JUNE 14, 1999 **BULLETIN NO. 99-11**

TECHNICAL SERVICE BULLETIN

FEATURED IN THIS BULLETIN:

- **TSB Special For Noise/Vibration/Harshness . . . . . 1995-97 COUGAR, F SUPER DUTY, F-250 HD, F-350, PROBE, THUNDERBIRD; 1995-98 MARK VIII; 1995-99 CONTINENTAL, CONTOUR, CROWN VICTORIA, ECONOLINE, ESCORT, EXPLORER, F-150, F-250 LD, GRAND MARQUIS, MOUNTAINEER, MUSTANG, MYSTIQUE, RANGER, SABLE, TAURUS, TOWN CAR, TRACER, VILLAGER, WINDSTAR; 1997-99 EXPEDITION; 1998-99 NAVIGATOR; 1999 COUGAR, SUPER DUTY F SERIES; 2000 LS**

PARTNERS IN CUSTOMER SATISFACTION

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• NOISE—TSB SPECIAL FOR NOISE/VIBRATION/HARSHNESS • VIBRATION—TSB SPECIAL FOR NOISE/VIBRATION/HARSHNESS	Article No. 99-11-1

FORD: 1995-1997 PROBE, THUNDERBIRD
1995-1999 CONTOUR, CROWN VICTORIA, ESCORT, MUSTANG, TAURUS

LINCOLN-MERCURY: 1995-1997 COUGAR
1995-1998 MARK VIII
1995-1999 CONTINENTAL, GRAND MARQUIS, MYSTIQUE, SABLE, TOWN CAR, TRACER
1999 COUGAR
2000 LS

LIGHT TRUCK: 1995-1997 F SUPER DUTY, F-250 HD, F-350
1995-1999 ECONOLINE, EXPLORER, F-150, F-250 LD, MOUNTAINEER, RANGER, VILLAGER, WINDSTAR
1997-1999 EXPEDITION
1998-1999 NAVIGATOR
1999 SUPER DUTY F SERIES

ISSUE

This TSB article is being published as a comprehensive Noise, Vibration and Harshness (NVH) diagnostic procedure. This procedure will also be in 2000 model year and future Workshop Manuals in the NVH Section.

ACTION

Utilize the flowchart diagrams to work a problem from SYMPTOM to SYSTEM to COMPONENT to CAUSE. The tools and techniques section is expanded to include ALL NVH diagnostic “tools”. There are expanded SYMPTOM CHARTS to assist with problem resolution. A revised NVH course is available through regional training centers. The course is “NVH Principals and Diagnostics”, course code # 30s03t0. This course utilizes the same techniques that are in the revised diagnostic procedure.

Refer to the Noise, Vibration and Harshness Work Shop Manual Section attached.

OTHER APPLICABLE ARTICLES: NONE
WARRANTY STATUS: INFORMATION ONLY
OASIS CODES: 497000, 597997, 701000, 702000, 703000

SECTION 100-04 Noise, Vibration and Harshness

VEHICLE APPLICATION: Noise, Vibration and Harshness

CONTENTS **PAGE**

DESCRIPTION AND OPERATION

Noise, Vibration and Harshness (NVH)

Noise is any undesirable sound, usually unpleasant in nature. Vibration is any motion, shaking or trembling, that can be felt or seen when an object moves back and forth or up and down. Harshness is a ride quality issue where the vehicle's response to the road transmits sharply to the customer. Harshness normally describes a firmer than usual response from the suspension system. Noise, vibration and harshness (NVH) is a term used to describe these conditions, which customers sense and result in varying degrees of dissatisfaction. Although, a certain level of NVH caused by road and environmental conditions is normal. This section is designed to aid in the diagnosis, testing and repair of NVH concerns.

Acceptable Noise, Vibration and Harshness

All internal combustion engines and drivelines produce some noise and vibration; operating in a real world environment adds noise that is not subject to control. Vibration isolators, mufflers and dampers reduce these to acceptable levels. A driver who is unfamiliar with a vehicle can think that some sounds are abnormal when actually the sounds are normal for the vehicle type. For example, Traction-Lok® differentials produce a slight noise on slow turns after extended highway driving. This is acceptable and has no detrimental effect on the locking axle function. As a technician, it is very important to be familiar with vehicle features and know how they relate to NVH concerns and their diagnosis. If, for example, the vehicle has automatic overdrive it is important to test drive the vehicle both in and out of overdrive mode.

Diagnostic Theory

The shortest route to an accurate diagnosis results from:

- system knowledge, including comparison with a known good system.
- system history, including repair history and usage patterns.
- condition history, especially any relationship to repairs or sudden change.
- knowledge of probable causes.
- using a systematic diagnostic method that divides the system into related areas.

The diagnosis and correction of noise, vibration and harshness concerns requires:

- a road or system test to determine the exact nature of the concern.
- an analysis of the possible causes.
- testing to verify the cause.
- repairing any concerns found.
- a road test or system test to make sure the concern has been corrected or brought back to within a acceptable range.

