
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](#)

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

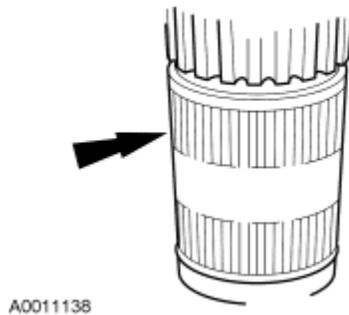
NOTE: Refer to Symptom Chart—Transmission Component Wear and Damage in this section for additional information relating to the following conditions.

Case Surface Roughness



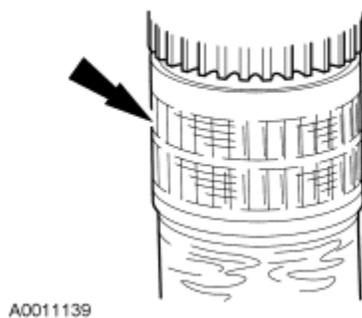
- The term describes areas of roughness on the case. The condition occurs in production, when even after a thorough cleaning, a tough, adhesive crust of sand remains on the surface. Normally, the visual impression is misleading and the housing is usable.

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.

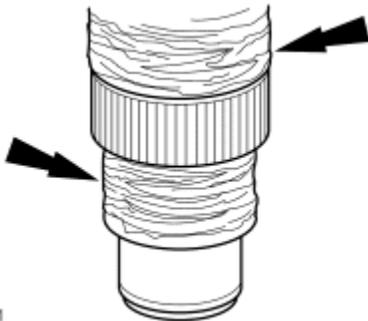
Shaft Damaged by Tribological Oxidation (Infinitely Brinelled Surface)



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.

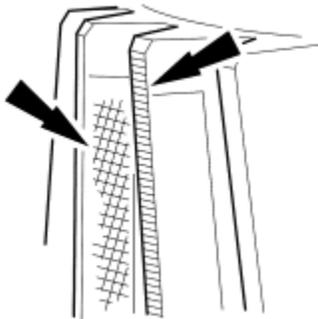
Shaft Damaged by Fretting



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

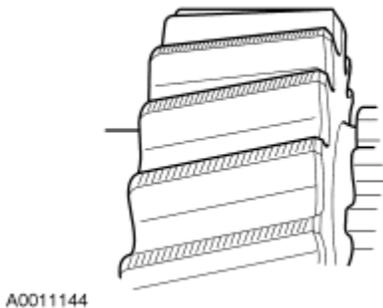
- The term describes grinding and shaving marks in the gear teeth. Rough peaks, formed during production, wearing away or, to some extent, rolling into the surface cause break-in wear. This type of wear normally ceases after the running-in period has expired, without damaging the components.

Gear Teeth Damaged by Scratches



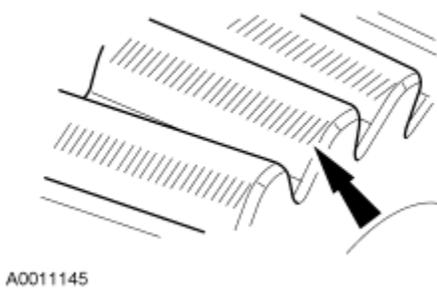
- The term describes shallow linear indentations on the flank, running in the direction of sliding. Assess scratches as damage.

Gear Teeth Damaged by Abrasive Wear



- 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

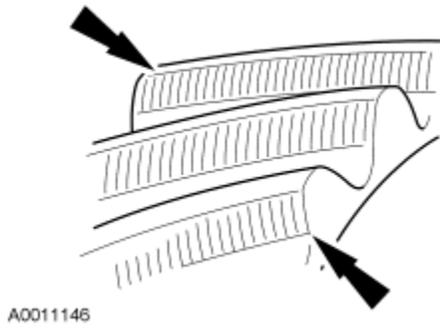


- The term describes extensive linear indentations in the gear teeth, running in the direction of sliding. Unlike scratching, these marks extend from the start or end of the meshing zone. These marks are particularly deep at the root or tip, where maximum sliding speeds impact the most. Unlike scuffing,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

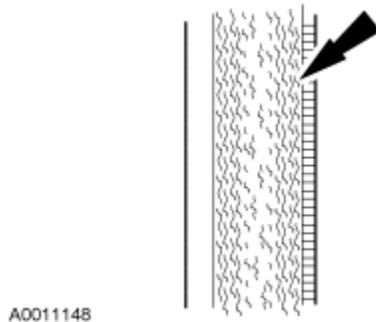
Gear Teeth Damaged by Severe Scoring



- 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

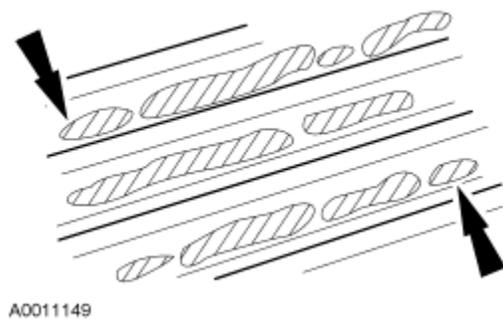
away between the flanks, permitting direct metal-to-metal contact. This may lead to seizure (welding). Because of the relative movement, these welded zones are immediately torn apart again, producing the associated damage.

Brinelling in Gear Teeth



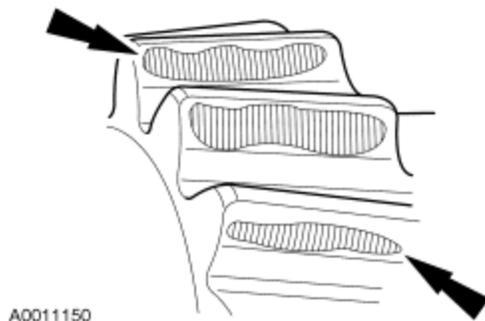
- The term describes ripple-like alterations in the surface structure, which run perpendicular to the direction of sliding. These marks resemble a washboard with differences in height of 1 micron. Do not assess these marks as damage.

Flank Fatigue



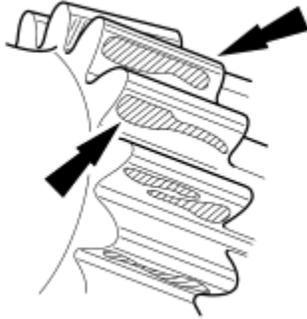
- The term describes extremely fine, localized pittings in the load-bearing flanks, visible as gray spots, or as a matte gray staining when found in clusters. Material fatigue resulting from a combination of contact pressure, sliding movement, and composite friction leads to the formation of this kind 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.

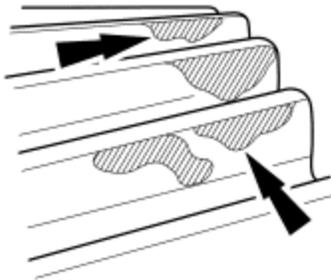
Gear Teeth with Heavy Pitting Damage



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.

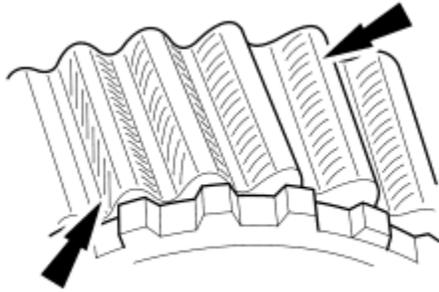
Gear Teeth Damaged by Spalling



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.

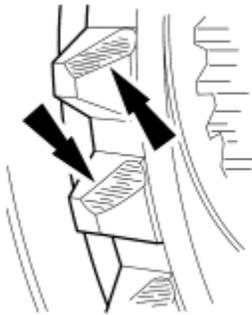
Overheating and Thermal Gear Deformation



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.

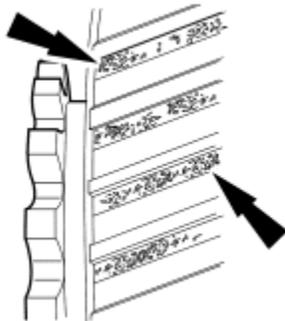
Gear Change Damage



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.

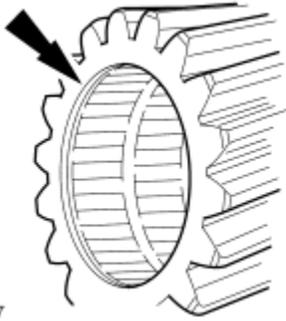
Gear Tooth Corrosion



A0011286

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

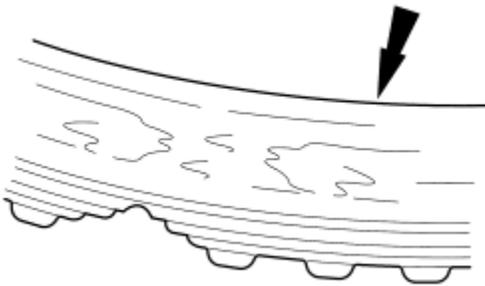
Idler Gear Damaged by Brinelling



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.

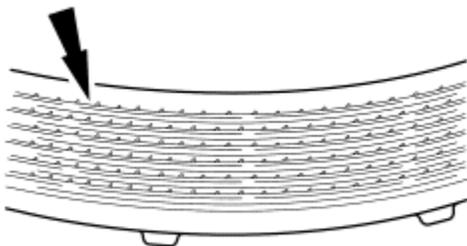
Synchronizer Ring Molybdenum Corrosion



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.

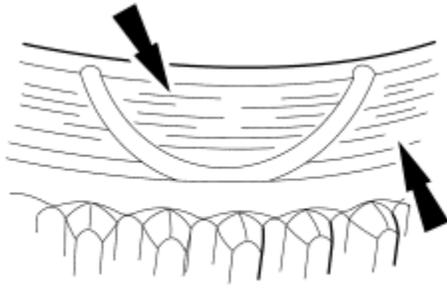
Synchronizer Ring Molybdenum Coat Destruction



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.

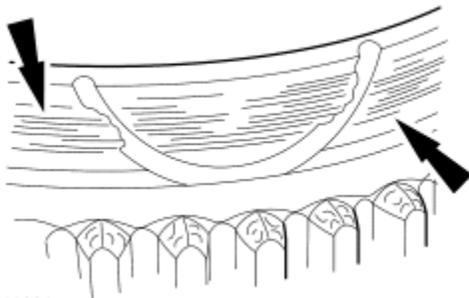
Synchronizer Friction Cone Slightly Worn



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.

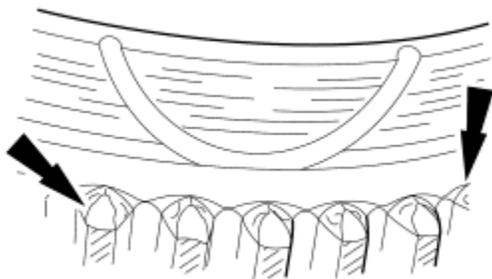
Synchronizer Friction Cone Worn with Material Displaced



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.

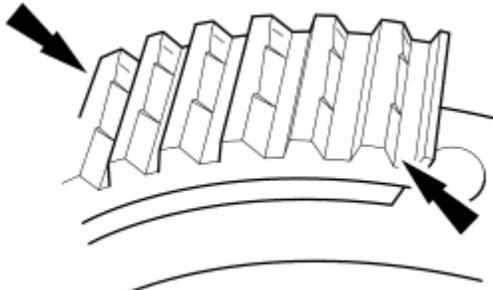
Synchronizer Gear Shift Teeth Worn



A0011292

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

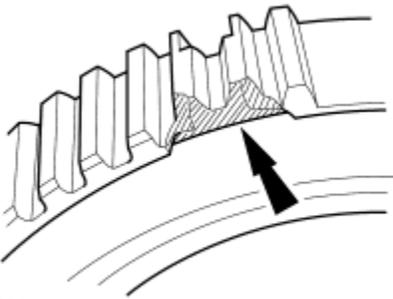
Synchronizer Body External Tooth Splines Worn



A0011293

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

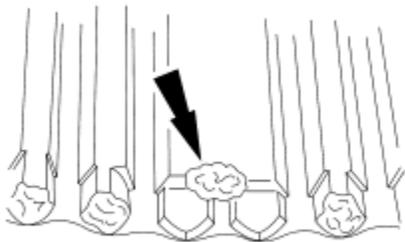
Synchronizer Body Stops Broken



A0011294

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

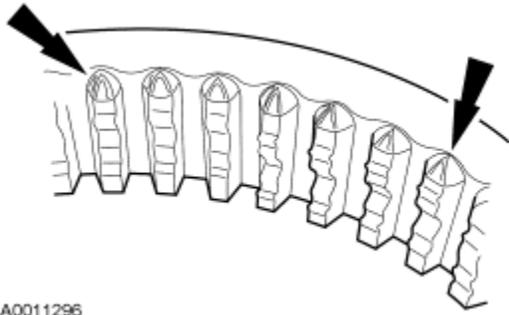
Synchronizer Sliding Sleeve Stop Deformed



A0011295

- 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.

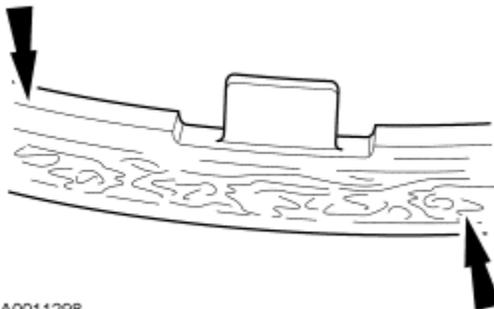
Synchronizer Inner Ring Heat Discolored with Slight Material Displacement



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.

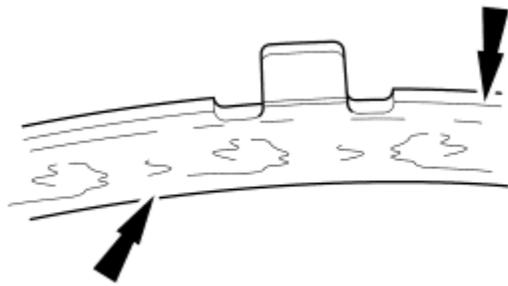
Synchronizer Inner Ring Material Displaced



A0011298

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

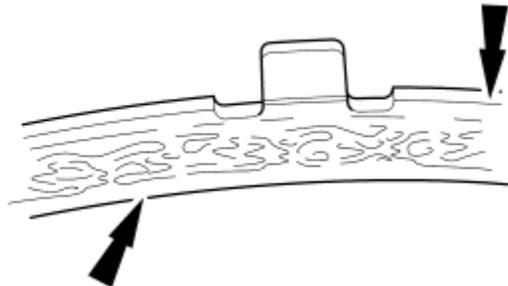
Synchronizer Outer Ring Heat Discolored



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.

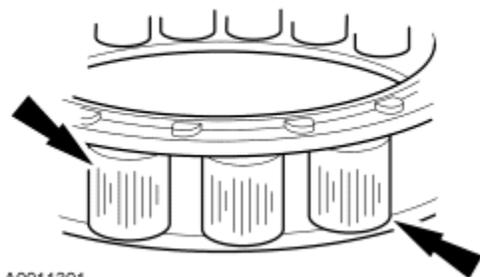
Synchronizer Outer Ring Material Displaced



A0011300

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

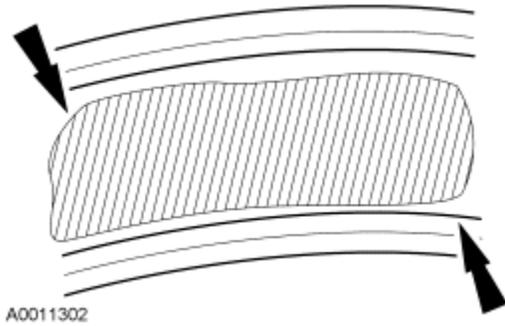
Bearing Worn with Subsequent Damage



A0011301

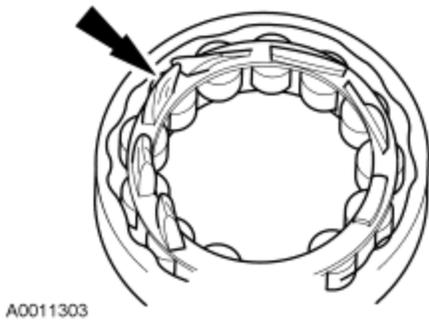
- The term describes grinding burrs on the races and the bearing components undergoing plastic deformation and some clip-off. The metallic particles this process creates give rise to abrasive wear. Additional consequences include the development of scoring and scratches, through to micro-pitting. The 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



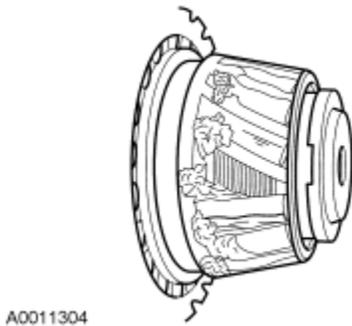
- The term describes a matte gray appearance to the race surface.

Bearing Collar Broken



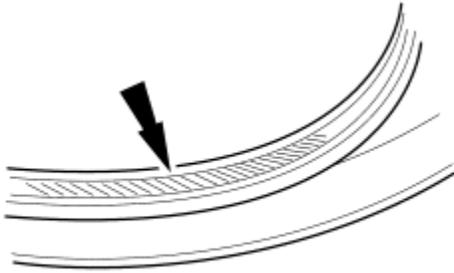
- The broken bearing collar is clearly visible.

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.

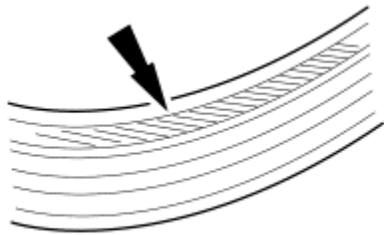
Sealing Element Radial Shaft Sealing Ring Damaged



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.

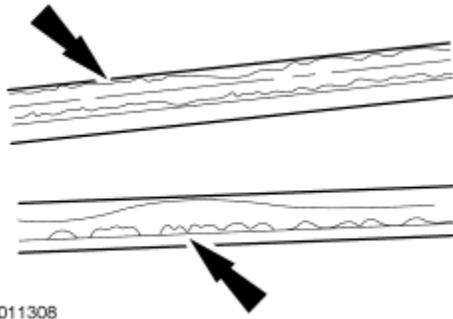
Sealing Element Rectangular/Lipped Sealing Ring Sheared



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.

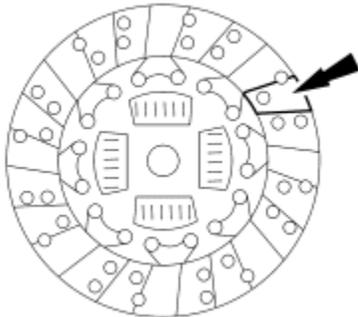
	<ul style="list-style-type: none"> • Vibration. 	<ul style="list-style-type: none"> • CORRECT the condition causing the vibration. REFER to Section 100-04 for NVH diagnosis.
	<ul style="list-style-type: none"> • High mileage. 	<ul style="list-style-type: none"> • REPAIR the transmission as necessary. 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

Clutch Disc Check

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

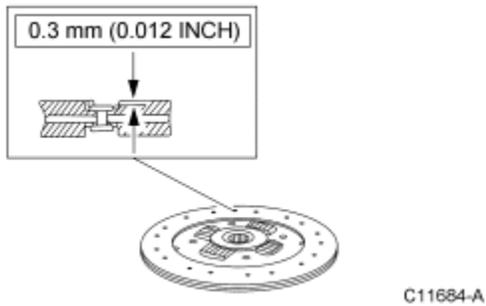
Inspect the clutch disc (7550) for:

- 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.

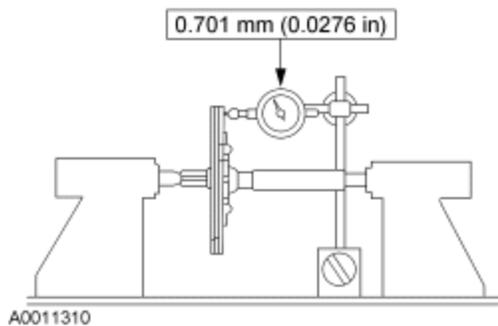


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2. Using a suitable slide caliper, measure the depth to the rivet heads.
 - Install a new clutch disc if the measurement is less than the specification.



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

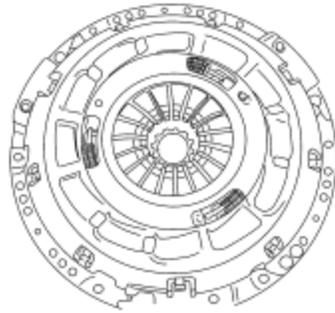
Clutch Pressure Plate Check

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.

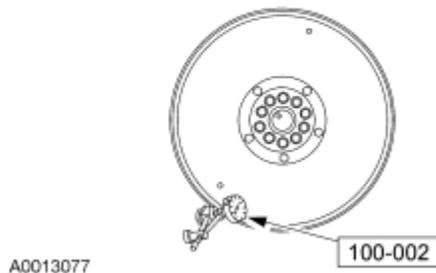
Using a suitable cleaning solution, clean the flywheel clutch surface.

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

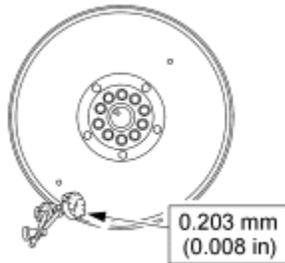
Special Tool(s)	
 ST1214-A	Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C) or equivalent

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.



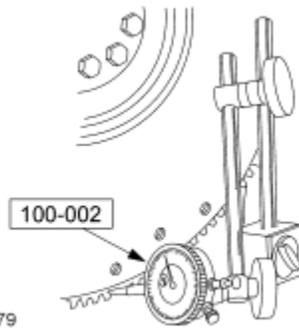
3. Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The flywheel TIR must not exceed the specification.
 - If the flywheel TIR does not exceed the specification, proceed to the next step in this procedure to check the ring gear runout.
 - If the flywheel TIR 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.



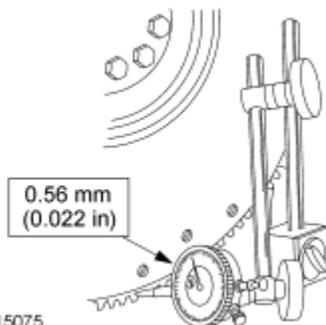
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4. Install the special tool against the ring gear face adjacent to the teeth. Zero the dial indicator.



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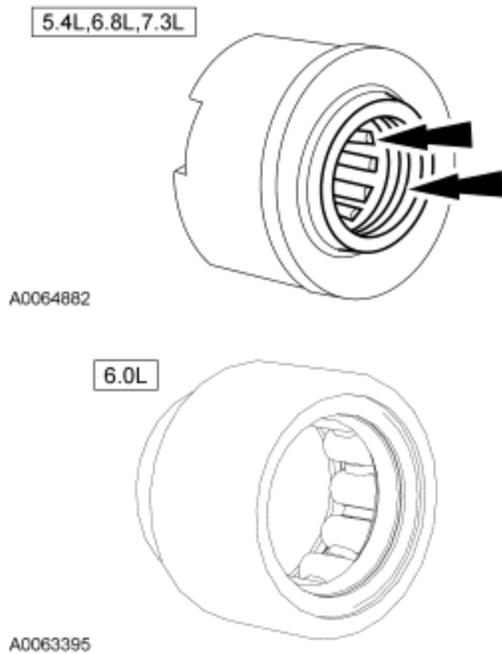
5. Turn the flywheel one complete revolution while observing the total indicator runout (TIR). The ring gear TIR must not exceed the specification.
 - If the ring gear TIR exceeds the specification, install a new flywheel and ring gear assembly.



A0015075

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](#).

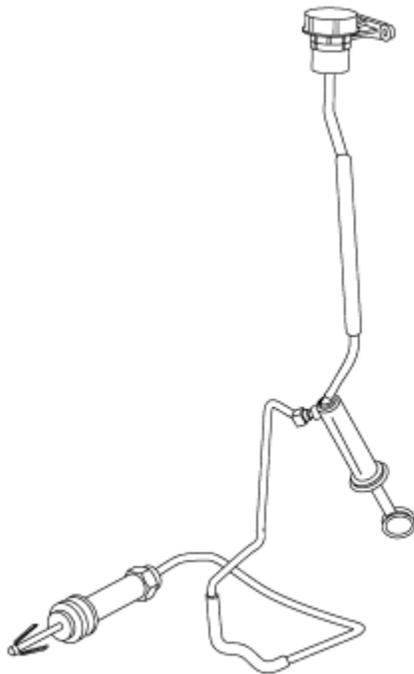


Clutch Cylinder Bench Bleeding

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

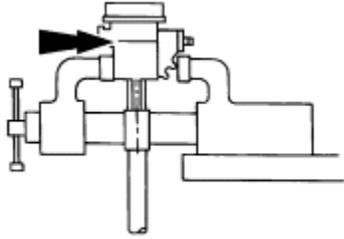
1.  **CAUTION:** So as not to trap air in the clutch hydraulic system, fill any disconnected component (such as master cylinder, slave cylinder) with the specified brake fluid before connecting it.

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.

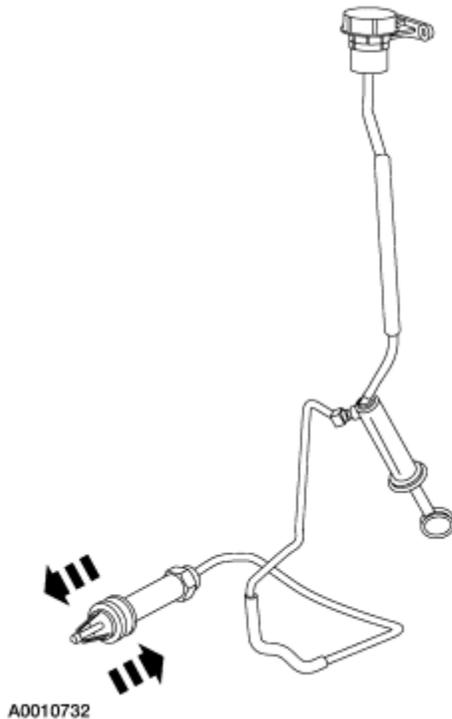


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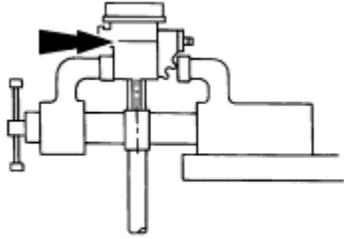
3.  **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**

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

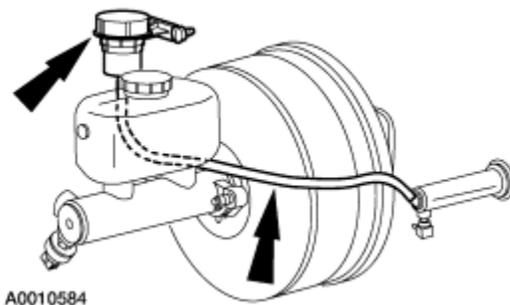
GENERAL PROCEDURES

Procedure revision date:
01/26/2000

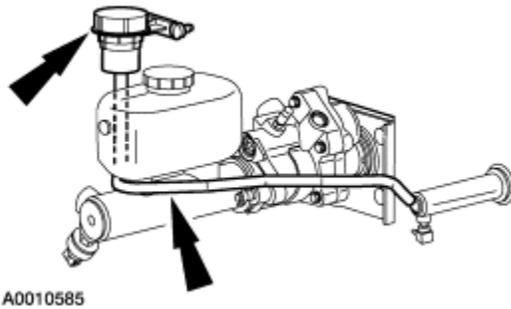
Clutch System Bleeding—In-Vehicle

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

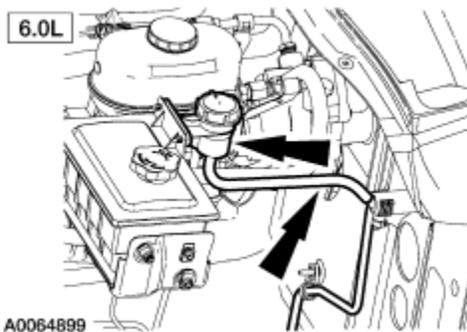
1. Fill the clutch master cylinder reservoir to the full line with DOT 3 Brake Fluid.
2. Verify that the reservoir-to-master cylinder tube routing is as shown so as not to trap air in the clutch hydraulic system. Correct the routing as necessary.
 - The routing for vacuum boost brakes and hydraboost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



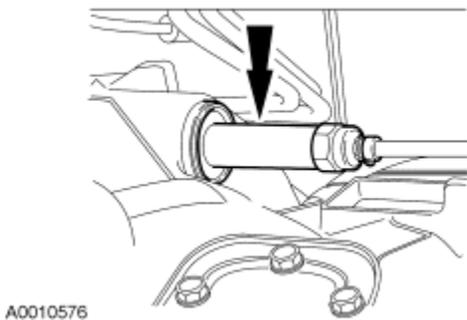
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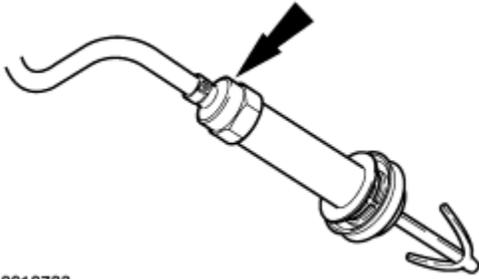
3. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).



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.

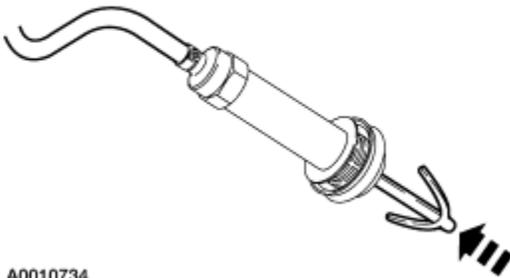


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7.  **CAUTION: Do not allow the clutch master cylinder reservoir to run dry.**

Purge the air from the clutch hydraulic system.

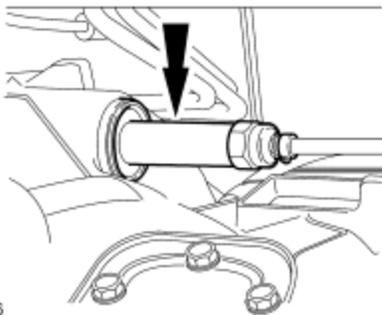
- Push the push rod slowly into the slave cylinder until it bottoms out the piston. Hold the push rod in this position for five to ten seconds to allow all trapped air to rise through the system. Very slowly, so that air is not drawn back into the slave cylinder, release the push rod (the spring in the 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

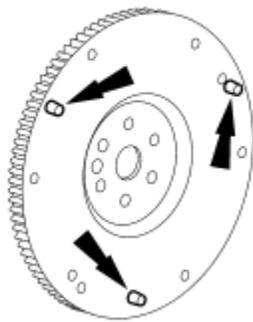
Clutch Pressure Plate Locating Dowels

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.**

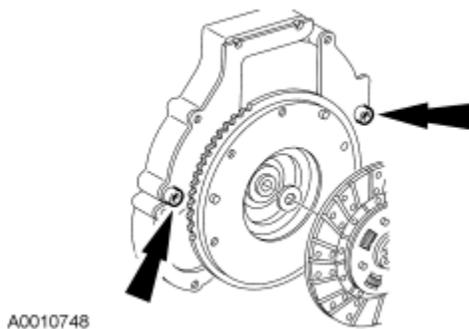
Using a brass or plastic mallet, drive the dowels squarely into place until fully seated in the bore.

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

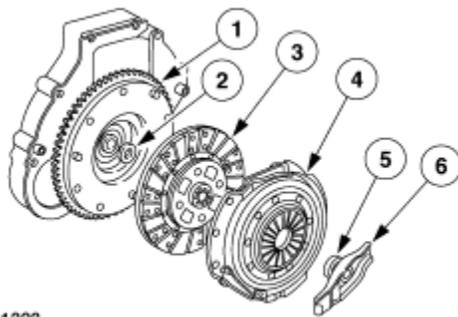
Lining material (7.3L Diesel)	F808 MCC woven non-asbestos
Lubricant	
High-Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A	ESA-M1C198-A

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



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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

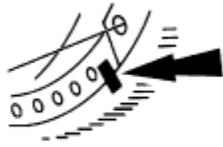
Refer to [Section 308-00](#).

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

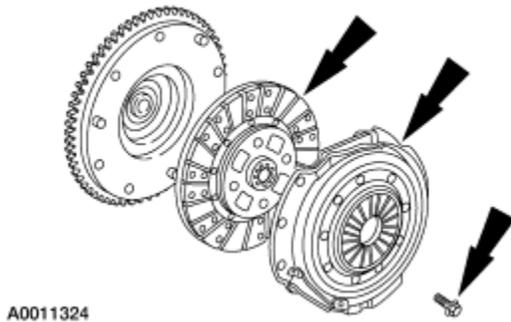
Removal

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.**

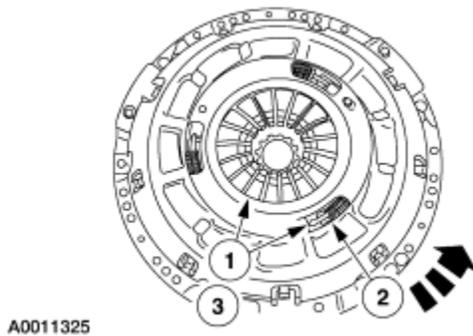
Lubricate the transmission input shaft pilot bearing, as necessary.

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

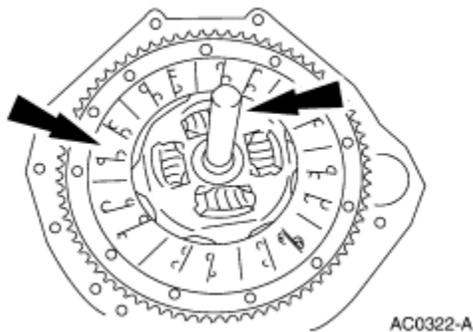
2.  **CAUTION: When installing the original clutch pressure plate on 5.4L and 6.8L applications, reset the wear indicator before installing the clutch pressure plate on the flywheel.**

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.

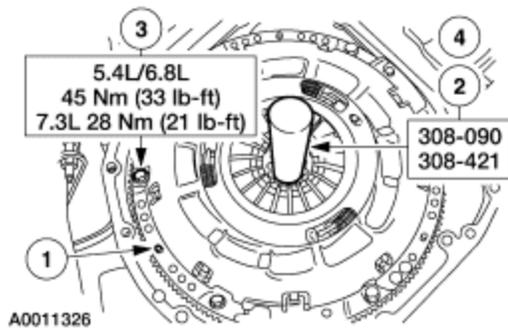


4. **NOTE:** Align the index marks if installing the original clutch pressure plate and flywheel.

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

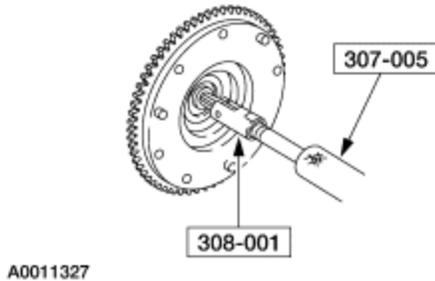
1999 F-Super Duty 250-550 Workshop Manual
[Procedure revision date: 01/26/2000](#)

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.

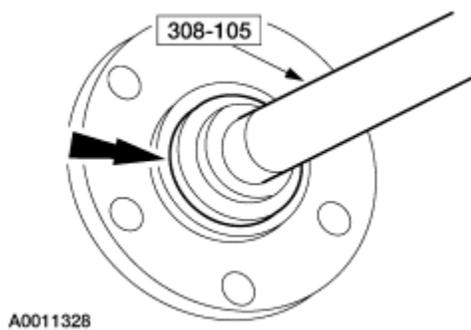


Installation

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.

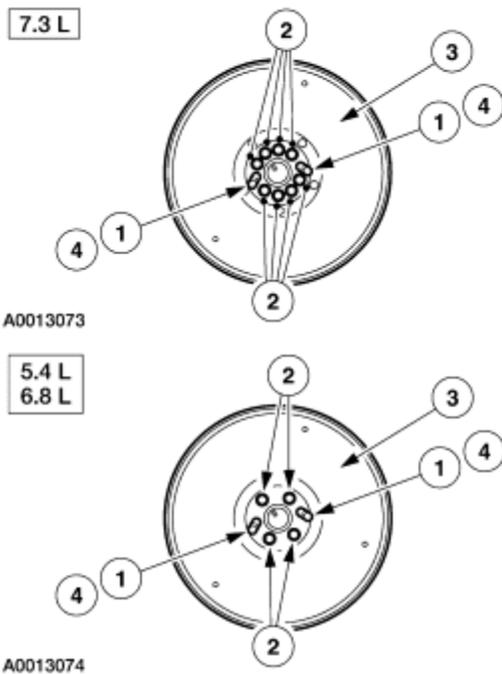
Using a soft-face hammer and the special tool, install the new transmission input shaft pilot bearing.



Flywheel

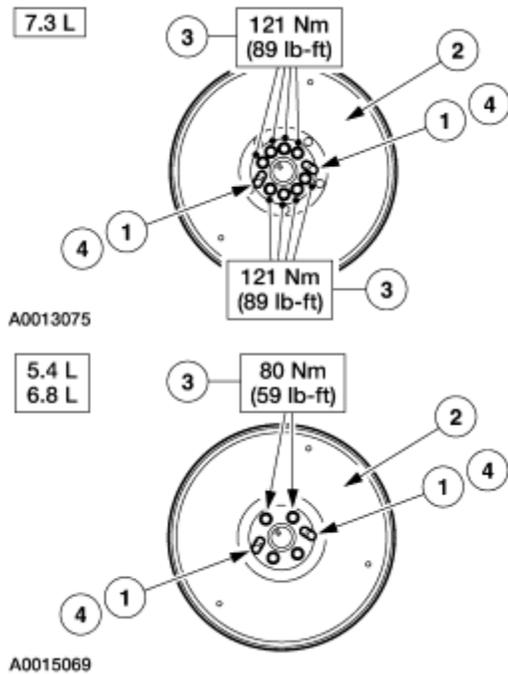
Removal

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.

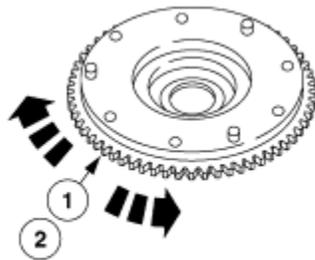
 **CAUTION:** Do not heat the flywheel ring gear above 278°C (500°F). Use heat indicating crayons to prevent overheating.

 **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.

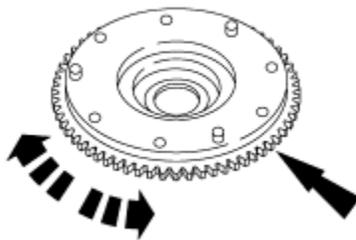
Heat the entire flywheel ring gear evenly.

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

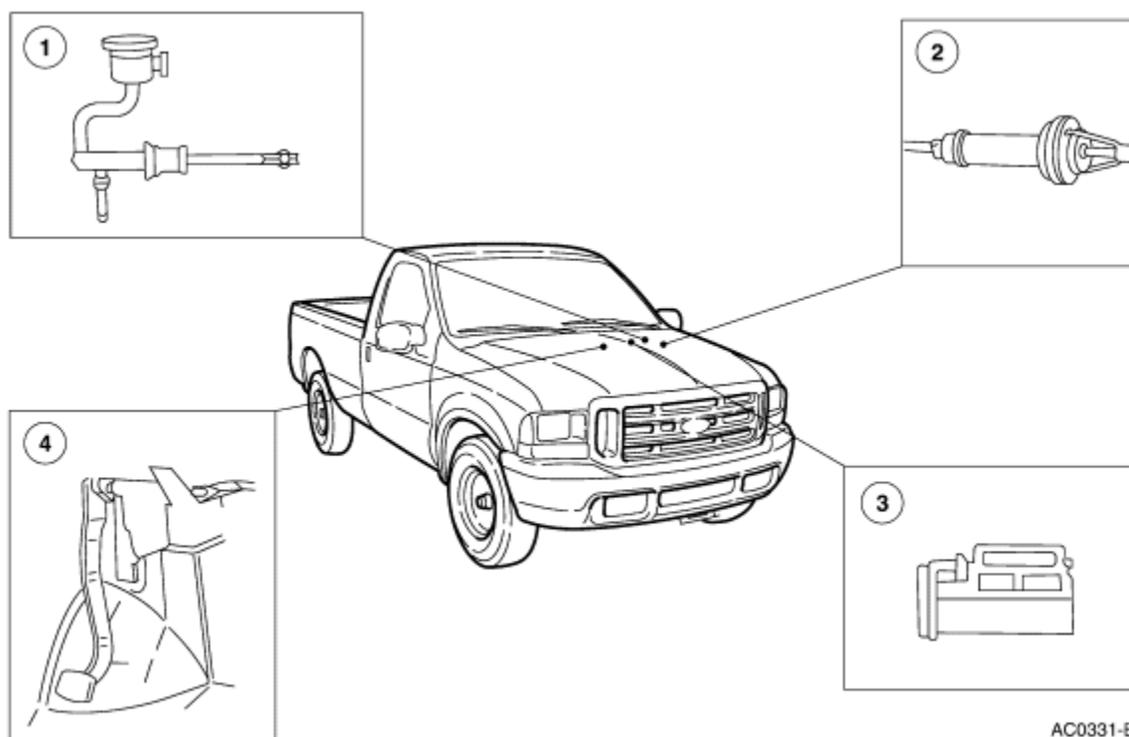
Torque Specifications

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](#).

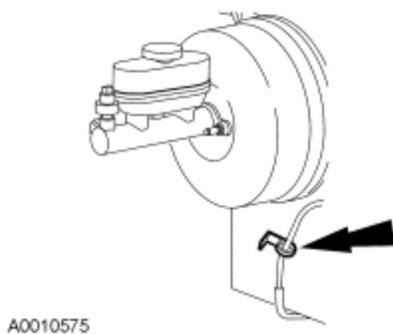
SECTION 308-02: Clutch Controls
REMOVAL AND INSTALLATION

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

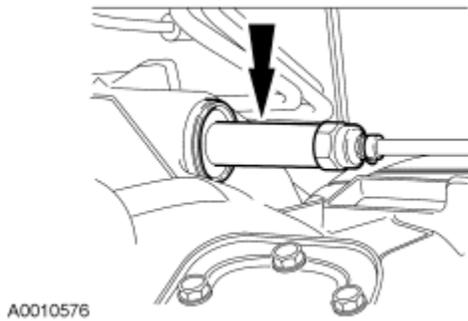
Clutch Pedal

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.

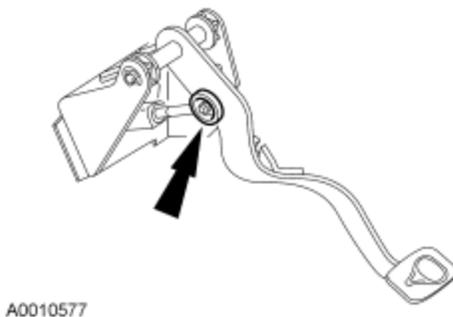


4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.

5. Lower the vehicle.

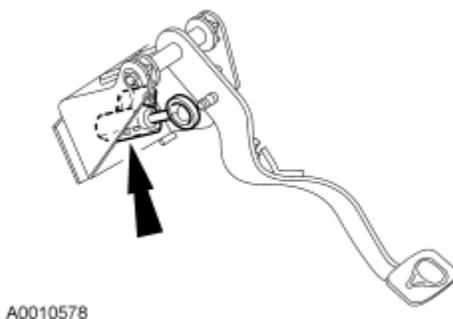
6.  **WARNING: The clutch pedal is under spring tension.**

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

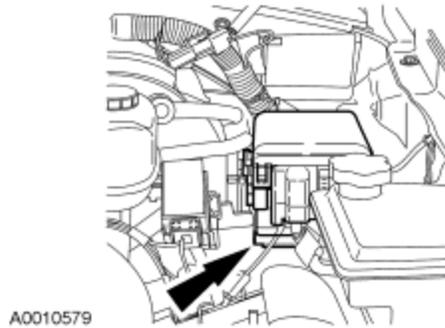


7. Remove and discard the push rod bushing (7526).

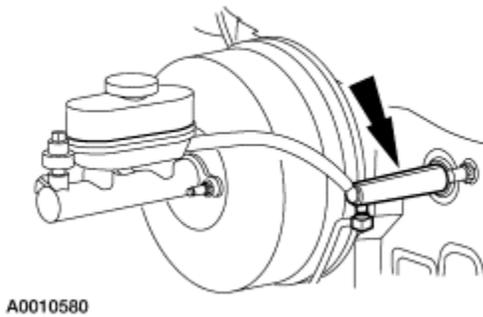
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



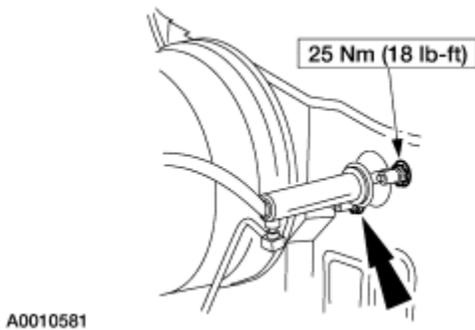
9. Separate the power distribution box from the bracket to gain access to the clutch master cylinder.



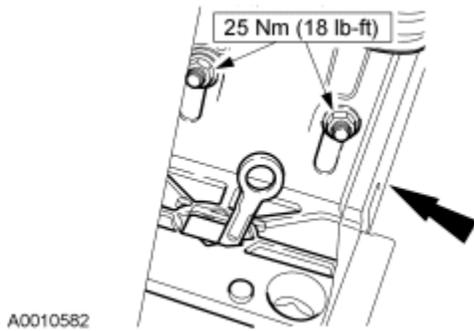
10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
- Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.



11. Remove the nuts.



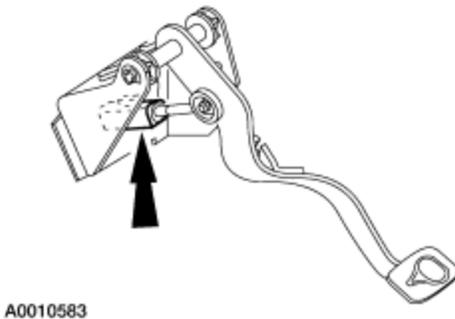
12. Remove the nuts and the clutch pedal and support bracket.



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.

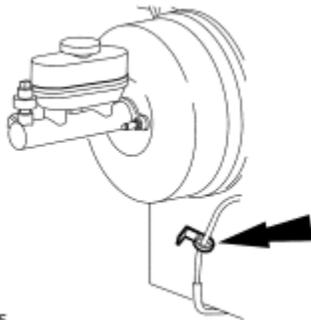


Clutch Master Cylinder and Reservoir

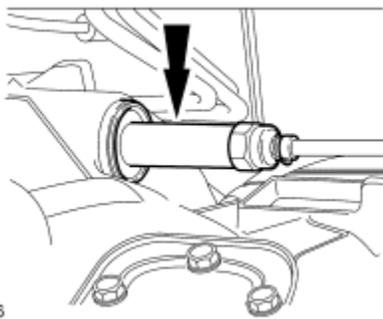
Removal

 **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.

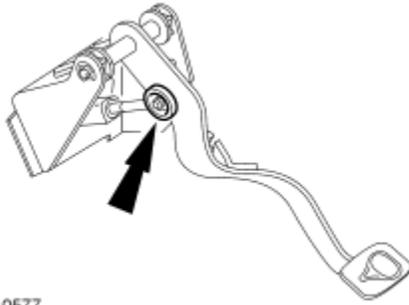


2. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
3. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



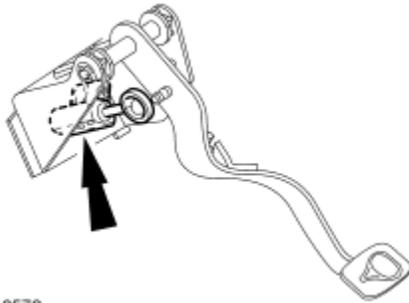
4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.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



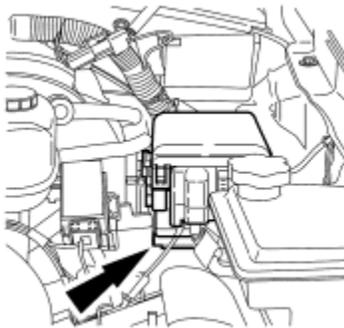
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7. Remove and discard the push rod bushing (7526).
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



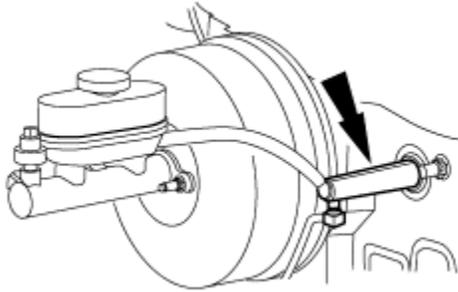
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9. Separate the power distribution box from the bracket to gain access to the clutch master cylinder.



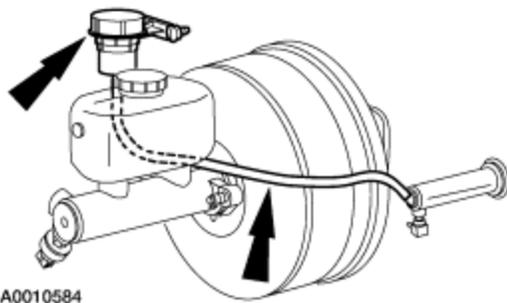
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10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
 - Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.

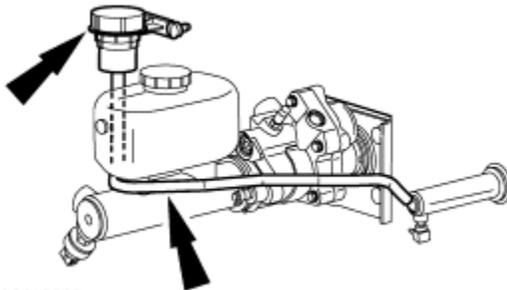


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11. Remove the clutch hydraulic reservoir from the wiring tray and separate the clutch hydraulic tube from the brake master cylinder assembly. Position the clutch hydraulic reservoir aside.



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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.



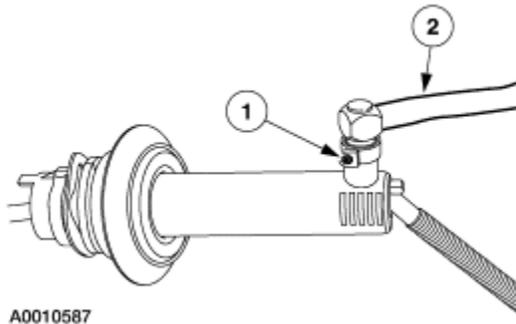
A0010586

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.



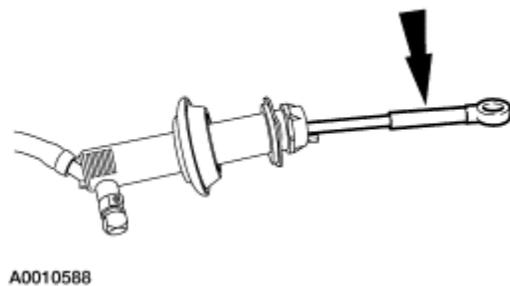
15. **NOTE:** Sometimes the O-ring seal will remain inside the clutch master cylinder.

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.

