

## Work Instructions – FL513E and FL513F

### Subject: Rack and Pinion Steering – Steering Stops

**Models Affected: Specific Freightliner Cascadia, Century Class S/T, and Columbia vehicles manufactured November 1, 2004, through September 26, 2007, with rack and pinion steering. (Note: One Freightliner Classic XL vehicle and one Freightliner Coronado vehicle are also involved in this recall.)**

This Work Instruction includes the following procedures:

- Replace Steering Stop Bolts and Set Wheel Cut (if needed)
- Replace Rack and Pinion Gear
- Replace Tie Rod Arms
- Replace I-Shaft
- Replace Stub Shaft and Front Wall Bearing
- Retrofit Steering Plumbing

### Recall Procedures

1. Check the base label (Form WAR259) for a completion sticker for campaign FL513 (Form WAR260) indicating this work has been done. The base label is usually located on the passenger-side door about 12 inches (30 cm) below the door latch. If a completion sticker is present, no further action is necessary. If a completion sticker is not present, go to the next step.
2. Shut down the engine, apply the parking brake, and chock the rear tires.
3. Raise the hood.
4. Remove the driver-side front quarter fender and mud flap.
5. Remove the bumper.
6. Replace the tie rod arms.
  - 6.1 Remove and discard the fasteners that hold the tie rod arms to the steering knuckles. Leave the tie rod arms attached to the steering gear; removing the arms is unnecessary because the gear will be replaced later in the procedure. See **Fig. 1** and **Fig. 2**.

IMPORTANT: Make sure that the new tie rod arms are installed on the correct side. The raised number on each arm will end in an "L" or an "R," which refers to left (driver) side or right (passenger) side of the vehicle.
  - 6.2 Using a solvent, remove all dirt, oil, and other foreign material from the female threads on the steering knuckles. Let the solvent dry completely.
  - 6.3 Apply Loctite 277 to the threads of the new M20 flanged hexbolts and install the new tie rod arms. Tighten the flanged hexbolts 387 to 461 lbf·ft (525 to 625 N·m).
7. Disconnect the hydraulic lines from the rack and pinion gear.
8. Remove the power steering fluid reservoir.
9. Remove the power steering fluid lines from the chassis.
10. Remove the left-front shock mount.
11. Remove the power steering reservoir bracket from the frame.

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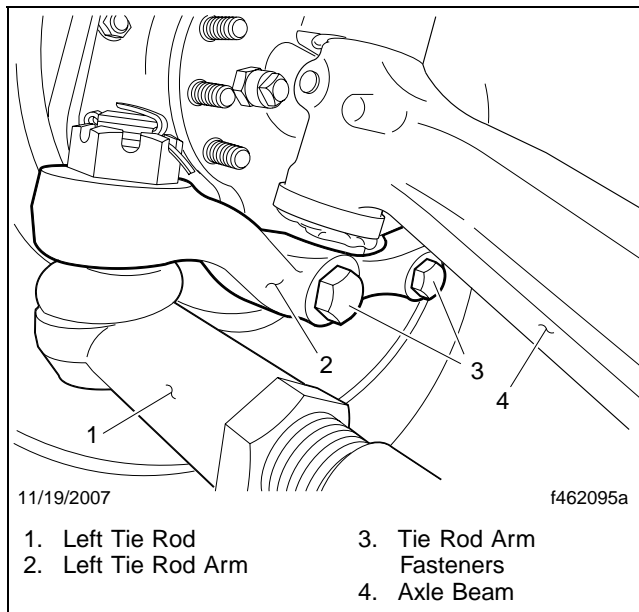


