yes GO to E18.</p> <p>→ No REPAIR circuit 810 (R/LG). TEST the system for normal operation.</p>
--	---

E18 CHECK CIRCUIT 22 (LB/BK) FOR SHORT TO GROUND

<p>1</p>  <p>Fuse Junction Panel C243</p>	
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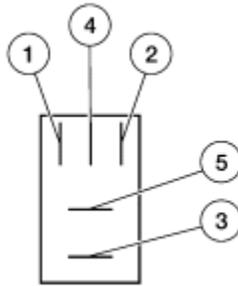
<p>2</p>  <p>GKB121-A</p>	<p>2 Measure the resistance between brake pedal position (BPP) switch C279-3, circuit 22 (LB/BK), and ground.</p>
---	---

	<ul style="list-style-type: none"> • Is the resistance greater than 10,000 ohms? <p>→ Yes REPLACE the BPP switch. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 22 (LB/BK). TEST the system for normal operation.</p>
--	--

Component Test

Relay — Micro ISO

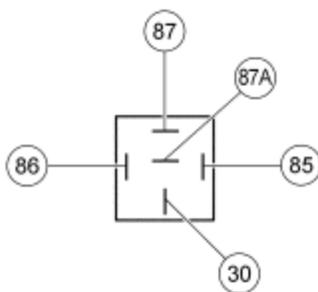
Use 73 Digital Multimeter to check for continuity between terminal 2 and all other terminals. If resistance is 5 ohms or less between terminal 2 and any other terminal, replace the relay. If resistance is greater than 5 ohms, continue with the test. Use two jumper wires to connect relay terminals 1 and 3 directly to the positive battery terminal. With 73 Digital Multimeter set in volts position, check for voltage at terminal 4. If battery voltage is not indicated, replace the relay. If battery voltage is indicated, connect a third jumper wire to terminal 2 and ground the jumper wire to a known good ground. Check for voltage at terminal 5. If battery voltage is not indicated, replace the relay.



GK2145-A

Relay — Mini ISO

Use 73 Digital Multimeter to check for continuity between terminal 85 and all other terminals. If resistance is 5 ohms or less between terminal 85 and any other terminal, replace the relay. If resistance is greater than 5 ohms, continue with the test. Use two jumper wires to connect relay terminals 86 and 30 directly to the positive battery terminal. Use 73 Digital Multimeter set in the volts position to check for voltage at terminal 87A. If battery voltage is not indicated, replace the relay. If battery voltage is indicated, connect a third jumper wire to terminal 85 and ground the jumper wire to a known good ground. Check for voltage at terminal 87. If battery voltage is not indicated, replace the relay.



GK4412-A

SECTION 308-07B:
Transfer Case

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Transfer Case](#)

DIAGNOSIS AND TESTING

[Transfer Case](#)

GENERAL PROCEDURES

[Transfer Case Draining and Filling](#)

IN-VEHICLE REPAIR

[Seal—Rear Output](#)

[Seal—Front Output](#)

[Transfer Case Shift Lever](#)

[Shift Switch](#)

[Indicator Switch—Three Position](#)

[Transfer Case Shift Motor](#)

DISASSEMBLY AND ASSEMBLY

[Transfer Case](#)

REMOVAL

[Transfer Case](#)

INSTALLATION

[Transfer Case](#)

General Specifications	
Item	Specification
Fluids	
Multi-Purpose Grease DOAZ-19584-AA	ESB-M1C93-B and ESR-M1C159-A
Motorcraft MERCON® Multi-Purpose ATF XT-2-QDX	MERCON®
Sealants	
Pipe Sealant with Teflon® D8AZ-19554-A	WSK-M2G350-A2 and ESR-M18P7-A
Silicone Rubber F4AZ-19562-B	WSE-M4G323-A1
Cleaner	
Metal Surface Cleaner F4A3-19A536-RA	WSE-M5B392-A

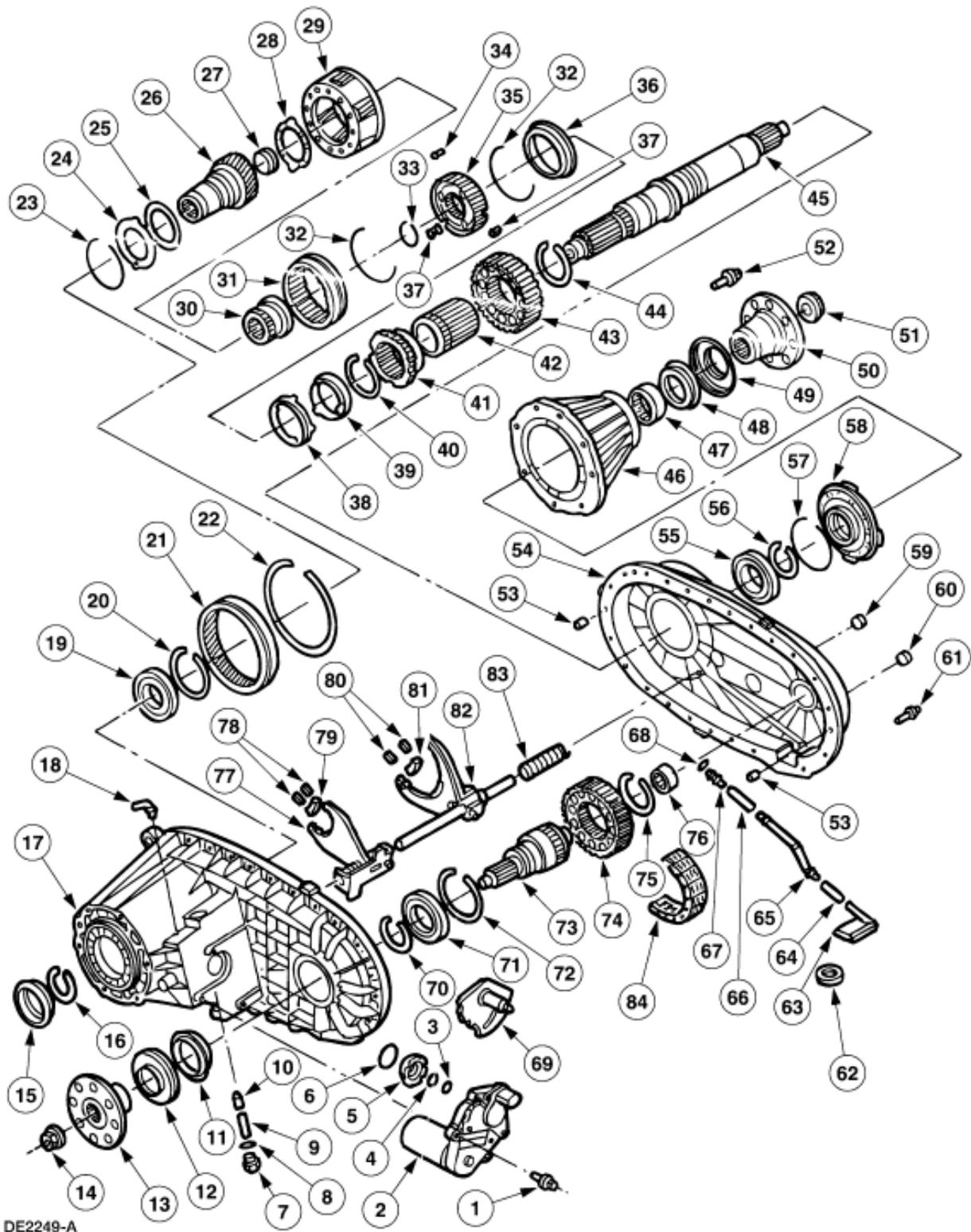
Torque Specifications		
Description	Nm	lb-ft
Transfer case control lever assembly bolts	115	85
Shift lever-to-control lever assembly bolt	28	21
Sector support	31	23
Poppet screw	20	15
Case bolts	31	23
Case bolts at dowel	24	18
Front output nut	223	165
Rear output nut	251	186
Shift lever nut	20	15
Shift motor bolts	20	15
Three position indicator switch	27	20
Drain and fill plugs	27	20
Transfer case mounting bolts	50	37

Transfer Case

The New Venture Gear transfer cases are either manual or electric shift. These transfer cases are specifically designed to withstand high engine torque loads under all modes of operation.

When in the 4 x 4 mode of operation, torque is transferred from the main input shaft through a high load capacity chain link belt to the transfer case front output shaft. The front output driveshaft then transfers this torque to the front differential.

Electric Shift Transfer Case



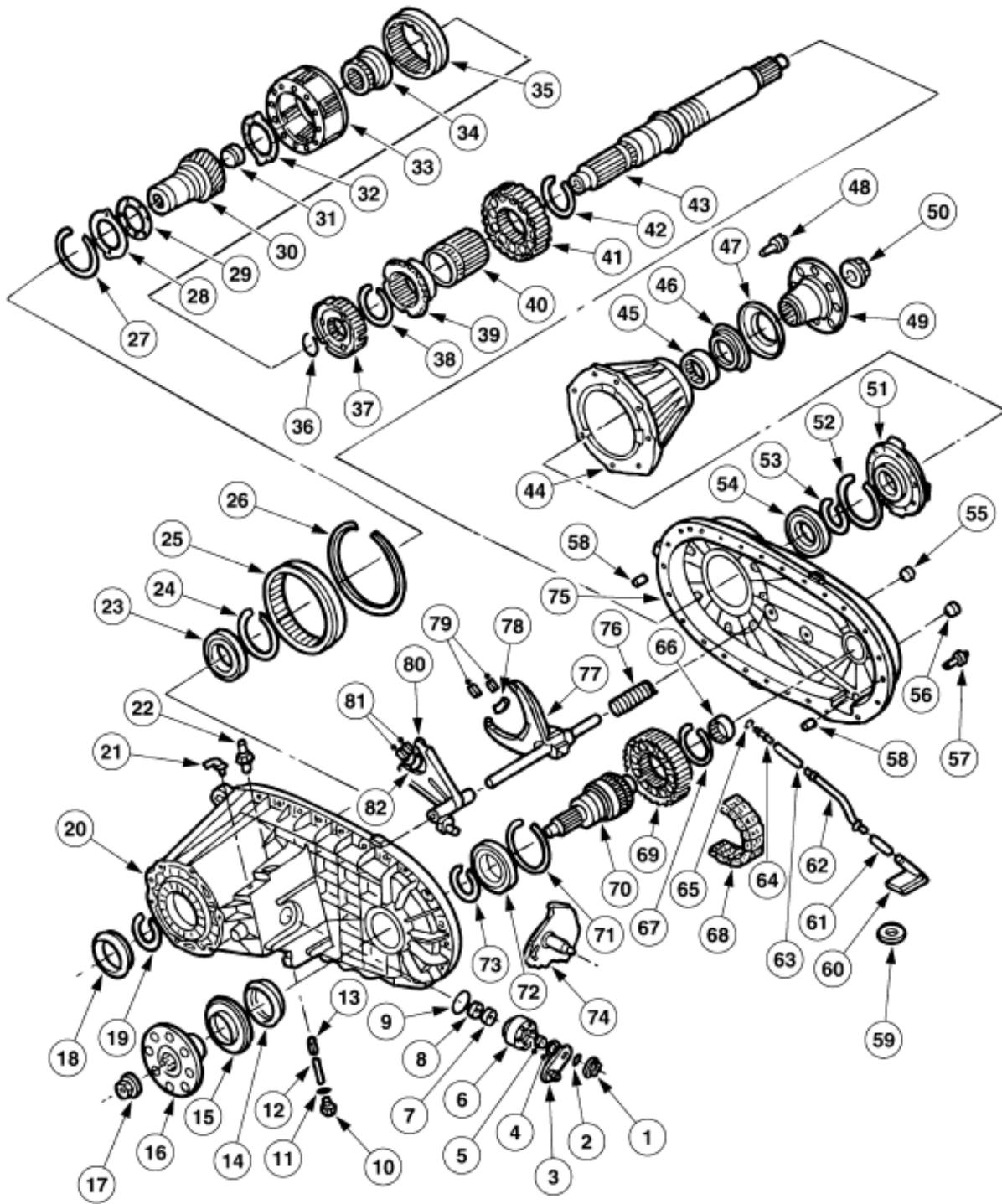
Item	Description
1	Bolt
2	Gearmotor Encoder Assy

3	Plastic Retainer
4	O-Ring Motor Seal
5	Motor Adapter
6	O-Ring Support Seal
7	Poppet Screw
8	O-Ring Seal
9	Spring
10	Poppet
11	Front Output Seal
12	Slinger
13	Front Flange
14	Hex Lock Nut
15	Input Seal
16	Input Bearing Retaining Ring
17	Front Half Case
18	Vent
19	Ball Bearing, Front Input
20	Front Input Bearing Retaining Ring
21	Annulus Gear
22	Annulus Retaining Ring
23	Lock Plate Retaining Ring
24	Lock Plate
25	Front Input Gear Thrust Washer
26	Input Gear
27	Pilot Bearing
28	Rear Input Gear Thrust Washer
29	Planetary Carrier Assy
30	Range Shift Sleeve
31	Synchronizer Sleeve
32	Synchronizer Spring
33	Hub Retaining Ring
34	Synchronizer Strut
35	Synchronizer Hub
36	Outer Ring
37	Synchronizer Strut

38	Middle Ring
39	Inner Ring
40	Clutch Gear Retaining Ring
41	Clutch Gear
42	Drive Sprocket Hub
43	Drive Sprocket
44	Sprocket Retaining Ring
45	Mainshaft
46	Rear Retainer
47	Needle Bearing
48	Rear Output Seal
49	Slinger
50	Rear Flange
51	Nut
52	Retainer Bolt
53	Bushing Dowel
54	Rear Half Case
55	Ball Bearing
56	Retaining Ring
57	Retaining Ring
58	Oil Pump Assy
59	Fill Plug
60	Drain Plug
61	Rear Case Bolt
62	Chip Collector Magnet
63	Oil Screen
64	Lower Tube Connector
65	Lower Oil Tube
66	Upper Tube Connector
67	Upper Oil Tube
68	O-Ring Seal
69	Sector Assy
70	Front Oil Pump Retaining Ring
71	Front Oil Pump Ball Bearing
72	Retaining Ring

73	Front Output Shaft
74	Driven Sprocket
75	Sprocket Retaining Ring
76	Needle Bearing
77	Range Fork Assy
78	Range Shift Fork End Pad
79	Range Shift Fork Center Pad
80	Mode Fork End Pad
81	Mode Fork Center Pad
82	Mode Fork Assy
83	Mode Spring
84	Drive Chain

Mechanical Shift Transfer Case



DE2292-B

Item	Description
1	Locknut, Lever
2	Washer, Lever
3	Lever ASM

4	Spacer, Lever
5	Sector Support Seal
6	Sector Shaft Support
7	Support Bearing
8	Support Bearing
9	O-Ring Sector Support
10	Poppet Screw
11	O-Ring Seal
12	Spring
13	Poppet
14	Front Output Seal
15	Slinger
16	Front Flange
17	Hex Lock Nut
18	Input Seal
19	Input Bearing Retaining Ring
20	Front Half Case
21	Vent
22	Precision 3 Position Switch
23	Ball Bearing, Front Input
24	Front Input Bearing Retaining Ring
25	Annular Gear
26	Annulus Retaining Ring
27	Lock Plate Retaining Ring
28	Lock Plate
29	Front Input Gear Thrust Washer
30	Input Gear
31	Pilot Bearing
32	Rear Input Gear Thrust Washer
33	Planetary Carrier Assy
34	Range Shift Sleeve
35	Synchronizer Sleeve
36	Hub Retaining Ring
37	Synchronizer Hub
38	Clutch Gear Retaining Ring

39	Clutch Gear
40	Drive Sprocket Hub
41	Drive Sprocket
42	Sprocket Retaining Ring
43	Mainshaft
44	Rear Retainer
45	Needle Bearing
46	Rear Output Seal
47	Slinger
48	Retainer Bolt
49	Rear Flange
50	Nut
51	Oil Pump Assy
52	Retaining Ring
53	Retaining Ring
54	Ball Bearing
55	Fill Plug
56	Drain Plug
57	Rear Case Bolt
58	Dowel Bushing
59	Chip Collector Magnet
60	Oil Screen
61	Lower Tube Connector
62	Lower Oil Tube
63	Upper Tube Connector
64	Upper Oil Tube
65	O-Ring Seal
66	Needle Bearing
67	Sprocket Retaining Ring
68	Drive Chain
69	Driven Sprocket
70	Front Output Shaft
71	Retaining Ring
72	Front Oil Pump Ball Bearing
73	Front Oil Pump Retaining Ring

74	Sector Assy
75	Rear Case Half
76	Mode Spring
77	Mode Fork Assy
78	Mode Fork Center Pad
79	Mode Fork End Pad
80	Range Fork Assy
81	Range Shift Fork End Pad
82	Range Shift Fork Center Pad

SECTION 308-07B: Transfer Case
DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transfer Case

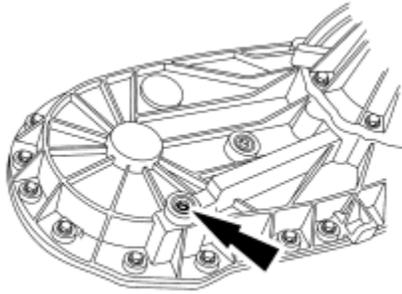
Refer to [Section 308-07A](#).

SECTION 308-07B: Transfer Case
GENERAL PROCEDURES

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transfer Case Draining and Filling

1. Position a suitable container under the transfer case.
2. Remove the drain plug and drain the transfer case.



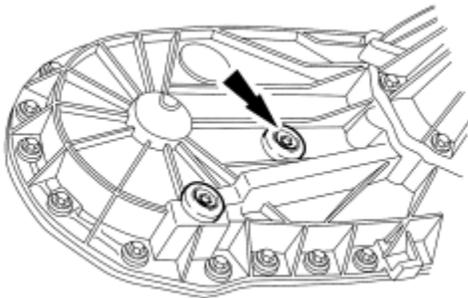
A0037548

3.  **CAUTION: If the correct fill procedures are not followed, a transfer case failure can result.**

NOTE: Fluid level must be just below the fill plug.

Remove the fill plug from the rear of the transfer case and check the fluid level.

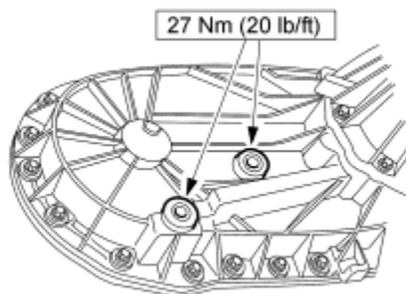
- If the fluid is below the level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or MERCON® equivalent.



DE2252-A

4.  **CAUTION: Do not use air tools.**

Tighten the drain and fill plugs.



DE1845-A

Seal—Rear Output

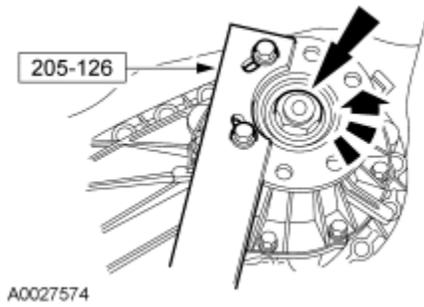
Special Tool(s)	
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 ST1758-A	Remover, Torque Converter Oil Seal 307-309 (T94P-77001-BH)
 ST1255-A	Adapter for 303-224 (Handle) 205-153 (T80T-4000-W)
 ST2233-A	Installer, Output Shaft Seal 308-403

Removal

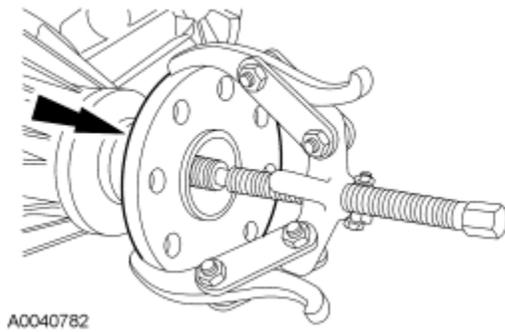
1. With the vehicle in NEUTRAL, raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. **CAUTION: Index mark the driveshaft to the flange to maintain proper driveline balance.**

Disconnect the rear driveshaft at the transfer case and position it aside. For additional information, refer to [Section 205-01](#).

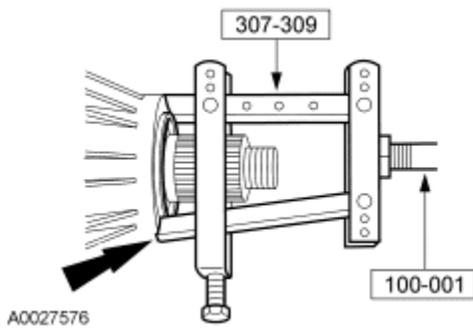
3. While using the Companion Flange Holding Tool to prevent the flange from turning, remove and discard the nut.



4. Using a suitable 2- or 3-jaw puller, remove the flange.



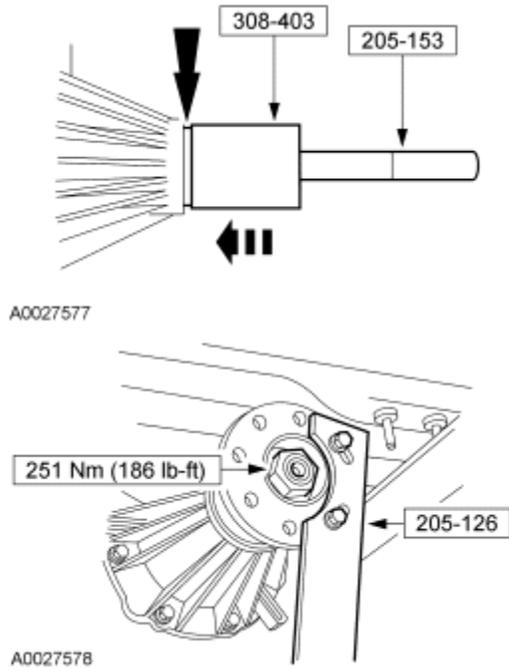
5. Using the special tools, remove the rear output seal.



6. Inspect the flange seal surface for wear and replace the rear retainer if necessary.

Installation

1. Follow the removal procedure in reverse order.
 - Using the special tools, install a new output seal.

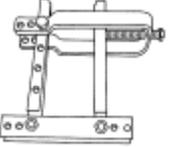
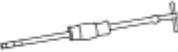


SECTION 308-07B: Transfer Case
IN-VEHICLE REPAIR

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

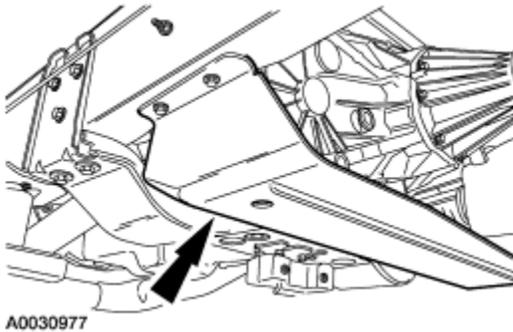
Seal—Front Output

Special Tool(s)	
 ST1255-A	Adapter for 303-224 (Handle) 205-153 (T80T-4000-W)
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)

 <p>ST2233-A</p>	<p>Installer, Output Shaft Oil Seal 308-403</p>
 <p>ST1758-A</p>	<p>Remover, Torque Converter Oil Seal 307-309 (T94P-77001-BH)</p>
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>

Removal

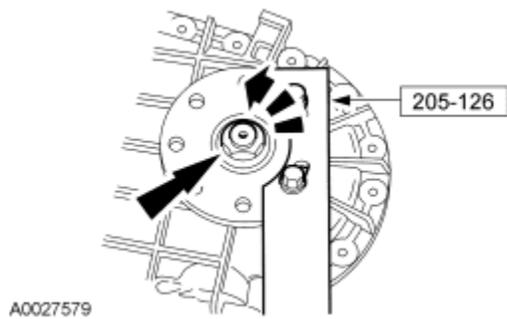
1. With the vehicle in NEUTRAL, raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. Remove the skid plate, if equipped.



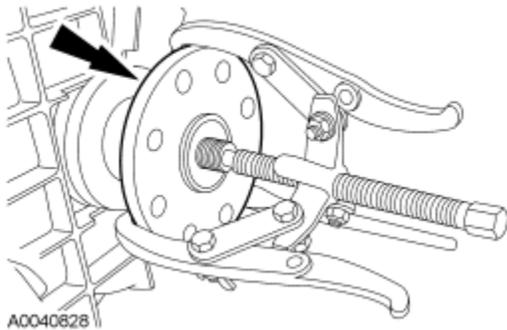
3. **NOTE:** Index-mark the front driveshaft and the transfer case front flange to maintain driveline balance.

Remove the front driveshaft. For additional information, refer to [Section 205-01](#).

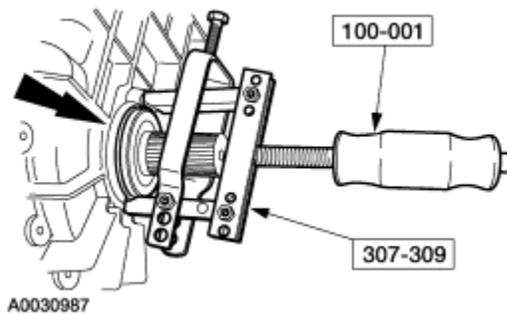
4. Remove and discard the nut.
 - Use the special tool to prevent the flange from turning.



5. Using a suitable 2- or 3-jaw puller, remove the flange.



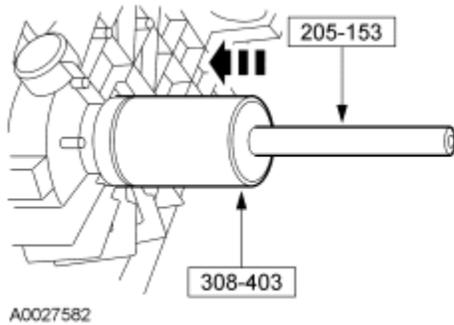
6. Using the special tools, remove the front output seal.



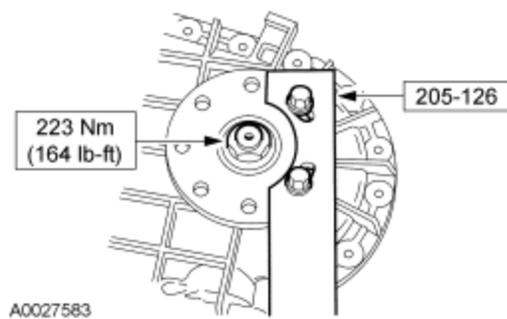
7. Inspect the flange seal surface for wear and damage. Discard the flange, if necessary.

Installation

1. Using the special tools, install a new front output seal.



2. Install the front flange.
 - Use the special tool to prevent the flange from turning while installing a new nut.



3.  **CAUTION: Align the index marks.**

Install the front driveshaft. For additional information, refer to [Section 205-01](#).

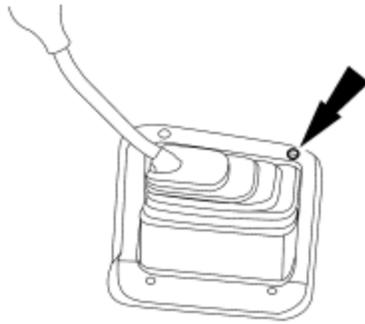
4. Check and, if necessary, fill the transfer case with the specified fluid to the specified level. For additional information, refer to [Transfer Case Draining and Filling](#) in this section.
5. Lower the vehicle.

Transfer Case Shift Lever

Removal

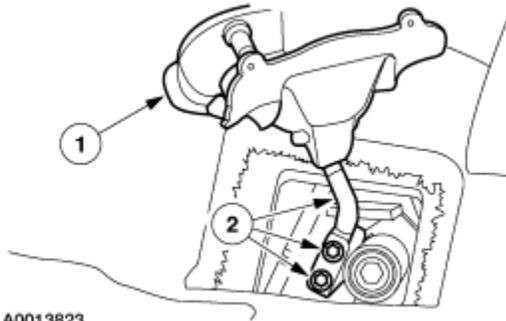
1. Shift the transfer case into 4H.

2. Remove the screws that attach the bezel and boot assembly to the floor.



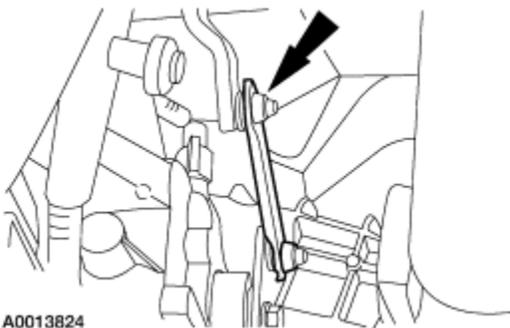
A0011835

3. Remove the bolts that attach 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.



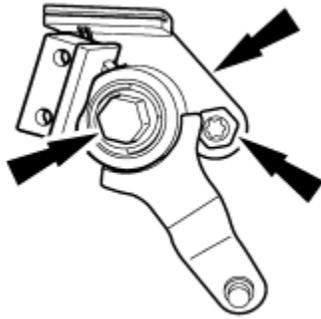
A0013823

4. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
5. Disconnect the control rod from the lower shifter arm.



A0013824

6. Remove the bolts and the transfer case control lever assembly.

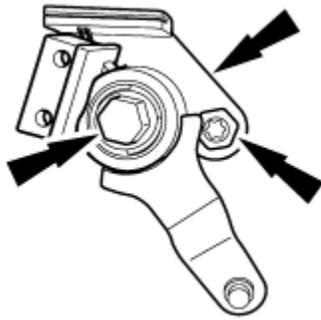


A0013825

Installation

1.  **CAUTION: Do not tighten the bolts that attach the transfer case control lever assembly to the transmission case at this time.**

Position the transfer case control lever assembly and start the bolts into the threaded holes by hand.

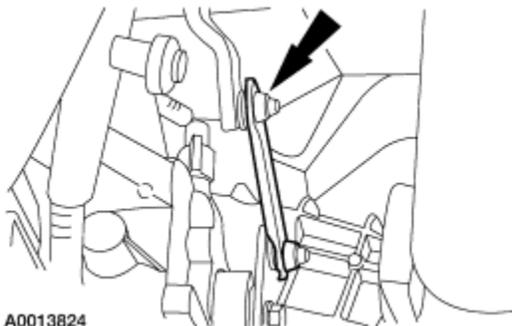


A0013825

2.  **CAUTION: Verify that the control rod is still attached correctly to the transfer case.**

 **CAUTION: Verify that the transfer case is still in 4H.**

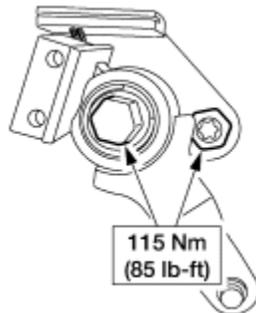
Connect the control rod to the lower shifter arm.



A0013824

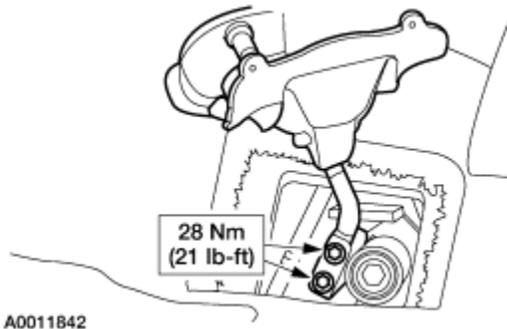
3.  **CAUTION: Hold the control lever against the 4H detent while tightening the bolts. This will ensure correct transfer case gear engagement during transfer case operation.**

Hold the control lever against the 4H detent while tightening the bolts.



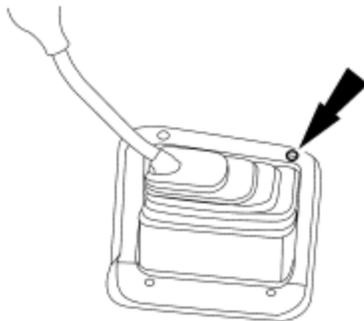
A0013826

4. Lower the vehicle.
5. Position the shift lever with the bezel and boot assembly and install the bolts.



A0011842

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



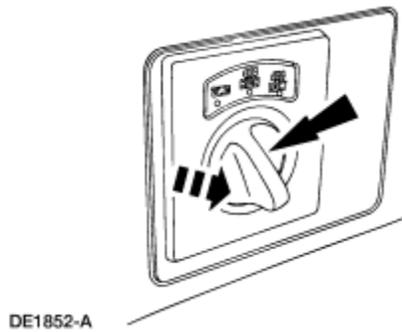
A0011835

7. Verify the shift sequence from 2H to 4L to 2H.
-

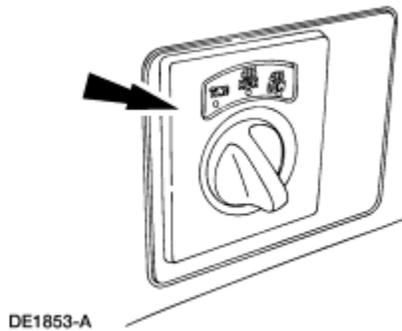
Shift Switch

Removal

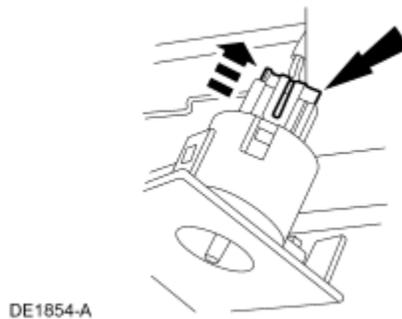
1. Remove the shift switch knob.



2. Remove the switch plate.



3. Disconnect the wiring harness connector.



4. Remove the two screws and the switch.



DE1855-A

Installation

1. Follow the removal procedure in reverse order.

SECTION 308-07B: Transfer Case
IN-VEHICLE REPAIR

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

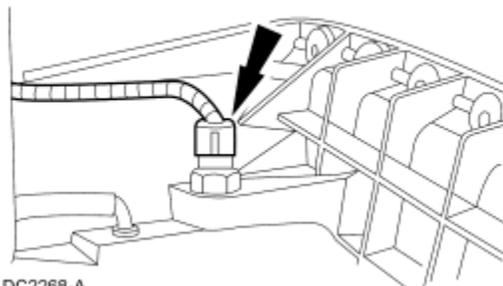
Indicator Switch—Three Position

Removal

1. **NOTE:** On the electric shift transfer case, the position indicator switch is integral to the gearmotor encoder assembly. For additional information, refer to [Transfer Case Shift Motor](#) in this section for replacement procedure.

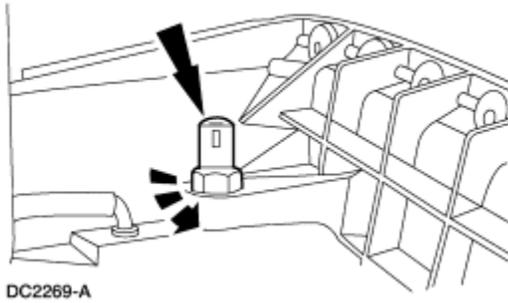
Raise and support the vehicle; for additional information, refer to [Section 100-02](#).

2. Disconnect the wiring harness connector.



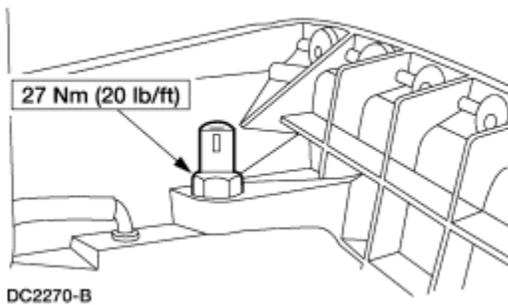
DC2268-A

3. Remove the 3 position switch.



Installation

1. Follow the removal procedure in reverse order.



SECTION 308-07B: Transfer Case
IN-VEHICLE REPAIR

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transfer Case Shift Motor

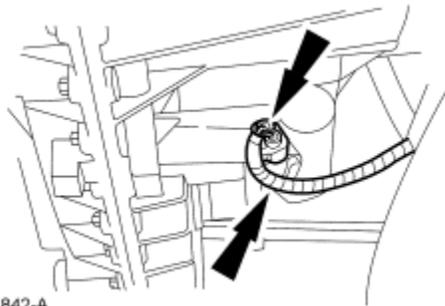
Removal

1. Set the selector switch to the 2W HI range position.

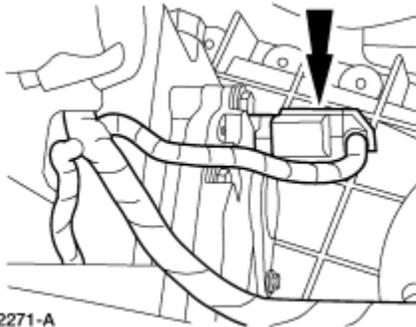


DE1853-A

2. Raise and support the vehicle; for additional information, refer to [Section 100-02](#).
3. Disconnect the gearmotor encoder assembly harness connectors.

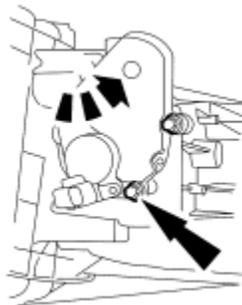


DE1842-A



DC2271-A

4. Remove the three retaining bolts and the gearmotor encoder assembly.
 - The gearmotor encoder assembly is not repairable and must be replaced as an assembly.



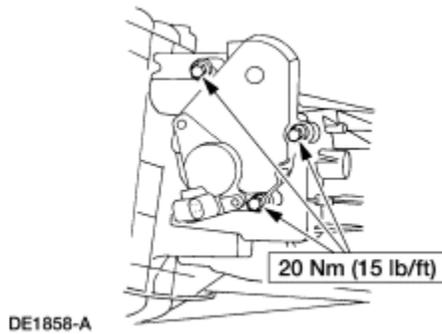
DE1857-A

- Remove the grease from the motor adapter and check for nicks or burrs.

Installation

- NOTE:** Apply a coat of Multi-Purpose Grease DOAZ-19584-AA meeting Ford specifications ESB-M1C93-B and ESR-M1C159-A or equivalent to the motor adapter.

Follow the removal procedure in reverse order.

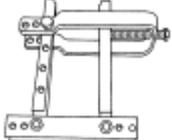
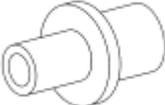
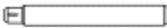


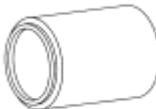
SECTION 308-07B: Transfer Case
DISASSEMBLY AND ASSEMBLY

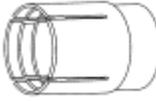
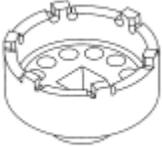
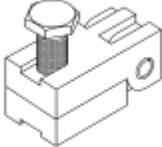
1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transfer Case

Special Tool(s)	
 <p>ST1186-A</p>	Holding Fixture, Transmission 307-003 (T57L-500-B)
 <p>ST1144-A</p>	Universal Puller Set 303-DS005 (D80L-100-A)

 <p>ST1257-A</p>	<p>Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)</p>
 <p>ST1758-A</p>	<p>Remover, Torque Converter Oil Seal 307-309 (T94P-77001-BH)</p>
 <p>ST2232-A</p>	<p>Installer, Transfer Case Needle Bearing 308-402</p>
 <p>ST2229-A</p>	<p>Installer, Front Shaft Oil Slinger 308-399 (Part of Kit 308-S398)</p>
 <p>ST2239-A</p>	<p>Installer, Output Shaft Front Bearing 308-410</p>
 <p>ST2235-A</p>	<p>Sleeve, Output Shaft Front Snap Ring 308-405</p>
 <p>ST1255-A</p>	<p>Adapter for 303-224 (Handle) 205-153 (T80T-4000-W)</p>
 <p>ST2239-A</p>	<p>Installer, Input Shaft Bearing 308-412</p>

 <p>ST2238-A</p>	<p>Installer, Input Shaft Oil Seal 308-408</p>
 <p>ST2236-A</p>	<p>Sleeve, Input Shaft Snap Ring 308-406</p>
 <p>ST2231-A</p>	<p>Installer, Output Shaft Rear Bearing 308-401</p>
 <p>ST2233-A</p>	<p>Installer, Output Shaft Oil Seal 308-403</p>
 <p>ST2230-A</p>	<p>Installer, Output Shaft Oil Slinger 308-400 (Part of Kit 308-S398)</p>
 <p>ST1568-A</p>	<p>Installer, Drive Pinion Bearing Cup 205-138 (T80T-4000-D)</p>
 <p>ST1568-A</p>	<p>Installer, Drive Pinion Bearing Cup 205-140</p>
 <p>ST1880-A</p>	<p>Installer, Rear Axle Oil Seal 205-155</p>

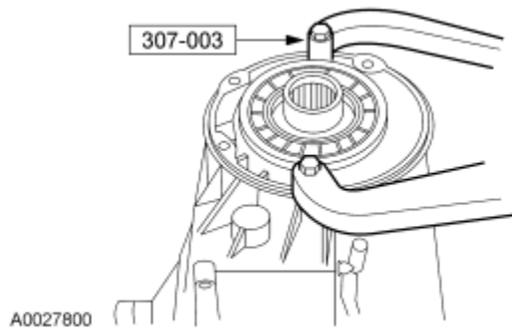
 <p>ST2239-A</p>	<p>Installer, Output Shaft Bearing 308-411 (rear output ball bearing installation)</p>
 <p>ST2234-A</p>	<p>Sleeve, Output Shaft Rear Snap Ring 308-404</p>
 <p>ST2237-A</p>	<p>Socket, Sector Shaft Nut 308-407</p>
 <p>ST2227-A</p>	<p>Spreader, Transfer Case Housing 308-396</p>

Material	
Item	Specification
Pipe Sealant with Teflon D8AZ-19554-A	WSK-M2G350-A2
Metal Surface Cleaner F4AZ-19A536-RA	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA	WSE-M4G323-A4
Multi-Purpose Grease D0AZ-19554-AA	ESB-M1C93-B

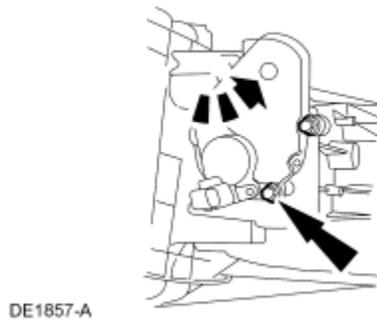
Disassembly

- 
CAUTION: During disassembly, all nuts, bolts and retaining rings are to be discarded and replaced with new components during assembly.

Mount the transfer case on a holding fixture.