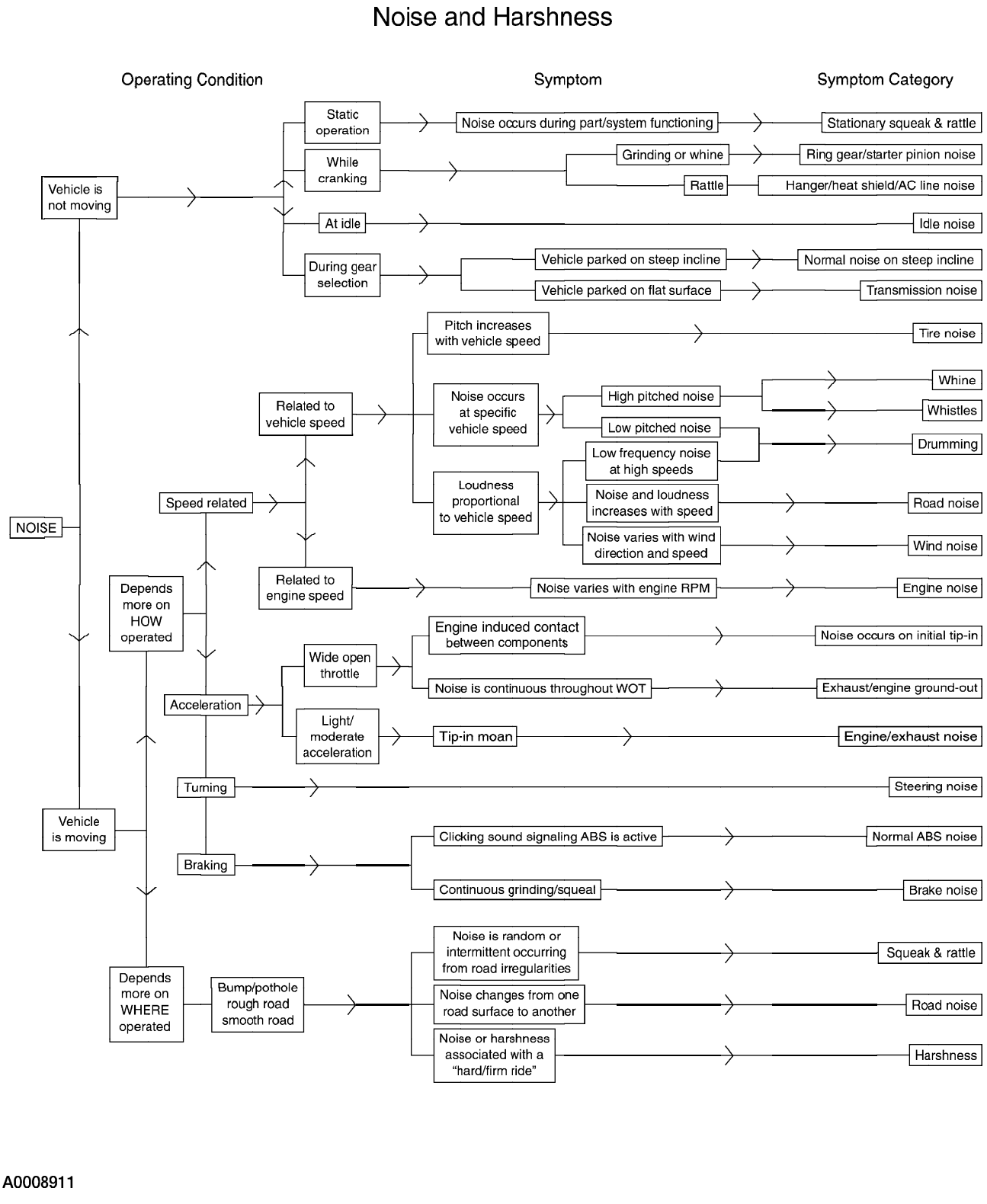
Diagnostic Process

A good diagnostic process is a logical sequence of steps that lead to the identification of a causal system. The following flowcharts are a graphic representation of the diagnostic process. Use the flowcharts as follows:

- Choose the appropriate flowchart.
- Identify the operating condition that the vehicle is exhibiting.
- Advance through the flowchart from left to right.
- Match the operating condition to the symptom.
- Verify the symptom.
- Identify which category or system could cause the symptom.
- Refer to the diagnostic symptom chart that the flowchart refers to.

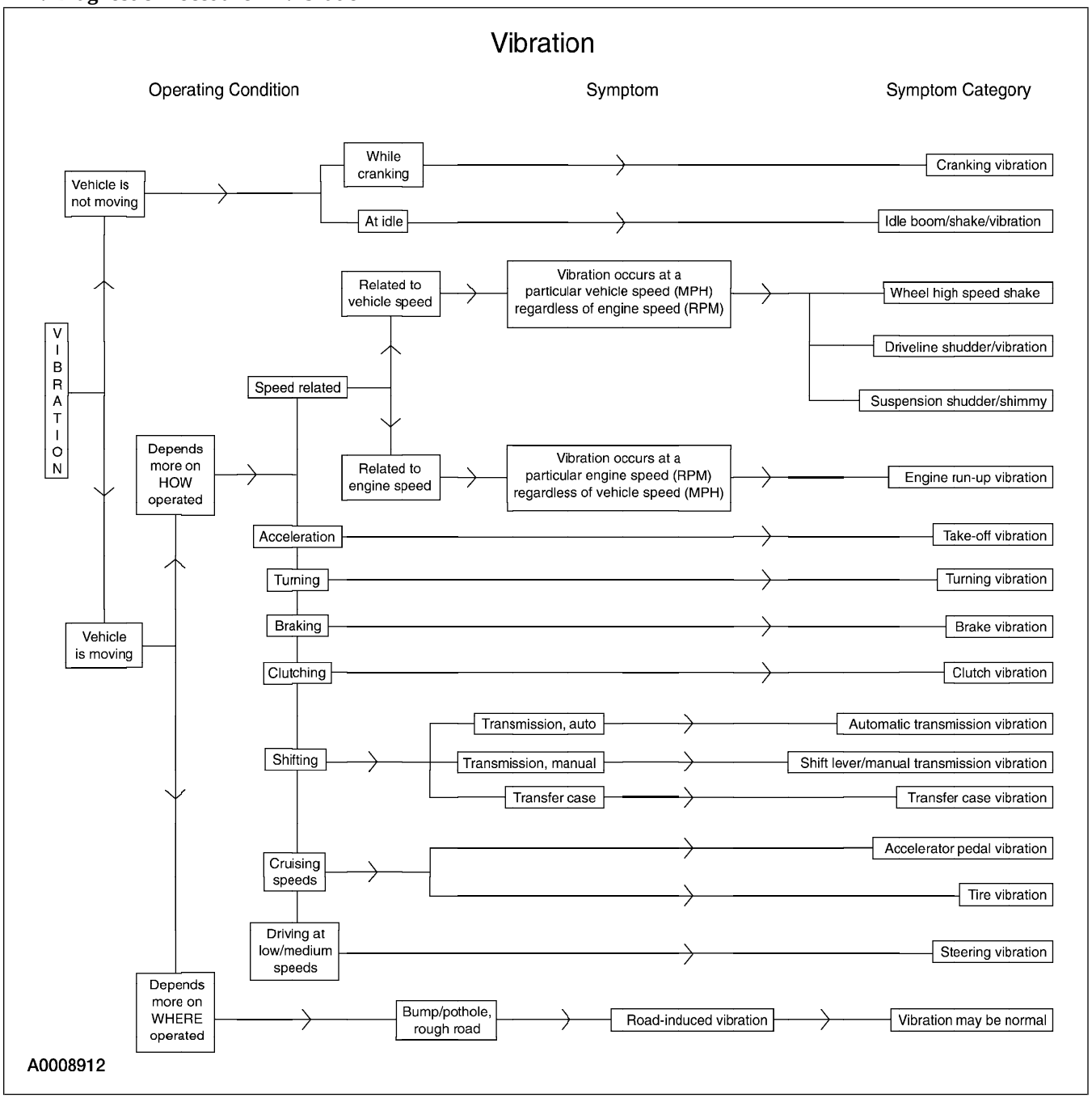
DESCRIPTION AND OPERATION (Continued)

NVH Diagnostic Procedure—Noise and Harshness



DESCRIPTION AND OPERATION (Continued)

NHV Diagnostic Procedure — Vibration



Glossary of Terms

Acceleration-Light
An increase in speed at less than half throttle.

Acceleration-Medium
An increase in speed at half to nearly full throttle, such as 0-97 km/h (0-60 mph) in approximately 30 seconds.

Acceleration-Heavy
An increase in speed at one-half to full throttle, such as 0-97 km/h (0-60 mph) in approximately 20 seconds.

Ambient Temperature
The surrounding or prevailing temperature.