Fig. 1, Left Side of Vehicle

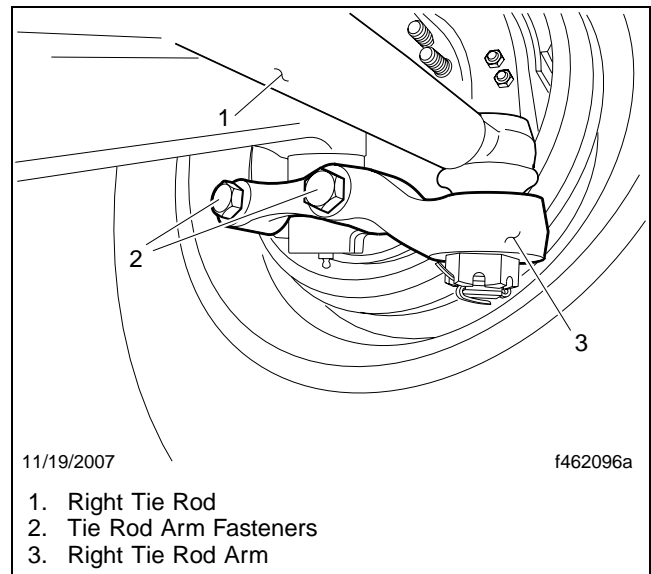


Fig. 2, Right Side of Vehicle

12. Remove and discard the upper and lower pinch bolts and nuts from the steering I-shaft, then remove the shaft.

## WARNING

**On vehicles equipped with an SRS air bag, do not rotate the upper steering column while the I-shaft is removed or disconnected. This can cause the clockspring in the steering wheel hub to become off center, which could result in the air bag failing to operate during a crash.**

13. Mark the layout of the holes on the frame, using the drilling diagram. See **Fig. 3**.

14. Check the area to be drilled for lines and wires that may be attached to the inside of the frame rail, and reroute as necessary.

15. Drill and deburr the new holes in the frame.

16. Clean and prime the holes in the frame and the new U-bolts, but do not paint the U-bolt threads.

17. Remove and discard the fasteners that connect the rack and pinion gear to the axle-mounted brackets, then remove the gear (along with the tie rod arms) from the vehicle.

18. Paint the frame and the new U-bolts from the kit, but do not paint the U-bolt threads.

19. Install the axle-mounted hose bracket.

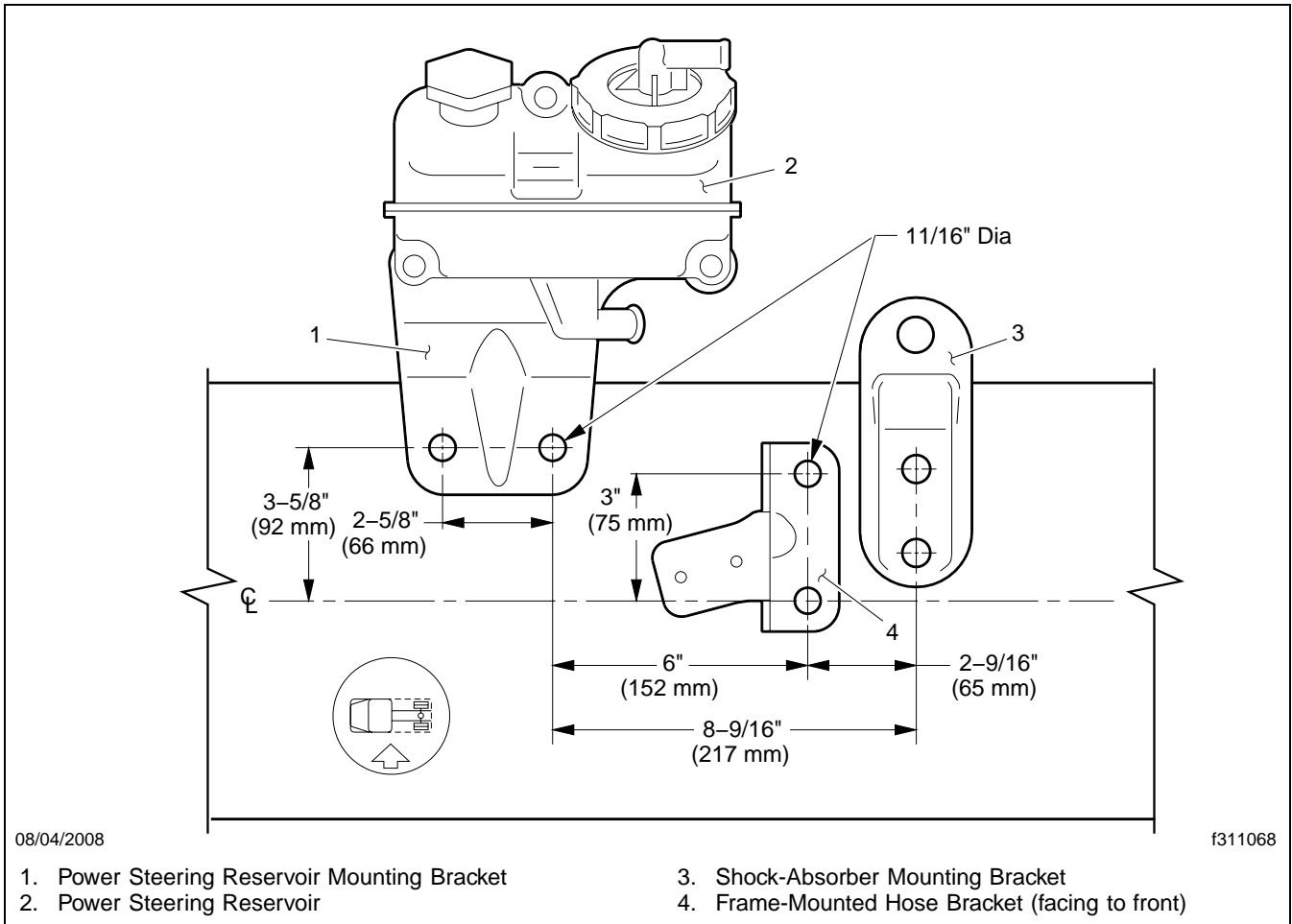
19.1 Remove the front U-bolt on the left side and replace it with a new one. Install the new plumbing bracket between the washers and axle pad.