2. On the electric shift transfer case, remove the gear motor encoder assembly.

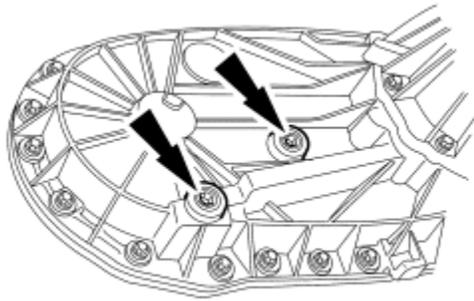


3. On the manual shift transfer case, remove the 3 position switch.



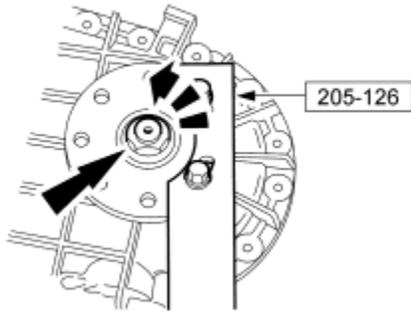
4.  **CAUTION: Do not use air tools to remove the plugs.**

Remove the drain and fill plugs.



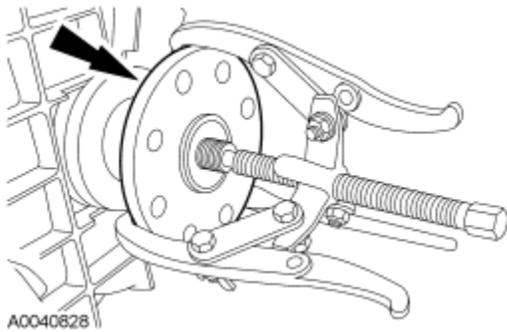
DE1843-A

5. While using the special tool to prevent the flange from turning, remove and discard the nut.



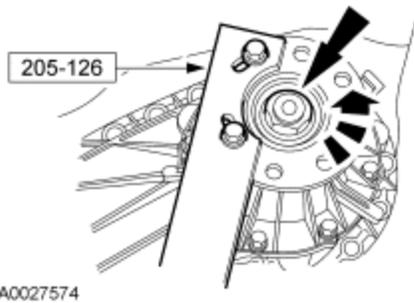
A0027579

6. Using a suitable 2- or 3-jaw puller, remove the flange.



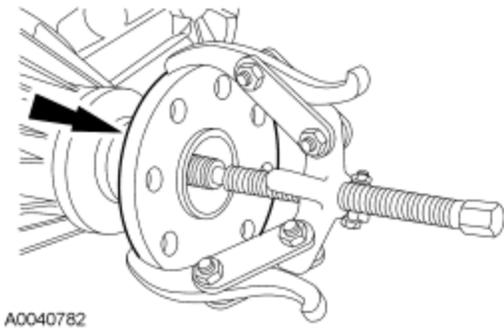
A0040828

7. While using the special tool, to prevent the flange from turning, remove and discard the nut.

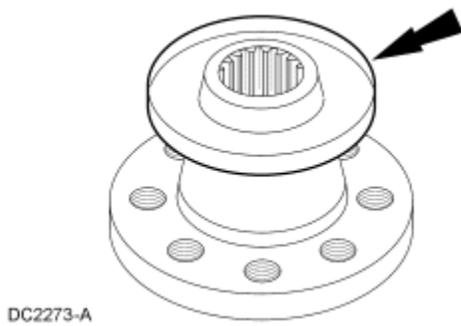


A0027574

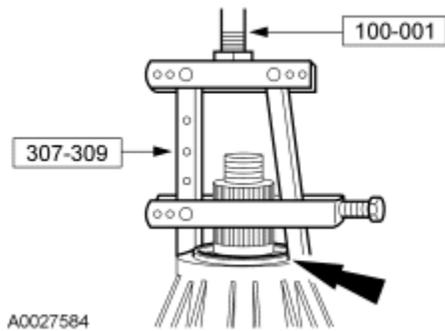
8. Using a suitable 2- or 3-jaw puller, remove the flange.



9. Remove the slinger from the front flange and the rear flange, if necessary.



10. Using the special tool, remove the rear output seal.

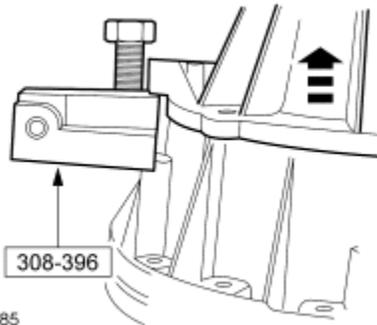


11. Remove and discard the rear bolts.



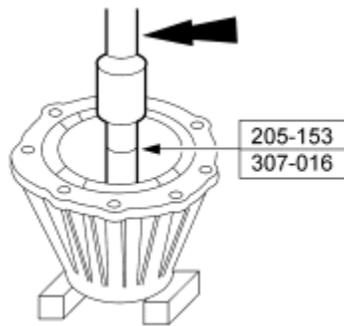
DE1867-A

12. Using the special tool, remove the rear retainer.



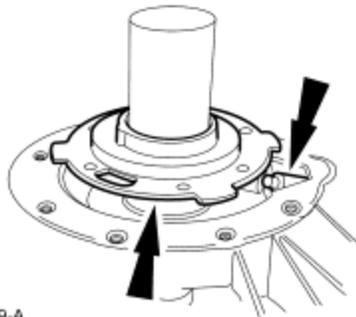
A0027585

13. Using the special tools and a suitable press, remove the needle bearing.



A0027586

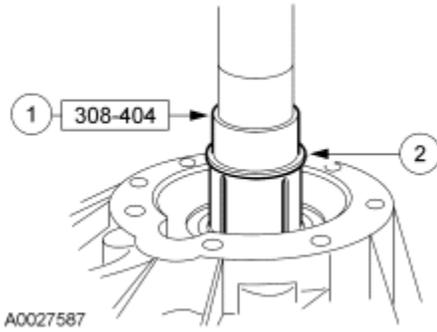
14. Disconnect the oil tube and remove the oil pump assembly.



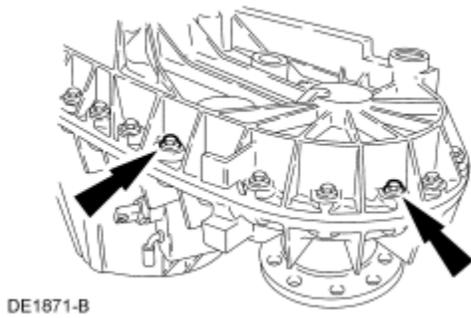
DE1869-A

15. Remove the retaining ring.

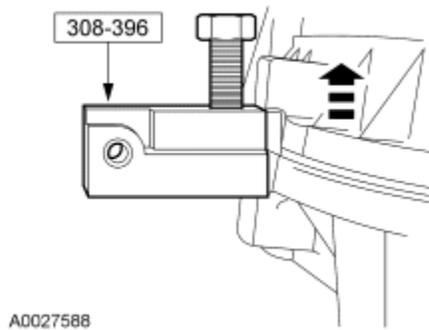
1. Install the special tool.
 2. Lift up on the shaft, and remove and discard the retaining ring.
- Remove the special tool.



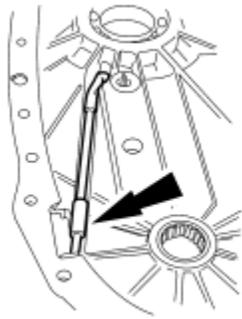
16. Remove and discard the 25 case bolts.



17. Using the special tool, separate the case halves. Remove the rear case.

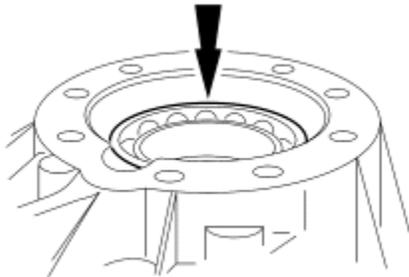


18. Remove the oil tube.



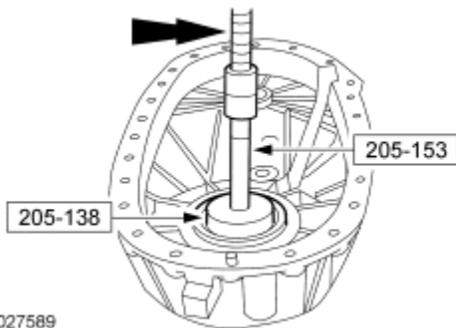
DE1873-A

19. Remove the ball bearing retaining ring.



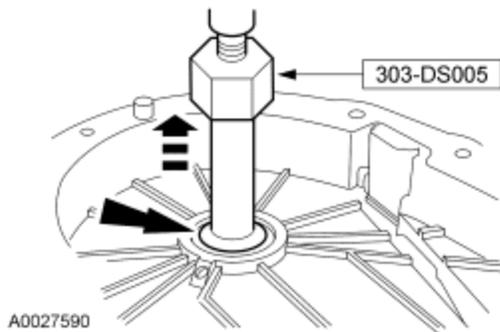
DC2276-A

20. Using the special tools and a suitable press, remove the ball bearing.



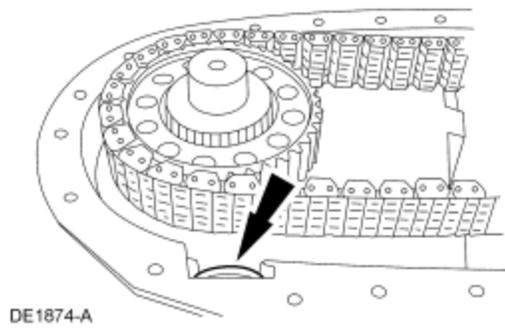
A0027589

21. Using the special tool, remove the needle bearing.

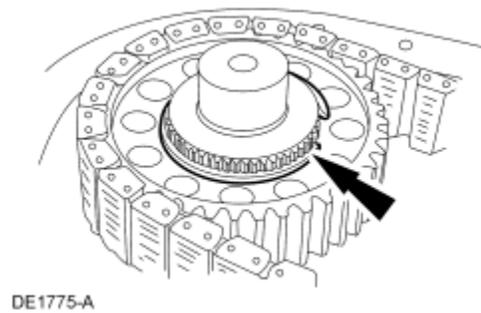


A0027590

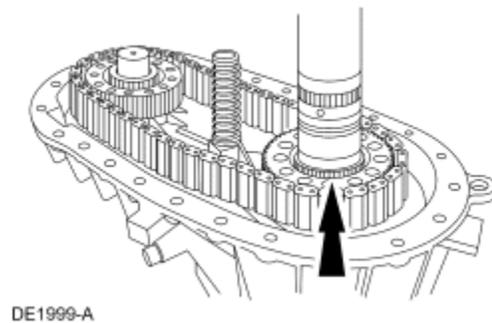
22. Remove the chip collector magnet.



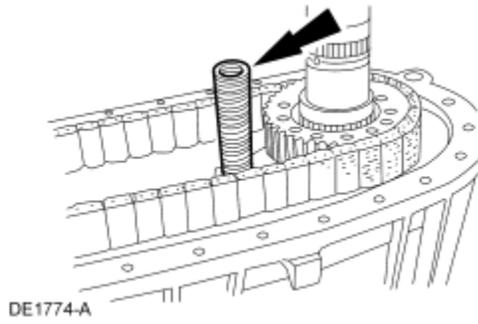
23. Remove the driven sprocket retaining ring.



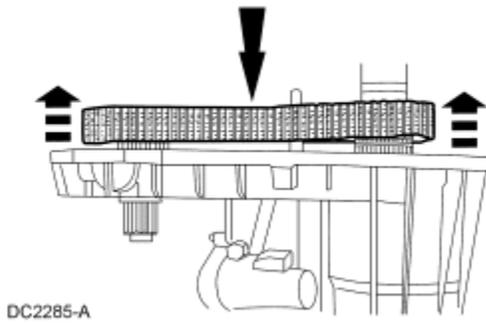
24. Remove the drive sprocket retaining ring.



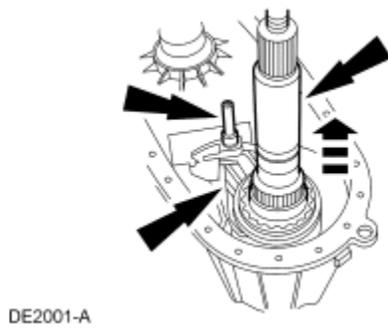
25. Remove the mode spring.



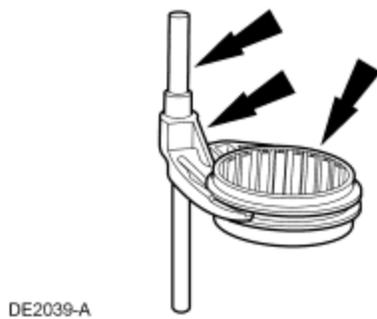
26. Remove the sprockets and chain as an assembly.



27. Remove the mainshaft and mode fork assembly as an assembly.

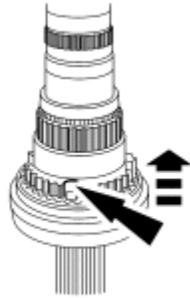


28. Slide the mode fork and synchronizer sleeve off of the mainshaft, and separate the components.



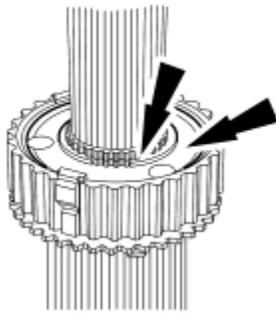
29. Place the mainshaft in a soft jawed vise with the threaded end up.

30. Remove the clutch gear.



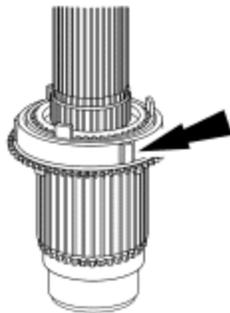
DE2002-A

31. Remove the retaining ring and the synchronizer hub.



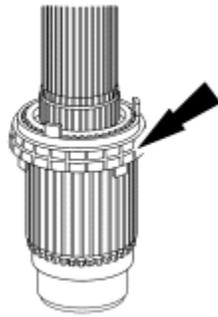
DE2010-A

32. On the electric shift transfer case mainshaft, remove the outer ring.



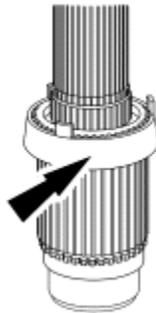
DE2011-A

33. On the electric shift transfer case mainshaft, remove the middle ring.



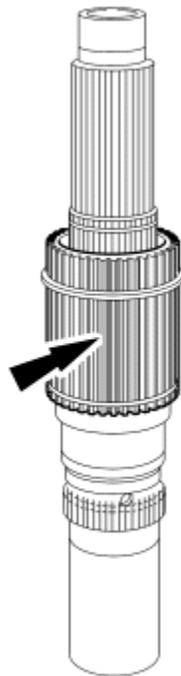
DE2012-A

34. On the electric shift transfer case mainshaft, remove the inner ring.



DE2013-A

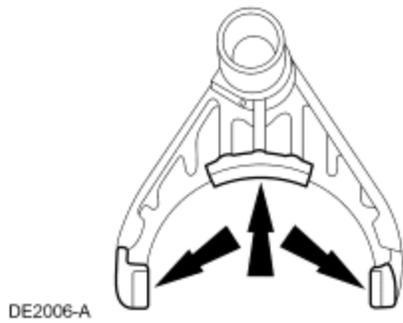
35. Remove the drive sprocket hub.



DE2014-A

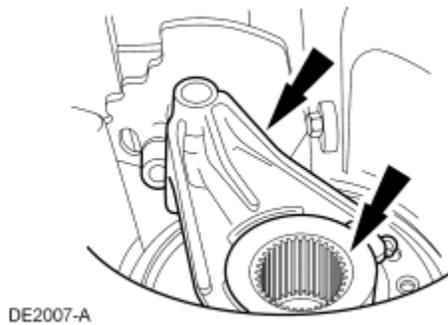
36. Inspect all of the components for wear and damage.

37. Inspect the mode fork pads for wear.

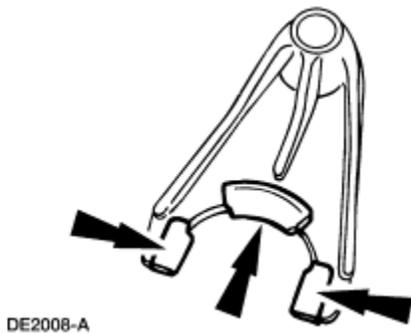


38. **NOTE:** Rotate the sector assembly to the 4-wheel high position for easy removal.

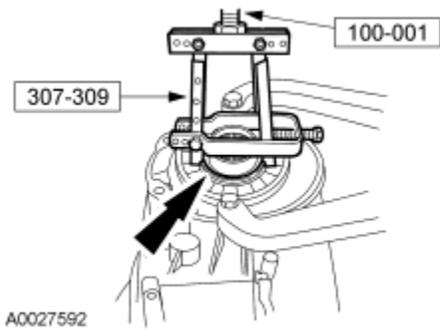
Remove the range fork assembly and the range shift sleeve.



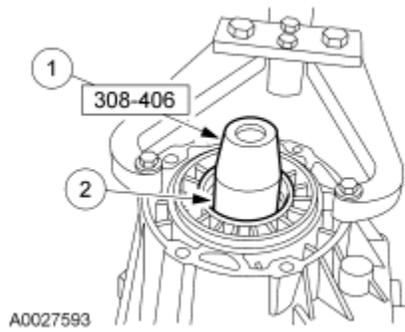
39. Inspect the range fork pads. If the pads are worn, discard the range fork, the pads, the mainshaft and the sleeve.



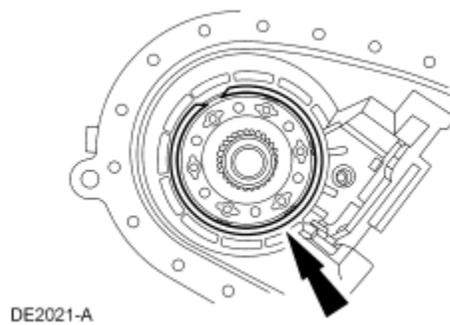
40. Using the special tool, remove the input seal.



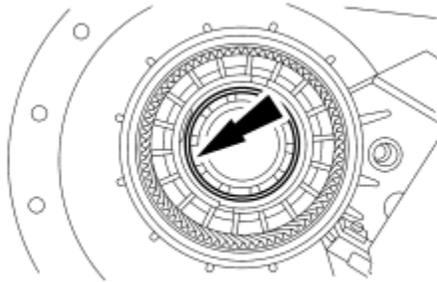
41. Remove the retaining ring.
1. Install the special tool.
 2. Remove and discard the retaining ring.



42. Remove the planetary assembly.

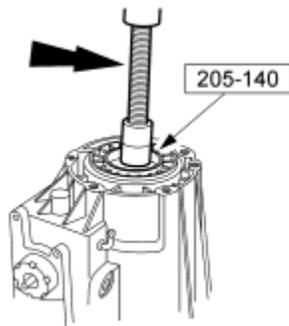


43. Remove the input bearing retaining ring.



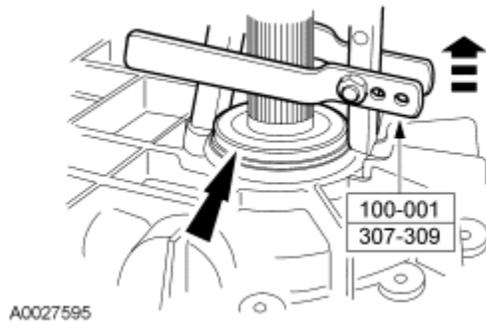
DE2030-A

44. Using the special tool and a suitable press, remove the front input bearing.



A0027594

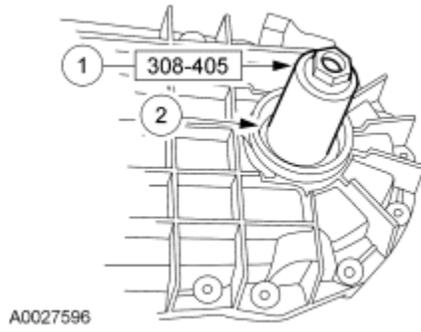
45. Using the special tool, remove the front output seal.



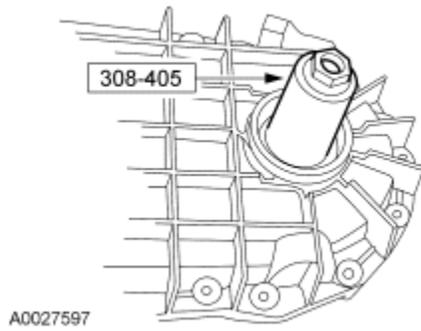
A0027595

46. Remove the retaining ring.

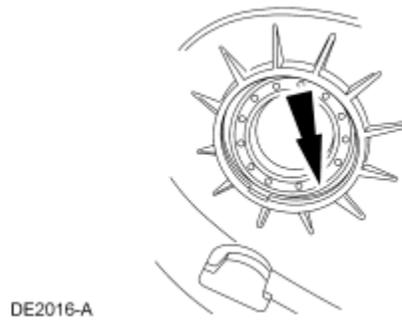
1. Install the special tool.
2. Remove and discard the retaining ring.



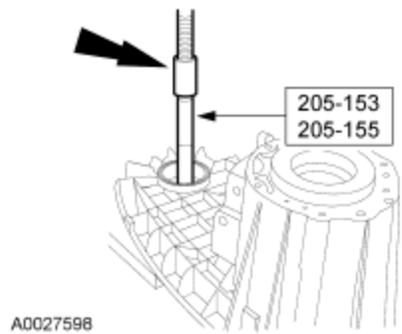
47. Remove the special tool and the front output shaft.



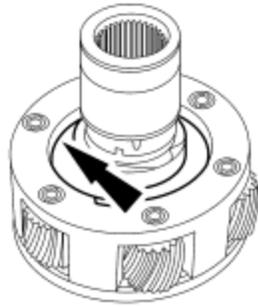
48. Remove the front output ball bearing retaining ring.



49. Using the special tools and a suitable press, remove the front output ball bearing.

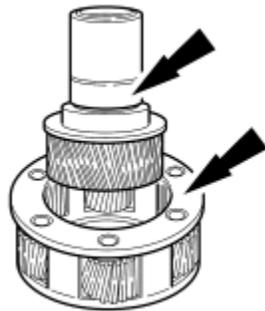


50. Remove the lock plate retaining ring.



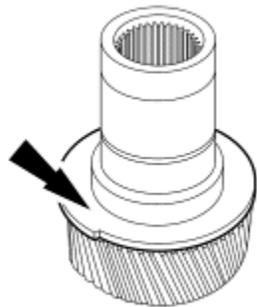
DE2022-A

51. Lift out the input gear from the planetary gear.



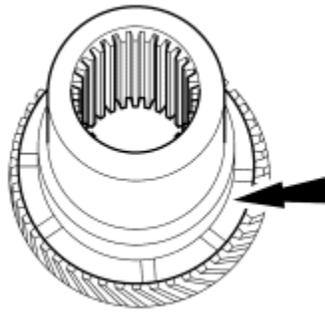
DE2023-A

52. Remove the lock plate.



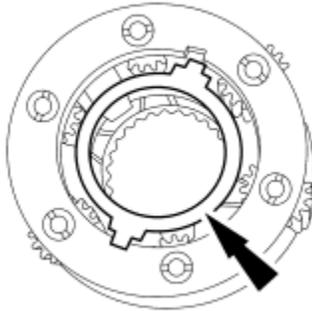
DE2024-A

53. Remove the front input gear thrust washer.



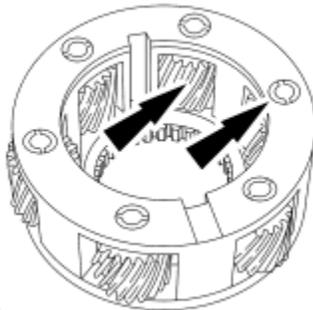
DE2025-A

54. Remove the rear input gear thrust washer.



DE2026-A

55. Inspect the gear teeth and thrust washers for wear or damage. Install a new planetary gear assembly, if necessary.



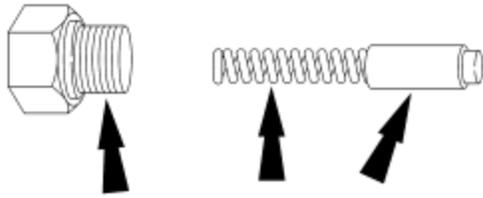
DE2027-A

56. Remove the poppet assembly.



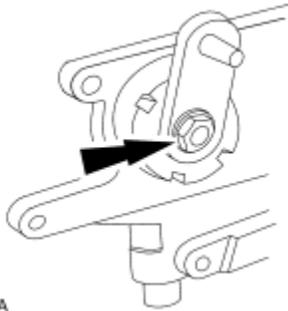
DE2028-A

57. Disassemble the poppet screw, spring and poppet.



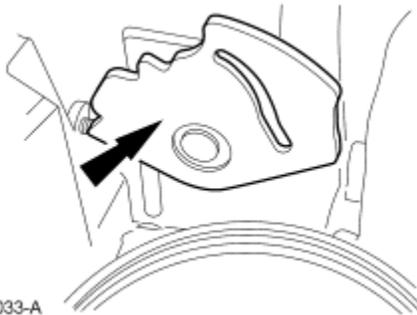
DE2029-B

58. On the manual shift transfer case, remove the locknut, washer, lever, spacer and the sector assembly.



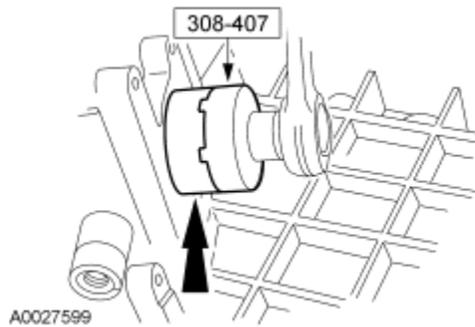
DC2282-A

59. On the electric shift transfer case, remove the plastic retainer and O-ring and remove the sector assembly.

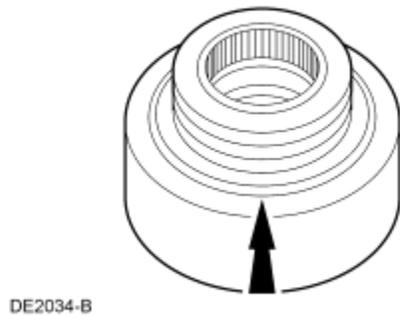


DE2033-A

60. Using the special tool, remove the sector shaft support (motor adapter for electric shift transfer case).

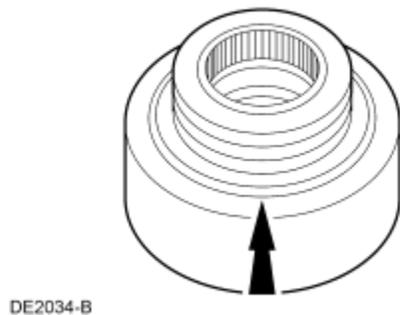


61. Remove and discard the support O-ring seal.



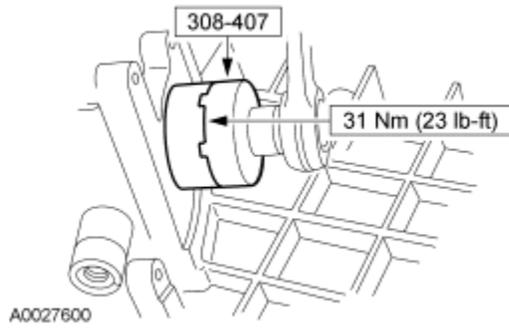
Assembly

1. Install a new support O-ring seal.

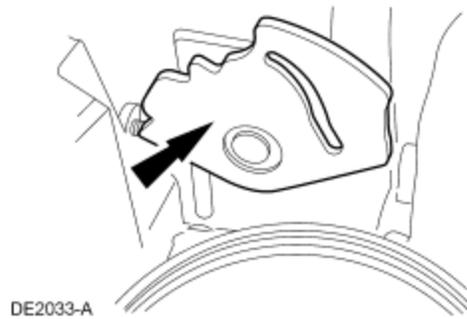


2. **NOTE:** Prior to assembly, coat the threads with pipe sealant.

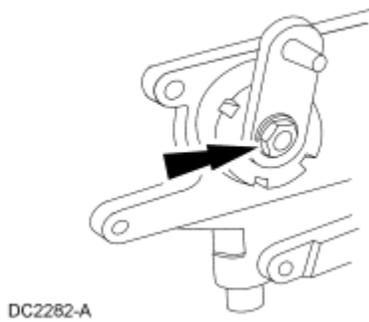
Using the special tool, install the sector shaft support (motor adapter for electric shift transfer case).



3. Install the sector assembly. On the electric shift transfer case, install the plastic retainer and O-ring.

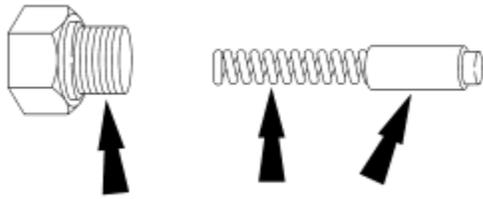


4. On the manual shift transfer case, install the spacer, lever, washer and the locknut.



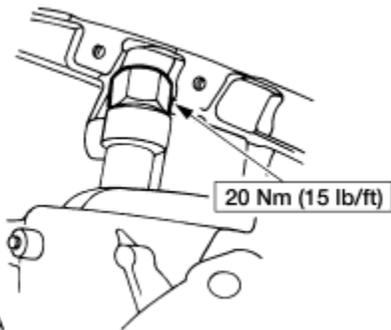
5. **NOTE:** If the poppet spring is being replaced, a like color spring must be used.

Assemble the poppet screw, spring and poppet.



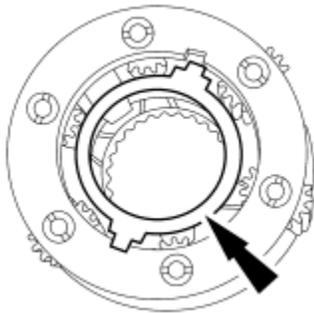
DE2029-B

6. Install the poppet assembly.



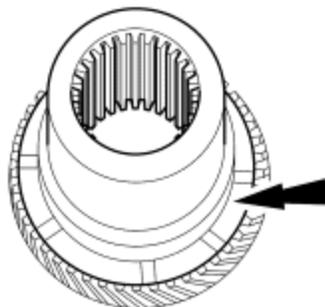
DE2037-A

7. Install the rear input gear thrust washer.



DE2026-A

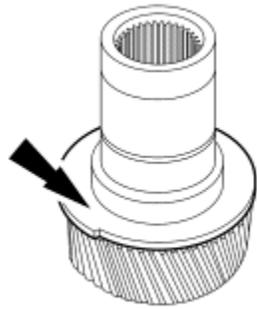
8. Install the front input gear thrust washer.



DE2025-A

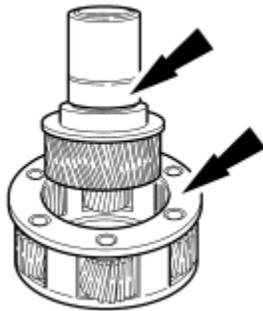
9. **NOTE:** Install the lock plate with the stamped letter E facing outward.

Install the lock plate.



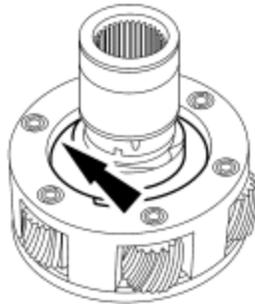
DE2024-A

10. Place the input gear into the planetary carrier assembly.



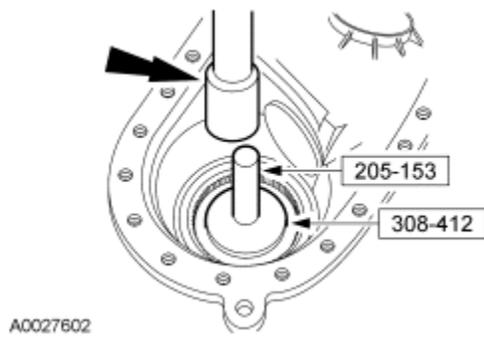
DE2023-A

11. Install a new lock plate retaining ring.

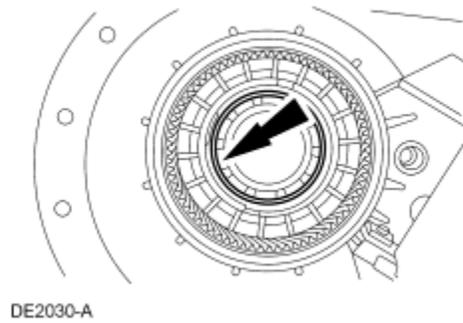


DE2022-A

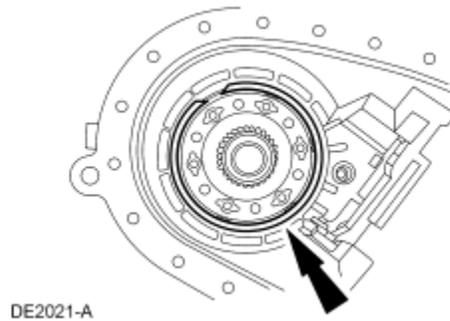
12. Using the special tools and a suitable press, install a new front input bearing.



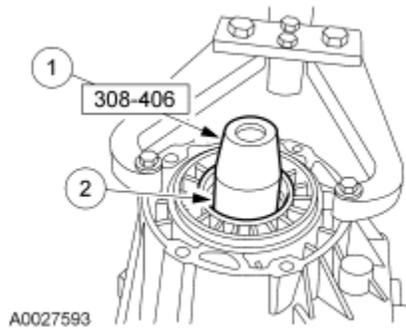
13. Install a new bearing retainer ring.



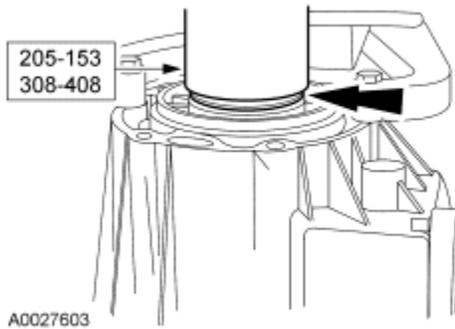
14. Position the planetary assembly into the front case.



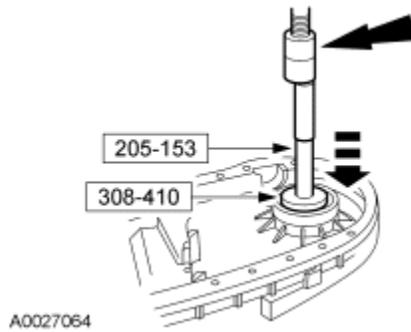
15. Install a new retaining ring.
1. Install the special tool.
 2. Install a new retaining ring.



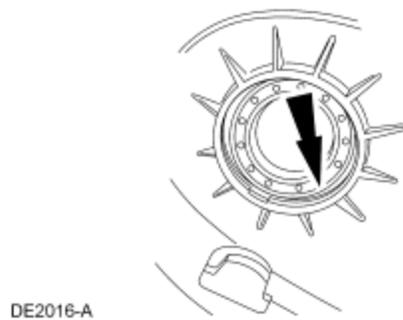
16. Using the special tools, install a new input seal.



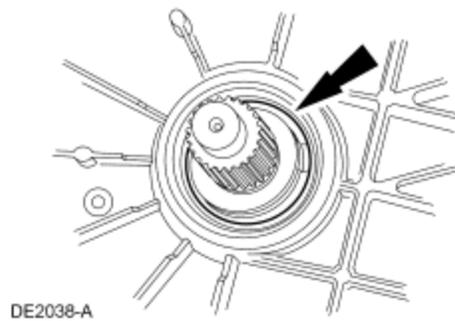
17. Using the special tools and a suitable press, install a new front output ball bearing.



18. Install a new front output ball bearing retaining ring.

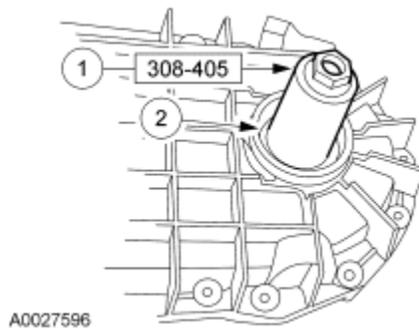


19. Position the front output shaft in the front case.

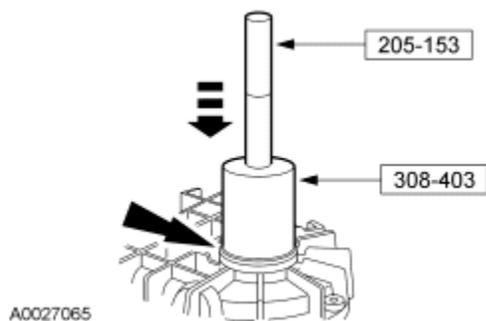


20. Install a new retaining ring.

1. Install the special tool.
 2. Install a new retaining ring.
- Remove the special tool.

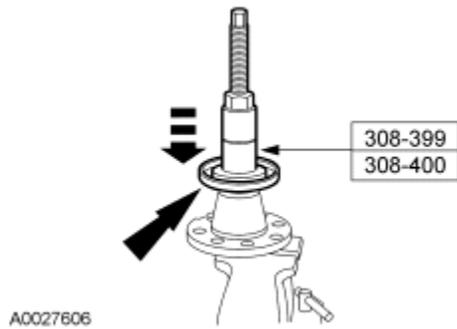


21. Using the special tools, install a new front output seal.



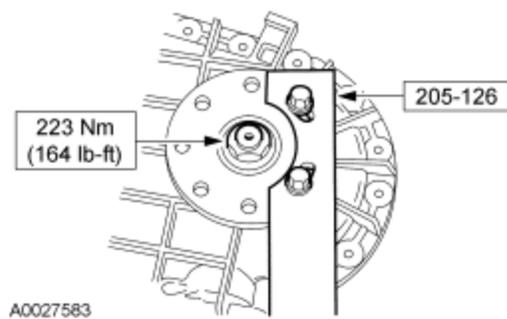
22. Install a new slinger if previously removed.

- Using the special tools, install a new slinger on the front flange.



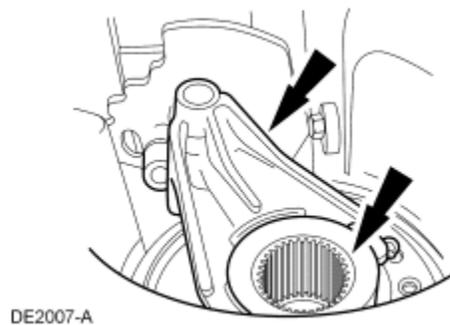
23. Install the front flange.

- While using the special tool to prevent the flange from turning, install a new nut.

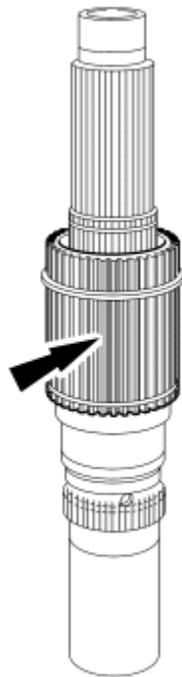


24. **NOTE:** Rotate the sector assembly to the 4-wheel high position for easy installation.

Position the range fork assembly and range shift sleeve in the front case.

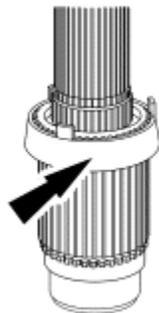


25. Position the drive sprocket hub onto the mainshaft.



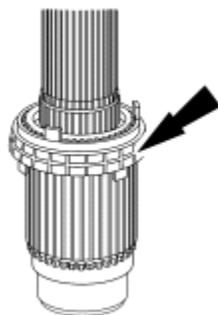
DE2014-A

26. On the electric shift transfer case mainshaft, position the inner ring onto the drive sprocket.



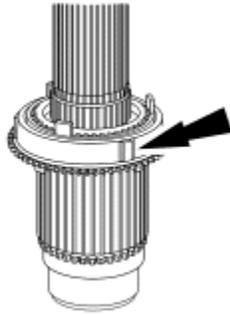
DE2013-A

27. On the electric shift transfer case mainshaft, position the middle ring onto the inner ring.



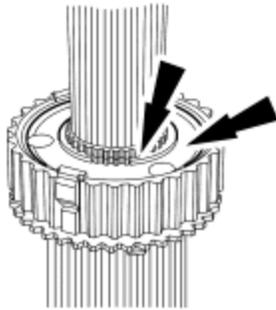
DE2012-A

28. On the electric shift transfer case mainshaft, position the outer ring onto the middle ring.



DE2011-A

29. Position and rotate the synchronizer hub until it drops into the installed position. Install a new retaining ring.



DE2010-A

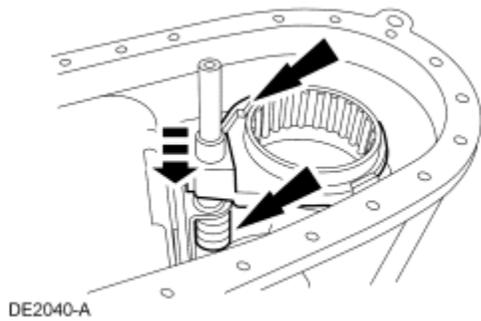
30. **NOTE:** The thin side of the synchronizer sleeve must face upward.

Assemble the mode fork, the shift rail and the synchronizer sleeve.



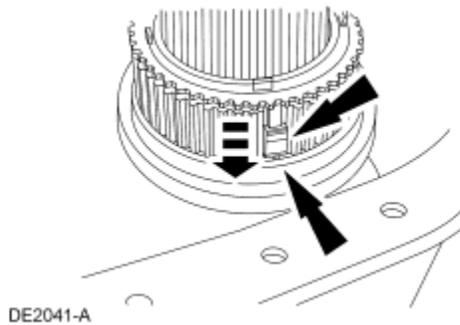
DE2039-A

31. Install the mode fork and shift rail assembly into the front case.
- Make sure to bottom the shift rail in the case.

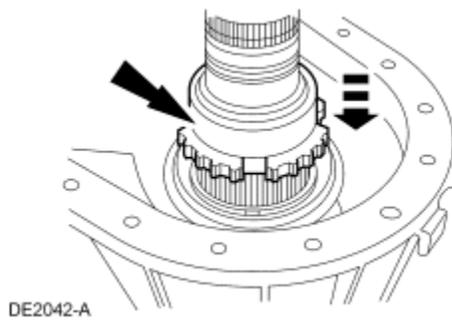


32.  **CAUTION:** Install the mainshaft assembly so that the synchronizer strut bears against one of the synchronizer sleeve teeth.

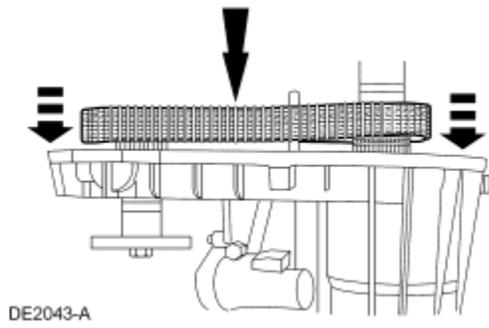
Install the mainshaft.