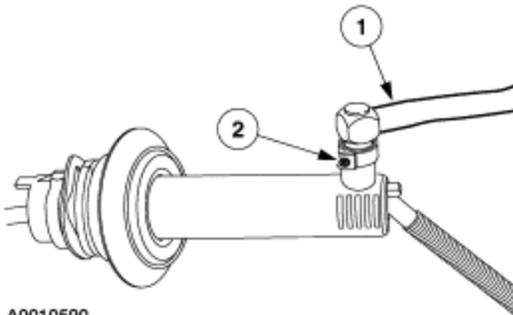


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3.  **CAUTION: Do not let the reservoir run dry.**

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.

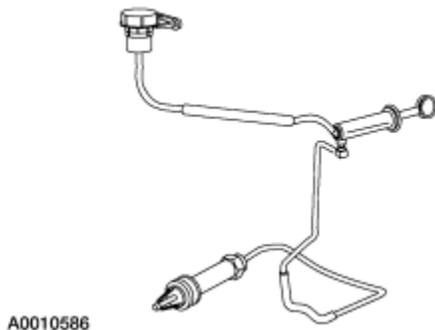


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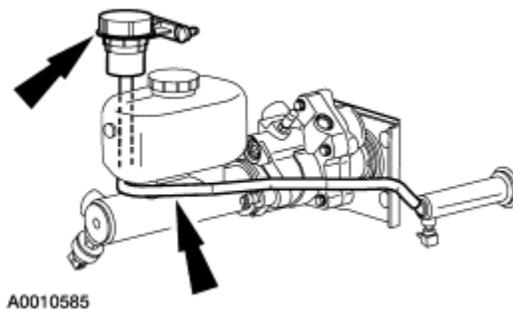
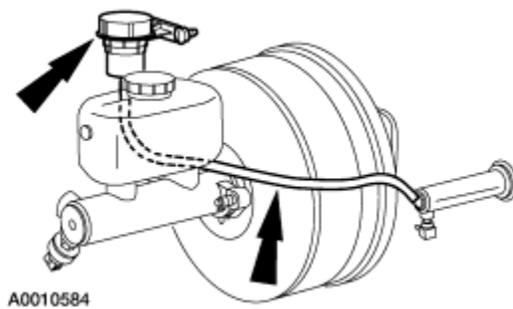
6. Bench bleed the clutch hydraulic system. For additional information, refer to [Section 308-00](#).

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.**

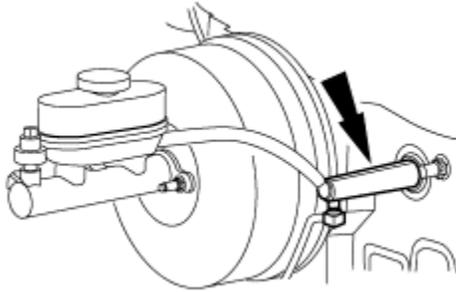
Position the clutch hydraulic system in the vehicle.



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

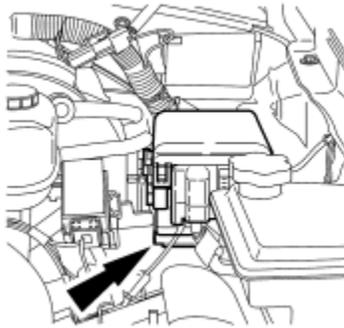


9. Install the clutch master cylinder.
- Compress and twist the clutch master cylinder counterclockwise 45 degrees to lock it to the clutch pedal and support bracket.



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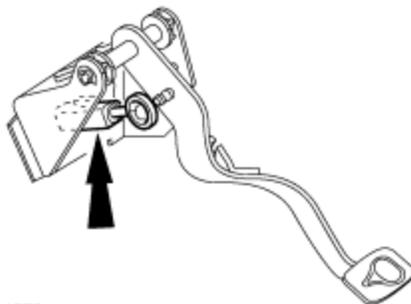
10. Seat the clutch master cylinder rubber seal to the bulkhead.
11. Route the clutch master cylinder-to-slave cylinder hydraulic tube under the brake booster reservoir.
12. Connect the power distribution box to the bracket.



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.

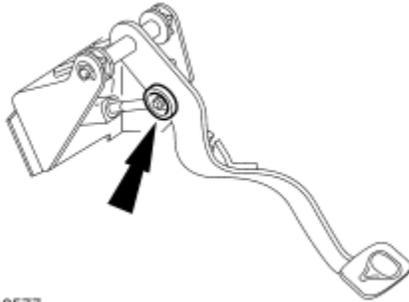


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14. Install the new push rod bushing.

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

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



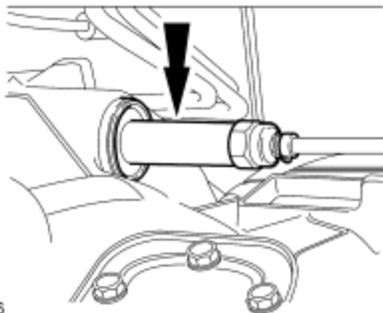
A0010577

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.

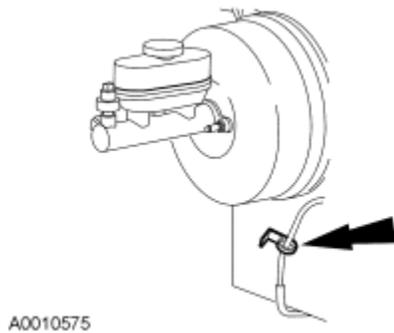


A0010576

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.

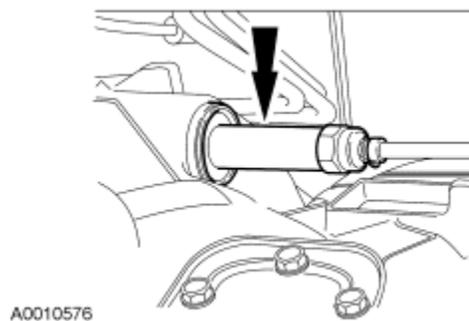
SECTION 308-02: Clutch Controls
REMOVAL AND INSTALLATION

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

Clutch Slave Cylinder

Removal

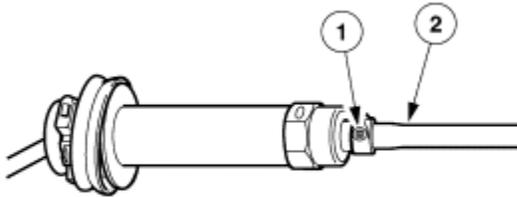
1. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
2. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.



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.

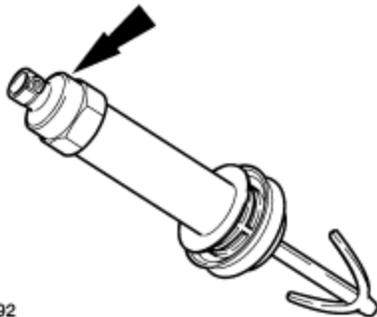
Remove the O-ring seal from the end of the hydraulic tube, and discard it. Cap the open end of the hydraulic tube.

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.

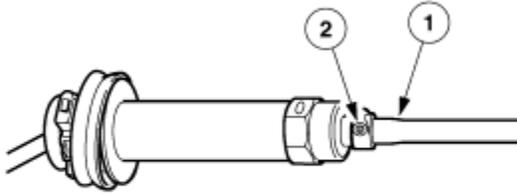
- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.



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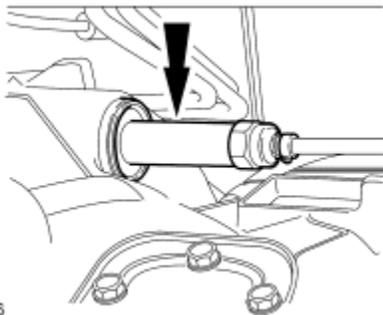
2. Remove the cap from the opening in the hydraulic tube. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
 - Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.
3. Connect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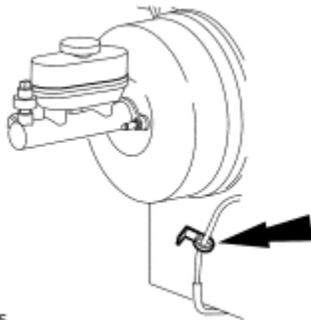
6. Lower the vehicle.
7. Test the system for normal operation.

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

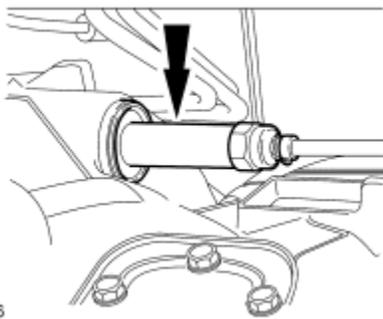
Removal

⚠ 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.

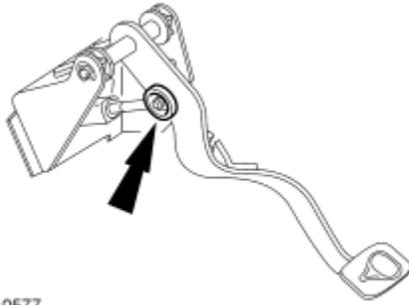


2. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
3. Unlock and remove the slave cylinder (7A564) from the transmission.
 - Compress and twist the slave cylinder to unlock it from the transmission.

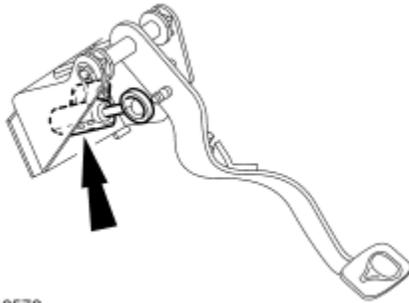


4. Disconnect the clutch hydraulic tube from the floor pan clip. Position the slave cylinder and hydraulic tube forward below the left engine bank. This will make it easier to unlock the clutch master cylinder from the clutch pedal and support bracket (7B633) by reducing tension on the hydraulic tube.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

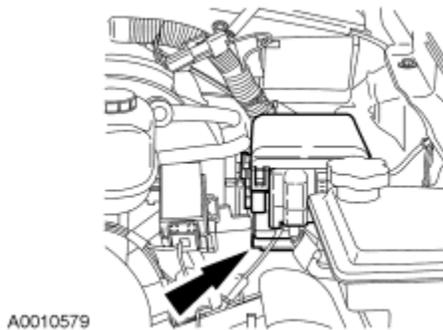
Unlock the push rod bushing retaining clips and separate the clutch master cylinder push rod from the clutch pedal.



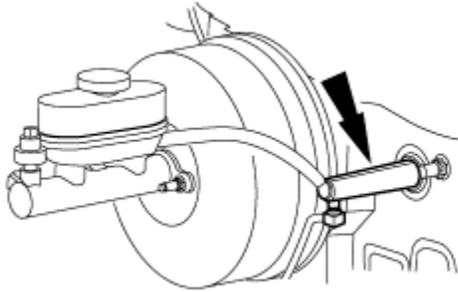
7. Remove and discard the push rod bushing (7526).
8. Remove the switch cover, and remove the clutch pedal position switch (7C534) from the clutch master cylinder push rod.



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

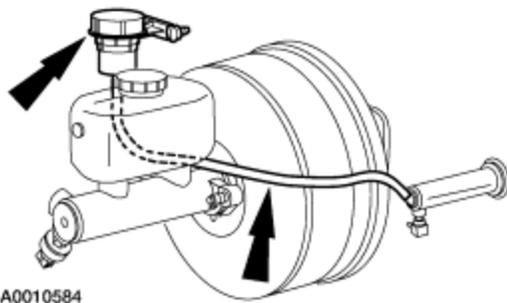


10. Unlock and remove the clutch master cylinder from the clutch pedal and support bracket.
 - Compress and twist the clutch master cylinder clockwise 45 degrees to unlock it from the clutch pedal and support bracket.

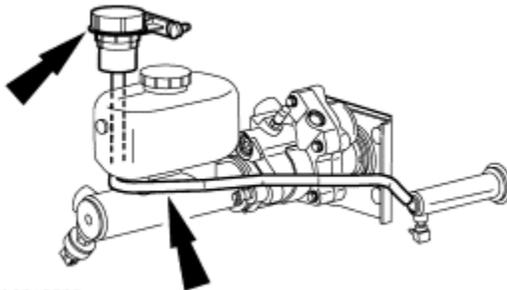


A0010580

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.



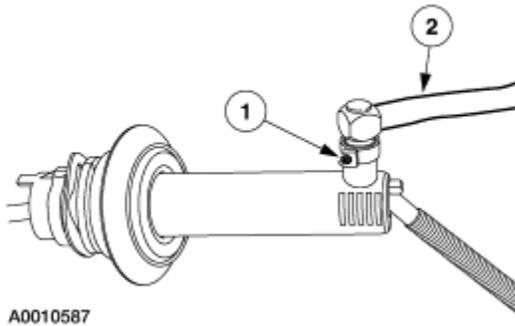
A0010586

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.

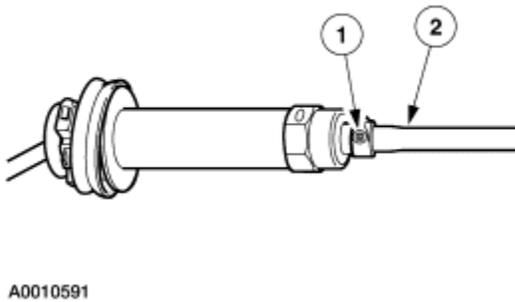
1. Using a 3/32-inch punch and a hammer, drive out the roll pin, and discard it.
2. Disconnect the hydraulic tube from the clutch master cylinder.



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.

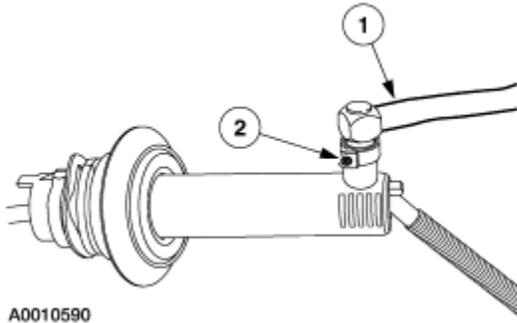


16. **NOTE:** Sometimes the O-ring seals will remain inside the clutch master cylinder and the slave cylinder.

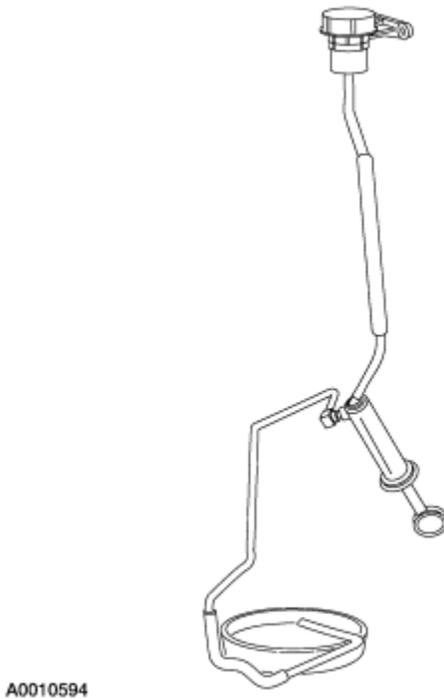
Remove and discard the O-ring seals.

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.**

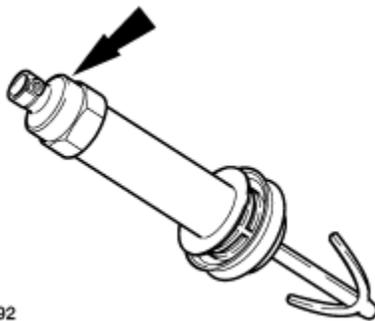
Purge the air from the clutch master cylinder assembly (7C522) and hydraulic tube. Cap the open end of the tube after purging the system of air.

- 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.**

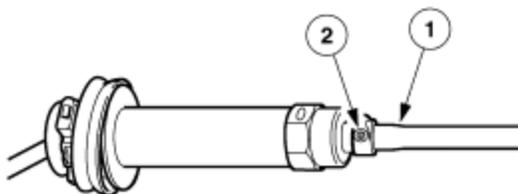
Angle the slave cylinder so that the hydraulic tube connection port is above the push rod. Fill the slave cylinder with DOT 3 brake fluid

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



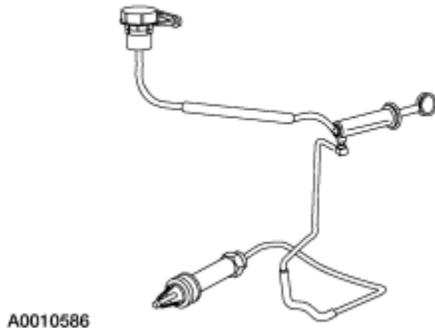
6. Remove the cap from the opening in the hydraulic tube. Position the new O-ring seal on the end of the hydraulic tube. Coat the O-ring seal with DOT 3 Brake Fluid.
- Use Ford High Performance DOT 3 Motor Vehicle Brake Fluid C6AZ-19542-AB or equivalent meeting Ford specification ESA-M6C25-A.

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.

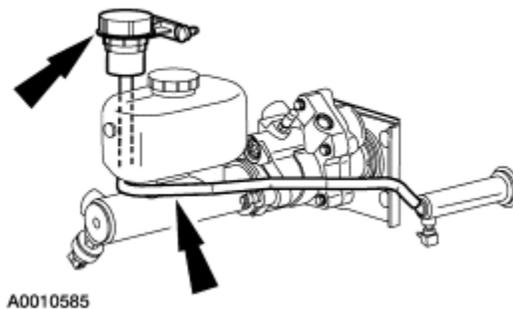
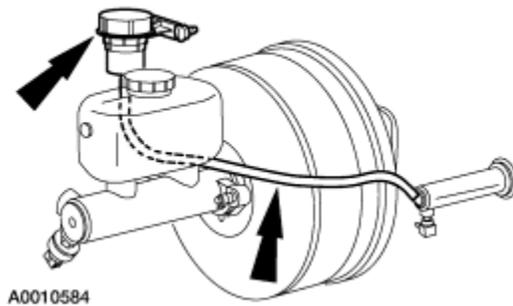


8. Bench bleed the clutch hydraulic system. For additional information, refer to [Section 308-00](#).
9.  **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, wash the surface with water immediately.**

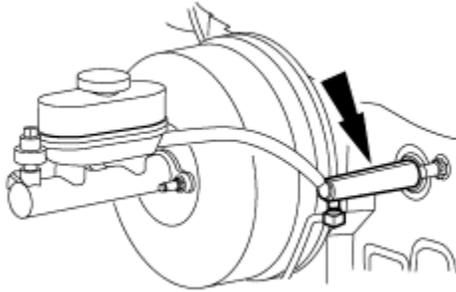
Position the clutch hydraulic system in the vehicle.



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

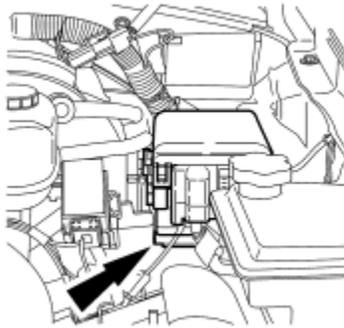


11. Install the clutch master cylinder.
 - Compress and twist the clutch master cylinder counterclockwise 45 degrees to lock it to the clutch pedal and support bracket.



A0010580

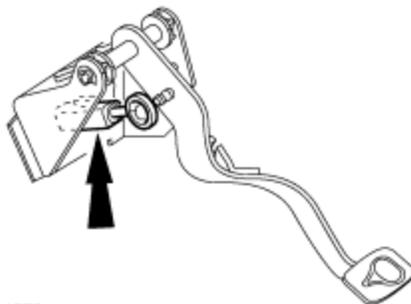
12. Seat the clutch master cylinder rubber seal to the bulkhead.
13. Route the clutch master cylinder-to-slave cylinder hydraulic tube under the brake booster reservoir.
14. Connect the power distribution box to the bracket.



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.

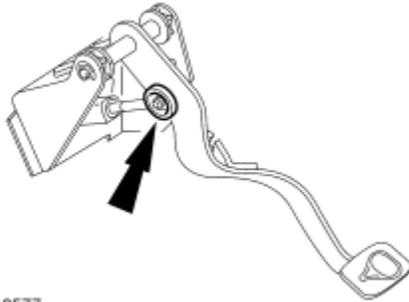


A0011873

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.



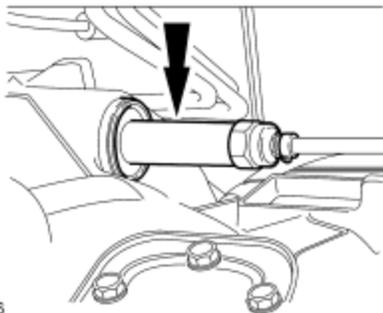
A0010577

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.

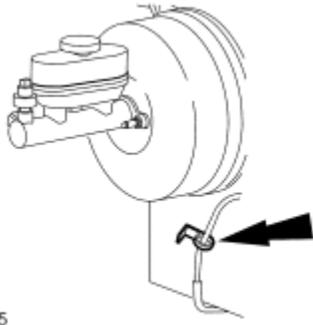


A0010576

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:

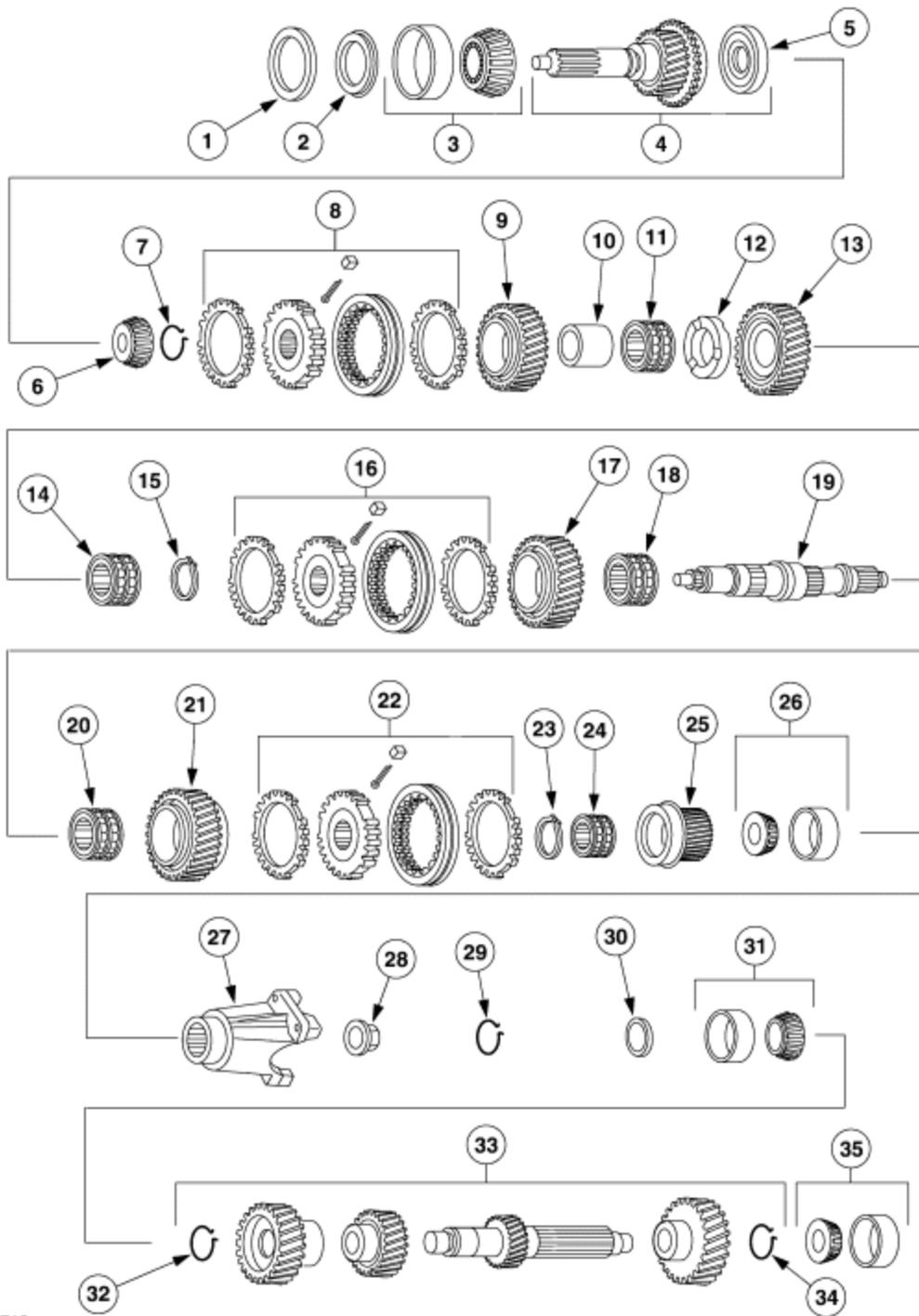
- First 5.72:1
- Second 2.94:1
- Third 1.61:1
- Fourth 1.00:1
- Fifth 0.76:1
- Reverse 5.24:1

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

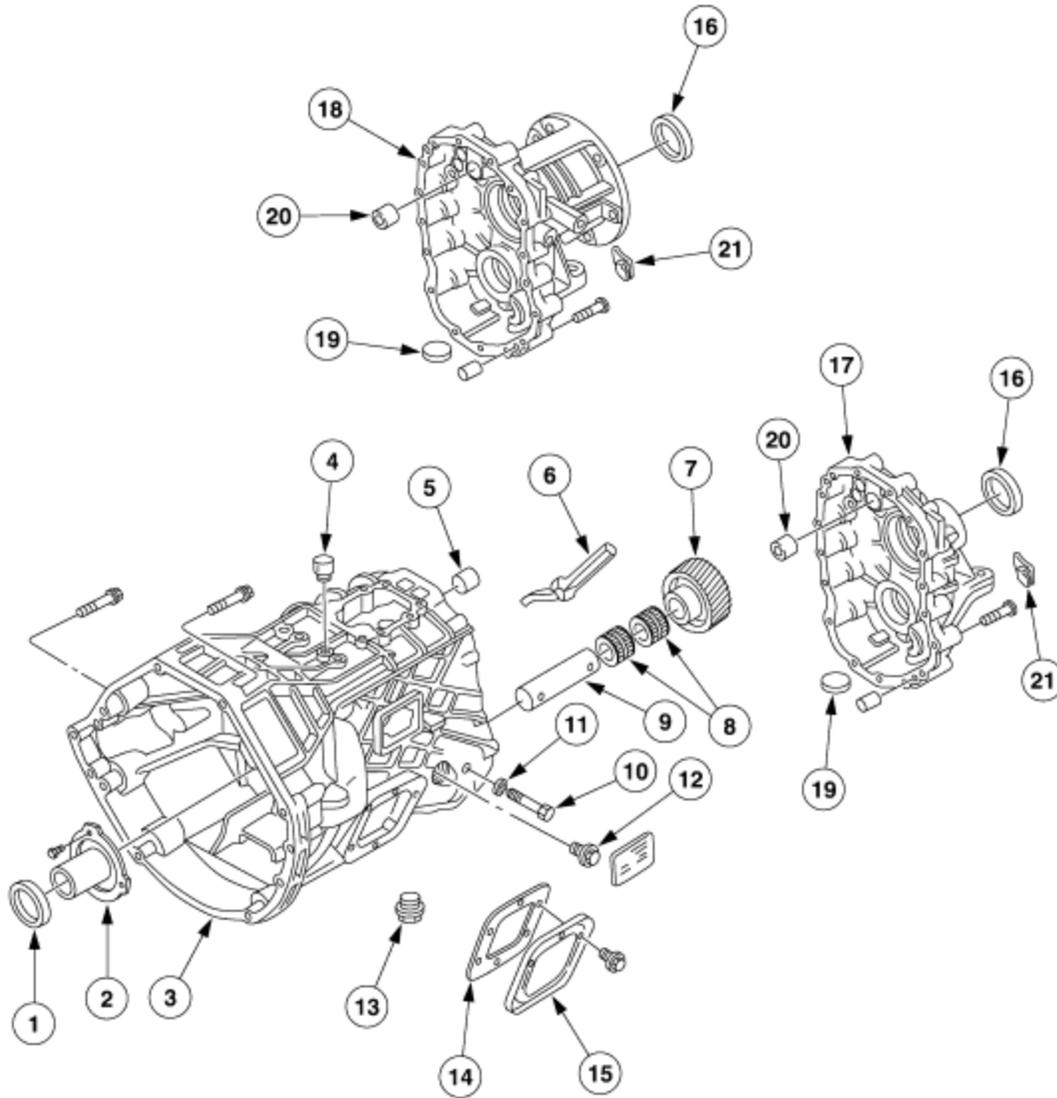


A0026710

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

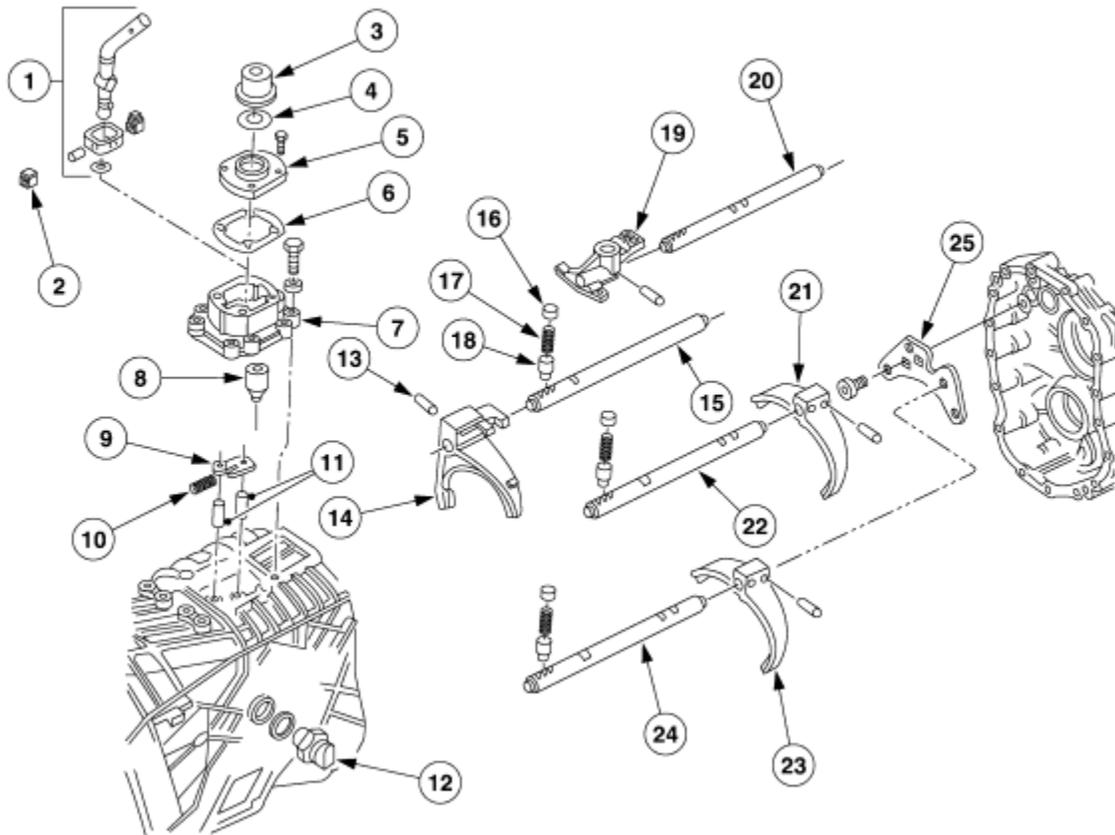


A0015363

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:

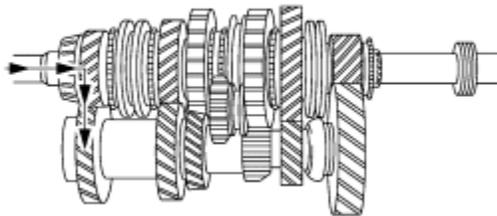
- Maintain the correct fluid level by inspecting it regularly.
- Change the fluid at recommended intervals. For additional information, refer to the Owners Literature for the recommended intervals.

- 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

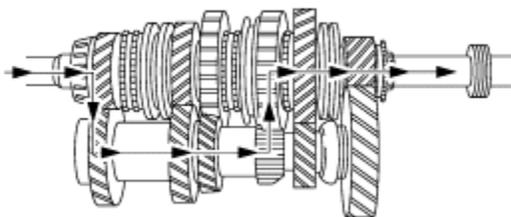
Powerflow in Neutral



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

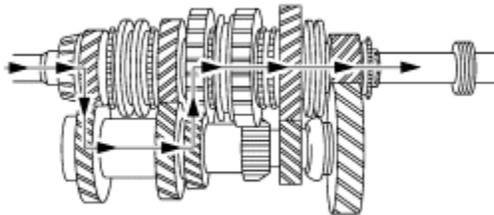


A0015364

- 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.

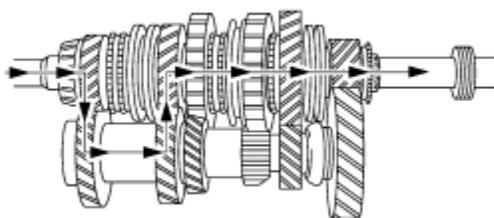
Powerflow in 2nd Gear



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.

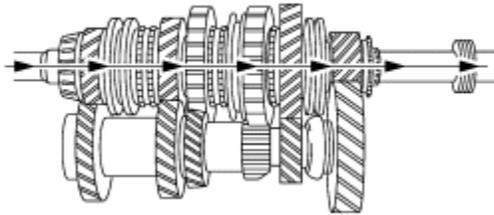
Powerflow in 3rd Gear



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.

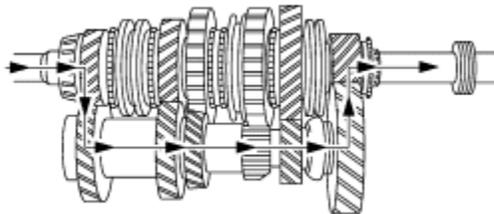
Powerflow in 4th Gear



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.

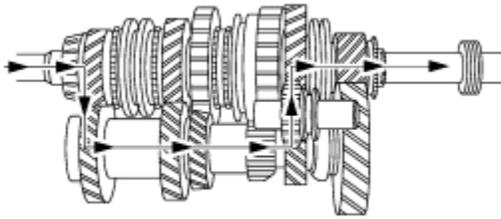
Powerflow in 5th Gear



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

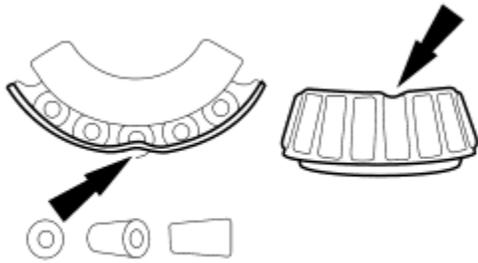
Refer to [Section 308-00](#).

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.



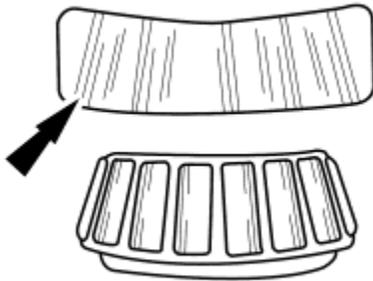
C11911-A

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.



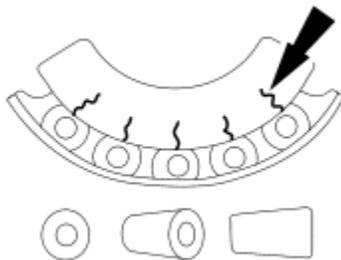
C11912-A

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



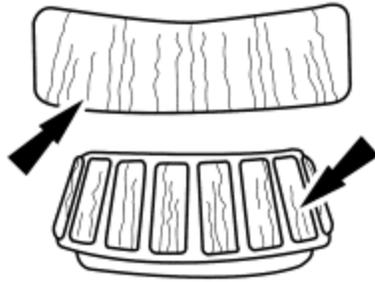
C11913-A

4. Inspect bearing for cracked inner race.



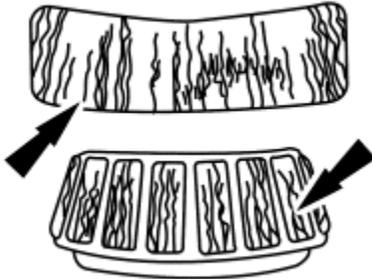
C11914-A

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



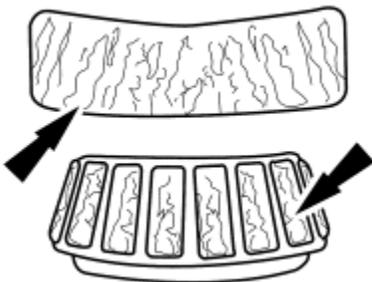
C11915-A

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.



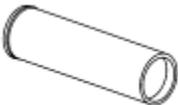
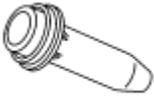
C11916-A

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



C11917-A

Seal—Rear

Special Tool(s)	
 <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>ST2142-A</p>	<p>Remover, Output Shaft Oil Seal 308-129 (T87T-7025-CH)</p>
 <p>ST1304-A</p>	<p>Screw, Bearing Removal Tube 308-092 (T84T-7025-B)</p>
 <p>ST2371-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</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>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>

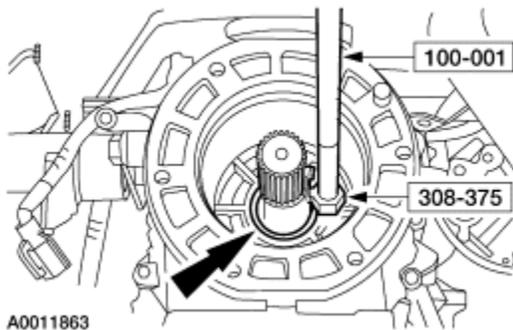
Removal

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](#).

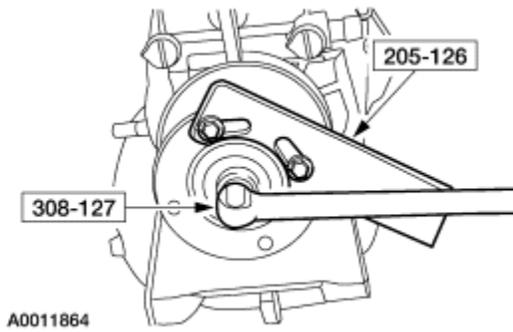
Vehicles with 4-wheel drive

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.

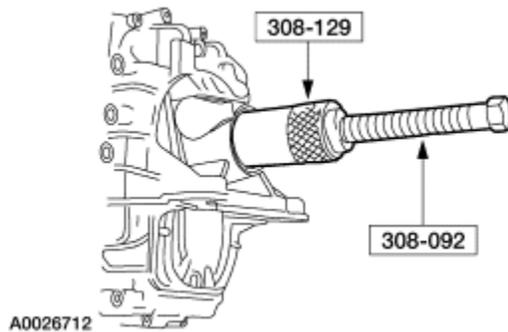


Vehicles with 2-wheel drive

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



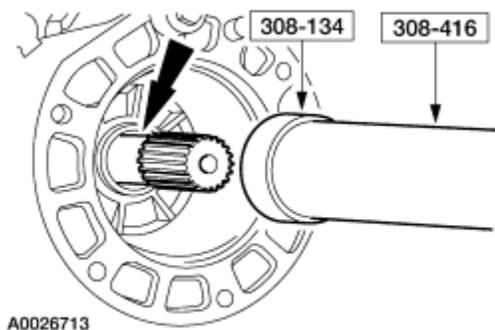
- Using the special tools, remove and discard the output oil seal.



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®.

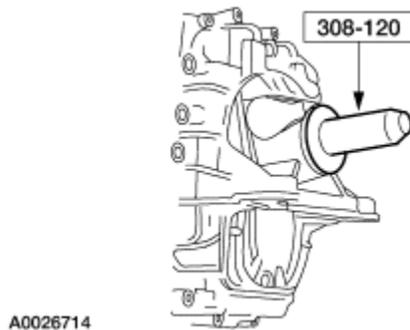


- Install the transfer case. For additional information, refer to [Section 308-07B](#).

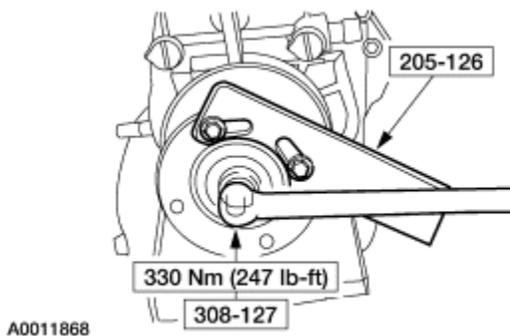
Vehicles with 2-wheel drive

- 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.



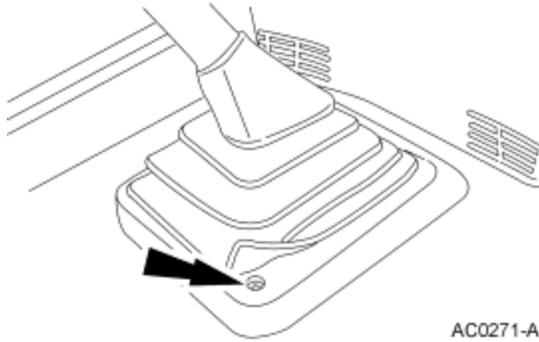
All vehicles

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

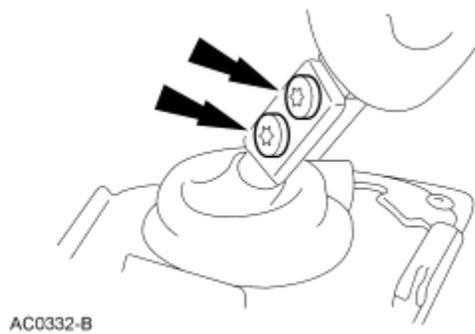
Shift Lever and Boot

Removal

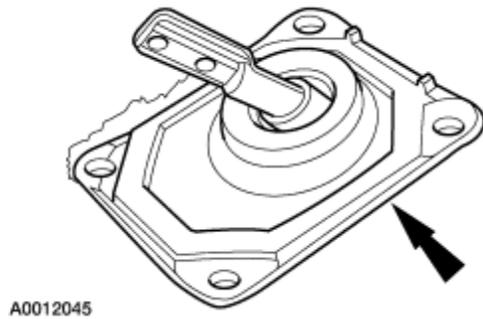
1. Remove the four screws and the gearshift lever boot.



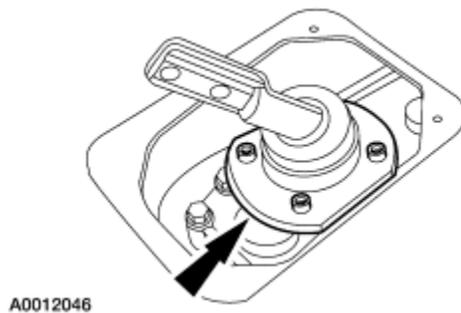
2. Remove the upper gearshift lever.



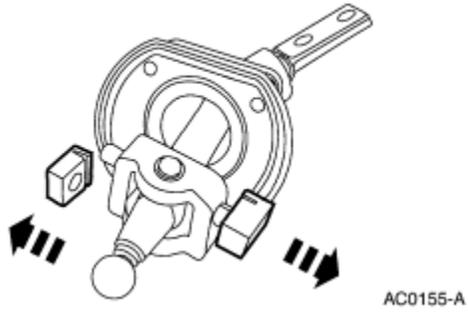
3. Remove the gearshift lever upper boot.



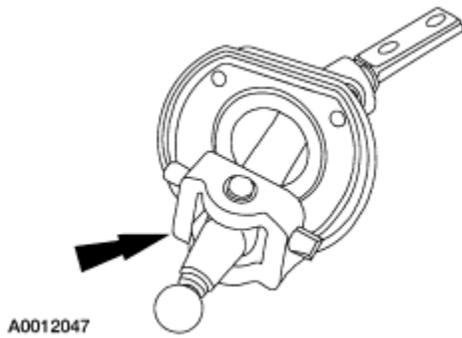
4. Remove the four bolts and the lower gearshift lever. Discard the gasket.



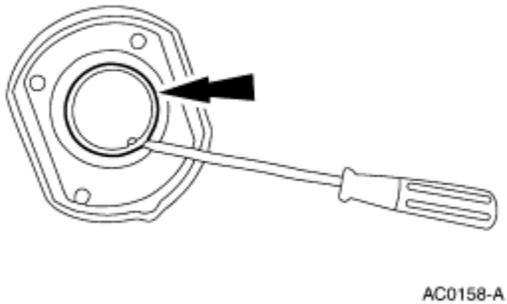
5. Remove the gearshift lever blocks.



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

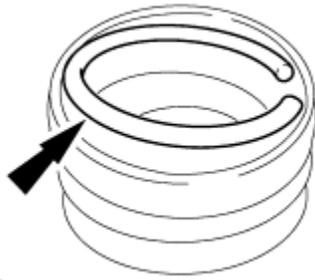


7. Remove the snap ring and the lower gearshift lever boot.



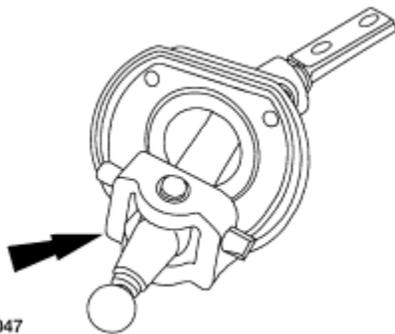
Installation

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



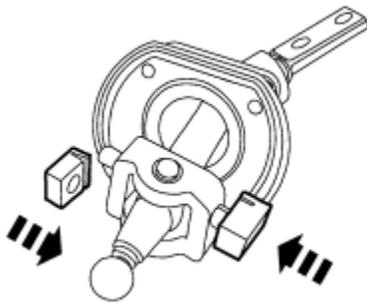
A0011870

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



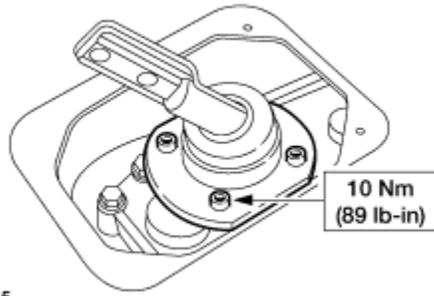
A0012047

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



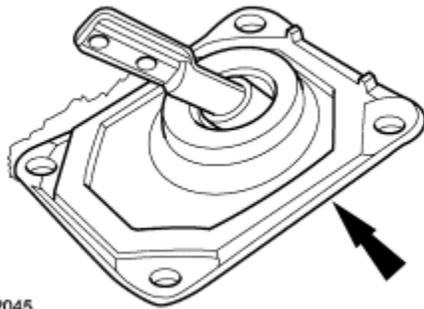
AC0159-A

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



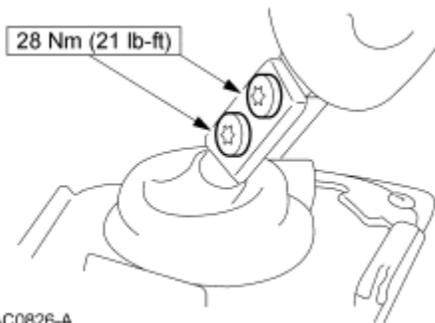
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6. Install the upper gearshift lever boot.



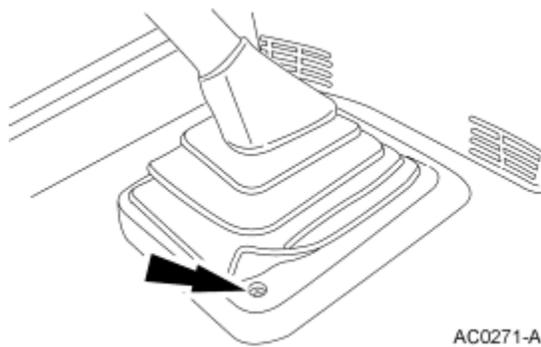
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7. Install the upper gearshift lever.



AC0826-A

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

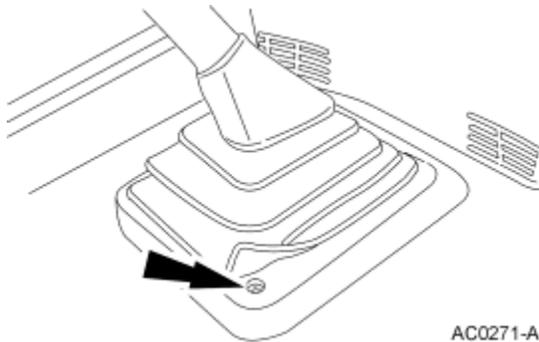


AC0271-A

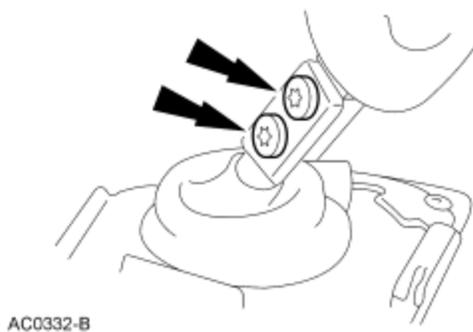
Transmission

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

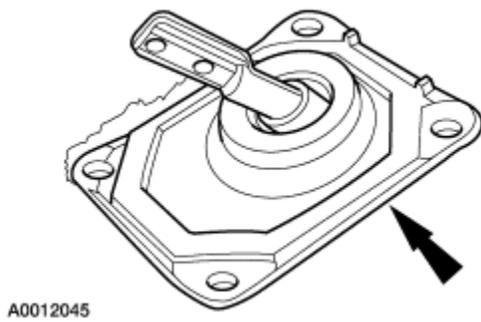
1. Disconnect the battery ground cable.
2. Remove the four screws and the shift lever boot.



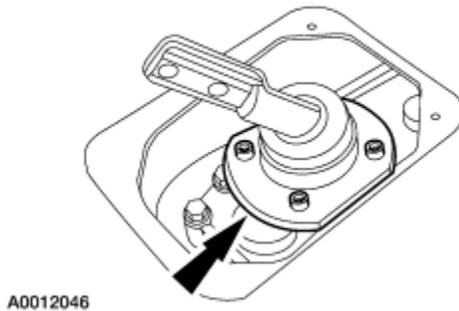
3. Remove the upper gearshift lever.



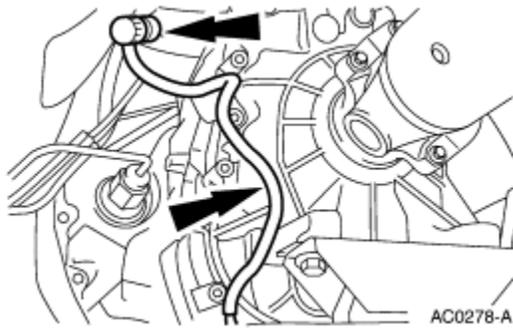
4. Remove the gearshift lever upper boot.



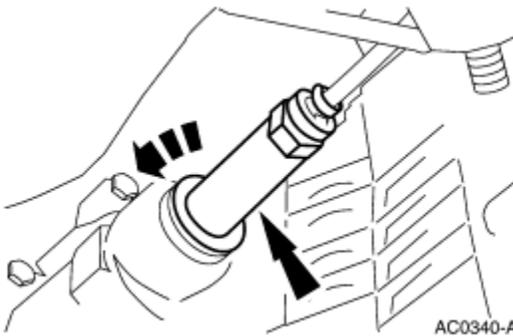
5. Remove the four bolts and the lower gearshift lever. Discard the gasket.