19.2 Lubricate the U-bolt threads to prevent galling and to ensure that the proper torque is achieved.

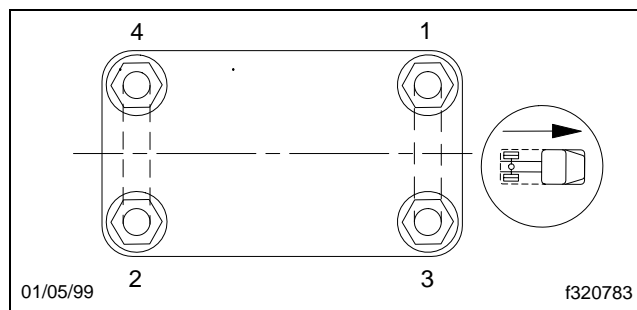
19.3 Replace the second U-bolt on the left side, and evenly tighten the U-bolts 60 lbf·ft (81 N·m) in the sequence shown in **Fig. 4**.

20. Using new fasteners, install the new rack and pinion gear. Tighten the fasteners 202 to 256 lbf·ft (274 to 347 N·m).

21. Tighten all the new U-bolts 200 lbf ft (270 N m), then tighten them all 270 to 330 lbf ft (370 to 450 N m).



**Fig. 3, Drilling and Mounting Locations**



**Fig. 4, U-Bolt Nut Tightening Sequence**

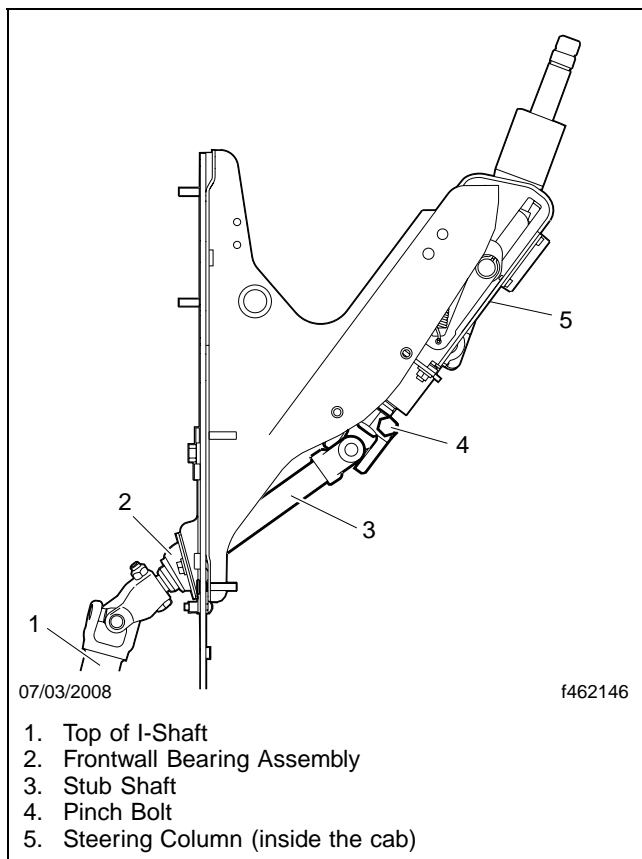
22. Attach the tie rods to the tie rod arms. Tighten the new castle nuts 240 lbf·ft (325 N·m), then install and lock a new cotter pin in each of the ball studs and nuts. If needed, continue tightening each nut until a slot on the nut aligns with the cotter-pin hole in the ball stud. Do not back off the nut to align it with the cotter pin hole.
23. Remove the knee bolster and lower steering column cover.
24. Remove the upper-stub-shaft pinch bolt, and draw the shaft up from inside the cab.

