NO: 03-05-99

SUBJECT: Axle Diagnosis

DATE: Sep. 24, 1999

OVERVIEW:

This bulletin involves the diagnosis of the vehicle axle.

SYMPTOM/CONDITION:

A sound may appear to be coming from the general area of the vehicle axle(s). The sound may be described as a growl, a howl, or a whine. They may occur at different vehicle or engine speeds. They may also occur during different axle loading conditions, i.e. light driving, heavy driving, float, cruise, or coast.

DIAGNOSIS:

A correct and thorough diagnosis of the axle condition is perhaps the most important tool that the technician has in effecting a successful axle service. Because the transmission of an axle-like sound may be due to vehicle components other than the axle, a good diagnostic procedure is necessary in determining if the condition can be corrected by service to the internal axle components. Proper diagnosis may lead the technician to vehicle components other than the axle.

A systematic diagnostic approach must be used to diagnosis, analyze, and repair any axle sound. The systematic diagnostic approach involves six steps: verify the condition, verify related symptoms, analyze the symptoms, isolate the condition, repair the condition, and verify the service.

VERIFY THE CONDITION:

1. Road test the vehicle with the customer to verify the driving environment and whether the condition is present. If a road test with the customer is not possible, then contact the customer and service writer. Obtain a detailed description of the condition and record this information. The customer should be questioned in detail to assist the technician in determining the exact driving conditions and environment that the customer states the condition is present. If no sound is present during your road test, then return the vehicle to the service advisor or customer. If an axle-like sound is present, then continue with your diagnosis.

   Questions to ask the vehicle customer:

   a. Condition description: a sound (a high pitched whine, a low frequency growl, or a cyclic howl), a vibration, or other related symptoms.
   b. Condition of occurrence: is it constant or intermittent.
   c. Vehicle description: engine speed, vehicle speed, load, temperature, maneuver.
   d. Environment: ambient temperature, wet or dry road, smooth or rough road.

2. Verify that all tires are inflated properly, are not damaged, are designed for the vehicle, are the correct size, and all four tires are the same. Inspect the wheels in like manner.

3. A thorough road test of the vehicle axle will involve different drive modes and is most effective when theaxles are at normal operating temperatures. While performing the road test, evaluate the vehicle using the following subjective rating system and sound description type. Enter your subjective rating along with the respective type of sound in the corresponding drive mode box.

   NOTE: THE VEHICLE SHOULD BE DRIVEN IN A SAFE AREA AND IN A SAFE MANNER WHILE PERFORMING THESE DIFFERENT DRIVE MODES. OBSERVE ALL VEHICLE SPEED LIMITS.

   Subjective Rating System:

10	Superior / Inaudible
9	Excellent / Audible trace
8	Very Good / Slightly noticeable
7	Good / Noticeable to critical observer
6	Fair / Noticeable to average observer
5	Acceptable / Noticeable to most observers
4	Unacceptable / Noticeable to all observers
3	Unacceptable to the average observer
2	Unacceptable to most observers
1	Unacceptable to all observers

   Drive Mode:

Light Drive	Slight acceleration, gradually increasing through target speed.
Float	Lightly lift foot on and off the accelerator while maintaining target speed.
Heavy Drive	Rapid acceleration through target speed.
Coast	Deceleration through a target speed.
Cruise	Maintaining target speed without accelerating or decelerating.
Turns	Left and right turns to load outer axle shaft bearings.

   Type Of Axle Sound:

Growl	a low pitch sound (most noticeable from 15 to 60 mph) usually associated with a bearing
Whine	a high pitch sound (most noticeable at highway speeds) usually associated with ring and pinion engagement
Howl	an oscillating sound (most noticeable between 45 to greater than 65 mph) usually associated with runout of the major rotating components within the axle like the differential case, pinion gear, or ring gear
Drone	a moderate to low pitch sound not usually associated with the axle

	25 to 35 mph	35 to 45 mph	45 to 55 mph	55 to 65 mph	65+ mph

Drive Mode	Subjective rating and type sound	Subjective rating and type sound	Subjective rating and type sound	Subjective rating and type sound	Subjective rating and type sound
Light Drive	-	-	-	-	-
Float	-	-	-	-	-
Heavy Drive	-	-	-	-	-
Coast	-	-	-	-	-
Cruise	-	-	-	-	-
Turns	-	-	-	-	-
Engine RPM	-	-	-	-	-

4. Road test the vehicle to obtain the necessary data to complete the Subjective Rating and Type Sound form above. Record on the form your subjective rating and the type sound that may be of concern. Record on the form if the noise is affected by vehicle turns (axle loading). If the sound is affected by engine speed, record the type sound and the engine speed.