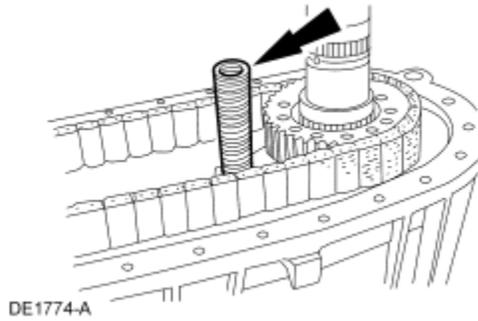
33. Install the clutch gear.



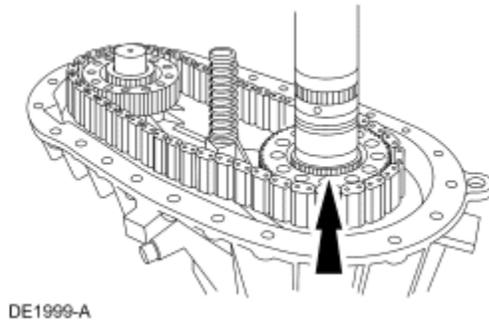
34. Install the drive sprocket, the driven sprocket and the drive chain as an assembly.



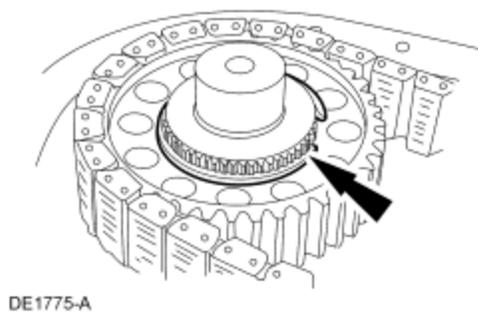
35. Install the mode spring.



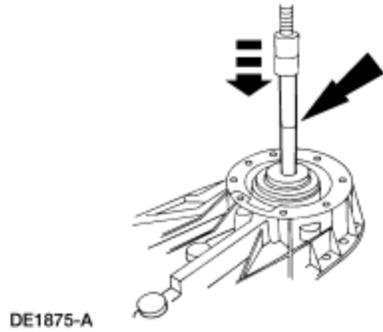
36. Install a new drive sprocket retaining ring.



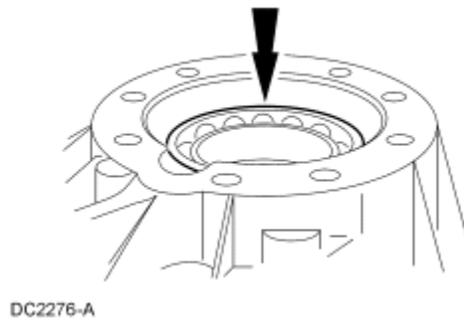
37. Install a new driven sprocket retaining ring.



38. Using the Rear Output Bearing Installer, the Handle and a suitable press, install a new ball bearing.

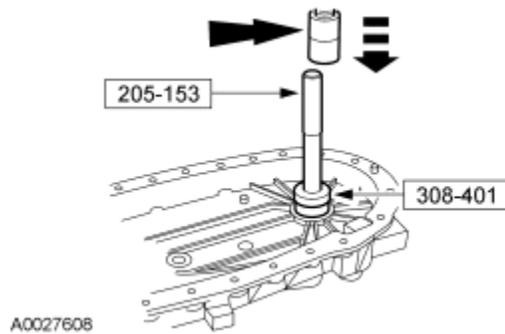


39. Install a new ball bearing retaining ring.

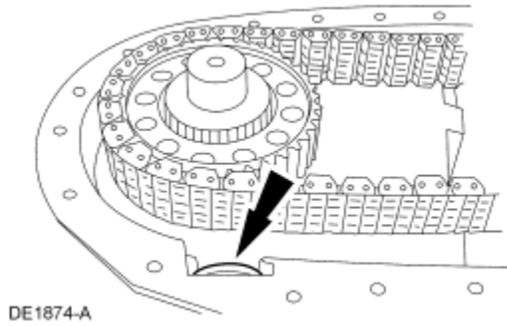


40. **NOTE:** The identification numbers must face the driver while installing.

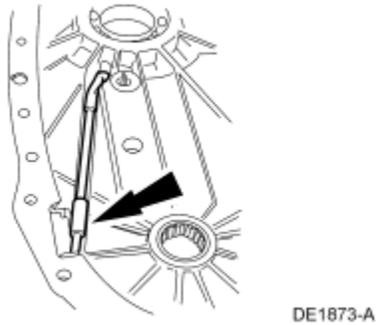
Using the special tools and a suitable press, install a new needle bearing.



41. Install the chip collector magnet.



42. Install the oil tube.



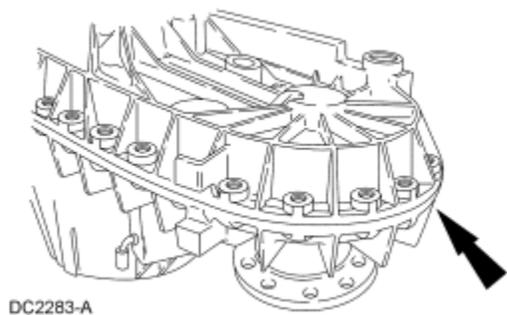
43. Clean both case mating surfaces with metal surface cleaner.

44. **NOTE:** The silicone bead must be no larger than 2 mm (0.08 in) in diameter.

Apply a bead of silicone gasket and sealant to the joint face of the case.

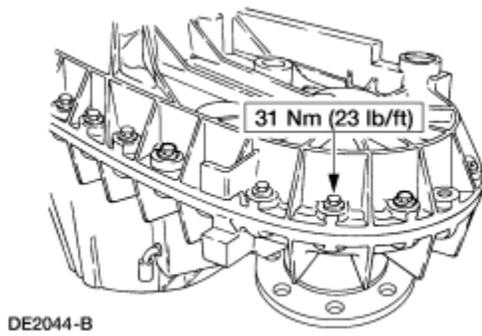
- The bead must be on the inside of the bolt holes, toward the inside of the case.

45. Position the rear case half onto the front case half.

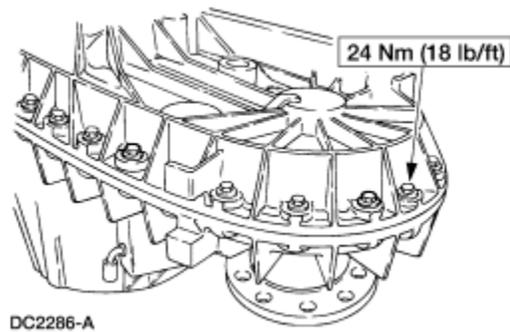


46. **NOTE:** Use a crisscross pattern when tightening the case bolts.

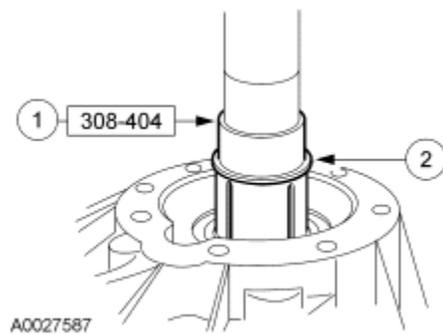
Install and tighten the 25 new case bolts.



47. Install the two new dowel bolts at each end of the case.

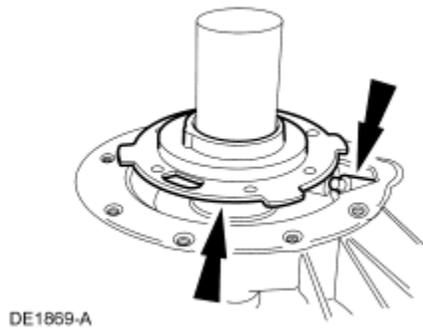


48. Install the new retaining ring.
1. Install the special tool.
 2. Install the new retaining ring.



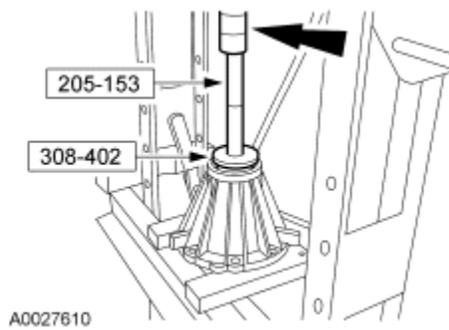
49. **NOTE:** Prior to assembly, make sure the O-ring is in the oil pump pickup inlet.

Slide the oil pump assembly onto the mainshaft and connect the oil tube.



50. **NOTE:** The identification numbers must face the driver while installing.

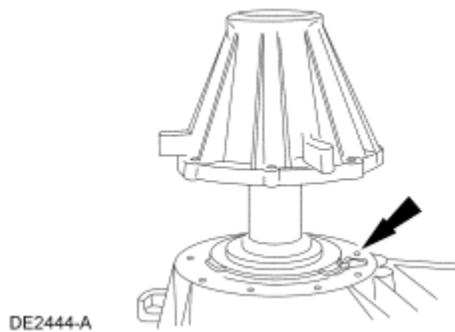
Using the special tools and a suitable press, install a new needle bearing.



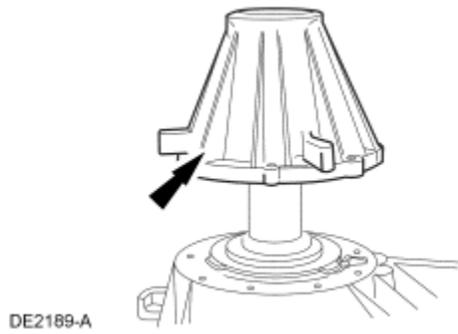
51. Clean the case and rear retainer mating surfaces with metal surface cleaner.

52. Apply a bead of silicone gasket and sealant to the rear retainer joint face.

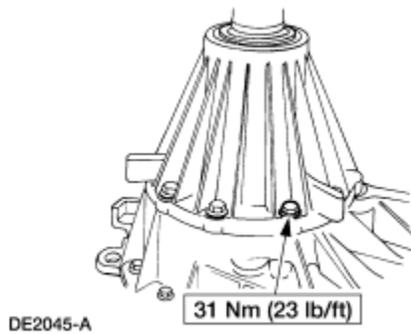
- The bead must be on the inside of all but one of the bolt holes.



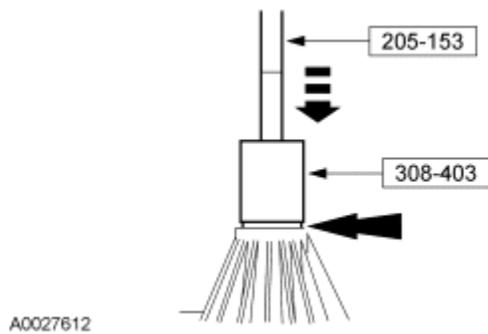
53. Position the rear retainer onto the rear case.



54. Install the eight new retaining bolts.

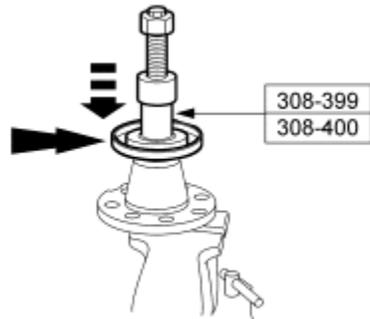


55. Using the special tool, install a new rear output seal.



56. **NOTE:** Install a new slinger if previously removed.

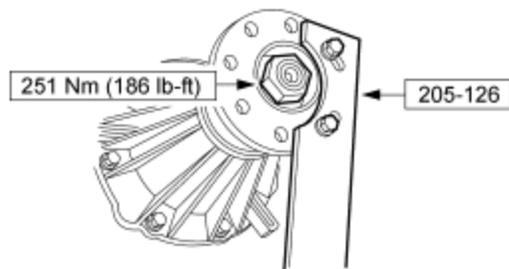
Using the special tools, install a new slinger.



A0027613

57. Install the rear flange.

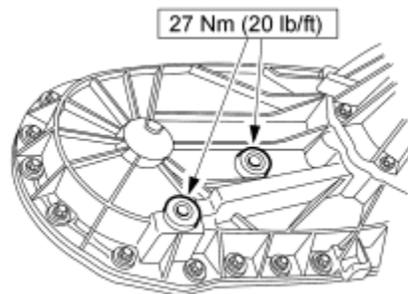
- While using the special tool to prevent the flange from turning, install a new nut.



A0027614

58.  **CAUTION: Do not use air tools.**

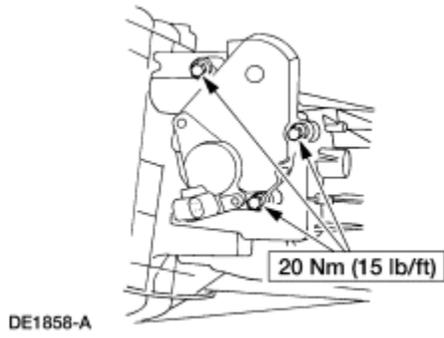
Install the drain and fill plugs.



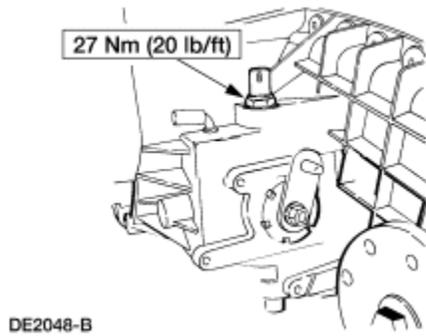
DE1845-A

59. **NOTE:** Apply a coat of multi-purpose grease to the motor adapter.

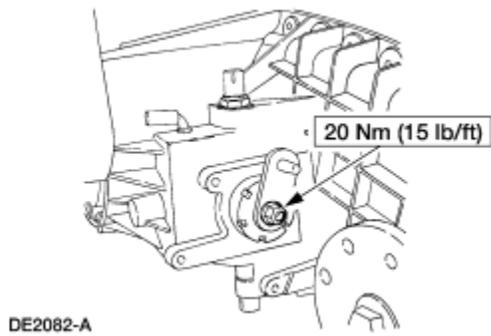
On the electric shift transfer case, install the gear motor encoder assembly.



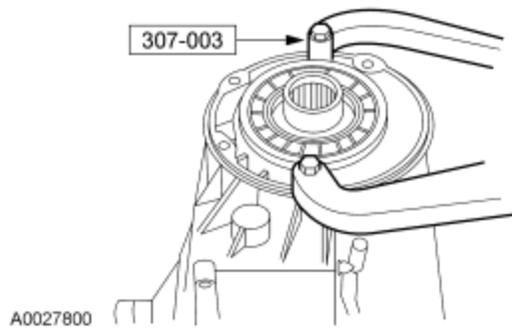
60. On the manual shift transfer case, install the 3-position switch.



61. Tighten the lever nut.



62. Remove the transfer case from the special tool.



Transfer Case

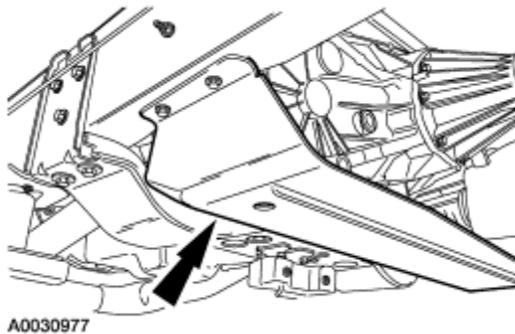
Material	
Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA	WSE-M5B392-A

All vehicles

1. **NOTE:** Shift the transfer case to 2W HI.

Raise and support the vehicle. For additional information, refer to [Section 100-02](#).

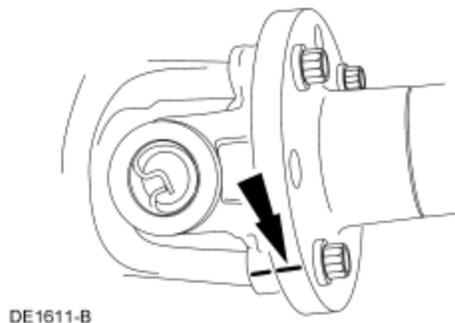
2. Remove the four bolts and the skid plate, if equipped.



3. **NOTE:** Index-mark the driveshaft to maintain driveline balance.

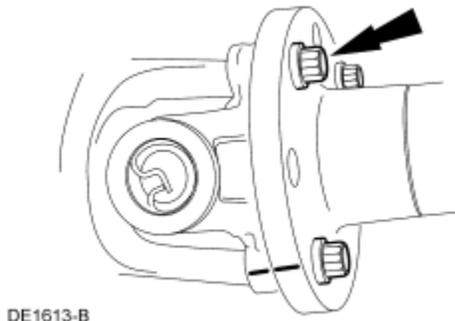
Remove the rear driveshaft. For additional information, refer to [Section 205-01](#).

4. Index-mark the front driveshaft to the transfer case flange.



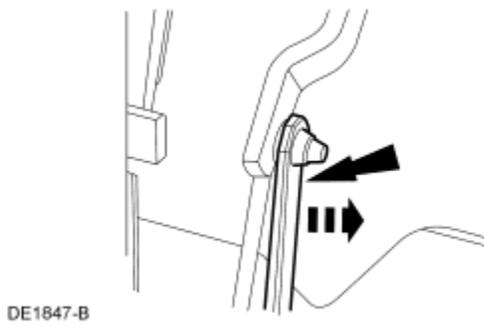
5. **NOTE:** Support the front driveshaft with wire or a strap.

Remove and discard the four bolts and position the front driveshaft aside.

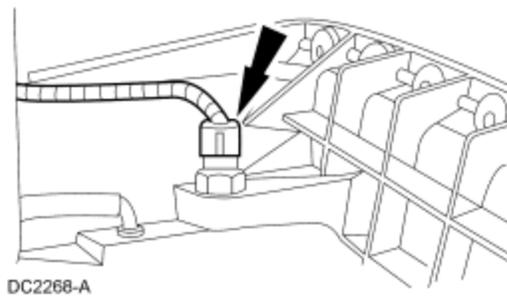


Manual shift transfer case

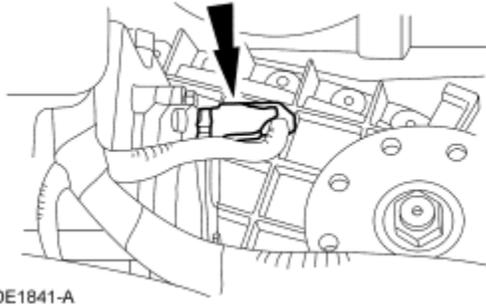
6. Remove the manual shift linkage, if equipped.



7. Disconnect the switch electrical connector. Position the wire harness aside.

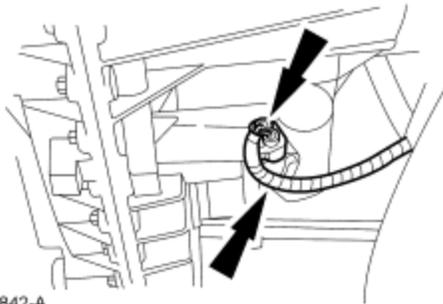


Electric shift transfer case



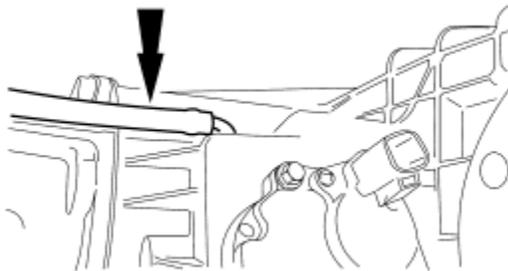
DE1841-A

8. Disconnect the gear motor encoder assembly electrical connector and the gear motor electrical connector. Position the wire harness aside.



DE1842-A

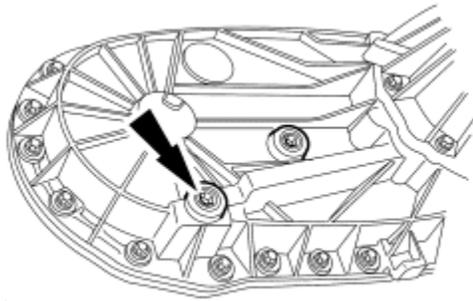
9. Disconnect the transfer case vent hose.



A0031976

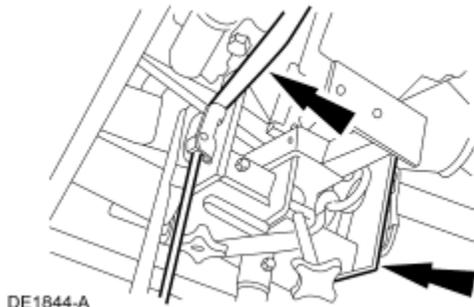
All transfer cases

10. If disassembly is necessary, drain the fluid into a suitable container.
 - Install the plug when finished.



DC2272-A

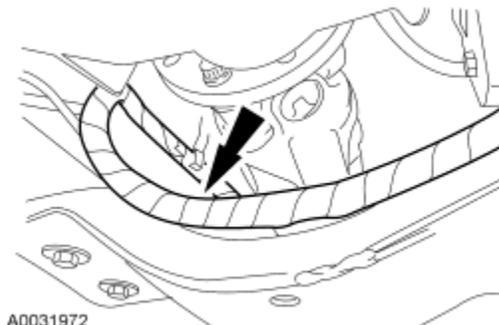
11. Position a suitable high-lift jack under the transfer case and secure it with safety straps.



DE1844-A

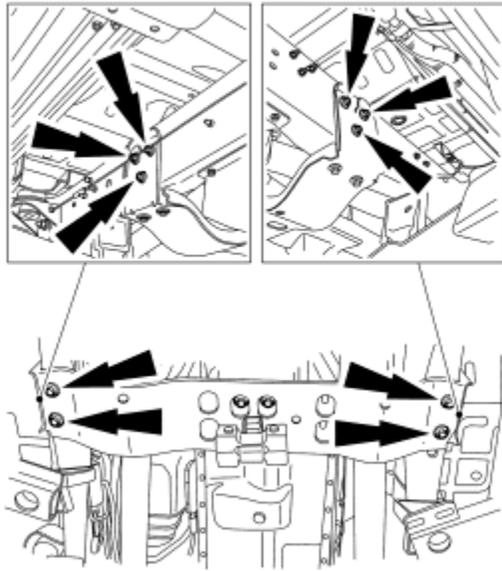
Excursion vehicles

12. Detach the wire harness from the crossmember.



A0031972

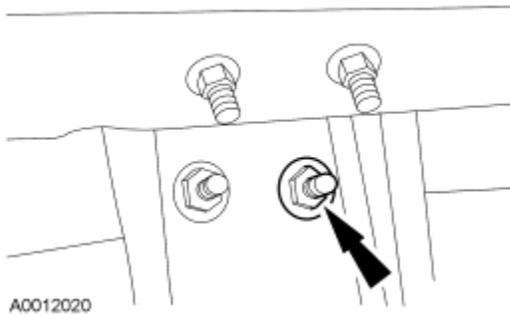
13. Remove the ten crossmember-to-frame bolts.



A0031974

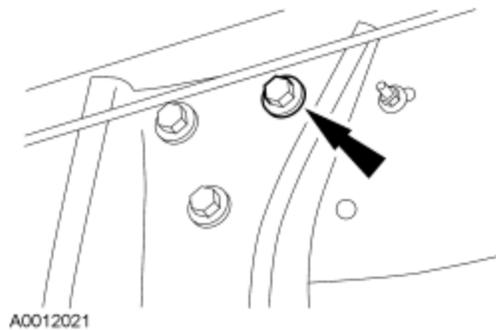
F-Super Duty automatic transmission vehicles

14. Remove the four RH crossmember bolts.



A0012020

15. Remove the three LH crossmember bolts.

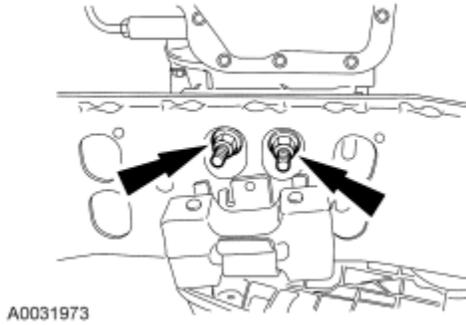


A0012021

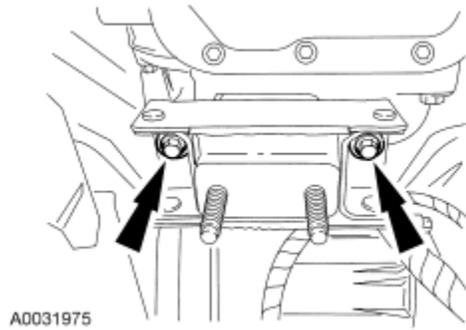
All vehicles equipped with automatic transmissions

16. **NOTE:** Typical is shown.

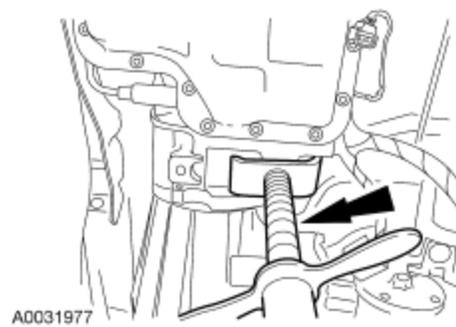
Remove the nuts and the crossmember.



17. Remove the transmission mount.

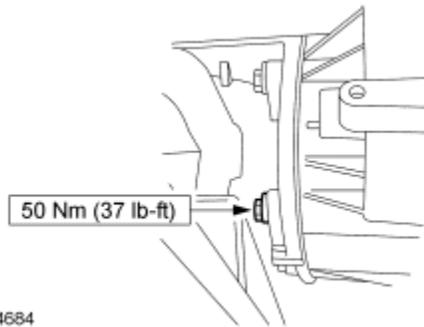


18. Position a suitable jack stand under the extension housing.



All vehicles

19. Remove the six transfer case-to-transmission bolts.

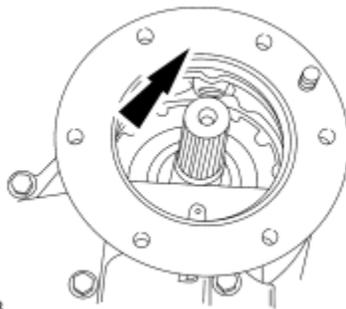


A0014684

20. Separate the transfer case from the extension housing. Pull the transfer case rearward, then lower the transfer case from the vehicle.

21.  **CAUTION: Carefully clean the gasket surfaces. Nicks and gouges cause fluid leaks.**

Remove the transfer case-to-transmission gasket. Clean the mating surfaces, using metal surface cleaner.



DE1846-B

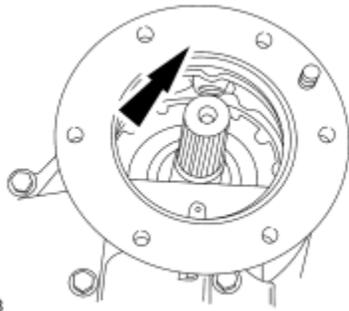
SECTION 308-07B: Transfer Case
INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/30/2002](#)

Transfer Case

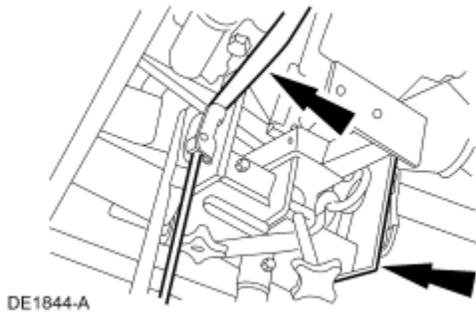
All vehicles

1. Install a new mounting gasket.

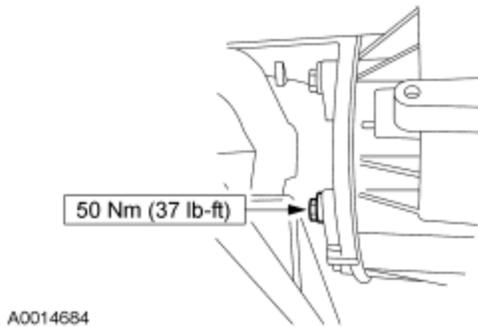


2. **⚠ CAUTION: Secure the transfer case to the high-lift jack with a safety strap.**

Raise the transfer case into position.

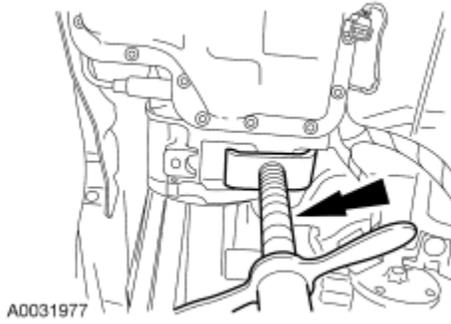


3. Install the six bolts retaining the transfer case to the extension housing.

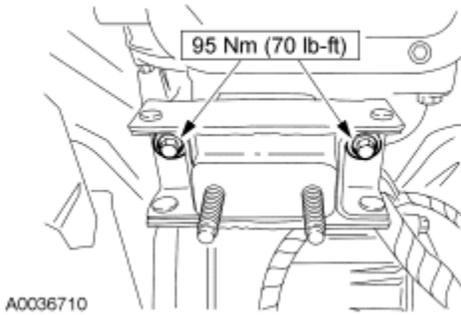


Automatic transmission vehicles

4. Remove the jack stand from the extension housing.

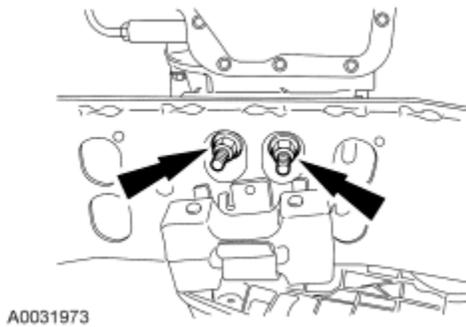


5. Install the transmission mount.



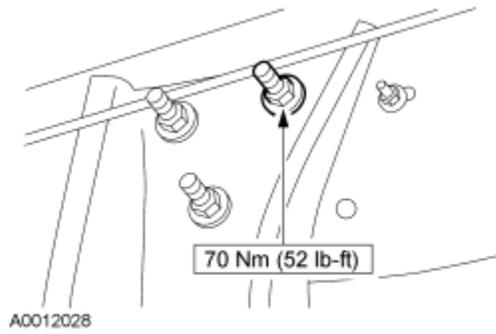
6. **NOTE:** Typical is shown.

Position the crossmember and loosely install the two nuts.

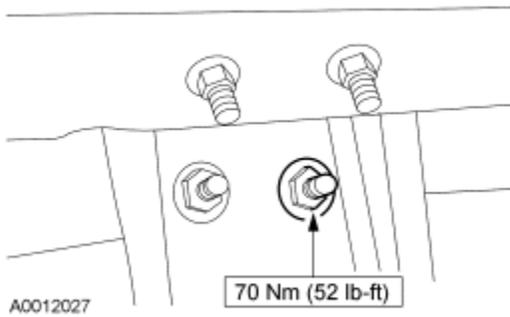


F-Super Duty automatic transmission vehicles

7. Install the three LH crossmember bolts.

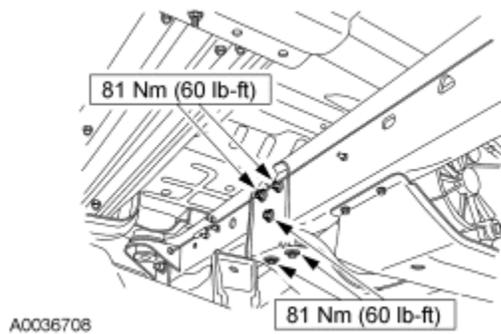
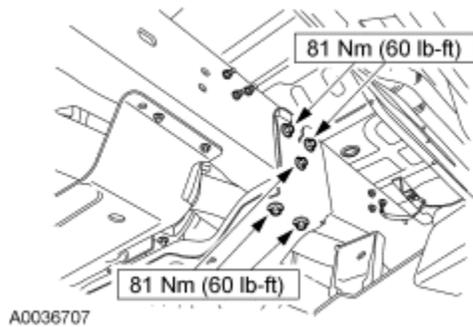


8. Install the RH crossmember bolts.

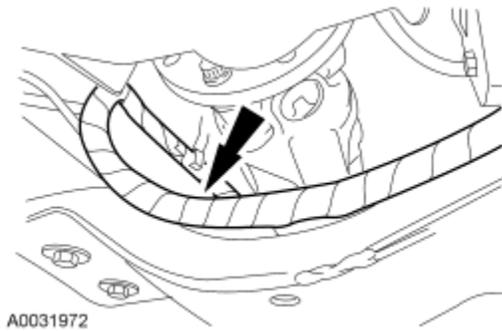


Excursion automatic transmission vehicles

9. Install the ten crossmember bolts.

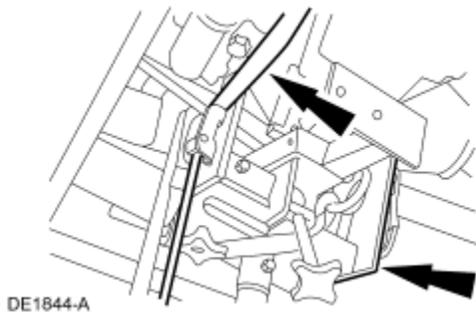


10. Attach the wire harness to the crossmember.



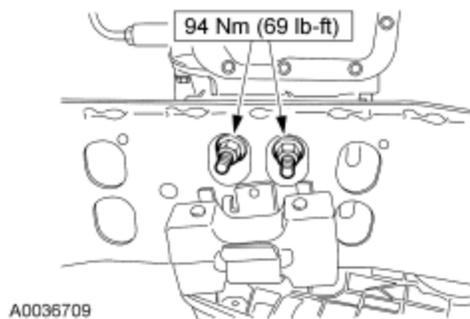
All vehicles

11. Remove the high-lift jack.



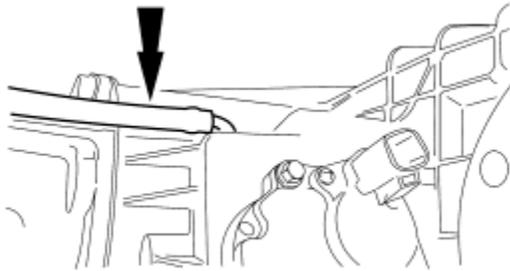
Automatic transmission vehicles

12. Tighten the transmission mount-to-crossmember nuts.



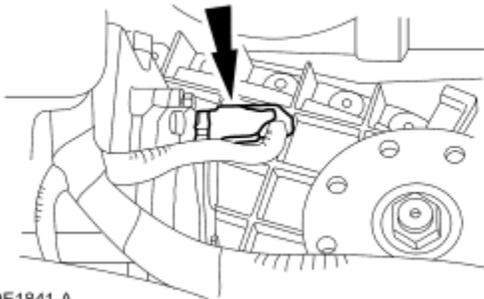
All electric shift transfer cases

13. Connect the vent hose.

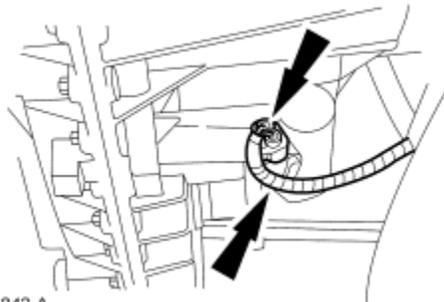


A0031976

14. Connect the two gear motor encoder assembly electrical connectors.



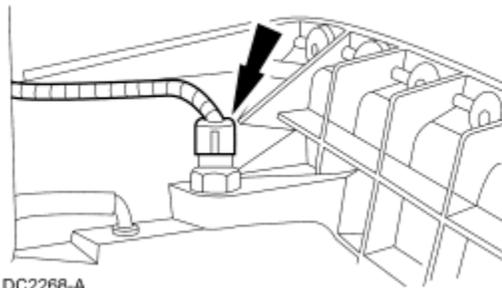
DE1841-A



DE1842-A

All manual shift transfer cases

15. Connect the 3-position mode switch harness connector.



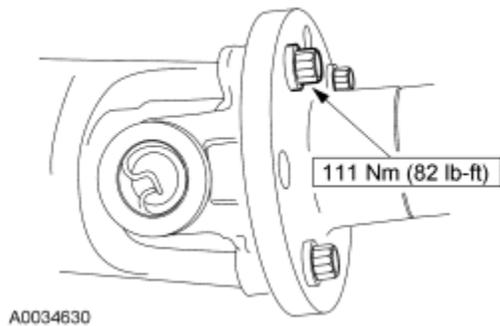
DC2268-A

16. Connect the manual shift linkage.

All vehicles

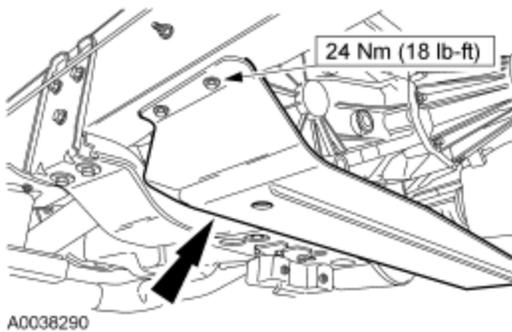
17.  **CAUTION: Align the index-marks when installing the driveshaft.**

Connect the front driveshaft to the transfer case and install the four new bolts.



18. Install the rear driveshaft. For additional information, refer to [Section 205-01](#).

19. If equipped, install the skid plate and the four bolts.



20. If drained, fill the transfer case. For additional information, refer to [Transfer Case Draining and Filling](#) in this section.
-

GROUP 09: Exhaust System

[SECTION 309-00: Exhaust System — General Information](#)

SECTION 309-00: Exhaust System — General Information

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Exhaust System](#)

DIAGNOSIS AND TESTING

[Exhaust System](#)

[Inspection and Verification](#)

[Symptom Chart](#)

[Pinpoint Tests](#)

REMOVAL AND INSTALLATION

[Muffler and Tailpipe—5.4L and 6.8L](#)

[Muffler and Tailpipe—7.3L Diesel](#)

[Muffler Inlet Pipe—5.4L and 6.8L](#)

[Muffler Inlet Pipe—7.3L Diesel](#)

[Three Way Catalytic Converters \(TWC\)—5.4L](#)

[Three Way Catalytic Converter \(TWC\)—6.8L](#)

[Heat Shield—Catalytic Converter and Muffler](#)

SECTION 309-00: Exhaust System — General
Information

1999 F-Super Duty 250-550 Workshop
Manual

SPECIFICATIONS

[Procedure revision date: 01/26/2000](#)

Torque Specifications		
Description	Nm	Lb/Ft

Heat Shield Screws	13-17	—
Muffler Inlet Pipe	34-46	25-33
Muffler Inlet Pipe-to-Exhaust Manifold Nuts	40-50	30-36
Muffler Inlet Pipe-to-Intermediate Pipe Flange Nuts—7.3L Diesel	40	30
Muffler-to-Catalytic Converter Clamp Nuts	47-63	35-46
Turbo-to-Muffler Inlet Pipe Clamp Nut	26-34	16-25
Muffler Inlet Pipe to TWC Clamp Nuts	40-55	30-40
Muffler to Catalytic Converter Pipe Clamp Nuts	40-55	30-40

SECTION 309-00: Exhaust System — General Information
DESCRIPTION AND OPERATION

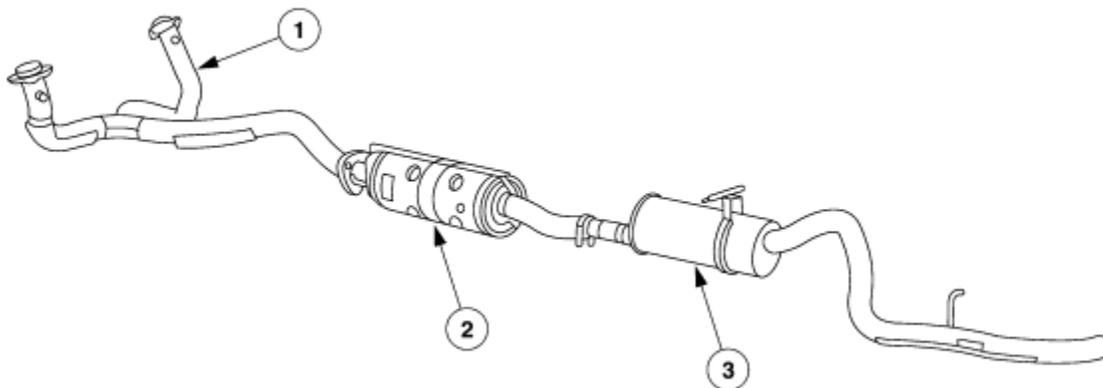
1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Exhaust System

The exhaust system:

- is constructed of stainless steel.
- contains dual three way catalytic converters (TWC).
- has two upstream heated oxygen sensors (HO2S) mounted before the TWCs.

Component Location—5.4L and 6.8L Engines

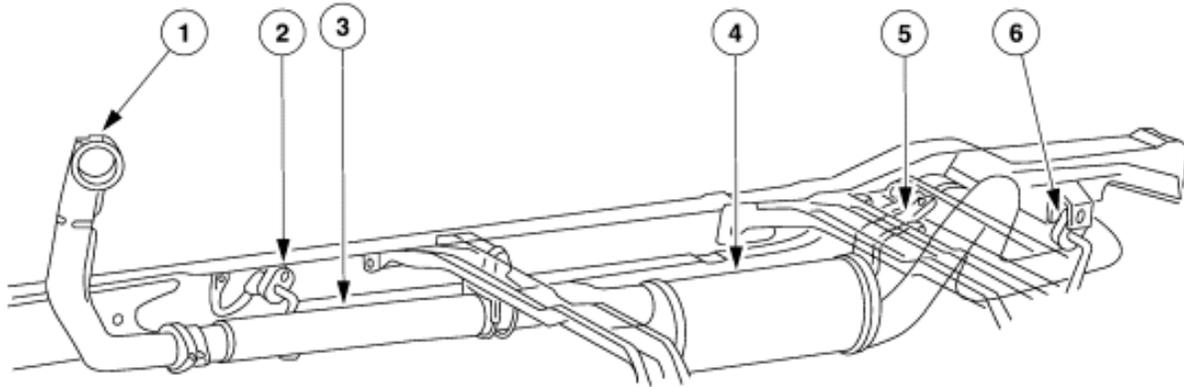


AU0148-A

Item	Part Number	Description
------	-------------	-------------

1	5242	Inlet Y-Pipe
2	5E212	Three Way Catalytic Converter
3	5K214	Muffler and Tailpipe Assembly

Component Location—7.3L Engine



AU0104-D

Item	Part Number	Description
1	6N646	Exhaust Inlet Pipe
2	5A246	Exhaust Hanger Insulator
3	—	Intermediate Pipe
4	5230	Muffler
5	5A242	Exhaust Hanger Insulator
6	5260	Exhaust Hanger Insulator

SECTION 309-00: Exhaust System — General
 Information
 DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550 Workshop
 Manual
[Procedure revision date: 01/26/2000](#)

Exhaust System

Inspection and Verification

1. Verify the customer's concern by running the engine or road testing the vehicle to duplicate the condition.
2. Visually inspect the components of the exhaust system and related controls that may affect exhaust gas quality or cause backfire or loss of power.
3. Visually inspect for obvious signs of mechanical and electrical damage; refer to the following chart.