Amplitude
The quantity or amount of energy produced by a vibrating component (G force). An extreme vibration has a high amplitude. A mild vibration has a low amplitude.

Backlash
Gear teeth clearance.

DESCRIPTION AND OPERATION (Continued)

Boom
Low frequency or low pitched noise often accompanied by a vibration. Also refer to Drumming.

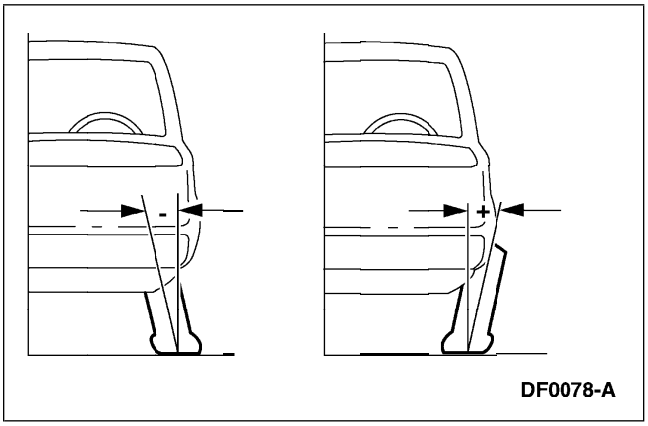
Bound Up
An overstressed isolation (rubber) mount that transmits vibration/noise instead of absorbing it.

Brakes Applied
When the service brakes are applied with enough force to hold the vehicle against movement with the transmission in gear.

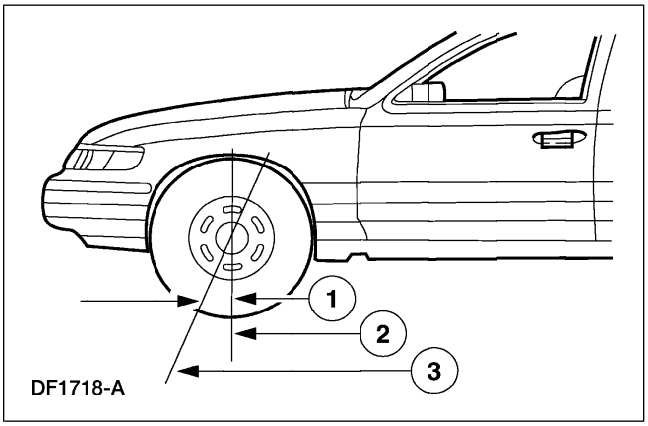
Buffet/Buffeting
Strong noise fluctuations caused by gusting winds. An example would be wind gusts against the side glass.

Buzz
A low-pitched sound like that from a bee. Often a metallic or hard plastic humming sound. Also describes a high frequency (200-800 Hz) vibration. Vibration feels similar to an electric razor.

Camber
The angle of the wheel in relation to the true vertical as measured looking from the front of the vehicle. Camber is positive when the wheel angle is offset so that the top of the wheel is positioned away from the vehicle.



Caster
The angle of the steering knuckle in relation to the true vertical as measured looking from the side of the vehicle.



Item	Description
1	Positive caster
2	True vertical
3	Steering axis

Chatter
A pronounced series of rapidly repeating rattling or clicking sounds.

Chirp
A short-duration high-pitched noise associated with a slipping drive belt.

Chuckle
A repetitious low-pitched sound. A loud chuckle is usually described as a knock.

Click
A sharp, brief, non-resonant sound, similar to actuating a ball point pen.

Clonk
A hydraulic knocking sound. Sound occurs with air pockets in a hydraulic system. Also described as hammering.

Clunk/Driveline Clunk
A heavy or dull, short-duration, low-frequency sound. Occurs mostly on a vehicle that is accelerating or decelerating abruptly. Also described as a thunk.

DESCRIPTION AND OPERATION (Continued)

Coast/Deceleration
Releasing the accelerator pedal at cruise, allowing the engine to reduce vehicle speed without applying the brakes.

Coast/Neutral Coast
Placing the transmission range selector in NEUTRAL (N) or depressing the clutch pedal while at cruise.

Constant Velocity (CV) Joint
A joint used to absorb vibrations caused by driving power being transmitted at an angle.

Controlled Rear Suspension Height
The height at which a designated vehicle element must be when driveline angle measurements are made.

Coupling Shaft
The shaft between the transfer case and the front drive axle or, in a two-piece rear driveshaft, the front section.

CPS
Cycles per second. Same as hertz (Hz).

Cracks
A mid-frequency sound, related to squeak. Sound varies with temperature conditions.

Creak
A metallic squeak.

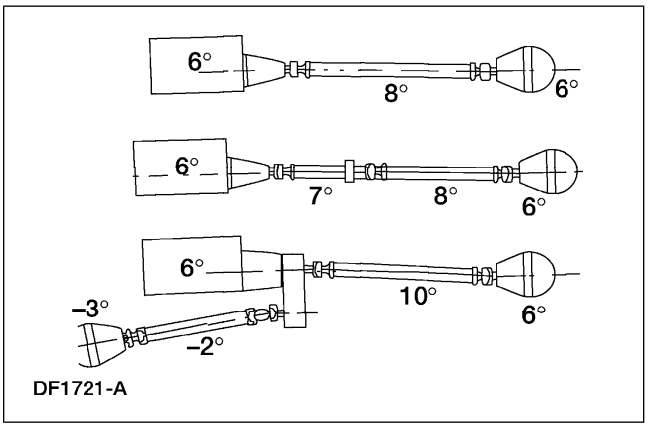
Cruise
Constant speed on level ground; neither accelerating nor decelerating.

Cycle
The process of a vibrating component going through a complete range of motion and returning to the starting point.

Decibel
A unit of measurement, referring to sound pressure level, abbreviated dB.

Drive Engine Run-Up (DERU) Test
The operation of the engine through the normal rpm range with the vehicle standing still, the brakes applied and the transmission engaged. This test is used for noise and vibration checks.

Driveline Angles
The differences of alignment between the transmission output shaft, the driveshaft, and the rear axle pinion centerline.



Driveshaft
The shaft that transmits power to the rear axle input shaft (pinion shaft). In a two-piece driveshaft, it is the rearmost shaft.

Drivetrain
All power transmitting components from the engine to the wheels; includes the clutch or torque converter, the transmission, the transfer case, the driveshaft, and the front or rear drive axle.

Drivetrain Damper
A weight attached to the engine, the transmission, the transfer case, or the axle. It is tuned by weight and placement to absorb vibration.

Drone
A low frequency (100-200 Hz) steady sound, like a freezer compressor. Also described as a moan.

Drumming
A cycling, low-frequency (20-100 Hz), rhythmic noise often accompanied by a sensation of pressure on the ear drums. Also described as a low rumble, boom, or rolling thunder.