   Road Test Procedure:

   a. Turn off the vehicle radio.
   b. Set the HVAC control to FLOOR mode and blower speed to mid level.
   c. Obtain target speed through light acceleration.
   d. Float the throttle so the vehicle is neither accelerating nor decelerating.
   e. Accelerate rapidly 10 mph higher than target speed without causing a downshift.
   f. Coast back down to target speed.
   g. Cruise by holding the throttle to maintain target speed.
   h. Turn the steering wheel left and right.
   i. Repeat this road test procedure for each set of target speeds.

5. Continue with the DIAGNOSIS if the condition is present. If the condition is not present or the subjective ratings are greater than a "7" (Good / Noticeable to critical observer), then return the vehicle to the customer with an explanation of your evaluation.
6. If the condition is changed by engine speed, then the sound is related to the engine, transmission, transfer case, exhaust, etc.

VERIFY RELATED SYMPTOMS:

Areas other than axles can contribute to sound complaints. A four wheel drive vehicle will have additional sound paths, including other driveline components. This means that you have to be especially careful before associating the cause of the sound complaint with the axle.

1. Continue with the Road Test. Determine that the noise is not being caused by related symptoms.
2. To determine if the sound is engine speed related, drive in different gears when the noise occurs. For example: cycle the OD button to obtain a 4-3 and 3-4 shift without changing the throttle angle. Lightly depressing and releasing the brake pedal, while driving, will cause the torque converter to unlock and lock.
3. Inspect vehicle for related vehicle vibrations, handling, and braking conditions. Inspect for any related diagnostic trouble codes (DTC’s) which may be present.

Related symptoms that may be confused for axle noise are:

- Wind induced vibration (roof rack cross bars, loose body components, etc.)
- Tire or wheel
- Axle shaft bearing
- Transfer case chatter/shudder
- Axle chatter/shudder from the limited slip / Vari-Lok unit
- Transmission overdrive unit chatter
- Loose or grounded suspension components
- Loose or grounded exhaust components
- Loosed or grounded engine, transmission, transfer case components or mounts

4. Stop the vehicle. Apply the parking brake. Place the transmission in NEUTRAL.
5. Slowly increase the engine speed to the rpm range that the sound occurs. A drone sound can often be detected using this method since it is often engine speed related and is not axle related.
6. Raise and support the vehicle in a safe manner.
7. Inspect the vehicle powertrain and suspension for related conditions.
8. If a related symptom is not the cause of the axle sound, then proceed with the DIAGNOSIS.

ANALYZE THE SYMPTOMS:

It is important to understand that all gears make sounds. Axle sounds are inherent. When a sound is perceived as a condition, by the customer, it becomes an issue that requires further investigation. The ability to identify the type of axle sound being generated will assist in determining what component of the axle will require service. There are three major types of axle sound: a growl, a howl, and a whine. Any axle may exhibit one or more of the sounds described in this TSB. It is very important for the technician to remember that the extent of repairs performed must address each of the sound conditions.

A growl sound generated by the axle may be caused by the contact surface of any bearing within the axle. This sound may occur when the surface of the axle bearing or the race becomes rough. The growl sound will tend to increase as the axle temperature rises and may increase as the bearing changes over time. The growl sound is often low in frequency and constant in intensity. The growl sound will occur through all speed ranges. Axle components that may generate this sound are a differential case bearing, a pinion bearing, or an outer axle shaft bearing. Exercising and/or loading the different bearings may assist in determining the affected component. Performing various turns with the vehicle is a method to exercise and load the outer axle bearings. If the axle is generating a growl sound then a visual and tactile inspection should be made of the contact surfaces of the affected component. Special attention should be paid to bearing preload and torque-to-turn values, as these indicators have a great impact on bearing life and sound.

A howl sound generated by the axle may be caused by runout of the major rotating axle components. This sound may oscillate rhythmically as the clearance between the rotating component change. The howl sound may be a low to medium frequency sound and may vary in pitch. A howl will be heard through all speed ranges, but can be torque sensitive. The vibration may accompany the howl and may be felt while driving in the pedals and steering wheel. Axle components may generate this sound are an out of round differential case, a pinion gear, or a ring gear. If the axle is generating a howl sound, attention should be paid to verify the runout for these major components.