Visual Inspection Chart	
Mechanical	Electrical
<ul style="list-style-type: none"> • Leaking fuel injectors. • Damaged intake air passages. • Inoperative exhaust gas recirculation (EGR) valve. • Exhaust pipe pinched, crushed. • Damaged, loose vacuum hoses. • Incorrect idle speed. • Dirty engine air cleaner element. • Damaged catalytic converter. 	<ul style="list-style-type: none"> • Misrouted, damaged wiring. • Damaged ignition coil, distributor or spark plugs. • Damaged, loose connectors.

4. Exercise the wiring and connectors for the solenoids and other components for obvious problems due to looseness, corrosion, or other damage. This must be done while the engine is fully warmed and the system controls are activated.
5. Check the vacuum lines and connections for looseness, pinching, leakage, splitting, blockage, or other damage.
6. If a vacuum line or orifice (restrictor) blockage is suspected, correct the cause before proceeding to the next step.
7. If the fault is not visually evident, determine the symptom and proceed to the Symptom Chart.

Symptom Chart

SYMPTOM CHART		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> • Noisy or Leaking Exhaust 	<ul style="list-style-type: none"> • Exhaust leak. • Misaligned exhaust. • Loose clamps. 	<ul style="list-style-type: none"> • GO to Pinpoint Test A.

	<ul style="list-style-type: none"> Restricted exhaust. 	
<ul style="list-style-type: none"> Loss of Power 	<ul style="list-style-type: none"> Kinked or damaged exhaust pipe. Clogged catalytic converter. Foreign object in exhaust pipe. 	<ul style="list-style-type: none"> GO to Pinpoint Test B.

Pinpoint Tests

PINPOINT TEST A: NOISY OR LEAKING EXHAUST

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE CLAMPS AND BRACKETS	
<div style="border: 1px solid black; padding: 2px; display: inline-block;">1</div> 	
	<div style="border: 1px solid black; padding: 2px; display: inline-block;">2</div> Inspect the exhaust system for loose or broken clamps and brackets. <ul style="list-style-type: none"> Are the clamps and brackets OK? <p>→ Yes GO to A2.</p> <p>→ No TIGHTEN or REPLACE the damaged clamps or brackets. TEST the system for normal operation.</p>
A2 CHECK THE EXHAUST COMPONENTS	
	<div style="border: 1px solid black; padding: 2px; display: inline-block;">1</div> Inspect the exhaust components for punctures, split seams, or improper welds. <ul style="list-style-type: none"> Are the exhaust components OK? <p>→ Yes GO to A3.</p>

	<p>→ No REPLACE the damaged exhaust components. TEST the system for normal operation.</p>
A3 CHECK THE EXHAUST MANIFOLD(S)	
	<p>1 Inspect the exhaust manifolds (9430) for loose fasteners or cracks.</p>
	<ul style="list-style-type: none"> • Are the exhaust manifolds OK? <p>→ Yes GO to Pinpoint Test B.</p> <p>→ No TIGHTEN loose fasteners or REPLACE the exhaust manifolds; REFER to Section 303-01A (5.4L), Section 303-01B (6.8L) or Section 303-01C (7.3L). TEST the system for normal operation.</p>

PINPOINT TEST B: LOSS OF POWER

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 PERFORM A VACUUM TEST	
<p>1</p> 	
	<p>2 Perform the Intake Manifold Vacuum Test; refer to Section 303-00.</p>
	<ul style="list-style-type: none"> • Is the vacuum within specification? <p>→ Yes REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual, for diagnosis and testing of the engine.</p> <p>→ No GO to B2.</p>
B2 PERFORM A VACUUM TEST — EXHAUST DISCONNECTED	
<p>1</p> 	
	<p>2 Disconnect the exhaust system at the exhaust manifolds; refer to the Three</p>

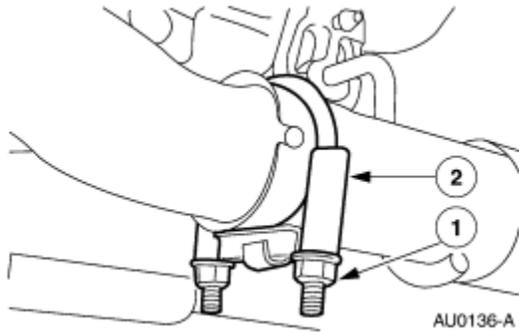
	Way Catalytic Converters (TWC)—5.4L or Three Way Catalytic Converter (TWC)—6.8L in this section.
3 	
	4 Perform the Intake Manifold Vacuum Test; refer to Section 303-00 .
	<ul style="list-style-type: none"> • Is the vacuum within specification? <p>→ Yes GO to B3.</p> <p>→ No GO to B4.</p>
B3 PERFORM A VACUUM TEST — MUFFLER DISCONNECTED	
1 	
	2 Reconnect the exhaust system at the exhaust manifolds; refer to the Three Way Catalytic Converters (TWC)—5.4L or Three Way Catalytic Converter (TWC)—6.8L in this section.
	3 Disconnect the muffler and tailpipe; refer to the Muffler and Tailpipe—5.4L and 6.8L or Muffler and Tailpipe—7.3L Diesel in this section.
4 	
	5 Perform an Intake Manifold Vacuum Test; refer to Section 303-00 .
	<ul style="list-style-type: none"> • Is the vacuum within specification? <p>→ Yes REPLACE the muffler and tailpipe; refer to the Muffler and Tailpipe—5.4L and 6.8L or Muffler and Tailpipe—7.3L Diesel in this section. TEST the system for normal operation.</p> <p>→ No REPLACE the three way catalytic converter; refer to the Three Way Catalytic Converters (TWC)—5.4L or Three Way Catalytic Converter (TWC)—6.8L in</p>

	this section. TEST the system for normal operation.
B4 CHECK THE EXHAUST MANIFOLD	
1 	
	2 Reconnect the exhaust system at the muffler and tailpipe; refer to the Muffler and Tailpipe—5.4L and 6.8L or Muffler and Tailpipe—7.3L Diesel in this section.
	3 Remove the exhaust manifolds; refer to Section 303-01A (5.4L), Section 303-01B (6.8L) or Section 303-01C (7.3L).
	4 Inspect the ports for casting flash.
	<ul style="list-style-type: none"> • Is there casting flash present? <p>→ Yes REMOVE the casting flash or REPLACE the exhaust manifolds; refer to Section 303-01A (5.4L), Section 303-01B (6.8L) or Section 303-01C (7.3L). TEST the system for normal operation.</p> <p>→ No REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual for diagnosis and testing of the engine.</p>

Muffler and Tailpipe—5.4L and 6.8L

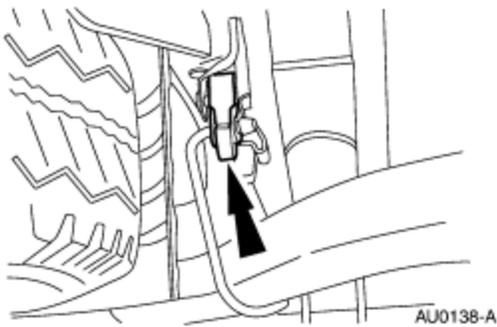
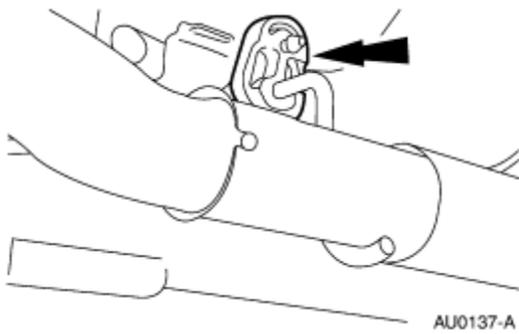
Removal

1. Raise and support the vehicle; refer to [Section 100-02](#).
2. Remove the muffler to three-way catalytic converter (TWC) pipe clamp.
 1. Remove the nuts.
 2. Remove the clamp.



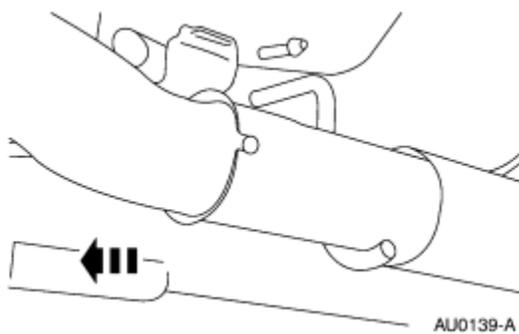
3. **NOTE:** The three tailpipe hanger insulators can be reused if they show no signs of damage.

Remove the tailpipe hanger insulators and discard if damaged.



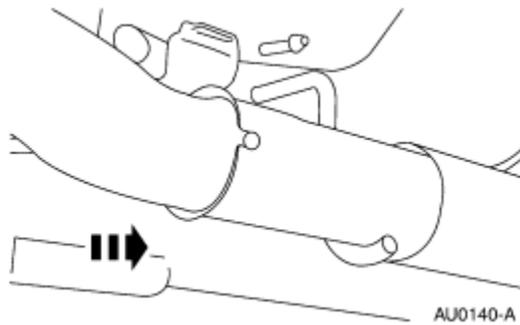
4. **NOTE:** It may be necessary to heat the joint to ease removal.

Remove the muffler and tailpipe assembly.



Installation

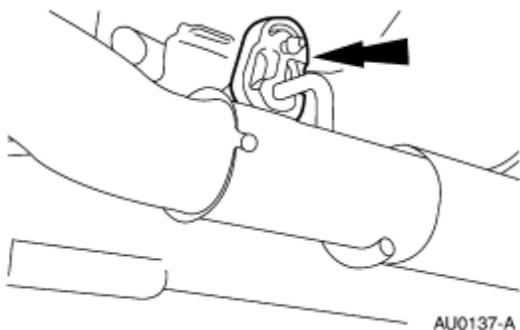
1. Position the muffler and tailpipe assembly.



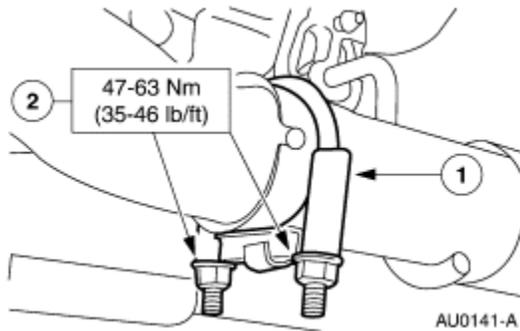
2.  **CAUTION: Do not use oil or grease-based lubricants on insulators which deteriorates the rubber.**

NOTE: A soap and water solution will ease installation of the muffler hangers into the rubber tailpipe hanger insulators.

Install the tailpipe hanger insulators.



3. Install the muffler to catalytic converter pipe clamp.
 1. Position the clamp.
 2. Install the nuts.



4. Lower the vehicle.

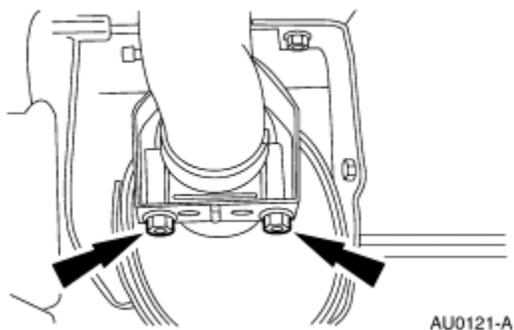
SECTION 309-00: Exhaust System — General
Information
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

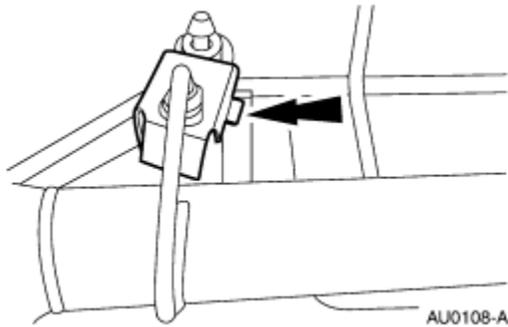
Muffler and Tailpipe—7.3L Diesel

Removal

1. Raise the vehicle on a hoist; refer to [Section 100-02](#).
2. Remove the clamp.



3. **NOTE:** It may be necessary to heat the muffler-to-intermediate joint to ease removal.
Separate the muffler from the intermediate pipe.
4. **NOTE:** The exhaust hanger insulators can be reused if they show no signs of damage.
Remove the exhaust hangers.



5. Remove the muffler and tailpipe.

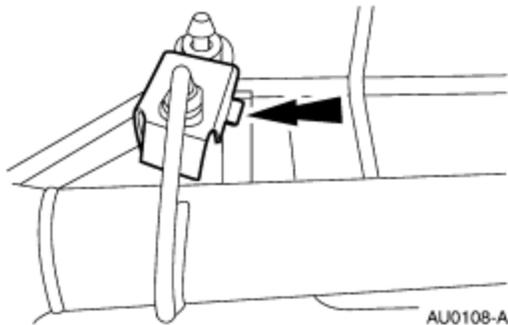
Installation

1. Position the muffler and tailpipe.

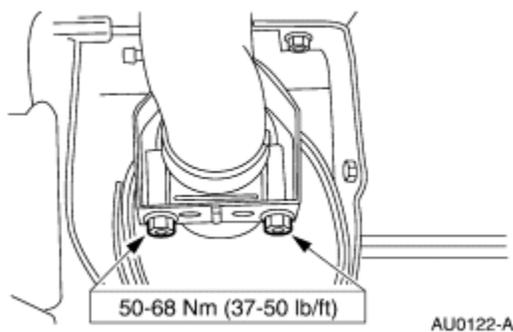
⚠ CAUTION: To prevent damage to the exhaust hanger insulators, do not lubricate with oil or grease-based lubricants.

2. **NOTE:** A soap and water solution will ease the installation of the exhaust insulator.

Install the exhaust hanger insulators.



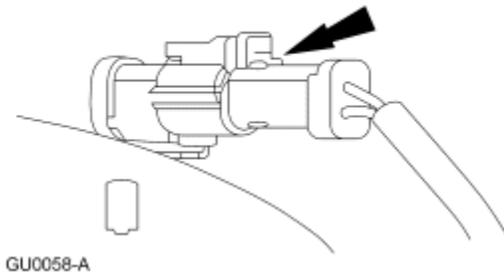
3. Install the clamp.



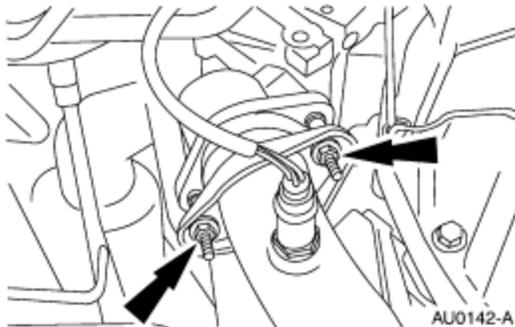
Muffler Inlet Pipe—5.4L and 6.8L

Removal

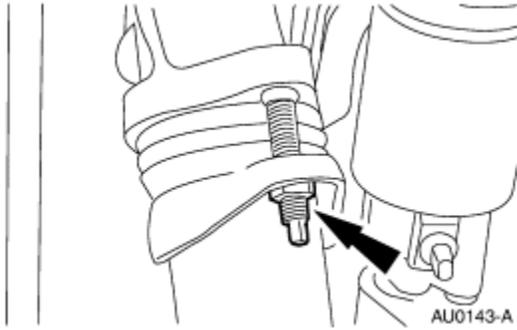
1. Raise the vehicle on a hoist; refer to [Section 100-02](#).
2. Disconnect the heated oxygen sensor electrical connections.



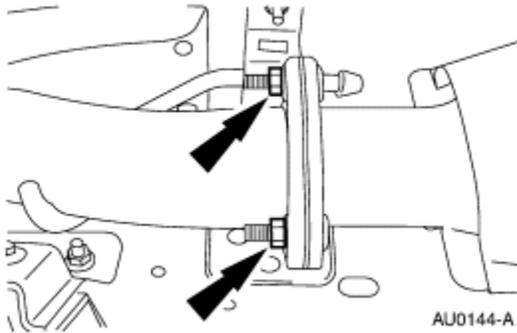
3. Remove the LH nuts.



4. Remove the RH nuts.



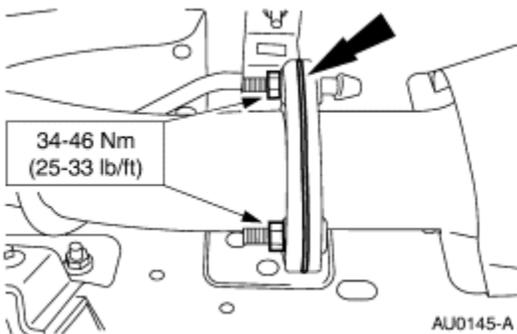
5. Remove the three nuts and discard the gasket.



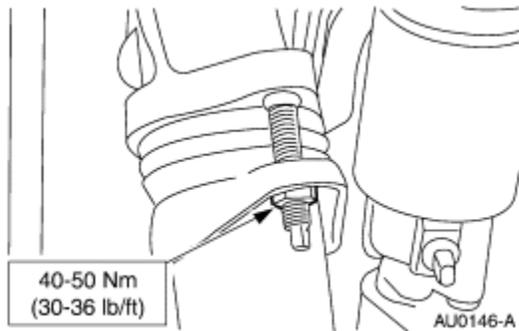
6. Remove the muffler inlet pipe.

Installation

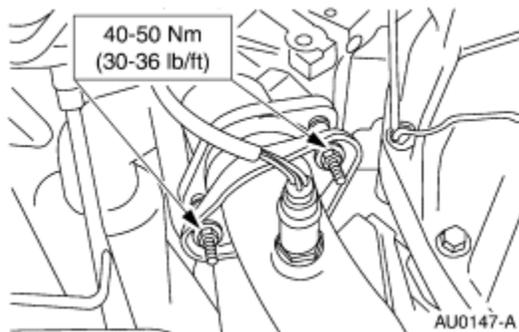
1. Position the muffler inlet pipe.
2. Install a new flange gasket and three nuts.



3. Install the two RH nuts.



4. Install the LH nuts.



5. Connect heated oxygen sensor electrical connections.
6. Lower the vehicle.

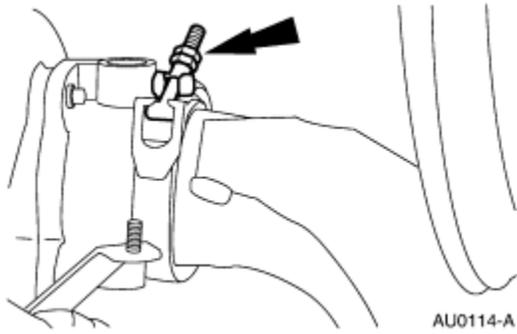
SECTION 309-00: Exhaust System — General
Information
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

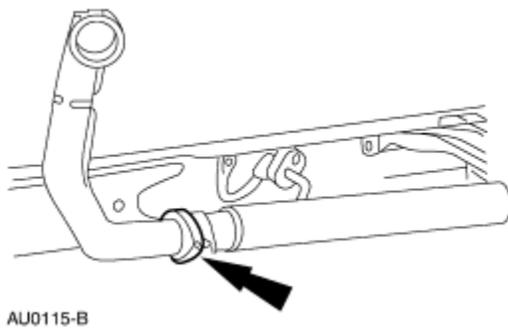
Muffler Inlet Pipe—7.3L Diesel

Removal

1. Remove the clamp.

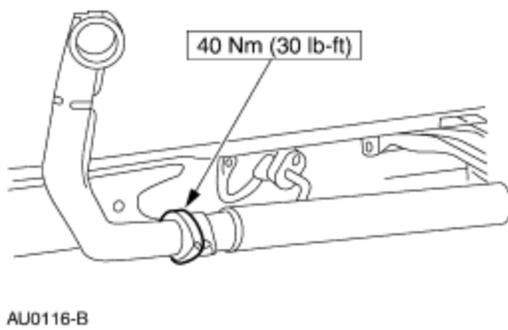


2. Raise the vehicle; refer to [Section 100-02](#).
3. Remove the nuts and discard the gasket.

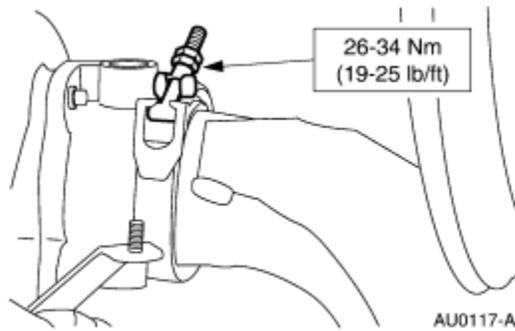


Installation

1. Position the muffler inlet pipe.
2. Install the nuts.



3. Lower the vehicle.
4. Install the clamp.



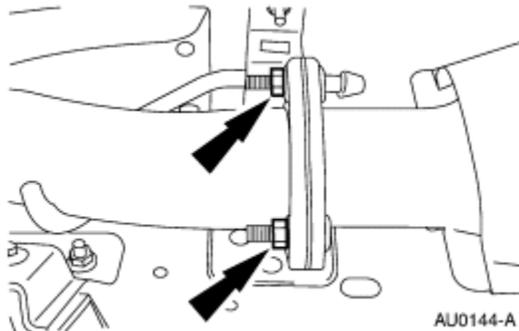
SECTION 309-00: Exhaust System — General
Information
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

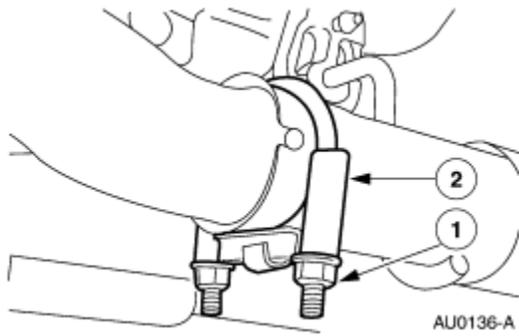
Three Way Catalytic Converters (TWC)—5.4L

Removal

1. Raise the vehicle on a hoist; refer to [Section 100-02](#).
2. Remove the three nuts.

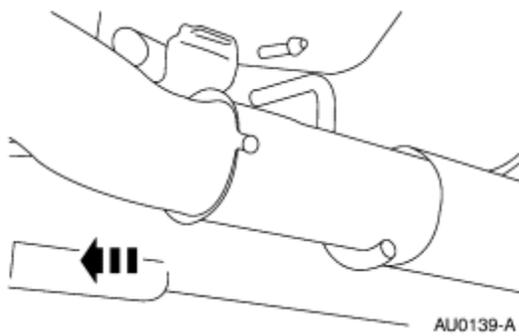


3. Remove the muffer-to-TWC clamp.
 1. Remove the nuts.
 2. Remove the clamp.



4. **NOTE:** It may be necessary to heat the joint to ease removal.

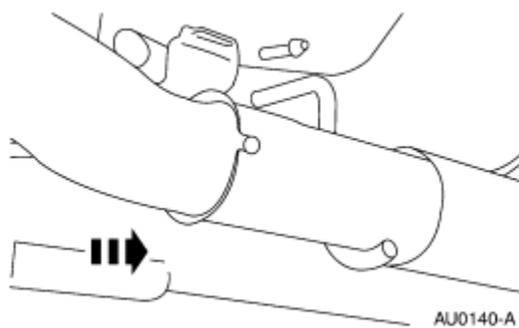
Separate the TWC from the muffler.



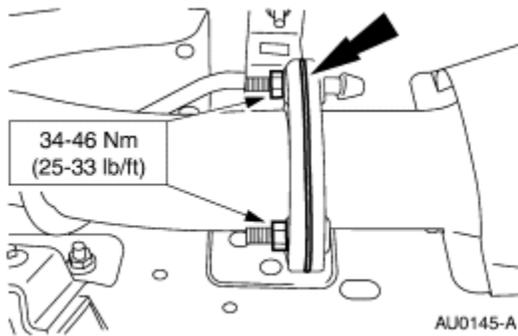
Installation

1. **NOTE:** It may be necessary to heat the joint to ease installation.

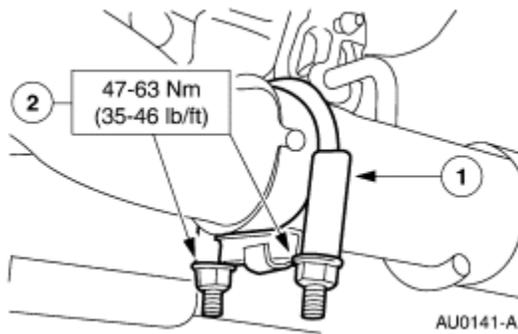
Insert the TWC into the muffler.



2. Install a new flange gasket and the three nuts.



3. Install the muffler to TWC clamp.
 1. Position the clamp.
 2. Install the nuts.



4. Lower the vehicle.

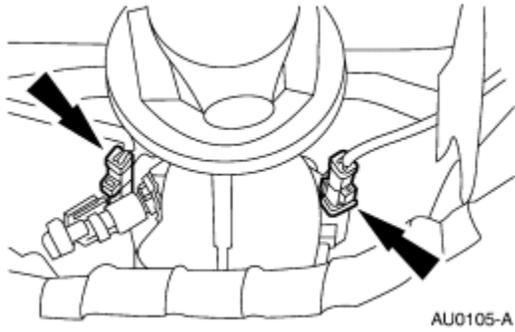
SECTION 309-00: Exhaust System — General
Information
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

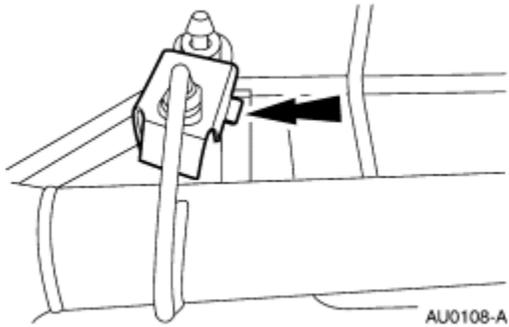
Three Way Catalytic Converter (TWC)—6.8L

Removal

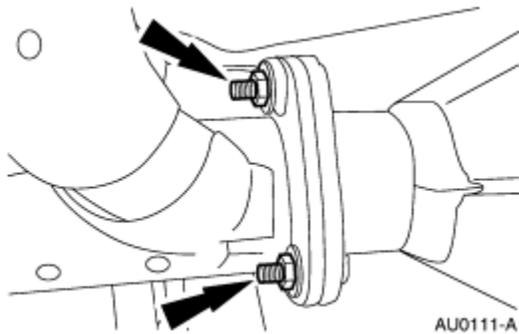
1. Raise the vehicle; refer to [Section 100-02](#).
2. Disconnect the catalytic monitor sensor electrical connector.



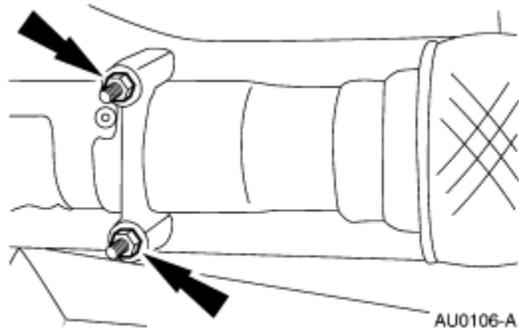
3. Support the exhaust system.



4. **NOTE:** The exhaust hanger insulators can be reused if they show no signs of damage.
Remove the exhaust hanger insulators and discard if damaged.
5. Remove the three nuts and the exhaust hanger bracket and gasket. Discard the gaskets.

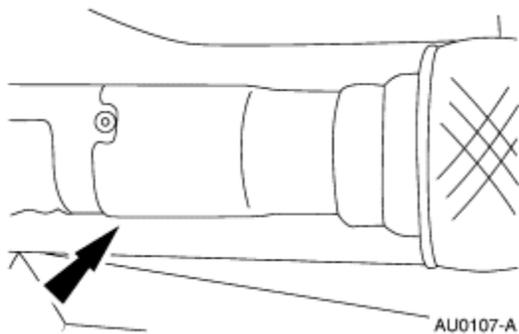


6. Remove the TWC-to-muffler clamp and exhaust hanger.



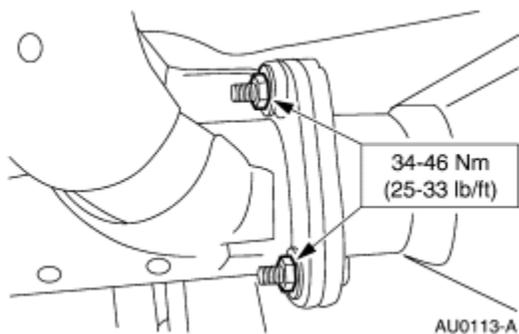
7. **NOTE:** It may be necessary to heat the TWC-to-muffler joint to ease removal.

Separate the three way catalytic converter (TWC) (5E212) from the muffler (5230).

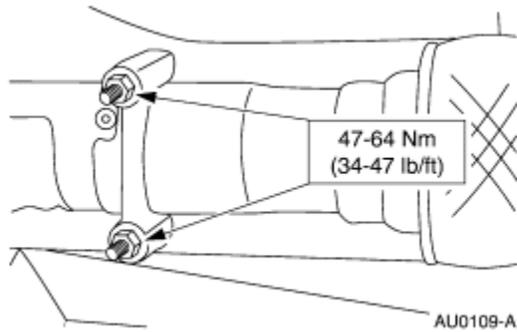


Installation

1. Position the three way catalytic converter and a new gasket.
2. Install the exhaust hanger bracket and the three nuts.



3. Install the TWC-to-muffler clamp and hanger.



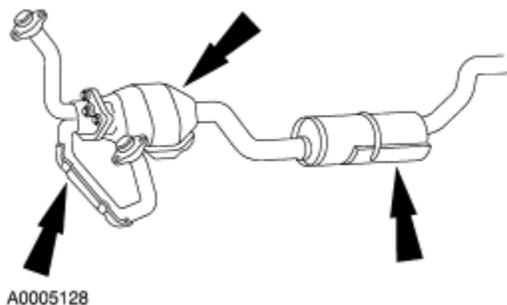
4. Connect the catalytic monitor sensor electrical connector.

SECTION 309-00: Exhaust System — General
Information
REMOVAL AND INSTALLATION

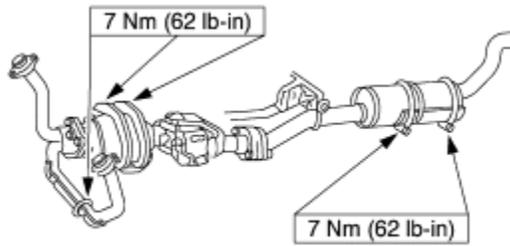
1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

Heat Shield—Catalytic Converter and Muffler

1. Disconnect the battery cable. For additional information, refer to [Section 414-01](#).
2. Raise the vehicle. For additional information, refer to [Section 100-02](#).
3. Inspect the catalytic converter and muffler for loose or missing heat shields.



4. Install worm clamps for heat shields that are loose.
 - Use one of the following clamps: FOTZ-5A231-A or W705949-S300.
 - Trim off the excess ear of the worm clamp.



A0005129

5. If the heat shields are missing, install new heat shields. If new heat shields are not available, install a new catalytic converter. For additional information, refer to [Three Way Catalytic Converters \(TWC\)—5.4L](#) or [Three Way Catalytic Converter \(TWC\)—6.8L](#) in this section.
6. Lower the vehicle.
7. Reconnect the battery cable.

GROUP 10: Fuel System

[SECTION 310-00: Fuel System — General Information](#)

[SECTION 310-01: Fuel Tank and Lines](#)

[SECTION 310-02: Acceleration Control](#)

[SECTION 310-03: Vehicle Speed Control](#)

**SECTION 310-00:
Fuel System — General Information**

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Fuel System—Gasoline Engines](#)

[Fuel System—Diesel Engines](#)

DIAGNOSIS AND TESTING

[Fuel System](#)

GENERAL PROCEDURES

[Pressure Relief](#)

[Draining—Midship Fuel Tank](#)

[Draining—Aft of Axle Fuel Tank](#)

[Draining—Fuel Filter Water](#)

[Push Connect Fittings](#)

[Spring Lock Couplings](#)

[Hairpin Clip Fitting](#)

[Vapor Tube Fittings](#)

SECTION 310-00: Fuel System — General
Information

1999 F-Super Duty 250-550 Workshop
Manual

SPECIFICATIONS

[Procedure revision date: 01/26/2000](#)

General Specifications	
Item	Specification
Fuel Capacity	
Wide Frame Vehicles Standard Bed Midship Tank	144 liters (38 gallons)
Wide Frame Vehicles Short Bed Midship Tank	110 liters (29 gallons)
Narrow Frame Chassis Cab Aft-of-Axle Tank Standard Equipment	139 liters (36 gallons)
Narrow Frame Chassis Cab Midship Tank (Optional)	69 liters (19 gallons)
Motor Home Chassis Aft-of-Axle Tank	283 Liters (75 gallons)
Fuel Pressure	

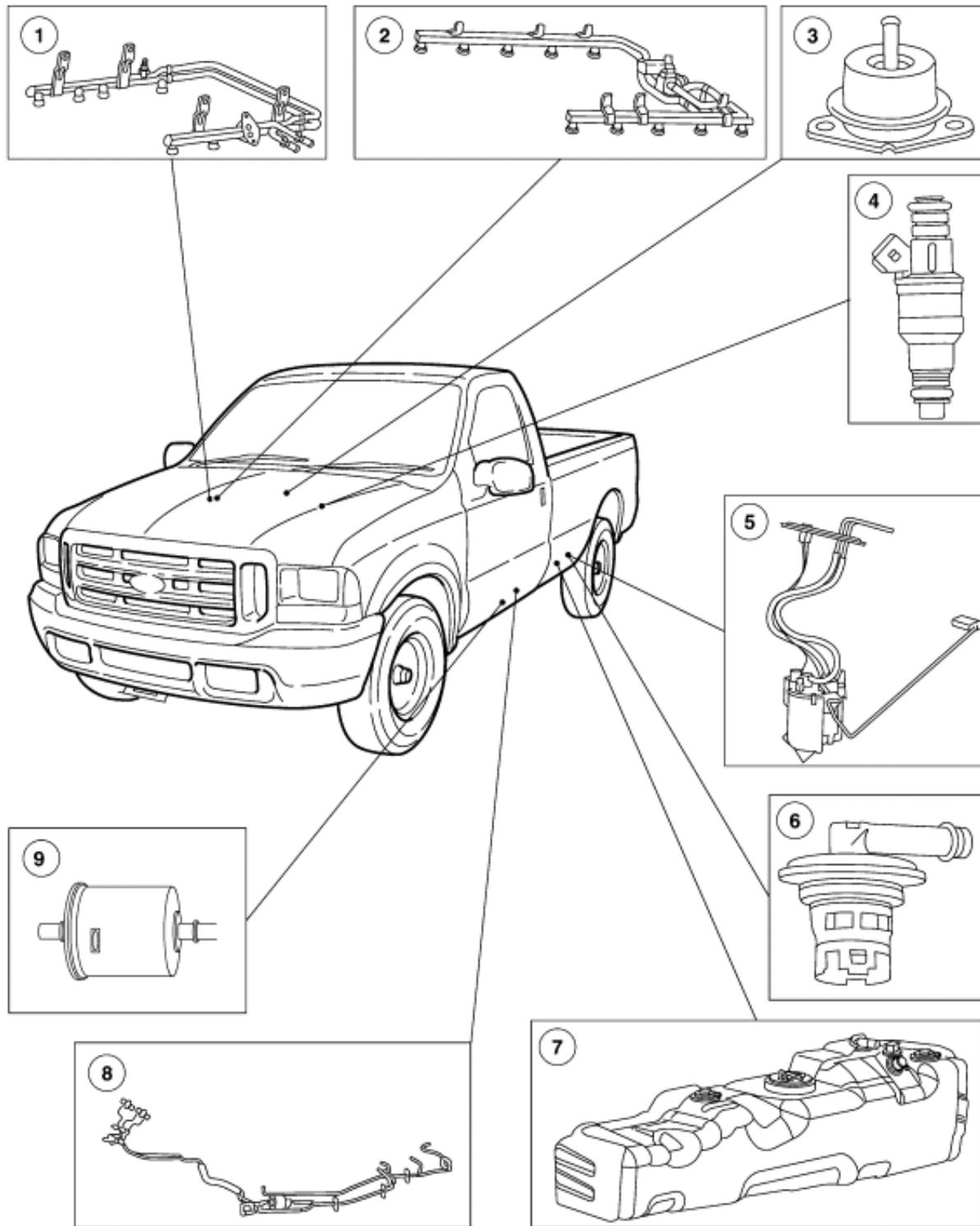
5.4L and 6.8L Gasoline Engine Running kPa (psi)	193-310 (28-45)
5.4L and 6.8L Gasoline Engine—Key On Engine Off kPa (psi)	240-310 (35-45)
7.3L Diesel Operating Fuel Line Primary Pump Pressure kPa (psi)	352 ± 28 (51 ± 4)
Lubricants	
Engine Oil	WSS-M2C153-G

SECTION 310-00: Fuel System — General
Information
DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

Fuel System—Gasoline Engines

Component Location



AV1099-A

Item	Part Number	Description
1	9D280	Fuel Injection Supply Manifold (5.4L)
2	9D280	Fuel Injection Supply Manifold (6.8L)
3	9C968	Fuel Pressure Regulator

4	9F593	Fuel Injector
5	9350	Fuel Pump
6	9B593	Vapor Valve
7	9002	Fuel Tank
8	9S278	Rear Fuel Supply Return and Vapor Tube
9	9155	Fuel Filter

 **WARNING:** The fuel in the fuel system remains under high pressure even when the engine is not running. Before repairing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

The vehicle:

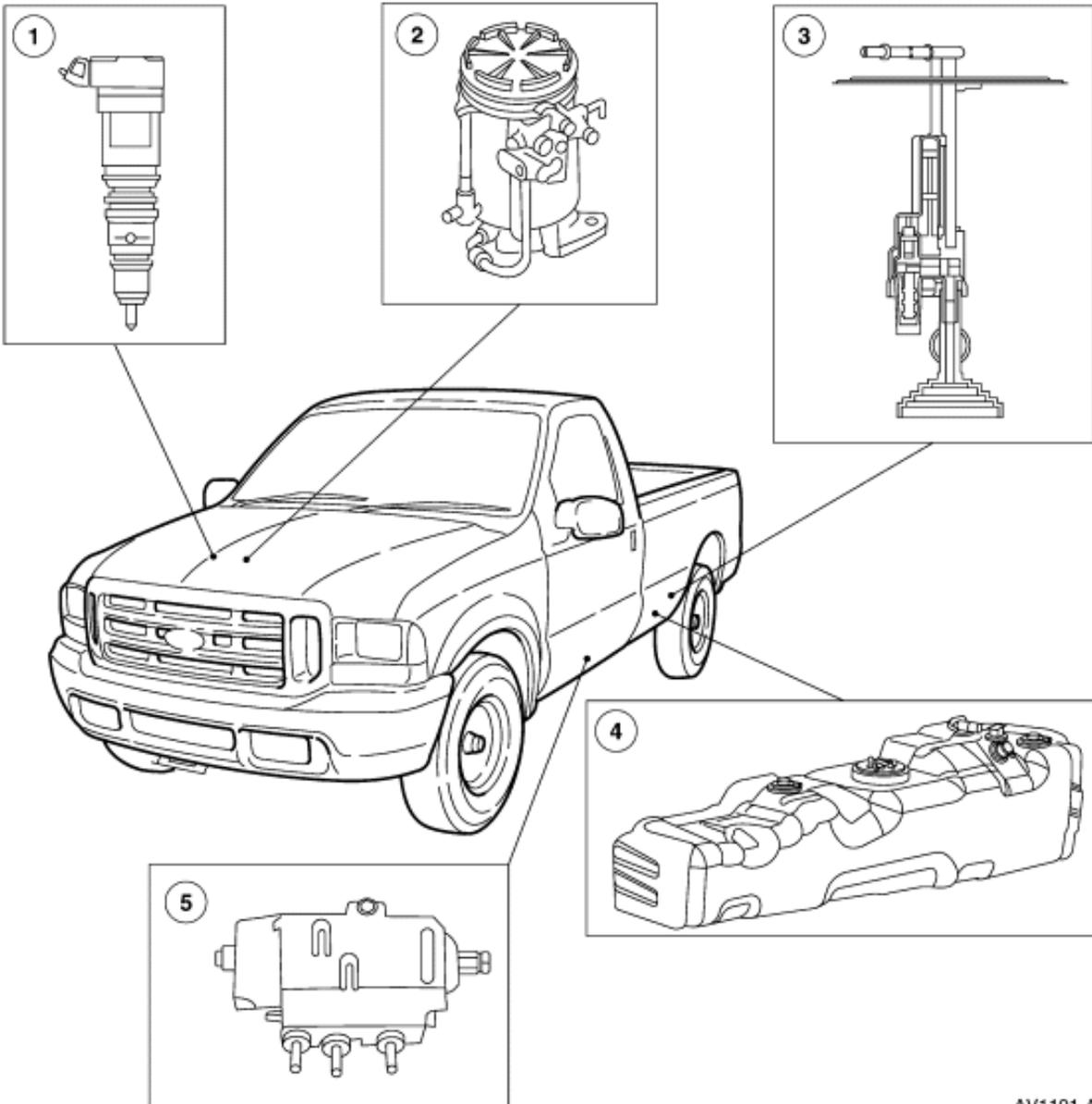
- is equipped with a multiport fuel injection (MFI) system.
- has separately controlled fuel injectors mounted to the intake manifold for each cylinder.
- has fuel injectors which are supplied with pressurized fuel from the fuel pump through the fuel injection supply manifold.
- has a fuel injection supply manifold which is equipped with a fuel pressure regulator.
- has a fuel pressure regulator controlling the pressure to the fuel injectors.
- has excess fuel to the fuel injectors returned to the fuel tank.

SECTION 310-00: Fuel System — General
Information
DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

Fuel System—Diesel Engines

Component Location—Diesel



AV1101-A

Item	Part Number	Description
1	9F593	Fuel Injector
2	9155	Fuel Filter (Heater and Water Separator Assembly)
3	9275	Fuel Level Sensor
4	9002	Fuel Tank (Midship Shown)
5	9350	Fuel Pump (Electric Frame Mount)

The fuel system for the 7.3L direct injection turbo (DIT) diesel:

- is controlled by the powertrain control module (PCM).