Dynamic Balance
The equal distribution of weight on each side of the centerline, so that when the wheel and tire assembly spins, there is no tendency for the assembly to move from side-to-side (wobble). Dynamically unbalanced wheel and tire assemblies can cause wheel shimmy.

Engine Imbalance
A condition in which an engine's center mass is not concentric to the rotation center. Excessive motion.

DESCRIPTION AND OPERATION (Continued)

Engine Misfire
When combustion in one or more cylinders does not occur or occurs at the wrong time.

Engine Shake
An exaggerated engine movement or vibration that directly increases in frequency as the engine speed increases. It is caused by non-equal distribution of mass in the rotating or reciprocating components.

Flexible Coupling
A flexible joint.

Float
A drive mode on the dividing line between cruise and coast where the throttle setting matches the engine speed with the road speed.

Flutter
Mid to high (100-200 Hz) intermittent sound due to air flow. Similar to a flag flapping in the wind.

Frequency
The rate at which a cycle occurs within a given time.

Gravelly Feel
A grinding or growl in a component, similar to the feel experienced when driving on gravel.

Grind
An abrasive sound, similar to using a grinding wheel, or rubbing sand paper against wood.

Hiss
Steady high frequency (200-800 Hz) noise. Vacuum leak sound.

Hoot
A steady low frequency tone (50-500 Hz), sounds like blowing over a long neck bottle.

Howl
A mid-range frequency noise between drumming and whine.

Hum
Mid-frequency (200-800 Hz) steady sound, like a small fan motor. Also described as a howl.

Hz
Hertz; a frequency measured in cycles per second.

Imbalance
Out of balance; heavier on one side than the other. In a rotating component, imbalance often causes vibration.

Inboard
Toward the centerline of the vehicle.

Intensity
The physical quality of sound that relates to the strength of the vibration (measured in decibels). The higher the sound's amplitude, the higher the intensity and vice versa.

Isolate
To separate the influence of one component to another.

Knock
A heavy, loud, repetitious sound, like a knock on the door.

Moan
A constant, low-frequency (100-200 Hz) tone. Also described as a hum.

Neutral Engine Run-Up (NERU) Test
The operation of the engine through the normal rpm range with the vehicle standing still and the transmission disengaged. This test is used to identify engine related vibrations.

Neutralize/Normalize
To return to an unstressed position. Used to describe mounts. Refer to Bound Up.

NVH
Noise, vibration and harshness. A term used to describe conditions, which customers sense and result in varying degrees of dissatisfaction.

Outboard
Away from the centerline of the vehicle.

Ping
A short duration, high-frequency sound, which has a slight echo.

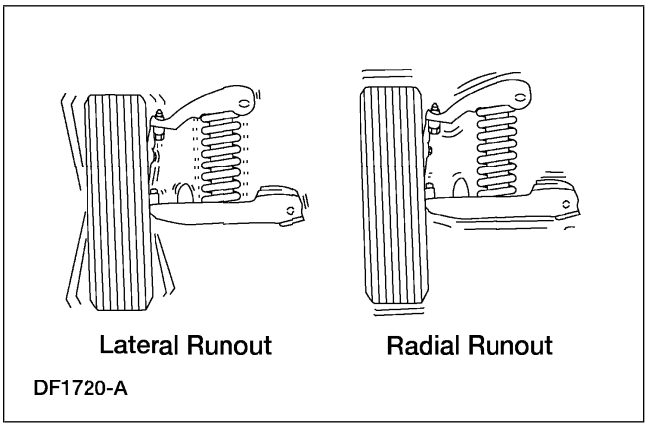
Pinion Shaft
The input shaft in a driving axle that is usually a part of the smaller driving or input hypoid gear of a ring and pinion gearset.

Pitch
The physical quality of sound that relates to its frequency. Pitch increases as frequency increases and vice versa.

Pumping Feel
A slow, pulsing movement.

DESCRIPTION AND OPERATION (Continued)

Radial/Lateral
Radial is in the plane of rotation; lateral is at 90 degrees to the plane of rotation.



Rattle
A random and momentary or short duration noise.

Ring Gear
The large, circular, driven gear in a ring and pinion gearset.

Road Test
The operation of the vehicle under conditions intended to produce the concern under investigation.

Roughness
A medium-frequency vibration. A slightly higher frequency (20 to 50 Hz) than a shake. This type of vibration is usually related to drivetrain components.

Runout
Out of round and wobble.

Rustling
Intermittent sound of varying frequency (100-200 Hz), sounds similar to shuffling through leaves.

Shake
A low-frequency vibration (5-20 Hz), usually with visible component movement. Usually relates to tires, wheels, brake drums or brake discs if it is vehicle speed sensitive, or engine if it is engine speed sensitive. Also referred to as a shimmy or wobble.

Shimmy
An abnormal vibration or wobbling, felt as a side-to-side motion of the steering wheel in the driveshaft rotation. Also described as waddle.

Shudder
A low-frequency vibration that is felt through the steering wheel or seat during light brake application.

Slap
A resonance from flat surfaces, such as safety belt webbing or door trim panels.

Slip Yoke/Slip Spline
The driveshaft coupling that allows length changes to occur while the suspension articulates and while the driveshaft rotates.

Squeak
A high-pitched transient sound, similar to rubbing fingers against a clean window.

Squeal
A long-duration, high-pitched noise.

Static Balance
The equal distribution of weight around the wheel. Statically unbalanced wheel and tire assemblies can cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear.

Tap
A light, rhythmic, or intermittent hammering sound, similar to tapping a pencil on a table edge.

Thump
A dull beat caused by two items striking together.

Tick
A rhythmic tap, similar to a clock noise.

Tip-In Moan
A light moaning noise heard during light vehicle acceleration, usually between 40-100 km/h (25-65 mph).

TIR
Total indicated runout

Tire Deflection
The change in tire diameter in the area where the tire contacts the ground.

Tire Flat Spots
A condition commonly caused by letting the vehicle stand while the tires cool off. This condition can be corrected by driving the vehicle until the tires are warm. Also, irregular tire wear patterns in the tire tread resulting from wheel-locked skids.

DESCRIPTION AND OPERATION (Continued)

Tire Force Vibration
A tire vibration caused by variations in the construction of the tire that is noticeable when the tire rotates against the pavement. This condition can be present on perfectly round tires because of variations in the inner tire construction. This condition can occur at wheel rotation frequency or twice rotation frequency.

Transient
Momentary, short duration.

Two-Plane Balance
Radial and lateral balance.

Vibration
Any motion, shaking or trembling, that can be felt or seen when an object moves back and forth or up and down.

Whine
A constant, high-pitched noise. Also described as a screech.