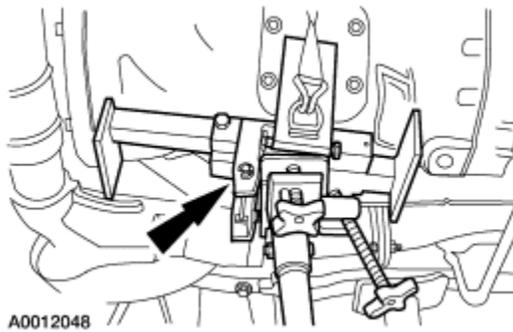
6. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
7. If the transmission is being disassembled, drain the transmission fluid.
8. Remove the starter. For additional information, refer to [Section 303-06B](#).
9. Disconnect the driveshaft and position it aside.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



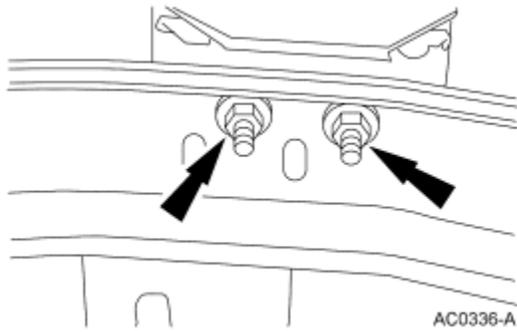
14. Remove the clutch slave cylinder and position it aside.
- Push inward then rotate the clutch slave cylinder counterclockwise 45 degrees to remove.



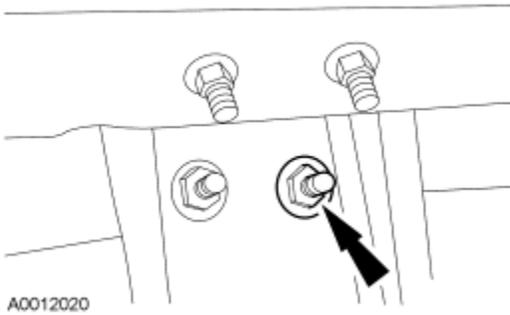
15. Using the special tool, support the transmission.
- Securely strap the jack to the transmission.



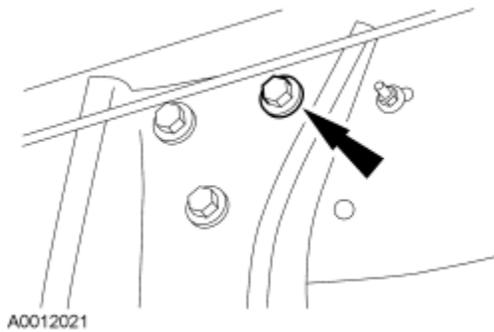
16. Remove the nuts.



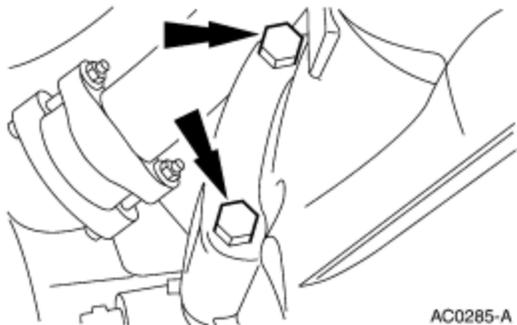
17. Remove the RH crossmember nuts.



18. Remove the LH crossmember bolts.



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



20. Remove the transmission.

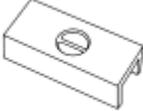
- Move the transmission rearward until the input shaft is clear of the clutch, then lower from the vehicle.

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>

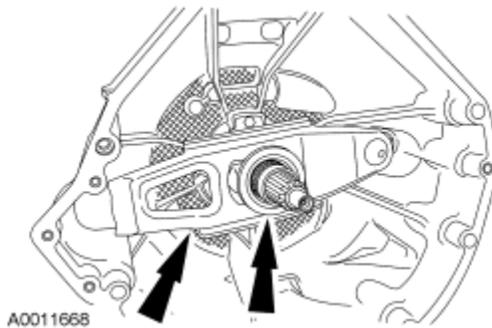
1.  **WARNING: Wear protective eyewear whenever using compressed air.**

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

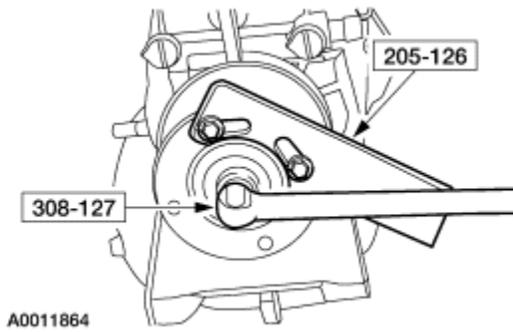
2.  **WARNING: Wear protective eyewear whenever using compressed air.**

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

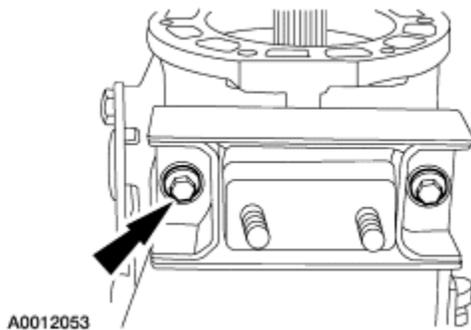
3. Remove the clutch release lever and the clutch release hub and bearing.



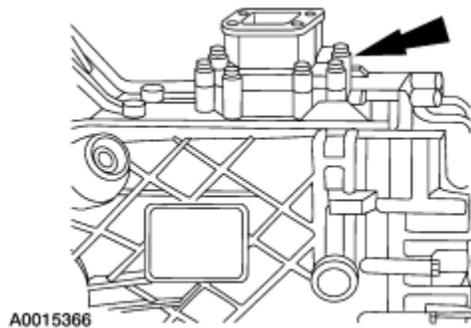
4. Using the special tools, remove the pinion flange on 2-wheel drive vehicles.



5. Remove the transmission mount.



6. Remove the eight bolts and the shift housing.

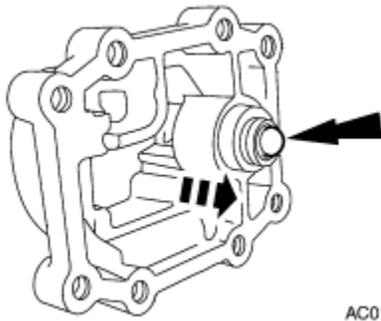


7.  **CAUTION:** To prevent damage, do not heat the shift housing higher than 150°C (300°F).

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

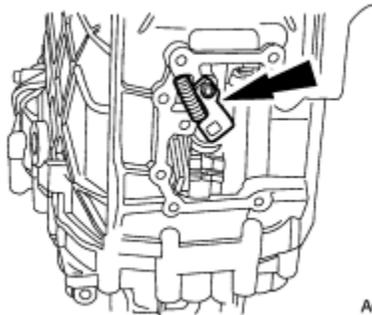
Using the Heat Gun, remove the shift detent plunger.

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

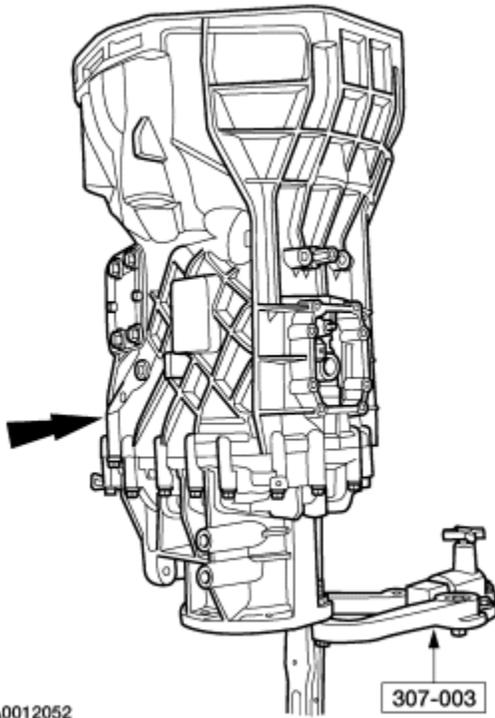


AC0183-A

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



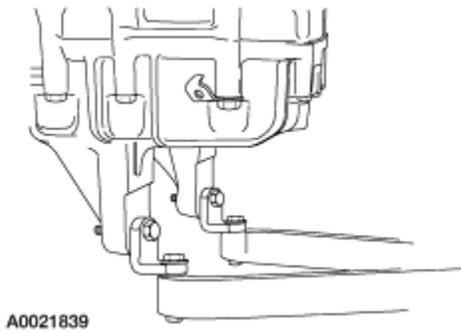
AC0164-A



A0012052

307-003

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

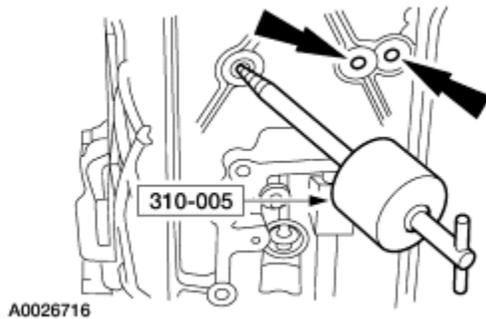


10. **⚠️ WARNING: Shift rail detent plug is under spring pressure. Always wear protective eyeglasses when performing this procedure to make sure that shift rail detent plug does not strike eyes when it is forced out by spring pressure.**

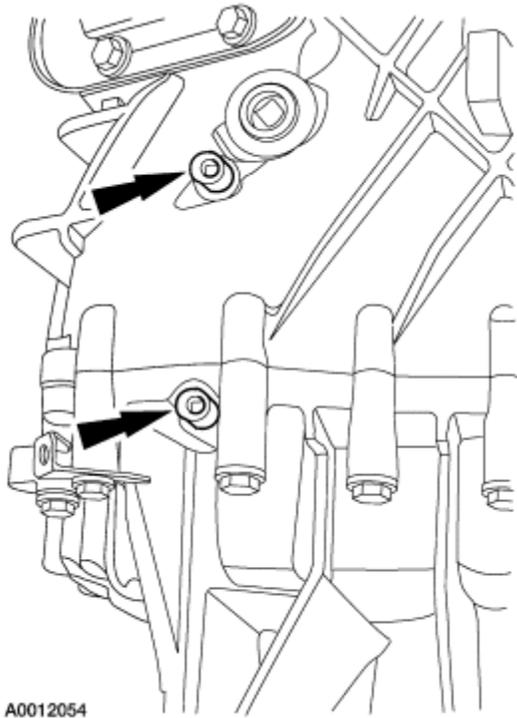
NOTE: Use a 1/8-inch center punch to create a pilot hole in the plug before installing the tool. Using the Jet Plug Remover to make the pilot hole will damage the tool.

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

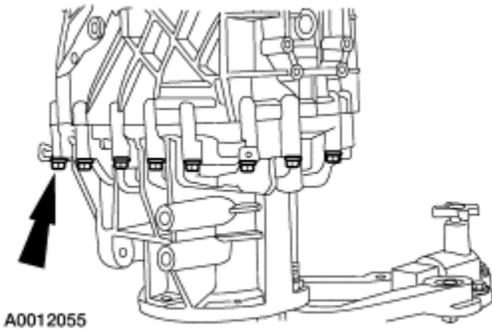
- Lightly thread in the Jet Plug Remover so as not to damage the springs.



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

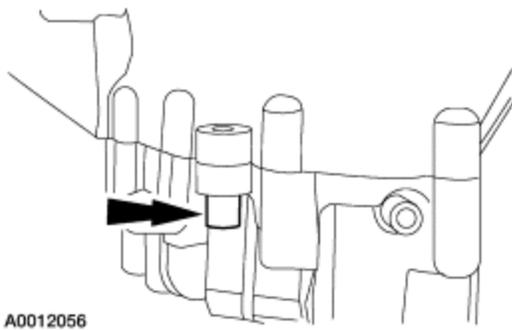


12. Remove the 17 bolts.



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

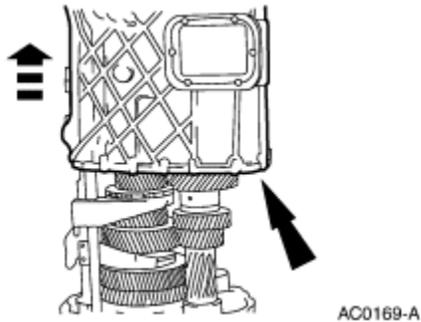
Using a hammer and punch, tap the two dowel pins down until they are past the main case.



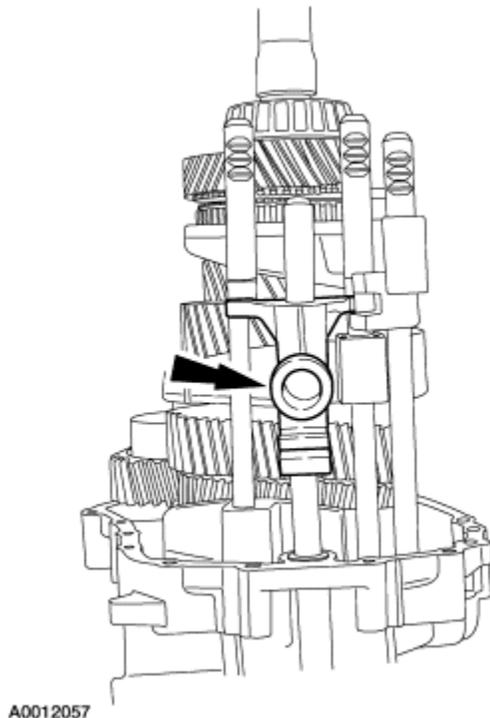
14.  **CAUTION: Do not use a pry bar or a screwdriver to force the main case and extension housing apart. This could damage the mating surfaces and cause leaks.**

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.

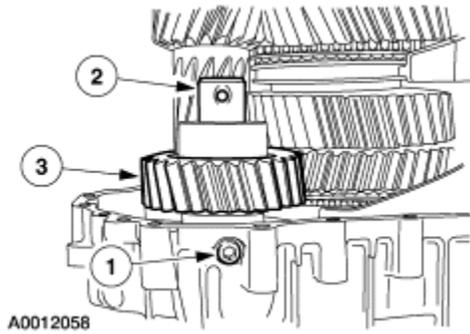


15. Remove the main shift rail and the main shift rail driver.

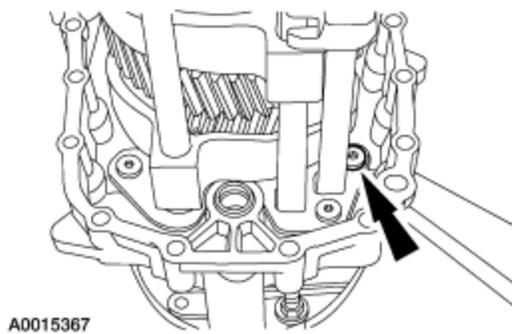


16. Remove the reverse idler gear assembly.
1. Remove the reverse idler gear bolt.
 2. Remove the reverse idler shaft.

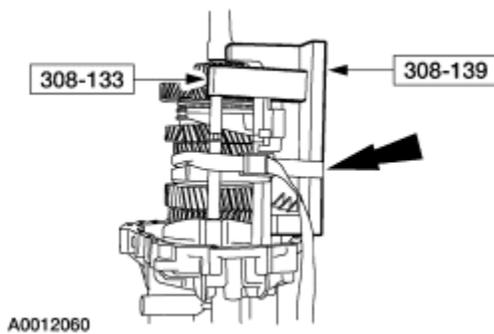
3. Remove the reverse idler gear and the two reverse idler gear bearings.
 - Inspect the idler shaft, gear and bearings for wear or damage. Install new components, as necessary.



17. Remove one bolt from the shift interlock plate.

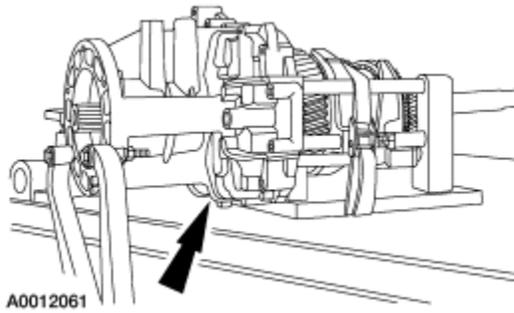


18. Position the special tools onto the gear assembly. Attach the tools to the gear assembly with a cargo strap.

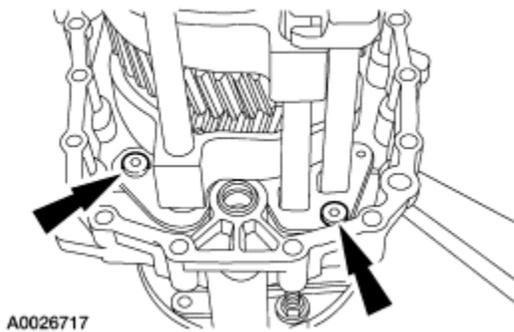


19. **NOTE:** An assistant will be needed to remove the gear assembly from the bench fixture.

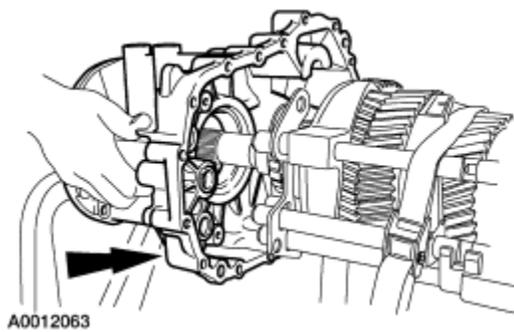
Firmly hold the gear assembly, release the Holding Fixture from the bench fixture, then remove the transmission. Place the gear assembly on a workbench.



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

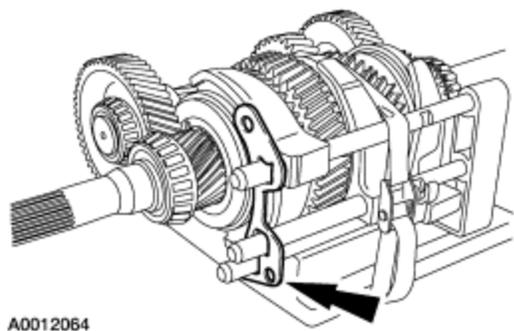


21. Separate the extension housing from the gear assembly.



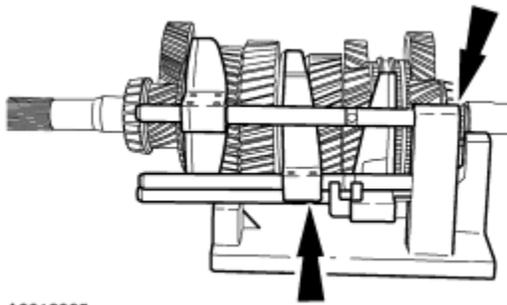
22. Remove the shift interlock plate.

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



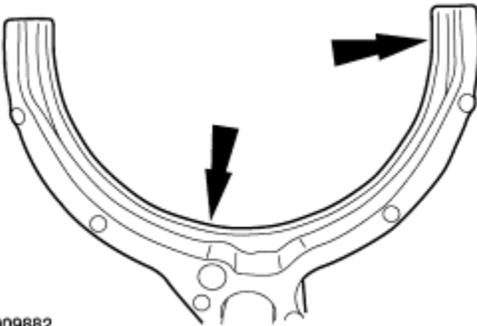
23. Remove the shift rail assembly with the Shift Rod Assemblies Aligner.

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



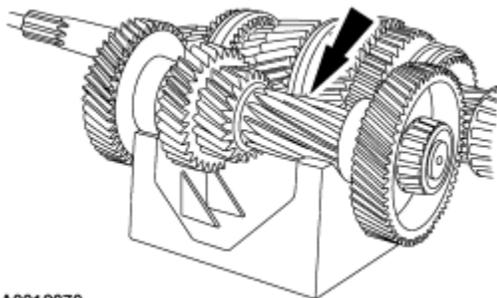
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24. Inspect the shift fork pads and centers for wear or damage. Install new shift forks as necessary.



A0009882

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

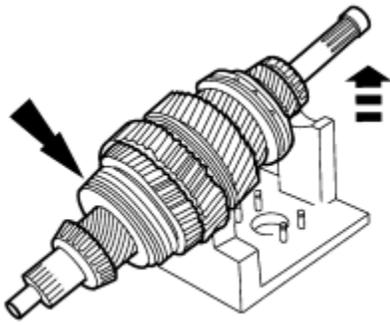


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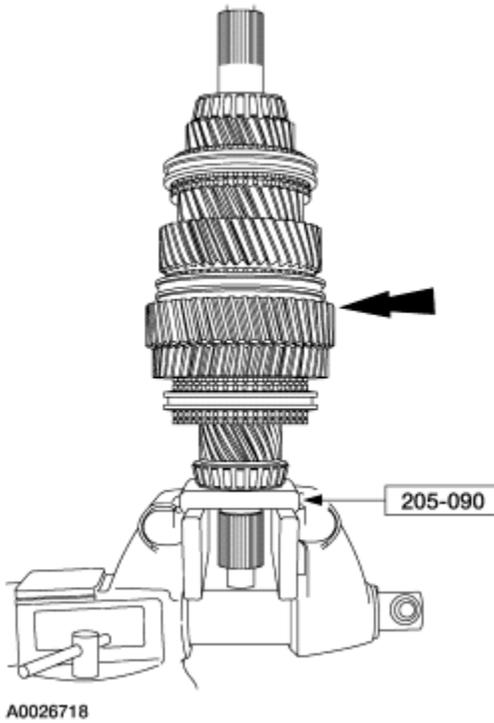
26. **NOTE:** Secure the Bearing/Oil Seal Plate in a vise.

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



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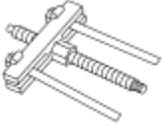
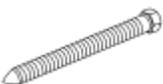
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
Manual

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

Counter Shaft Bearing

Special Tool(s)

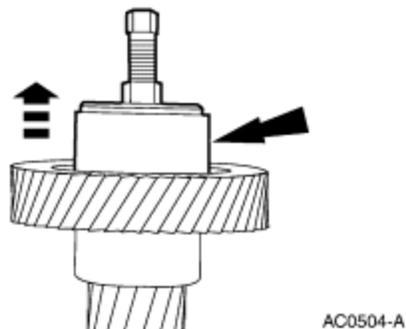
 <p>ST1516-A</p>	<p>Collet 5/8 to 3/4 303-D018 (D80L-1008-P)</p>
 <p>ST1304-A</p>	<p>TOD Forcing Screw T84T-7025-B</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164R-3900</p>

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.



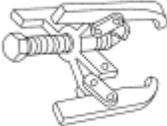
Assembly

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).

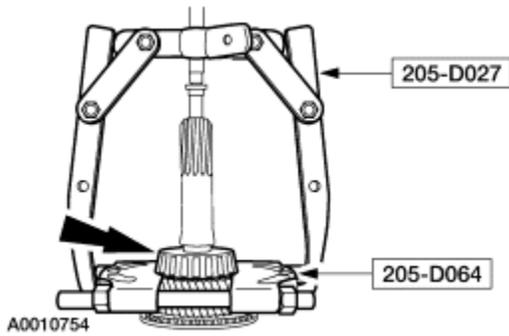
2. Install the output shaft bearing until it seats against its stop.
-

Input Shaft and Bearing

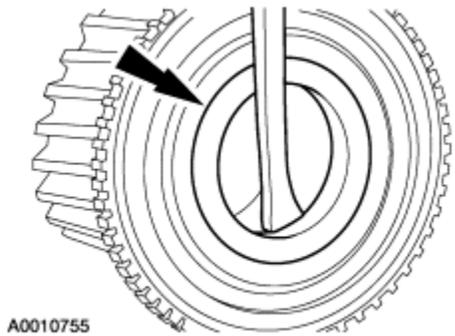
Special Tool(s)	
 ST2369-A	Hub Sensing Ring Replacer 205-059 (T94P-20202-B1)
 ST1585-A	2 or 3 Jaw Puller 205-D027 (D80L-1013-A)
 ST2143-A	Inner Pinion Bearing Cone Replacer 205-232 (T85T-4621-AH)
 ST1254-A	Axle Bearing/Seal Service Plate 205-090 (T75L-1165-B)
 ST2156-A	Gear/Bearing Heater 164-R3900
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

Disassembly

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

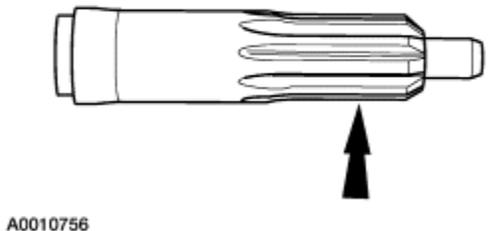


2. Remove the input shaft rear oil dam.



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).**

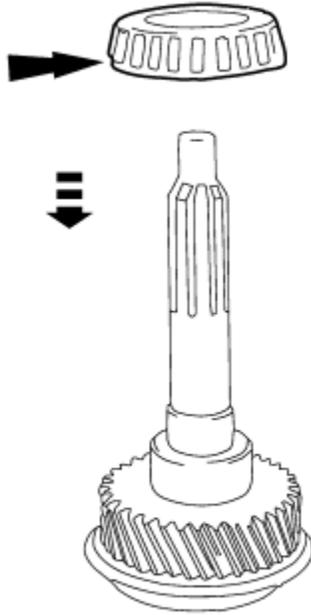
New or original components should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater.

Assembly

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

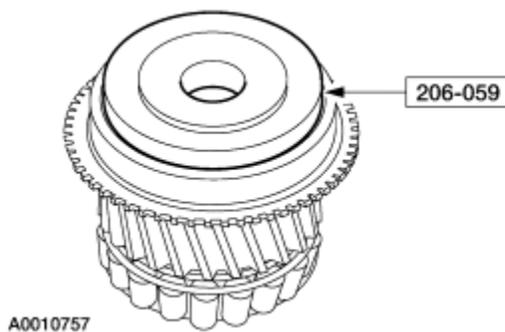
Install the input shaft bearing.

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



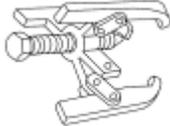
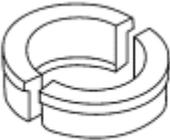
AC0206-A

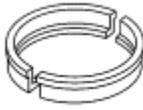
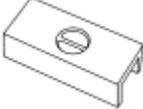
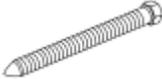
2. Using the special tool, install the input shaft rear oil dam.
 - Position the input shaft in the Gear Pack Assembly Fixture.

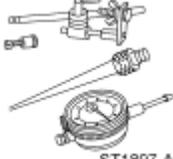
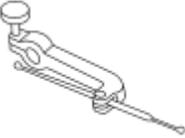


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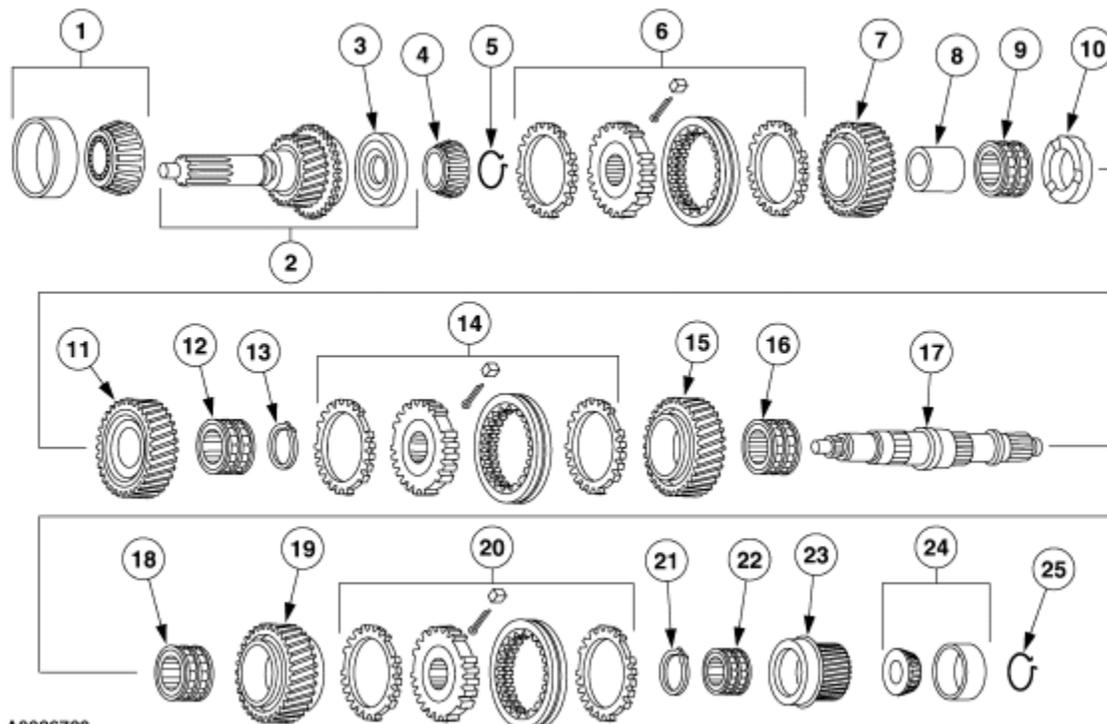
Main Shaft

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

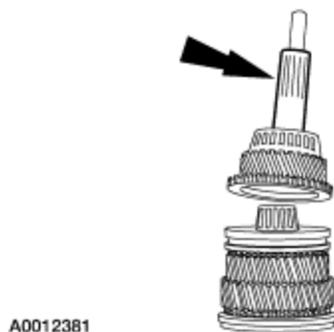
Item	Part Number	Description
1	7025	Input shaft bearing and bearing cup
2	7017	Input shaft
3	7046	Input shaft rear oil dam
4	7120	Input shaft pocket bearing

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

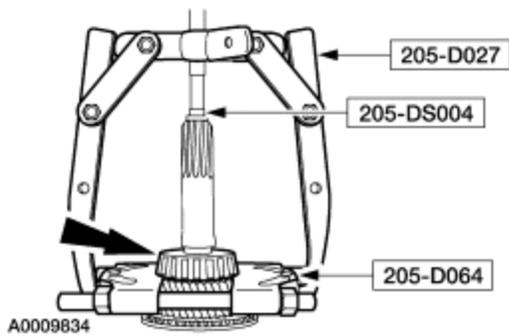
1. **NOTE:** Installing a new input shaft will affect mainshaft clearance. Carry out mainshaft clearance measurement.

Remove the input shaft.

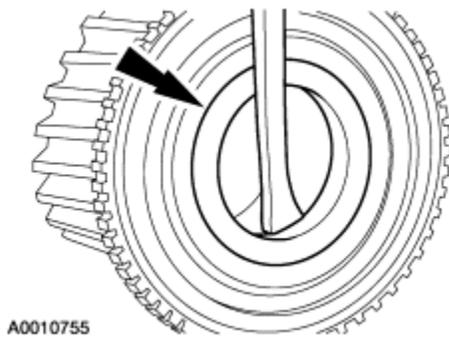


2. Using the special tools, remove and discard the input shaft bearing.

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

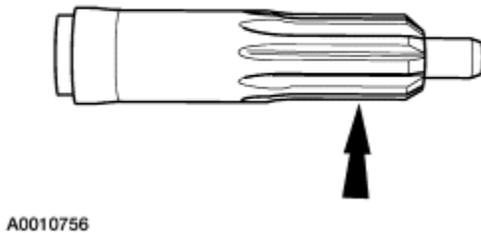


3. Remove and discard the input shaft rear oil dam.
 - Removing the oil dam will damage it, only remove as necessary.



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.

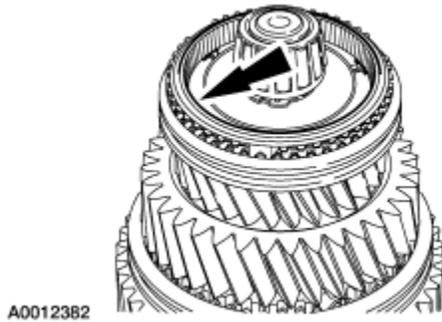
Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



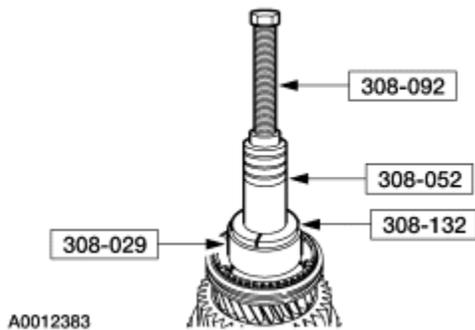
5. **⚠ CAUTION:** To prevent damage, do not heat the bearing higher than 150°C (300°F).

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.

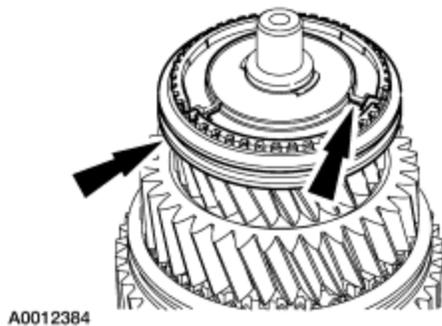


7. Using the special tools, remove the input shaft pocket bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary. Install new bearings and cups in a set only. Do not install one without the other.

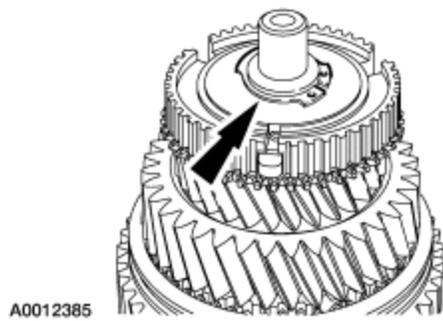


8.  **CAUTION: Place a cloth around the synchronizer to catch the detent springs and detents that will be released when the sliding sleeve is removed.**

Remove the synchronizer sliding sleeve, detents and detent springs.

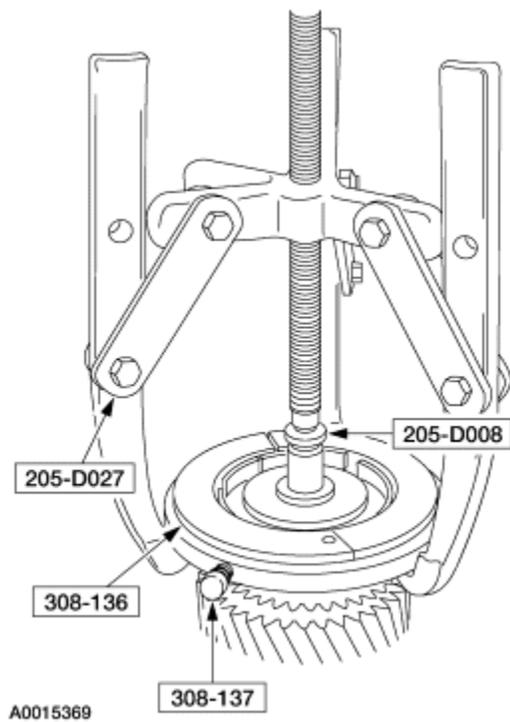


9. Remove and discard the snap ring.



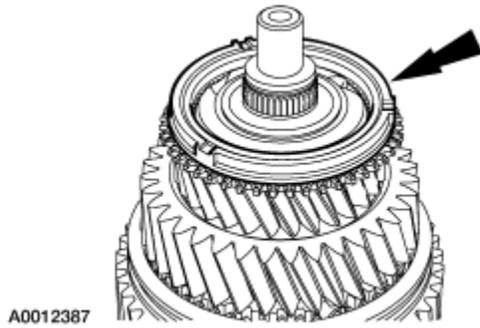
10. Using the special tools, remove the synchronizer body.

- Place the Synchronizer Remover under the third gear synchronizer ring



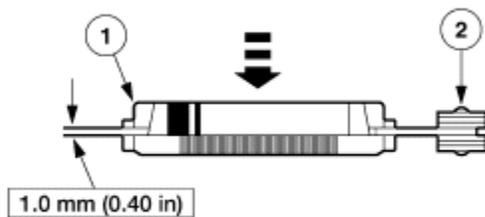
11. Remove the synchronizer ring.

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



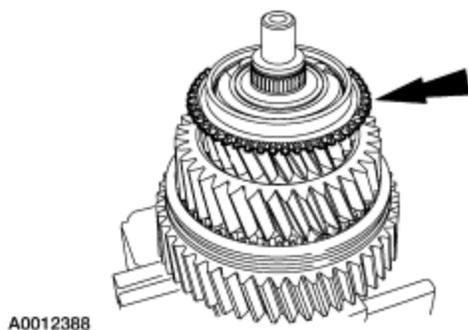
12. Check the clearance between the synchronizer rings and the gear.

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.



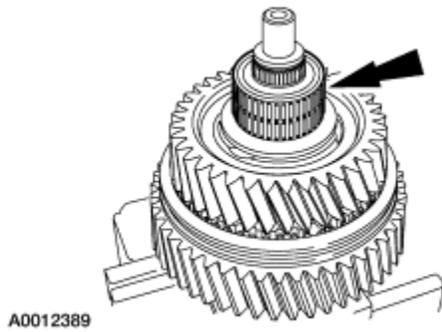
13. Remove third gear.

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

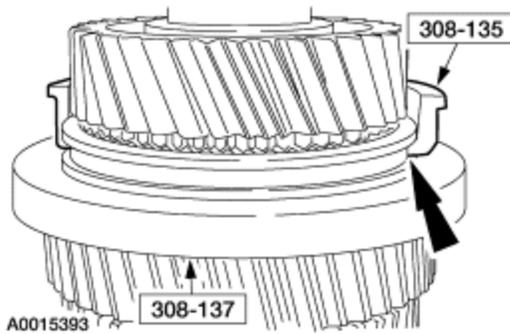


14. Remove mainshaft needle bearing.

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



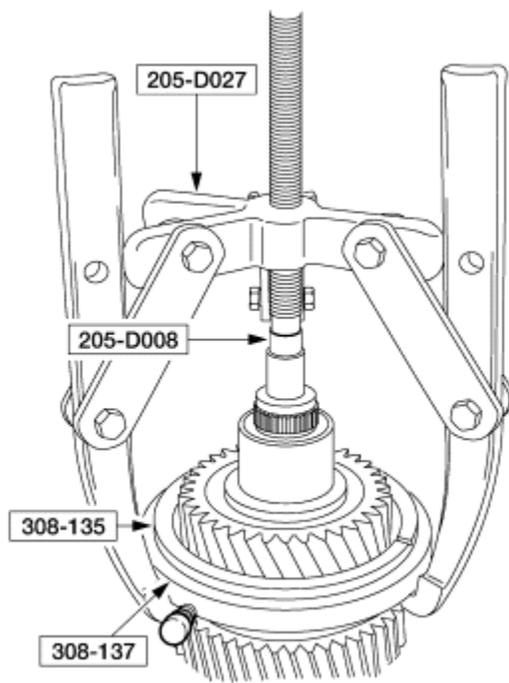
15. Engage second gear. Position the Collet Puller and Collet Ring into the first and second synchronizer sliding sleeve.



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.

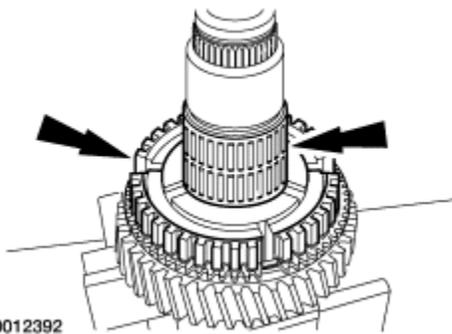
- Inspect the gear for wear or damage. Install a new gear as necessary.



A0015392

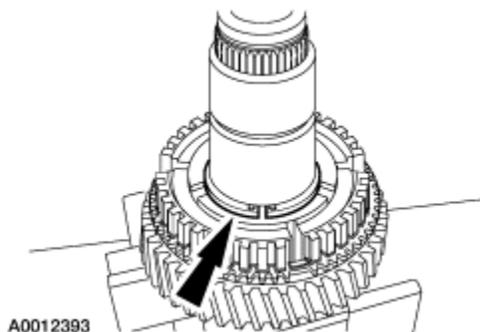
17. Remove the synchronizer ring and the mainshaft needle bearing.

- 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.

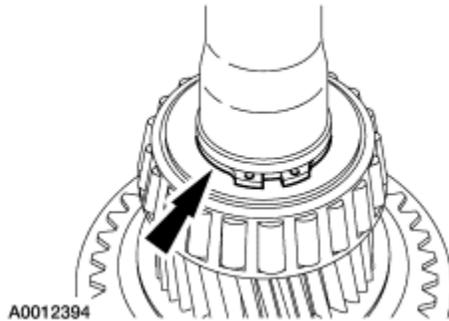


A0012393

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

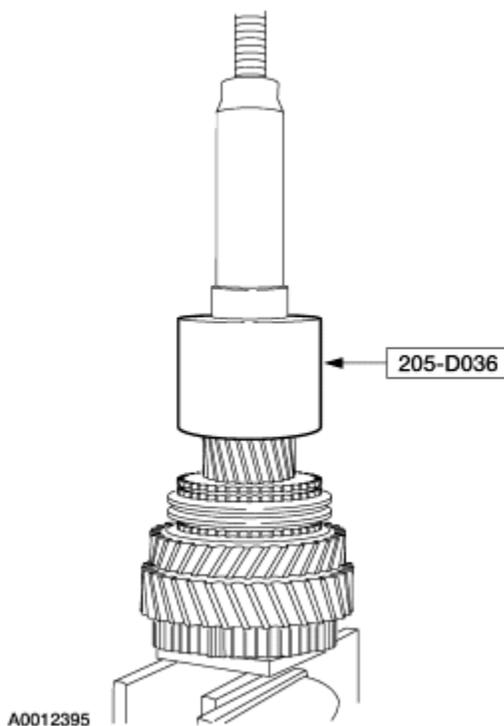
20. **NOTE:** The snap ring is used on 4-wheel drive vehicles only.

Remove and discard the snap ring.



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

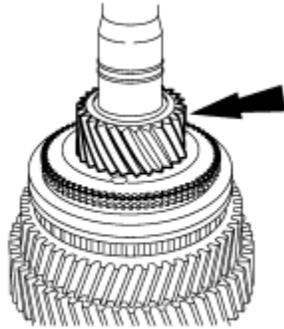
- Damage to the bearing can occur during removal. Inspect the bearing for wear or damage. Install a new bearing as necessary. Install new bearings and cups in a set only. Do not install one without the other.



22. Remove fifth gear.

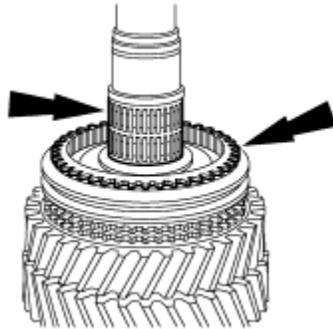
- Inspect the gear for wear or damage. Install a new gear as necessary.

A0012396



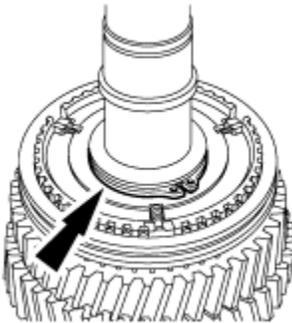
23. Remove the fifth gear mainshaft needle bearing and the synchronizer ring.
- The fifth gear mainshaft bearing is a split bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary.
 - Inspect the internal surface of the synchronizer rings for a contact pattern.

A0012397



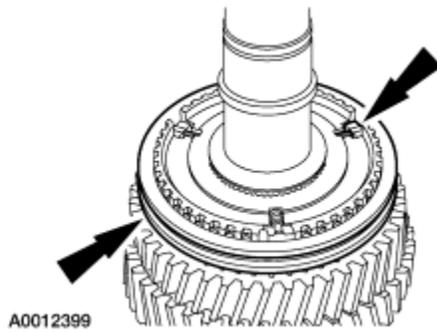
24. Remove and discard the snap ring.

A0012398

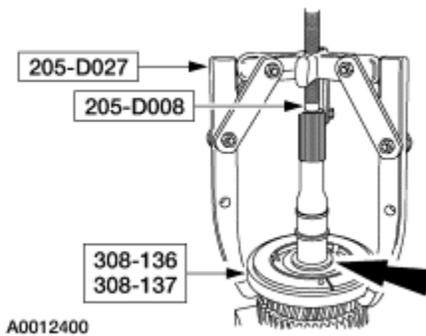


25.  **CAUTION:** The detent springs and detents will be released when the synchronizer sliding sleeve is lifted off the synchronizer body.

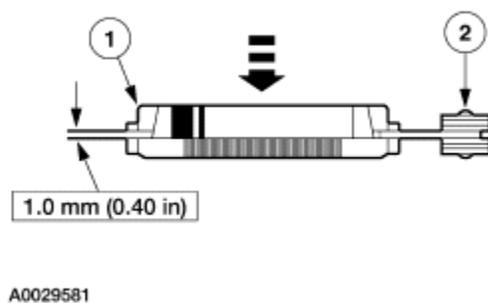
Remove the synchronizer sliding sleeve, the detent springs and the detents.



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.

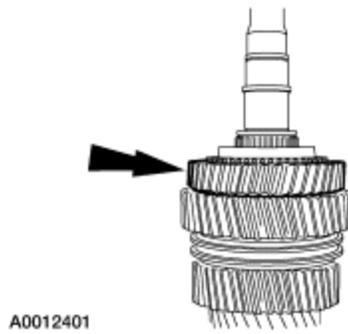


27. Check the clearance between the synchronizer rings and the gear.
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
 2. Insert a feeler gauge and measure the clearance while applying pressure and rotating the synchronizer ring. The clearance 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.



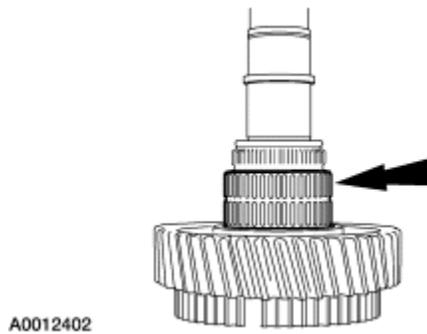
28. Remove reverse gear.

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



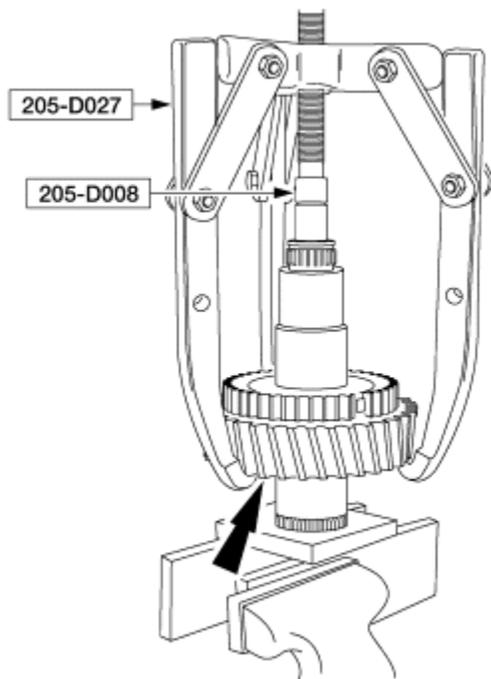
29. Remove the mainshaft needle bearing.

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



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

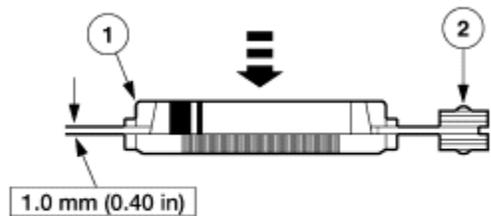
31. Using the special tools, remove the synchronizer body and first gear.



A0012420

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

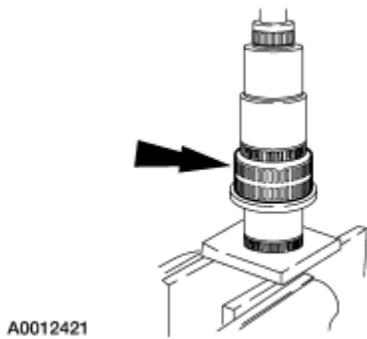
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
2. Insert a feeler gauge and measure the clearance while applying pressure and rotating the synchronizer ring. The clearance should be the same around the entire circumference. Place the feeler 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.**

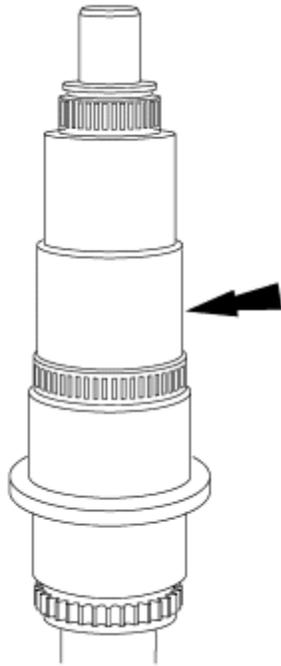
New or original components should be heated in advance of the assembly procedure. Heating will ease the assembly process. Place the input shaft pocket bearing, the synchronizer bodies, the mainshaft third gear thrust washer, the mainshaft third gear bushing and the output shaft rear bearing into the 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.**

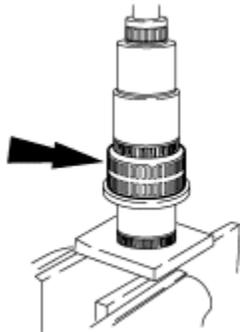
Lubricate all mainshaft components with the recommended transmission lubricant, MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.

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



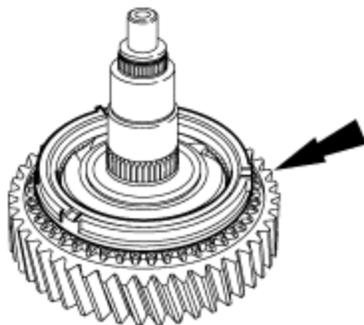
A0013134

4. Install the mainshaft first gear needle bearing.



A0012421

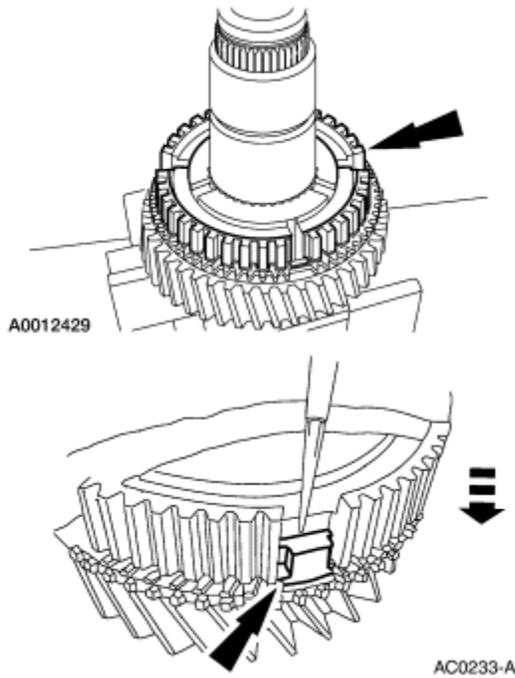
5. Install first gear and the first gear synchronizer ring.