- utilizes an electric, frame mounted fuel pump.
- incorporates a fuel filter and water separator assembly.
- incorporates an internal check valve with a built-in orifice that will bleed off system pressure approximately ten minutes after the pump is shut off.

The electric fuel pump:

- draws fuel from the fuel tank.
- circulates fuel under pressure through the fuel filter and water separator and the pressure regulator to the cylinder head fuel galleries and to the fuel injectors.

Excess fuel is returned to the fuel tank through the fuel return hose.

Fuel Filter/Water Separator

The diesel engine is equipped with a fuel filter and water separator assembly. Drain the water from the fuel filter at the recommended maintenance intervals. Refer to the Service Guide for the maintenance intervals.

A water in fuel indicator on the instrument panel will alert the operator. When the indicator glows continuously while the engine is running, drain the water from the fuel filter and water separator bowl as soon as possible to prevent damage to the fuel injection system; refer to [Draining—Fuel Filter Water](#) in this section.

SECTION 310-00: Fuel System — General
Information
DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

Fuel System

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

SECTION 310-00: Fuel System — General
Information
GENERAL PROCEDURES

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

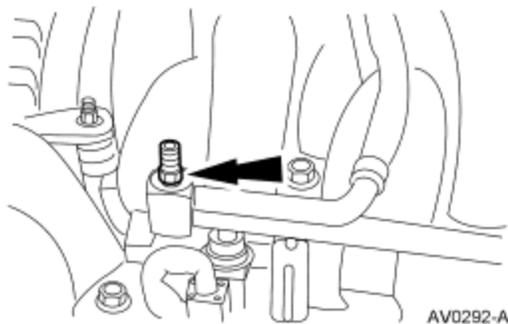
Pressure Relief

Special Tool(s)	
 ST1371-A	EFI/CFI Fuel Pressure Gauge 310-012 (T80L-9974-B)

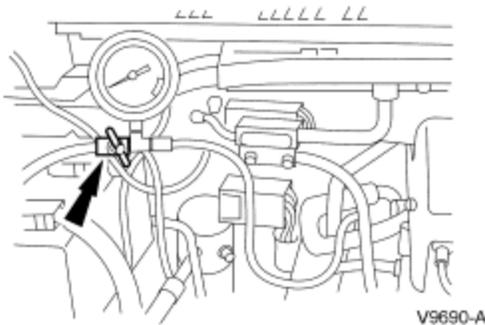
⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

⚠ WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before servicing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

1. Remove the Schrader valve cap and install the EFI/CFI Fuel Pressure Gauge.



2. Open the manual valve slowly on the EFI/CFI Fuel Pressure Gauge and relieve the fuel pressure.
 - This will drain some fuel out of the system; place the fuel in a suitable container.

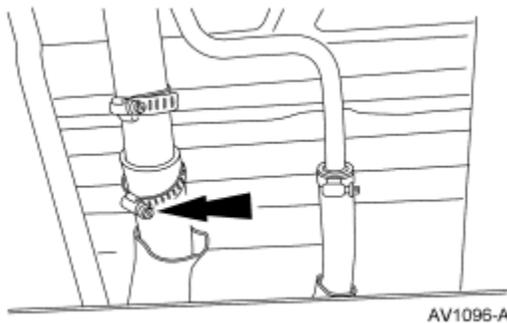


Draining—Midship Fuel Tank

Special Tool(s)	
 ST1114-A	30 Gallon Gasoline Hand Pump Storage Tanker 164-R3201 or equivalent

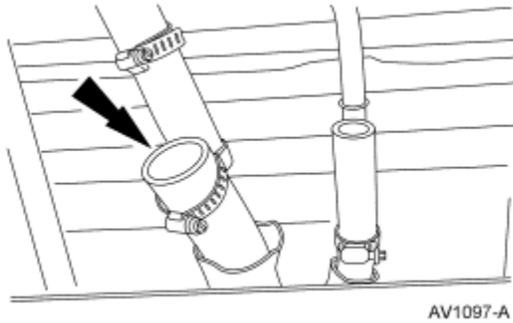
⚠ WARNING: Do not smoke or carry lighted tobacco or have open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury or property damage.

1. Disconnect the battery ground cable (14301).
2. Raise and support the vehicle.
3. Remove the filler pipe hose at the filler pipe hose connection. Loosen the clamp and disconnect the hose.



4. **NOTE:** Follow the operating instructions supplied by the equipment manufacturer.

Insert the hose from the storage tanker and siphon the fuel through the evaporative emission valve opening.



SECTION 310-00: Fuel System — General
 Information
 GENERAL PROCEDURES

1999 F-Super Duty 250-550 Workshop
 Manual
[Procedure revision date: 01/26/2000](#)

Draining—Aft of Axle Fuel Tank

Special Tool(s)	
 <p>ST1114-A</p>	30 Gallon Gasoline Hand Pump Storage Tanker 164-R3201 or equivalent

1. Disconnect the battery ground cable.
2. Raise and support the vehicle.
3. Position the storage tanker beneath the fuel tank and remove the drain plug.

SECTION 310-00: Fuel System — General
 Information
 GENERAL PROCEDURES

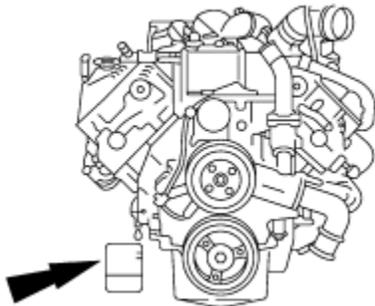
1999 F-Super Duty 250-550 Workshop
 Manual
[Procedure revision date: 01/26/2000](#)

Draining—Fuel Filter Water

 **WARNING:** The vehicle must be stopped with the engine off when draining the fuel filter water bowl. Fuel can ignite if the fuel filter is drained while the engine is running.

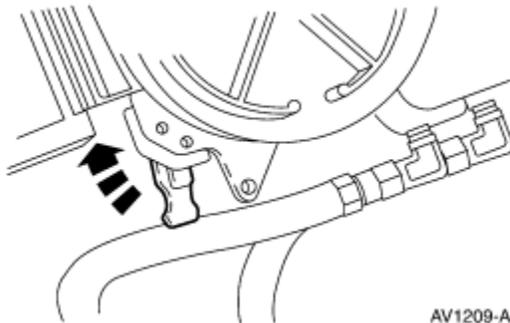
NOTE: Diesel fuel can damage asphalt and other surfaces. Always place an appropriate container under the fuel filter water drain and dispose of the waste in accordance with all federal, state and local requirements.

1. Place an appropriate container under the fuel filter water drain underneath the vehicle.



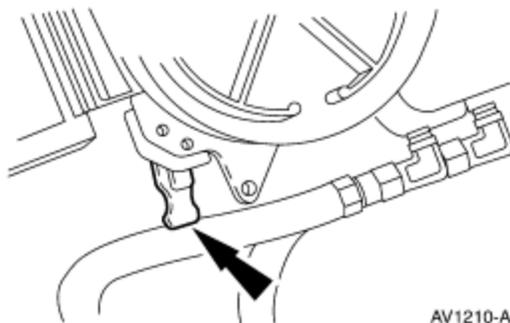
AV1208-A

2. Open the fuel filter water drain valve release lever. Allow the fuel to drain for approximately 30 seconds or until clean fuel is observed.



AV1209-A

3. Close the drain valve by resetting the lever to its original position.



AV1210-A

4. Remove the container from under the vehicle. Dispose of waste properly.

SECTION 310-00: Fuel System — General
Information
GENERAL PROCEDURES

1999 F-Super Duty 250-550 Workshop
Manual
[Procedure revision date: 01/26/2000](#)

Push Connect Fittings

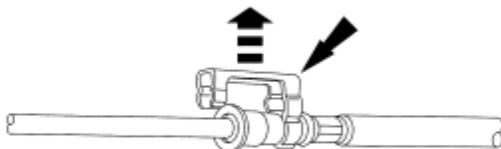
Special Tool(s)	
 ST1399-A	Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)

Disconnect

 **WARNING:** Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

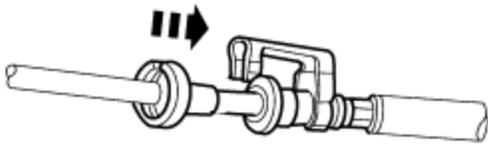
 **WARNING:** Fuel in the fuel system remains under high pressure even when the engine is not running. Before servicing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

1. Relieve the fuel pressure; refer to [Pressure Relief](#) in this section.
2. Disconnect the safety clip from the male hose.



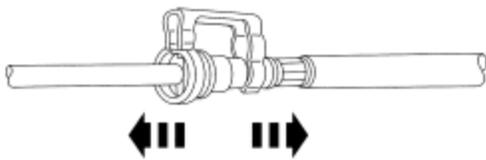
V9506-A

3. Install the fuel line disconnect tool and push into the fitting.



AV0311-A

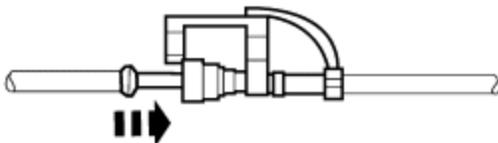
4. Separate the fittings.
 - Inspect for damage.
 - Clean the fittings.



V9483-A

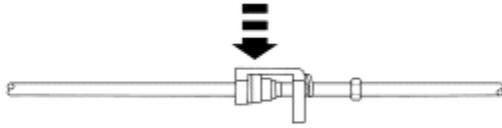
Connect

1. Connect the fitting.
 - Lubricate the tube end with clean engine oil meeting Ford specification WSS-M2C153-G to ease assembly.
 - Align the tube to the fitting and push until you hear a click.



AV0312-A

2. Pull on the fitting to make sure it is fully engaged, then install the safety clip.



V9485-A

SECTION 310-00: Fuel System — General
 Information
 GENERAL PROCEDURES

1999 F-Super Duty 250-550 Workshop
 Manual
[Procedure revision date: 01/26/2000](#)

Spring Lock Couplings

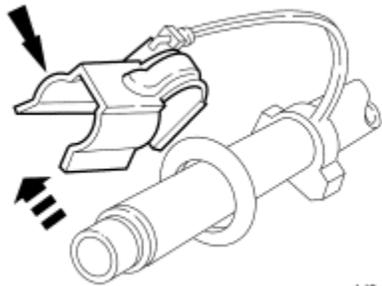
Special Tool(s)	
	Disconnect Tool (3/8 inch) 310-D004 (D87L-9280-A) or equivalent
	Disconnect Tool (1/2 inch) 310-D005 (D87L-9280-B) or equivalent

Disconnect

 **WARNING:** Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

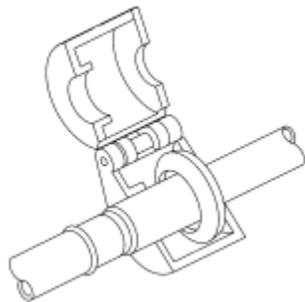
 **WARNING:** Fuel in the fuel system remains under high pressure even when the engine is not running. Before servicing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

1. Relieve the fuel pressure; refer to [Pressure Relief](#) in this section.
2. Remove the fuel tube clip.



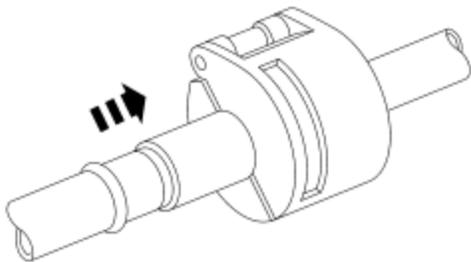
V9486-A

3. Install the Disconnect Tool.



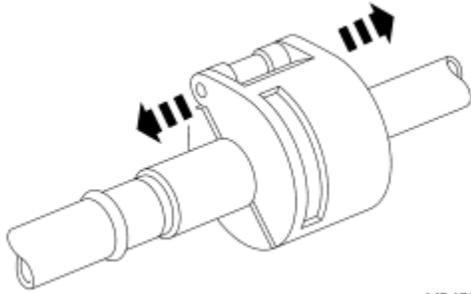
V9487-A

4. Close and push the Disconnect Tool into the open side of the cage.



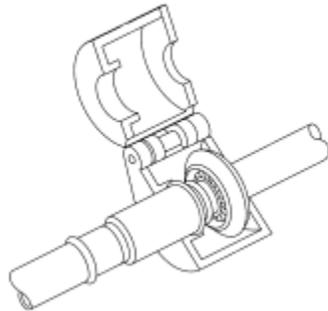
V9488-A

5. Separate the fitting.



V9489-A

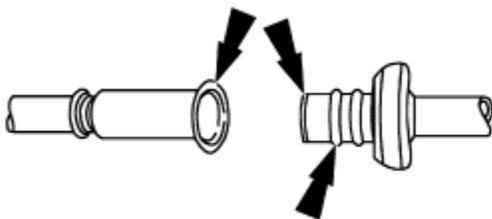
6. Remove the Disconnect Tool.



V9356-A

Connect

1. Connect the fitting.
 - Inspect and clean both the coupling ends.
 - Lubricate the O-rings with clean engine oil meeting Ford specification WSS-M2C153-G.
 - Connect the fitting.
 - Pull on the fitting to make sure it is fully engaged.
 - Install the safety clip.



V9491-A

Hairpin Clip Fitting

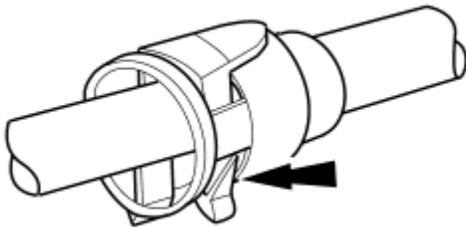
Disconnect

⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

⚠ WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before servicing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing possible personal injury or a fire hazard.

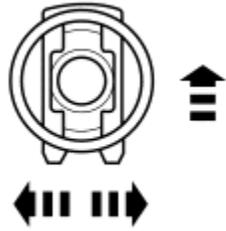
⚠ CAUTION: Do not use any tools. The use of tools may cause a deformity in the clip components which may cause fuel leaks.

1. Relieve the fuel pressure; refer to [Pressure Relief](#) in this section.



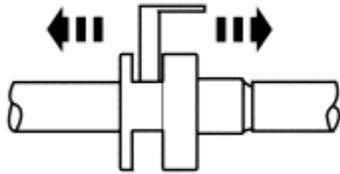
AV0313-A

2. Remove the shipping tab by bending downward.
3. Spread the hairpin clip legs and push the clip into the fitting.



AV0314-A

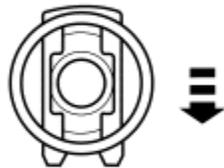
4. Separate the fitting from the tube.



AV0315-B

Connect

1. Inspect the fitting and the tube for damage. Remove any dirt or obstructions.
2. Apply a light coat of clean engine oil meeting Ford specification WSS-M2C153-G to the male tube end.
3. Insert the hairpin clip into the fitting.



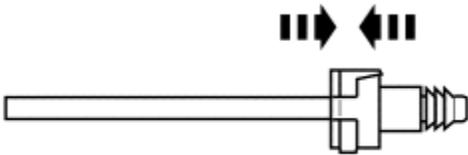
AV0316-A

4. Align the tube and the fitting.



AV0317-A

5. Insert the tube in the fitting and push together until a click is heard.



AV0318-A

6. Pull on the connection to make sure it is fully engaged.

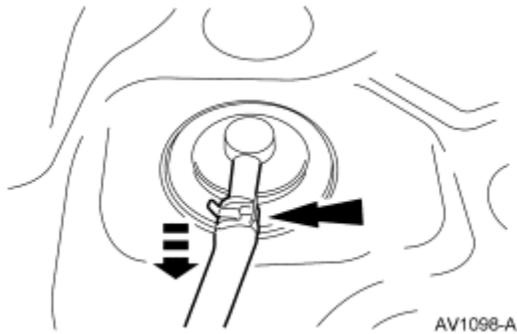


AV0319-A

Vapor Tube Fittings

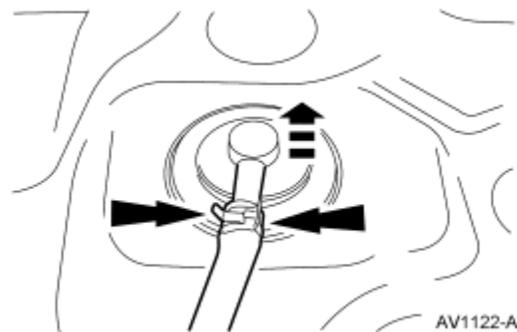
Disconnect

1.  **WARNING:** The evaporative emission system contains fuel vapor and condensed fuel vapor. Although not present in large quantities, it still presents the danger of explosion or fire. Disconnect the battery ground cable from the battery to minimize the possibility of an electrical spark occurring, possibly causing a fire or explosion if fuel vapor or fuel liquid is present in the area.
2. Disconnect the vapor tube from the fitting. Remove by compressing the tabs of the clamp together and disconnecting the tube.



Connect

1. Inspect the fitting and the tube for damage.



2. Remove any dirt or obstructions.
 3. Compress the tabs on the clamp and install the vapor tube on the fitting.
-

**SECTION 310-01:
Fuel Tank and Lines**

SPECIFICATIONS

DESCRIPTION AND OPERATION

[Fuel Tank and Lines](#)

DIAGNOSIS AND TESTING

[Fuel Tank and Lines](#)

REMOVAL AND INSTALLATION

[Fuel Tank—Midship](#)

[Fuel Tank—Aft-of-Axle](#)

[Fuel Tank—Motorhome Chassis](#)

[Support Straps](#)

[Pump—Midship Tank, Gasoline Engines](#)

[Pump—Aft of Axle Tank, Gasoline Engines](#)

[Pump—Electric](#)

[Fuel Pump Relay](#)

[Filler Pipe](#)

[Filter](#)

[Filter—Water Separator](#)

[Inertia Fuel Shutoff \(IFS\) Switch](#)

SECTION 310-01: Fuel Tank and Lines
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

General Specifications	
Item	Specification
Fuel Capacity	
Wide Frame Standard Bed Midship Tank	144 Liters (38 gal.)
Wide Frame Short Bed Midship Tank	110 Liters (29 gal.)
Narrow Frame Chassis Cab Aft-of-Axle Tank Standard Equipment	139 Liters (36 gal.)
Narrow Frame Chassis Cab Midship Tank (Optional)	69 Liters (18 gal.)

Motorhome Chassis Aft-of-Axle Tank	2.83 liters (75 gal.)
Fuel Pressure Specifications—7.3L Diesel Engine	
Key On Engine Running kPa (psi)	276-414 (40-60)
Key On Engine Off kPa (psi)	0-414 (0-60)

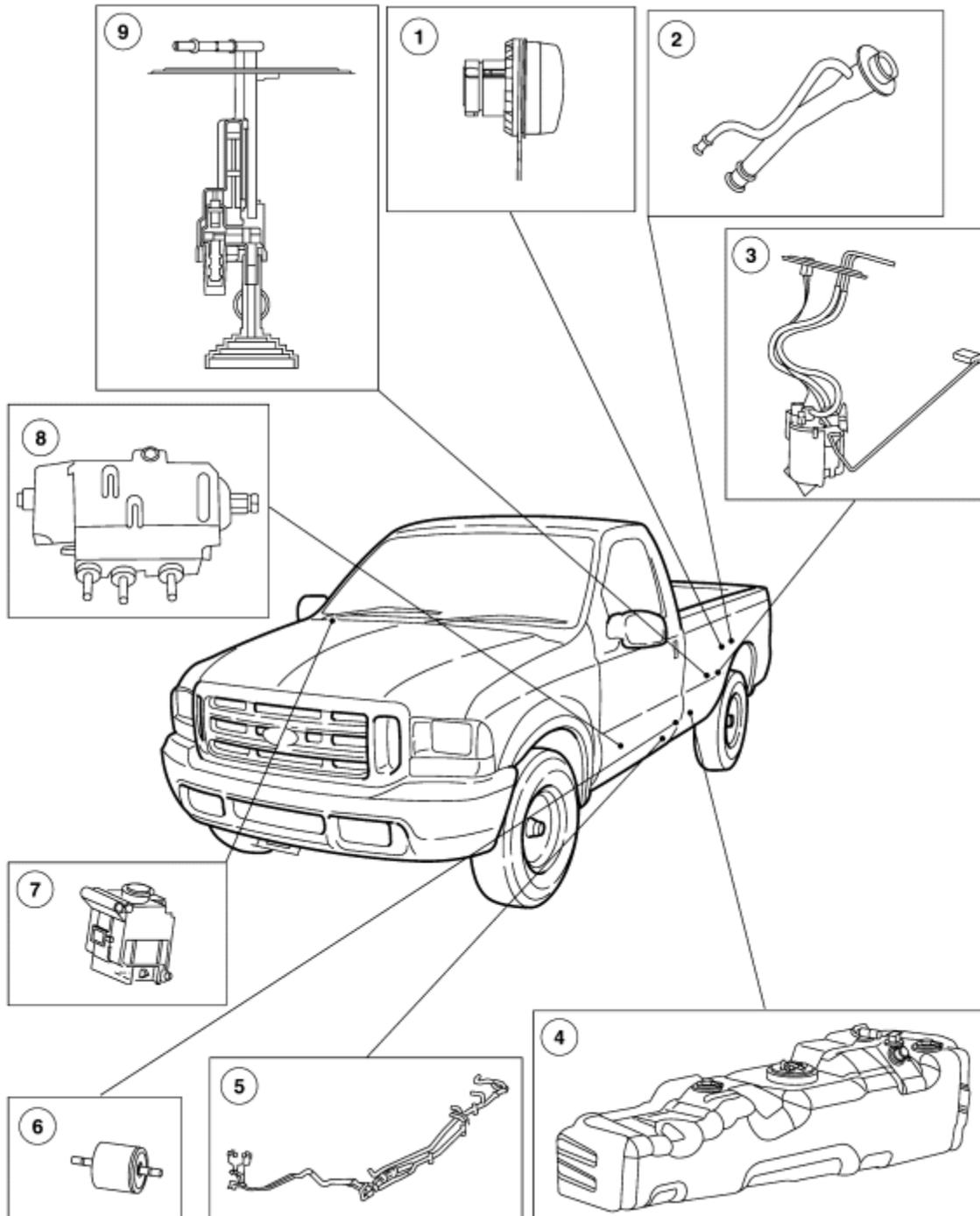
Torque Specifications			
Description	Nm	lb-ft	lb-in
Fuel Pump Bolts (Aft-of-Axle)	9-12	—	80-107
Fuel Pump Nuts (Diesel)	17	13	—
Fuel Pump Locking Retaining Ring (Midship Tanks)	68-95	50-70	—
Motorhome Chassis Fuel Tank Support Strap Bolts	68-92	50-68	—
Fuel Tank Filler Pipe Screws	2-4	—	18-35
Fuel Tank Support Strap Bolts (Midship Tank)	34-46	25-33	—
Fuel Tank Support Strap Bolts (Aft-of-Axle Tank)	80-100	59-73	—
Inertia Fuel Shutoff Switch Bolts	0.5-1.0	—	5-8
Skid Plate Bolts	17-23	—	13-16
Fuel Level Sensor (Diesel)	9-12	—	80-107

SECTION 310-01: Fuel Tank and Lines
DESCRIPTION AND OPERATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Fuel Tank and Lines

Fuel System Component Location—Midship Fuel Tank

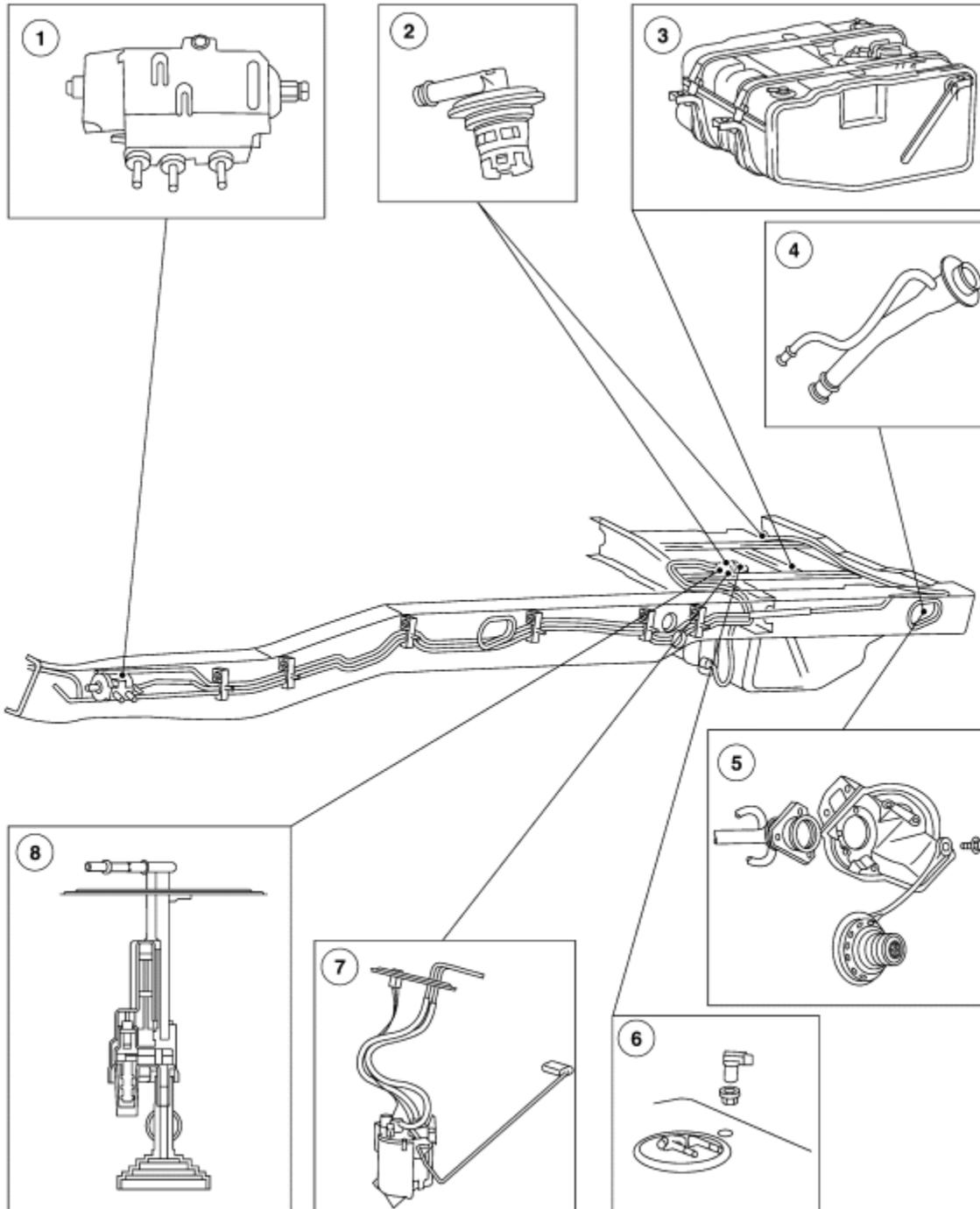


AV1126-A

Item	Part Number	Description
1	9030	Fuel Tank Filler Cap
2	9034	Fuel Tank Filler Pipe
3	9350	Fuel Pump (Gasoline)
4	9002	Fuel Tank
5	9S278	Rear Fuel Supply Return and Vapor Tube

6	9155	Fuel Filter
7	9341	Inertia Fuel Shutoff Switch
8	9350	Fuel Pump (Diesel)
9	9275	Fuel Level Sensor (Diesel)

Fuel System Component Location—Aft of Axle Tank



Item	Part Number	Description
1	9350	Fuel Pump (Diesel)
2	9B593	Evaporative Emission Valve
3	9002	Fuel Tank
4	9034	Fuel Tank Filler Pipe
5	9030	Fuel Tank Filler Cap (Diesel)
6	9C052	Fuel Tank Pressure Sensor
7	9350	Fuel Pump (Gasoline)
8	9275	Fuel Level Sensor (Diesel)

Gasoline Engines

The fuel system consists of:

- the fuel tank (9002).
 - The midship fuel tank is mounted to the LH frame side rail.
 - The aft of axle fuel tank is mounted between the side rails.
- a fuel tank filler pipe (9034) which contains a restrictor plate to permit only unleaded fuel to be pumped into the fuel tank.
- a 1/8 turn fuel tank filler cap (9030).
- a fuel filter (9155) providing filtration to protect the fuel injectors.
- fuel lines.
- a fuel pressure regulator.
- a fuel pump (9350) which provides pressurized fuel to the engine and contains:
 - a serviceable fuel sender
 - an inlet filter
 - a check valve which maintains system pressure after the pump is shut off.
 - a pressure relief valve for overpressure protection in the event of restricted flow.

The fuel pump is controlled by the fuel pump powertrain control module relay. Electrical power to the fuel pump is provided through the inertia fuel shutoff switch (IFS switch) (9341).

Diesel Engines

The fuel system consists of:

- the fuel tank.
 - The midship fuel tank is mounted to the LH frame side rail.
 - The aft of axle fuel tank is mounted between the side rails.
- a fuel tank filler pipe without a restrictor plate.
- a threaded fuel tank filler cap.
- a fuel filter and water separator to protect the fuel injectors.
- a fuel circulation/filter unit (located inside the fuel tank on the fuel sender assembly).
- fuel lines.

- an internal check valve with a built in orifice that will allow system pressure to bleed off after approximately 10 minutes after the pump is shut off.
- frame mounted in-line fuel pump which provides pressurized fuel to the engine and contains:
 - an integral non-serviceable coarse inlet filter.
 - a pressure relief valve for overpressure protection in the event of restricted flow.

The fuel pump is controlled by the fuel pump powertrain control module relay. Electrical power to the fuel pump is provided through the inertia fuel shutoff switch (IFS switch).

The fuel recirculation/filter unit assist in preventing the fuel from getting in the fuel lines during cold weather operations.

SECTION 310-01: Fuel Tank and Lines
DIAGNOSIS AND TESTING

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Fuel Tank and Lines

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

SECTION 310-01: Fuel Tank and Lines
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Fuel Tank—Midship

Special Tool(s)	
	Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)



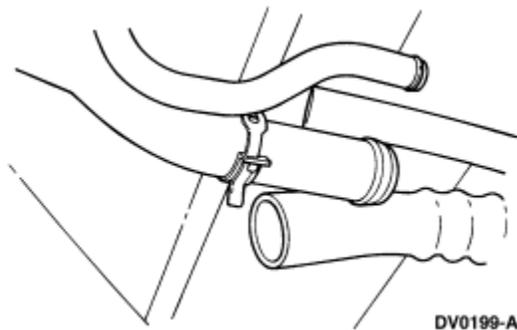
High-Lift Transmission Jack
014-00942 or equivalent

Removal

⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

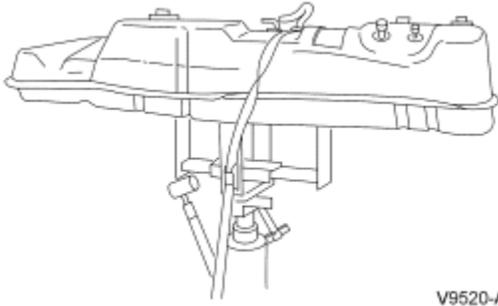
⚠ WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before repairing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

1. Disconnect the battery ground cable.
2. Relieve the fuel pressure; refer to [Section 310-00](#).
3. Drain the fuel from the fuel tank (9002); refer to [Section 310-00](#).
4. Raise and support the vehicle.
5. Disconnect the fuel tank filler pipe hose and the filler pipe vent tube.



6. **NOTE:** If equipped, the skid plate must be removed.

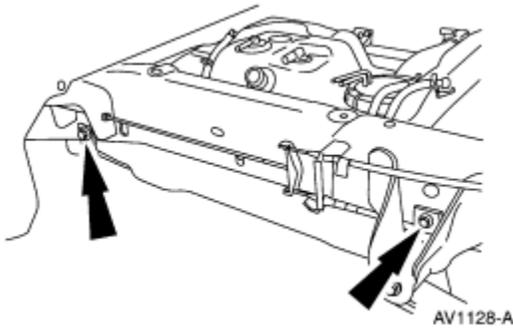
Position the jack under the fuel tank.



V9520-A

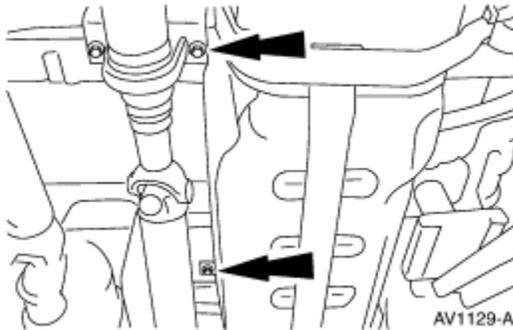
7. **NOTE:** The body has been removed in illustration for clarity.

Remove the bolts.



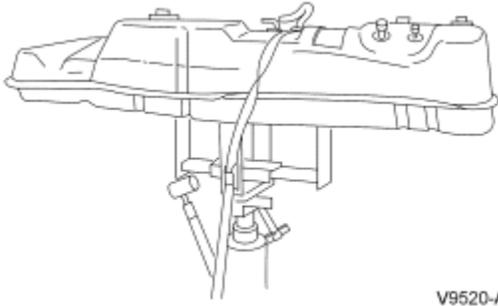
AV1128-A

8. Remove the bolts.



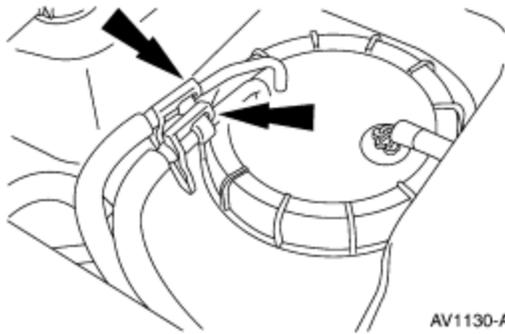
AV1129-A

9. Partially lower the fuel tank.



V9520-A

10. Use the Fuel Line Disconnect Tool to disconnect the fuel lines from the fuel pump; refer to [Section 310-00](#).



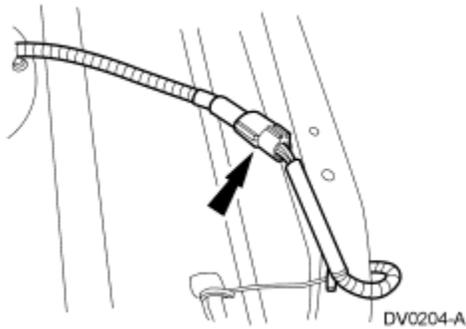
AV1130-A

11. Disconnect the fuel tank connections.
 - Disconnect the evaporative emission return tubes.
 - Disconnect the fuel tank pressure sensor connector.

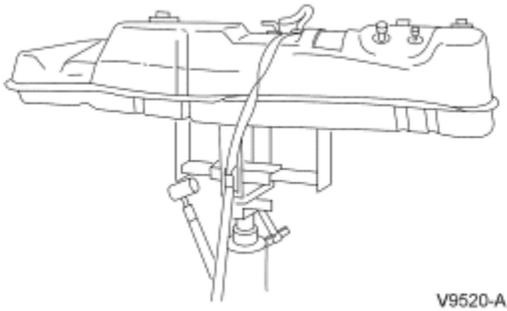


DV0201-A

12. Disconnect the fuel pump electrical connector.



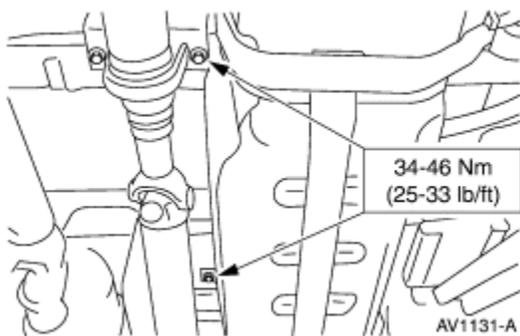
13. Lower the fuel tank.

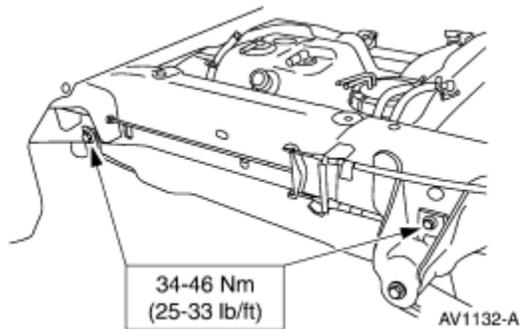


14. If the fuel tank is being replaced, transfer the fuel pump, fuel tank sending unit, the evaporative emissions valves, and the fuel tank pressure sensor (if equipped) to the new fuel tank.

Installation

1. Follow the removal procedure in reverse order.





SECTION 310-01: Fuel Tank and Lines
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Fuel Tank—Aft-of-Axle

Special Tool(s)	
<p>ST1399-A</p>	Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)
	High-Lift Transmission Jack 014-00942 or equivalent

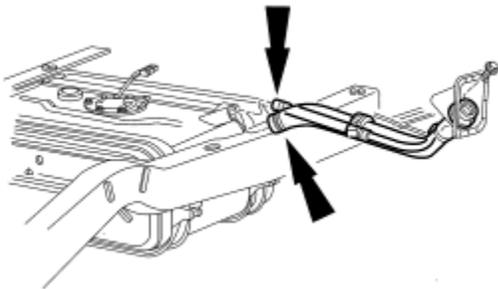
Removal

⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

⚠ WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before repairing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

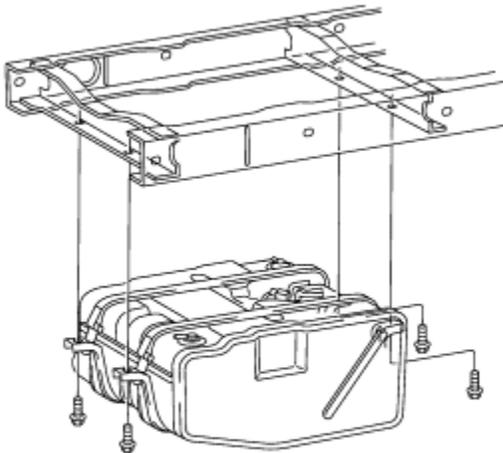
1. Disconnect the battery ground cable.
2. Relieve the fuel pressure; refer to [Section 310-00](#).
3. Drain the fuel from the fuel tank (9002); refer to [Section 310-00](#).
4. Raise and support the vehicle.
5. **NOTE:** In this illustration, the vehicle body is shown removed for clarity.

Disconnect the fuel tank filler pipe (9034) and the filler vent tube from the fuel tank.



DV0198-A

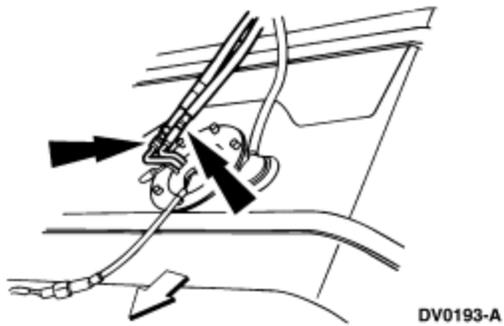
6. Position the jack under the fuel tank.
7. Remove the bolts.



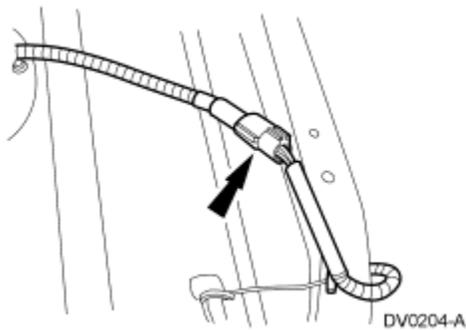
AV1133-A

8. Partially lower the fuel tank.

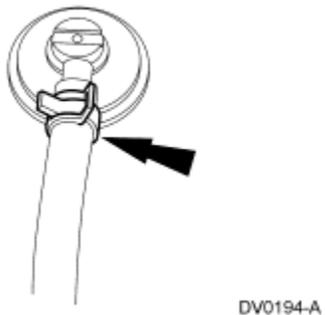
9. Disconnect the fuel lines from fuel pump; refer to [Section 310-00](#).



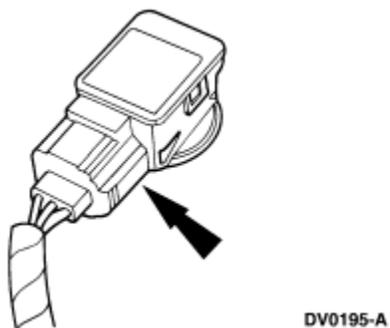
10. Disconnect the fuel pump and fuel tank sending unit electrical connector.



11. On gasoline fuel tanks, disconnect the hose(s) from the evaporative emission valve.



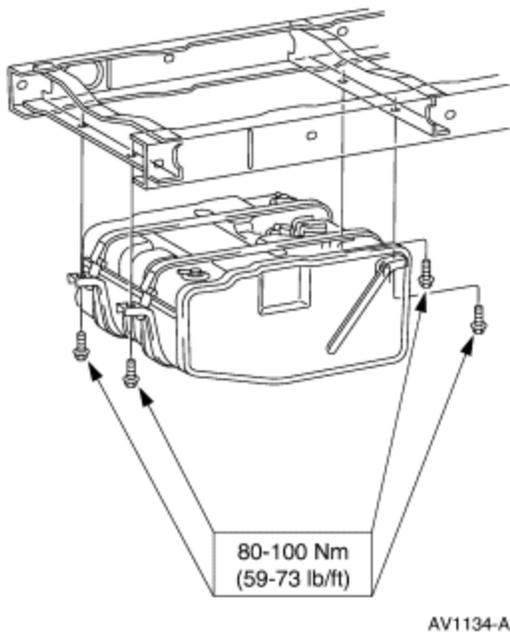
12. On gasoline fuel tanks only, disconnect the fuel tank pressure sensor electrical connector.



13. Lower the fuel tank.
14. If the fuel tank is being replaced, transfer the fuel pump, fuel tank sending unit, the evaporative emission valves and the fuel tank pressure sensor (gasoline fuel tanks) or the plug (diesel fuel tanks) to the new fuel tank.