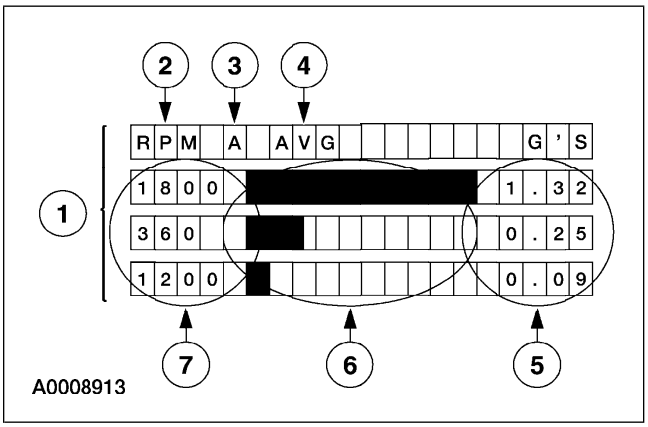
Whistle
High-pitched noise (above 500 Hz) with a very narrow frequency band. Examples of whistle noises are a turbocharger or airflow around an antenna.

Wind Noise
Any noise caused by air movement in, out or around the vehicle.

WOT
Wide-open throttle

Tools and Techniques

Electronic Vibration Analyzer (EVA)
The EVA is a hand-held electronic diagnostic tool which will assist in locating the source of unacceptable vibrations. The vibration sensor can be remotely mounted anywhere in the vehicle for testing purposes. The unit displays the three most common vibration frequencies and their corresponding amplitudes simultaneously. A bar graph provides a visual reference of the relative signal strength (amplitude) of each vibration being displayed and its relative G force. The keypad is arranged to make the EVA simple to program and use. Some of the functions include the ability to average readings as well as record, play back and freeze readings. The EVA has a strobe balancing function that can be used to detect imbalance on rotating components such as a driveshaft or engine accessories.



Item	Part Number	Description
1	—	EVA screen
2	—	Frequency mode displayed in rpm or Hz
3	—	Active sensor input (A or B)
4	—	Current active mode
5	—	G force indicators or the strongest frequencies in descending strength of each vibration
6	—	Strength of each vibration
7	—	Frequency in rpm/Hz of each vibration

The EVA allows for a systematic collection of information that is necessary to accurately diagnose and repair NVH problems. For the best results, carry out the test as follows:

a. Test drive the vehicle with the vibration sensor inside the vehicle.

b. Place the sensor in the vehicle according to feel.

— If the condition is felt through the steering wheel, the source is most likely in the front of the vehicle.

— A vibration that is felt in the seat or floor only will most likely be found in the driveline, drive axle or rear wheels and tires.

DESCRIPTION AND OPERATION (Continued)

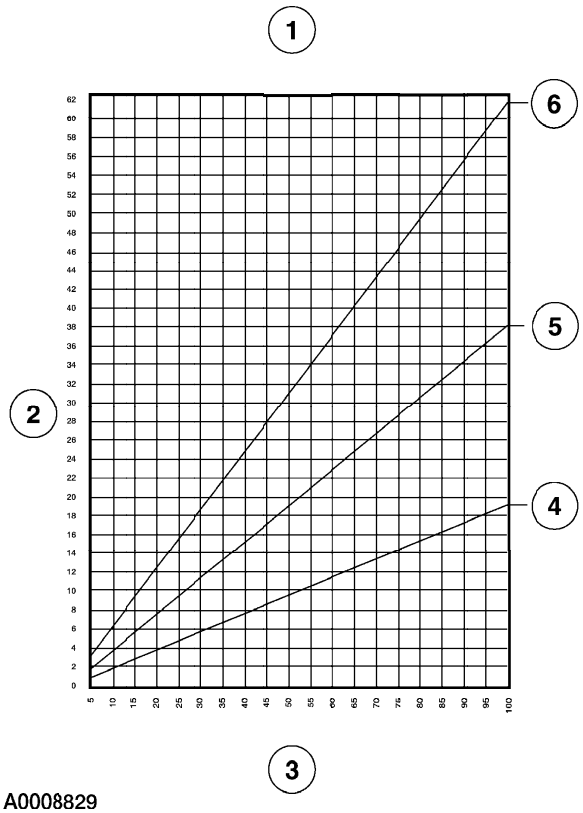
c. Record the readings. Also note when the condition begins, when it reaches maximum intensity, and if it tends to diminish above/below a certain speed.
   - — Frequencies should be read in the ‘‘avg’’ mode.
   - — Frequencies have a range of plus or minus 2. A reading of 10 Hz can be displayed as an 8 Hz through 12 Hz.

d. Determine what the normal frequency is for the vehicle at a specified speed. Multiply the rear axle ratio by the Hz (1 Hz per every 5 mph). Example: A vehicle travelling 50 mph with a 3.08 rear axle ratio, the acceptable amount of Hz for the vehicle at that speed would be 10 (1 Hz per every 5 mph) X 3.08 (rear axle ratio) = 30.8 Hz.

e. Place the vibration sensor on or near the suspect area outside the vehicle.

f. Continue the road test, driving the vehicle at the speed the symptom occurs, and take another reading.

g. Compare the readings.
   - — A match in frequency indicates the problem component or area.
   - — An unmatched test could indicate the concern is caused by the engine, torque converter, or engine accessory. Use the EVA in the rpm mode and check if concern is rpm related.
   - — Example: A vibration is felt in the seat, place the sensor on the console. Record the readings. Place the vibration sensor on the rear axle. Compare the readings. If the frequencies are the same, the axle is the problem component. Also refer to the following chart as a reference to acceptable vibration and noise ranges for the specified components.



Item	Part Number	Description
1	—	Acceptable vibration ranges for specified components
2	—	Hertz (Hz)
3	—	Miles per hour (mph)

(Continued)

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
4	—	First order tire (one disturbance for each revolution)
5	—	Second order tire (two disturbances for each revolution)
6	—	Driveline

Vibrate Software®
Vibrate software® (Rotunda tool number 215-00003) is a diagnostic aid which will assist in pinpointing the source of unacceptable vibrations. The engine's crankshaft is the point of reference for vibration diagnosis. Every rotating component will have an angular velocity that is faster, slower, or the same as the engine's crankshaft. Vibrate software® calculates the angular velocity of each component and graphically represents these velocities on a computer screen and on a printed vibration worksheet. The following steps outline how Vibrate software® helps diagnose a vibration concern:

- Enter the vehicle information. Vibrate will do all the calculations and display a graph showing tire, driveshaft and engine vibrations.
- Print a Vibration Worksheet graph. The printed graph is to be used during the road test.
- Road test the vehicle at the speed where the vibration is most noticeable. Record the vibration frequency (rpm) and the engine rpm on the worksheet graph. The point on the graph where the vibration frequency (rpm) reading and the engine rpm reading intersect indicates the specific component group causing the concern.
  - — An EVA or equivalent tool capable of measuring vibration frequency and engine rpm will be needed.
- Provides pictures of diagnostic procedures to aid in testing components.

ChassisEAR
An electronic listening device used to quickly identify noise and the location under the chassis while the vehicle is being road tested. The chassisEARs can identify the noise and location of damaged/worn wheel bearings, CV joints, brakes, springs, axle bearings or driveshaft carrier bearings.