A whine sound generated by the axle is very much torque and load sensitive. The whine sound is often a high frequency noise and does not oscillate. The whine sound will often be speed sensitive at one or more speed ranges. If the axle is generating a whine sound it may be due to reduced loads on the pinion

or differential case bearings (preload). The low bearing loads may cause a change in the ring and pinion backlash and the contact pattern they create. Special attention should be paid to bearing preload, torque-to-turn values, and the contact pattern.

NOTE: THE WHINE SOUND MAY BE CAUSED BY MACHINING VARIATION OF THE RING AND PINION GEAR SET. WHINE SOUND MAY BE CAUSED BY A RING AND PINION GEAR SET WITH A MACHINE VARIANCE EVEN THOUGH THE GEAR BACKLASH AND CONTACT PATTERN APPEAR ACCEPTABLE. IN THESE RARE CASES, THE TECHNICIAN WILL NOT BE ABLE TODETERMINE VISUALLY THE MACHINING VARIATION AND CAN ONLY REPLACE THE GEAR SET TO ADDRESS THE WHINE CONDITION.

If the analysis is leading the technician toward a diagnosis that the condition is caused by an axle sound, then proceed with the ISOLATE THE CONDITION.

ISOLATE THE CONDITION:

Refer to the 2000 Jeep Grand Cherokee Service Manual (81-370-0047), Group 3 Differential and Driveline, for additional information regarding the following procedure.

Isolate The Front Axle (if four wheel drive):

1. Raise the vehicle and support in a safe manner.
2. For later installation reference, mark the front propeller shaft to the pinion companion flange and the front propeller shaft to the transfer case flange.
3. Remove the front propeller shaft and lower the vehicle.
4. Road test the vehicle through the different drive modes.
5. If the noise decreases or changes in pitch, then the cause of the sound is probably the front axle.

   NOTE: THE FRONT AXLE MAY GENERATE SUFFICIENT SOUND THAT THE REMOVAL OF THE FRONT PROPELLER SHAFT MAY CAUSE MINIMUM CHANGE IN THE LEVEL OF THE SOUND GENERATED BY THE FRONT AXLE.

6. If the sound does not appear to be caused by the front axle, then proceed with the isolation of the rear axle, step 8. If the front axle is determined to be the cause of the sound then proceed to the Axle Inspection and Analysis

   Isolate The Rear Axle:

7. Raise the vehicle and support in a safe manner.
8. Install the front propeller shaft. Align the previously made marks on the propeller shaft, pinion companion flange, and transfer case flange.
9. For later installation reference, mark the rear propeller shaft to the pinion yoke.
10. Remove the rear propeller shaft
11. Plug the hole around the transfer case rear output shaft with a shipping plug. Use Snap On kit YA321 or YA2340 for the appropriate size shipping plug.
12. Secure the shipping plug to the transfer case to prevent possible loosening during the road test.
13. Lower the vehicle.
14. If the vehicle is equipped with a NV-242 (Select-Trac) tansfer case, then shift the transfer case selector to 4x4 part time.

15. If the vehicle is equipped with a NV-247 (Quadra-Drive) transfer case, be certain that the transfer case selector is in four high.

    NOTE: IT IS NORMAL TO EXPERIENCE A MOMENTARY SHUDDER FROM THE NV-247 (QUADRA-DRIVE) TRANSFER CASE WHEN INITIALLY PULLING AWAY FROM A STOP WHEN THE REAR PROPELLER SHAFT HAS BEEN REMOVED.

16. Road test the vehicle through the different condition noted drive modes.

    NOTE: KEEP STOP AND GO DRIVING TO A MINIMUM WHILE THE REAR PROPELLER SHAFT IS REMOVED.

17. If the sound decreases or changes in pitch, then the cause of the sound is probably the rear axle.

    NOTE: REPLACE THE NV-247 (QUADRA-DRIVE) TRANSFER CASE FLUID IF A ROAD TEST IS PERFORMED WHERE THE REAR PROPELLER SHAFT HAS BEEN REMOVED. PERFORM THIS FLUID CHANGE ONLY WHEN ALL AXLE REPAIRS ARE COMPLETE AND VERIFIED. ONLY USE AN APPROVED TRANSFER CASE FLUID (P/N 05016796AA) AND REFER TO TECHNICAL SERVICE BULLETIN 21-09-99 FOR FURTHER INSTRUCTIONS.