Installation

1. Follow the removal procedure in reverse order.



SECTION 310-01: Fuel Tank and Lines
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Fuel Tank—Motorhome Chassis

Special Tool(s)

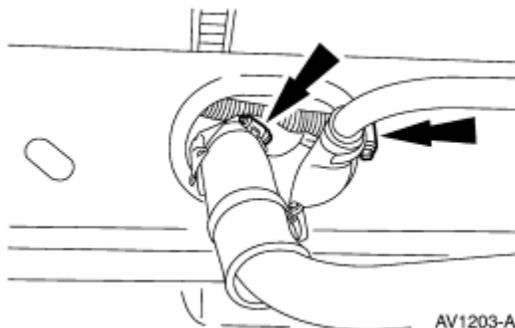
 <p>ST1399-A</p>	<p>Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)</p>
 <p>ST1130-A</p>	<p>High-Lift Transmission Jack 014-00942 or equivalent</p>

Removal

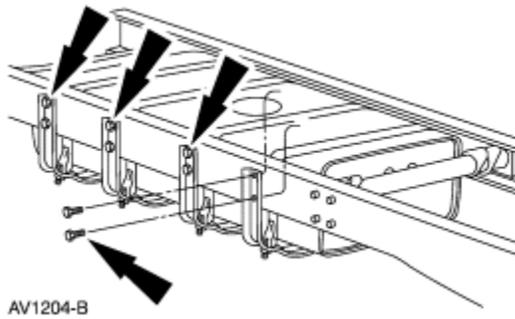
⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

⚠ WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before repairing or disconnecting any of the fuel lines or fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

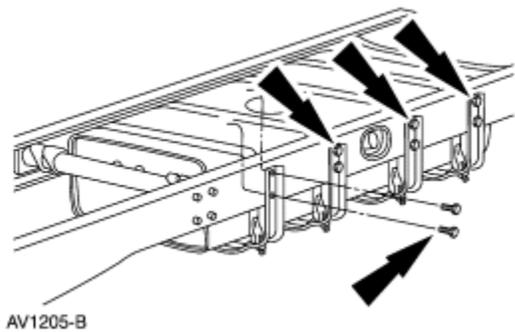
1. Disconnect the battery ground cable. For additional information, refer to [Section 414-01](#).
2. Relieve the fuel pressure. For additional information, refer to [Section 310-00](#).
3. Drain the fuel from the fuel tank (9002). For additional information, refer to [Section 310-00](#).
4. Raise and support the vehicle.
5. Disconnect the fuel tank filler pipe and the filler vent tube.



6. Position the jack under the fuel tank.
7. Remove the eight bolts from the RH frame rail.



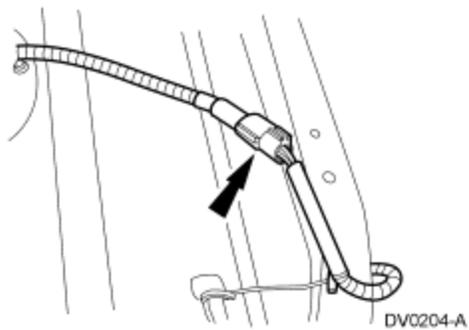
8. Remove the bolts from the LH frame rail.



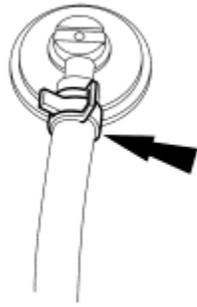
9. Partially lower the fuel tank.

10. Disconnect the fuel lines from the fuel pump (9350). For additional information, refer to [Section 310-00](#).

11. Disconnect the fuel pump and fuel tank sending unit electrical connector.

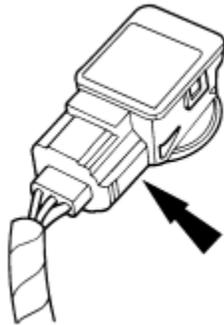


12. Disconnect the hose(s) from the evaporative emission valve (9B593).



DV0194-A

13. Disconnect the fuel tank pressure sensor electrical connector.

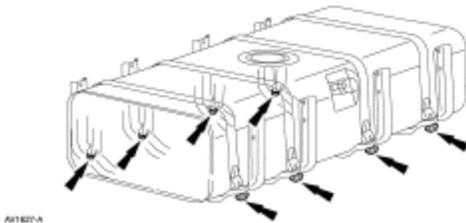


DV0195-A

14. Lower the fuel tank.

15. If the fuel tank is being replaced, transfer the fuel pump, fuel tank sending unit, the evaporative emission valves and the fuel tank pressure sensor to the new fuel tank.

16. Remove the eight fuel tank strap nuts, and remove the fuel tank from the cradle.



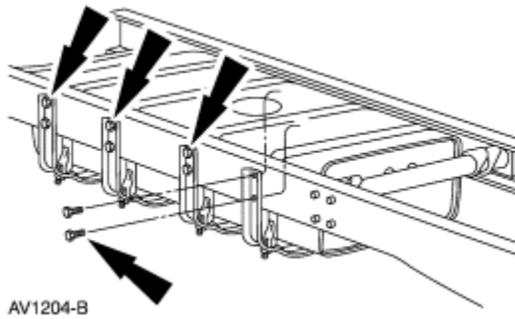
17. Remove the fuel tank straps from the fuel tank cradle brackets.

Installation

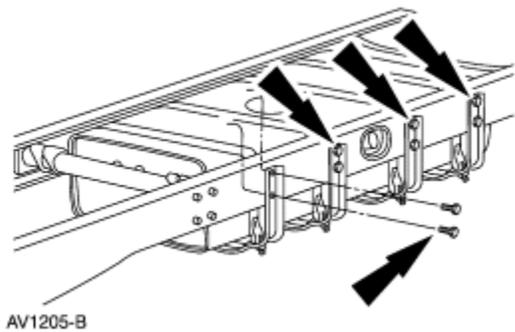
1. Position a new fuel tank in the cradle brackets.

2.  **CAUTION: Steps 2-4 must be followed to prevent damage to the fuel tank.**

Install the fuel tank straps and tighten the RH nuts with four threads showing.

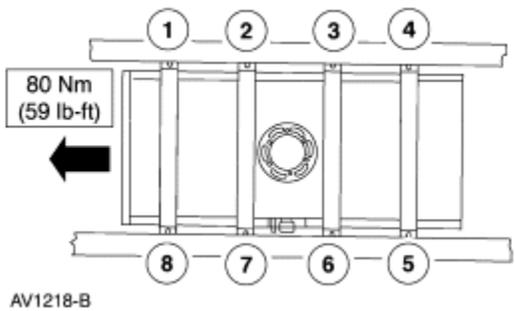


3. Tighten the LH fuel tank strap nuts.

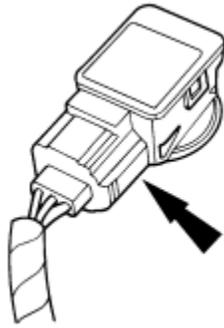


4. Position the fuel tank sub-assembly below the frame rail.
5. **NOTE:** The fuel tank must be loose in the cradle for proper positioning.

Tighten eight fuel tank strap nuts.

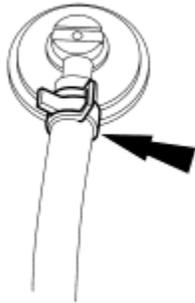


6. Connect the fuel tank pressure sensor electrical connector.



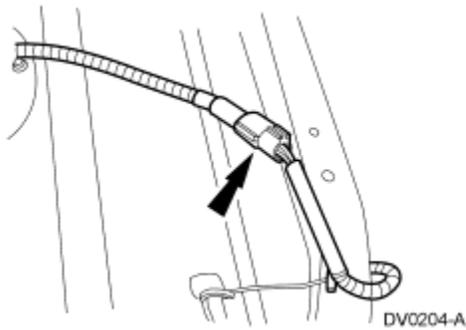
DV0195-A

7. Connect the hose at the evaporative emission valve.



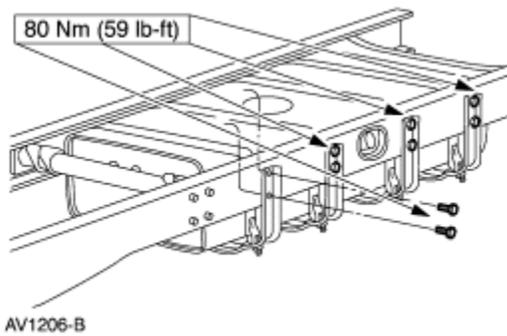
DV0194-A

8. Connect the fuel pump and fuel tank sending unit electrical connector.



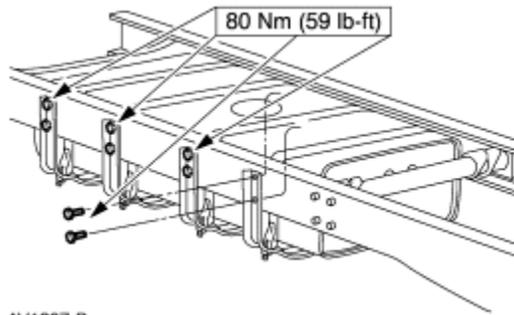
DV0204-A

9. Tighten the eight RH bolts.



AV1206-B

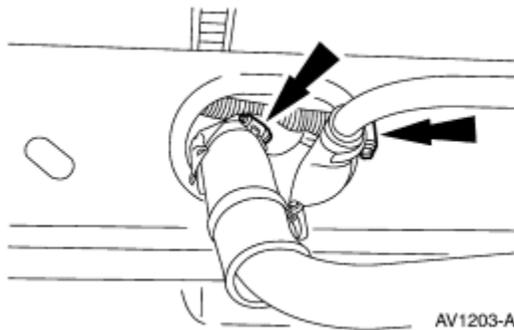
10. Tighten the eight LH bolts.



AV1207-B

11. Connect the fuel lines at the fuel pump. For additional information, refer to [Section 310-00](#).

12. Connect the fuel tank filler pipe and the filler vent tube.



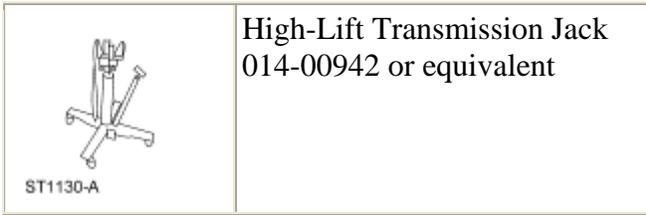
AV1203-A

13. Lower the vehicle.

14. Connect the battery.

Support Straps

Special Tool(s)

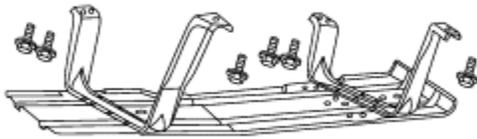


Removal

1. **NOTE:** Only the midship fuel tanks have support straps separate from the fuel tank. Aft of axle fuel tanks have support straps that are part of the fuel tank assembly and are not serviced separately.

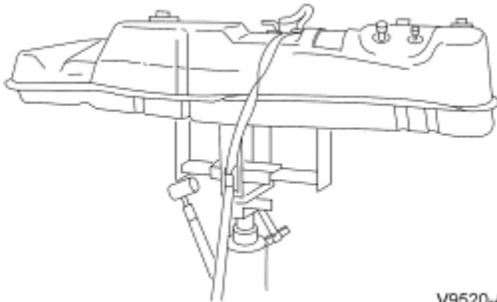
Raise and support the vehicle; refer to [Section 100-02](#).

2. If equipped, remove the fuel tank skid plate.



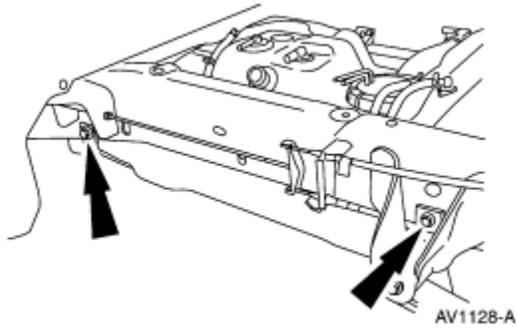
AV1108-A

3. Position a High-Lift Transmission Jack under the fuel tank.

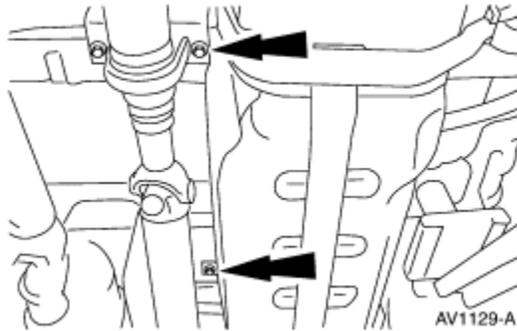


V9520-A

4. Remove the bolts.

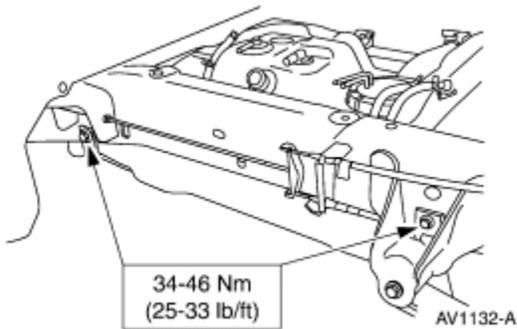
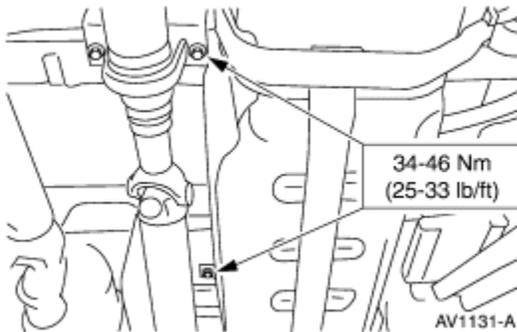


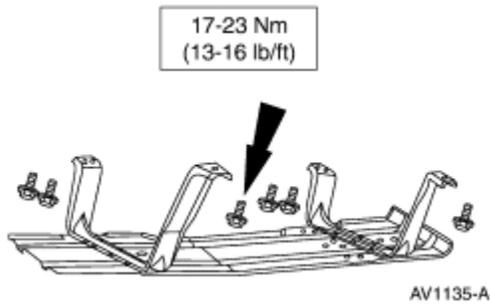
5. Remove the bolts and remove the fuel tank support strap.



Installation

1. Follow the removal procedure in reverse order.





SECTION 310-01: Fuel Tank and Lines
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Pump—Midship Tank, Gasoline Engines

Special Tool(s)	
 <p>ST1698-A</p>	<p>Fuel Tank Locking Wrench T97T-9275-A</p>

Removal

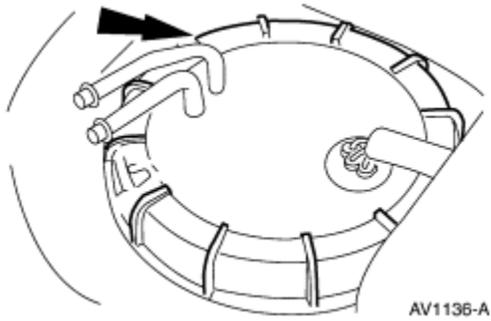
1. **NOTE:** For diesel engine applications, follow this procedure, Steps 1-3 to remove the diesel fuel level sensor.

NOTE: There is an optional steel midship tank on the narrow frame chassis cab models. For the optional tank, follow the Midship Fuel Pump procedure.

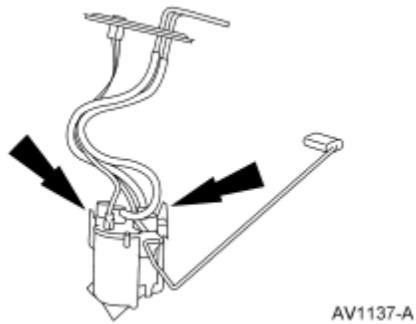
Remove the fuel tank; refer to [Fuel Tank—Midship](#) in this section.

2. Clean the area around the fuel pump mounting area.
3. **NOTE:** The fuel pump module must be handled carefully to avoid damage to the pump assembly.

Remove the locking retaining ring from the fuel tank mounting flange using the Fuel Tank Locking Wrench and lift up on the fuel pump sender flange to gain access to the pump module.



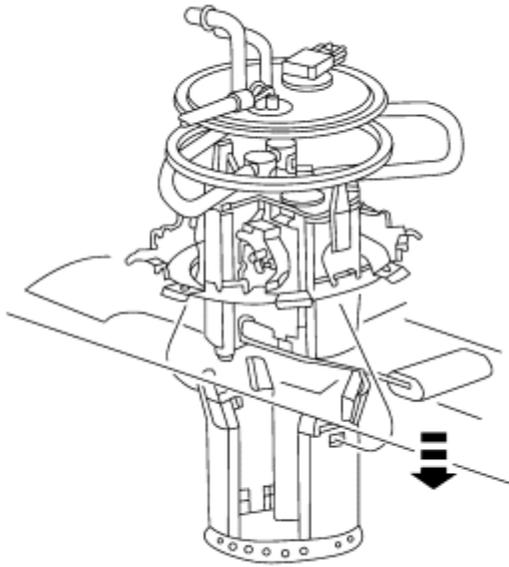
4. Reach into the tank to disconnect the retaining latches by squeezing the latches together while pushing down on the module to release the pump from the mounting bracket in the bottom of the fuel tank. Remove the pump assembly.



5. Remove and discard the fuel pump mounting gasket.

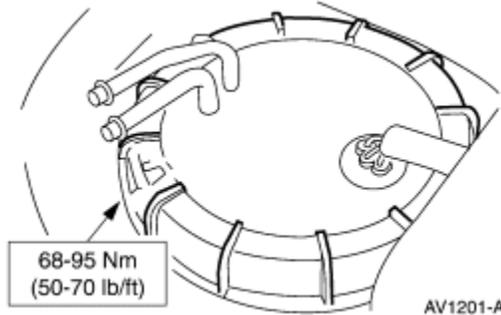
Installation

1. Clean and inspect the fuel pump mounting flange and the fuel tank mounting surface.
2. Connect the retaining latches of the pump module into the mounting bracket by aligning pump and pushing down until the pump is latched on both sides.



AV1143-A

3. Install a new fuel pump mounting gasket and install the fuel pump sender flange. Align the fuel pump tubes so they point toward the frame rail. Tighten the fuel pump retaining cap.



AV1201-A

4. Install the fuel tank; refer to [Fuel Tank—Midship](#) in this section.
-

Pump—Aft of Axle Tank, Gasoline Engines

Removal

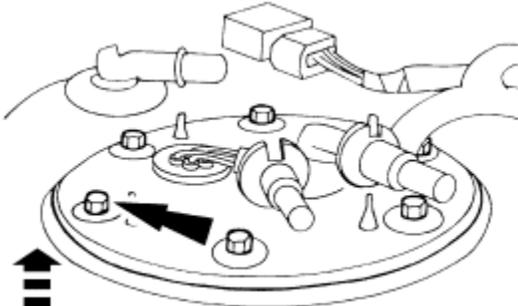
1. **NOTE:** Narrow frame chassis cab models do have an optional midship 18-gallon steel tank available. The motorhome chassis has an aft-of-axle 75 gallon steel tank. For such applications, refer to the following aft of axle procedure.

NOTE: For diesel engine applications, follow this procedure Steps 1-3 to remove the diesel fuel level sensor.

Remove the fuel tank; refer to [Fuel Tank—Aft-of-Axle](#) in this section.

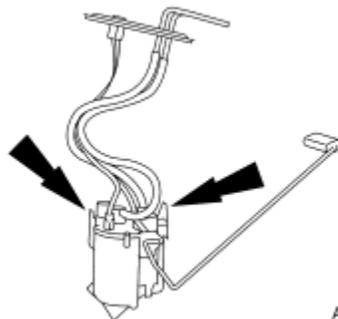
2. Clean the area around the fuel pump mounting flange.
3. **NOTE:** The fuel pump module must be handled carefully to avoid damage.

Remove the bolts and lift up on the fuel pump sender flange.



GV0116-A

4. Depress the locking tabs on the pump while applying downward pressure on the pump module to release the pump from the mounting bracket. Remove the pump assembly.

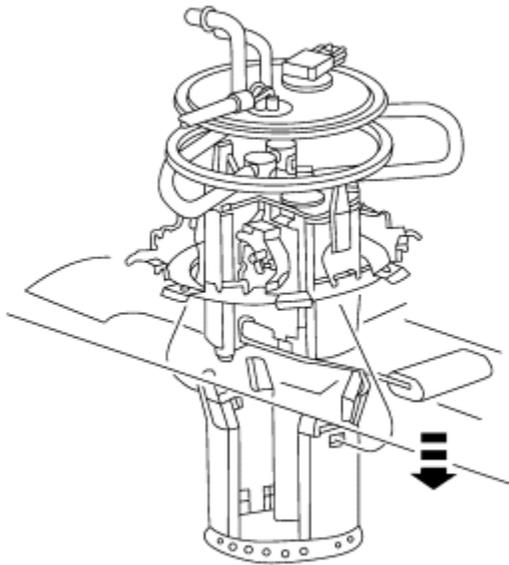


AV1137-A

5. Remove and discard the mounting flange gasket.

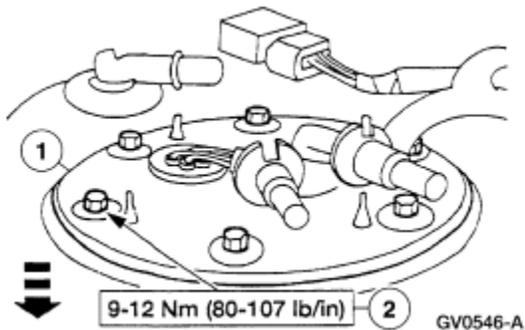
Installation

1. Clean and inspect the fuel pump mounting flange and the fuel tank mounting surface.
2. Connect the retaining latches of the pump module into the mounting bracket by aligning pump and pushing down until pump is latched on both sides.



AV1143-A

3. Install a new fuel pump.
 1. Install a new fuel pump mounting gasket and install fuel pump sender flange.
 2. Align the fuel pump tubes so they point to the front of the vehicle. Install the bolts.



4. Install the fuel tank; refer to [Fuel Tank—Aft-of-Axle](#) in this section.

Pump—Electric

Special Tool(s)	
 ST1399-A	Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)

Removal

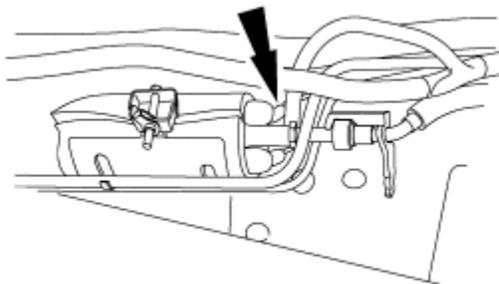
 **WARNING:** Smoking or open flame of any type must not be present when working near fuel or fuel vapor.

 **CAUTION:** The fuel system contains pressurized fuel after the vehicle is shut down and will maintain this pressure for a long period of time.

1. Disconnect both battery ground cables. On vehicles equipped with dual batteries, refer to [Section 414-01](#).
2. Open the fuel filter/water separator drain valve to release the fuel pressure.
3. Raise and support the vehicle; refer to [Section 100-02](#).
4. **NOTE:** The electrical connector is located behind the fuel pump near the frame rail.

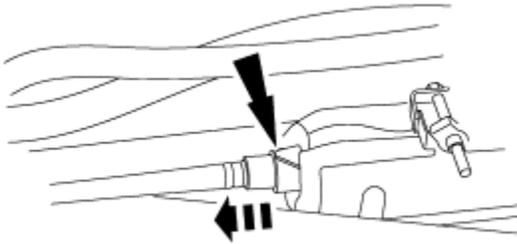
Disconnect the fuel pump harness.

- Disconnect the fuel pump electrical connector.



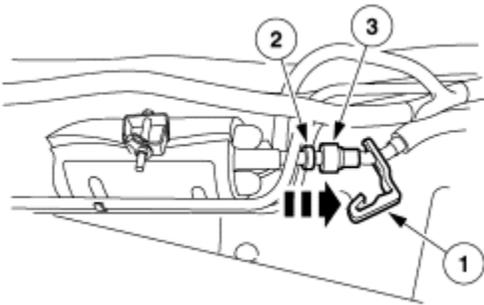
DV0898-A

5. Disconnect the fuel pump supply line.
 - Remove the fuel line retaining clip and discard, then remove the fuel line from the fuel pump.



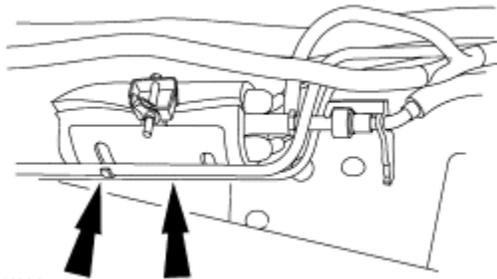
DV0899-A

6. Disconnect the fuel pump delivery line.
 1. Slide the clip up and off from the quick connect fitting.
 2. Insert the fuel line tool.
 3. Remove the fuel pump delivery line.



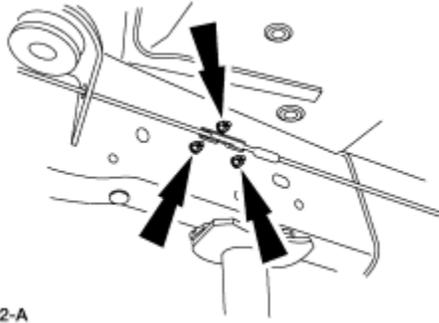
DV0900-A

7. Unclip the brake lines from the fuel pump bracket.



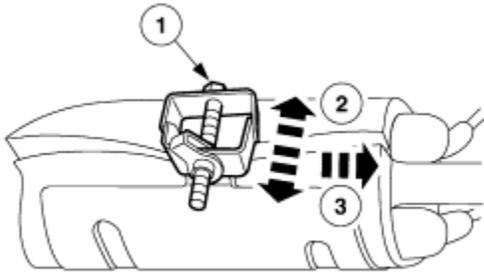
DV0901-A

8. Remove the pump mounting nuts, and the fuel pump.



DV0902-A

9. Remove the fuel pump from the mounting bracket.
 1. Loosen the pinch bolt.
 2. Spread the mounting bracket.
 3. Remove the fuel pump.

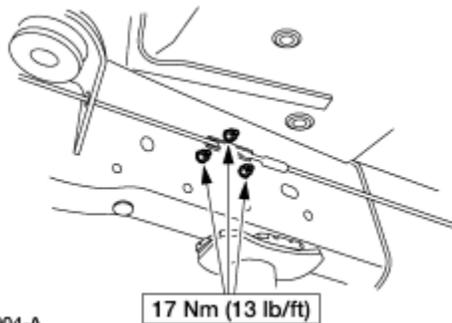


DV0903-A

Installation

1. **NOTE:** On vehicles equipped with dual batteries, refer to [Section 414-01](#) for battery reconnect procedure.

Follow the removal procedure in reverse order.

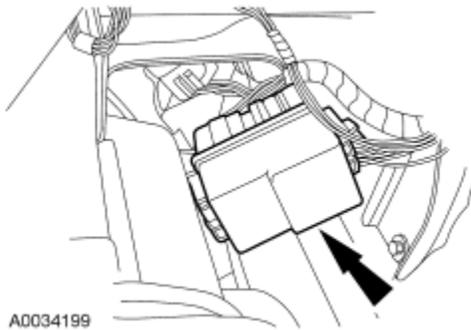


DV0904-A

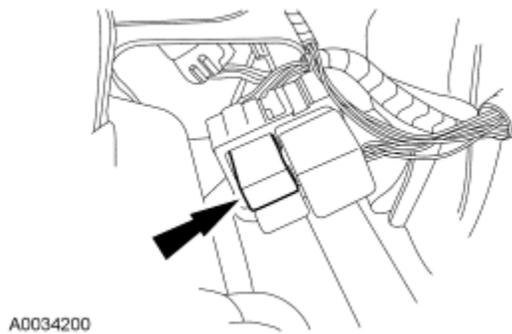
Fuel Pump Relay

Removal and Installation

1. Remove the radio. For additional information, refer to [Section 415-01](#).
2. Remove the relay cover.



3. Remove the fuel pump relay.



4. To install, reverse the removal procedure.
-

Filler Pipe

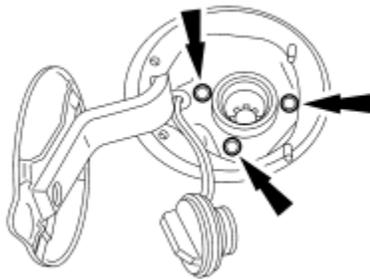
Removal

 **WARNING:** Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

1. **NOTE:** This procedure covers both midship and aft-of-axle filler pipes. Midship filler pipe is shown in the illustrations, the aft-of-axle is similar.

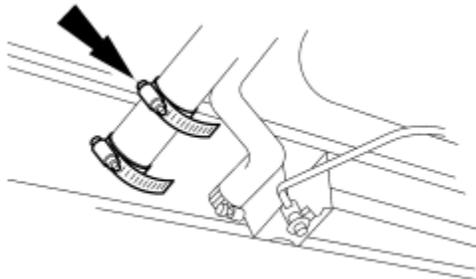
Remove the fuel tank filler cap.

2. Remove the screws.



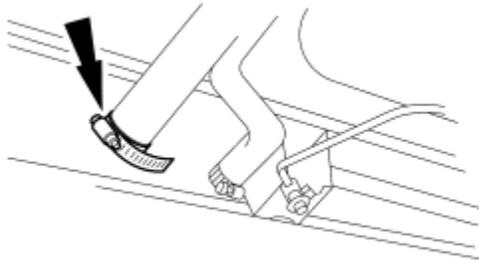
N12092-A

3. Loosen the hose clamp on the fuel tank filler pipe support and grounding bracket, if applicable.



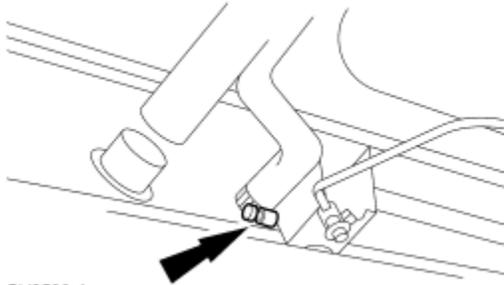
GV0571-A

4. Disconnect the fuel tank filler pipe hose from the fuel tank.



GV0570-A

5. Loosen the vent hose clamp and remove the fuel filler vent hose from the fuel tank.

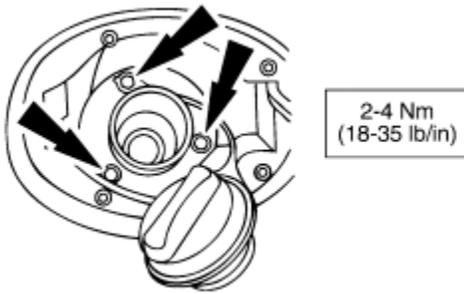


GV0569-A

6. Remove the fuel tank filler pipe.

Installation

1. Follow the removal procedure in reverse order.



AV1144-A

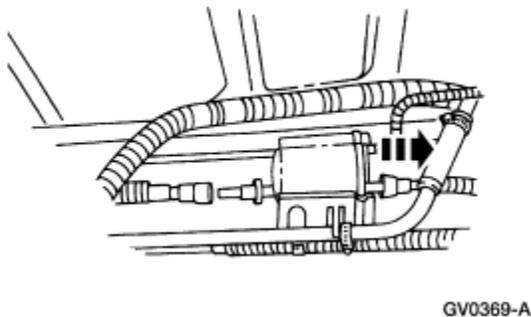
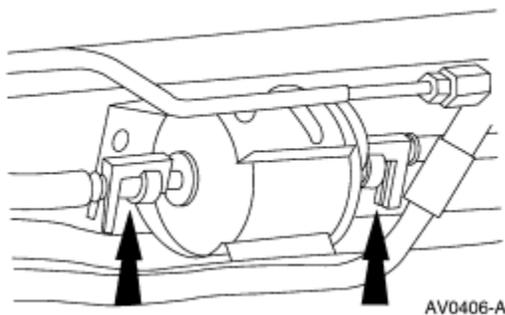
Filter

Special Tool(s)	
 ST1399-A	Fuel Line Disconnect Tool 310-S039 (T90T-9550-S)

Removal

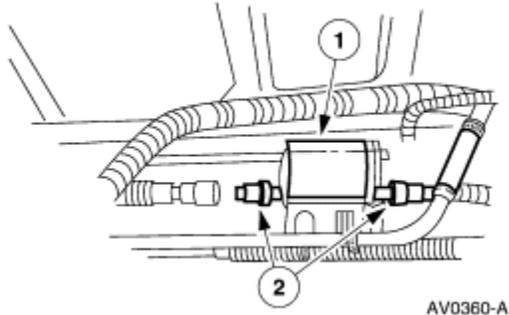
⚠ WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related component. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

1. Relieve the fuel system pressure; refer to [Section 310-00](#). Use the fuel line disconnect tool to disconnect the fuel lines from the fuel filter; refer to [Section 310-00](#).



Installation

1. When installing fuel lines to the fuel filter, push the lines onto the ports until a definite "click" is heard, then pull on the fittings to make sure they are engaged.
 1. Install the fuel filter.
 2. Connect the fuel lines.



SECTION 310-01: Fuel Tank and Lines
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 11/20/2002](#)

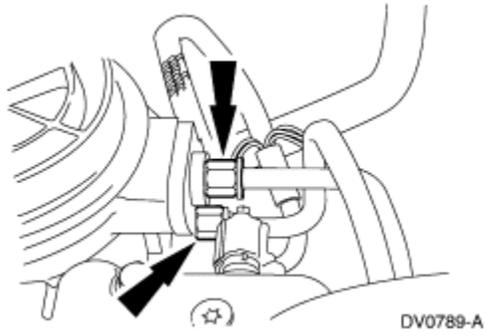
Filter—Water Separator

Removal

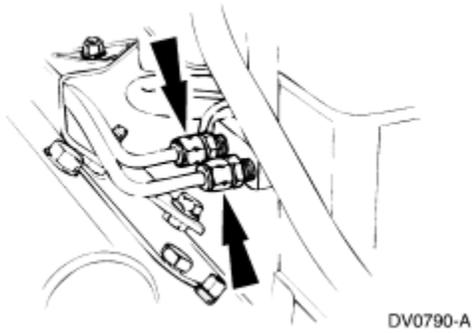
 **WARNING:** Smoking or open flame of any type must not be present when working near fuel or fuel vapor.

 **CAUTION:** The fuel system contains pressurized fuel after the vehicle is shut down and will maintain this pressure for a long period of time.

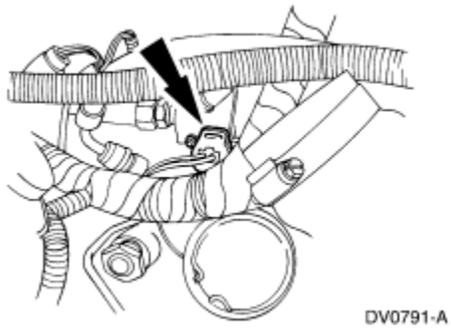
1. Disconnect both battery ground cables. On vehicles equipped with dual batteries, refer to [Section 414-01](#).
2. Open the fuel filter/water separator drain valve to release the fuel pressure. Completely drain the fuel filter/water separator assembly.
3. Disconnect the fuel supply and fuel return lines.



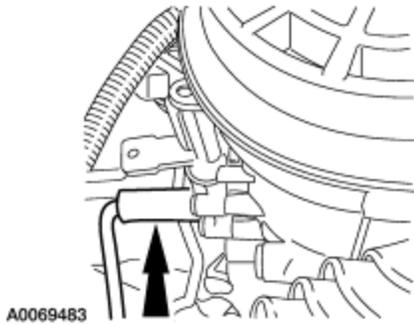
4. Disconnect the two cylinder head fuel supply lines.



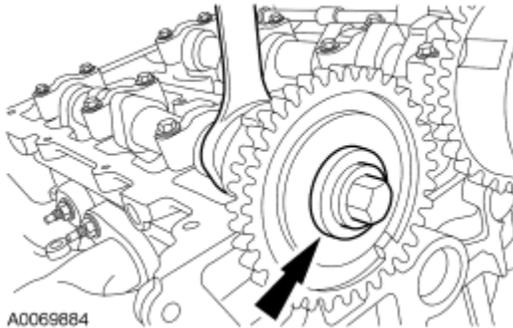
5. **NOTE:** The turbocharger compressor manifold is removed for clarity.
Disconnect the electrical connector from the fuel filter/water separator.



6. Disconnect the fuel drain tube.



7. Remove the fuel filter/water separator from the vehicle.
 1. Disconnect the exhaust back pressure sensor electrical connector.
 2. Remove the fuel filter/water separator retaining bolts.



Installation

1.  **WARNING: Clean all the fuel residue from the engine compartment. Failure to do so can cause personal injury or damage to the vehicle.**

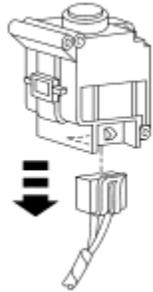
Follow the removal procedure in reverse order.

Inertia Fuel Shutoff (IFS) Switch

Removal

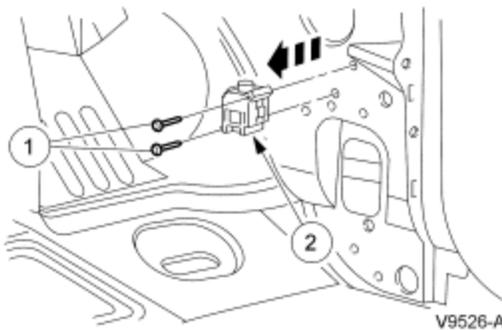
1. Disconnect the battery ground cable.

2. Remove the RH cowl side trim panel; refer to [Section 501-05](#). On motorhome chassis, the inertia fuel shutoff (IFS) switch is located near the engine cover under the dash, above the accelerator pedal.
3. Disconnect the electrical connector.



V9525-A

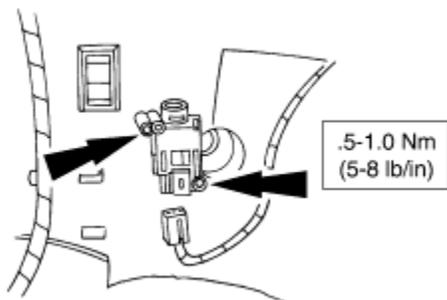
4. Remove the inertia fuel shutoff switch.
 1. Remove the bolts.
 2. Remove the inertia fuel shutoff switch.



V9526-A

Installation

1. Follow the removal procedure in reverse order.



AV0169-A

**SECTION 310-02:
Acceleration Control**

SPECIFICATIONS

DESCRIPTION AND OPERATION

[Acceleration Control](#)

DIAGNOSIS AND TESTING

[Acceleration Control](#)

[Inspection and Verification](#)

[Symptom Chart](#)

REMOVAL AND INSTALLATION

[Pedal—Accelerator, Gasoline Engine](#)

[Pedal—Accelerator and Sensor Assembly, Diesel Engine](#)

[Cable—Accelerator](#)

[Cable Bracket—Accelerator](#)

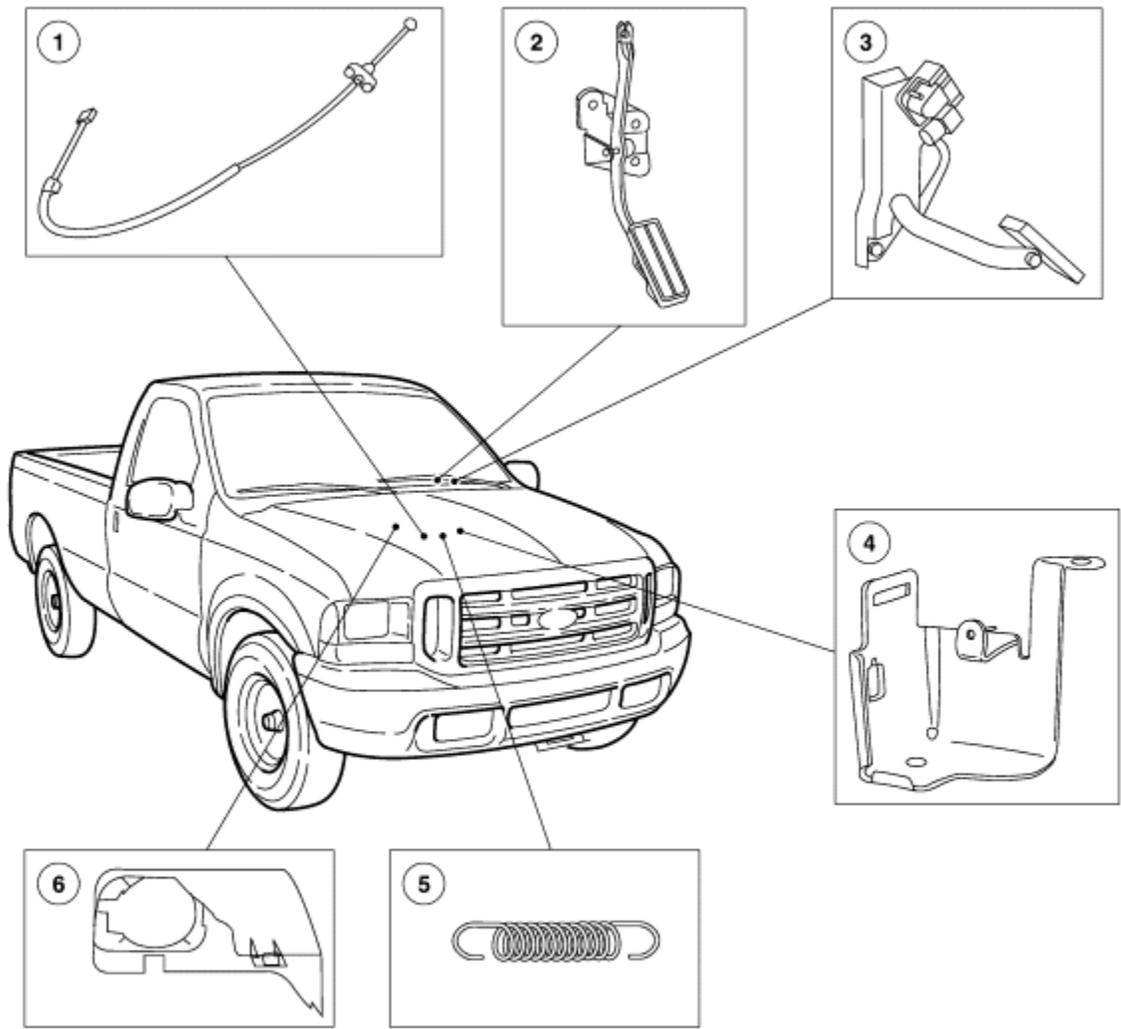
SECTION 310-02: Acceleration Control
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Torque Specifications			
Description	Nm	Lb/Ft	Lb/In
Accelerator Pedal and Shaft Bolts (Gasoline)	22-28	17-20	—
Accelerator Pedal and Sensor Assembly Bolts (7.3L Diesel)	22-28	17-20	—
Accelerator Cable Bracket Bolts	9-12	—	80-106
Throttle Body Inlet Air Duct Screw Clamp	3-5	—	27-44
Accelerator Cable Bulkhead Retaining Bolts	2-4	—	18-35

Acceleration Control

Component Location



AV1085-B

Item	Part Number	Description
1	9A758	Accelerator Cable
2	9725	Accelerator Pedal and Shaft
3	9F836	Accelerator Pedal and Sensor Assembly (7.3L Diesel Engine)

4	9728	Accelerator Cable Bracket (Gasoline Engines)
5	9E894	Secondary Return Spring
6	9E766	Accelerator Control Splash Shield

The throttle is controlled by an accelerator cable attached to the accelerator pedal and shaft. The accelerator pedal and shaft should travel smoothly from the idle to the wide open throttle positions. Hesitation on return or prevention of return to the idle position must not occur. Surrounding components such as wiring, hoses, sound insulator and floor carpet must not contact the sliding inner member of the accelerator cable or the accelerator pedal and shaft. The throttle assembly is not adjustable.