EngineEAR
An electronic listening device used to detect even the faintest noises. The EngineEARs can detect the noise of damaged/worn bearings in generators, water pumps, A/C compressors and power steering pumps. They are also used to identify noisy lifters, exhaust manifold leaks, chipped gear teeth and for detecting wind noise. The EngineEAR has a sensing tip, amplifier, and headphones. The directional sensing tip is used to listen to the various components. Point the sensing tip at the suspect component and adjust the volume with the amplifier. Placing the tip in direct contact with a component will reveal structure-borne noise and vibrations, generated by or passing through, the component. Various volume levels can reveal different sounds.

Ultrasonic Leak Detector
The Ultrasonic Leak Detector is used to detect wind noises caused by leaks and gaps in areas where there is weather-stripping or other sealing material. It is also used to identify A/C leaks, vacuum leaks and evaporative emission noises. The Ultrasonic Leak Detector includes a multi-directional transmitter (operating in the ultrasonic range) and a hand-held detector. The transmitter is placed inside the vehicle. On the outside of the vehicle, the hand-held detector is used to sweep the area of the suspected leak. As the source of the leak is approached, a beeping sound is produced which increases in both speed and frequency.

Squeak and Rattle Repair Kit
The squeak and rattle repair kit contains lubricants and self-adhesive materials that can be used to eliminate interior and exterior squeaks and rattles. The kit consists of the following materials:

- PVC (soft foam) tape
- Urethane (hard foam) tape
- Flocked (black fuzzy) tape

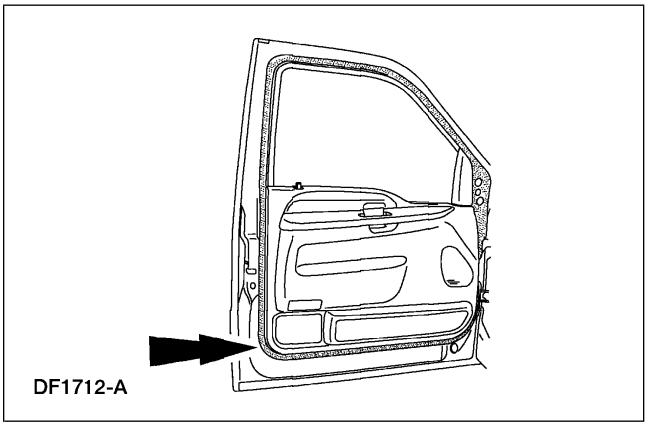
DESCRIPTION AND OPERATION (Continued)

- UHMW (frosted) tape
- Squeak and rattle oil tube
- Squeak and rattle grease tube

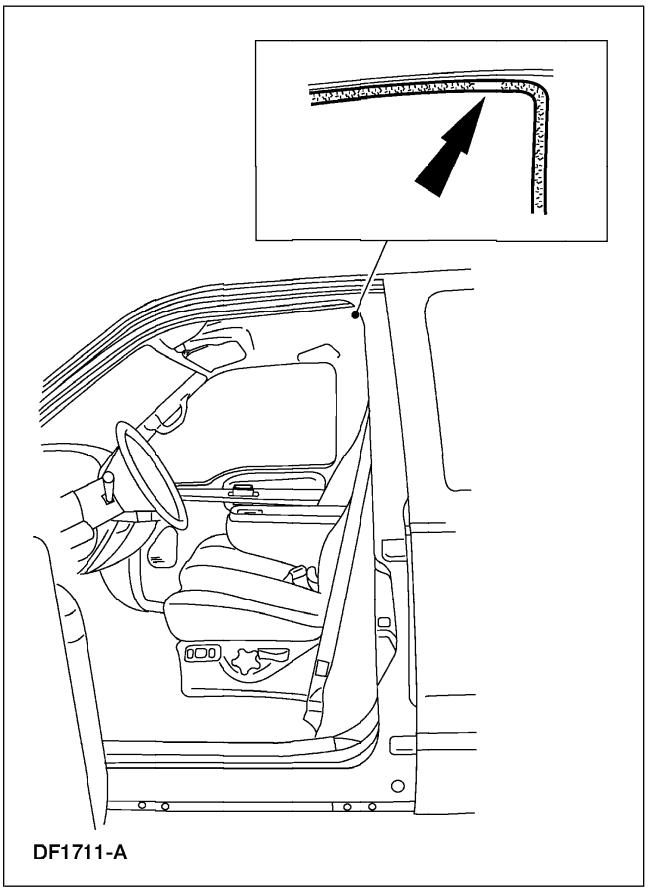
DF1753-A

Tracing Powder

Tracing powder is used to check both the uniformity of contact and the tension of a seal against its sealing surface. These tests are usually done when a suspected air leak/noise appears to originate from the seal area or during the alignment and adjustment of a component to a weatherstrip. Tracing powder can be ordered from Crest Industries as ATR Leak Trace. Their toll-free number is 1-800-822-4100. Carry out the tracing powder test as follows:


DF1712-A

a. Clean the weatherstrip.
b. Spray the tracing powder on the mating surface only.
c. Close the door completely. Do not slam the door.
d. Open the door. An imprint is made where the weatherstrip contacted the mating surface seal. Gaps or a faint imprint will show where there is poor contact with the weatherstrip.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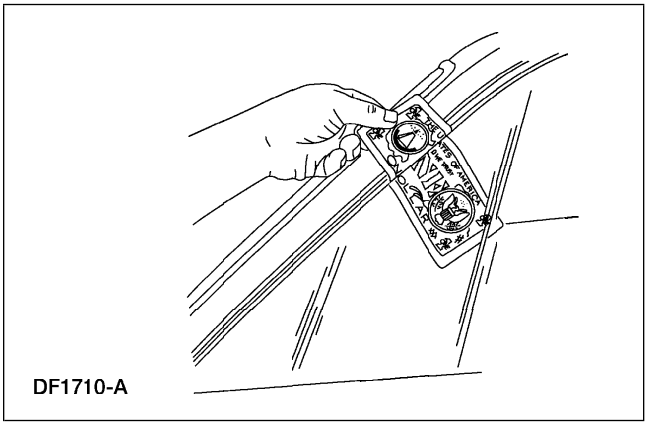
Dollar bill or 3x5 Card

Place a dollar bill or 3x5 card between the weatherstrip and the sealing surface, then close the door. Slowly withdraw the bill or 3x5 card after the door is closed and check the amount of pressure on the weatherstrip. There should be a medium amount of resistance as the dollar bill or 3x5 card is withdrawn. Continue around the entire seal area. If there is little or no resistance, this indicates insufficient contact to form a good seal. At these points, the door, the glass, or the weatherstrip is out of alignment.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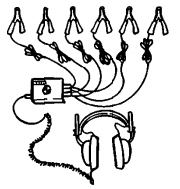
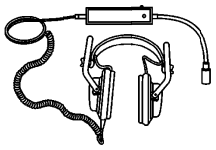
DIAGNOSIS AND TESTING

Noise, Vibration and Harshness (NVH)

Special Service Tool(s)

 ST2048-A	ChassisEAR 107-R2102 or Equivalent
 ST2311-A	Electronic Vibration Analyzer 014-00344 or Equivalent
 ST2312-A	EngineEAR 107-R2100 or Equivalent
 ST2314-A	Ultrasonic Leak Detector 134-R0135 or Equivalent

Diagnostic Process

To assist the service advisor and the technician, a Write-up Job Aid and an NVH Diagnostic Guide are included with this material. The Write-up Job Aid serves as a place to record all important symptom information. The NVH Diagnostic Guide serves as a place to record information reported on the Write-up Job Aid as well as data from the testing to be carried out.