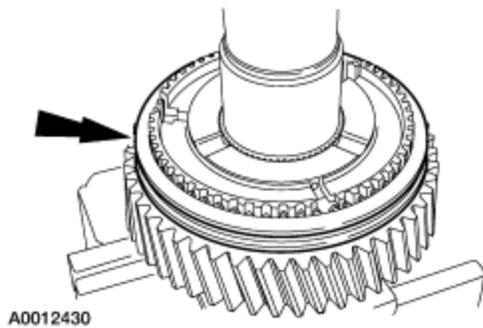
A0013135

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

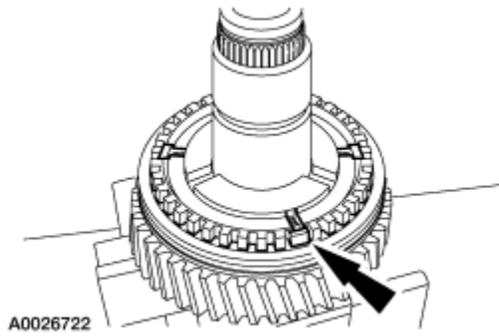
- Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.
- Use a suitable tube to fully seat the synchronizer body.



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.

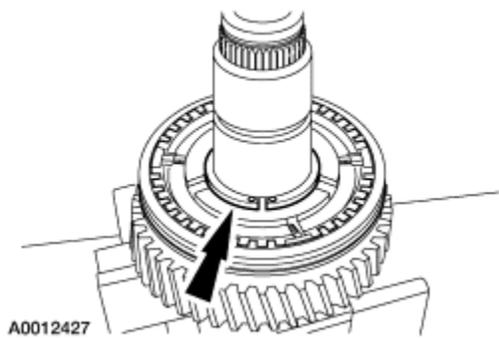


8. Install the detent springs and the detents.



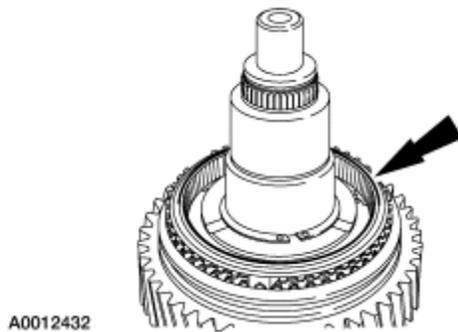
9. Install a new snap ring.

- 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).

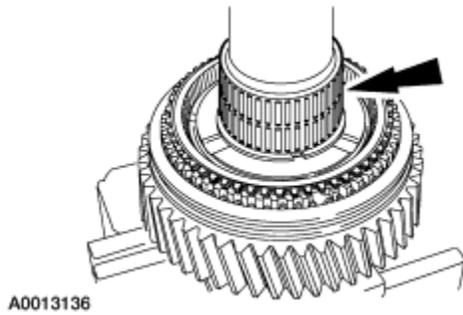


10. Install the second gear synchronizer ring.

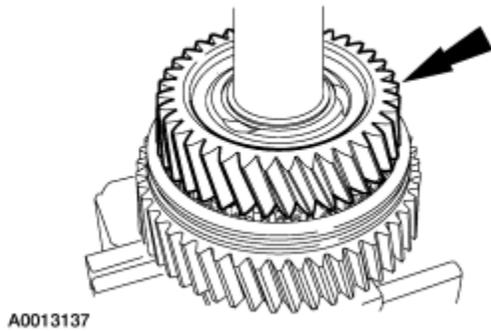
- Move the synchronizer sliding sleeve to the center position.



11. Install the mainshaft second gear needle bearing.

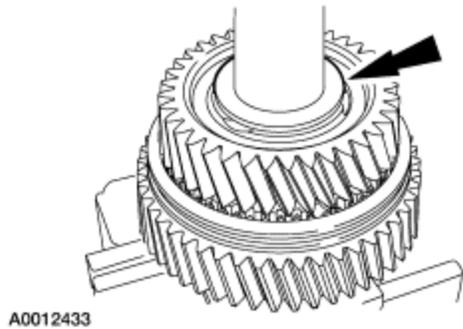


12. Install second gear.



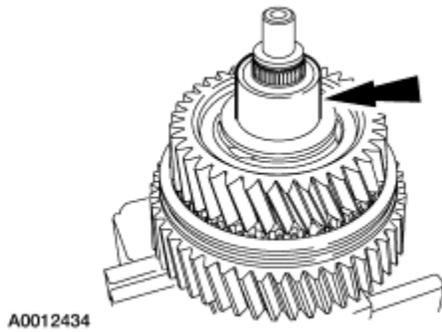
13. Remove the mainshaft third gear thrust washer from the Gear/Bearing Heater and install it on the mainshaft.

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



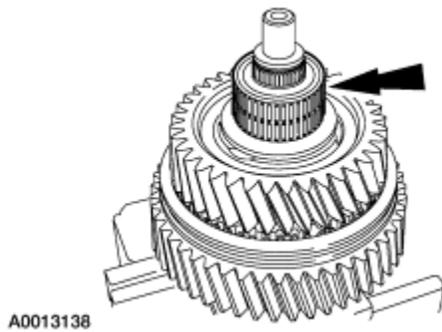
14. Remove the mainshaft third gear bushing from the Gear/Bearing Heater and install it on the mainshaft.

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

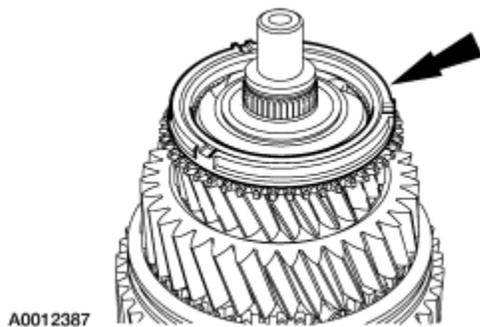


15. **NOTE:** Let the mainshaft third gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

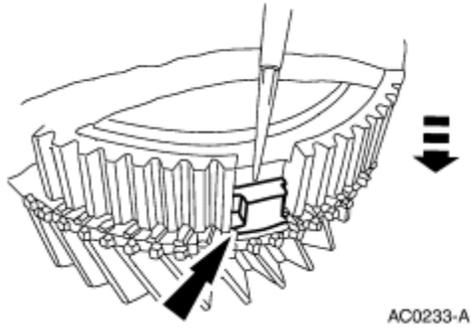
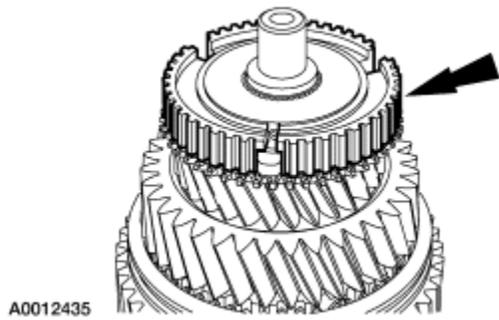
Install the mainshaft third gear needle bearing.



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

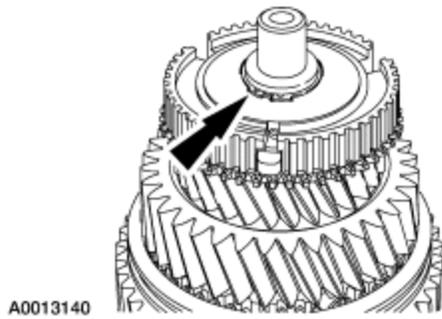


17. Remove the third and fourth gear synchronizer body from the Gear/Bearing Heater and install it on the mainshaft.
- Install the synchronizer body with the part numbers facing upward.
 - Use a suitable tube to fully seat the synchronizer body.

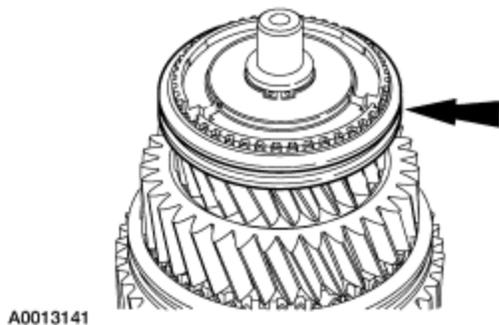


18. Install a new snap ring.

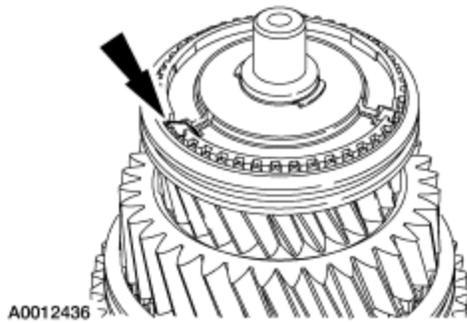
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



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

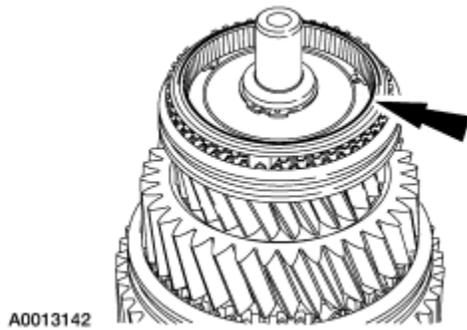


20. Install the detent springs and the detents.



21. Install the fourth gear synchronizer ring.

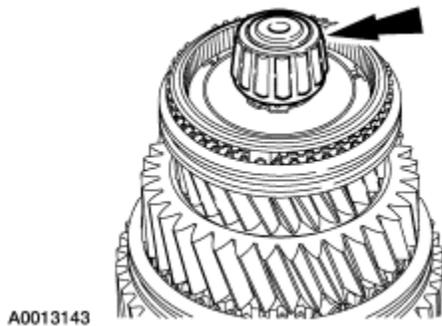
- Move the synchronizer sliding sleeve to the center position.

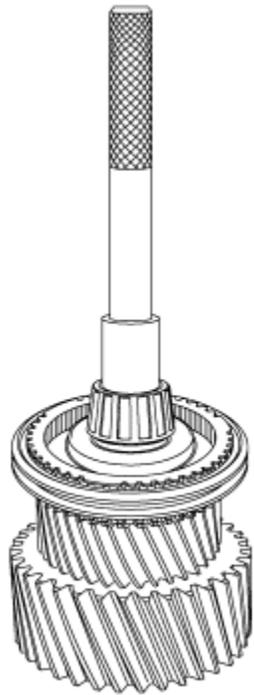


22.  **CAUTION: Drive the input shaft pocket bearing onto the mainshaft by the inner race only. Using the outer race will damage the bearing.**

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.

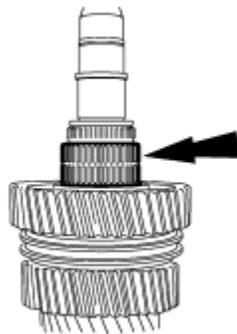




A0026723

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

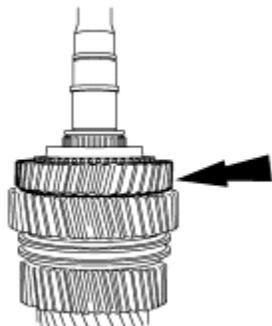
24. Install the mainshaft reverse gear needle bearing.



A0013144

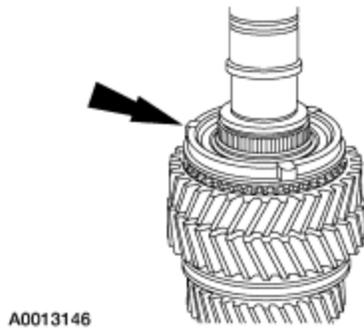
25. Install the reverse gear.

- The gear clutching teeth must face upward.



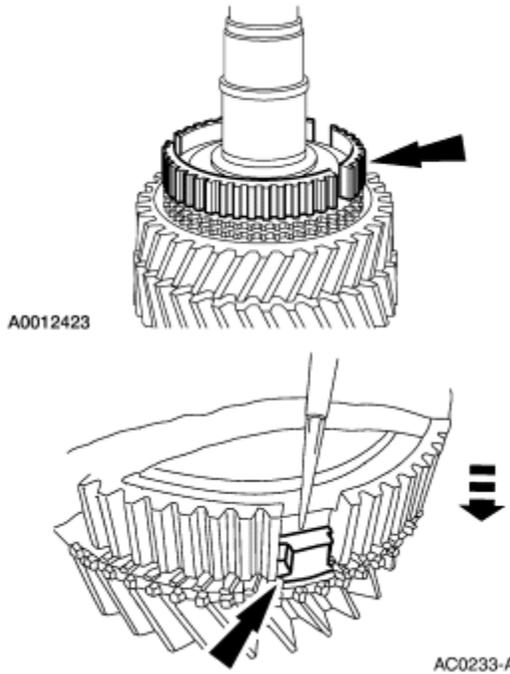
A0013145

26. Install the reverse gear synchronizer ring.



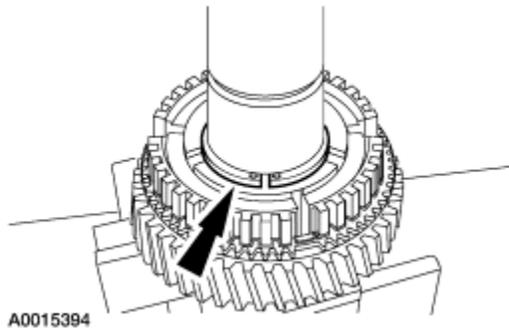
27. Remove the fifth and reverse synchronizer body from the Gear/Bearing Heater and install it on the mainshaft.

- 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.

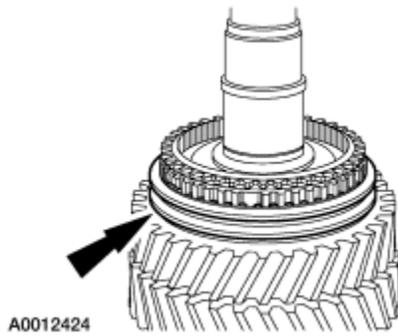


28. Install a new snap ring.

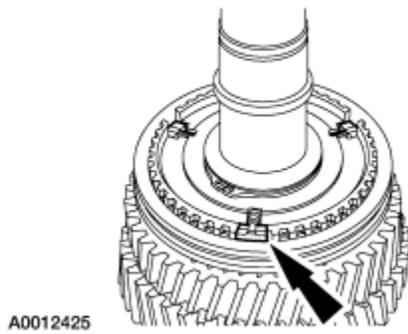
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



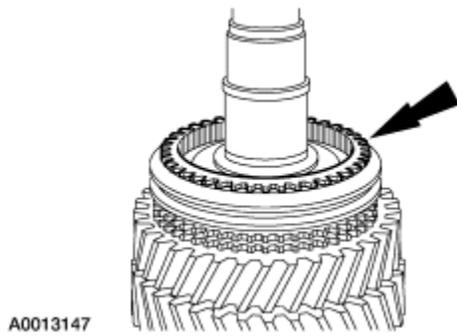
29. Install the synchronizer sliding sleeve, sliding the sleeve down to engage the clutching teeth of the reverse gear.



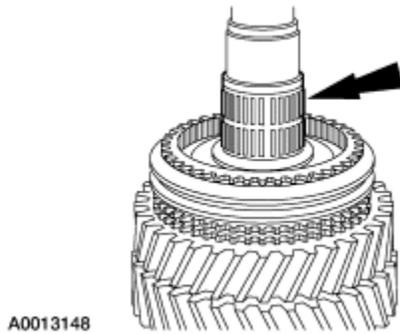
30. Install the detent springs and the detents.



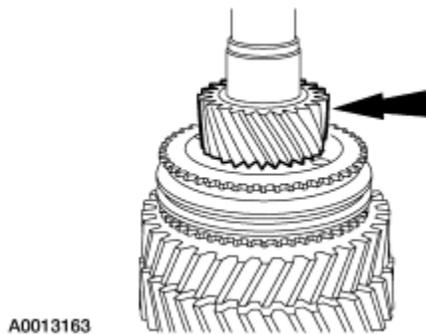
31. Install the fifth gear synchronizer ring.
- Pull the sliding sleeve into the neutral position.



32. Install the mainshaft fifth gear split needle bearing.



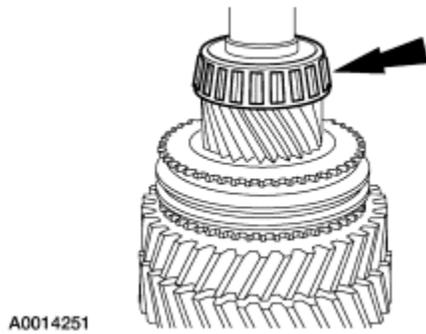
33. Install fifth gear.



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.

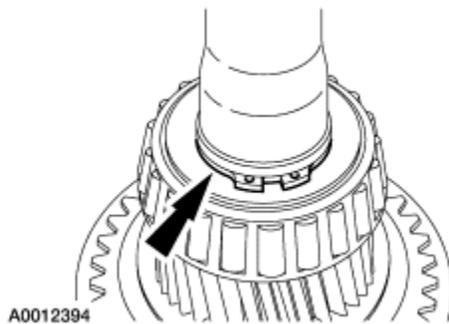
- Using a suitable tube, tap on the inside bearing race to make sure the bearing is seated against the stop.



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.

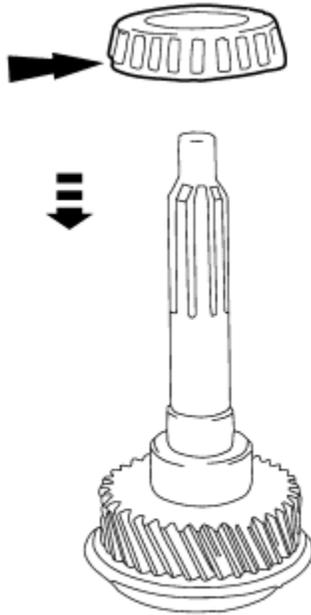
Place the mainshaft in the neutral position.

- 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.**

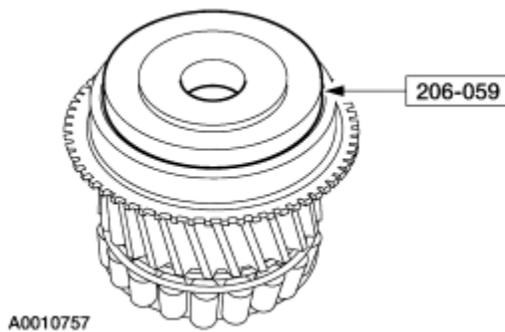
Remove the input shaft bearing from the Gear/Bearing Heater and install the bearing.

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



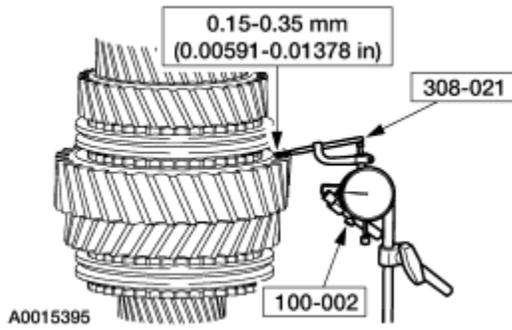
AC0206-A

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.

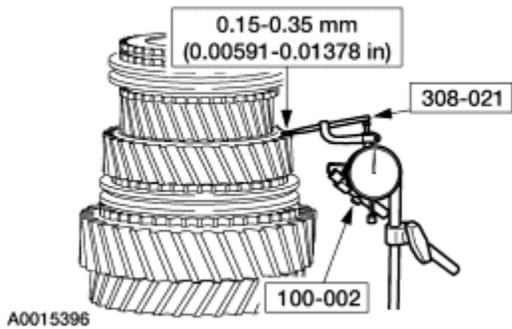


39. Install the input shaft.
- Fill the input shaft pocket with a suitable engine assembly white grease.
40. **NOTE:** If the following axial gear clearances are not within specification, it will be necessary to disassemble and reinspect.

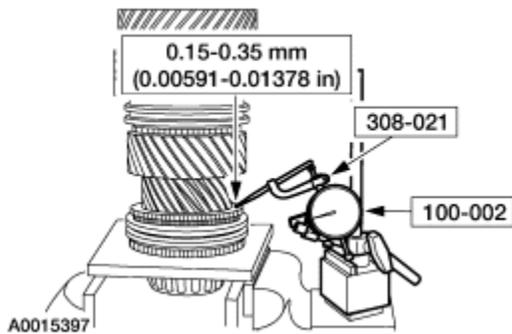
Using the special tools, check the axial gear clearance at the mainshaft first gear.



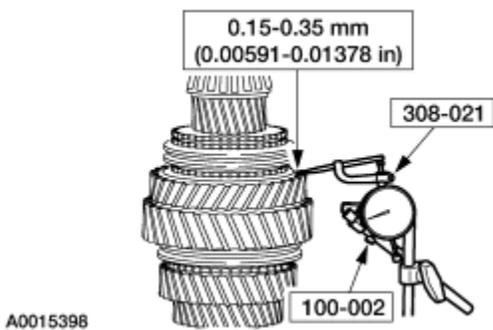
41. Using the special tools, check the axial gear clearance at the mainshaft second gear.



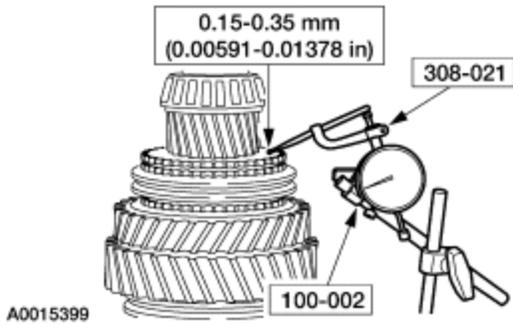
42. Rotate the mainshaft with the input shaft facing downward. Using the special tools, check the axial gear clearance at the mainshaft third gear.



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

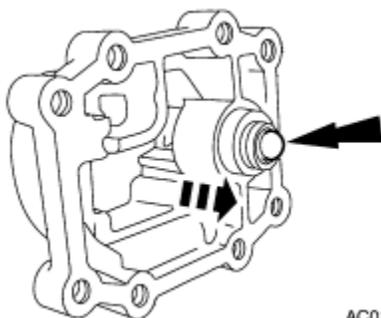
[Procedure revision date: 01/26/2000](#)

Shift Control Housing

Special Tool(s)	
<p>ST1110-A</p>	Rotunda Heat Gun 107-R0300

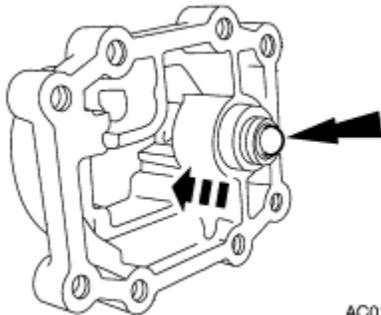
Disassembly

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

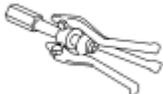
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF

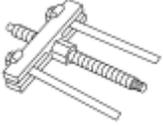
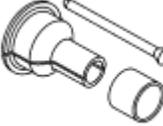
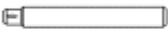
1999 F-Super Duty 250-550 Workshop
Manual

DISASSEMBLY AND ASSEMBLY OF
SUBASSEMBLIES

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

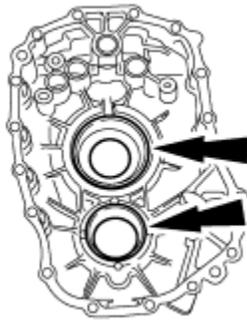
Extension Housing

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>

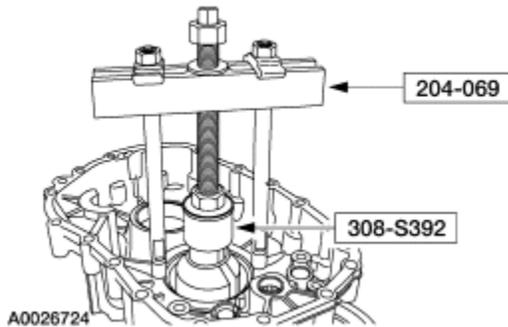
Disassembly

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.



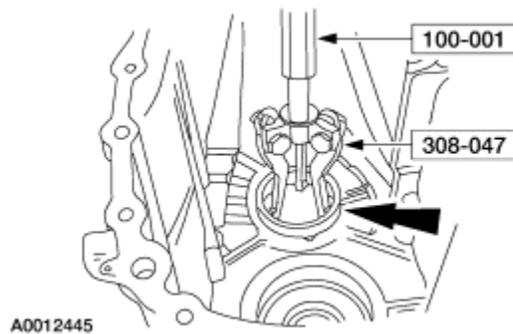
A0012437

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



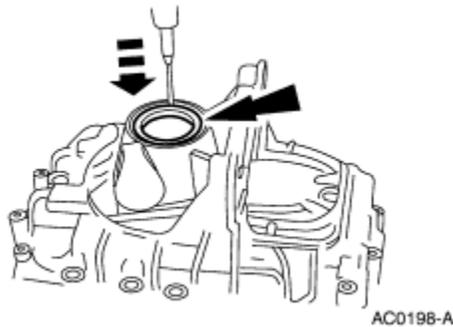
A0026724

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



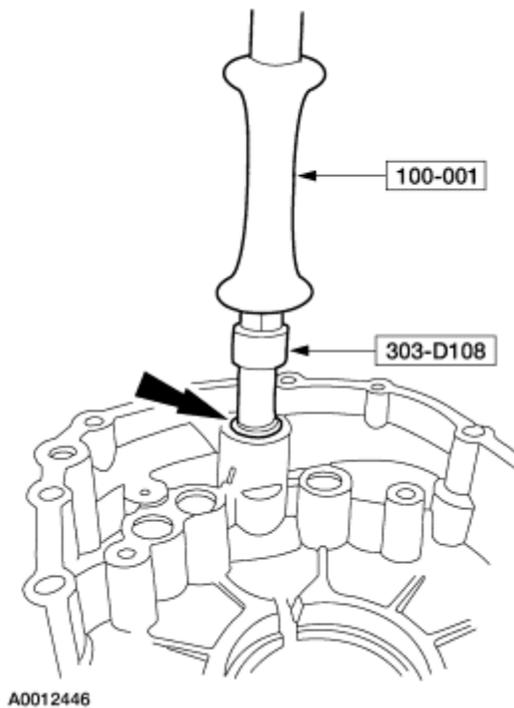
A0012445

4. Remove and discard the oil seal.



AC0198-A

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



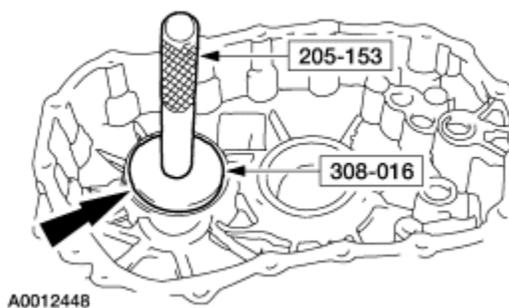
6. **NOTE:** Use care when cleaning the mating surfaces. Nicks and gouges can prevent sealing and cause leaks. Clean the mating surfaces with an oil stone.

Clean the mating surface of the extension housing.

Assembly

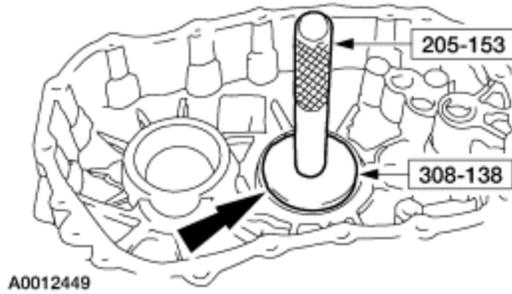
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

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).



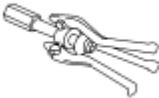
4. Install a new output oil seal after the bearing preload is completed during transmission assembly.

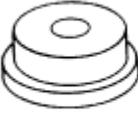
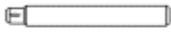
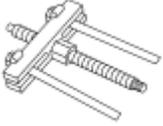
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
 Manual

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

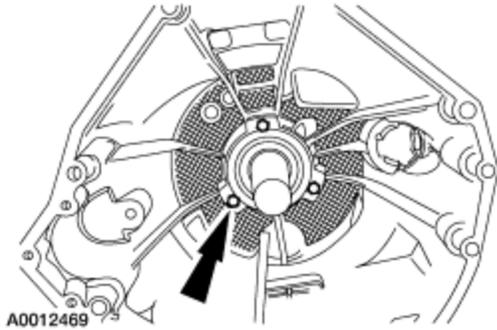
Case

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

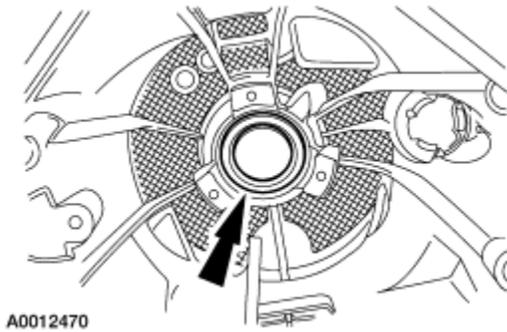
 <p>ST1616-A</p>	<p>Actuator Pin (Dia. 3/16 in) 303-D011 (D80L-100-G) or equivalent</p>
 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Cup 308-390</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

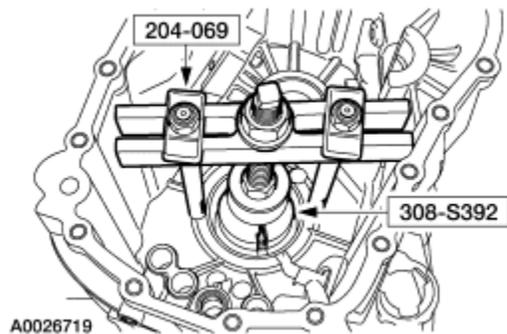
1. Remove the guide tube.
 - Inspect the guide tube for wear or damage. Install a new guide tube as necessary.



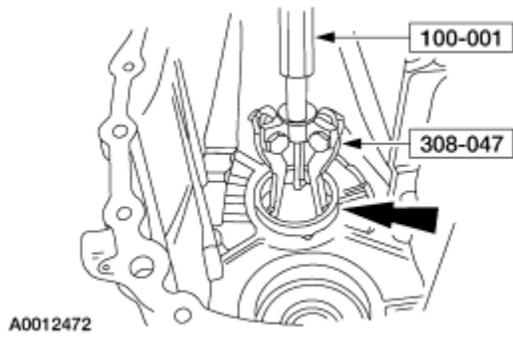
2. Remove and discard the input shaft oil seal.



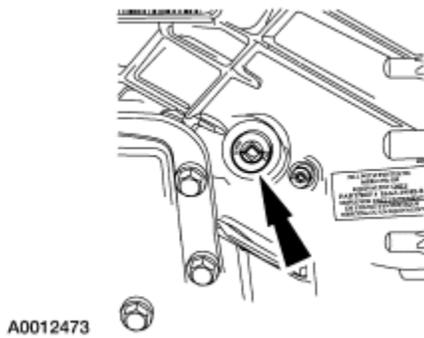
3. Using the special tools, remove the input shaft bearing cup, the oil dam and the shims.
 - Using a hammer and punch, tap down two areas on the oil dam, 180 degrees apart, to insert the puller under the cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new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



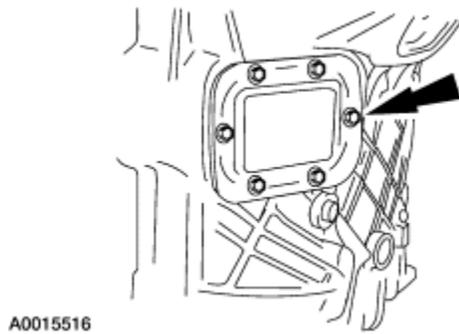
4. Use the special tools, remove the countershaft front bearing cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the countershaft, install a new cup.



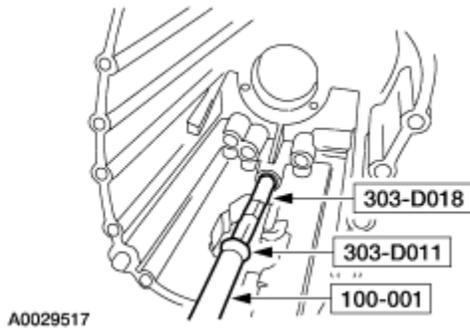
5. Remove the case plug and discard the seal.



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

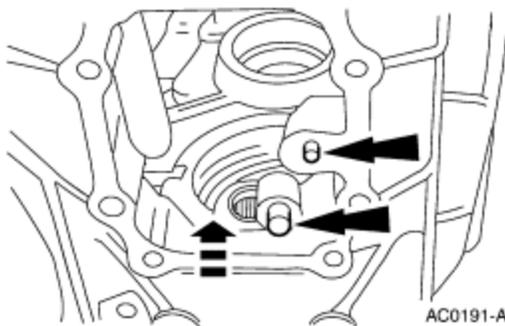
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

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

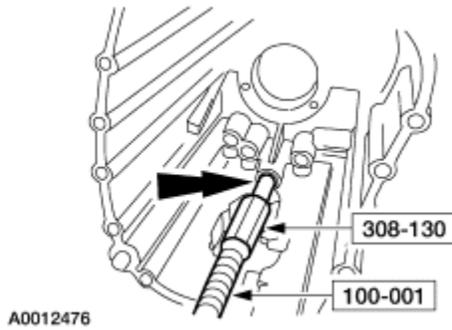
Install the interlock plate roll pins.

- 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.

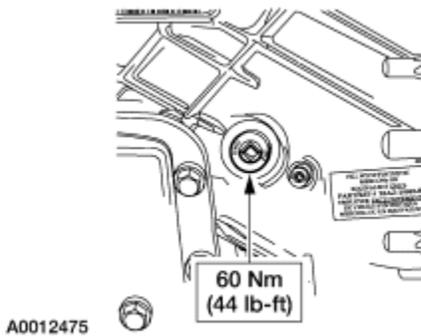
Install the small pin (will stick out 4-5 mm [0.158-0.197 in]).



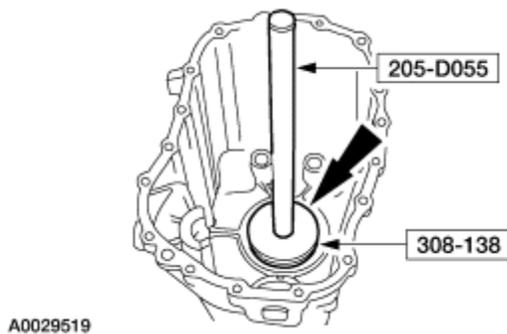
2. Using the special tools, install a new shift rail bearing.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).
 - Bearing should be flush with the surface of the bore.



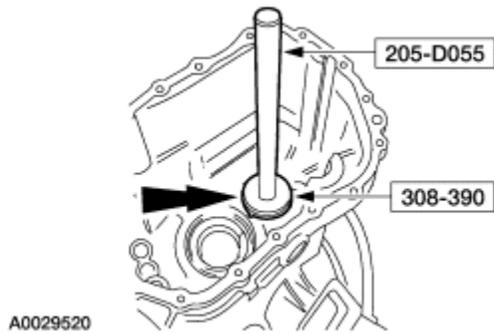
3. Install the case plug with a new seal.



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).



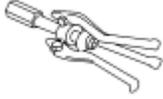
6. Install a new input shaft oil seal and the guide tube after the bearing preload is completed. For additional information, refer to [Transmission](#) in this section.

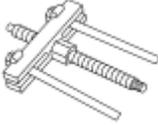
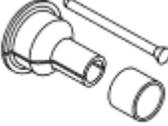
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550 Workshop
 Manual

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

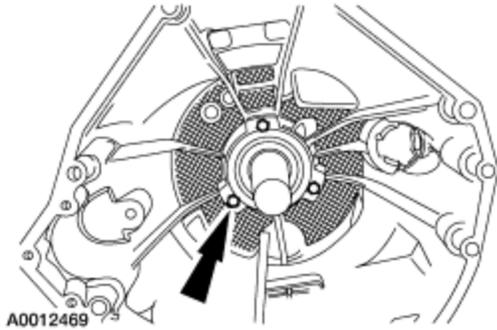
Case

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

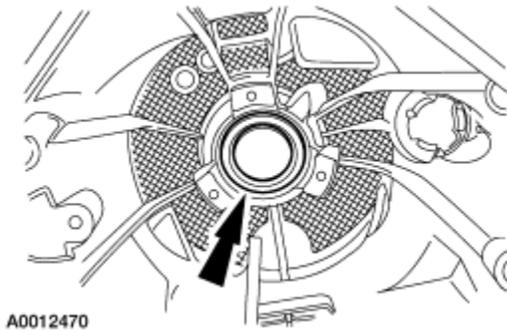
 <p>ST1616-A</p>	<p>Actuator Pin (Dia. 3/16 in) 303-D011 (D80L-100-G) or equivalent</p>
 <p>ST2149-A</p>	<p>Installer, Shift Rail Needle Bearing 308-130 (T87T-7025-DH)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Cup 308-390</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

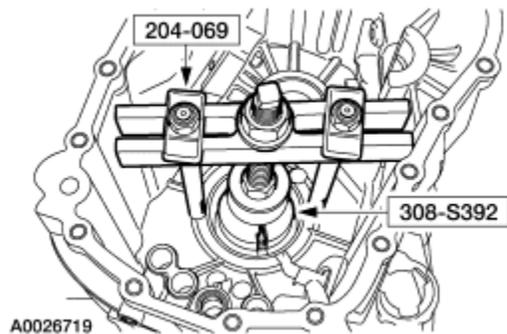
1. Remove the guide tube.
 - Inspect the guide tube for wear or damage. Install a new guide tube as necessary.



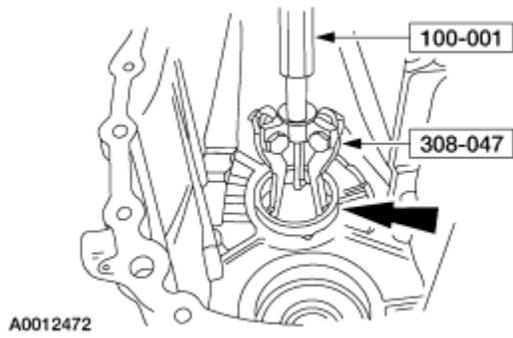
2. Remove and discard the input shaft oil seal.



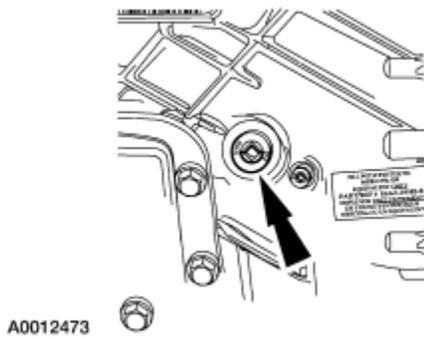
3. Using the special tools, remove the input shaft bearing cup, the oil dam and the shims.
 - Using a hammer and punch, tap down two areas on the oil dam, 180 degrees apart, to insert the puller under the cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new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



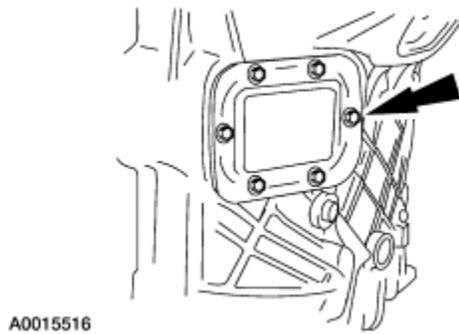
4. Use the special tools, remove the countershaft front bearing cup.
 - Inspect the bearing cup for wear or damage. Install a new cup as necessary.
 - If a new bearing was installed on the countershaft, install a new cup.



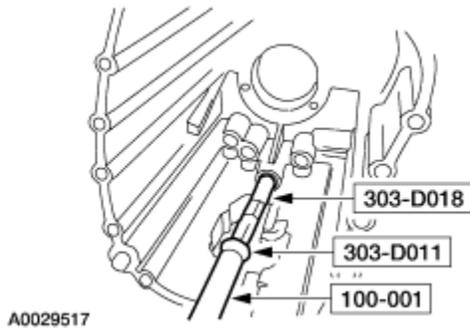
5. Remove the case plug and discard the seal.



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

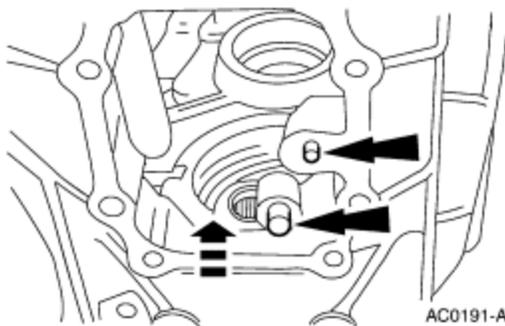
NOTE: A preload measurement must be taken after transmission disassembly. For additional information, refer to [Transmission](#) in this section.

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

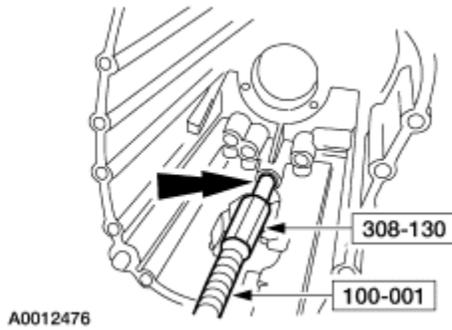
Install the interlock plate roll pins.

- 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.

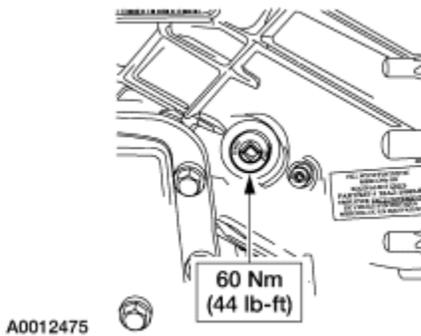
Install the small pin (will stick out 4-5 mm [0.158-0.197 in]).



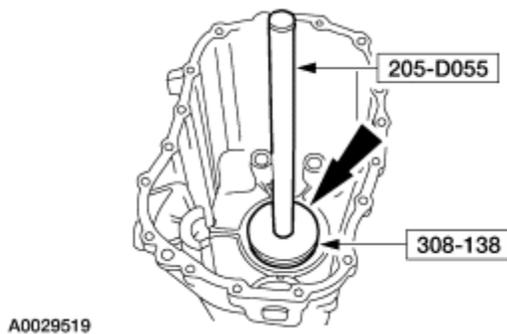
2. Using the special tools, install a new shift rail bearing.
 - Use the Heat Gun to heat the bearing bore to 150°C (300°F).
 - Bearing should be flush with the surface of the bore.



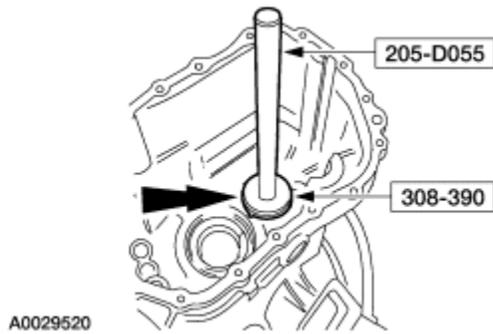
3. Install the case plug with a new seal.



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

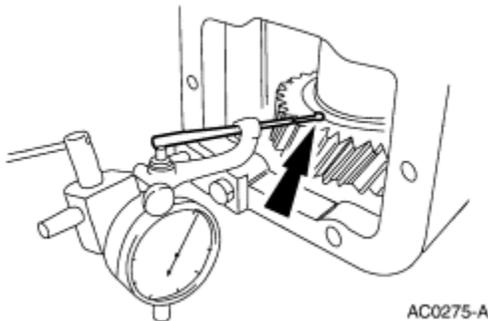
1999 F-Super Duty 250-550 Workshop
 Manual

[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.

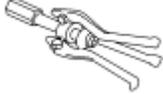
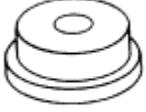
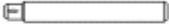
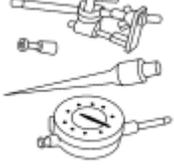
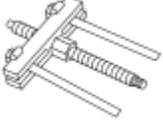
5. Inspect the pry bar through the PTO opening and position them beneath the 4th speed gear on the counter shaft. Pry up on the counter shaft.
6. Record the dial indicator reading.
7. The thrust washer should have a thickness of the recorded reading plus 0.02-0.11 mm (0.00079-0.00434 inch).
8. After 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.

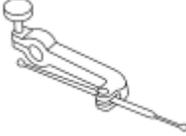
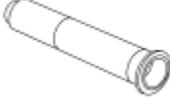
SECTION 308-03A: Manual Transmission —
 Model S5-47 ZF
 ASSEMBLY

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)

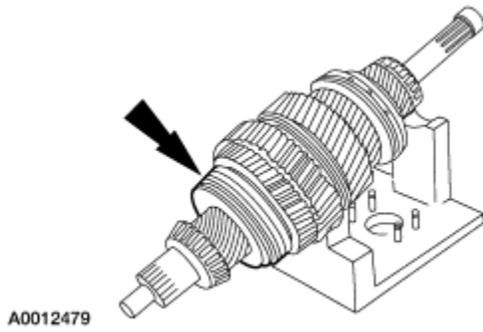
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>
 <p>ST1200-A</p>	<p>Remover, Bearing Cup 308-047 (T77F-1102-A)</p>
 <p>ST2151-A</p>	<p>Installer, Mainshaft Bearing 308-138 (T87T-7025-PH)</p>
 <p>ST1555-A</p>	<p>Installer, Centerplate Front Bearing Cup 308-390</p>
 <p>ST1255-A</p>	<p>Handle 205-D055 (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>

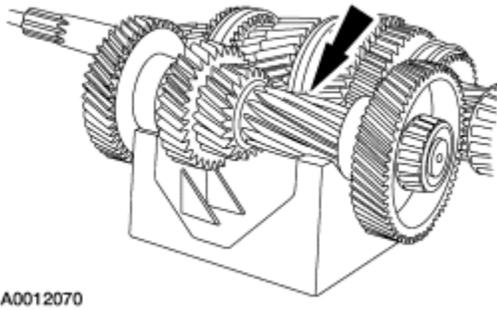
1.  **CAUTION: Do not reassemble the transmission dry. Apply lubricant throughout the assembly procedure.**

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.

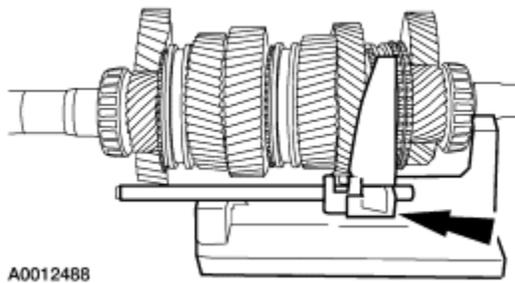


3. Position the countershaft assembly on the Holding Fixture.



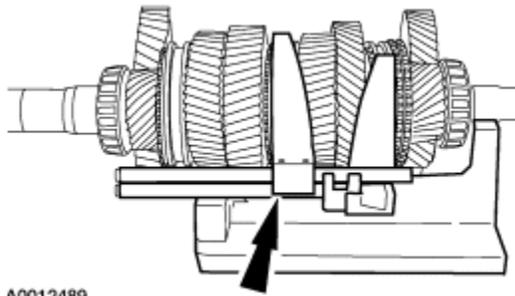
4. **NOTE:** If new components were installed, use new roll pins to assemble the shift fork to the shift rail.

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.

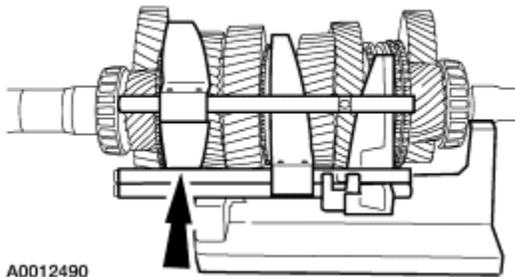
Install the first and second shift fork and shift rail.



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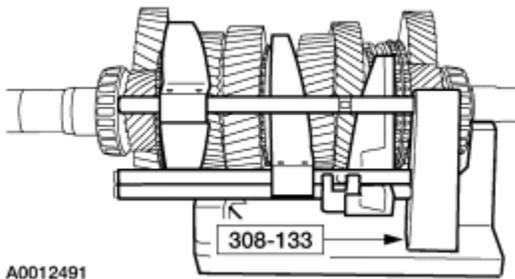
6. **NOTE:** If new components were installed, use new roll pins to assemble the shift fork to the shift rail.

Install the fifth and reverse shift fork and shift rail.



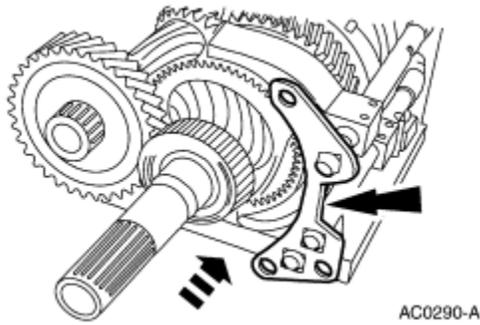
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7. Install the Shift Rod Support.



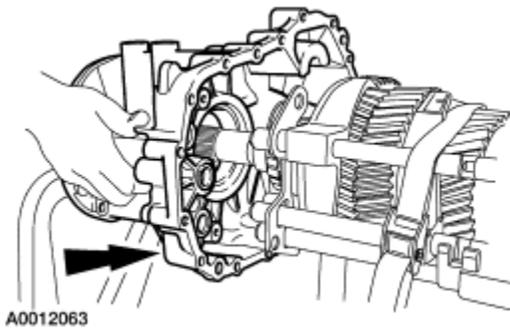
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8. Install the shift interlock plate, then position the plate in the grooves on the main shift rail.
 - The part numbers on the shift interlock plate face toward the input shaft.

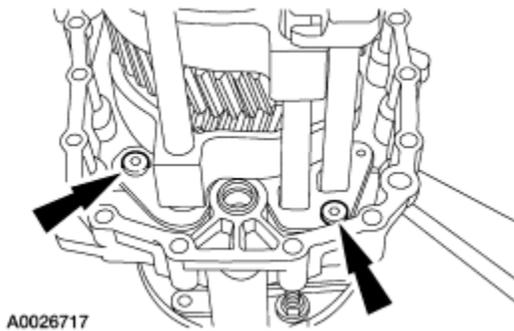


9. **NOTE:** Attach the Holding Fixture to the extension housing.

Install the extension housing.

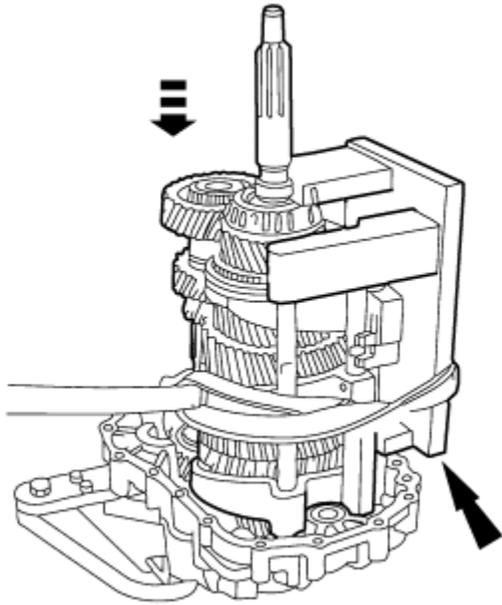


10. Install two shift interlock plate bolts. Do not tighten at this time.



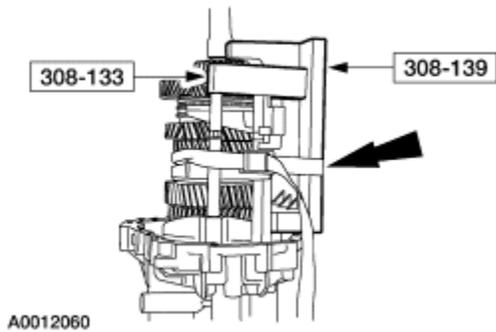
11. **NOTE:** An assistant will be needed to install the gear assembly into the bench fixture.