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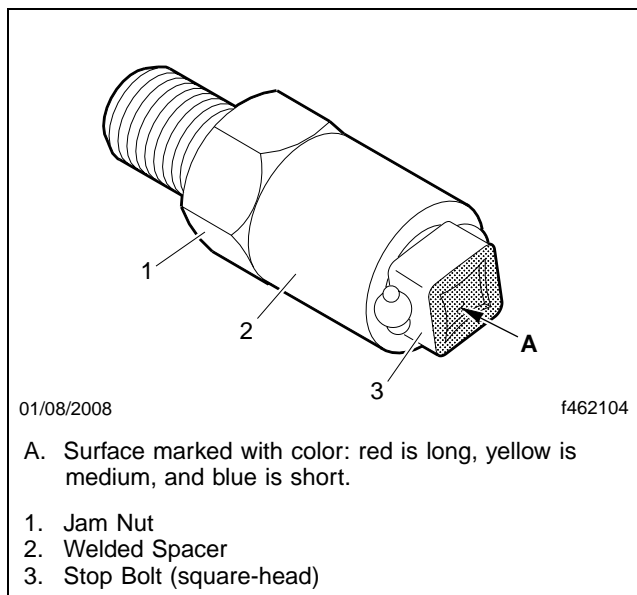
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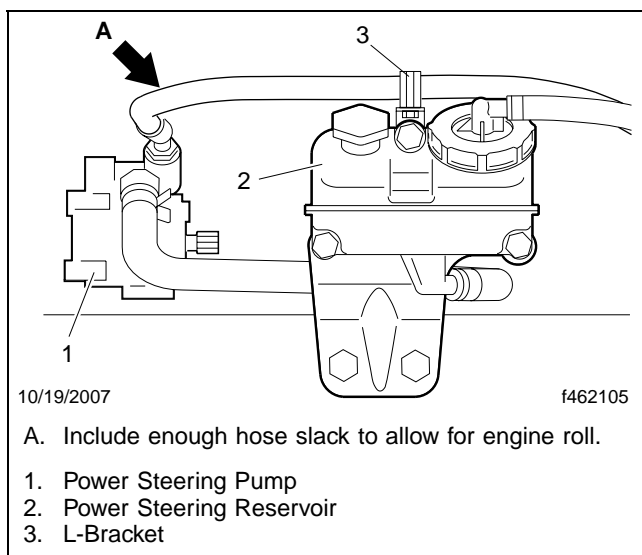
25. Replace the frontwall bearing.
  26. Install the new stub-shaft, and fit a new pinch bolt and nut in the U-joint; as shown in **Fig. 5**. Tighten the nut 30 to 35 lbf·ft (41 to 47 N·m).
- NOTE: The clocking between the cross bolt hole in the stub-shaft U-joint and the whistle-notch in the steering column shaft may be slightly off, but if the stub-shaft is in the correct position, the cross bolt can be tapped through easily.
27. Install the knee bolster and lower steering column cover.
  28. Raise the vehicle and place the front wheels on turnplates.
  29. If **FL512** has been completed on the vehicle (a claim, a completion sticker, or both), installing new stop bolts is not needed; skip those steps below, and go to *Step 33*.
  30. Remove the existing axle-stop bolts from the steering knuckles.
  31. If not already done, hand-tighten the jam nut against the welded spacer before installing each stop bolt. See **Fig. 6**.
  32. Install the new axle-stop bolts with the red-marked bolt heads.
  33. Install the shock bracket and the shock.
  34. Install the frame-mounted hose bracket, as shown in **Fig. 3**.
  35. Install fasteners and washers in any holes in the frame that will not be occupied by parts, to maintain frame integrity.
  36. Install the new fittings on the power steering pump. Tighten the pump suction adaptor 33 to 43 lbf·ft (45 to 58 N·m), and the pump output adaptor 42 to 52 lbf·ft (57 to 70 N·m).
  37. Install and route the new pressure line from the frame-mounted hose bracket to the pump, and include extra hose between the L-bracket on the top-mount of the reservoir and the pump to allow for engine roll. See **Fig. 7**. Tighten the fitting 42 to 52 lbf·ft (57 to 70 N·m).
  38. Install the power steering reservoir mounting bracket on the frame.
  39. Install the power steering reservoir on the reservoir mounting bracket.
  40. Using hose clamps, install the new power steering pump suction line on the reservoir and pump. See **Fig. 7**.
  41. Connect the return hose between the reservoir and formed line. The hose should have no necking or kinks that may impede the return fluid flow. See **Fig. 8**.
  42. Install the adaptor fittings in the steering gear, and tighten 30 to 35 lbf·ft (41 to 47 N·m).
  43. Attach the lines to the plumbing adaptors on the steering gear, while ensuring that the lines will not touch the axle or each other once installed. Snug the connection with a wrench to ensure the fittings are seated, which is equivalent to approximately 2 lbf·ft (3 N·m). Then, using a backup wrench to keep the adaptors from turning, tighten the return and supply hoses by 1 flat of the tube nut (60 degrees). See **Fig. 9**.
  44. Include a little slack in the return line between the steering rack and the axle-mounted hose bracket ( **Fig. 10**), to keep the hoses between the axle-mounted hose bracket and the frame bracket ( **Fig. 11**) from rubbing together.
  45. After securing the formed section of the line to the frame-mounted bracket and connecting the lines to the rack and pinion gear, fasten the rubber bushing and clamp to the axle-mounted hose bracket.