18. If the sound is still present, then the condition is not axle related and may be coming from other driveline components on the vehicle. Proceeding with this DIAGNOSIS will be of no further assistance.

    Axle Inspection and Analysis Procedure:

    The axle inspection and analysis is used to gather complete information about the axle in question. It is used to determine whether one or more of the specific problems defined (a gear, a component run out problem, or a bearing) exist within the subject axle. Having identified the type of sound(s) (growl, howl, or whine) should give you an idea of what needs to be checked.

Growl	Check bearings (differential case, pinion gear, axle shaft).
Howl	Check runout (pinion gear, ring gear, differential case).
Whine	Check backlash measurement, gear contact pattern, and bearing preload.

19. Remove the wheels and the axle shafts.
20. Obtain a clean container to drain the axle fluid into.
21. Remove the differential housing cover.
22. Inspect the axle fluid for discoloration, burnt, metal filings, etc.

    NOTE: THE USE OF UNAPPROVED AXLE FLUIDS AND ADDITIVES MAY CONTRIBUTE TO AXLE SOUND. DUE TO THE UNIQUE PERFORMANCE OF THIS VEHICLE, ONLY MANUFACTURER APPROVED FLUIDS AND ADDITIVES ARE RECOMMENDED.

23. Place 16 equally spaced marks around the perimeter of the ring gear.
24. Measure the ring gear backlash at all 16 points. Set the dial indicator against the drive side of the ring gear tooth heel when taking measurements. Record your measurements.

NOTE: IT IS IMPORTANT THAT ALL 16 MEASUREMENTS BE TAKEN, SO THAT THE RING GEAR AND PINION GEAR ARE FULLY CHECKED.

25. Ring gear backlash should be between 0.13-0.20 mm (0.005-0.008 in.).
26. The ring gear backlash measurements should not vary by more than 0.05 mm (0.002 in.) between the highest measurement and the lowest measurement. If the backlash variation is greater than 0.05 mm (0.002 in.), then the cause may be runout in pinion gear, a ring gear, or a differential case.
27. Rotate the pinion gear 10 times, in both directions, with an inch pound torque wrench. Note if the pinion rotates smoothly by observing variation in the torque wrench dial. The torque wrench dial should not fluctuate. A rapid fluctuation of the torque wrench dial may indicate a possible bearing condition. A gradual sweeping like fluctuation of the torque wrench dial may indicate the binding or interference of a component.
28. Using an inch pound torque wrench, applied to the pinion nut, measure and record the total turning torque required to rotate the pinion gear. Record the measured torque. This measurement is called total torque to rotate or TTR.
29. Paint the drive and coast sides of the ring gear with Mopar Gear Marking Compound (p/n 04883065).
30. While placing a load on the pinion gear, rotate the ring gear one full turn in one direction. Note the pattern.
31. While placing a load on the pinion gear, rotate the ring gear one full turn in the opposite direction. Note the pattern.

    The areas on the ring gear teeth with the greatest degree of contact against the pinion teeth will squeegee the compound to the areas with the least amount of contact.

32. Compare the Gear Tooth Contact Patterns. Refer to the appropriate 2000 Jeep Grand Cherokee Service Manual – Group 3 page 3-134 for additional assistance with interpreting the contact patterns.
33. Install an axle differential housing spreader.
34. Spread the differential housing and remove the differential case and ring gear.

NOTE: DO NOT SPREAD THE DIFFERENTIAL HOUSING OVER 0.50 MM (0.020 IN.). IF THE HOUSING IS OVERSPREAD, IT COULD BE DISTORTED OR DAMAGED.

35. Rotate the pinion gear 10 times, in both directions, with an inch pound torque wrench. Note if the pinion rotates smoothly by observing variation in the torque wrench dial. If variation is noted, then the pinion bearings may be the affected components.
36. Using an inch pound torque wrench, applied to the pinion nut, measure and record the pinion turning torque.
37. Subtract the pinion bearing turning torque measurement from the total torque to rotate measurement (taken in Step 28) to obtain the differential turning torque. Record this measurement.
38. Remove the pinion gear. Inspect the ring and pinion gear set for nicks, chips, burrs, scratches, or high spots.
39. Inspect each pinion bearing and bearing race for damage or wear.
40. Compare the match number on the pinion gear to the match number on the ring gear. The match numbers must be the same.
41. Record the match number and the pinion gear depth variance.
42. Using a micrometer or caliper, record the thickness of the pinion gear depth shim.
43. Mark the ring gear to the differential case for possible later installation reference.