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



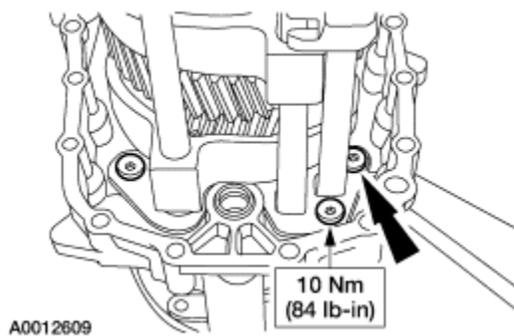
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12. Remove the special tools.



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

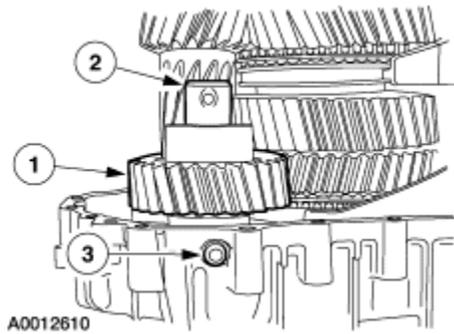


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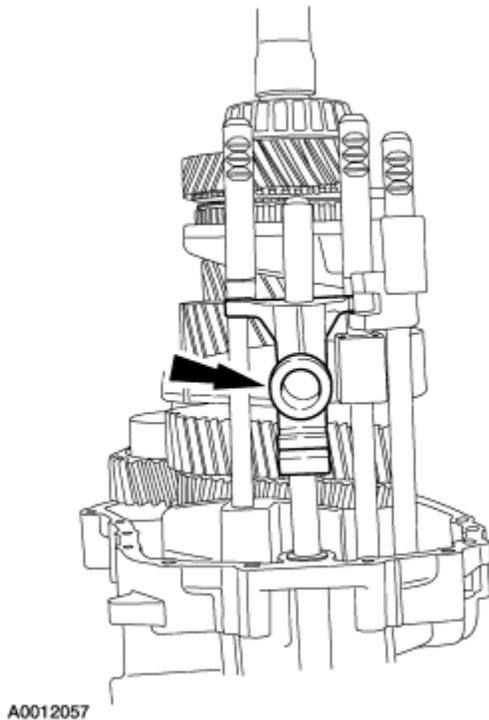
14. Install the reverse idler gear assembly.

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.

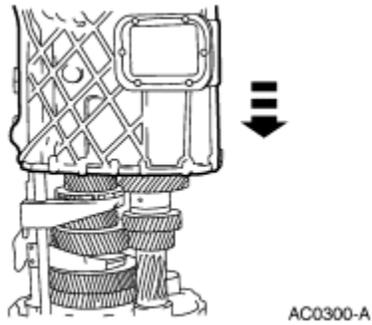


15. Install the main shift rail and main shift rail driver.

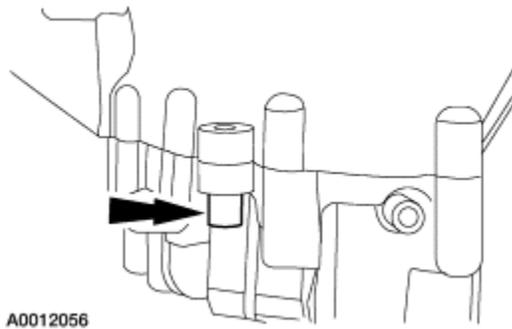


16.  **CAUTION: Make sure that the shift rail detents do not obstruct entry of the shift rails.**

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



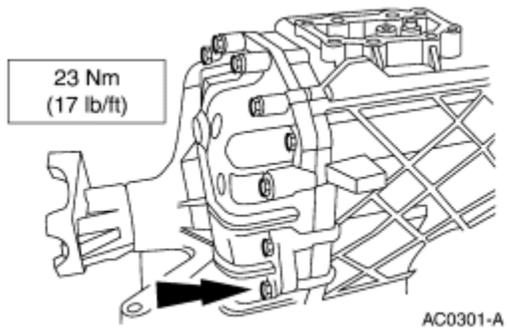
17. Tap the dowel pins into the upper case.



18. Rotate the transmission 180°.

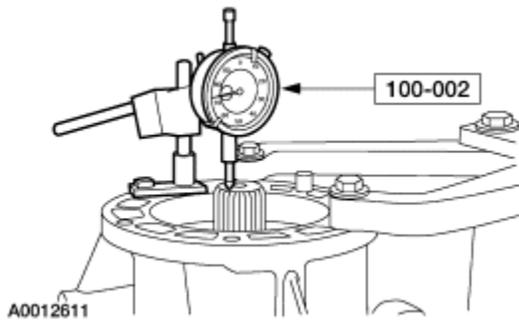
- The input shaft is pointing down.

19. Install the remaining 15 bolts.

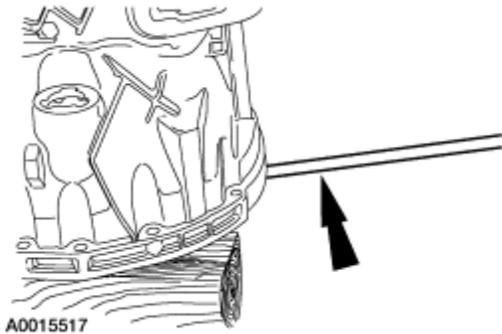


20. Install the special tool to measure mainshaft clearance.

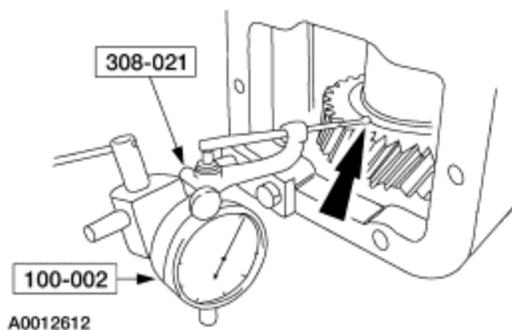
- Mount the indicator stand to the extension housing.
- Position the indicator on the end of the mainshaft.
- Zero the dial indicator.



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.

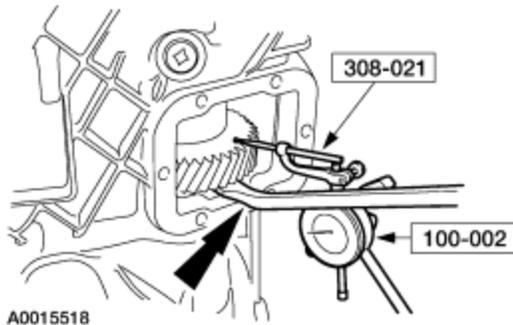


23. Install the special tool to measure countershaft clearance.
 - Mount the indicator stand to the case.
 - Position the indicator on the fourth gear of the countershaft.
 - Zero the dial indicator.



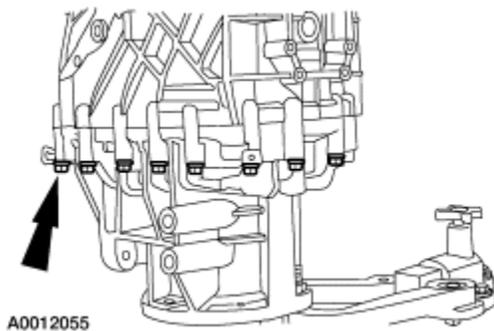
24. Measure countershaft clearance.

- 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.



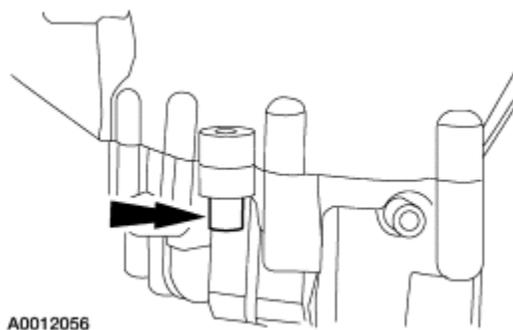
25. Reinstall the transmission into the bench fixture. Rotate the transmission so the input shaft is pointing upward.

26. Remove the 17 bolts.

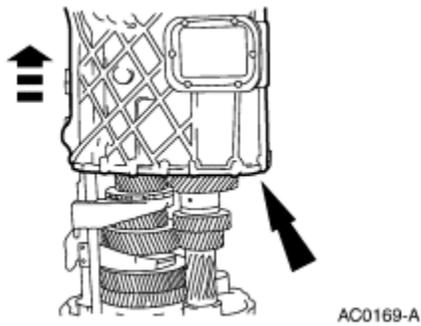


27. **NOTE:** The dowel pins do not have to be removed.

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

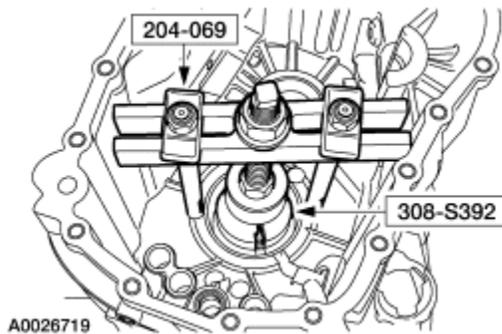


28. Carefully lift the main case off the extension housing. Set the case on the floor.



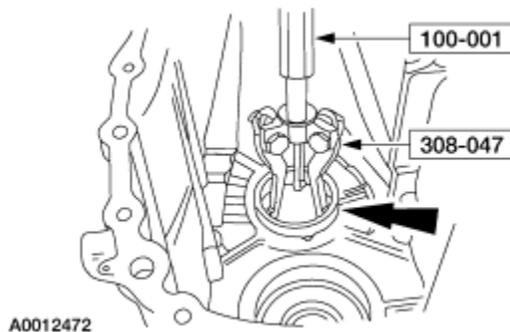
29. Using the special tools, remove the input shaft bearing cup.

- 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.

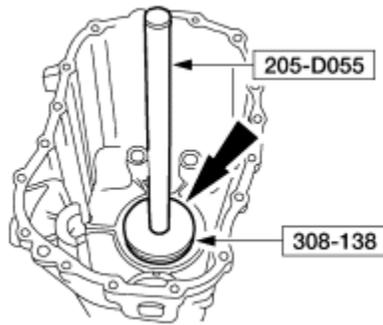
- If a new bearing was installed on the countershaft, install a new cup.



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.

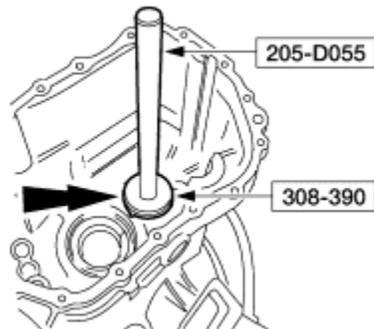


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32. **NOTE:** Using the Heat Gun, heat the case bearing cup area to aid installation.

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.**

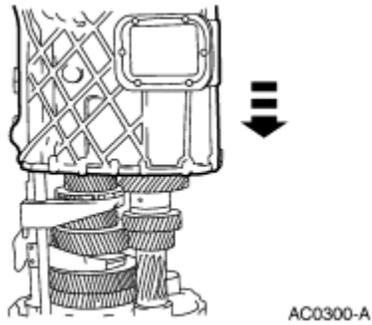
⚠ CAUTION: Use an oil stone or sanding block to clean the mating surfaces.

⚠ CAUTION: Do not use a silicone sealing compound.

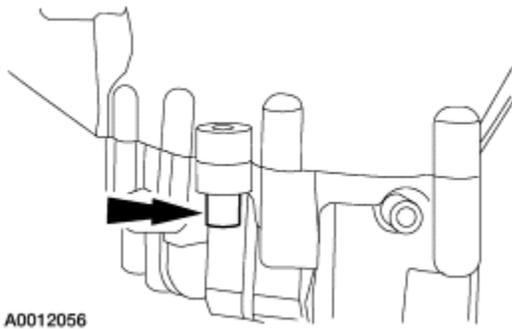
NOTE: Do not wait longer than ten minutes to tighten the bolts due to the rapid cure time of the sealant.

Carefully install the case onto the extension housing.

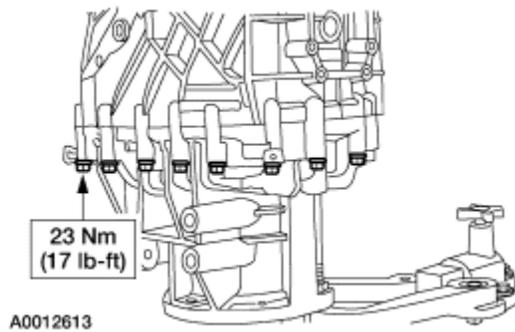
- Using Gasket Maker F8AZ-19B508-AB or equivalent meeting Ford specification WSK-M2G348-A5, apply a thin coat to the sealing surface of the case and the extension housing.



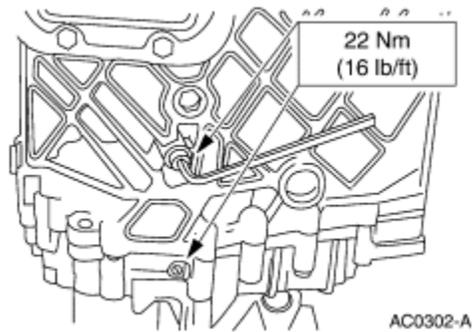
34. Tap the dowel pins into the upper case.



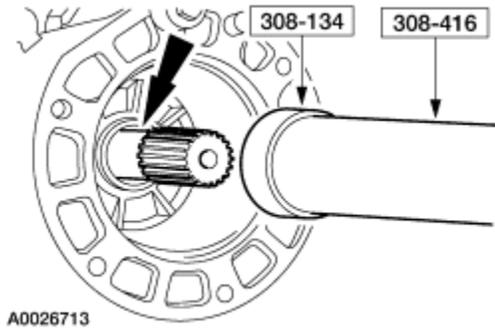
35. Install the 17 bolts.



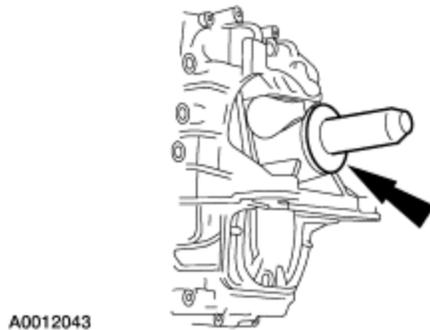
36. Install a new seal and the upper reverse idler bolt. Tighten both the upper and lower bolts.



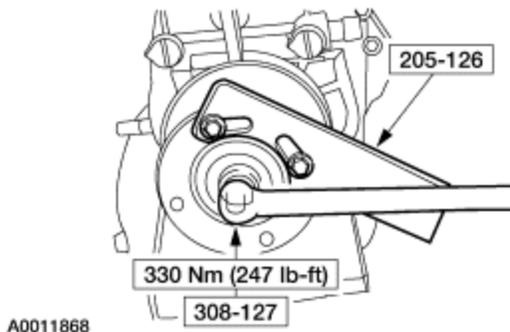
37. On 4-wheel drive vehicles, use the special tool and install a new output oil seal.
- Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.



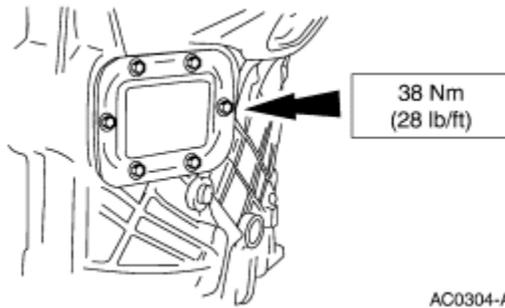
38. On 2-wheel drive vehicles, use the special tool and install a new output oil seal.
- Coat the outer diameter of the new seal with Gasket and Trim Adhesive F3AZ-19B508-AA or equivalent.



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.



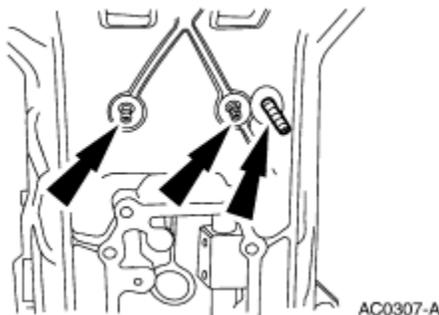
40. On all vehicles, install the PTO covers with new gaskets.
- Apply Threadlock and Sealer EOAZ-19554-AA or equivalent meeting Ford specification WSK-M2G351-A5 to the threads of the PTO cover bolts.



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.

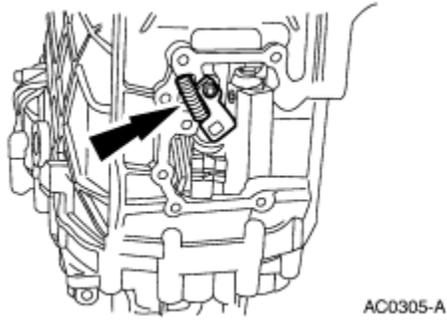


42. **⚠ CAUTION: The procedure must be followed exactly to make sure that the interlock function operates correctly.**

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

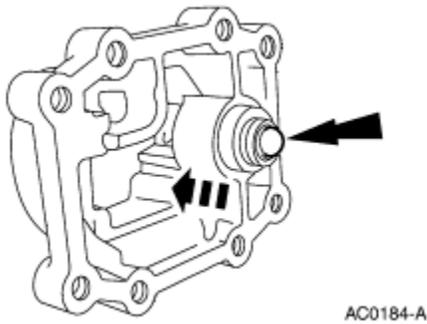
Position the fifth-reverse gear interlock plate into its installed position. Using Gasket Maker F8AZ-19B508-AB or equivalent meeting Ford specification WSK-M2G348-A5, apply a thin coat to the sealing surface of the shift control housing on the case.

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



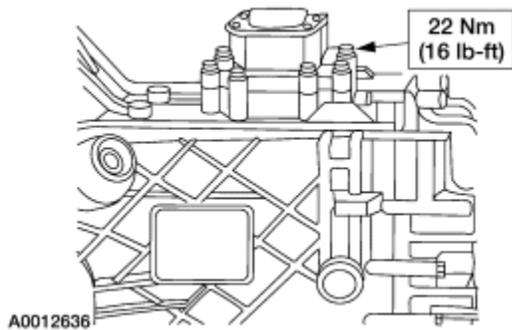
43. Install the detent.

- 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.

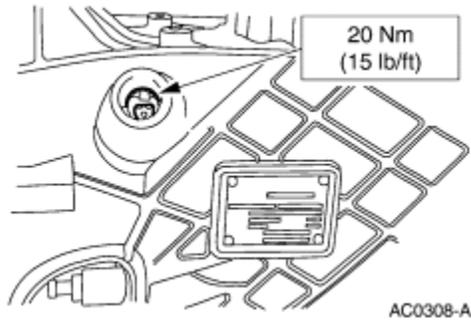


44. Install the shift housing.

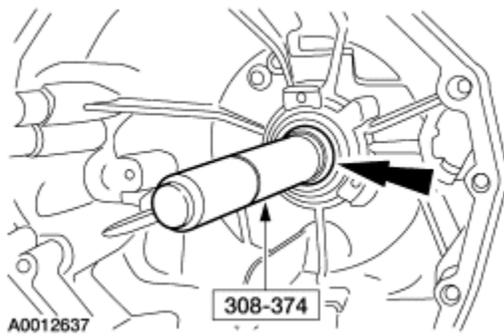
- Rotate the transmission to the horizontal position.
- Check the functioning of the interlock. Temporarily install the shift lever. The nose on the shift lever located just above the ball must point toward the interlock plate.



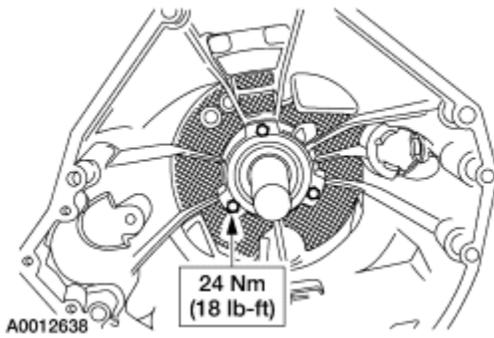
45. Install the reverse lamp switch with a new seal.



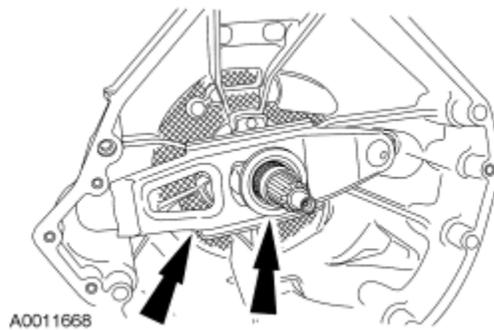
46. Using the special tool, install the input shaft seal.



47. Install the guide tube.

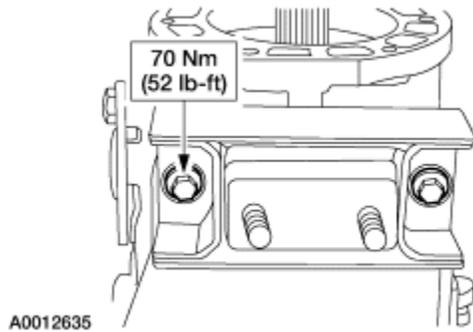


48. Install the clutch release lever and the clutch release hub and bearing.



49. Remove the transmission from the Holding Fixture.

50. Install the transmission mount.



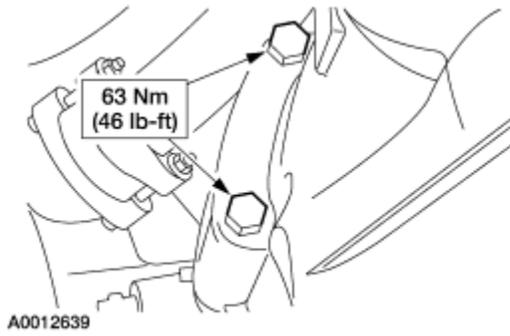
SECTION 308-03A: Manual Transmission —
Model S5-47 ZF
INSTALLATION

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

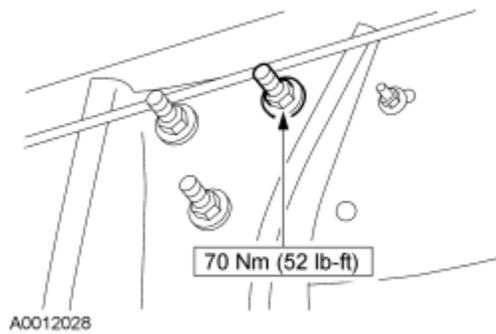
Transmission

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

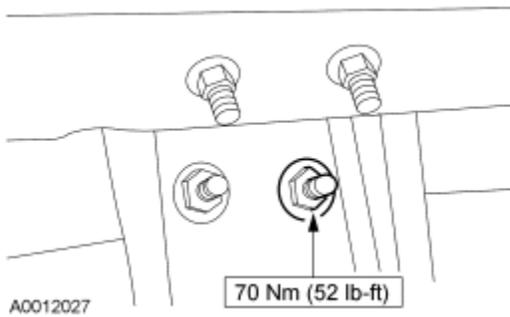
1. Using the High Lift Transmission Jack, raise and position the transmission to the engine and clutch.
 - Use a suitable clutch aligner to align the clutch disc.
2. Install the nine bolts.



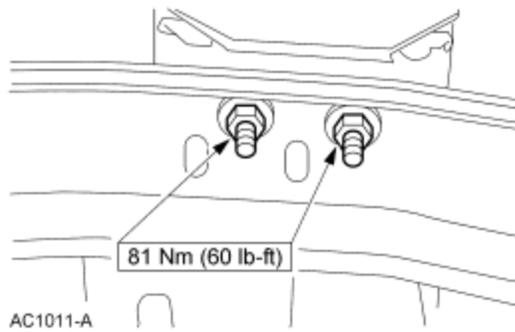
3. Install the crossmember bolts.



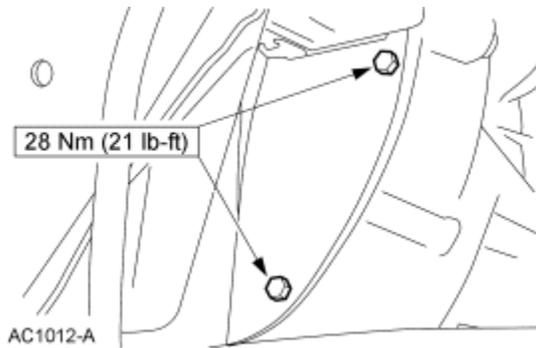
4. Install the nuts.



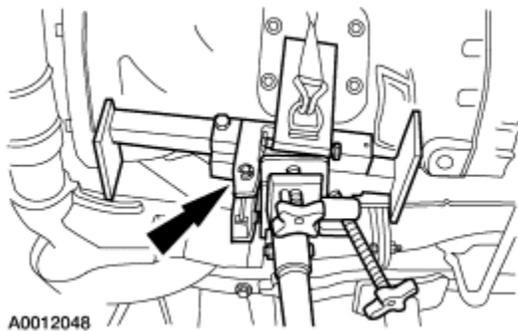
5. Install the nuts.



6. Install the bolts.

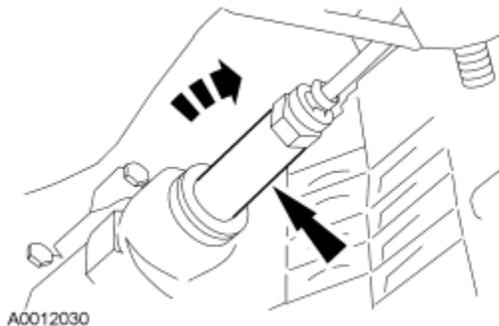


7. Remove the transmission jack.



8. Install the clutch slave cylinder.

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



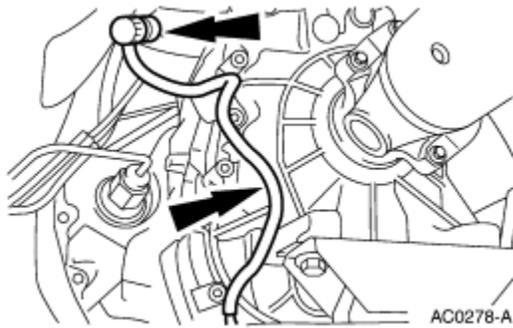
9. Install the starter. For additional information, refer to [Section 303-06B](#).

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

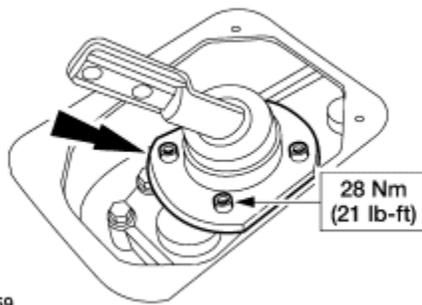
11. Connect the rear driveshaft. For additional information, refer to [Section 205-01](#).

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

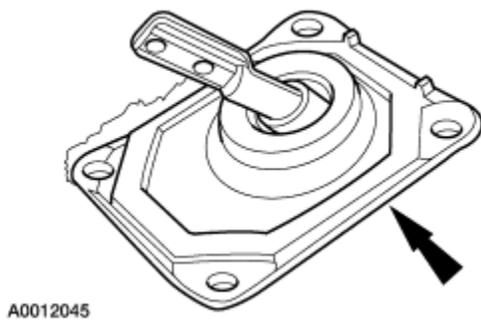
13. Connect the reverse lamp switch electrical connector then attach the harness to the transmission.



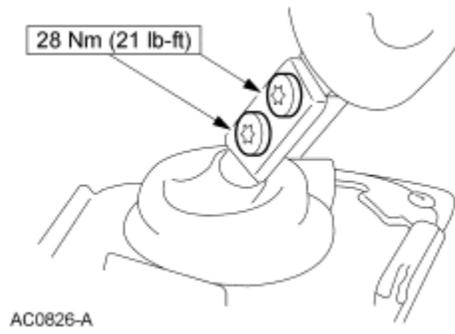
14. Refill the transmission with the specified amount.
 - Refill the transmission with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting Ford specification MERCON®.
15. Lower the vehicle.
16. Install a new gasket and the lower gear shift lever.



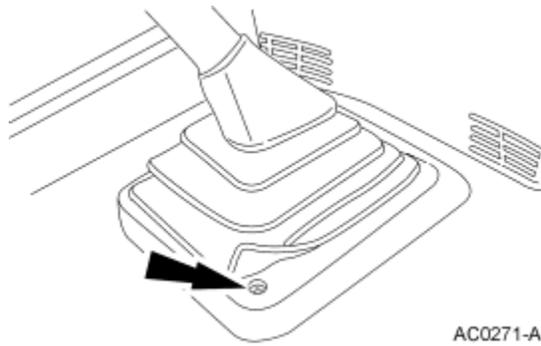
17. Install the gearshift lever upper boot.



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

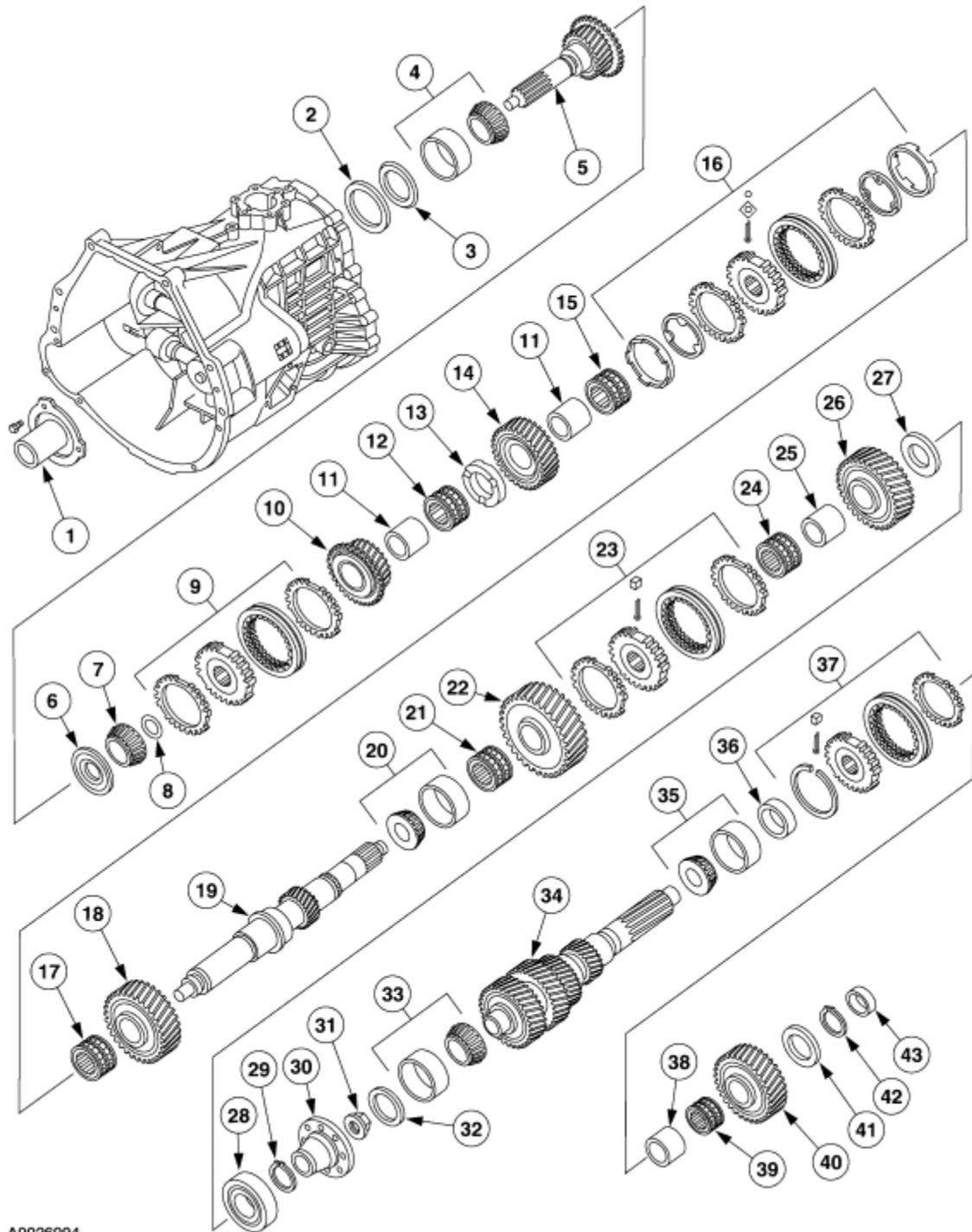
The S6-650 and the M6HD have six forward speeds that feature a LOW gear for take-off under heavy loads and a OVERDRIVE gear for highway driving conditions. The gear ratios are as follows:

- 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



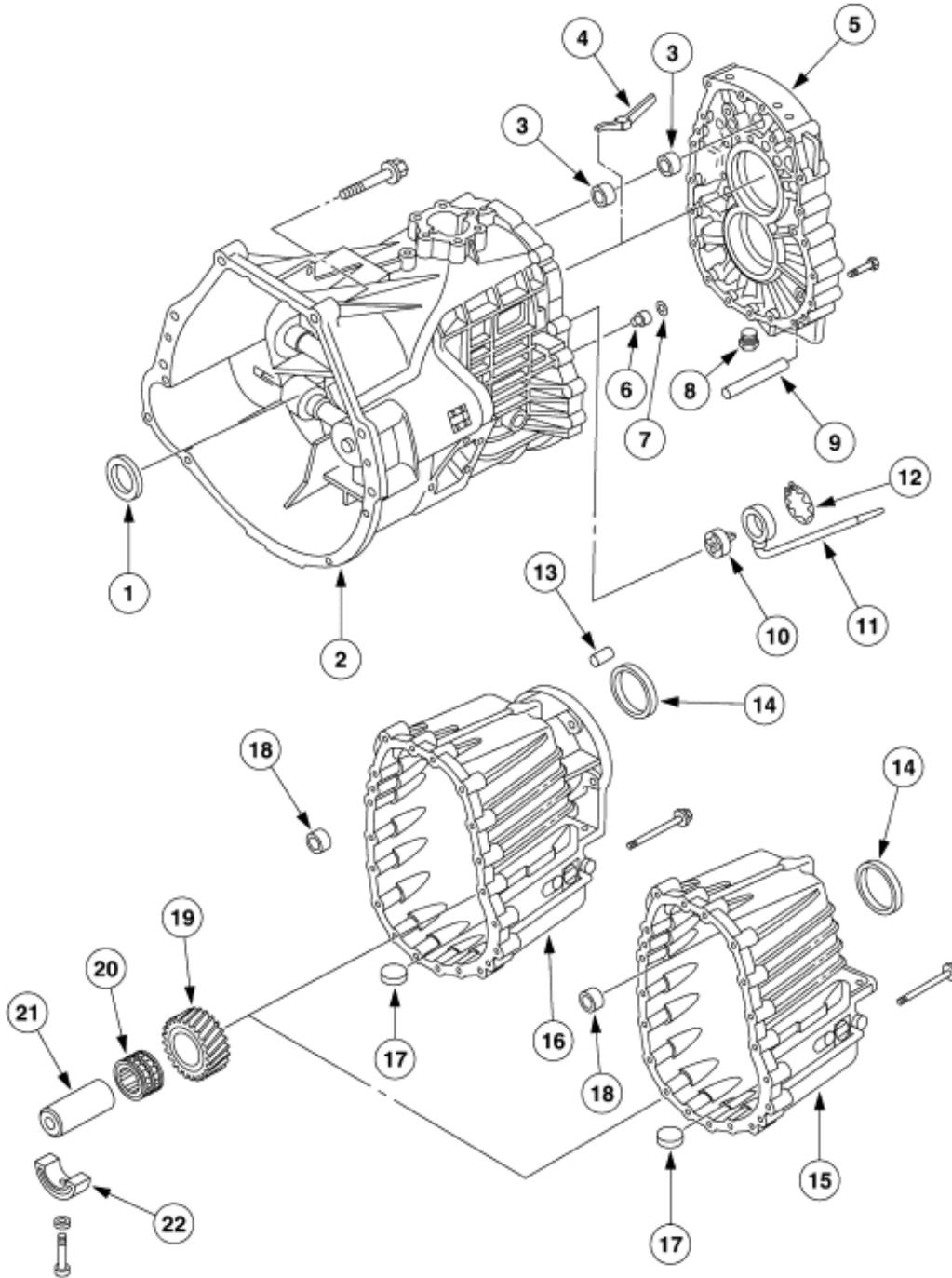
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Item	Part Number	Description
1	7050	Guide tube
2	7029	Input shaft shim (selective fit)
3	7046	Input shaft oil dam bearing ring
4	7025	Input shaft bearing and bearing cup
5	7017	Input shaft

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

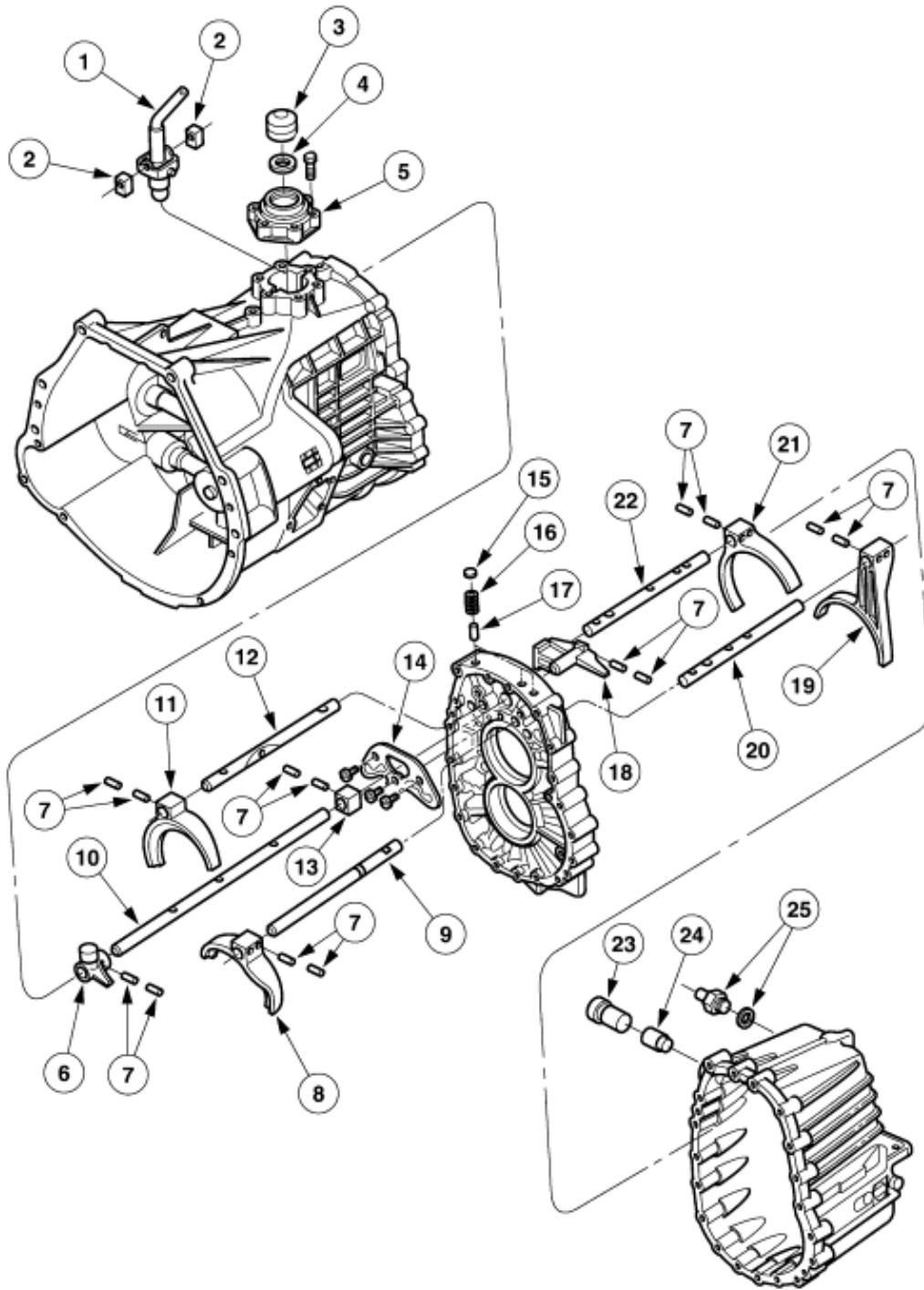
41	7A385	Countershaft rear thrust washer
42	7B331	Snap ring kit
43	7065	Countershaft rear bearing

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](#)

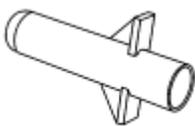
Manual Transmission

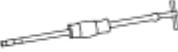
Refer to [Section 308-00](#).

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

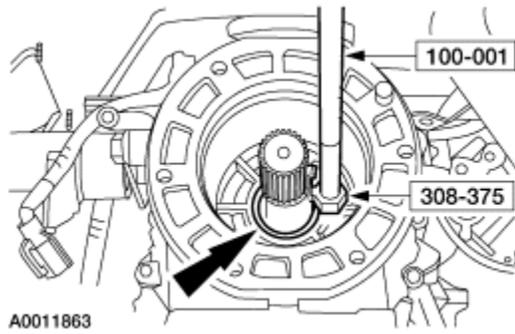
Removal

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](#).

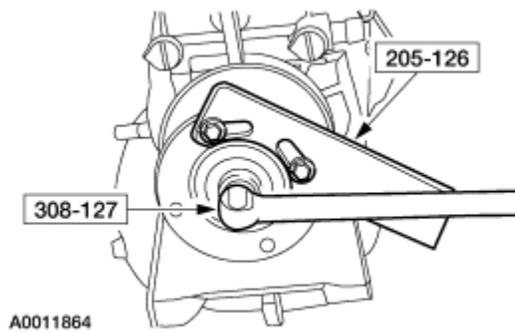
Vehicles with 4-wheel drive

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.

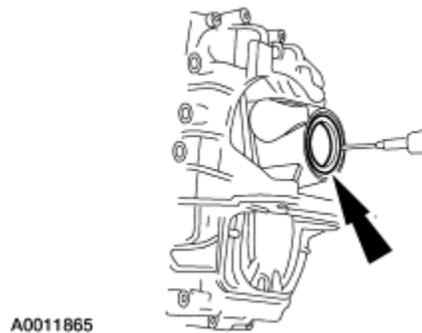


Vehicles with 2-wheel drive

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



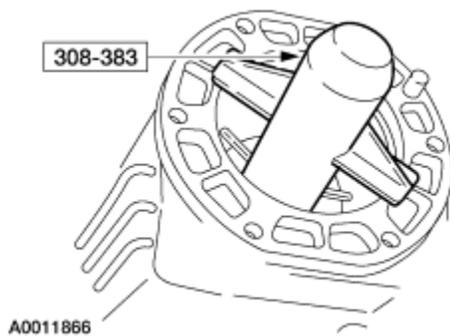
6. Remove and discard the output oil seal.



Installation

Vehicles with 4-wheel drive

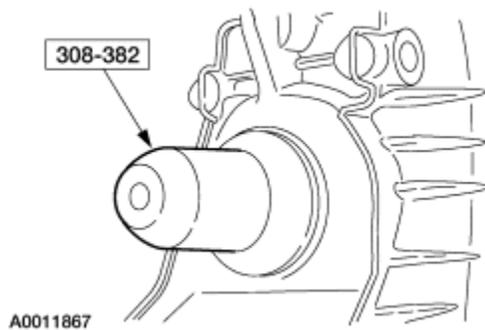
1. Using the special tool, install a new output oil seal.
 - Coat the outer diameter of the new seal with gasket and trim adhesive.



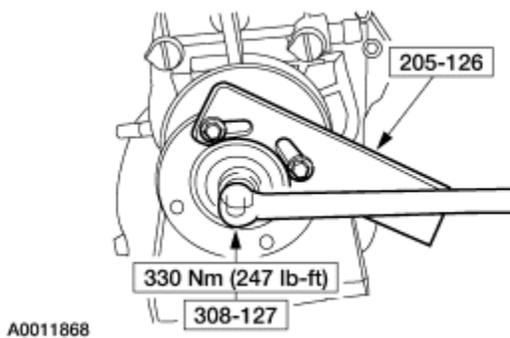
2. Install the transfer case. For additional information, refer to [Section 308-07B](#).

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](#).
-

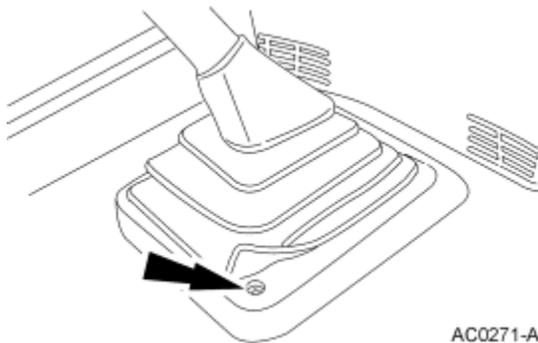
Shift Lever and Boot

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

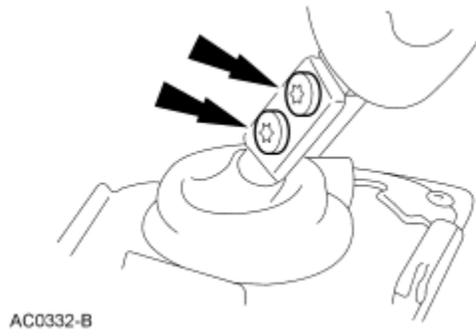
Material	
Item	Specification
Silicone Lubricant F7AZ-19G208-BA	ESR-M13P4-A
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (type II)

Removal

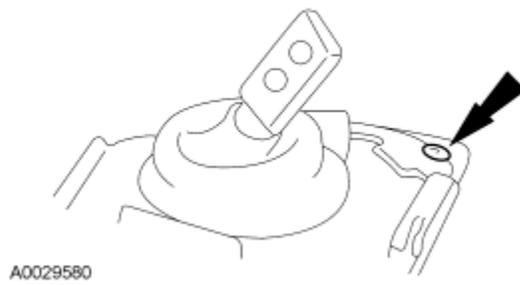
1. Remove the four screws and the shift lever boot.



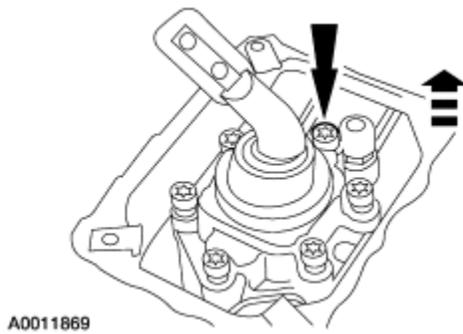
2. Remove the upper gearshift lever.



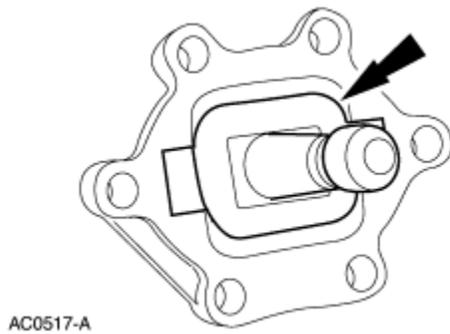
3. Remove the lower shift lever boot.



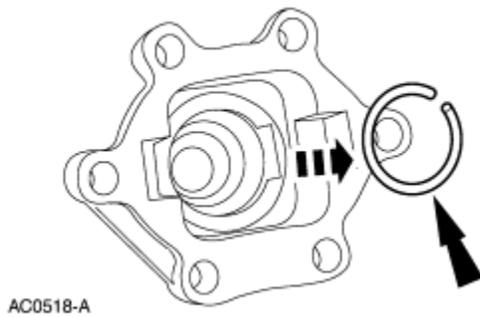
4. Remove the lower gearshift lever and the shift housing.



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

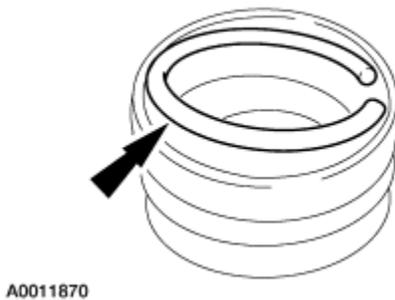


6. Remove the inner shift lever boot ring, then the shift lever boot.

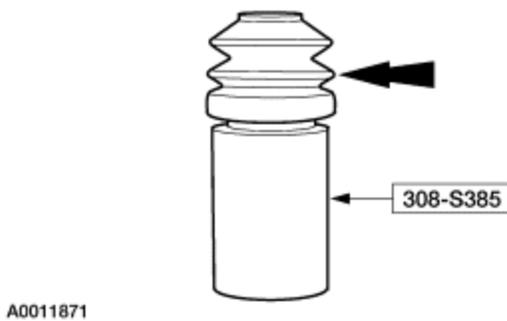


Installation

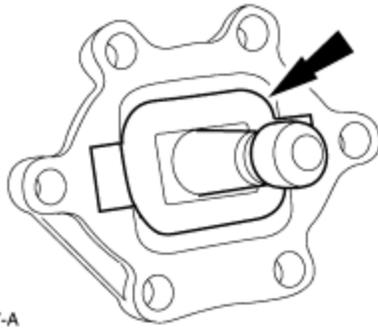
1. Install the inner shift lever boot ring into the shift lever boot.



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.



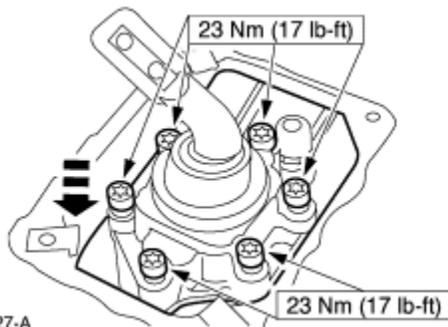
AC0517-A

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.

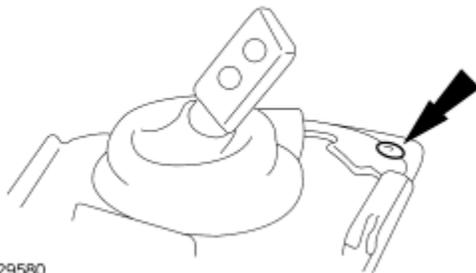
Install the shift housing.

- Apply gasket maker to the sealing surfaces.



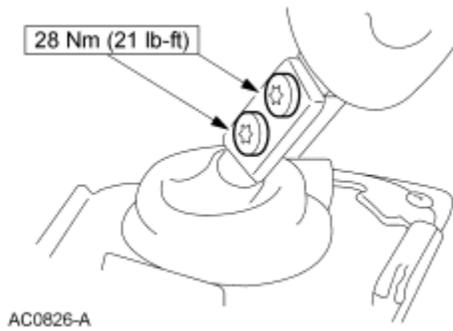
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6. Install the lower shift lever boot.

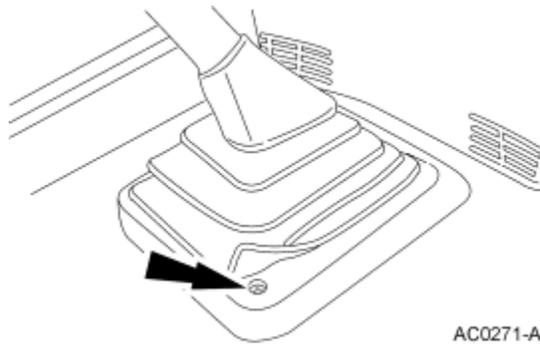


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7. Apply threadlock and sealer to the gearshift lever bolts, and install the upper gearshift lever.