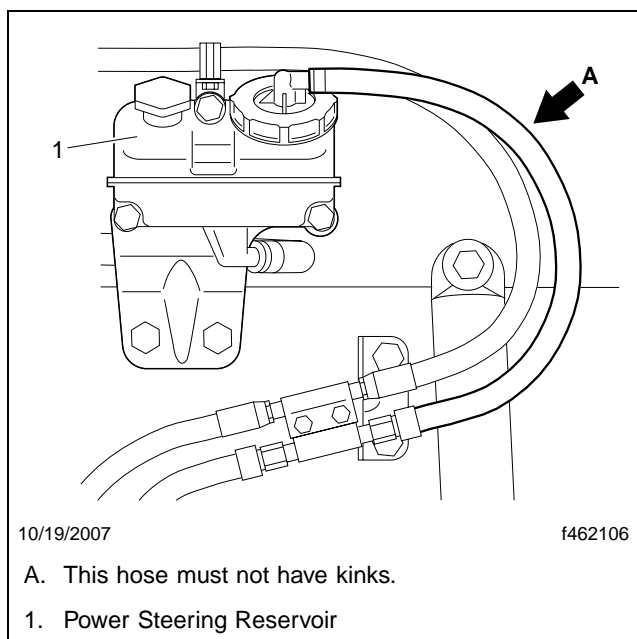
**Fig. 5, Stub Shaft Installation, Side View**



**Fig. 6, New Axle Stop Bolt**



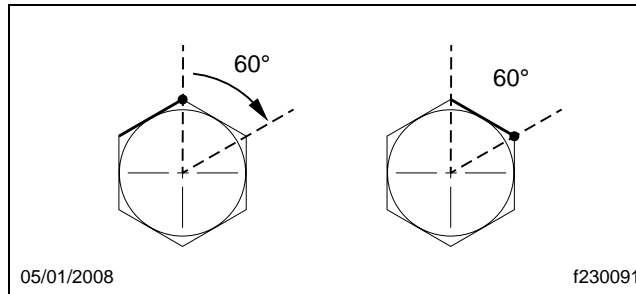
**Fig. 7, Hose Routing To Pump (S60 Shown)**



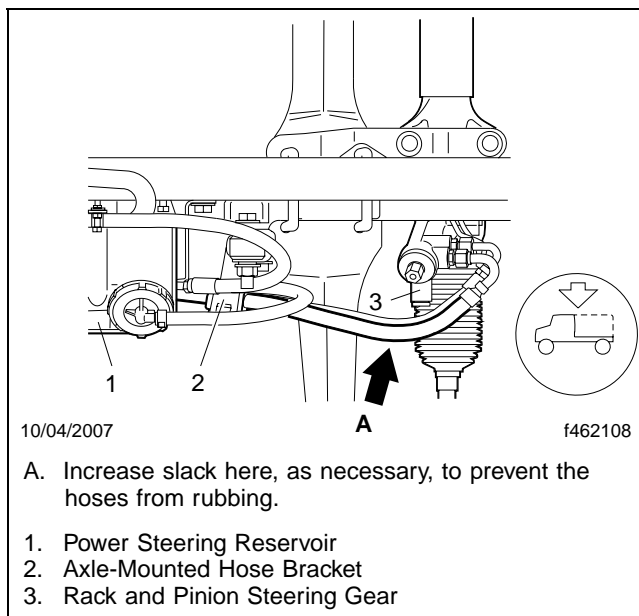
**Fig. 8, Hose Routing From Power Steering Reservoir**