The 7.3L diesel engine does not use an accelerator cable. Instead, the 7.3L diesel engine uses an accelerator sensor assembly located on the accelerator pedal assembly. This drive by wire system is entirely electronic, and except for the accelerator pedal assembly, does not use mechanically moving parts. The accelerator sensor assembly is not adjustable.

Acceleration Control

Inspection and Verification

1. Verify the customer's concern by operating the acceleration control system to duplicate the condition.
2. Inspect to determine if any of the following mechanical concerns apply.

Visual Inspection Chart	
Mechanical	
•	Damaged accelerator pedal and shaft.
•	Damaged linkage.
•	Damaged accelerator cable.
•	High engine idle speed.
•	Damaged throttle body.

3. If the inspection reveals an obvious concern that can be readily identified, repair it as required.
4. If the concern remains after the inspection, determine the symptoms and go to the Symptom Chart.

Symptom Chart

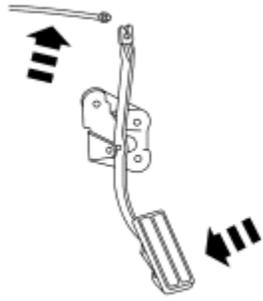
SYMPTOM CHART		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> • Excessive Effort Is Needed to Depress the Accelerator Pedal and Shaft 	<ul style="list-style-type: none"> • Worn accelerator lever pivot bushing. 	<ul style="list-style-type: none"> • REPLACE the accelerator pedal and shaft.
	<ul style="list-style-type: none"> • The accelerator cable is binding. 	<ul style="list-style-type: none"> • REPLACE the accelerator cable.
	<ul style="list-style-type: none"> • Worn or damaged throttle body. 	<ul style="list-style-type: none"> • REPLACE the throttle body; REFER to Section 303-04A (5.4L), Section 303-04B (6.8L).
<ul style="list-style-type: none"> • The Accelerator Pedal and Shaft Feels Rough or Raspy 	<ul style="list-style-type: none"> • Frayed or binding accelerator cable. 	<ul style="list-style-type: none"> • REPLACE the accelerator cable.
	<ul style="list-style-type: none"> • Worn or damaged throttle body. 	<ul style="list-style-type: none"> • REPLACE the throttle body; REFER to Section 303-04A (5.4L), Section 303-04B (6.8L).
<ul style="list-style-type: none"> • The Accelerator Pedal and Shaft Is Binding or Sticking 	<ul style="list-style-type: none"> • Kinked accelerator cable. 	<ul style="list-style-type: none"> • REPLACE the accelerator cable.
	<ul style="list-style-type: none"> • Foreign object caught in the accelerator pedal 	<ul style="list-style-type: none"> • CHECK the accelerator pedal linkage.

	linkage.	
	<ul style="list-style-type: none"> Worn or damaged throttle body. 	<ul style="list-style-type: none"> REPLACE the throttle body; REFER to Section 303-04A (5.4L), Section 303-04B (6.8L).
<ul style="list-style-type: none"> High Engine Idle Speed 	<ul style="list-style-type: none"> Kinked accelerator cable. 	<ul style="list-style-type: none"> REPLACE the accelerator cable.
	<ul style="list-style-type: none"> Foreign object caught in the accelerator pedal linkage. 	<ul style="list-style-type: none"> CHECK the accelerator pedal linkage.
	<ul style="list-style-type: none"> Incorrect engine idle speed. 	<ul style="list-style-type: none"> REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual for diagnosis and testing of the idle control system.
<ul style="list-style-type: none"> Irregular Engine Idle Speed (Diesel) 	<ul style="list-style-type: none"> Incorrect engine idle speed adjustment or idle validation switch. 	<ul style="list-style-type: none"> REPLACE the accelerator pedal and sensor assembly.

Pedal—Accelerator, Gasoline Engine

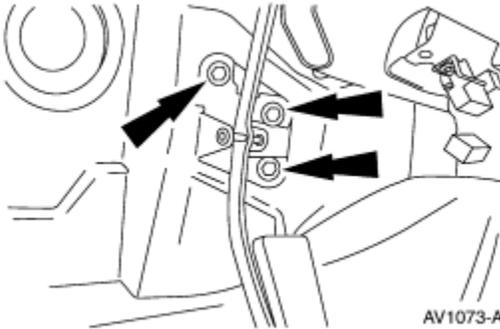
Removal

1. Hold the pedal in place and disconnect the accelerator cable from the accelerator pedal and shaft.



AV1211-A

2. Remove the bolts.

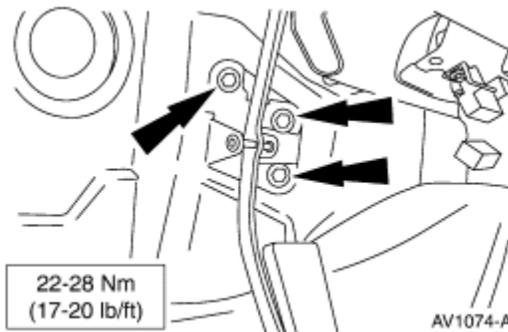


AV1073-A

3. Remove the accelerator pedal and shaft.

Installation

1. Follow the removal procedure in reverse order.



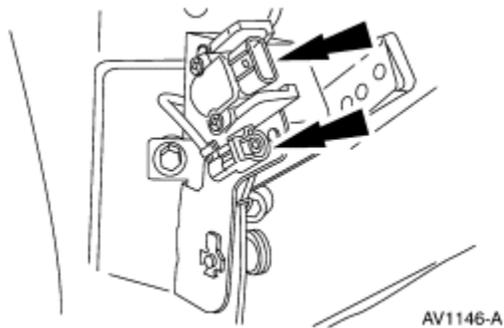
AV1074-A

Pedal—Accelerator and Sensor Assembly, Diesel Engine

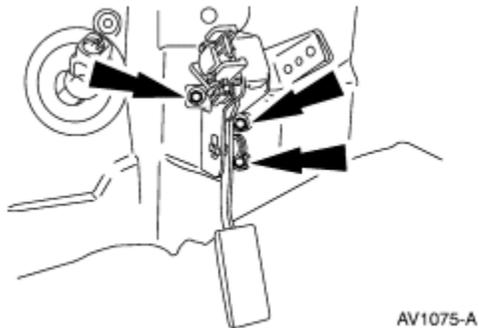
Removal

⚠ CAUTION: The accelerator pedal and sensor assembly is a non-adjustable, calibrated unit and must be handled with care.

1. Disconnect the electrical connectors.

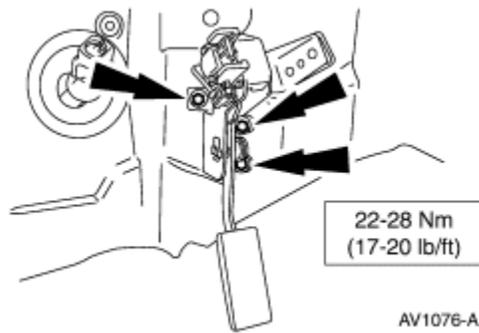


2. Remove the bolts and remove the accelerator pedal and sensor assembly.



Installation

1. Follow the removal procedure in reverse order.



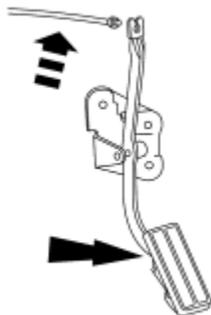
SECTION 310-02: Acceleration Control
REMOVAL AND INSTALLATION

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 03/18/2002](#)

Cable—Accelerator

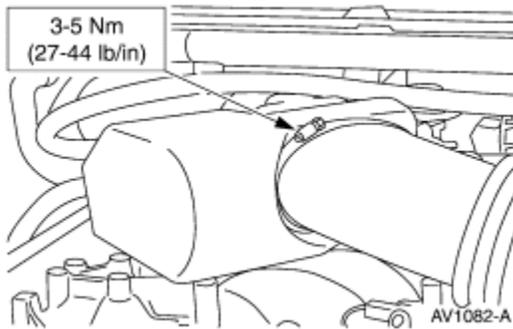
Removal and Installation

1. Hold the accelerator pedal in place and disconnect the accelerator cable from the accelerator pedal and shaft.

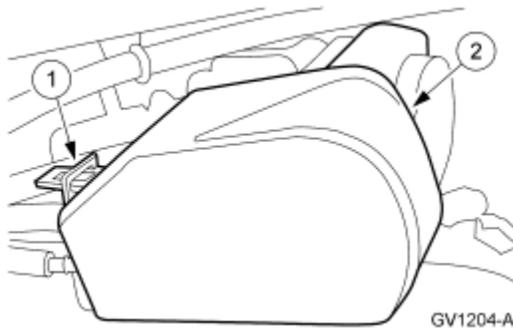


2.  **CAUTION: The air cleaner outlet tube must be securely sealed to prevent unmetered air from entering the engine.**

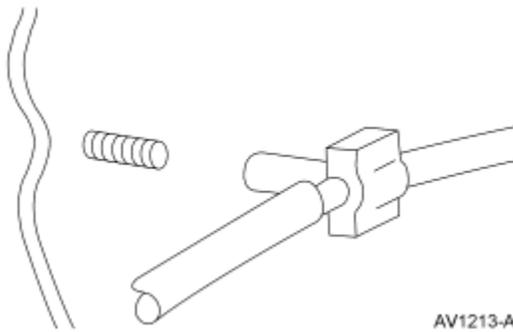
Disconnect the air cleaner outlet tube from the throttle body.



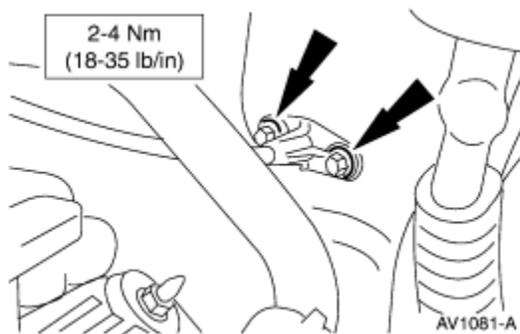
3. Remove the accelerator control splash shield.
 1. Release the tab.
 2. Remove the splash shield.



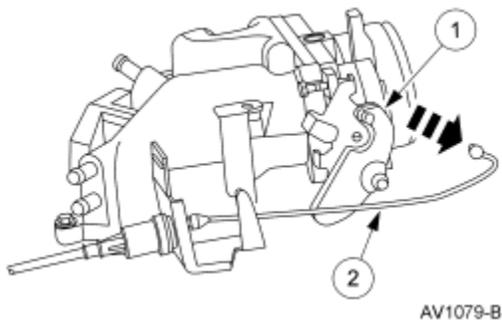
4. Disconnect the accelerator cable pushpin from the dash panel stud.



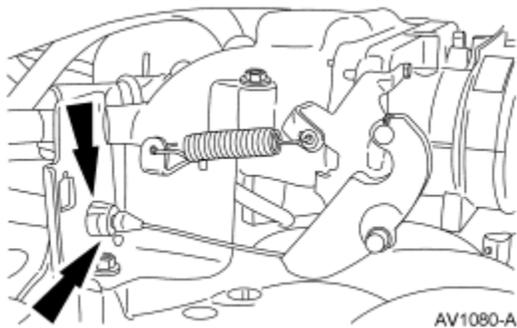
5. Remove the bolts and pull the cable through the bulkhead.



6. Disconnect the accelerator cable from the throttle body lever.
 1. Rotate the throttle body lever forward.
 2. Disconnect the accelerator cable.



7. Depress the locking tabs and remove the accelerator cable.



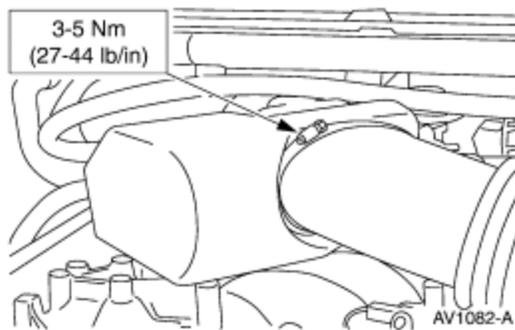
8. Remove the accelerator cable from the vehicle.
 9. To install, reverse the removal procedure.
-

Cable Bracket—Accelerator

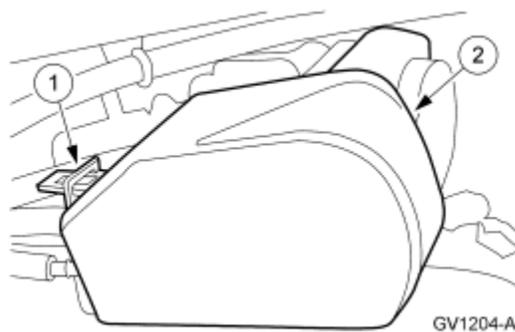
Removal and Installation

1.  **CAUTION: The air cleaner outlet tube must be securely sealed to prevent unmetered air from entering the engine.**

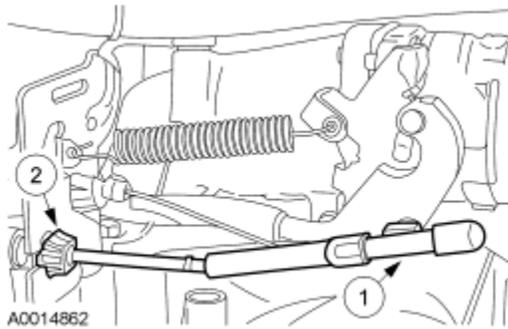
Disconnect the air cleaner outlet tube from the throttle body.



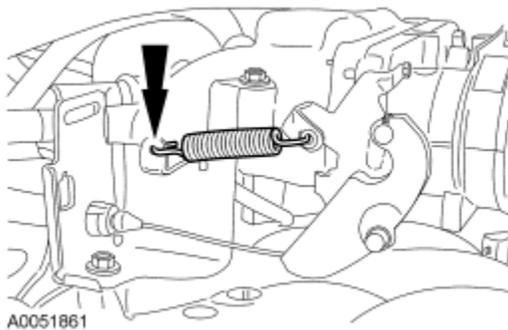
2. Remove the accelerator control splash shield.
 1. Remove the tab.
 2. Remove the accelerator control splash shield.



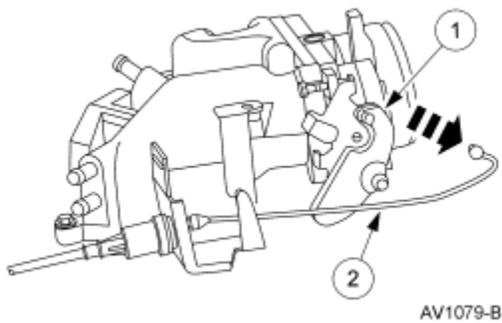
3. Disconnect the speed control cable.
 1. Disconnect the speed control cable from the throttle body cam and position aside.
 2. Depress the retaining clips to remove the cable from the bracket.



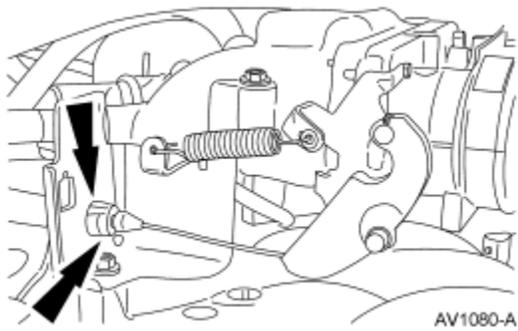
4. Disconnect the throttle return spring.



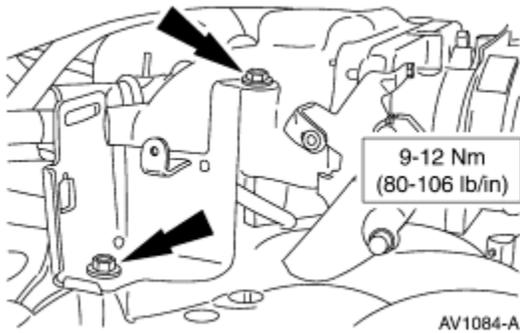
5. Disconnect the accelerator cable from the throttle body lever.
 1. Rotate the throttle body lever.
 2. Disconnect the accelerator cable.



6. Depress the locking tabs and remove the accelerator cable.



7. Remove the bolts and remove the accelerator cable bracket.



8. To install, reverse the removal procedure.
-

**SECTION 310-03:
Vehicle Speed Control**

[SPECIFICATIONS](#)

DESCRIPTION AND OPERATION

[Speed Control](#)

DIAGNOSIS AND TESTING

[Speed Control](#)

[Inspection and Verification](#)

[Symptom Chart](#)

[Pinpoint Tests](#)

REMOVAL AND INSTALLATION

[Actuator Cable—Speed Control](#)

[Actuator—Speed Control Servo](#)

[Switch—Speed Control Actuator](#)

[Switch—Deactivator](#)

[Brush Assembly](#)

[Brush Assembly—Control and Spring](#)

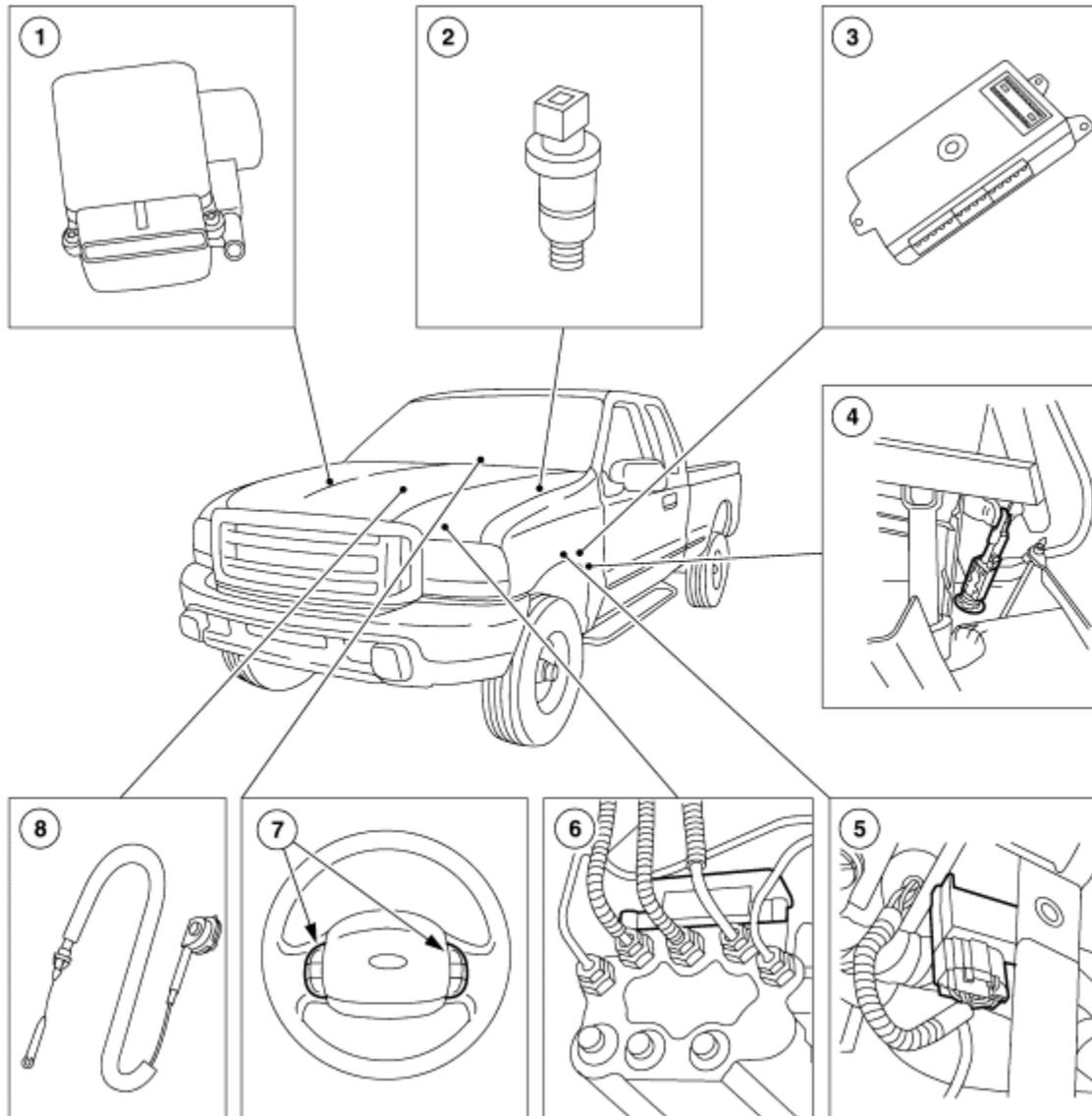
SECTION 310-03: Vehicle Speed Control
SPECIFICATIONS

1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Torque Specifications			
Description	Nm	Lb/Ft	Lb/In
Accelerator Control Splash Shield Bolts (5.4L)	3.1-4.3	—	28-38
Brush Assembly Screw	2.5	—	22
Control and Spring Retaining Screws	1	—	9
Deactivator Switch	15-20	11-15	—
Speed Control Servo Bracket to Vehicle Bolts	8-10	—	72-89
Speed Control Servo Bracket to Speed Control Servo	8-10	—	72-89

Speed Control

Vehicle Speed Control Components



GV1217-A

Item	Part Number	Description
1	9C735	Speed Control Servo
2	9F924	Deactivator Switch
3	—	GEM/CTM
4	7641	Clutch Pedal Position (CPP) Switch

5	13480	Brake Pedal Position (BPP) Switch
6	2B373	Anti-Lock Brake Control Module
7	9C888	Speed Control Actuator Switches
8	9A825	Speed Control Actuator Cable

The speed control system is designed to maintain vehicle speed above 48 km/h (30 mph). After the ON switch is depressed, depressing the SET/ACCEL switch will activate the speed control servo. To increase a set speed, either depress and hold for continuous acceleration, or momentarily tap the SET/ACCEL switch for 1.6 km/h (1 mph) acceleration increments. To decrease a set speed, depress and hold the COAST switch until the target speed is reached, or momentarily tap the COAST switch for 1.6 km/h (1 mph) deceleration increments. When the speed control system has been disabled by tapping the brake pedal, the RESUME switch can be depressed and the vehicle will return to the original set speed if the vehicle is traveling over 48 km/h (30 mph) and the OFF switch has not been depressed.

NOTE: The clutch pedal position (CPP) switch or jumper is replaced with the clutch master cylinder push rod.

NOTE: The deactivator switch is provided as an additional safety feature. Normally, when the brake pedal is depressed, an electrical signal from the brake lamp circuit to the speed control servo will deactivate the system. Under increased brake pedal effort, the deactivator switch will open and remove power to the speed control servo, releasing the throttle independent of the speed control servo.

NOTE: The air bag sliding contact (motorhome, control and spring brush assembly) provides the electrical interface between the steering column wiring and the speed control actuator switches in the steering wheel.

The inputs to the speed control servo are:

- Vehicle speed signal from the anti-lock brake control module.
- Speed control actuator switches.
- Brake pedal position (BPP) switch.
- CPP switch or jumper.
- Deactivator switch.

The outputs of the speed control servo are:

- Speed control actuator cable controlling the throttle position.
-

Speed Control

Refer to Wiring Diagrams Cell 31 ([F-53 Motorhome Chassis](#), [F-Super Duty 250-550](#)), Speed Control for schematic and connector information.

Special Tool(s)	
 ST1137-A	73 Digital Multimeter or equivalent 105-R0051

Inspection and Verification

NOTE: If any concerns are noted with the speedometer or horn, address those concerns by referring to their associated sections before continuing speed control diagnosis.

NOTE: When in speed control mode, initial depression of the clutch pedal may cause a normal momentary increase of engine rpm.

1. Verify the customer concern by operating the speed control system.
2. Visually inspect for obvious signs of mechanical and electrical damage.

Visual Inspection Chart	
Mechanical	Electrical
<ul style="list-style-type: none"> • Damaged speed control actuator cable • Speed control actuator cable not attached to throttle 	<ul style="list-style-type: none"> • Fuse(s) • Damaged wiring • Loose, corroded, or dirty connections • Damaged speed control actuator switches

3. If the fault is not visually evident, verify the symptom and refer to Symptom Chart.

Symptom Chart

NOTE: New speed control diagnostic software is available in version 12 or higher for New Generation STAR (NGS) Tester 418-F048 (007-00500). When using this software, it is necessary to use NGS Electronic Speed Control Interface Cable Kit 007-00586 with NGS Tester.

Symptom Chart		
Condition	Possible Sources	Action
<ul style="list-style-type: none"> The Speed Control Is Inoperative 	<ul style="list-style-type: none"> Actuator cable not attached to throttle. Fuse. Circuitry. Deactivator switch. Brake pedal position (BPP) switch. Speed control actuator switch (9C888). GEM/CTM (if equipped with RABS) or anti-lock brake control module (if equipped with 4WABS). Speed control servo (9C735). Clutch pedal position (CPP) switch or jumper. 	<ul style="list-style-type: none"> GO to Pinpoint Test A.
<ul style="list-style-type: none"> The Set Speed Fluctuates 	<ul style="list-style-type: none"> Speed control servo. Speed control actuator switch. Circuitry. Loose fit or binding between speed control actuator cable and throttle body. 	<ul style="list-style-type: none"> GO to Pinpoint Test B.
	<ul style="list-style-type: none"> Engine controls. 	<ul style="list-style-type: none"> Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. REPAIR engine as required.
<ul style="list-style-type: none"> The Speed Control Does Not Disengage When the Brakes Are 	<ul style="list-style-type: none"> Brake pedal position (BPP) switch. Deactivator switch. Speed control servo. Fuse. 	<ul style="list-style-type: none"> GO to Pinpoint Test C.

Applied	<ul style="list-style-type: none"> • Circuitry. • Binding speed control actuator cable. • Clutch pedal position (CPP) switch or jumper. 	
<ul style="list-style-type: none"> • The Speed Control Does Not Disengage When the Clutch Is Applied 	<ul style="list-style-type: none"> • Clutch pedal position (CPP) switch. • Circuitry. • Speed control servo. 	<ul style="list-style-type: none"> • GO to Pinpoint Test D.
<ul style="list-style-type: none"> • The Coast Switch Is Inoperative 	<ul style="list-style-type: none"> • Speed control actuator switch. • Speed control servo. 	<ul style="list-style-type: none"> • GO to Pinpoint Test E.
<ul style="list-style-type: none"> • The SET/ACCL Switch Is Inoperative 	<ul style="list-style-type: none"> • Speed control actuator switch. • Speed control servo. 	<ul style="list-style-type: none"> • GO to Pinpoint Test F.
<ul style="list-style-type: none"> • The Resume Switch Is Inoperative 	<ul style="list-style-type: none"> • Speed control actuator switch. • Speed control servo. 	<ul style="list-style-type: none"> • GO to Pinpoint Test G.
<ul style="list-style-type: none"> • The OFF Switch Is Inoperative 	<ul style="list-style-type: none"> • Speed control actuator switch. • Speed control servo. 	<ul style="list-style-type: none"> • GO to Pinpoint Test H.

Pinpoint Tests

PINPOINT TEST A: THE SPEED CONTROL IS INOPERATIVE

CONDITIONS	DETAILS/RESULTS/ACTIONS
A1 CHECK THE SPEED CONTROL ACTUATOR ATTACHMENT TO THROTTLE	
<div style="border: 1px solid black; padding: 2px; display: inline-block;">1</div> 	
	<div style="border: 1px solid black; padding: 2px; display: inline-block;">2</div> Remove the accelerator control splash shield.

Inspect the speed control actuator cable attachment. Check the speed control actuator cable by pulling on the cable and noting the throttle movement.

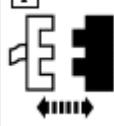
- **Is the speed control actuator cable OK?**

→ **Yes**
GO to [A2](#) .

→ **No**
REPAIR/REATTACH the speed control actuator cable. TEST the system for normal operation.

A2 CHECK THE VOLTAGE TO THE SPEED CONTROL SERVO

1

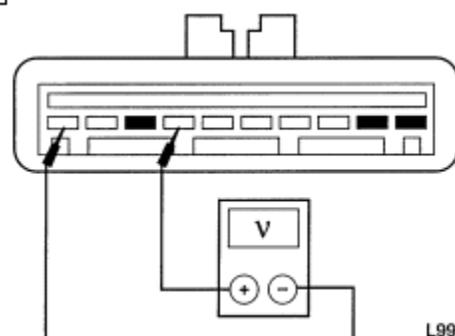


Speed Control Servo C1067 (Motorhome C146)

2



3



L9976-A

3 Measure the voltage between speed control servo C1067-7 (motorhome C146-7), circuit 295 (LB/PK), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

- **Is the voltage greater than 10 volts?**

→ **Yes**
GO to [A5](#).

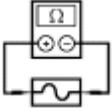
→ **No**
GO to [A3](#).

A3 CHECK FUSE JUNCTION PANEL FUSE 28 (10A) (MOTORHOME FUSE 26 [10A])

1



2



Fuse Junction Panel Fuse 28 (10A)
(Motorhome Fuse 26 [10A])

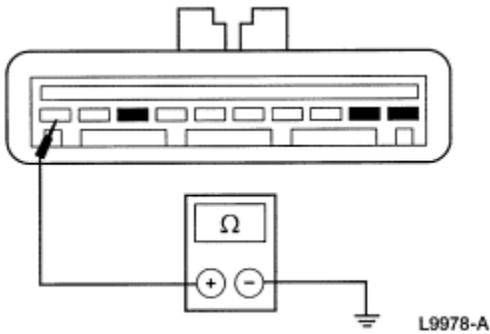
- **Is the fuse OK?**

→ **Yes**
GO to [A4](#).

→ **No**
REPLACE the fuse. TEST the system for normal operation. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. TEST the system for normal operation.

A4 CHECK THE SPEED CONTROL SERVO GROUND CIRCUIT 57 (BK)

1



1 Measure the resistance between speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK), and ground.

- **Is the resistance less than 5 ohms?**

→ **Yes**
REPAIR circuit 295 (LB/PK). TEST the system for normal operation.

→ **No**
REPAIR circuit 57 (BK). TEST the system for

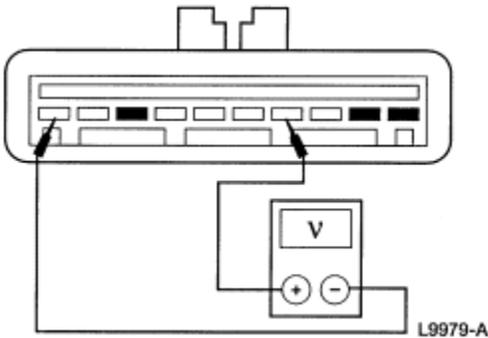
normal operation.

A5 CHECK FOR BRAKE PEDAL POSITION (BPP) SWITCH INPUT WITH NO BRAKES APPLIED

1



2



2 Measure the voltage between speed control servo C1067-4, circuit 306 (T/LB) (motorhome C146-4, circuit 810 [R/LG]), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

- Is voltage present?

→ Yes

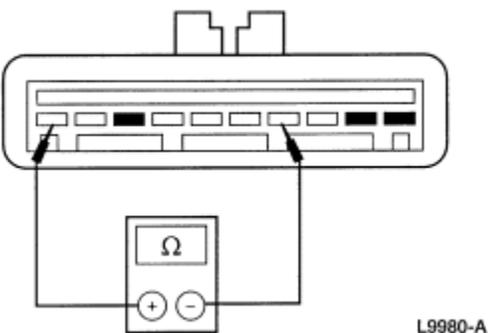
REPLACE the BPP switch; REFER to [Section 417-01](#). TEST the system for normal operation.

→ No

GO to [A6](#).

A6 CHECK THE BRAKE/CLUTCH CIRCUIT

1



1 Measure the resistance between speed control servo C1067-4, circuit 306 (T/LB) (motorhome C146-4, circuit 810 [R/LG]), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

- Is the resistance less than 5 ohms?

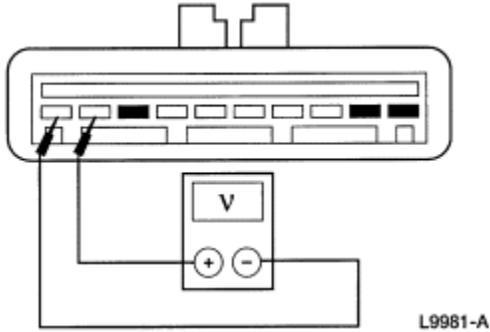
→ Yes

GO to [A7](#).

→ No
GO to [A16](#).

A7 CHECK THE DEACTIVATOR SWITCH INPUT TO SPEED CONTROL SERVO

1



1 Measure the voltage between speed control servo C1067-9 (motorhome C146-9), circuit 307 (BK/Y), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

- Is the voltage greater than 10 volts?

→ Yes
GO to [A10](#).

→ No
GO to [A8](#).

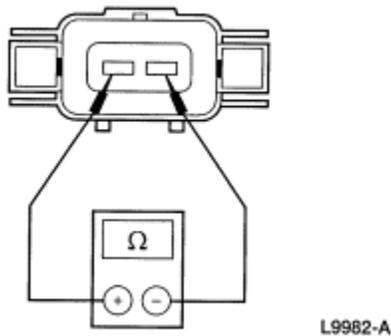
A8 CHECK THE DEACTIVATOR SWITCH CIRCUIT

1



Deactivator Switch C102 (Motorhome C125)

2



2 Measure the resistance between the deactivator switch terminals (component side).

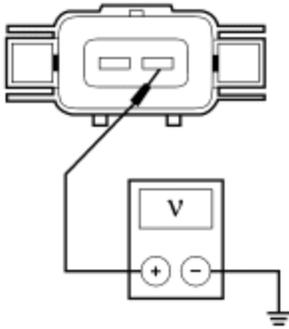
- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [A9](#).

→ **No**
REPLACE the deactivator switch; REFER to [Switch—Deactivator](#). TEST the system for normal operation.

A9 CHECK DEACTIVATOR SWITCH POWER

1



L9983-A

1 Measure the voltage between deactivator switch C102 (motorhome C125), circuit 10 (LG/R), and ground.

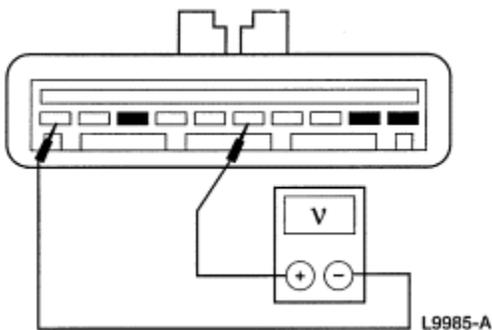
- **Is the voltage greater than 10 volts?**

→ **Yes**
REPAIR circuit 307 (BK/Y). TEST the system for normal operation.

→ **No**
REPAIR circuit 10 (LG/R) and/or fuse 13 (20A) (motorhome fuse 8 [10A]). TEST the system for normal operation.

A10 CHECK FOR STUCK SPEED CONTROL ACTUATOR SWITCH

1

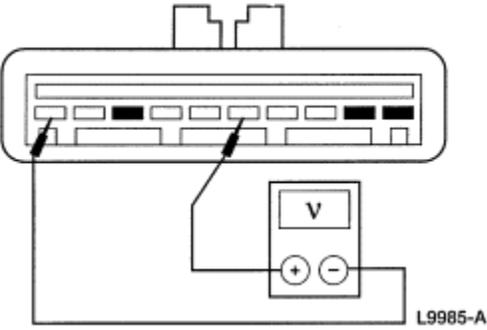


L9985-A

1 Measure the voltage between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

	<ul style="list-style-type: none"> • Is voltage present? <p>→ Yes GO to A17.</p> <p>→ No GO to A11.</p>
--	---

A11 CHECK THE SPEED CONTROL ACTUATOR SWITCH OPERATION

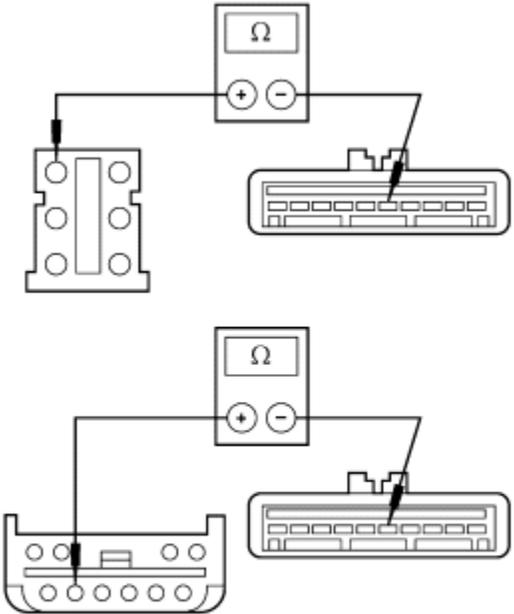
<p>1</p> 	<p>1 With the speed control actuator switch depressed to the ON position, measure the voltage between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).</p>
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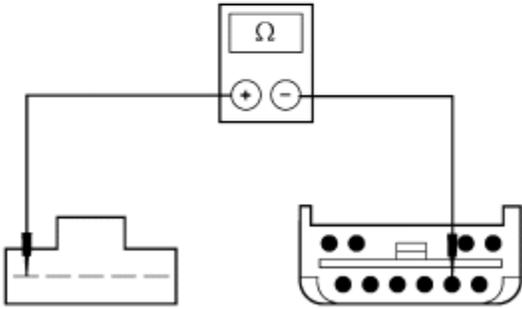
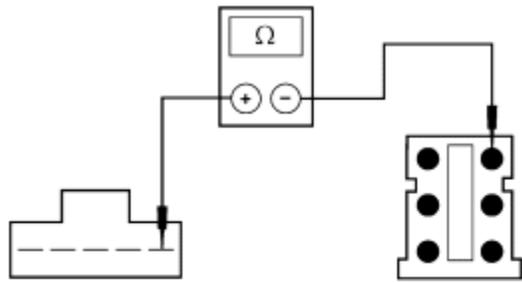
	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes GO to A14.</p> <p>→ No GO to A12.</p>
--	---

A12 CHECK CIRCUIT 151 (LB/BK) FOR AN OPEN

<p>1</p>  <p>Air Bag Sliding Contact C219 or Control and Brush Assembly C222</p>	
---	--

<p>2</p>	<p>2 Measure the resistance between speed control servo C1067-6 (motorhome C146-6), circuit 151 (LB/BK), and air bag sliding contact C219F-1, circuit 151 (LB/BK) (6 pin) or control and spring brush assembly C222F-5, circuit 151 (LB/BK) (10 pin).</p>
----------	---

 <p style="text-align: right;">GV1215-A</p>	
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to A13.</p> <p>→ No REPAIR circuit 151 (LB/BK). TEST the system for normal operation.</p>
<p>A13 CHECK THE AIR BAG SLIDING CONTACT OR CONTROL AND BRUSH ASSEMBLY FOR AN OPEN</p>	
	<p>1 Remove the driver side air bag (if equipped); refer to Section 501-20B.</p>
<p>2</p>	<p>2 Measure the resistance between air bag sliding contact C219M-1, and top of air bag sliding contact terminal 5 (6 pin) or between control and spring brush assembly C222M-5, and top of control and spring brush assembly terminal 1 (10 pin).</p>



GV1216-A

- **Is the resistance less than 1 ohm?**

→ **Yes**

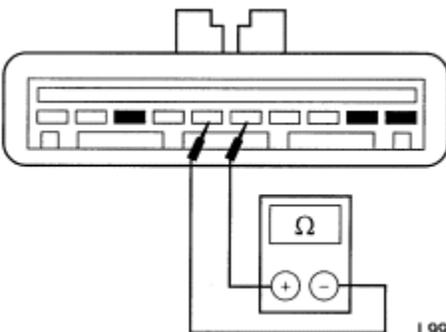
REPLACE the speed control actuator switch; REFER to [Switch—Speed Control Actuator](#). TEST the system for normal operation.

→ **No**

REPLACE the air bag sliding contact (14A664); REFER to [Section 501-20B](#) or REPLACE the control and spring brush assembly; REFER to [Brush Assembly—Control and Spring](#). TEST the system for normal operation.

A14 CHECK THE SET/ACCEL SWITCH

1



L9987-A

1

With the SET/ACCEL switch depressed, measure the resistance between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-6 (motorhome C146-6), circuit 848 (DG/O).

	<ul style="list-style-type: none"> • Is the resistance between 612 and 748 ohms? <p>→ Yes GO to A15.</p> <p>→ No REPLACE the speed control actuator switch; REFER to Switch—Speed Control Actuator. TEST the system for normal operation.</p>
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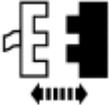
A15 CHECK THE SPEEDOMETER

	<p>1 Check the speedometer for proper operation by driving the vehicle.</p>
--	---

	<ul style="list-style-type: none"> • Does the speedometer operate properly? <p>→ Yes REPAIR circuit 679 (GY/BK). TEST the system for normal operation.</p> <p>→ No REFER to Section 413-01.</p>
--	---

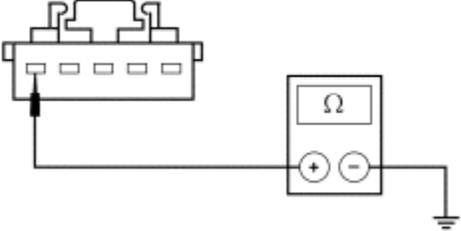
A16 CHECK CIRCUIT 676 (PK/O) (MOTORHOME 1203 [BK/BL]) FOR AN OPEN

1



Brake Pedal Position (BPP) Switch C279 (Motorhome C231)

2



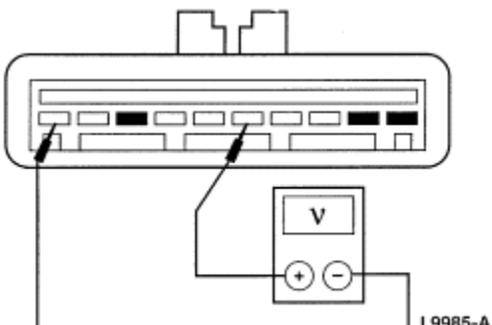
2 Measure the resistance between BPP switch C279-1, circuit 676 (PK/O) (motorhome C231-1, circuit 1203 [BK/BL]), and ground.