8. Install the shift lever boot.



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

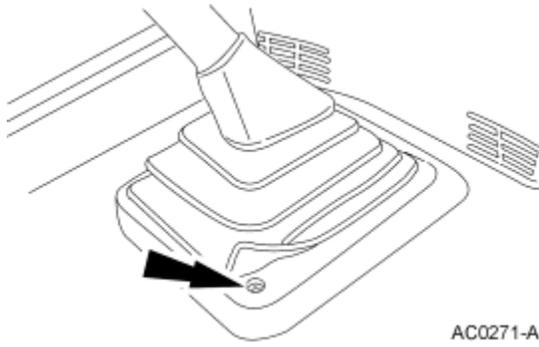
1999 F-Super Duty 250-550
 Workshop Manual
[Procedure revision date: 01/26/2000](#)

Transmission

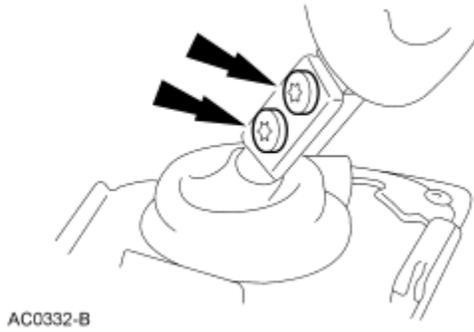
Special Tool(s)	
 <p>ST1130-A</p>	<p>Transmission Jack 014-00942</p>

All vehicles

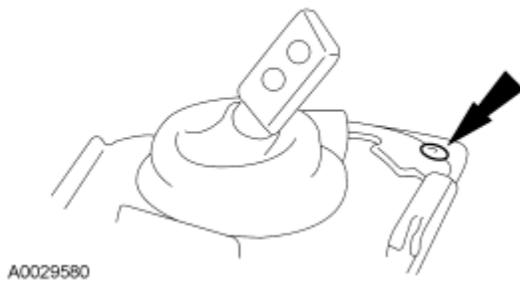
1. Remove the four screws and the outer shift lever boot.



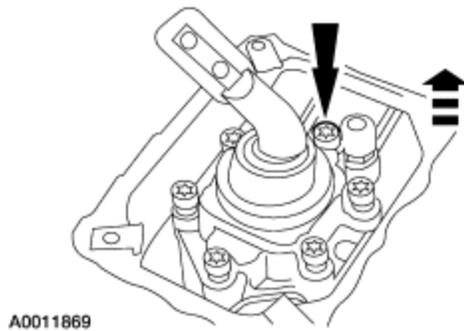
2. Remove the upper gearshift lever.



3. Remove the lower shift lever boot.

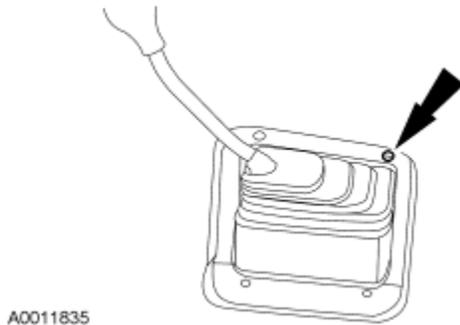


4. Remove the lower gearshift and shift housing.



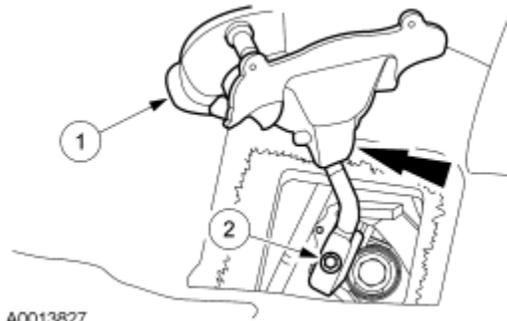
Vehicles with a manual shift lever

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



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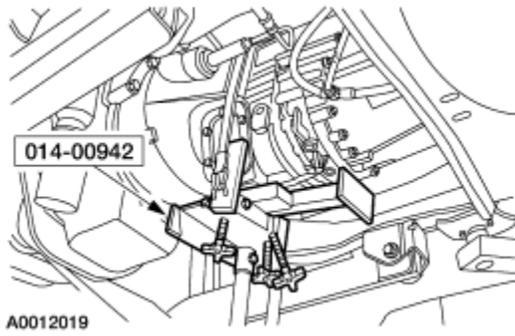
7. Remove the bolt that attaches the shift lever to the transfer case control lever assembly, and remove the shift lever, and the bezel and boot assembly.
 1. Slide the bezel and boot assembly upward on the shift lever.
 2. Remove the bolt, the shift lever, and the bezel and boot assembly.



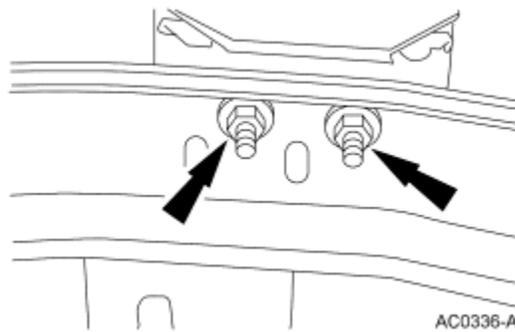
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All vehicles

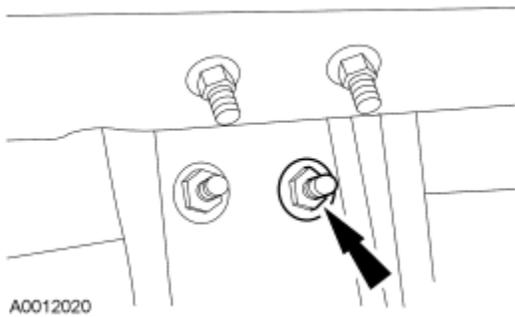
8. Raise and support the vehicle. For additional information, refer to [Section 100-02](#).
9. If the transmission is being disassembled, drain the transmission fluid.
10. Remove the starter. For additional information, refer to [Section 303-06B](#).
11. Disconnect the rear driveshaft and position it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



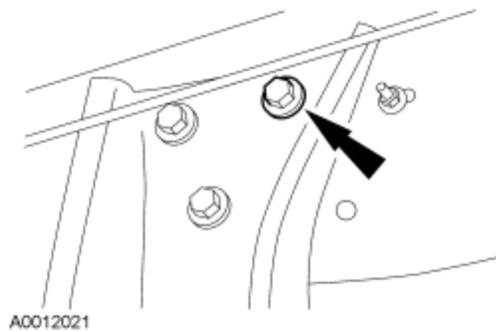
15. Remove the transmission mount nuts.



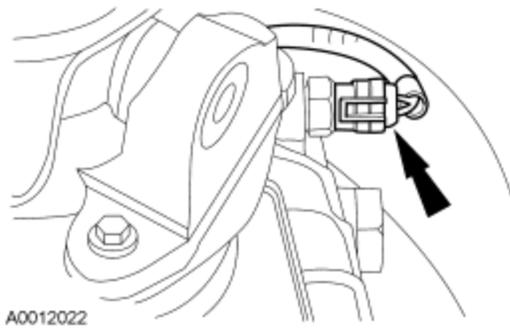
16. Remove the RH crossmember nuts.



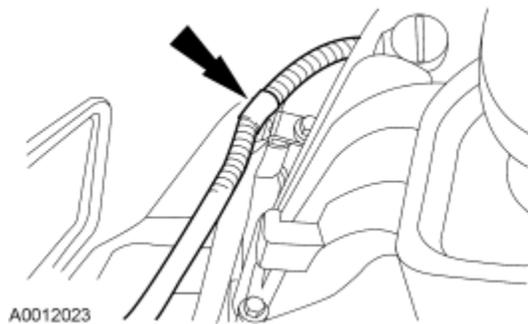
17. Remove the LH crossmember bolts.



18. Disconnect the reverse lamp switch electrical connector.

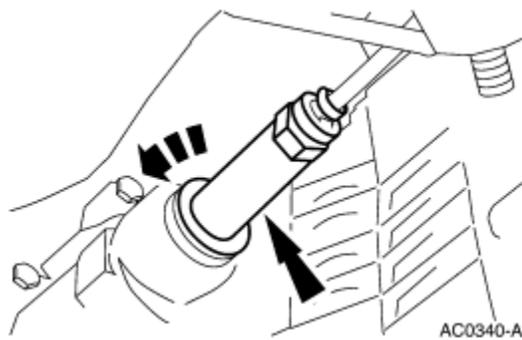


19. Disconnect wiring harness from the transmission.

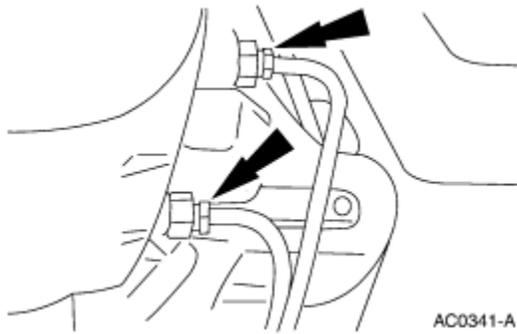


20. Remove the clutch slave cylinder and position it aside.

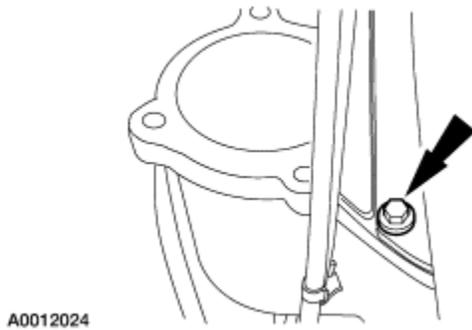
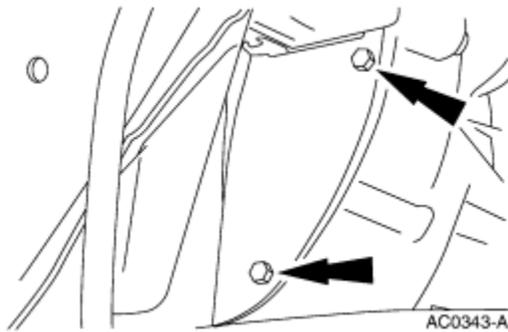
- Push the clutch slave cylinder inward, then rotate counterclockwise 45 degrees to remove.



21. Disconnect the transmission cooling tubes.

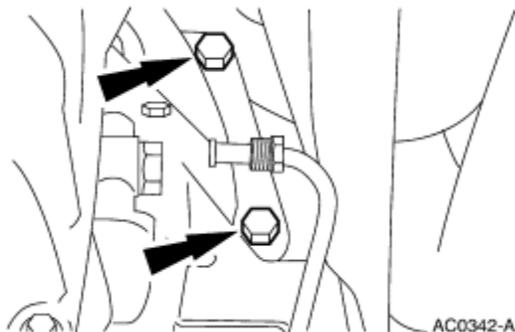


22. Remove the dust cover bolts.



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.

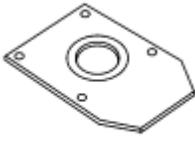
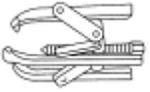
- Move the transmission rearward until the input shaft is clear of the clutch, then lower from the vehicle.

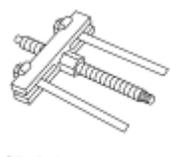
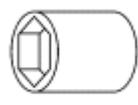
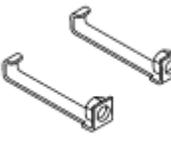
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY

1999 F-Super Duty 250-550
 Workshop Manual

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

Transmission

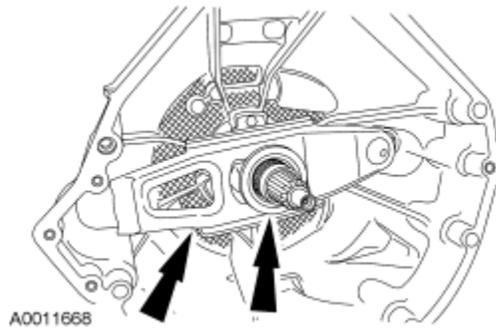
Special Tool(s)	
 <p>ST2168-A</p>	Fixture, Gear Pack 308-381
 <p>ST1257-A</p>	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 <p>ST1184-A</p>	2 or 3 Jaw Puller 205-D027 (D80L-1013-A)
 <p>ST2111-A</p>	Remover, Jet Plug 310-005 (T77L-9533-B)
 <p>ST1835-A</p>	Shaft Protector Set 205-DS004 (D80L-625-A)

 <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

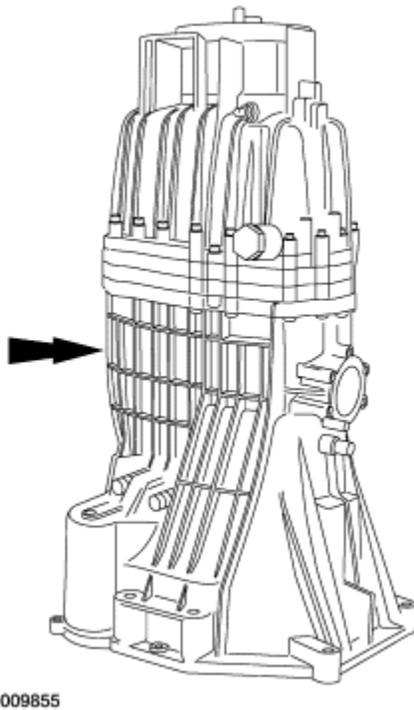
All vehicles

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.



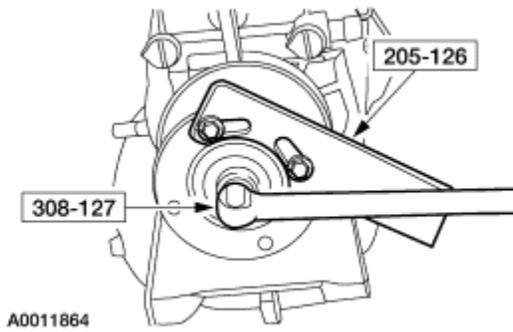
4. **NOTE:** For vehicles equipped with gasoline engines, the transmission must be elevated, 50-101 mm (2-4 inches), to prevent damage to the input shaft.

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



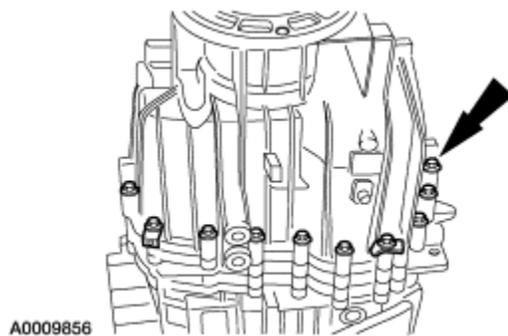
4x2 vehicles

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



All vehicles

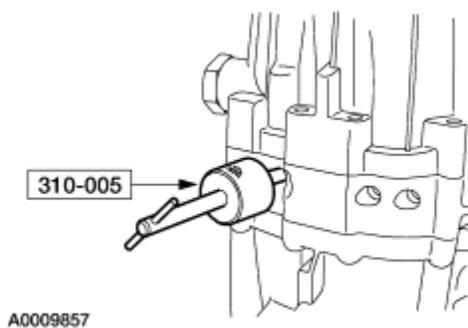
6. Remove the 19 bolts.



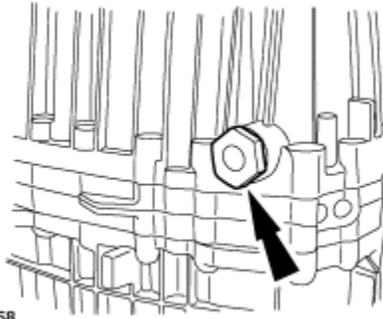
7. **NOTE:** Use a 1/8 inch center punch to create a pilot hole in the plug before installing the tool. Using the Jet Plug Remover to make the pilot hole will damage the tool.

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.

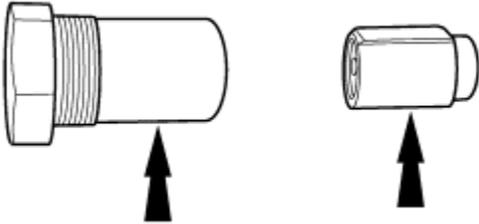


8. Remove the main shift detent.



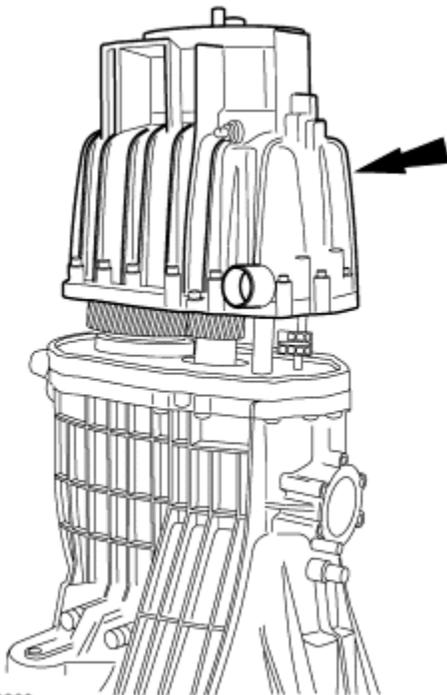
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9. Separate the main shift detent from the detent plunger.
 - Inspect the detent plunger for wear or damage. Install a new detent plunger as necessary.



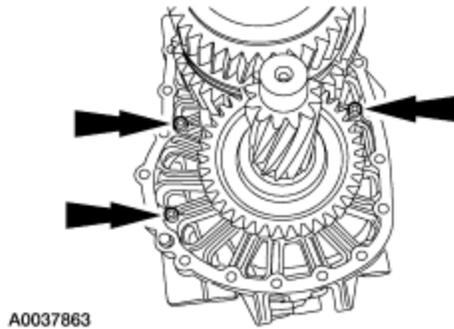
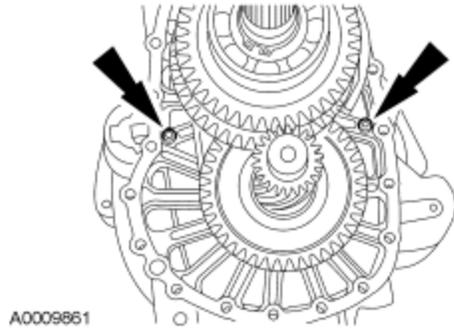
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10. Remove the extension housing from the intermediate housing.
 - Using a soft-faced hammer, tap the extension housing lightly to break the gasket seal.

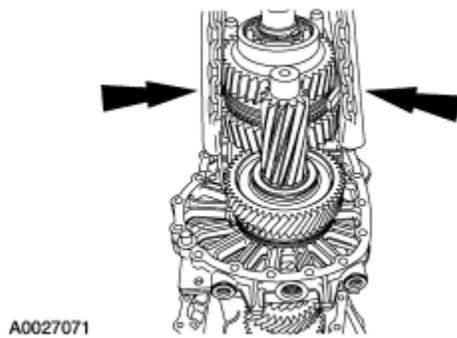
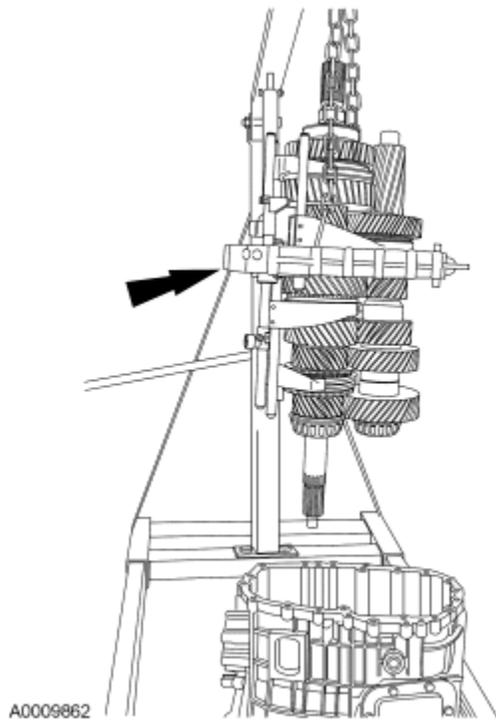


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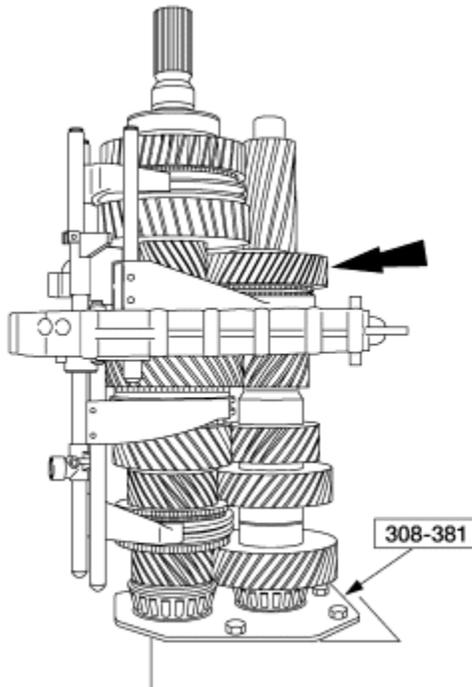
11. Remove the intermediate housing to case bolts.
- Early production vehicles will have three bolts.



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.

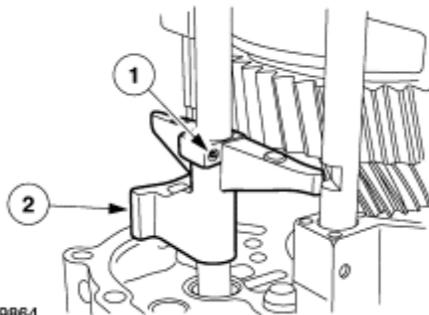


13. Position the intermediate housing and gear assembly on the special tool.
- Securely fasten the holding plate to a sturdy work bench.



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.

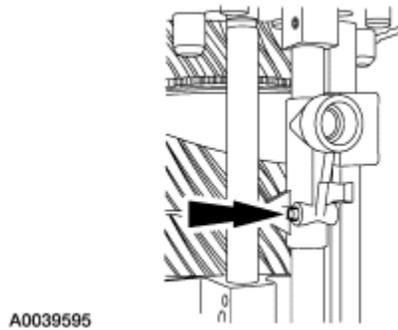
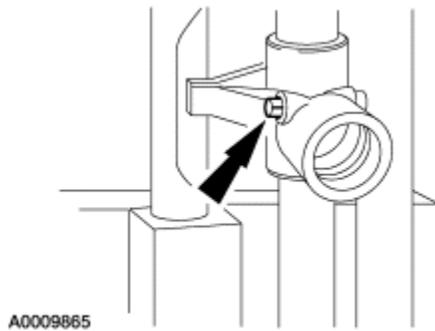


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15. **NOTE:** The shift finger is also the first/second and third/fourth rail driver.

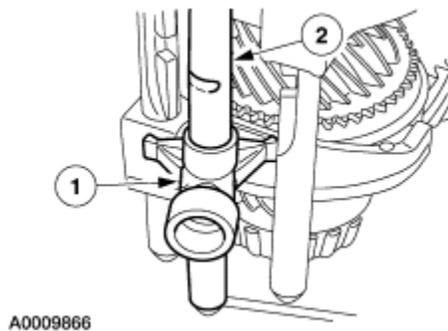
Remove the lower roll pins.

- 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.



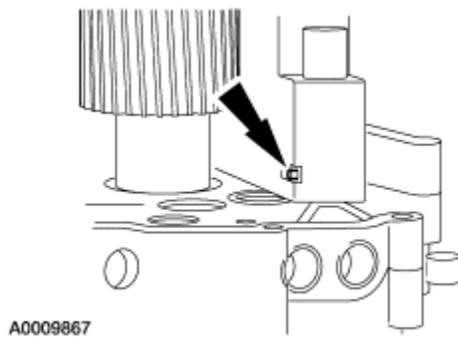
16. Remove the lower shift finger and the main shift rail.

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



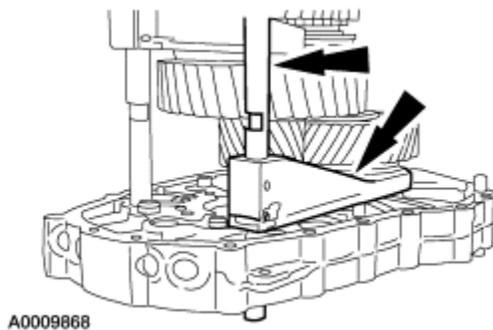
17. Align the interlock plate into second gear position, engage second gear, then remove the two fifth gear shift fork roll pins.

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



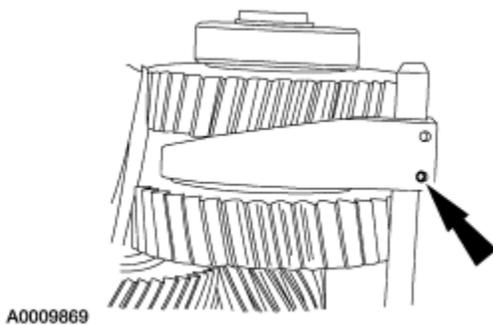
18. Remove the fifth gear shift fork and shift rail.

- 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.



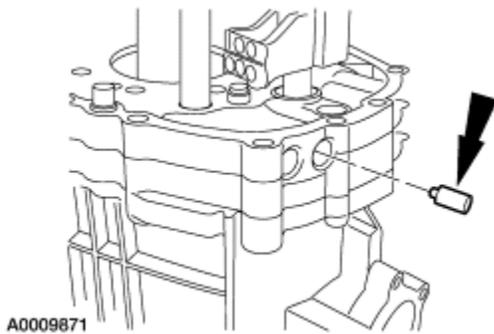
20. Remove the low/reverse gear shift fork and shift rail.

- 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.

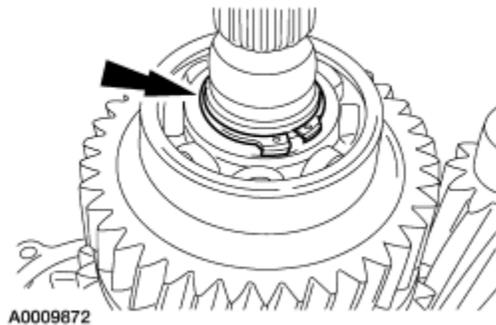


21. Remove the shift rail detents, if necessary.

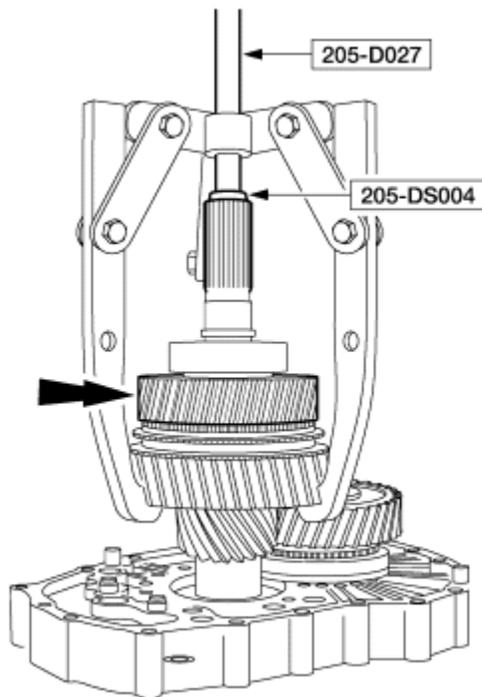
- The shift rail detents can be difficult to remove. Using a heat gun, apply heat to the intermediate plate to ease removal.



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

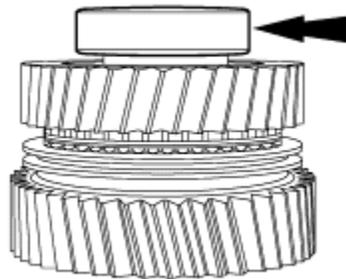


23. Using the special tools, remove the mainshaft rear bearing, the output bearing thrust washer, mainshaft low gear, the mainshaft low gear bushing, the synchronizer assembly (low and reverse) and the mainshaft reverse gear.



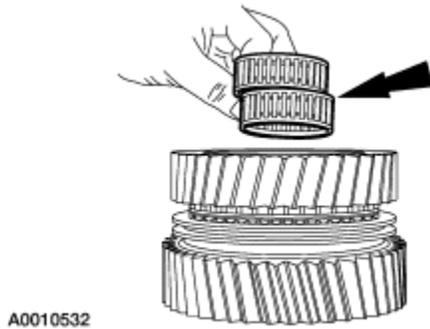
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24. Remove the mainshaft rear bearing and the output bearing thrust washer from the low and reverse assembly.
- Inspect the bearing for wear or damage. Install a new bearing as necessary.
 - Always install new bearings and cups as a set. Do not install one without the other.

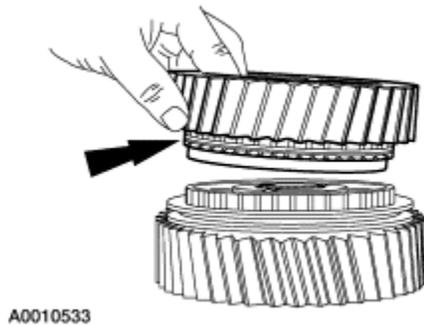


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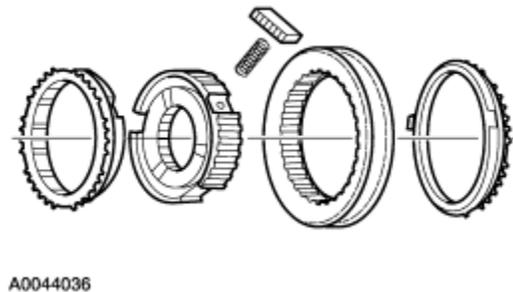
25. Remove the mainshaft needle bearings.
- Inspect the bearings for wear or damage. Install new bearings as necessary.



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.

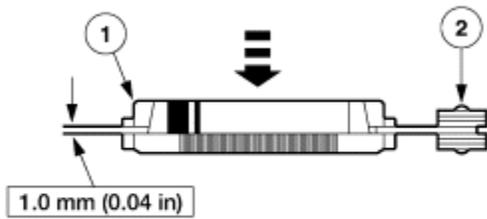


27. Disassemble the low and reverse synchronizer assembly.
- Inspect the components for wear or damage. Inspect the internal surface of the synchronizer rings for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.



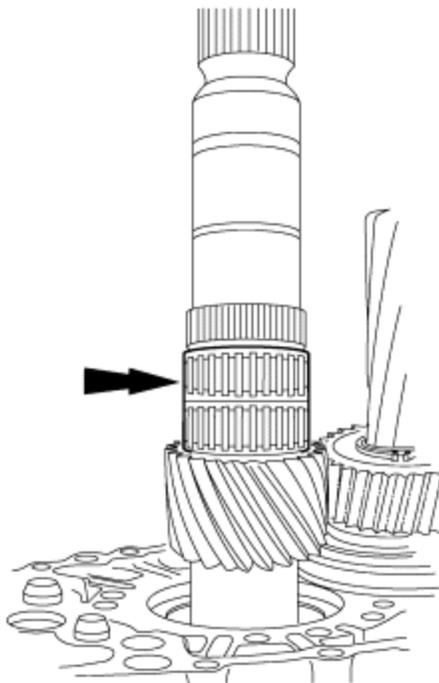
28. Check the clearance between the synchronizer ring and the gear.
1. Place the synchronizer ring onto the synchronizer sliding sleeve. Position the synchronizer ring on the gear.
 2. Insert a feeler gauge and measure the clearance, while applying pressure and rotating the synchronizer ring. The clearance 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 an 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.



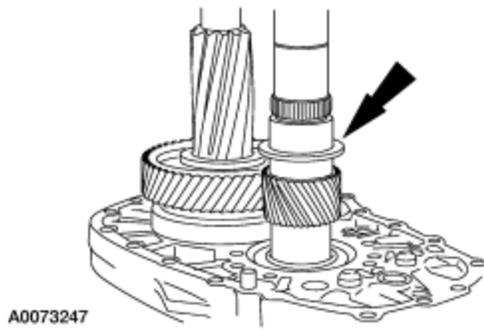
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29. Remove the mainshaft needle bearing.

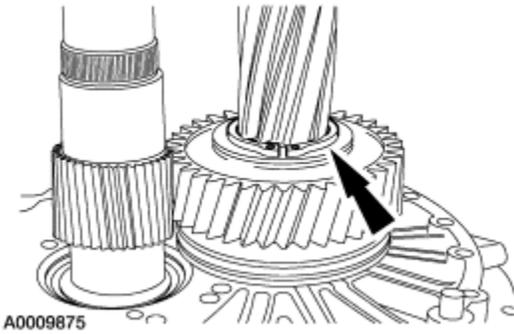


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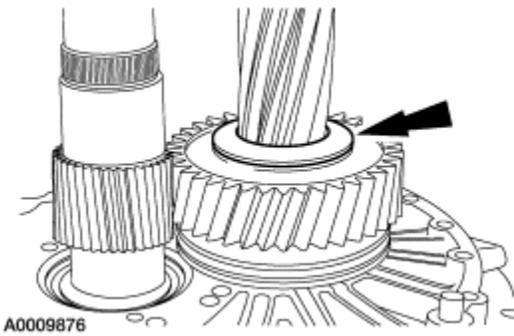
30. For vehicles equipped with a 6.0L engine, remove the low gear thrust washer.



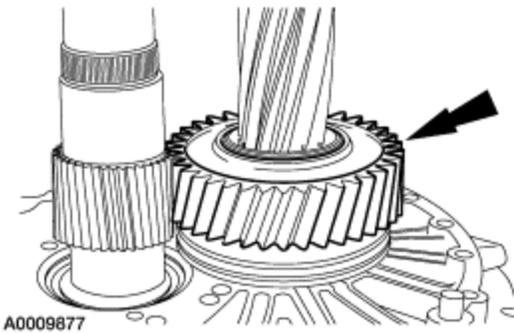
31. Remove and discard the snap ring.



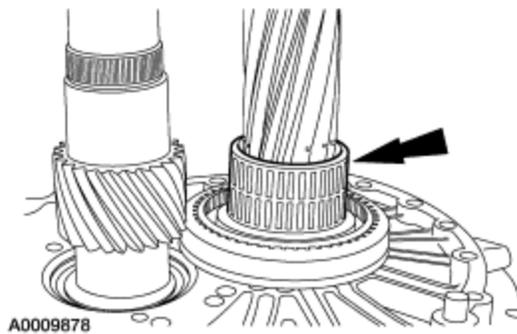
32. Remove the countershaft rear thrust washer.



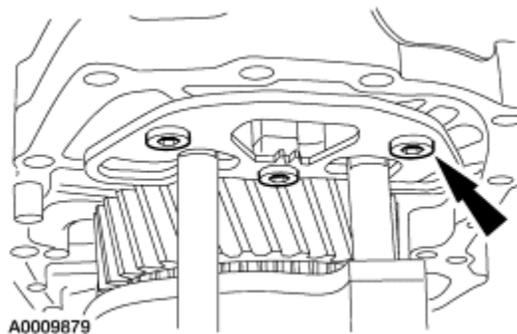
33. Remove fifth gear.



34. Remove the countershaft needle bearing.



35. Remove the interlock plate bolts.

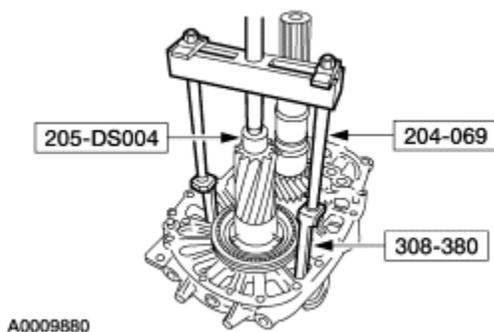


36. **NOTE:** Do not use power tools to remove.

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

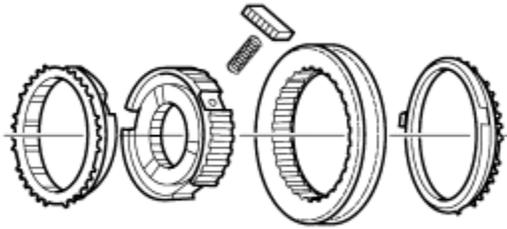
Using the special tools, remove the countershaft bushing, the countershaft fifth gear synchronizer assembly and the intermediate housing.

- 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.

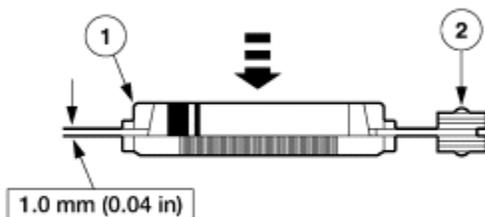
- Inspect the components for wear or damage. Inspect the internal surface of the synchronizer ring for a contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.



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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.



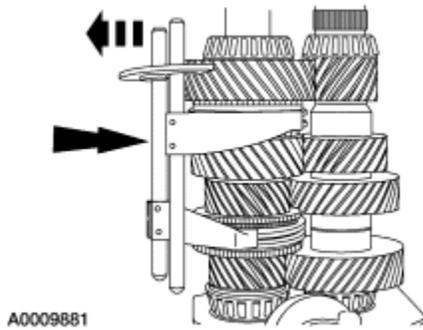
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39. **⚠ CAUTION: To prevent damage, do not heat the mainshaft rear bearing, the countershaft or mainshaft rear thrust washer, the mainshaft bushing or the countershaft bushing higher than 150°C (300°F) maximum.**

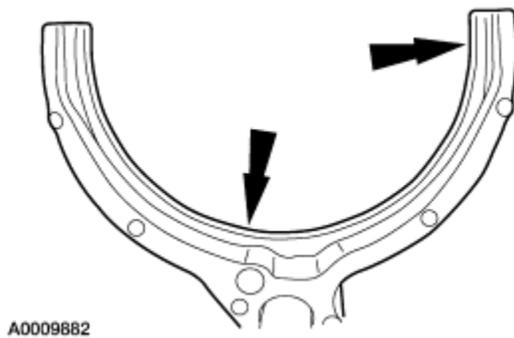
NOTE: Make sure the components are heated to 150°C (300°F) for reassembly.

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.

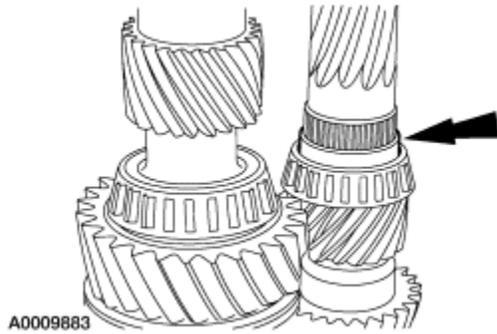


42.  **CAUTION: To prevent damage, do not heat the bearings higher than 150°C (300°F) maximum.**

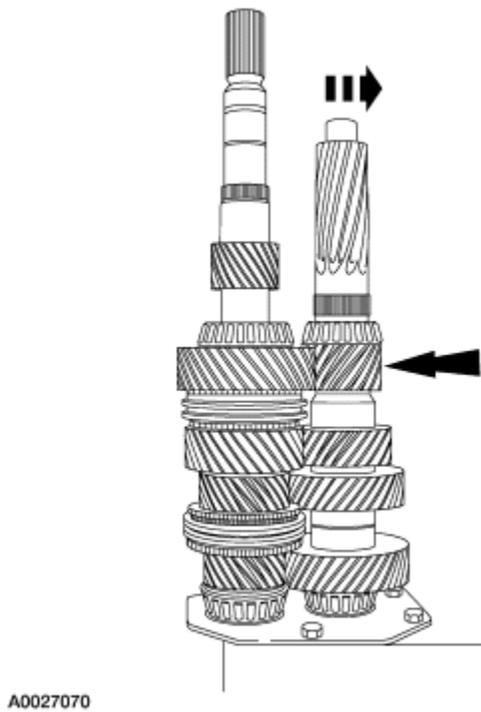
Inspect the mainshaft middle bearing, the countershaft middle bearing and the bearing cups in the intermediate housing for wear or damage. Install new components as necessary.

- 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

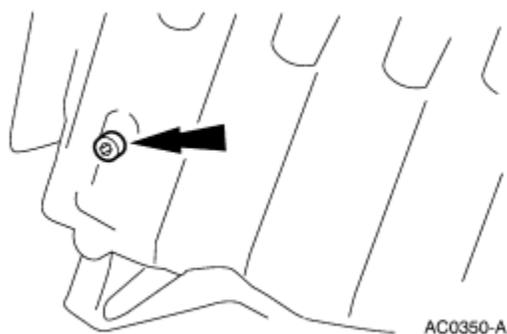
Special Tool(s)

<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>

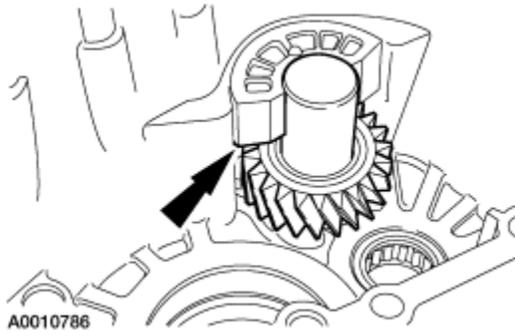
Disassembly

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

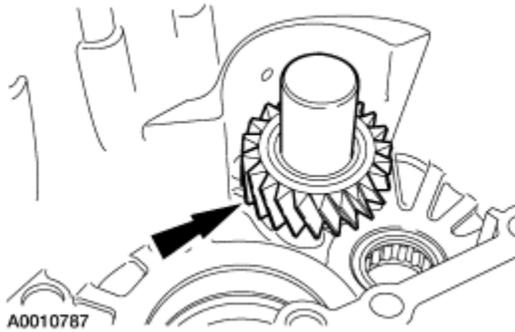
Remove the bolt and seal. Discard the seal.



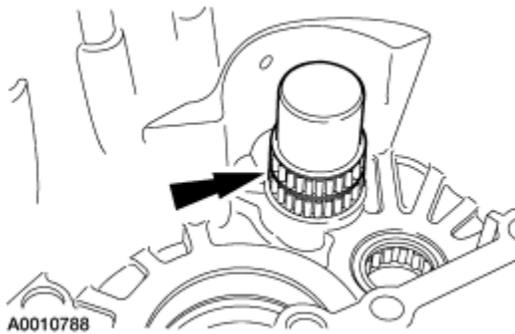
2. Remove the reverse idler shaft support.



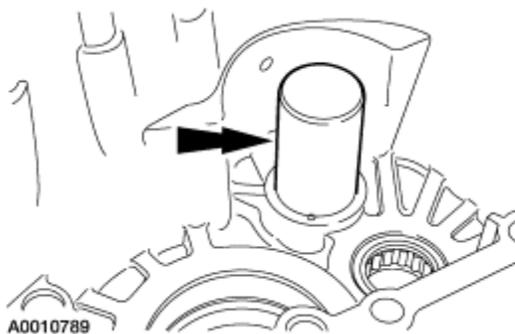
3. Remove the reverse idler gear.



4. Remove the reverse idler gear bearing.

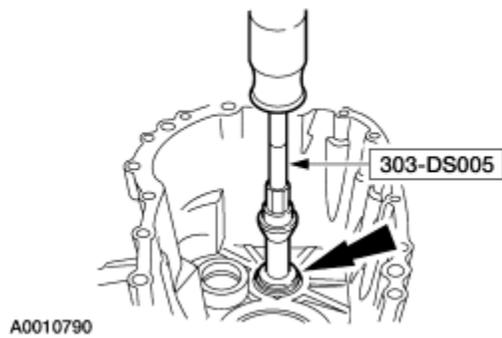


5. Remove the reverse idler shaft.



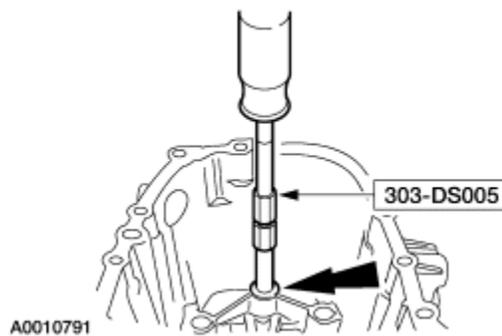
6. **NOTE:** Inspect the countershaft front bearing for wear or damage before removing.

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

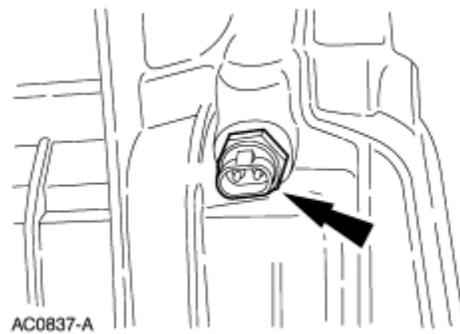


7. **NOTE:** Inspect the bearing for wear or damage before removing.

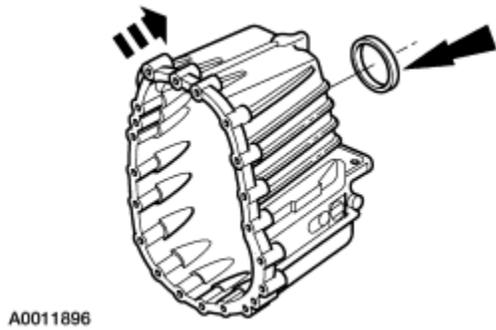
Using the special tools, remove and discard the shift rail bearing.



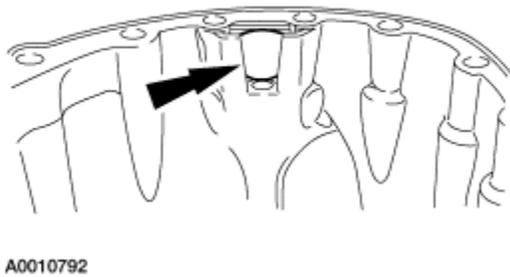
8. Remove the reverse lamp switch and seal. Discard the seal.



9. Remove and discard the output oil seal.



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

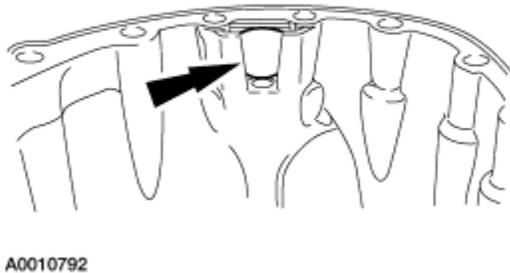


Assembly

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

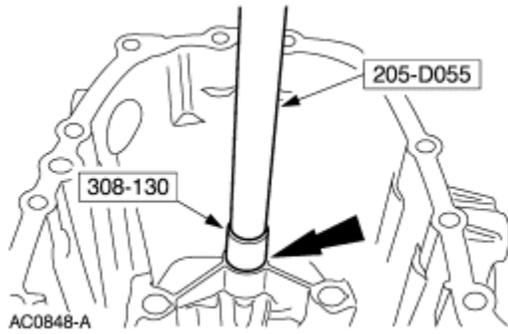
Apply adhesive to the magnet and install.

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

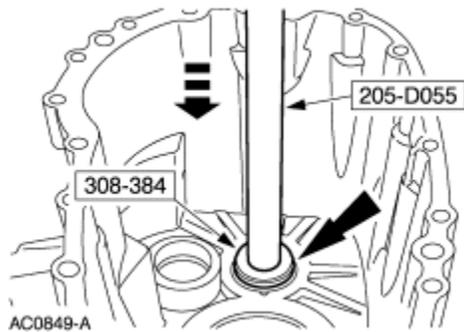


2. Using the special tools, install a new shift rail bearing.

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



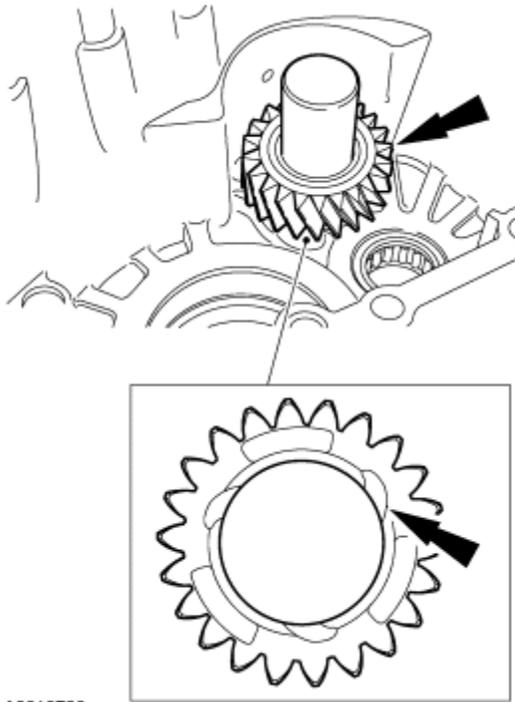
3. Using the special tool, install a new countershaft bearing.
 - Using a Heat Gun, heat the bearing area of the housing to ease installation.



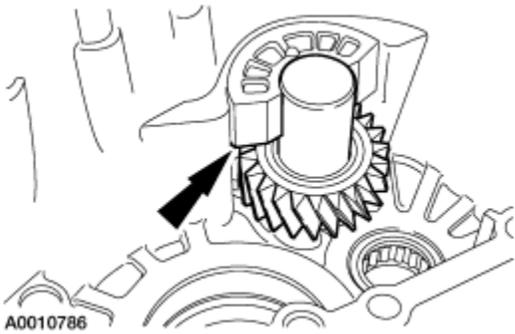
4. **NOTE:** Make sure the hole in the shaft aligns with the hole in the extension housing.

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

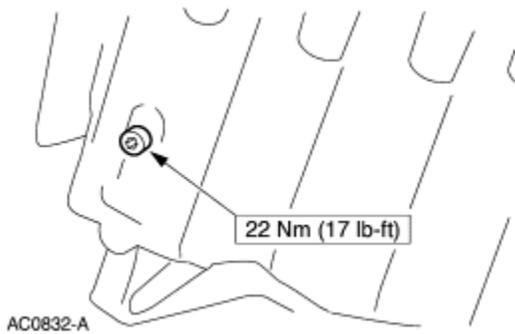
Install the reverse idler shaft, reverse idler gear bearings and reverse idler gear.



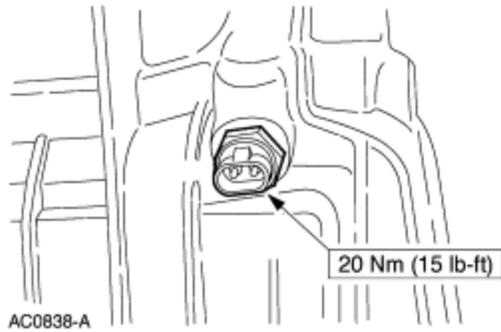
5. Install the reverse idler shaft support.
 - The ribs on the reverse idler shaft support face upward.



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



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



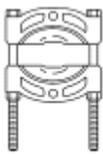
8. Install the new output oil seal after the bearing preload is completed during transmission assembly.