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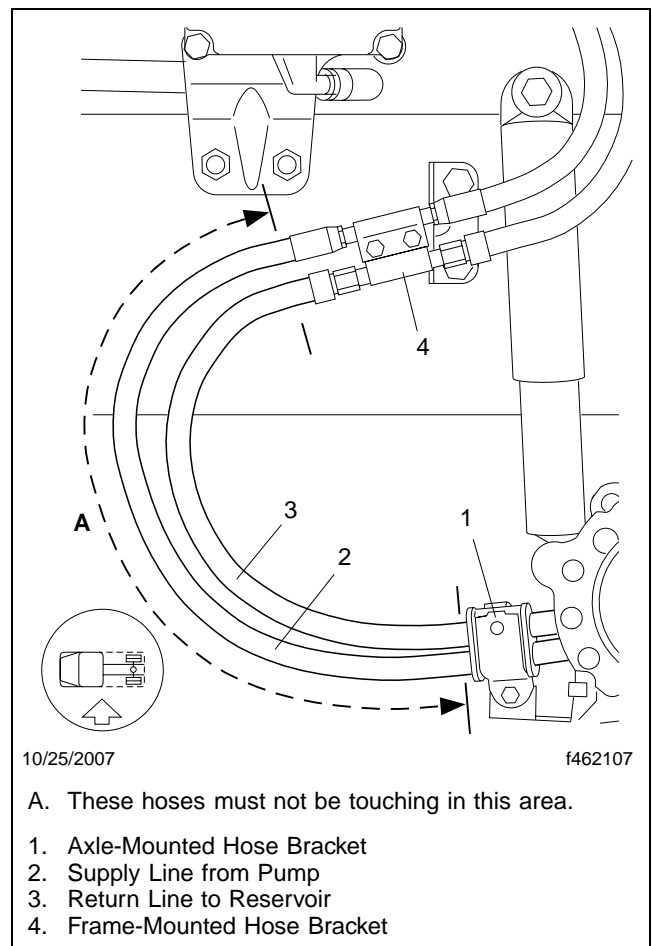
**Fig. 9, Turning the Fitting One Flat (60 degrees)**



**Fig. 10, View from Above**

A. Increase slack here, as necessary, to prevent the hoses from rubbing.

1. Power Steering Reservoir
2. Axle-Mounted Hose Bracket
3. Rack and Pinion Steering Gear



**Fig. 11, Side View (fuel/water separator installed forward)**

A. These hoses must not be touching in this area.

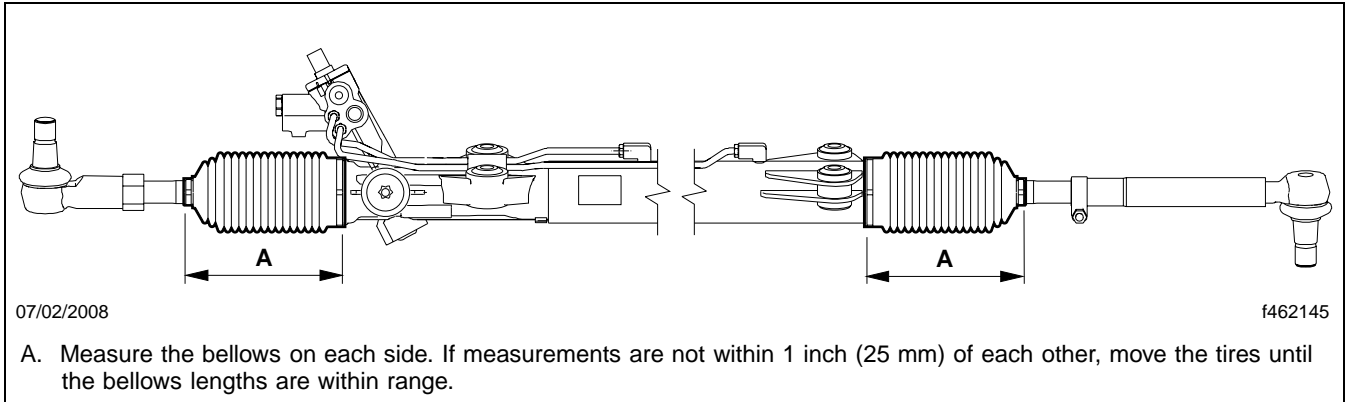
1. Axle-Mounted Hose Bracket
2. Supply Line from Pump
3. Return Line to Reservoir
4. Frame-Mounted Hose Bracket