44. Remove the ring gear from the differential case. Inspect the mating surfaces of the ring gear and differential case for nicks, chips, burs, or high spots.
45. Install the differential case in to the axle differential housing.
46. Using a dial indicator, measure and record the differential case flange runout of the ring gear flange (lateral runout check). This measurement is taken on the ring gear side of the differential case flange. The maximum allowed runout is 0.025 mm (0.001 in.).

    NOTE: ONLY THE VARI-LOK DIFFERENTIAL CASE IS A TWO PIECE UNIT. IT IS HELD TOGETHER BY ATTACHING SCREWS WHICH ARE COUNTER SUNK INTO THE FACE OF THE DIFFERENTIAL CASE FLANGE. THE COUNTER SUNK HOLES AND SCREW HEADS ARE COVERED OVER BY THE RING GEAR. MINOR RUNOUT VARIATION OCCURS IN THE IMMEDIATE AREA AROUND THE COUNTER SUNK HOLES AND SCREW HEADS.

47. Using a dial indicator, measure and record the differential case flange center pilot runout (radial runout check). The flange center pilot is the machined lip that is used to center the ring gear on the differential case. The maximum allowed runout is 0.025 mm (0.001 in.).

    NOTE: THE COMBINED ASSEMBLY RUNOUT IS 0.051 MM (0.002 IN.), AS MEASURED WITH THE16 STEP BACKLASH METHOD, BUT INDIVIDUAL COMPONENT RUNOUT MUST BE KEPT TO A TOLERANCE OF 0.025 MM (0.001 IN.).

48. Using the appropriate special tools, measure and record the pinion depth. Compare this measurement with the previously obtained pinion gear depth shim and the pinion gear depth variance.
49. Determine what may need to be adjusted or serviced.

REPAIR THE CONDITION:

Service the axle component in question. Refer to the 2000 Jeep Grand Cherokee Service Manual (81-370-0047), Group 3 – Differential and Driveline for detailed instructions.

Before lowering the vehicle off of the hoist, inspect the lower control arms of the front axle for clearance. Check for a minimum clearance of 0.075 mm (0.003 in.) between the sill rail (frame) and the rear lower control arm attachment.

VERIFY THE REPAIR:

1. Fully road test the vehicle in the different drive modes.
2. If the axle sound is now rated a 7 or higher, then return the vehicle to the customer.
3. If a whine (that has been rated lower than a 7) is still present only on a coast and if the ring and pinion gear set has been replaced, then the pinion gear depth may be adjusted.

   NOTE: THIS ADDITIONAL PINION DEPTH ADJUSTMENT SHOULD ONLY BE PERFORMED IF THE RING AND PINION GEAR SET HAS BEEN RECENTLY REPLACED. THE SOUND BEING GENERATED BY THE AXLE MUST BE A WHINE THAT OCCURS ONLY DURING THE COAST DRIVE MODE.

   The maximum allowed amount of pinion depth adjustment is a negative 0.051 mm (-0.002 in.). A negative pinion depth adjustment involves moving the head of the pinion gear closer to the pinion

bearing and closer to the heel of the ring gear. This involves replacing the pinion gear depth shim with a shim that is 0.051 mm (0.002 in.) thinner.

Once a pinion depth adjustment has been performed all preload and backlash adjustments must be redone.

4. If an axle sound is still present, and is rated lower than a 7, then contact your Zone Office or the STAR CENTER for addition assistance.

POLICY:

Reimbursable within the provisions of the warranty.

TIME ALLOWANCE:

Labor Op. No.	Description	Time
03-30-02-00	Axle Noise Diagnosis – Includes road Test	A/T
02-50-50-90	Pinion Depth – Front Axle – Adjust	3.2 Hrs.
03-50-01-94	Pinion Depth – Rear Axle – Adjust	2.8 Hrs.

FAILURE CODE:

Code	Description
CG	Customer Satisfaction
XX	Service Adjustment