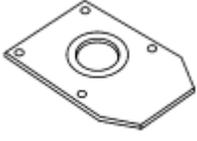
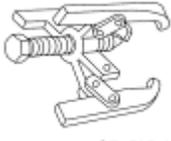
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550
 Workshop Manual

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

Input Shaft and Bearing

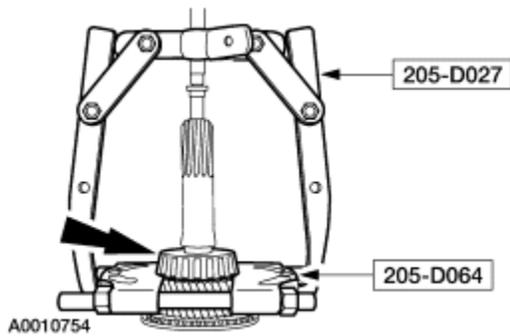
Special Tool(s)	
 <p>ST1368-A</p>	<p>Bearing Puller 205-D064 (D84L-1123-A) or equivalent</p>
 <p>ST2369-A</p>	<p>Hub Sensing Ring Replacer 205-059 (T94P-20202-B1)</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164R-3900</p>

 <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>

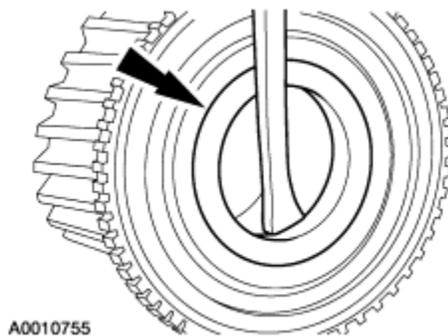
Disassembly

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.

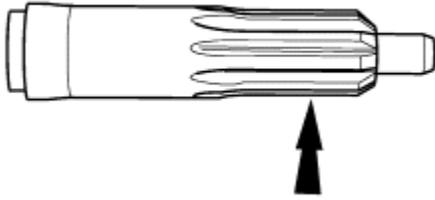
1. Using the special tools, remove the input shaft bearing.



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).**

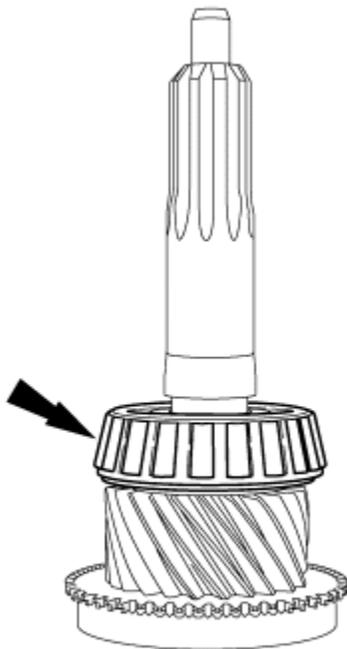
New or original components should be heated in advance of the assembly procedure. Heating components will ease the assembly process. Place the input shaft bearing into the Gear/Bearing Heater.

Assembly

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

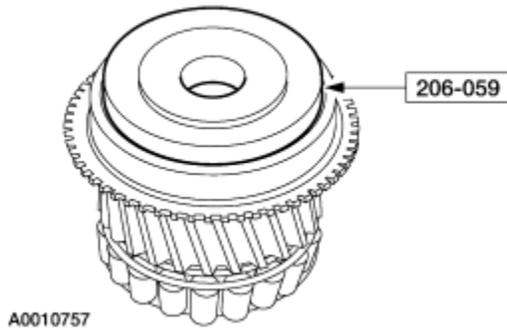
Using a suitable driver, install the input shaft bearing.

- 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.

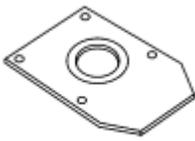


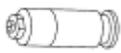
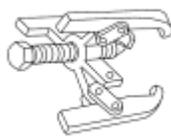
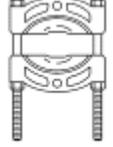
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

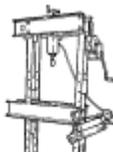
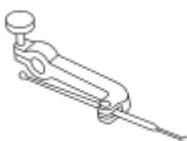
1999 F-Super Duty 250-550
 Workshop Manual

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

Main Shaft

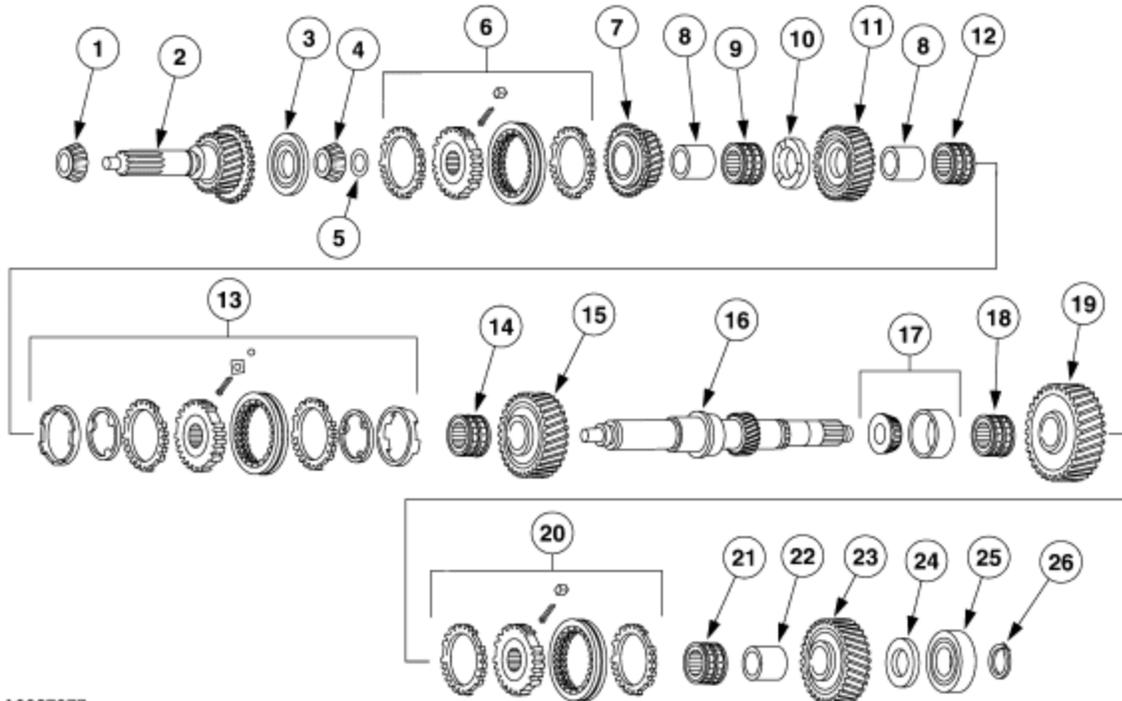
Special Tool(s)	
 <p>ST2168-A</p>	Fixture, Gear Pack 308-381
 <p>ST2144-A</p>	Remover/Installer, Transmission Bearing Collet 308-132 (T87T-7025-FH)
 <p>ST2370-A</p>	Guide, Thrust Washer 308-415

 <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

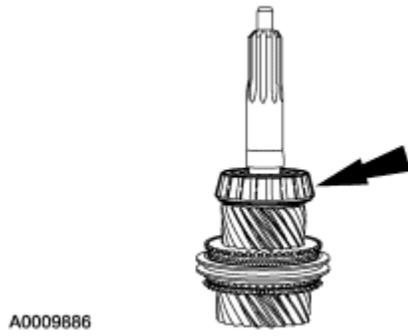
Mainshaft Components—Disassembled View



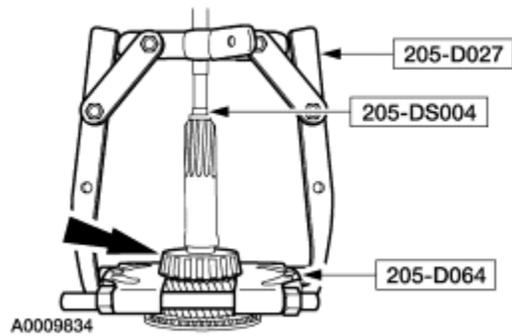
Item	Part Number	Description
1	7025	Input shaft bearing
2	7017	Input shaft
3	7046	Input shaft rear oil dam
4	7120	Input shaft pocket bearing
5	7B331	Snap ring (kit)
6	7124	Synchronizer assembly, third and fourth
7	7196	Mainshaft third gear
8	7N318	Mainshaft second and third gear bushing
9	7K169	Mainshaft 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.

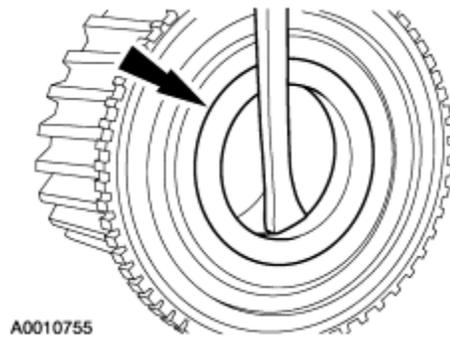
Remove the input shaft.



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



- Remove and discard the input shaft rear oil dam.



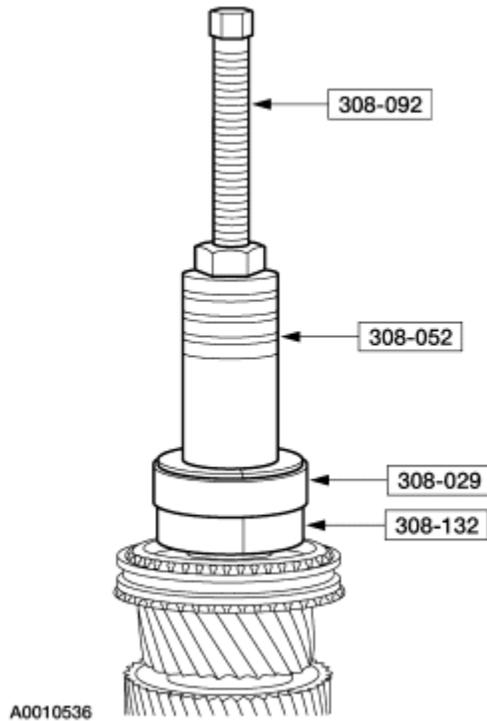
- Inspect the input shaft and input shaft bearing for damage or wear. For additional information, refer to [Section 308-00](#).



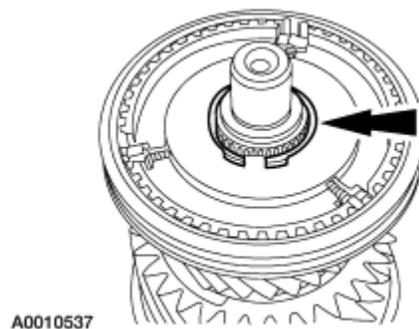
6.  **CAUTION: To prevent damage, do not heat the bearing higher than 150°C (300°F).**

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).

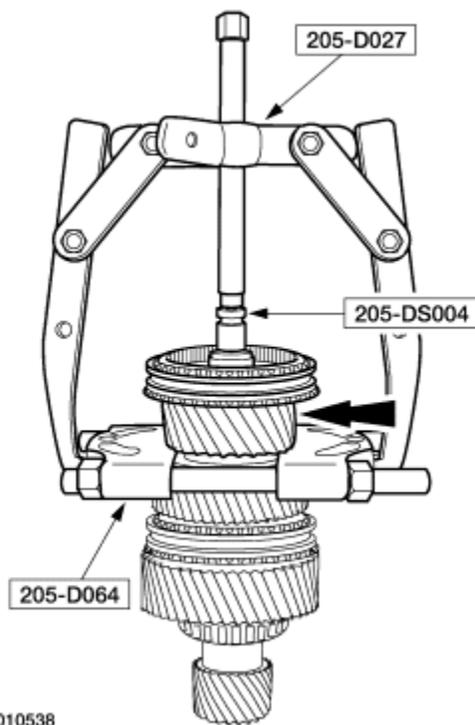
7. Using the special tools, remove the input shaft pocket bearing.
- Inspect the bearing for wear or damage. Install a new bearing as necessary.



8. Remove and discard the snap ring.

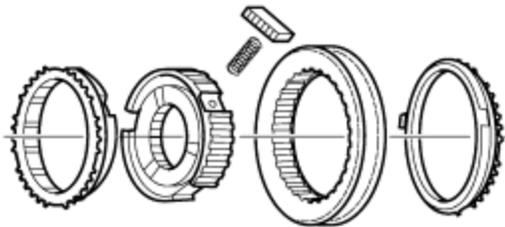


9. Using the special tools, remove the third and fourth synchronizer assembly and third gear.
- Inspect third gear for wear or damage. Install a new gear as necessary.



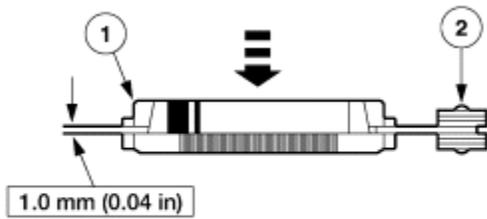
10. Disassemble the third and fourth synchronizer assembly.

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



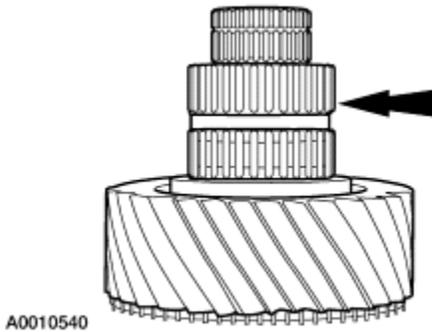
11. Check the clearance between the synchronizer ring and the gear.

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.



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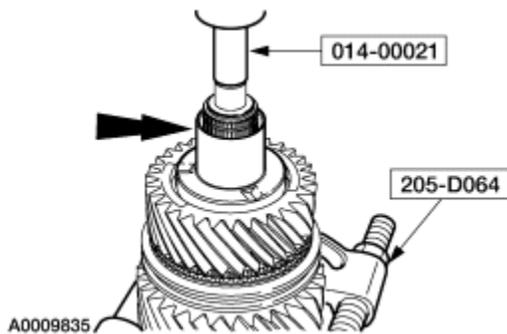
12. Remove the mainshaft needle bearing.
 - Inspect the bearing for wear or damage. Install a new bearing as necessary.



A0010540

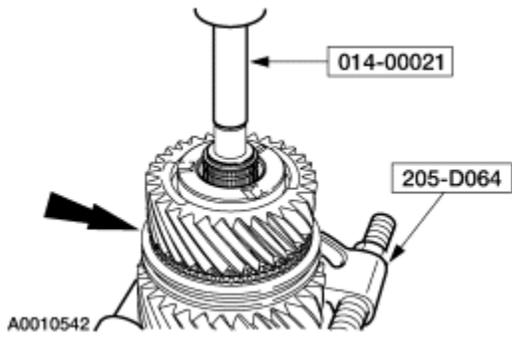
13. **NOTE:** When installing the Bearing Puller, make sure it is installed above the mainshaft bearing race.

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

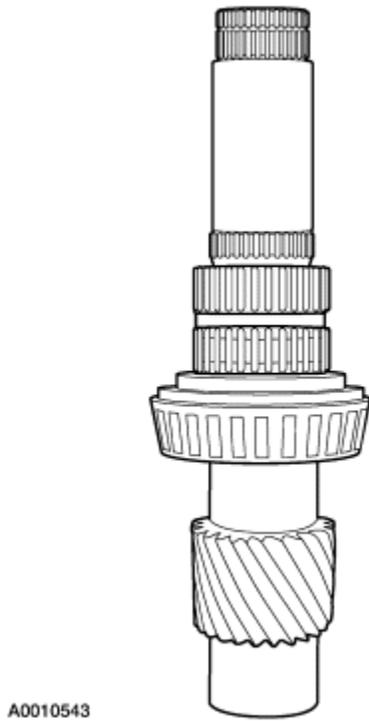


A0009835

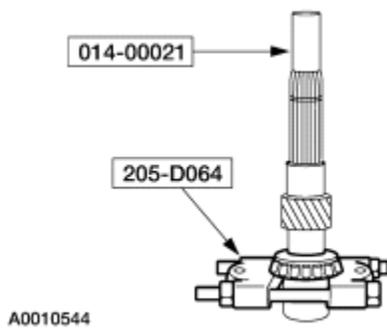
14. Using the special tool, press the mainshaft second gear thrust washer, the mainshaft second gear, the mainshaft needle bearing, the mainshaft gear bushing, first and second synchronizer assembly and mainshaft first gear.
 - Inspect the gears and bearing for wear or damage. Install new components 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.

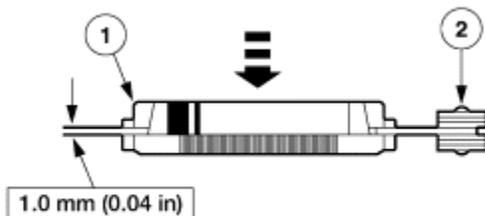
- Inspect the components for wear or damage. Install a new synchronizer assembly as necessary.



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).**

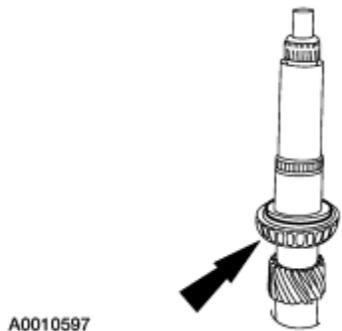
New or original components should be heated in advance of the assembly procedure. Heating the specified components will ease the assembly process. Place the input shaft pocket bearing, the mainshaft second gear thrust washer, the mainshaft center bearing, the synchronizer bodies and the mainshaft gear bushings into the Gear/Bearing Heater.

Assembly

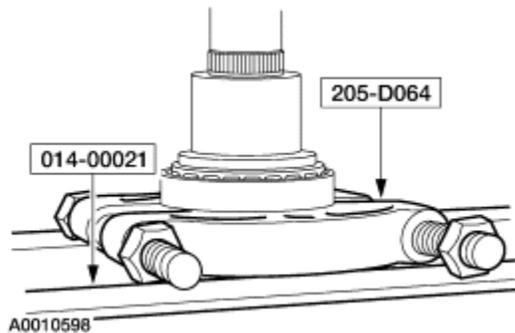
1. Inspect the mainshaft and all mainshaft components for wear or damage. For additional information, refer to [Section 308-00](#).
2.  **CAUTION: Do not reassembly the mainshaft dry. Apply lubricant throughout the assembly procedure.**

Lubricate all mainshaft components with the recommended transmission lubricant during reassembly.

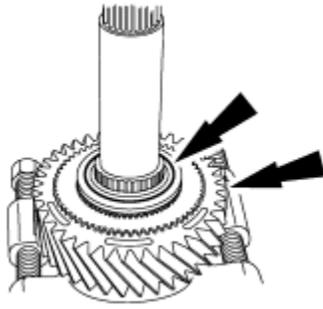
3. Install the center mainshaft bearing.
 - Make sure the bearing is installed against the stop on the mainshaft.



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.

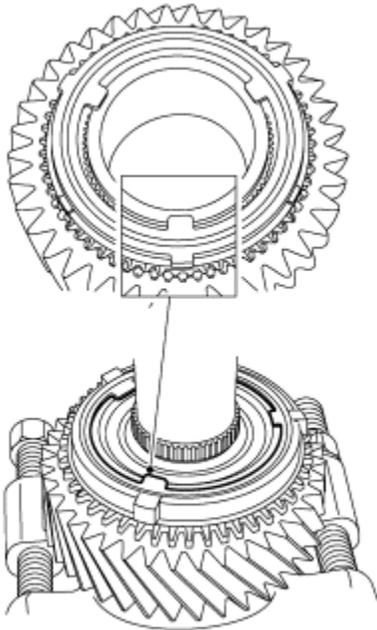


5. Install the first gear bearing and first gear.



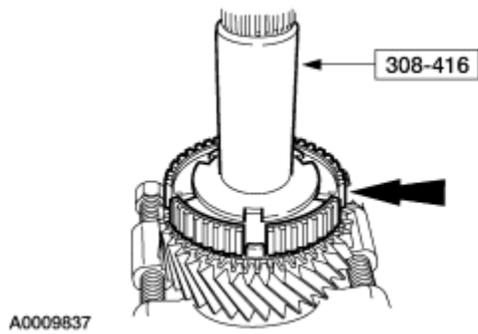
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6. Install the three synchronizer rings for first gear.
 - Make sure the tabs on the synchronizer ring are in the slots on the gear.
 - Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.



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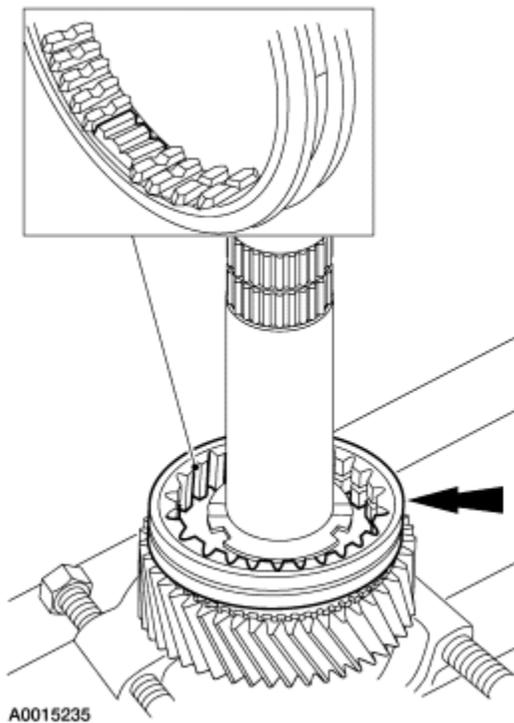
7. Using the special tools, press the first and second gear synchronizer body into place.
 - The numbers on the synchronizer hub must face upward.
 - Make sure to align the notches on the synchronizer body with the tabs on the synchronizer ring.



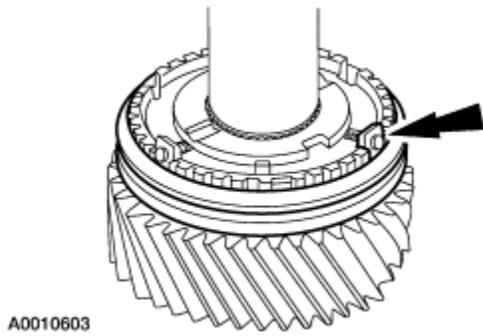
8. **NOTE:** Install the synchronizer sliding sleeve with the flats aligned with the detent notches.

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.



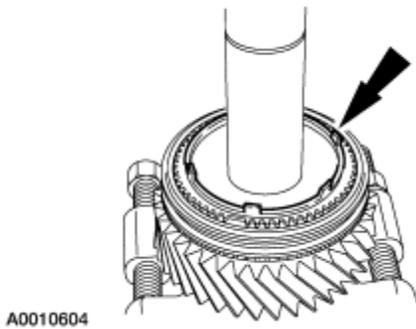
9. Install the synchronizer spring and plate, then tilt the plate up and install the detent ball.
- If the springs are difficult to install, check the alignment of the synchronizer sliding sleeve flat areas.



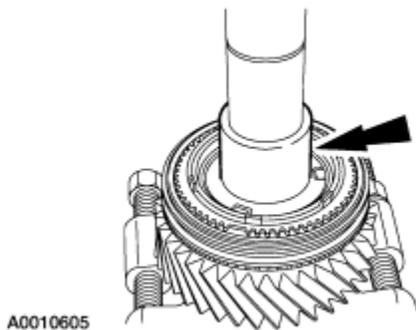
10. **NOTE:** Position the synchronizer into the neutral position.

Install the synchronizer rings for second gear.

- Align the tabs on the synchronizer rings with the slots in the synchronizer body.

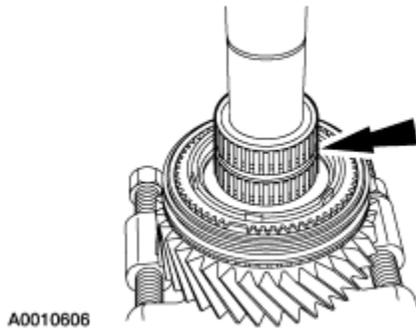


11. Install the mainshaft second gear bushing.



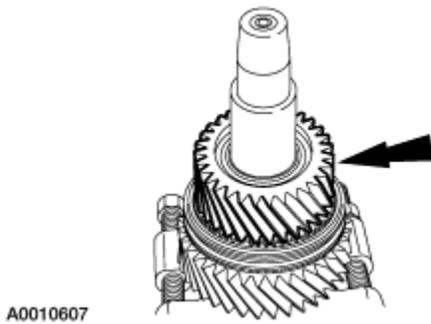
12. **NOTE:** Let the mainshaft second gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

Install the mainshaft needle bearing.

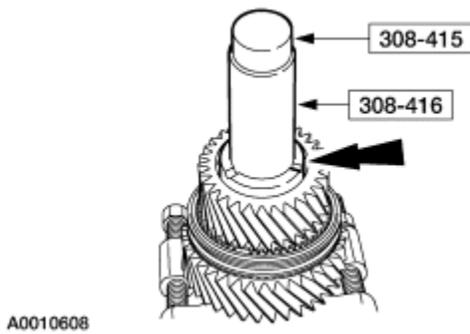


13. Install second gear.

- Make sure to align the tabs on the synchronizer ring with the slots on the gear.

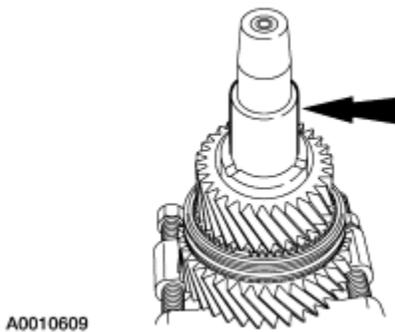


14. Using the special tools, press the mainshaft second gear thrust washer into place.



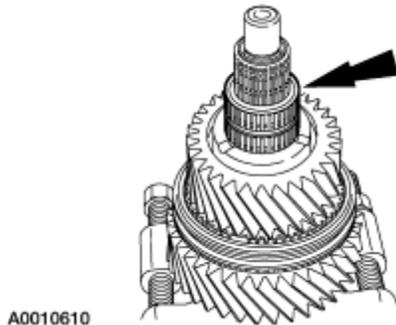
15. Using the special tool, install the mainshaft third gear bushing on the mainshaft.

- Pull the first/second gear sliding sleeve into the neutral position.

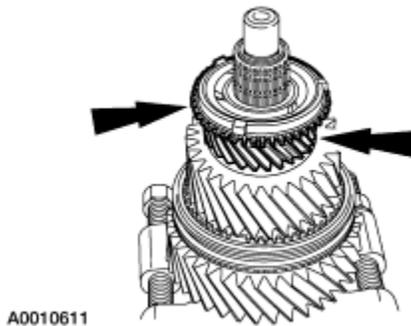


16. **NOTE:** Let the mainshaft third gear bushing cool down for 2-4 minutes before trying to install the mainshaft needle bearing.

Install the mainshaft needle bearing.

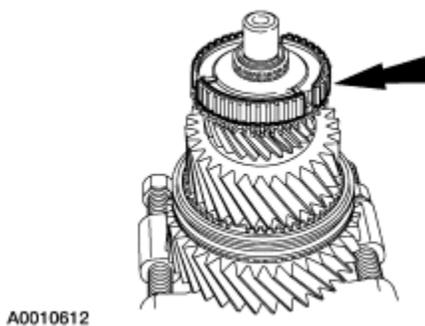


17. Install the mainshaft third gear and synchronizer ring.



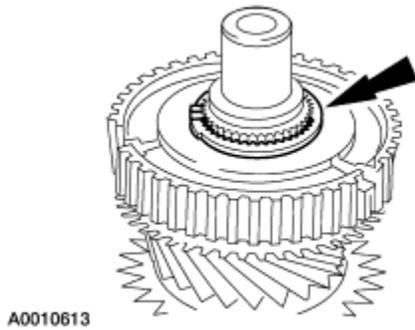
18. Install the third and fourth gear synchronizer body.

- 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.

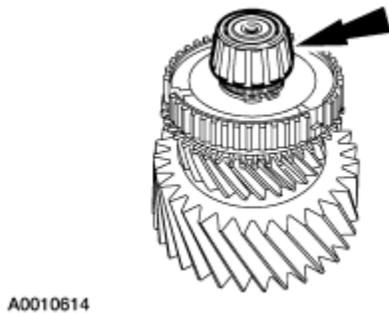
- Install the snap ring with the small holes facing upward.
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.



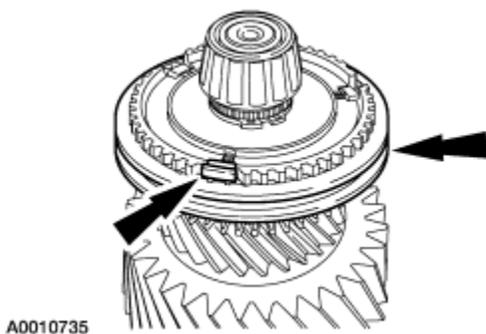
20. **⚠ CAUTION: Press the input shaft pocket bearing onto the mainshaft by the inner race only. Pressing on the outer race will damage the bearing.**

Press the input shaft pocket bearing into place.

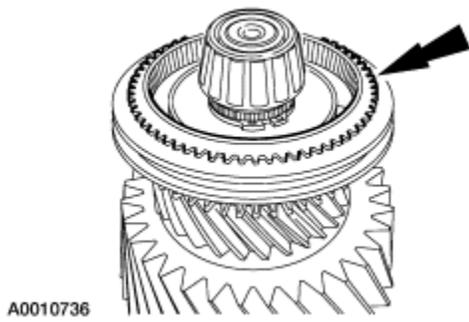
- Make sure the bearing is correctly seated. At the bottom of the bearing, there should be no gap. At the top of the bearing, check for a small amount of the mainshaft to be above the inner bearing race.



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.



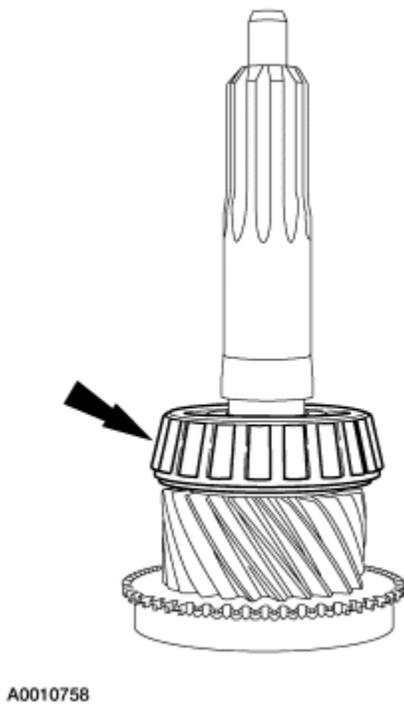
23. Install the synchronizer ring, then move the synchronizer sliding sleeve up on the synchronizer body.



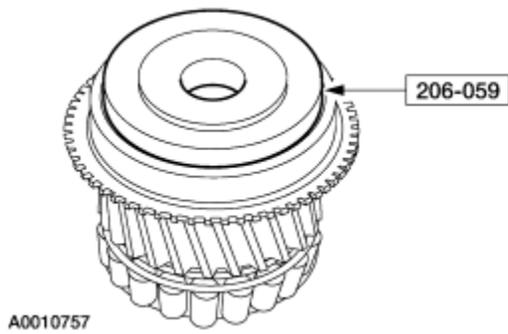
24.  **CAUTION: Do not drive against the bearing cone. Drive against the inner race only.**

Using a suitable driver, install a new input shaft bearing.

- Seat the bearing against its stop.

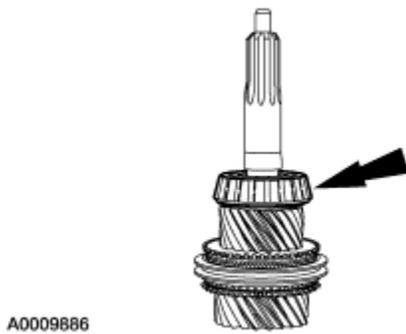


25. Using the special tool, install the input shaft rear oil dam.
- Rotate the input shaft to make sure the input shaft rear oil dam is completely seated.



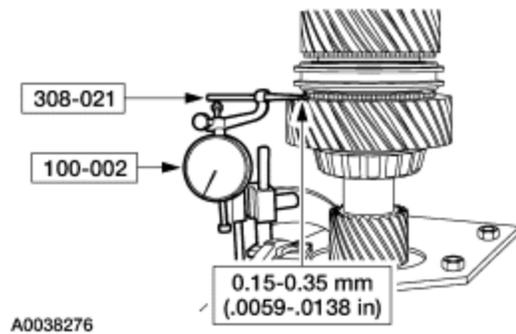
26. Install the input shaft.

- Fill the input shaft pocket with a suitable engine assembly white grease.

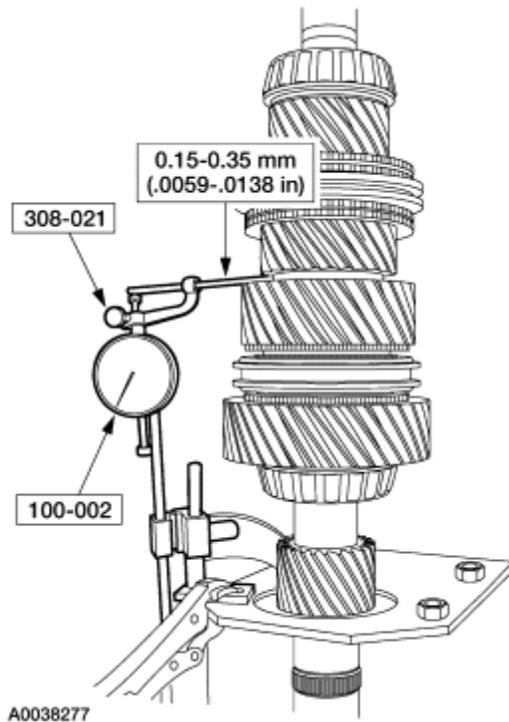


27. **NOTE:** If the following axial gear clearances are not within specification, it will be necessary to disassemble and reinspect.

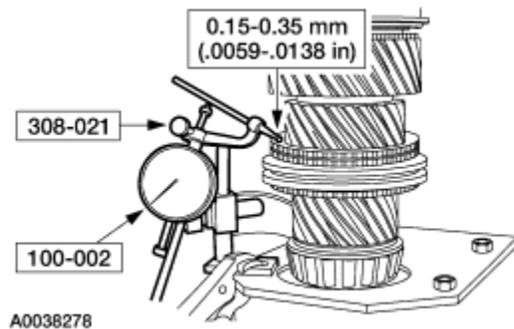
Using the special tool, check the axial gear clearance at the mainshaft first gear.



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.



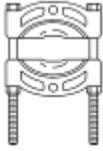
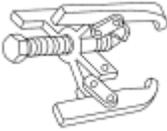
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
 SUBASSEMBLIES

1999 F-Super Duty 250-550
 Workshop Manual

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

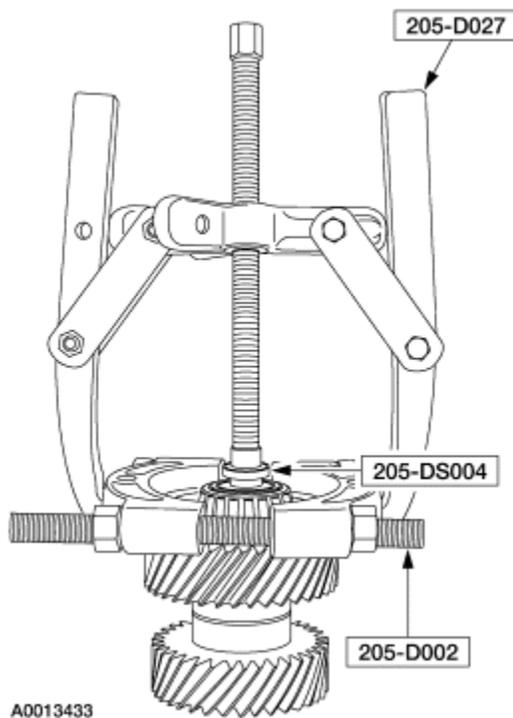
Countershaft and Bearing

Special Tool(s)

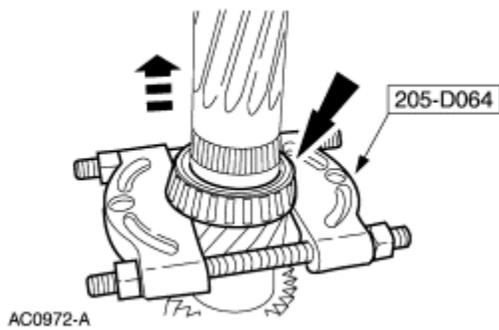
 <p>ST1368-A</p>	<p>Puller, Bearing 205-D064 (D84L-1123-A) or equivalent</p>
 <p>ST1585-A</p>	<p>2 or 3 Jaw Puller 205-D027 (D80L-1013-A) or equivalent</p>
 <p>ST2156-A</p>	<p>Gear/Bearing Heater 164-R3900</p>
 <p>ST2474-A</p>	<p>Remover/Installer, Thrust Washer Bearing Cup 308-416</p>

Disassembly

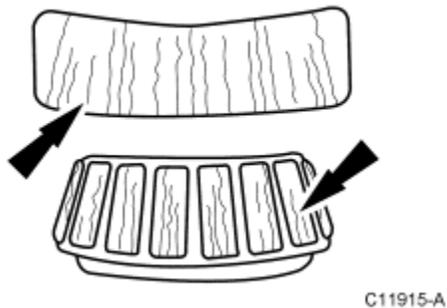
1. Using the special tools, remove the front countershaft bearing.



- 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.

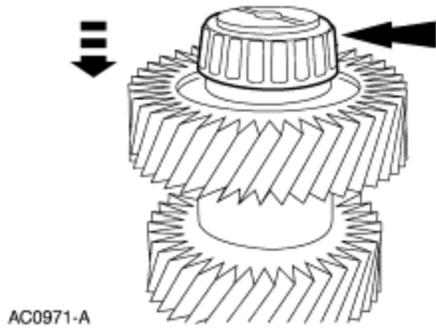


- ⚠ CAUTION: To prevent damage, do not heat the countershaft middle bearing or the countershaft front bearing higher than 150°C (300°F) maximum.**

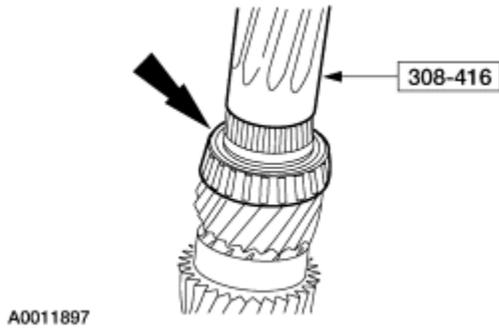
New or original components should be heated in advance of the assembly procedure. Heating the specified components will ease the assembly process. Place the countershaft middle bearing and the countershaft front bearing into the Gear/Bearing Heater.

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.

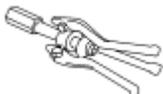


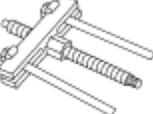
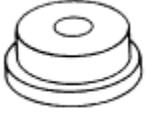
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 DISASSEMBLY AND ASSEMBLY OF
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 Workshop Manual

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

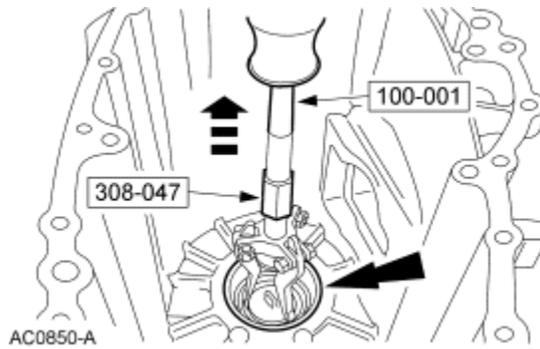
Case

Special Tool(s)	
 ST1200-A	Remover, Bearing Cup 308-047 (T77F-1102-A)

 <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>

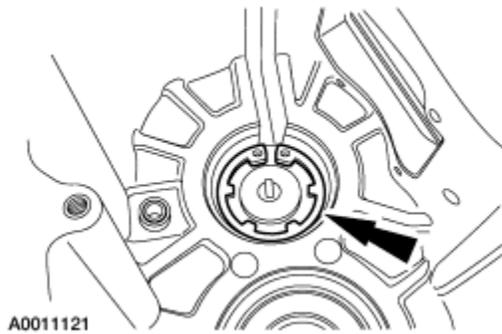
Disassembly

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.

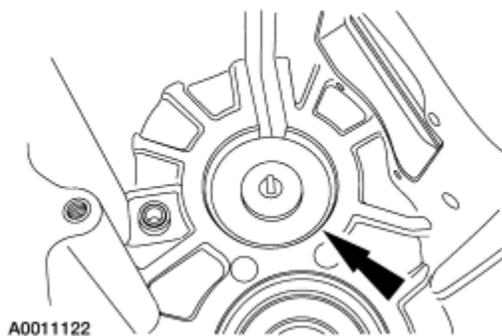


2. **NOTE:** Oil pump removal is only necessary if a large amount of particles were in the transmission during disassembly.

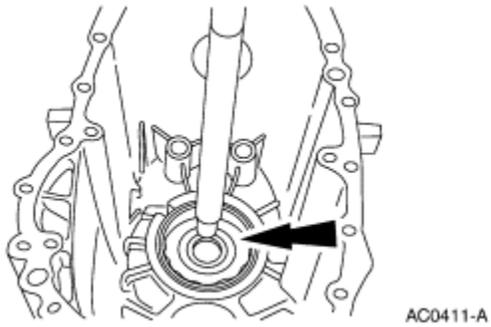
Remove the oil pump snap ring.



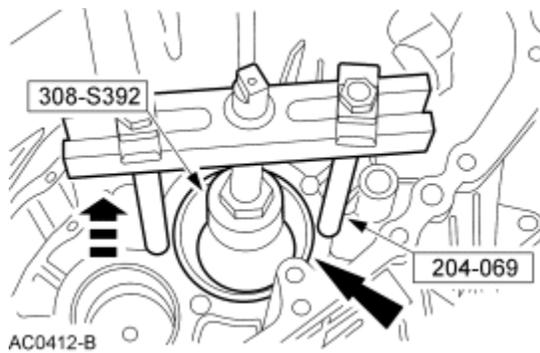
3. Remove the oil pump assembly.
 - Using vise-grips, pull upward on the center shaft.
 - Thoroughly clean the oil pump housing. Inspect the oil pump for wear or damage. Install a new oil pump assembly as necessary.



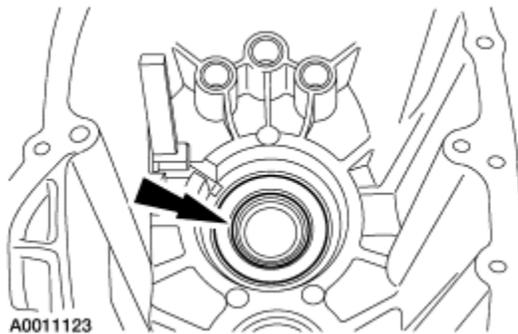
4. Using a brass drift, dent the input shaft oil baffle for puller tool clearance.



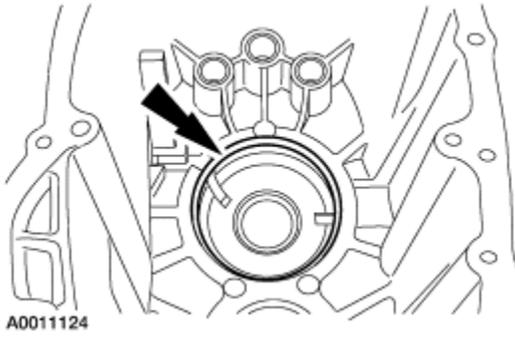
5. Using the special tools, remove the input shaft bearing cup.
 - Inspect the input shaft bearing cup for wear or damage. Install a new cup as necessary.
 - Install a new cup if the input shaft bearing was installed new.



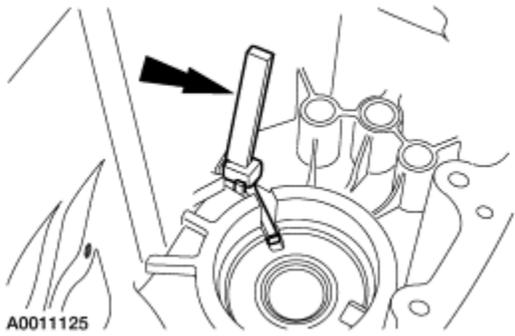
6. Remove the input shaft oil dam bearing ring.



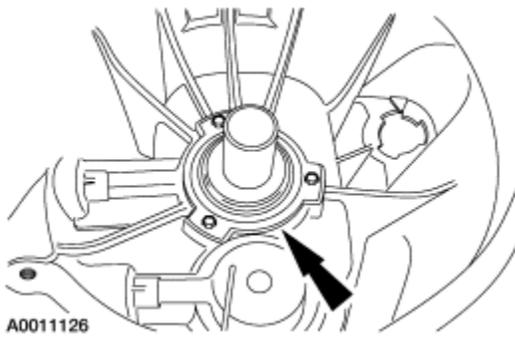
7. Remove the input shaft shim. Discard the shim.



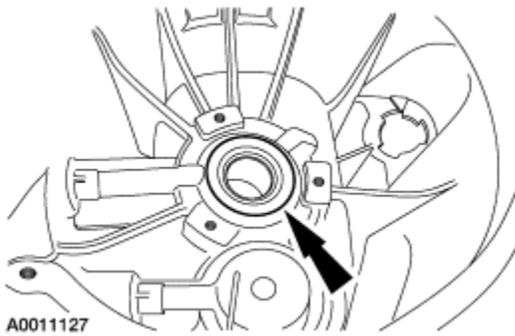
8. Remove the oil trough.



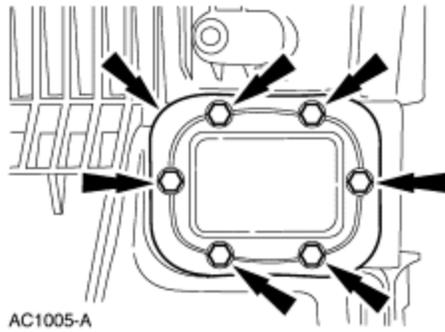
9. Remove the guide tube.



10. Remove the input shaft oil seal.

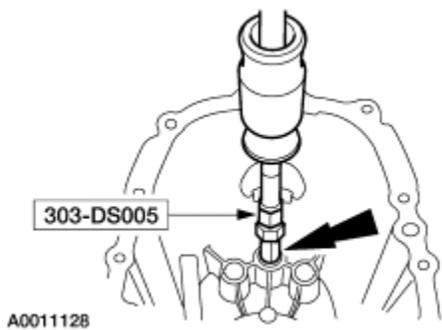


11. Remove the PTO cover.



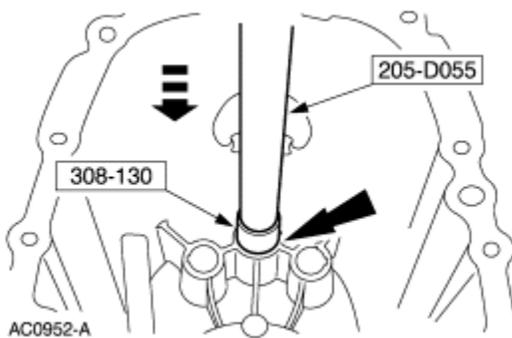
12. **NOTE:** Inspect the bearing for wear or damage before removing.

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



Assembly

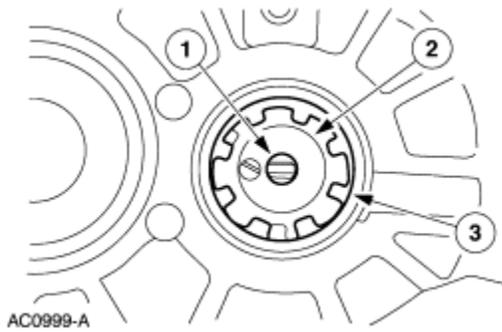
1. Using the special tools, install a new shift rail bearing.



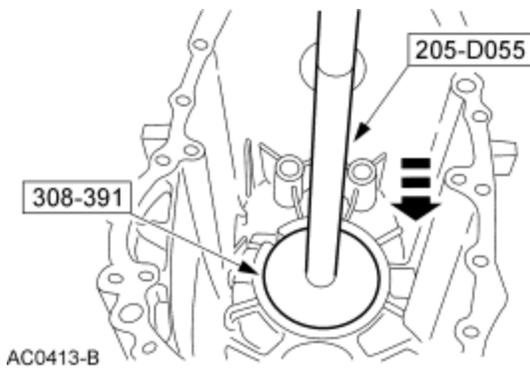
2. **NOTE:** Fill the oil pump housing with a suitable engine assembly white grease.

Install the oil pump assembly.

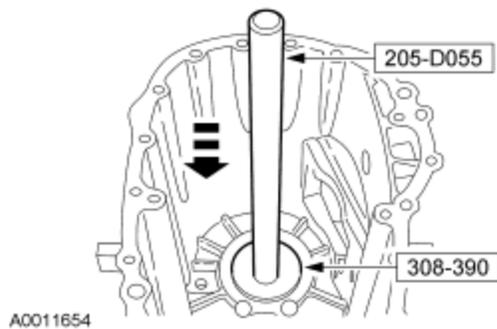
1. Install the rotor into the pump housing.
2. Install the oil pump body.
3. Install the oil pump snap ring.



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.

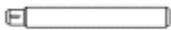
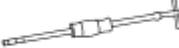


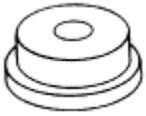
4. Using the special tools, install the countershaft bearing cup.
 - Do not install the shim at this time. The bearing preload adjustment procedure will determine the thickness of the shim to be installed.



5. The case assembly will be completed during the assembly procedure. For additional information, refer to [Transmission](#) assembly in this section.
-

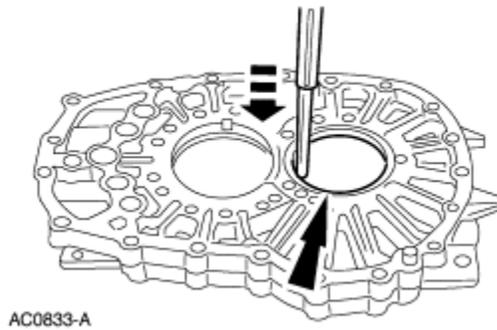
Case—Intermediate Housing

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

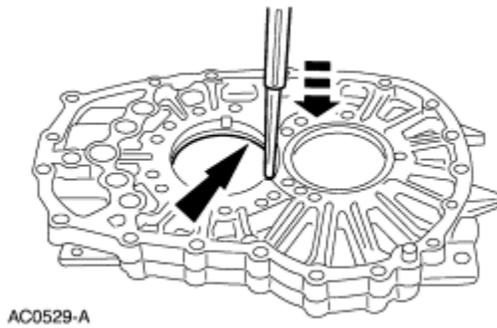
 <p>ST1555-A</p>	<p>Installer, Centerplate Mainshaft Bearing Cup 308-389</p>
 <p>ST1073-A</p>	<p>Heat Gun 107-R0300</p>

Disassembly

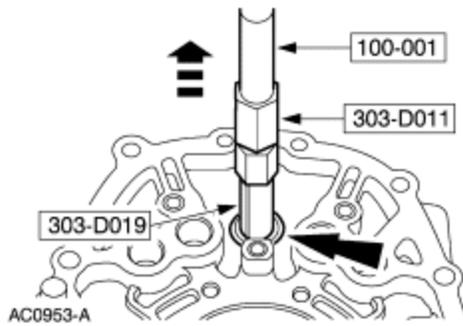
1. Using a brass drift, remove the intermediate housing countershaft bearing race.