46. Center the rack and pinion gear.

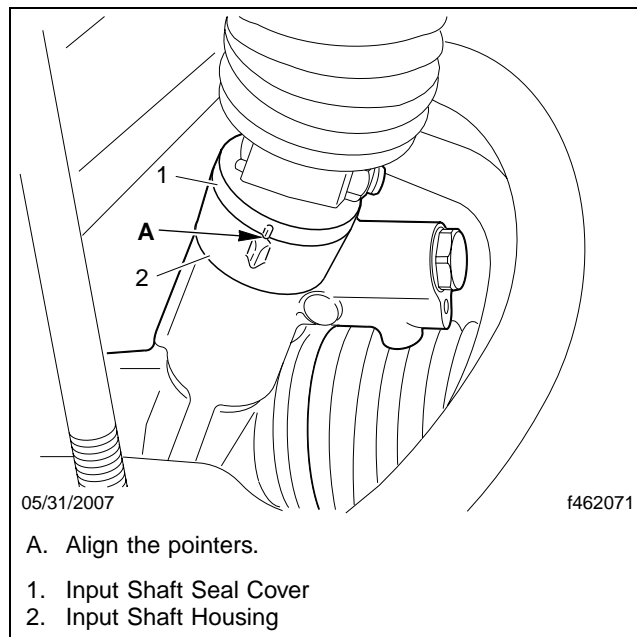
46.1 Measure the length of the bellows from clamp to clamp on each side of the gear. See **Fig. 12**. If measurements are not within 1 inch (25 mm) of each other, move the tires until the bellows lengths are within range.

46.2 Align the pointers on the input shaft seal cover and the input shaft housing. See **Fig. 13**.

- 47. Install the I-shaft, then install a new upper and lower pinch bolt and nut in the U-joints of the steering I-shaft. Tighten the nuts 30 to 35 lbf-ft (41 to 47 N·m).
- 48. Install the quarter fender and mud flap.
- 49. Fill and bleed the power steering system.
  - 49.1 Raise the front wheels off the ground or put the front wheels on turnplates.



**Fig. 12, Measuring the Tie Rod Bellows**



**Fig. 13, Pointer Alignment**

- 49.2 Fill the power steering reservoir with automatic transmission fluid that meets Dexron III or TES-389 specifications.
- 49.3 With the engine off, turn the wheel fully left and right five times to bleed the air from the rack.
- 49.4 Start the engine, turn the wheel fully left and right several times to bleed the remaining air from the rack.
- 49.5 If the steering system needs additional bleeding, repeat the previous substep after the fluid in the reservoir has had time to release any air.

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50. Align the front wheels using a computerized alignment tool.

NOTE: If you do not have access to this type of tool, the alignment procedure must be done by a facility that does.

50.1 Complete the setup needed for the computerized alignment tool (identical to the setup for integral steering gears).

50.2 With the wheels on turnplates, center the rack travel by aligning the timing pointers on the input shaft seal cover and the input shaft housing. See **Fig. 13**.

Whenever the computerized alignment program requires that the steering wheel be pointed straight ahead, the steering rack on-center pointers should be aligned.

NOTE: Do not center the steering wheel; it must be centered at the end of the procedure.

50.3 Loosen the driver-side tie rod jam nut. If necessary, hold the inner tie rod in place with a backup wrench on the inner tie rod flat.

50.4 With the gear on-center, place a wrench on the driver-side inner tie rod flat and align the left tire by rotating the inner tie rod.

Total left side toe-in should be between 0 and 1/16 inch (1.58 mm).

50.5 Tighten the tie rod jam nut 285 to 305 lbf-ft (386 to 413 N·m)

50.6 Loosen the passenger-side tie rod clamp nut.

50.7 With the gear on-center, place a wrench on the passenger-side inner tie rod flat and align the right tire by rotating the inner tie rod.

Total right side toe-in should be between 0 and 1/16 inch (1.58 mm).

50.8 Tighten the tie rod clamp nut 30 to 36 lbf-ft (41 to 48 N·m).

IMPORTANT: Total toe-in for both sides should be between 0 and 1/8 inch (3.18 mm), and the target should be 1/16 inch (1.58 mm).