GV0976-A

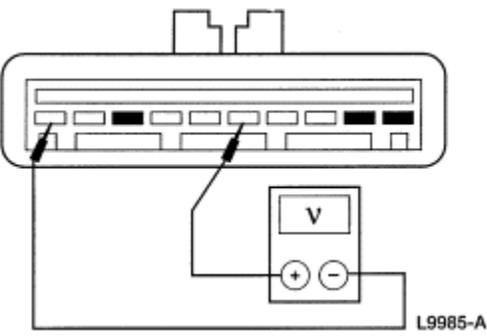
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	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to A19.</p> <p>→ No REPAIR circuit 676 (PK/O) (motorhome 1203 [BK/BL]). TEST the system for normal operation.</p>
--	--

A17 CHECK THE SPEED CONTROL ACTUATOR SWITCH

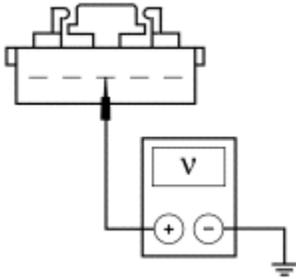
<p>1</p> 	
<p>2</p>  <p>Speed Control Actuator Switches</p>	
<p>3</p> 	
<p>4</p> 	<p>4 Measure the voltage between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).</p>

	<ul style="list-style-type: none"> • Is voltage present? <p>→ Yes GO to A18.</p> <p>→ No REPLACE the speed control actuator switch; REFER to Switch—Speed Control Actuator. TEST</p>
--	--

	the system for normal operation.
A18 CHECK CIRCUIT 151 (LB/BK) FOR SHORT TO POWER	
<p>1</p> 	
<p>2</p>  <p>Air Bag Sliding Contact C219 or Control and Spring Brush Assembly C222</p>	
<p>3</p> 	
<p>4</p> 	<p>4 Measure the voltage between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).</p>
	<ul style="list-style-type: none"> • Is voltage present? <p>→ Yes REPLACE the air bag sliding contact; refer to Section 501-20B or REPLACE the control and spring brush assembly; REFER to Brush Assembly—Control and Spring. TEST the system for normal operation.</p> <p>→ No REPAIR circuit 151 (LB/BK). TEST the system for normal operation.</p>
A19 CHECK CIRCUIT 22 (LB/BK) FOR AN OPEN	
<p>1</p>	



2



GV1099-A

2 Measure the voltage between BPP switch C279-3 (motorhome C231-3), circuit 22 (LB/BK), and ground.

- Is the voltage greater than 10 volts?

→ Yes

If not motorhome, GO to [A20](#) .

If motorhome, REPAIR circuit 810 (R/LG). TEST the system for normal operation.

→ No

REPAIR circuit 22 (LB/BK). TEST the system for normal operation.

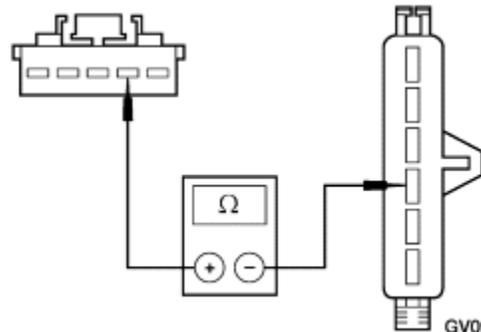
A20 CHECK CIRCUIT 810 (R/LG) FOR AN OPEN

1



Clutch Pedal Position (CPP) Switch or Jumper C261

2

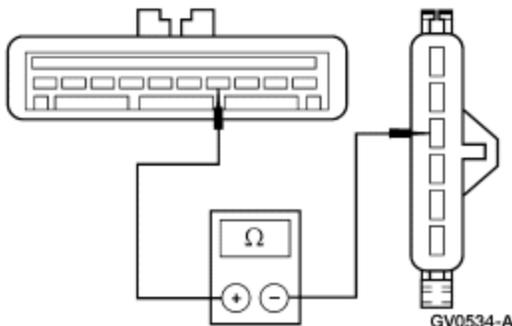


GV0904-A

2 Measure the resistance between BPP switch C279-2, circuit 810 (R/LG), and CPP switch or jumper C261-3, circuit (R/LG).

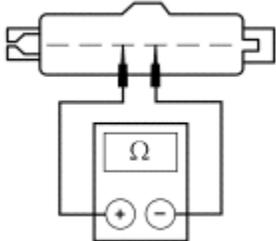
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to A21.</p> <p>→ No REPAIR circuit 810 (R/LG). TEST the system for normal operation.</p>
--	---

A21 CHECK CIRCUIT 306 (T/LB) FOR AN OPEN

<p>1</p>  <p>GV0534-A</p>	<p>1 Measure the resistance between CPP switch or jumper C261-4, circuit 306 (T/LB), and speed control servo C1067-4, circuit 306 (T/LB).</p>
--	---

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to A22.</p> <p>→ No REPAIR circuit 306 (T/LB). TEST the system for normal operation.</p>
--	---

A22 CHECK THE CPP SWITCH

<p>1</p>  <p>GV1098-A</p>	<p>1 Measure the resistance between CPP switch or jumper terminal 3, and terminal 4.</p>
--	--

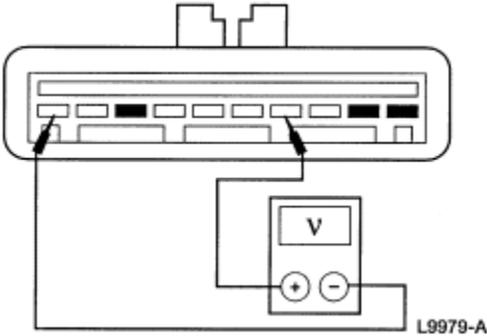
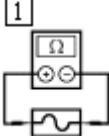
	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms?
--	--

	<p>→ Yes REPLACE the BPP switch; refer to Section 417-01. TEST the system for normal operation.</p> <p>→ No REPLACE the CPP switch or jumper. TEST the system for normal operation.</p>
--	---

PINPOINT TEST B: THE SET SPEED FLUCTUATES

CONDITIONS	DETAILS/RESULTS/ACTIONS
B1 CHECK SPEED CONTROL ACTUATOR CABLE/THROTTLE BODY LINKAGE	
<p>1</p> 	
	<p>2 Remove the speed control actuator cable from the speed control servo. Visually inspect the core wire and check the speed control actuator cable by pulling on the cable and noting the throttle movement.</p>
	<ul style="list-style-type: none"> • Is the speed control actuator cable OK? <p>→ Yes GO to B2.</p> <p>→ No REPLACE the speed control actuator cable and/or REPAIR the throttle body linkage. REFER to Section 310-02. TEST the system for normal operation.</p>
B2 CHECK THE SPEEDOMETER	
	<p>1 Check the speedometer for proper operation by driving the vehicle.</p>
	<ul style="list-style-type: none"> • Does the speedometer fluctuate? <p>→ Yes REFER to Section 413-01.</p> <p>→ No REPLACE the speed control servo; REFER to Actuator—Speed Control Servo. TEST the system for normal operation.</p>

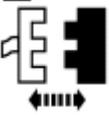
PINPOINT TEST C: THE SPEED CONTROL DOES NOT DISENGAGE WHEN THE BRAKES ARE APPLIED

CONDITIONS	DETAILS/RESULTS/ACTIONS
C1 CHECK THE BRAKE PEDAL POSITION (BPP) SWITCH OPERATION	
<p>1</p>  <p>Speed Control Servo C1067 (Motorhome C146)</p>	
<p>2</p> 	<p>2</p> <p>Measure the voltage between speed control servo C1067-4, circuit 306 (T/LB) (motorhome C146-4, circuit 810 [R/LG]), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK), while pressing and releasing the brake pedal.</p>
	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts with the brake pedal pressed and 0 volts with the brake pedal released? <p>→ Yes GO to C7.</p> <p>→ No GO to C2.</p>
C2 CHECK THE FUSE JUNCTION PANEL FUSE 15 (5A) (MOTORHOME FUSE 8 [10A])	
<p>1</p>  <p>Fuse Junction Panel Fuse 15 (5A) (Motorhome Fuse 8 [10A])</p>	
	<ul style="list-style-type: none"> • Is the fuse OK?

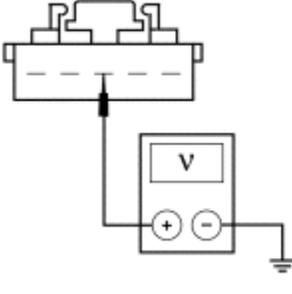
	<p>→ Yes GO to C3.</p> <p>→ No REPLACE the fuse. TEST the system for normal operation. If the fuse fails again, CHECK for short to ground. REPAIR as necessary. TEST the system for normal operation.</p>
--	---

C3 CHECK CIRCUIT 22 (LB/BK) FOR AN OPEN

<p>1</p> 	
--	--

<p>2</p>  <p>Brake Pedal Position (BPP) Switch C279 (Motorhome C231)</p>	
---	--

<p>3</p> 	
---	--

<p>4</p>  <p style="text-align: right;">GV1099-A</p>	<p>4 Measure the voltage between BPP switch C279-3 (motorhome C231-3), circuit 22 (LB/BK), and ground.</p>
---	--

	<ul style="list-style-type: none"> • Is the voltage greater than 10 volts? <p>→ Yes If not motorhome, GO to C4 .</p> <p>If motorhome, REPAIR circuit 810 (R/LG). TEST the system for normal operation.</p> <p>→ No</p>
--	--

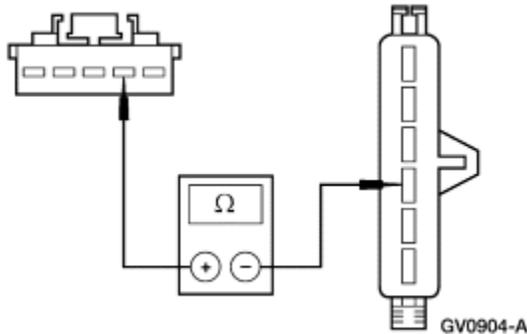
REPAIR circuit 22 (LB/BK). TEST the system for normal operation.

C4 CHECK CIRCUIT 810 (R/LG) FOR AN OPEN



Clutch Pedal Position (CPP) Switch or Jumper C261

2



2 Measure the resistance between BPP switch C279-2, circuit 810 (R/LG), and CPP switch or jumper C261-3, circuit (R/LG).

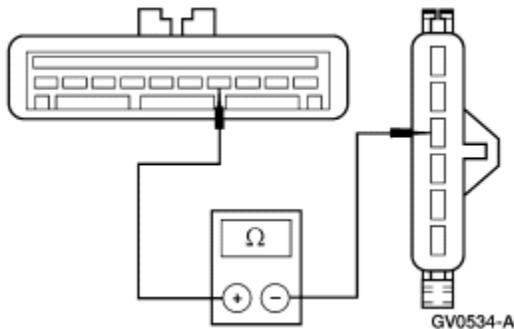
- Is the resistance less than 5 ohms?

→ **Yes**
GO to [C5](#).

→ **No**
REPAIR circuit 810 (R/LG). TEST the system for normal operation.

C5 CHECK CIRCUIT 306 (T/LB) FOR AN OPEN

1



1 Measure the resistance between CPP switch or jumper C261-4, circuit 306 (T/LB), and speed control servo C1067-4, circuit 306 (T/LB).

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes GO to C6.</p> <p>→ No REPAIR circuit 306 (T/LB). TEST the system for normal operation.</p>
--	--

C6 CHECK THE CPP SWITCH

<p>1</p> <p style="text-align: right;">GV1098-A</p>	<p>1 Measure the resistance between CPP switch or jumper terminal 3, and terminal 4.</p>
---	--

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes REPLACE the BPP switch; refer to Section 417-01. TEST the system for normal operation.</p> <p>→ No REPLACE the CPP switch or jumper. TEST the system for normal operation.</p>
--	--

C7 CHECK THE DEACTIVATOR SWITCH CIRCUITRY

<p>1</p> <p style="text-align: right;">L9981-A</p>	<p>1 Measure the voltage between speed control servo C1067-9 (motorhome C146-9), circuit 307 (BK/Y), and ground, while firmly pressing and releasing the brake pedal.</p>
--	---

	<ul style="list-style-type: none"> • Is the voltage 0 volts with the brake pedal
--	--

firmly pressed, and greater than 10 volts with the brake pedal released?

→ **Yes**
 REPLACE the speed control servo; REFER to [Actuator—Speed Control Servo](#). TEST the system for normal operation.

→ **No**
 GO to [C8](#).

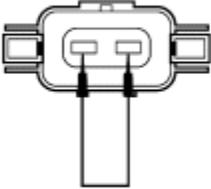
C8 CHECK THE DEACTIVATOR SWITCH

1



Deactivator Switch C102 (Motorhome C125)

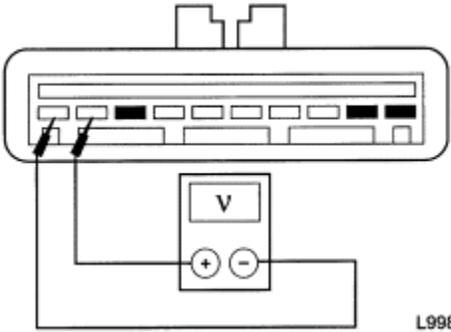
2



GV0970-A

2 Connect a jumper wire between deactivator switch C102 (motorhome C125), circuit 10 (LG/R), and deactivator switch C102 (motorhome C125), circuit 307 (BK/Y).

3



L9981-A

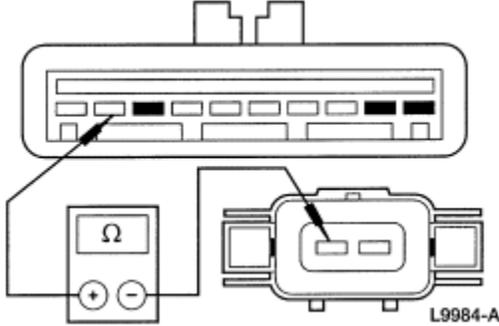
3 Measure the voltage between speed control servo C1067-9 (motorhome C146-9), circuit 307 (BK/Y), and speed control servo C1067-10 (motorhome C146-10), circuit 57 (BK).

• Is the voltage greater than 10 volts?

→ **Yes**
 REPLACE the deactivator switch; REFER to [Switch—Deactivator](#). TEST the system for normal

	operation. → No GO to C9 .
--	---

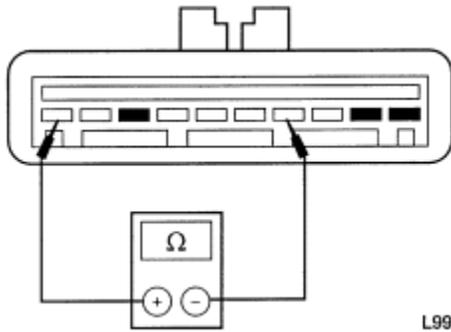
C9 CHECK CIRCUIT 307 (BK/Y) FOR AN OPEN

<p>1</p>  <p>L9984-A</p>	<p>1 Measure the resistance between speed control servo C1067-9 (motorhome C146-9), circuit 307 (BK/Y), and deactivator switch C102 (motorhome C125), circuit 307 (BK/Y).</p>
---	---

	<ul style="list-style-type: none"> • Is the resistance less than 5 ohms? <p>→ Yes REPAIR circuit 10 (LG/R). TEST the system for normal operation.</p> <p>→ No REPAIR circuit 307 (BK/Y). TEST the system for normal operation.</p>
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PINPOINT TEST D: THE SPEED CONTROL DOES NOT DISENGAGE WHEN THE CLUTCH IS APPLIED

CONDITIONS	DETAILS/RESULTS/ACTIONS
D1 CHECK THE CLUTCH PEDAL POSITION (CPP) SWITCH CIRCUIT	
<p>1</p> 	
<p>2</p>  <p>Speed Control Servo C1067</p>	
<p>3</p>	<p>3 Measure the resistance between speed control servo C1067-4, circuit 306 (T/LB), and speed control</p>



servo C1067-10, circuit 57 (BK).

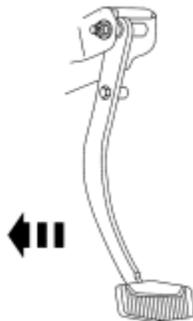
- **Is the resistance less than 5 ohms?**

→ **Yes**
GO to [D2](#).

→ **No**
GO to [Pinpoint Test A](#).

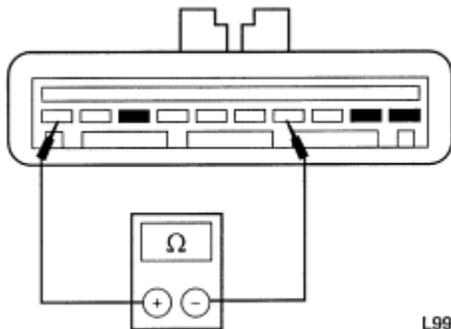
D2 CHECK THE CLUTCH SWITCH OPERATION

1



1 Depress the clutch pedal.

2



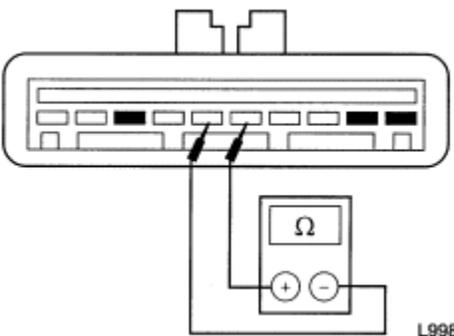
2 Measure the resistance between speed control servo C1067-4, circuit 306 (T/LB), and speed control servo C1067-10, circuit 57 (BK).

- **Is the resistance greater than 10,000 ohms?**

→ **Yes**
REPLACE the speed control servo; REFER to

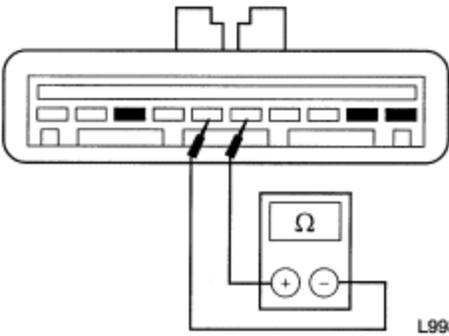
	<p>Actuator—Speed Control Servo. TEST the system for normal operation.</p> <p>→ No REPLACE the CPP switch. TEST the system for normal operation.</p>
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PINPOINT TEST E: THE COAST SWITCH IS INOPERATIVE

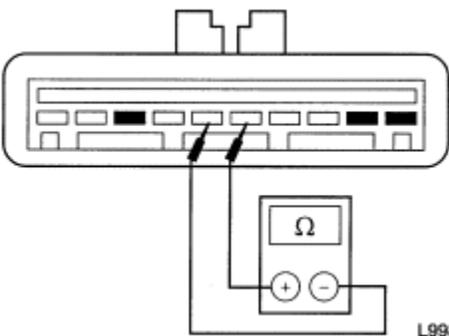
CONDITIONS	DETAILS/RESULTS/ACTIONS
E1 CHECK THE COAST SWITCH OPERATION	
<p>1</p> 	
<p>2</p>  <p>Speed Control Servo C1067 (Motorhome C146)</p>	
<p>3</p>  <p>L9987-A</p>	<p>3 With the COAST switch depressed, measure the resistance between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-6 (motorhome C146-6), circuit 848 (DG/O).</p>
	<ul style="list-style-type: none"> • Is the resistance between 108 and 132 ohms? <p>→ Yes REPLACE the speed control servo; REFER to Actuator—Speed Control Servo. TEST the system for normal operation.</p> <p>→ No REPLACE the speed control actuator switch;</p>

	REFER to Switch—Speed Control Actuator . TEST the system for normal operation.
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PINPOINT TEST F: THE SET/ACCL SWITCH IS INOPERATIVE

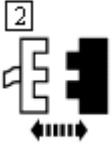
CONDITIONS	DETAILS/RESULTS/ACTIONS
F1 CHECK THE SET/ACCEL SWITCH OPERATION	
<p>1</p> 	
<p>2</p>  <p>Speed Control Servo C1067 (Motorhome C146)</p>	
<p>3</p> 	<p>3 With the SET/ACCEL switch depressed and while rotating the steering wheel from stop to stop, measure the resistance between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-6 (motorhome C146-6), circuit 848 (DG/O).</p>
	<ul style="list-style-type: none"> • Is the resistance between 612 and 748 ohms? <p>→ Yes REPLACE the speed control servo; REFER to Actuator—Speed Control Servo. TEST the system for normal operation.</p> <p>→ No REPLACE the speed control actuator switch; REFER to Switch—Speed Control Actuator. TEST the system for normal operation.</p>

PINPOINT TEST G: THE RESUME SWITCH IS INOPERATIVE

CONDITIONS	DETAILS/RESULTS/ACTIONS
G1 CHECK THE RESUME SWITCH OPERATION	
<p>1</p> 	
<p>2</p>  <p>Speed Control Servo C1067 (Motorhome C146)</p>	
<p>3</p> 	<p>3 With the RESUME switch depressed and while rotating the steering wheel from stop to stop, measure the resistance between speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-6 (motorhome C146-6), circuit 848 (DG/O).</p>
	<ul style="list-style-type: none"> • Is the resistance between 1980 and 2420 ohms? <p>→ Yes REPLACE the speed control servo; REFER to Actuator—Speed Control Servo. TEST the system for normal operation.</p> <p>→ No REPLACE the speed control actuator switch; REFER to Switch—Speed Control Actuator. TEST the system for normal operation.</p>

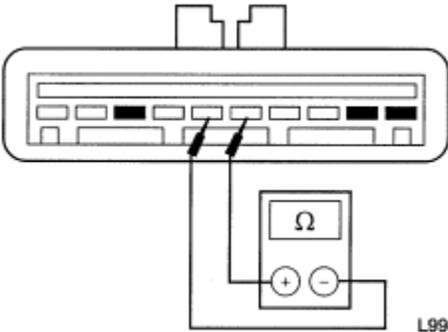
PINPOINT TEST H: THE OFF SWITCH IS INOPERATIVE

CONDITIONS	DETAILS/RESULTS/ACTIONS
H1 CHECK THE OFF SWITCH OPERATION	
<p>1</p>	



Speed Control Servo C1067 (Motorhome C146)

3



3 With the OFF switch depressed and while rotating the steering wheel from stop to stop, measure the resistance between the speed control servo C1067-5 (motorhome C146-5), circuit 151 (LB/BK), and speed control servo C1067-6 (motorhome C146-6), circuit 848 (DG/O).

- **Is the resistance less than 5 ohms?**

→ **Yes**

REPLACE the speed control servo; REFER to [Actuator—Speed Control Servo](#). TEST the system for normal operation.

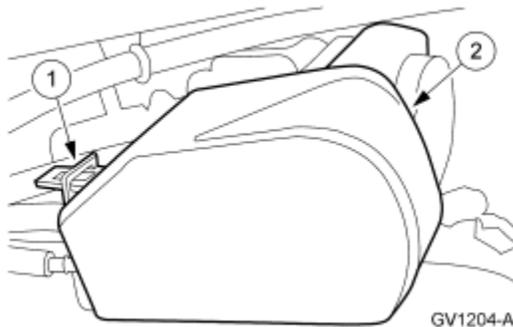
→ **No**

REPLACE the speed control actuator switch; REFER to [Switch—Speed Control Actuator](#). TEST the system for normal operation.

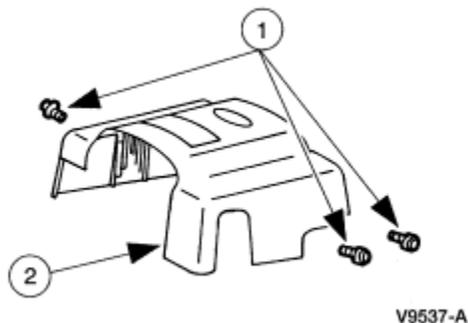
Actuator Cable—Speed Control

Removal

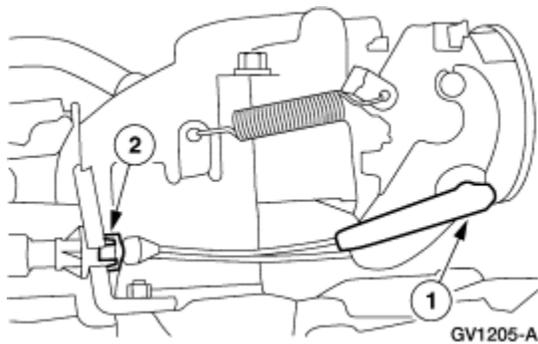
1. Remove the air cleaner outlet tube. For additional information, refer to [Section 303-12](#).
2. Remove the accelerator control splash shield (9E766) (6.8L shown).
 1. Release the tab.
 2. Remove the splash shield.



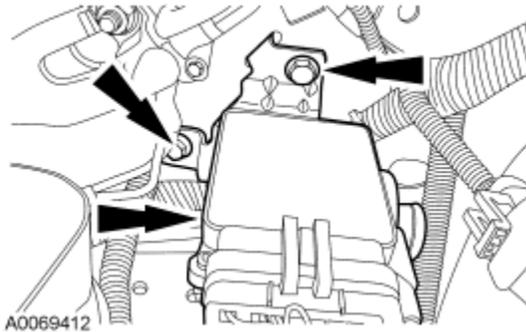
3. Remove the accelerator control splash shield (5.4L shown).
 1. Remove the bolts.
 2. Remove the splash shield.



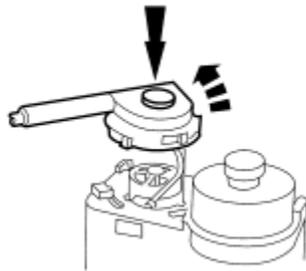
4. Disconnect the speed control actuator cable (9A825).
 1. Disconnect the speed control actuator cable from the throttle body cam and position aside.
 2. Depress the retaining clips to remove the cable from the bracket.



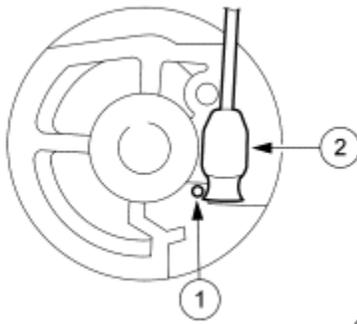
5. Remove the bolts and position the speed control actuator and bracket aside.



6. Remove the speed control actuator cable cap from the speed control servo (9C735).
 - Push in the locking arm on the speed control actuator cable cap then rotate the cap counterclockwise.



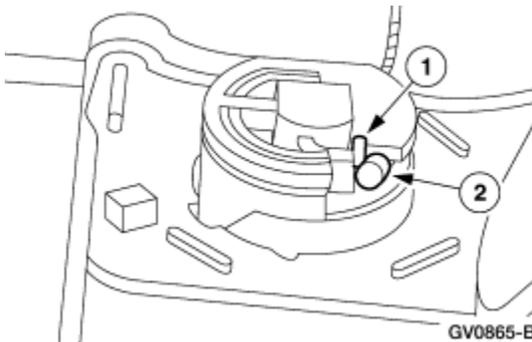
7. Disconnect the speed control core wire end from the speed control servo pulley.
 1. Depress the spring retainer.
 2. Slide the core wire end out of the speed control servo pulley.



GV1211-A

Installation

1. Insert the speed control cable slug into the speed control servo pulley slot.
 1. Gently compress the speed control servo spring.
 2. Insert the speed control cable slug into the speed control servo pulley slot.

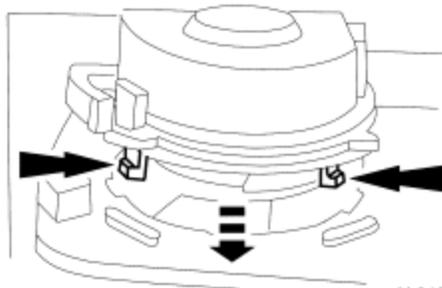


GV0865-B

2. **NOTE:** Ensure the rubber seal is fully seated onto the speed control actuator cable cap.

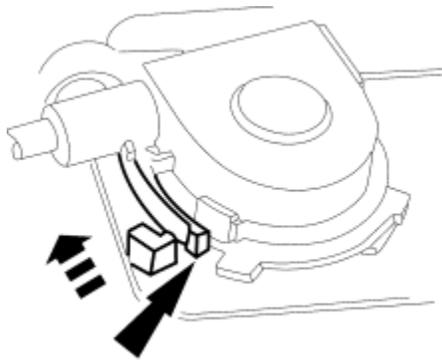
NOTE: Incorrect wrapping of the speed control actuator cable around the speed control servo pulley may result in a high idle condition.

Release the compressed spring while aligning the speed control actuator cable cap tabs with the slots in the speed control servo housing.



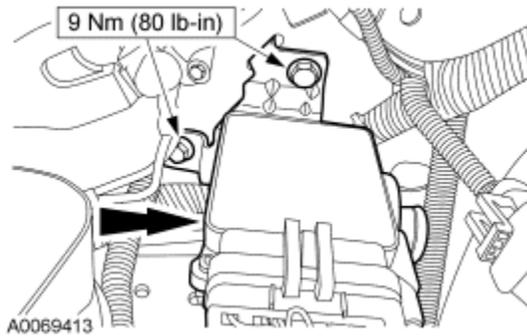
AL0401-A

3. Rotate the speed control actuator cable cap until the locking arm engages.

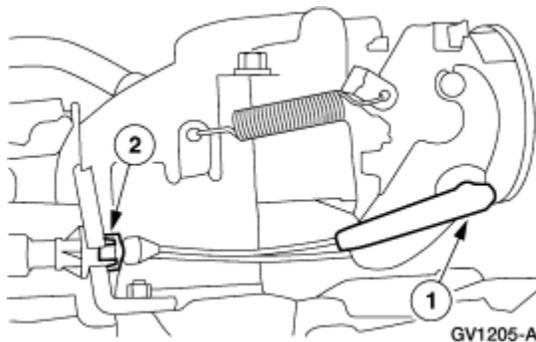


AL0402-A

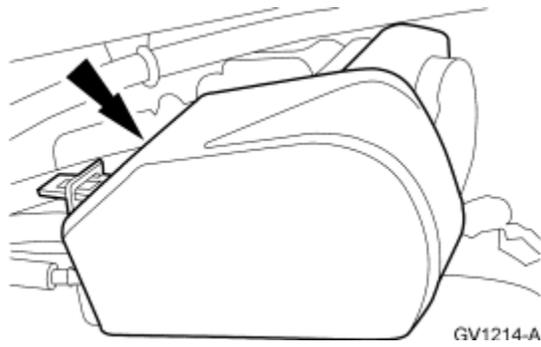
4. Position the speed control actuator and bracket and install the bolts.



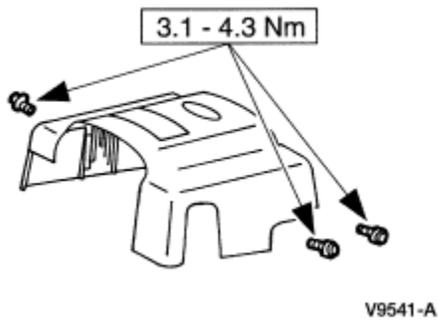
5. Connect the speed control actuator cable to the throttle body cam.
 1. Connect the speed control actuator cable to the throttle body cam by snapping it in place.
 2. Position the speed control actuator cable in the bracket.



6. Install the accelerator control splash shield (5.8L shown).



7. Install the accelerator control splash shield (5.4L shown).

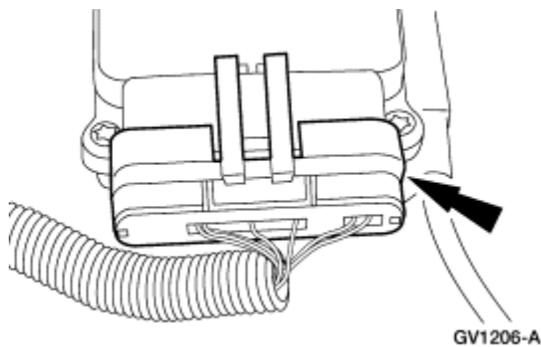


SECTION 310-03: Vehicle Speed Control 1999 F-Super Duty 250-550 Workshop Manual
REMOVAL AND INSTALLATION [Procedure revision date: 01/26/2000](#)

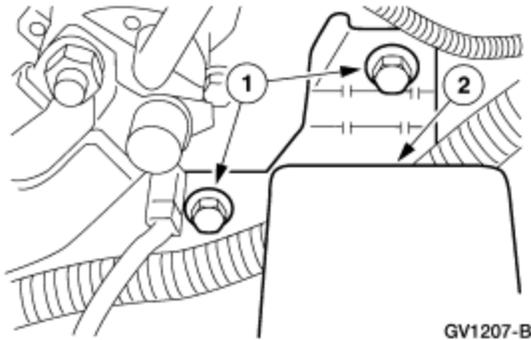
Actuator—Speed Control Servo

Removal

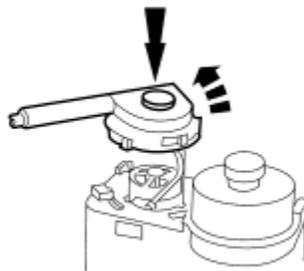
1. Disconnect the speed control servo electrical connector.



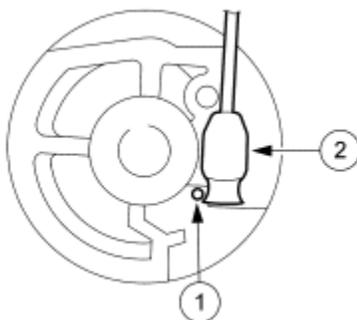
2. Remove the speed control servo and bracket.
 1. Remove the bolts.
 2. Remove the speed control servo and bracket.



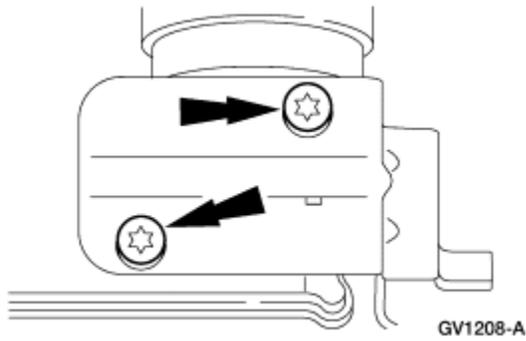
3. Remove the speed control actuator cable cap from the speed control servo.
 - Push in the locking arm on the speed control actuator cable cap and rotate the cap counterclockwise.



4. Disconnect the speed control core wire from the speed control servo pulley.
 1. Depress the spring retainer.
 2. Slide the core wire end out of the speed control servo pulley.

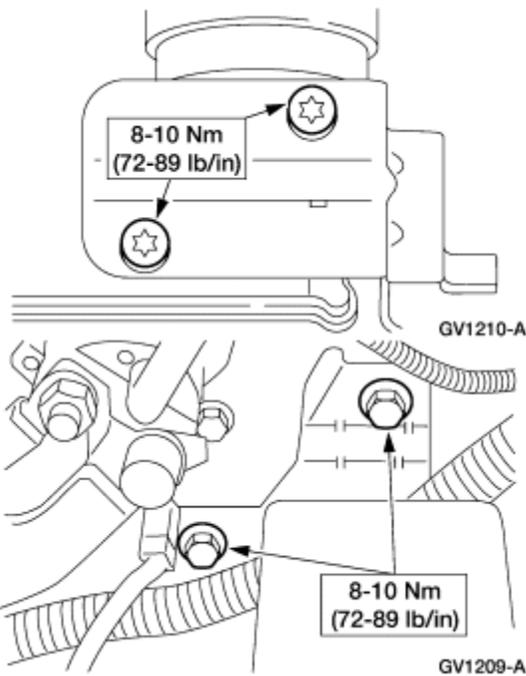


5. Remove the speed control servo bracket.
 1. Remove the screws.
 2. Remove the speed control servo bracket.



Installation

1. To install, reverse the removal procedure.

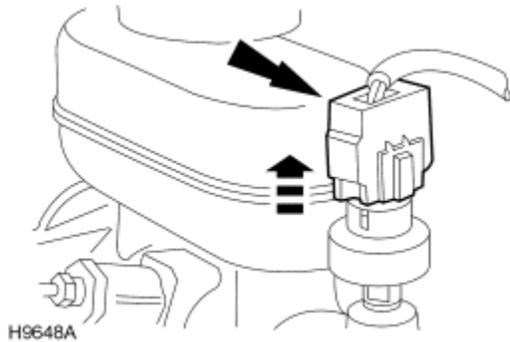


Switch—Speed Control Actuator

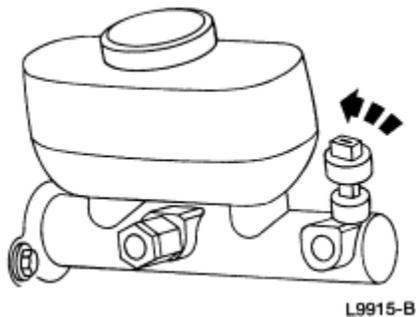
Removal

Disconnect the battery ground cable.

2. Disconnect the deactivator switch electrical connector.



3. Remove the deactivator switch.

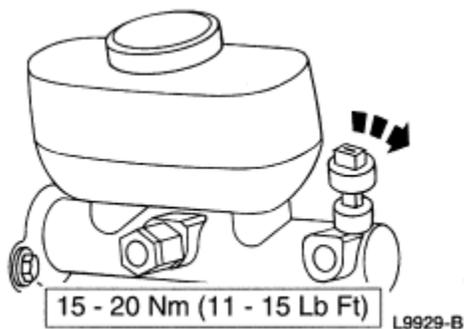


Installation

1. **NOTE:** When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

NOTE: After the deactivator switch is installed, it is necessary to bleed the brake system. For additional information, refer to [Section 206-00](#).

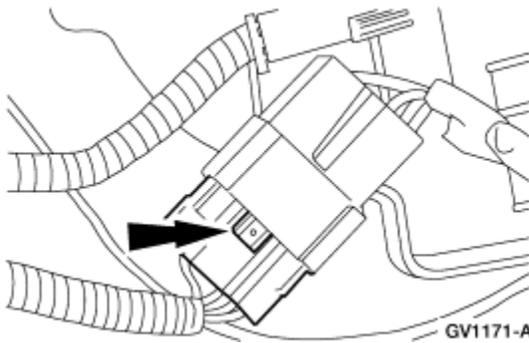
To install, reverse the removal procedure.



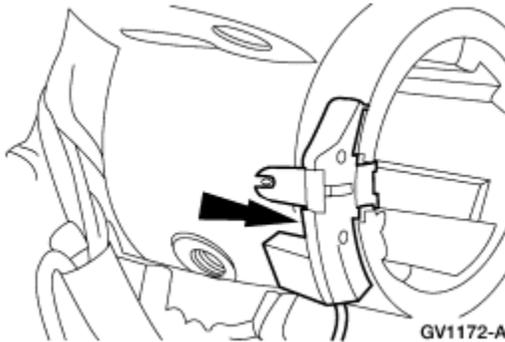
Brush Assembly

Removal

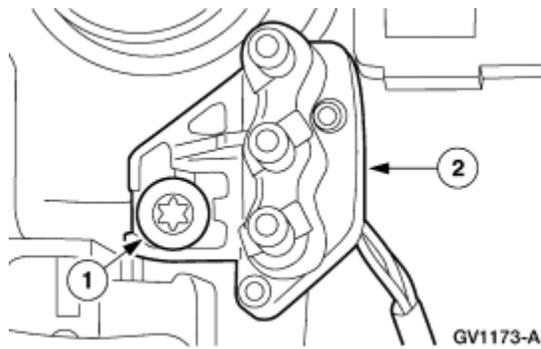
1. Remove the steering wheel. For additional information, refer to [Section 211-04](#).
2. Remove the steering column shrouds. For additional information, refer to [Section 211-04](#).
3. Disconnect the brush assembly electrical connector.



4. Remove the key in ignition warning switch.

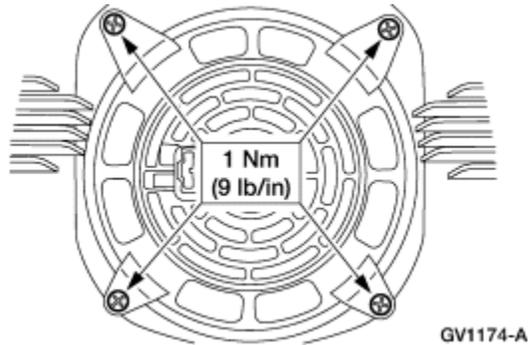
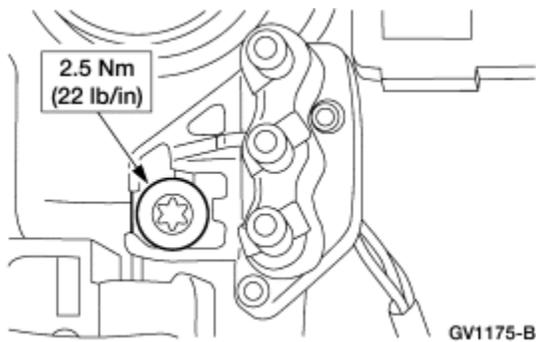


5. Remove the brush assembly.
 1. Remove the screw.
 2. Remove the brush assembly.



Installation

1. To install, reverse the removal procedure.



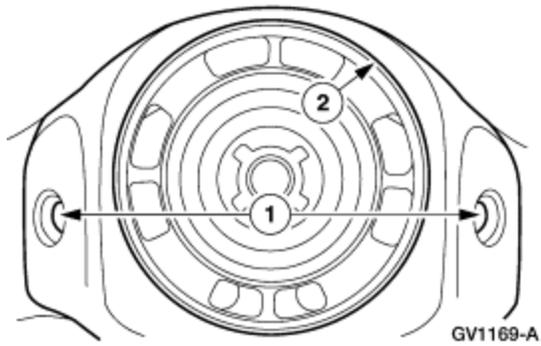
SECTION 310-03: Vehicle Speed Control 1999 F-Super Duty 250-550 Workshop Manual
REMOVAL AND INSTALLATION [Procedure revision date: 01/26/2000](#)

Brush Assembly—Control and Spring

Removal

1. Remove the steering wheel. For additional information, refer to [Section 211-04](#).
2. Remove the steering wheel cover.
 1. Remove the steering wheel cover screws.

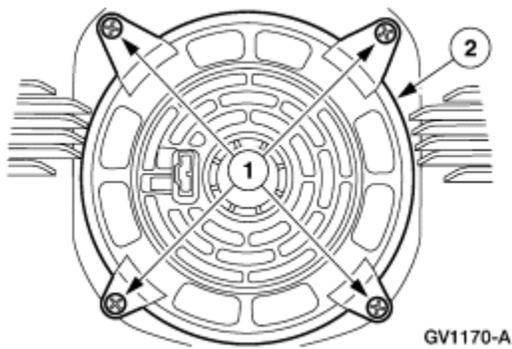
2. Remove the steering wheel cover.



3. Remove the brush control and spring.

1. Remove the screws.

2. Remove the control and spring.



Installation

1. To install, reverse the removal procedure.