2. Using a brass drift, remove the intermediate housing mainshaft bearing race.

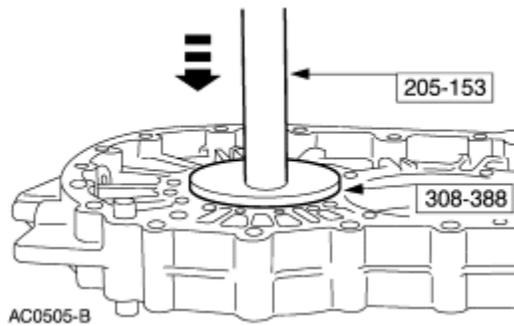


3. Using the special tools, remove and discard the center shift rail bearing.

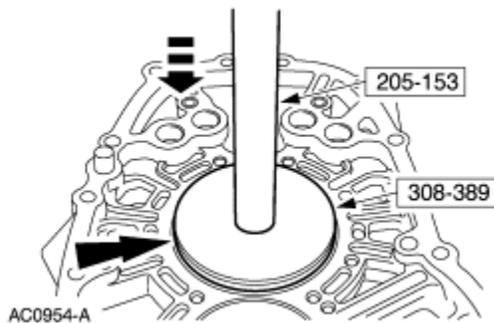


Assembly

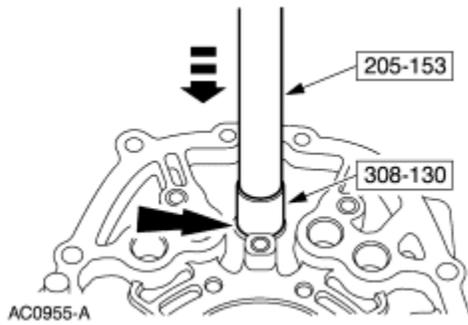
1. Using the special tools, install the intermediate housing countershaft bearing race.
 - Using the Heat Gun, heat the bearing area of the housing.



2. Using the special tools, install the intermediate housing mainshaft bearing race.
 - Using the Heat Gun, heat the bearing area of the housing.



3. Using the special tools, install the center rail shift bearing.
 - Using the Heat Gun, heat the bearing area of the housing.



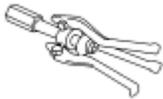
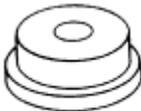
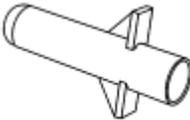
SECTION 308-03B: Manual Transaxle/Transmission
 — ZF 6-Speed
 ASSEMBLY

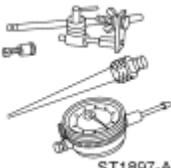
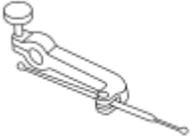
1999 F-Super Duty 250-550
 Workshop Manual

[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>

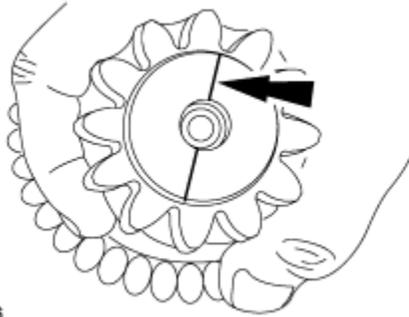
 ST2365-A	Installer, Input Shaft Oil Seal 308-379
 ST1257-A	Holding Fixture, Drive Pinion Flange 205-126 (T78P-4851-A)
 ST2141-A	Socket, Mainshaft Locknut (36mm) 308-127 (T87T-7025-AH)
 ST1897-A	Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C)
 ST1348-A	Gauge, Clutch Housing 308-021 (T75L-4201-A)

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

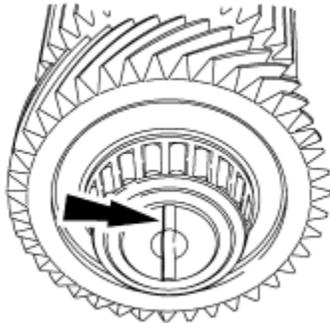
1.  **CAUTION: Do not reassembly the transmission dry. Apply lubricant throughout the assembly procedure.**

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.

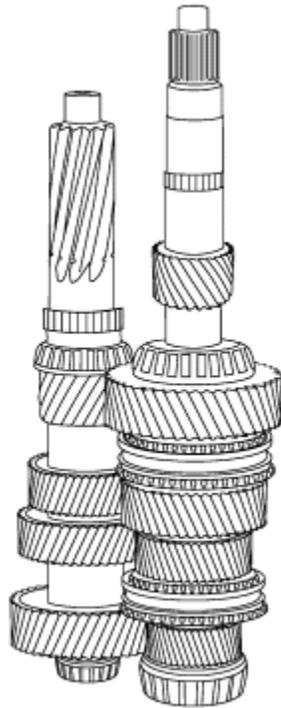


A0011576



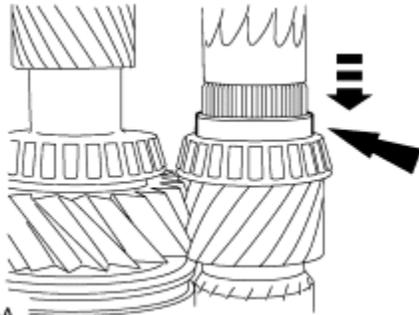
A0011577

3. Position the countershaft to the mainshaft on the Gear Pack Assembly Fixture.



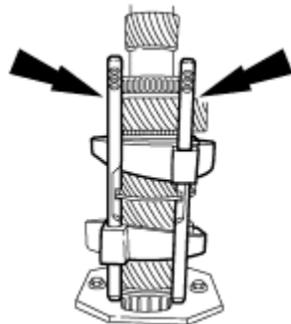
AC0394-B

4. Install the countershaft rear bearing spacer.
 - The countershaft rear bearing spacer can be installed either way.



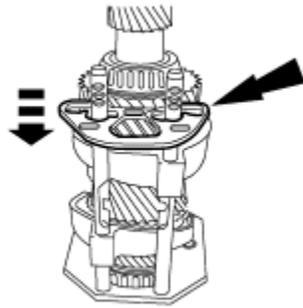
AC0974-A

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.



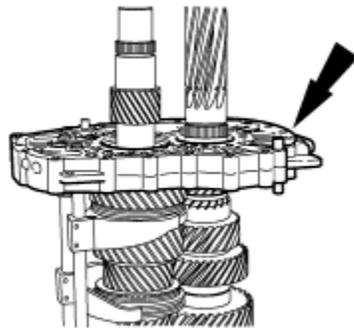
A0038251

6. Install the interlock plate.
 - The stamped part numbers on the interlock plate must face toward the input shaft.



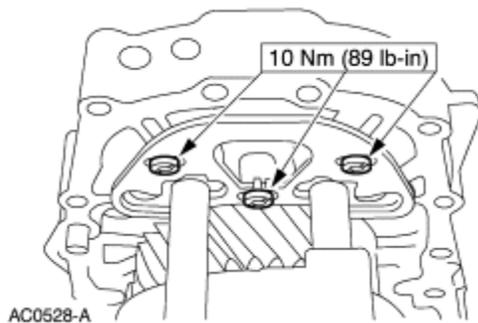
AC0545-A

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.



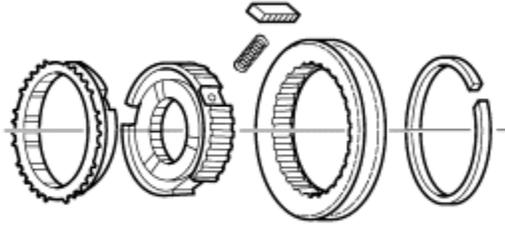
A0011578

8. Install the interlock plate bolts.



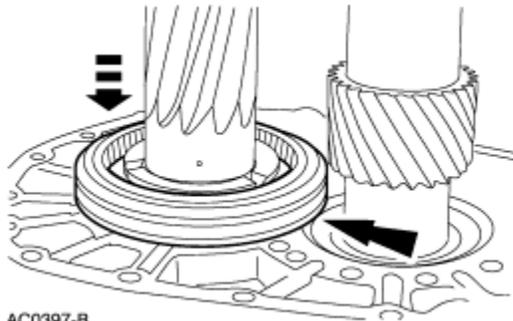
AC0528-A

9. Assemble the fifth gear synchronizer assembly.



A0038237

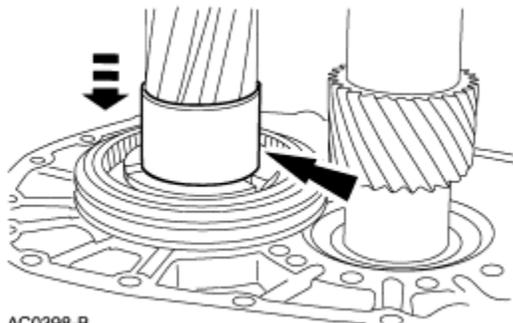
10. Install the fifth gear synchronizer assembly.
 - Install the fifth gear synchronizer with the snap ring on the synchronizer body facing down against the intermediate housing.
 - The fifth gear synchronizer will slide into place and does not require heat to install.



AC0397-B

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

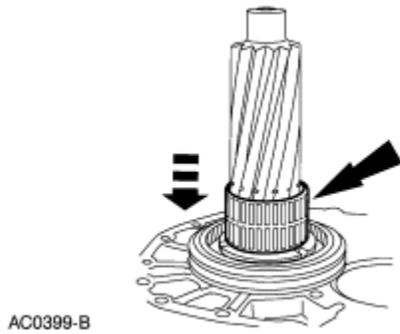
Remove the countershaft bushing from the Gear/Bearing Heater, then install the countershaft bushing.



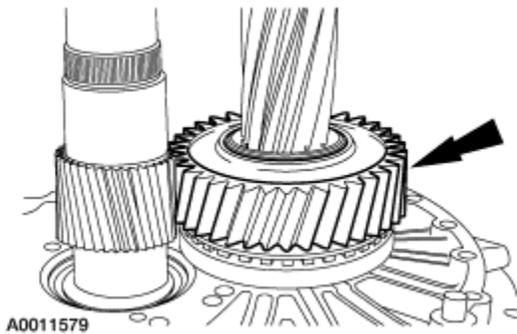
AC0398-B

12. **NOTE:** Allow the countershaft bushing to cool for 2-4 minutes before installing the countershaft needle bearing.

Install the countershaft needle bearing.

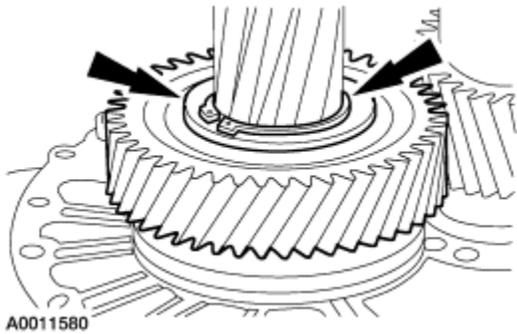


13. Install the fifth gear.

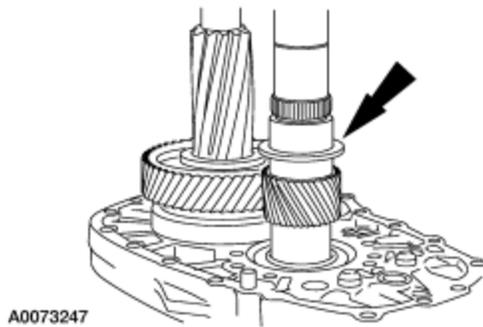


14. Install the countershaft rear thrust washer and a new snap ring.

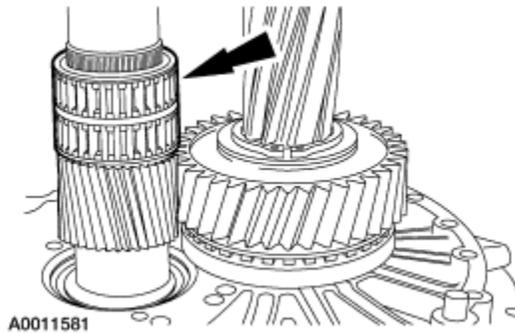
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.
- Install the snap ring with the small holes upward.
- Make sure the snap ring is completely seated, with one tab of the snap ring under the gear tooth.



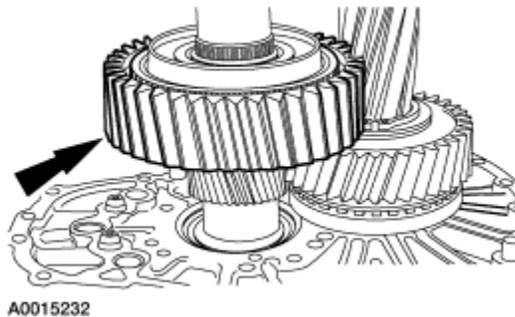
15. For vehicles equipped with a 6.0L engine, install the low gear thrust washer.



16. Install the two mainshaft low gear needle bearings.

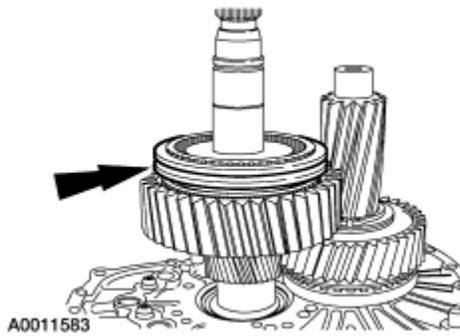


17. Install low gear.



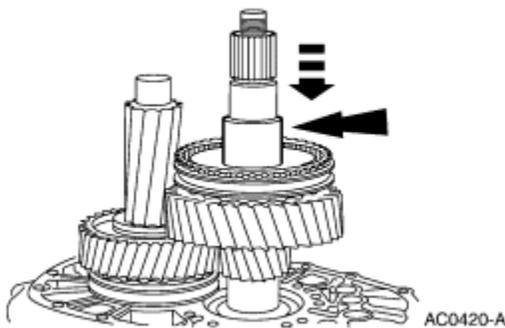
18. Install the low and reverse synchronizer assembly and synchronizer ring.

- 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.



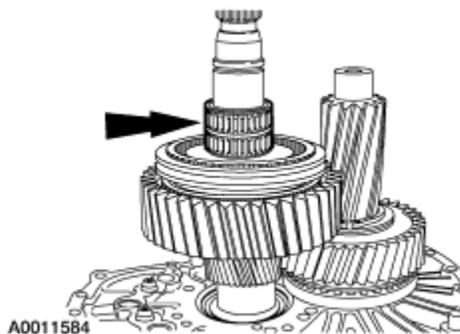
19. **⚠ CAUTION:** To prevent damage, do not heat the reverse gear bushing higher than **150°C (300°F) maximum.**

Remove the mainshaft reverse gear bushing from the Gear/Bearing Heater, then install the mainshaft bushing.

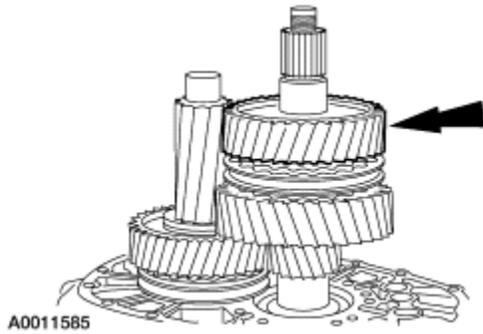


20. **NOTE:** Allow the mainshaft reverse gear bushing to cool for 2-4 minutes before installing mainshaft needle bearing.

Install the mainshaft needle bearing.

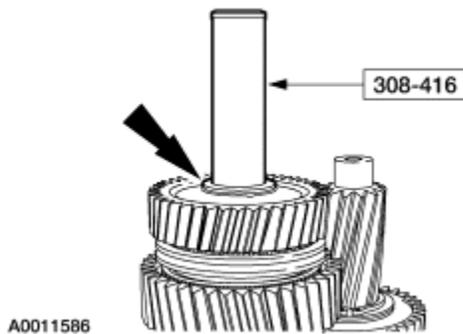


21. Install the reverse gear. Pull the synchronizer sliding sleeve into the neutral position.



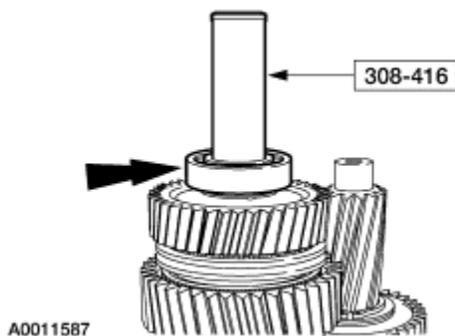
22. **⚠ CAUTION: To prevent damage, do not heat the output bearing thrust washer higher than 150°C (300°F) maximum.**

Remove the output bearing thrust washer from the Gear/Bearing Heater, then using the special tools, install the output bearing thrust washer.

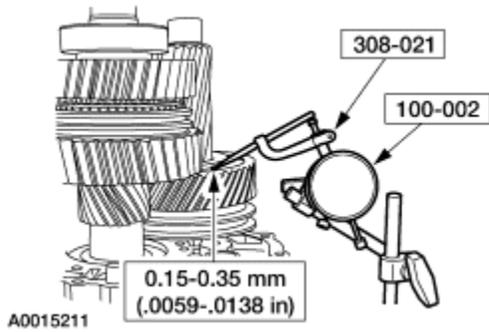


23. **⚠ CAUTION: To prevent damage, do not heat the rear mainshaft output bearing higher than 150°C (300°F) maximum.**

Remove the mainshaft output bearing from the Gear/Bearing Heater, then using the special tools, install the rear mainshaft output bearing.

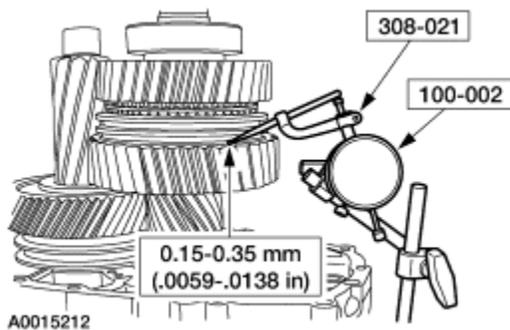


24. Using the Dial Indicator with Bracketry and the Clutch Housing Gauge, check the axial gear clearance at fifth gear.
- If not within specifications, disassemble and reinspect.



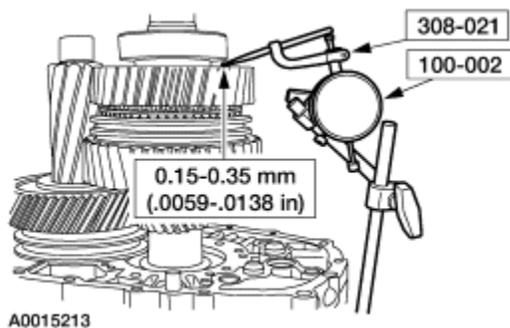
25. Using the Dial Indicator with Bracketry and the Clutch Housing Gauge, check the axial gear clearance at low gear.

- 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.

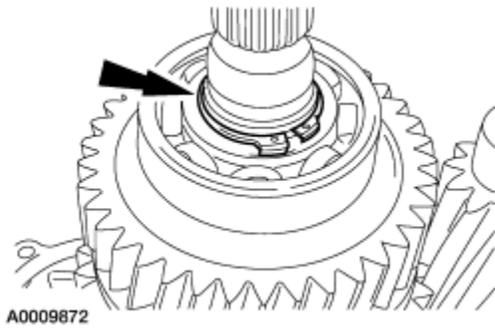
- If not within specifications, disassemble and reinspect.



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

Install a new snap ring.

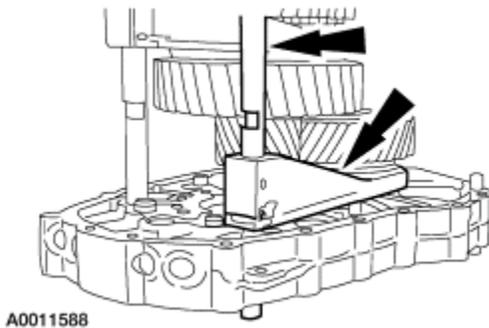
- The snap ring is a selective fit. The correct snap ring should completely fill the groove when seated.
- Install the snap ring with the small holes upward.



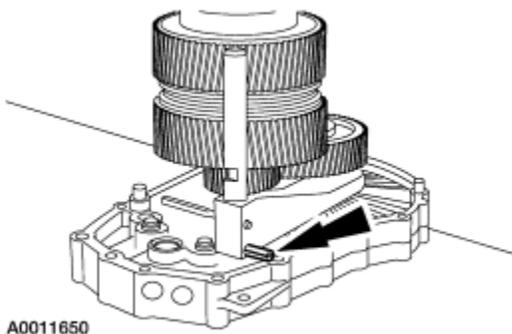
28. **NOTE:** Using an oil stone or emery cloth, lightly condition the shift rails and clean them with transmission fluid before installing the shift forks and shift rails.

NOTE: Move the interlock plate into the fifth gear position.

Install the fifth gear shift fork and the shift rail.



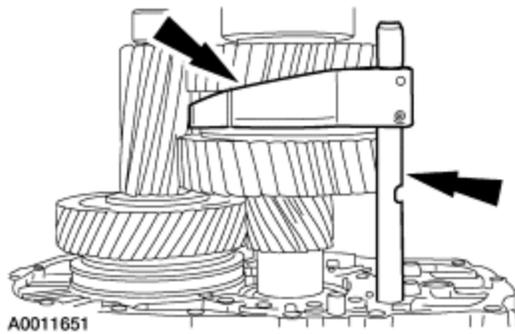
29. Using a 5 mm (3/16 in) punch, align the roll pin hole with the top hole of the shift fork. Install the double roll pin in the lower hole, then install a roll pin in the upper hole.
- Do not hit the sealing surface of the intermediate plate.
 - Make sure the slot of the roll pin is facing away from the shift rail.



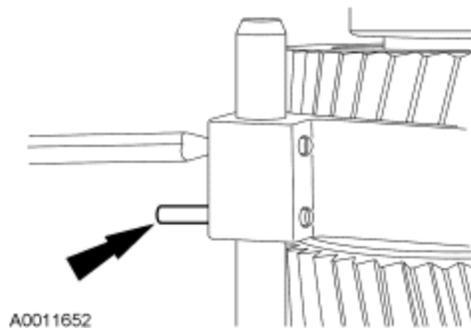
30. **NOTE:** Using an oil stone or emery cloth, lightly condition the shift rails and clean them with transmission fluid before installing the shift forks and rails.

NOTE: Move the interlock plate into the low/reverse position.

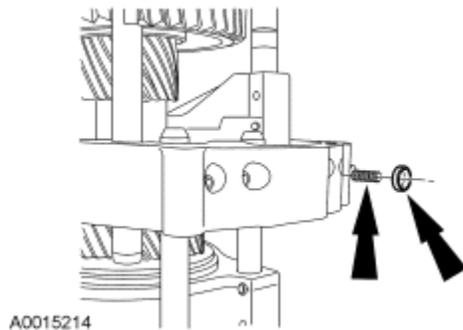
Install the low/reverse gear shift fork and the shift rail.



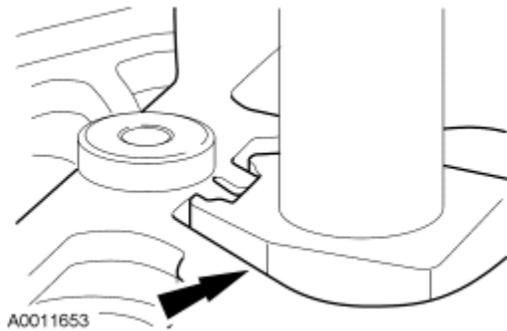
31. Using a 5 mm (3/16 in) punch, align the roll pin hole with the top hole of the shift fork. Install the double roll pin in the lower hole, then install a roll pin in the upper hole.
- Make sure the slot of the roll pin is facing away from the shift rail.



32. Install the four shift detent springs and four new detent plugs.
- Apply gasket maker to the detent plugs before installing.

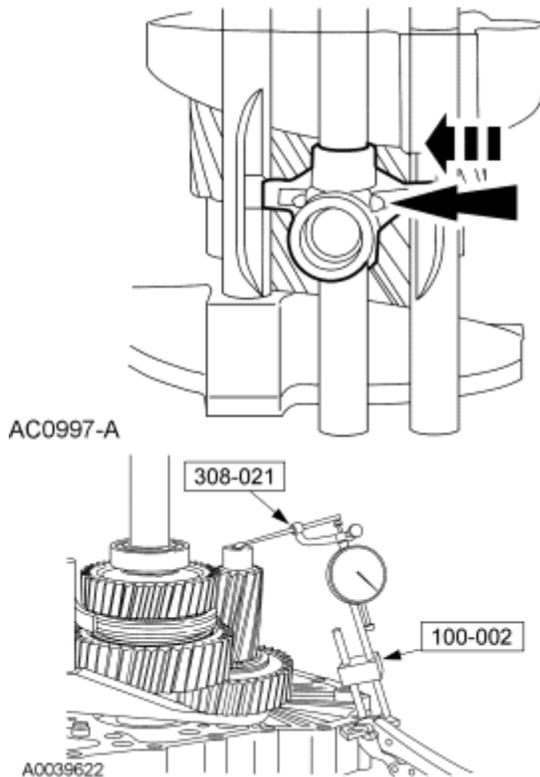


33. Install the main shift rail, aligning the center of the interlock driver with the center of the interlock plate.
- The part numbers on the main shift rail, shift position block and shift finger face the output side of the transmission. The roll pin groove on the main shift rail with the shorter distance 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.

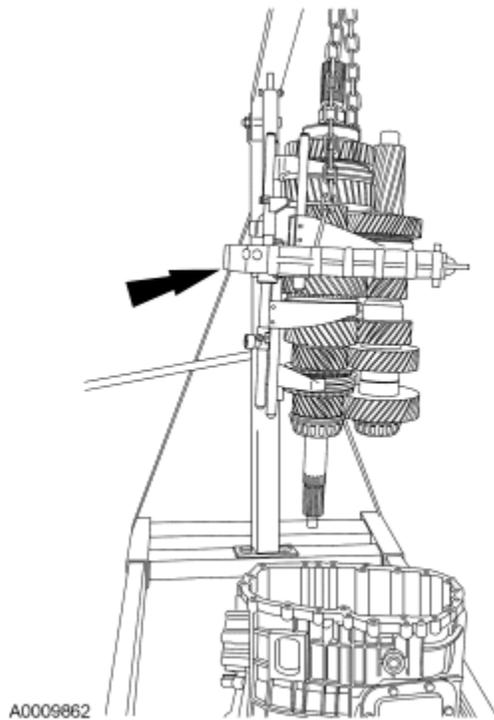
37. **NOTE:** Do not apply sealer at this time.

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.

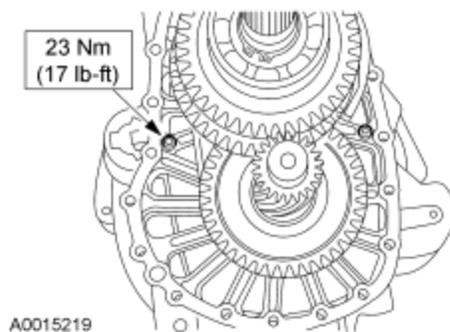
Using a suitable lifting device, a suitable chain and two S-hooks, lift the intermediate housing and gear assembly into the case.

- 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.

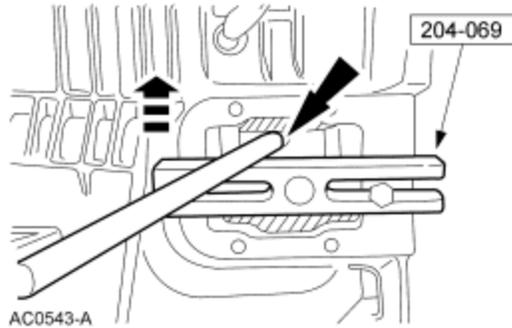
- Mount the indicator stand to the intermediate housing.
- Install the Dial Indicator Gauge. Make sure the indicator is off center on the end of the countershaft.
- Zero the dial indicator.

40. **NOTE:** The tool is installed on the PTO opening.

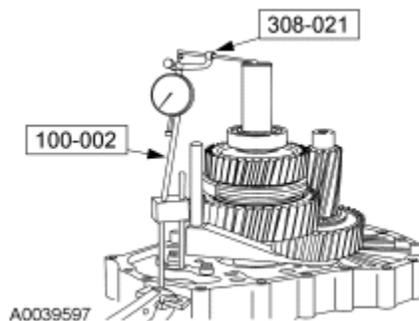
Using the special tool, measure for countershaft clearance.

- 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

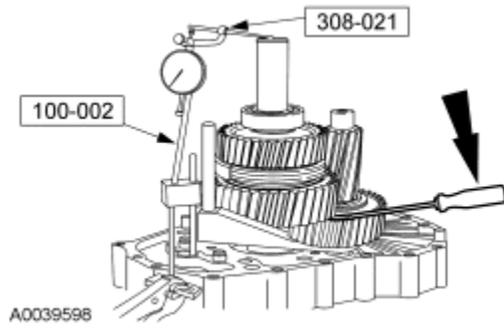
mm (0.00079 in) Preload = Shim size. Countershaft clearance + 0.09 mm (0.0035 in)
Preload = Shim size.



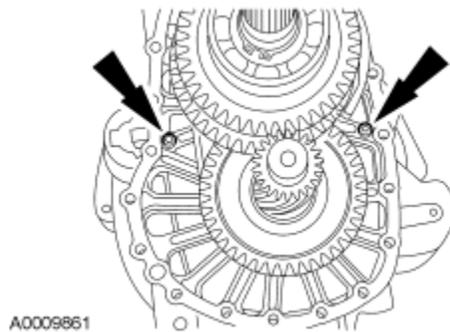
41. Install the special tools to measure mainshaft clearance.
- Mount the indicator stand to the intermediate housing.
 - Install the Dial Indicator Gauge. Make sure the indicator is off center on the end of the mainshaft.
 - Zero the dial indicator.



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.

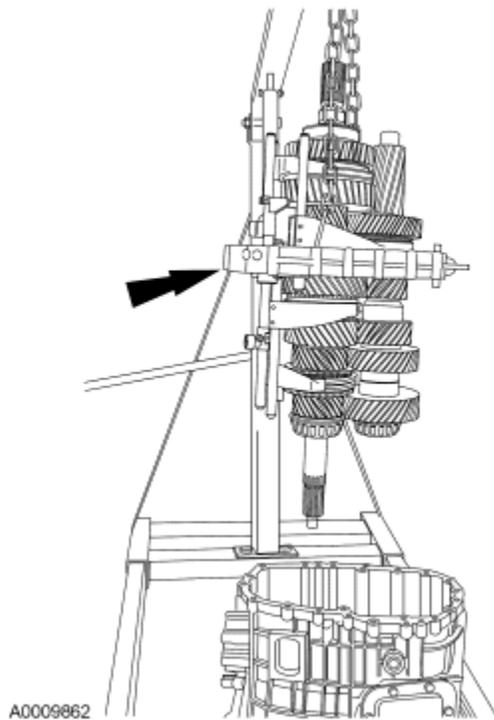


43. Remove the special tools, then remove the bolts.

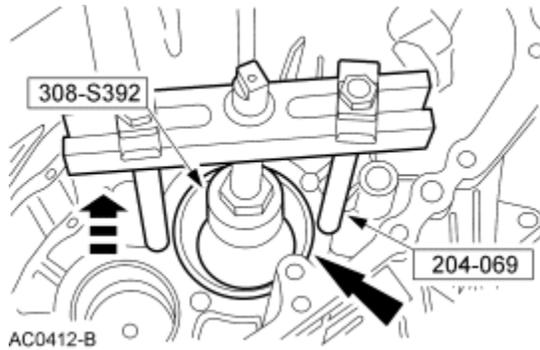


44. Using a suitable lifting device, a suitable chain and two S-hooks, lift the intermediate housing and gear assembly out of the case.

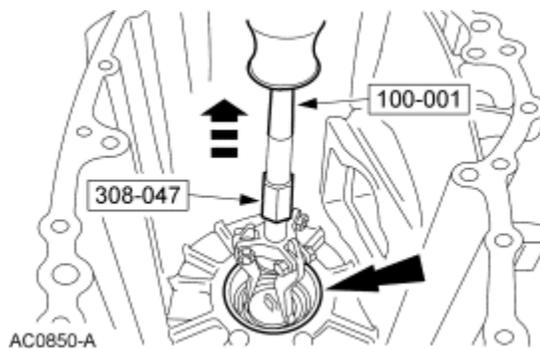
- Place the S-hooks in the area where the bolts were removed.



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



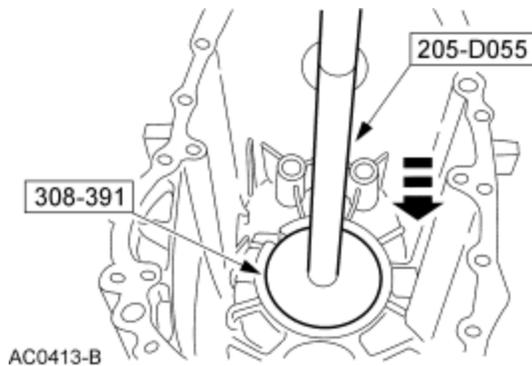
46. Using the special tools, remove the countershaft bearing cup.



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.

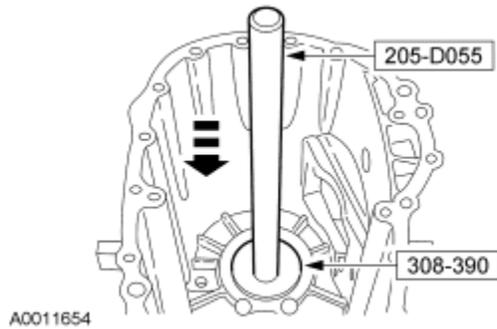
- Using the clearance measurement plus the preload, select the appropriate shim and input shaft oil dam bearing ring.



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.

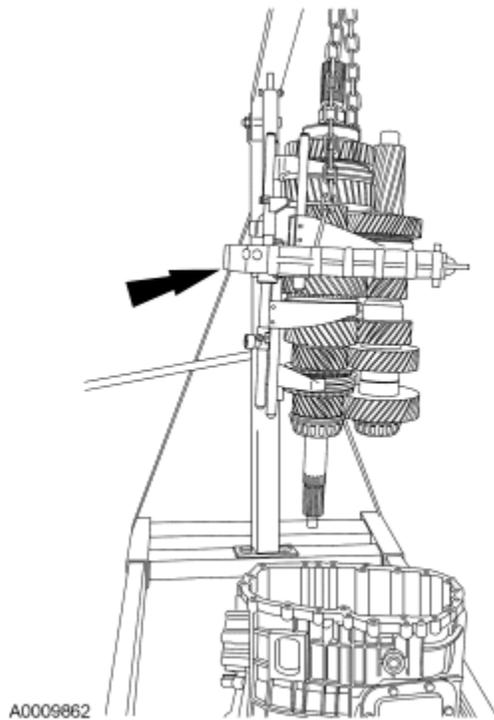
Thinly coat the rear sealing surface of the case and the front sealing surface of the intermediate housing with gasket maker.

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.

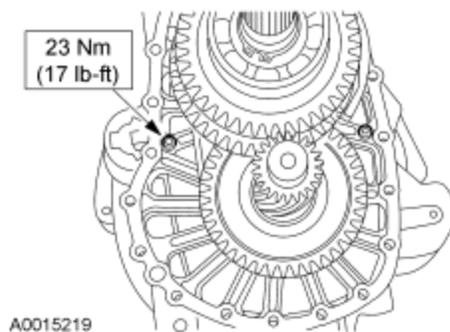
Install the intermediate housing and gear assembly into the case.

- 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.

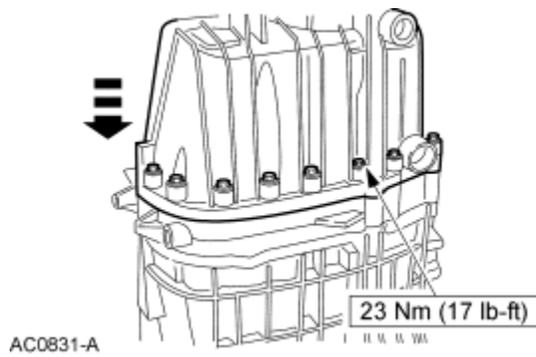
- Apply threadlock and sealer to the intermediate housing bolts.



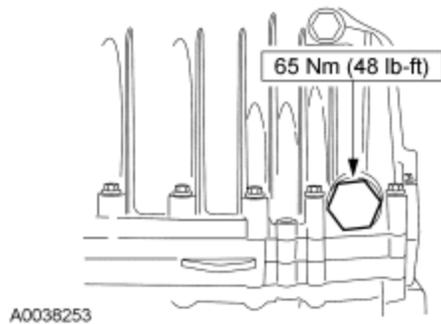
52.  **CAUTION: Do not use a silicone sealing compound.**

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.

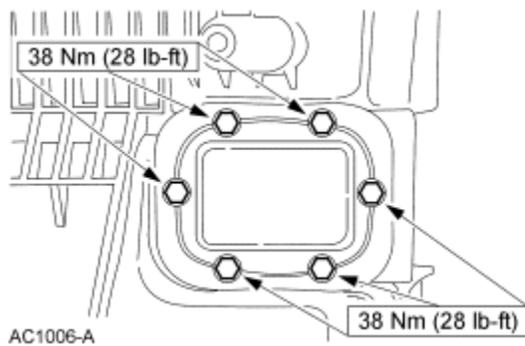


53. Apply threadlock and sealer to the threads of the main shift detent. Install the detent plunger and the main shift detent.

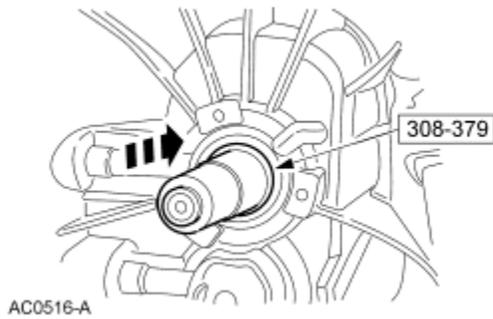


54. **NOTE:** Cross tighten the bolts.

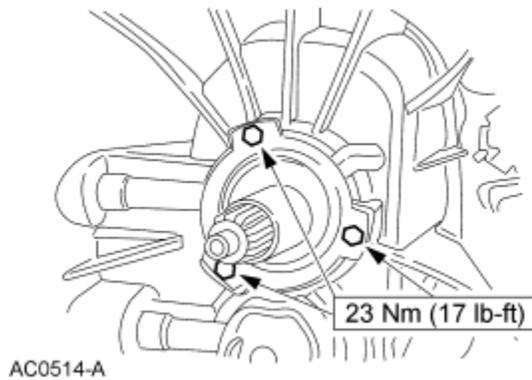
Apply threadlock and sealer to the threads of the PTO cover bolts. Install a new gasket and the PTO cover.



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®.

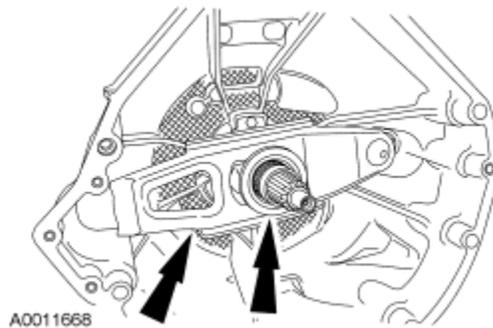


56. Apply threadlock and sealer to the threads of the guide tube bolts. Install the guide tube.

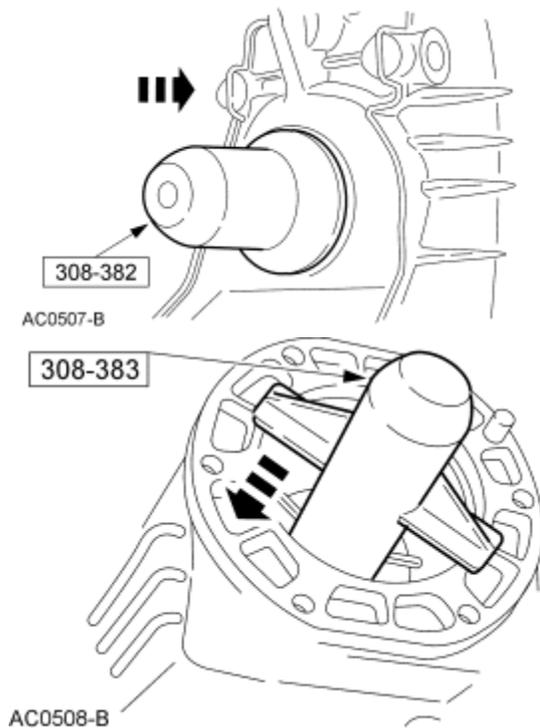


57. Install the release lever and clutch release hub and bearing.

- 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.

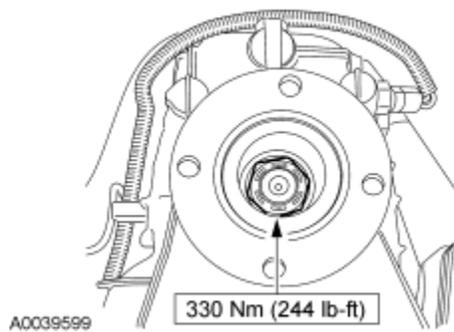


58. Coat the outer diameter of the new output oil seal with gasket and trim adhesive. Using the special tool, install a new output oil seal.



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.

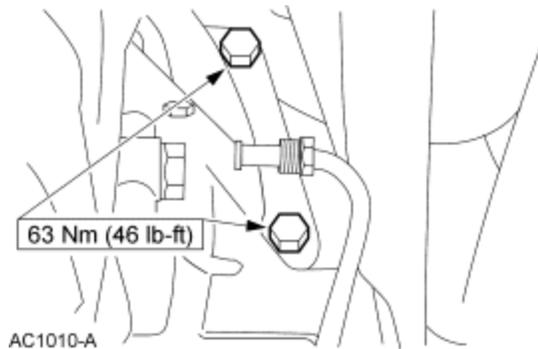
Transmission

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

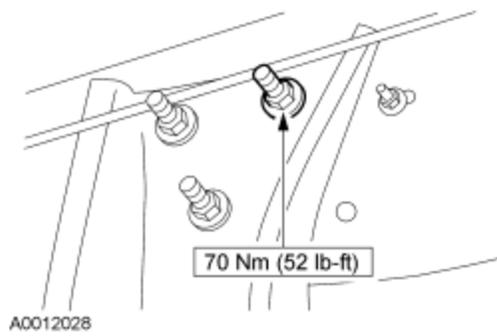
Material	
Item	Specification
MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX	MERCON®
Gasket Maker F8AZ-19B508-AB	WSK-M2G348-A5
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5 (type II)

All vehicles

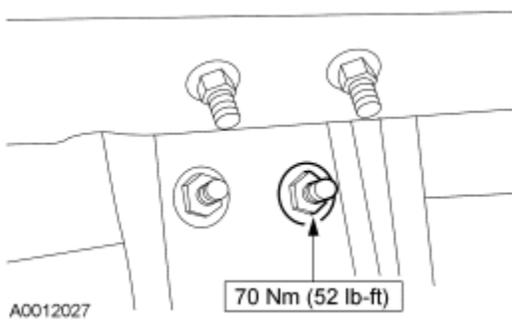
1. Using the transmission jack, raise and position the transmission to the engine and clutch.
2. Install the transmission-to-engine bolts.
 - For vehicles equipped with diesel engines, install six bolts.
 - For vehicles equipped with gasoline engines, install seven bolts.



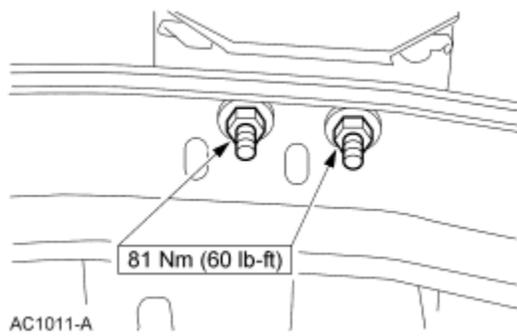
3. Install the LH crossmember bolts.



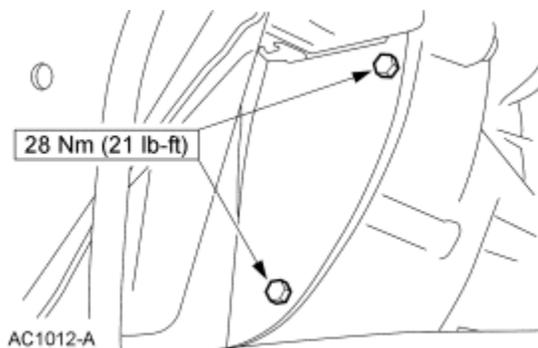
4. Install the RH crossmember nuts.

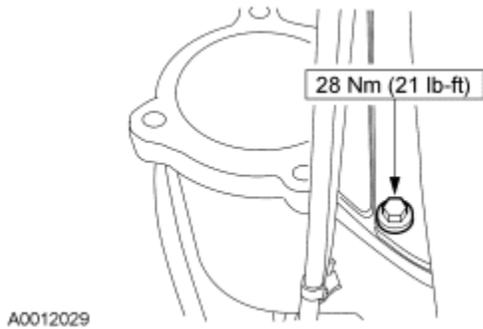


5. Install the transmission mount nuts.

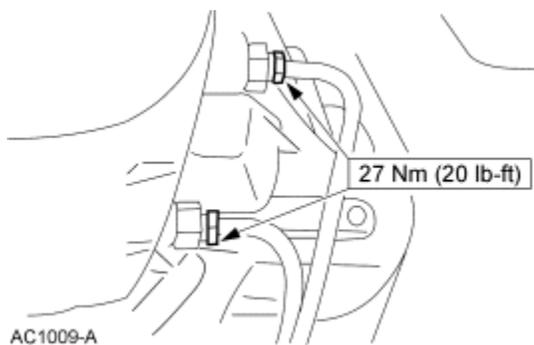


6. Install the engine plate bolts.

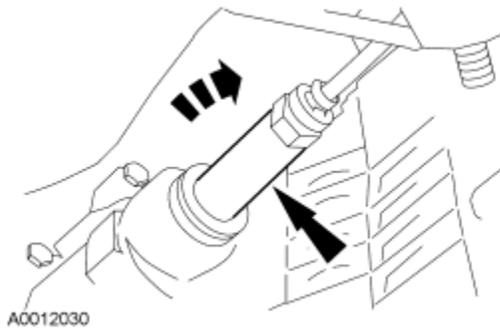




7. Remove the transmission jack.
8. Connect the transmission cooler tubes.

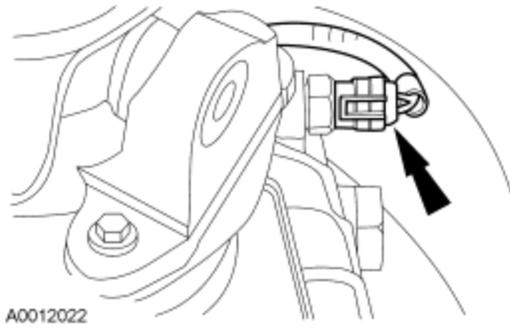


9. Install the clutch slave cylinder.
 - Rotate the clutch slave cylinder clockwise 45 degrees to lock in position.

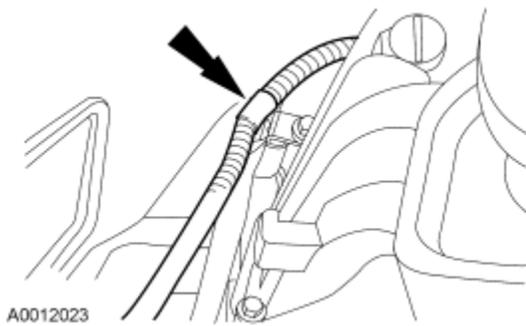


10. Install the starter. For additional information, refer to [Section 303-06B](#).
11. Install the transfer case, if equipped. For additional information, refer to [Section 308-07B](#).
 - If the transfer case control lever assembly was removed from the transmission, it must be correctly aligned.
12. 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.

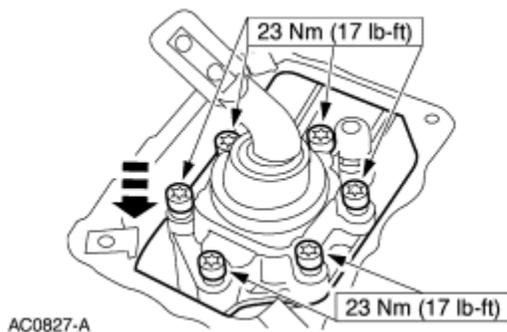
17. Lower the vehicle.

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

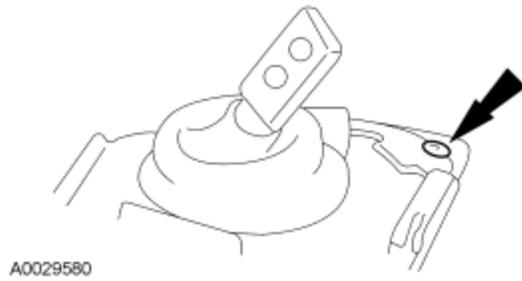
NOTE: Do not wait longer than ten minutes to tighten the six bolts due to the rapid cure time of the sealant.

Install the lower gearshift lever and shift housing assembly.

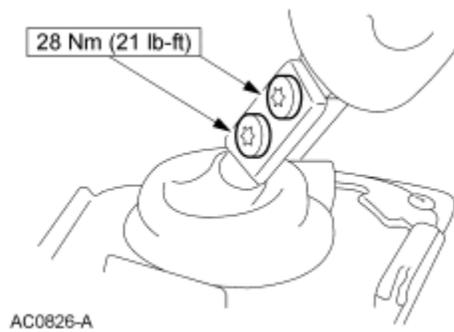
- Apply gasket maker to the shift housing and the main case.



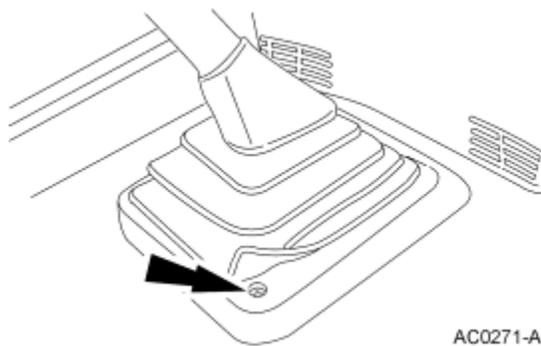
19. Install the lower shift lever boot.



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

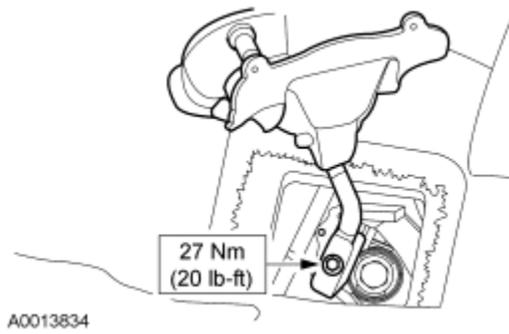


21. Install the screws.

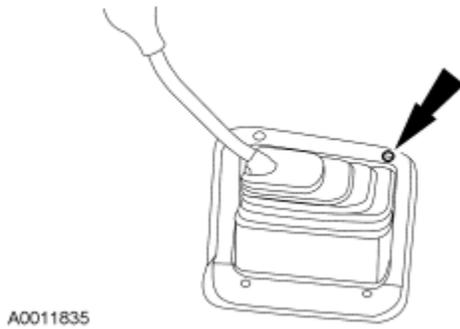


Vehicles with a manual shift lever

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.