NOTE: If **FL512** has been performed, wheel cut may have been set below 44 degrees to compensate for clearance issues.

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## NOTICE

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**Wheel cut cannot exceed 46 degrees. Excessive wheel cut may damage the inner tie rod.**

50.9 If the vehicle is not included in FL512 **or** FL512 has been completed, go to step 50.11. If the vehicle is included in FL512 and it has not been completed, to go step 50.10.

50.10 Check the wheel cut. With the wheels turned all the way to the right and left, the wheel cut should be 44 degrees to 46 degrees. It should never exceed 46 degrees. If it is less than 44 degrees, from kit 25-FL512-000, use the yellow-marked stop bolts to increase the wheel cut by 2 degrees, or the blue-marked stop bolts to increase the wheel cut by 4 degrees. Every 2 mm (0.79 inch) of stop-bolt spacing equals 2 degrees of wheel cut.

NOTE: Because the stop-bolt lengths are in 2 mm (0.79 inch) increments, you may ultimately have to use different lengths for the left and right sides to achieve wheel cuts in the acceptable range. The wheel cuts do not have to be exactly the same on both sides of the vehicle, just within the acceptable range.

50.11 Check the clearance of the front wheels. With the wheels turned all the way to the right and left, there must be at least 1/2-inch (13-mm) clearance between the wheels and any stationary components, and at least 3/4-inch (19-mm) clearance between the wheels/tires and any moving components.

If the clearance is inadequate, back out the stop bolts and adjust the jam nuts to limit the turning angles and to prevent possible contact with components.

50.12 Tighten the stop-bolt jam nuts 80 to 120 lbf·ft (108 to 163 N·m).

50.13 Return the wheels to the straight-ahead position.

51. Make sure that the steering wheel is within 10 degrees of center as shown in **Fig. 14**. If it is not, remove and center the steering wheel.

**IMPORTANT:** The spline/pinch bolt connections between the steering gear and the steering wheel fit in only one position. Clocking the splined connections after alignment is not possible.

51.1 If the vehicle has an air bag, deactivate and remove the air bag according to the instructions in the applicable vehicle workshop manual. If the vehicle does not have an air bag, remove the horn button by prying it out around the edges.

**IMPORTANT:** The steering wheel does not have threaded wheel-puller holes. The tapered fit between the steering wheel and the column is designed to be removed by hand.

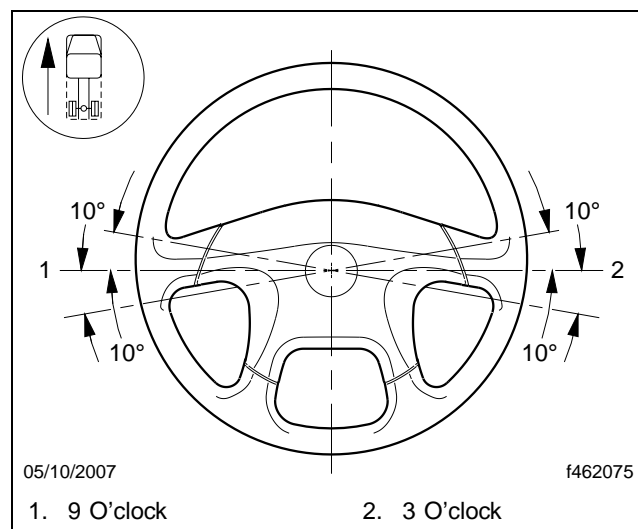
51.2 Loosen the nut that holds the steering wheel on the steering column, but leave it on the shaft until the wheel has been released from the tapered fit.

51.3 Remove the wheel from the tapered fit by striking it from below, at the rim/spoke intersections, with both hands.

51.4 Remove and discard the steering wheel nut, and install and center the steering wheel.

51.5 Install a new steering wheel nut and tighten it 33 to 41 lbf·ft (45 to 55 N·m).

51.6 If the vehicle has an air bag, install and reactivate the air bag according to the instructions in the applicable workshop manual. If the vehicle does not have an air bag, install the horn button.



**Fig. 14, Steering Wheel Centered**

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52. Remove the turnplates and alignment equipment.
53. Recheck the power steering fluid level.
54. Install and adjust the bumper.
55. Clean a spot on the base label (Form WAR259), write the recall number, FL513, on a blank completion sticker (Form WAR260), and attach it to the base label.