To begin a successful diagnosis, fill out the NVH Diagnostic Guide, record the reported findings, then proceed to each of the numbered process steps to complete the diagnosis.

DIAGNOSIS AND TESTING (Continued)

"WRITE-UP" JOB AID

REPAIR ORDER #_____

CUSTOMER CONCERN #_____

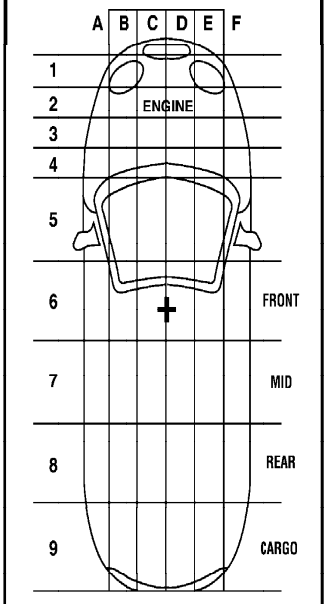
SPECIFIC SENSE IDENTIFICATION AND LOCATION ON VEHICLE OF CUSTOMER SYMPTOM(S)

INSTRUCTIONS: Check below sense affected and location of concern on the generic vehicle illustration (darken the vehicle area). Plus circle appropriate responses to the right.

NOTE: Shaded backgrounds indicate caution areas. Selection of two or more caution areas "flag" difficult repairs. In general, shaded areas are the more difficult to verify and repair, and require all applicable columns to be completed.

SEE YES ☐ | FEEL YES ☐

HEAR YES ☐ | SMELL YES ☐



VEHICLE SYMPTOM AREA	HOW OFTEN?	VEHICLE OPERATING MODE	VEHICLE CONDITIONS	VEHICLE SPEED(mph)	WHEN VEHICLE IS?	AMBIENT CONDITION
Front of Vehicle	Always	Start Up	Accessories On	0	Turning Left	____° Below Zero
Engine Compartment	Daily A.M. P.M.	Idle	(define below)	1-9	Turning Right	Below Freezing (0°-19°)
Dash	Conditional	Gear Selection	Windows Open	10-19	Over Bumps	Below Freezing (20°-32°)
Steering Wheel	Weekly	Accel Light	4x4	20-29	Up Hills	33°-49°
Accelerator Pedal	Monthly	Accel Moderate	Hauling	30-39	Down Hills	50°-69°
Brake Pedal	Intermittent	Accel Heavy	Towing	40-49	Shifting	70°-89°
Cluch Pedal	Unknown	Steady Speed	Snow Plowing	50-59	Parked	90°+
Seat		Deceleration	Other	60-69	In Traffic	Sunny
Rear of Vehicle		Neutral	(define below)	70+		Dry
Top of Vehicle		Reverse		ENGINE		Windy
Floor Pan		Stopping/Braking		TEMP		Wet/Humid
Under Vehicle				Cold		Rain
Other (define below)				Normal		Snow
				Hot		Ice

DEALER VERIFICATION

	YES	NO
SERVICE ADVISOR	☐	☐
SHOP FOREMAN	☐	☐
SERVICE MANAGER	☐	☐
QC MANAGER	☐	☐
TECHNICIAN	☐	☐
VERIFIED WITH CUSTOMER	☐	☐

WHAT THE CUSTOMER SAID

OASIS SYMPTOM CODE(S)

VIN NUMBER

DF1687-B

DIAGNOSIS AND TESTING (Continued)

NVH DIAGNOSTIC GUIDE

Dealer: _____ Date: _____

P.A. Code: _____ Order No. _____ Technician: _____

Owner's Name: _____ Address: _____

Phone No. Home: _____ Work: _____

Vehicle Make: _____ Model: _____ Year: _____

VIN: _____ Mileage: _____ Engine: _____ Trans: _____ Axle: _____

OWNER'S DESCRIPTION OF COMPLAINT:

Did Condition Exist When Vehicle Was New? **Yes / No** (circle one)

How Did Condition Begin? Gradually ☐ Suddenly ☐

At What Mileage Did It Occur Or Begin Occuring? _____

Which Driving Conditions Affect The Vehicle?

Light Accel ☐	Closed Throttle Decel ☐	Brakes Applied/Released ☐
Medium Accel ☐	Coast (Float) ☐	Driving The Vehicle: Straight ☐
Heavy Accel ☐	Constant Speed ☐	Cornering ☐

Is Vibration Noticed? If So, Where:

Seat ☐ Steering Wheel ☐ Instrument Panel ☐ Floor ☐ Body Panels ☐ Ft/Rr of Vehicle ☐

Is There Sound Or Sensation Of Sound? **Yes / No** (circle one)

If So, Describe The Sound :

Boom ☐ Hum ☐ Whine ☐ Growl ☐ Other: _____

Drone ☐ Tip-In-Moan ☐ Squeak ☐ Rattle ☐

PREDRIVE CHECKS

Tire Condition/Pressure: _____

Vehicle Body Damage? _____

Other: _____

ROAD TEST:

Vibration/Noise Occurs:

Vehicle Speed _____ Accel _____ Vibration Frequency _____ Hz/RPM

Gear Range _____ Decel/Coast _____ Engine Speed _____ RPM

ENGINE RUN-UP TESTS

Neutral Engine Run-Up (NERU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPM

Drive Engine Run-Up (DERU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPM

Drivetrain Run-Up (DTRU) **Yes / No** Engine RPM _____ Vibration/Frequency _____ Hz/RPM

Indicate Suspected Area of Concern:

Tire/Wheel/Brakes ☐	Engine/Accessory ☐	Rear ☐
Driveline/Axle ☐	Susp/Steering ☐	Right ☐
Body ☐	Front ☐	Left ☐

Other _____

Equipment Used:

Reed Tachometer ☐	Electronic Noise Detector ☐	Tape ☐
Engine Tachometer ☐	Ultrasonic Leak Detector ☐	Other _____

DF1688-A

DIAGNOSIS AND TESTING (Continued)

WHEEL/TIRE/BRAKES CHECK:

Balance Check **Yes / No**

Maximum Runout Allowed:

Wheel: Radial _____ Lateral _____

Tire: Radial _____ Lateral _____

Measured Runout:

Tire/Wheel Radial: LF _____ LR _____ RF _____ RR _____

Lateral: LF _____ LR _____ RF _____ RR _____

Wheel Only Radial: LF _____ LR _____ RF _____ RR _____

Lateral: LF _____ LR _____ RF _____ RR _____

SUSPENSION INSPECTION:

Can Cause: Shimmy ☐ Clunk ☐ Squeak ☐ Harshness ☐

Suspension Bushings: Loose ☐ Worn ☐ Missing ☐ OK ☐

Front Upper Control Arm ☐ Stabilizer (sway bar) ☐ Rear Lower Control Arm ☐

Front Lower Control Arm ☐ Rear Upper Control Arm ☐ Rear Upper Control Arm ☐

Other _____

Suspension/Steering Components: Loose Worn Missing OK

Ball Joints ☐ Idler Arm ☐ Pitman Arm ☐

Shock Absorbers F/R ☐ Center Link ☐ Steering Gear ☐

Springs F/R ☐ Tie Rod Ends/Sleeve ☐ Steering Coupler ☐

DRIVESHAFT CONDITION: Noise ☐ Vibration ☐

Balance Weights Missing/Other Visual Defects? **Yes / No**

Maximum Allowable Runout: _____

Actual Runout: Front _____ Middle _____ Rear _____

Two-Piece Driveshaft Runout: Front _____ Rear _____

Middle Support Bearing: Loose ☐ Damaged ☐ Worn ☐ Other _____

Suspect Driveshaft Balanced? **Yes / No**

Pinion Angle: Engine Height: Specification _____ Actual _____

Pinion Angle: Specification _____ Actual _____

Driveline Angle - Truck: Specification _____ Actual _____

ENGINE/ACCESSORY CHECK:

Visual Inspection for Damage or Grounded Condition:

Powertrain Mounts ☐ Fuel Lines ☐ A/C Lines ☐ Power Steering/Cooler Lines ☐

Air Intake ☐ Accessories ☐ Exhaust ☐ Radiator/Condensor ☐

BODY (NOISE/RATTLE)

Indicate Suspected Area of Concern: Doors ☐ Windows ☐ Dash Panel ☐ Other _____

Tests Used to Isolate

NVH Concern: Vacuum/Leak Detector ☐ Ultrasonic Leak Detector ☐ Tracing Powder ☐

Electronic Noise Detector ☐ Other _____

ROAD/ENGINE RUN-UP TESTS: Improved? **Yes / No** Vehicle Acceptable? **Yes / No**

Comments: _____

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DIAGNOSIS AND TESTING (Continued)

1: Customer Interview

The diagnostic process starts with the customer interview. The service advisor must obtain as much information as possible about the problem and take a test drive with the customer. There are many ways a customer will describe NVH concerns and this will help minimize confusion arising from descriptive language differences. It is important that the concern is correctly interpreted and the customer descriptions are recorded. During the interview, ask the following questions:

- When was it first noticed?
- Did it appear suddenly or gradually?
- Did any abnormal occurrence coincide with or proceed it's appearance?

Use the information gained from the customer to accurately begin the diagnostic process.

2: Pre-Drive Check

It is important to do a pre-drive check before road testing the vehicle. A pre-drive check verifies that the vehicle is relatively safe to drive and eliminates any obvious faults on the vehicle.

The pre-drive check consists of a brief visual inspection. During this brief inspection, take note of anything that will compromise safety during the road test and make those repairs/adjustments before taking the vehicle on the road.

3: Preparing for the Road Test

Observe the following when preparing for the road test:

- Review the information recorded on the NVH Diagnostic Guide. It is important to know the specific concern the customer has with the vehicle.
- Do not be misled by the reported location of the noise/vibration. The cause can actually be some distance away.
- Remember that the vibrating source component (originator) may only generate a small vibration. This small vibration can in turn cause a larger vibration/noise to emanate from another receiving component (reactor), due to contact with other components (transfer path).
- Conduct the road test on a quiet street where it is safe to duplicate the vibration/noise. The ideal testing route is an open, low-traffic area where it is possible to operate the vehicle at the speed in which the condition occurs.
- If possible, lower the radio antenna in order to minimize turbulence. Identify anything that could potentially make noise or be a source of wind noise. Inspect the vehicle for add-on items that create vibration/noise. Turn off the radio and the heating and cooling system blower.
- The engine speed is an important factor in arriving at a final conclusion. Therefore, connect an accurate tachometer to the engine, even if the vehicle has a tachometer. Use a tachometer that has clearly defined increments of less than 50 rpm. This ensures an exact engine speed reading.

4: Verify the Customer Concern

Verify the customer concern by carrying out a road test, an engine run-up test, or both.

The decision to carry out a road test, an engine run-up test, or both depends on the type of NVH concern. A road test may be necessary if the symptom relates to the suspension system or is sensitive to torque. A drive engine run-up (DERU) or a neutral engine run-up (NERU) test identifies noises and vibrations relating to engine and drivetrain rpm. Remember, a condition will not always be identifiable by carrying out these tests, however, they will eliminate many possibilities if carried out correctly.

DIAGNOSIS AND TESTING (Continued)

5: Road Test

Note: It may be necessary to have the customer ride along or drive the vehicle to point out the concern. During the road test, take into consideration the customer's driving habits and the driving conditions. The customer's concern just may be an acceptable operating condition for that vehicle.

The following is a brief overview of each test in the order in which it appears. A review of this information helps to quickly identify the most appropriate process necessary to make a successful diagnosis. After reviewing this information, select and carry out the appropriate test(s), proceeding to the next step of this process.

- The Slow Acceleration Test is normally the first test to carry out when identifying an NVH concern, especially when a road test with the customer is not possible.
- The Heavy Acceleration Test helps to determine if the concern is torque-related.
- The Neutral Coast Down Speed Test helps to determine if the concern is vehicle speed-related.
- The Downshift Speed Test helps to determine if the concern is engine speed-related.
- The Steering Input Test helps to determine how the wheel bearings and other suspension components contribute to a vehicle speed-related concern.
- The Brake Test helps to identify vibrations or noise that are brake related.
- The Road Test Over Bumps helps isolate a noise that occurs when driving over a rough or bumpy surface.
- The Engine Run-Up Tests consist of the Neutral Run-up Test and the Engine Load Test. These tests help to determine if the concern is engine speed-related.
- The Neutral Run-up Test is used as a follow-up test to the Downshift Speed Test when the concern occurs at idle.
- The Engine Load Test helps to identify vibration/noise sensitive to engine load or torque. It also helps to reproduce engine speed-related concerns that cannot be duplicated when carrying out the Neutral Run-up Test or the Neutral Coast Down Test.
- The Engine Accessory Test helps to locate faulty belts and accessories that cause engine speed-related concerns.
- The Vehicle Cold Soak Procedure helps to identify concerns occurring during initial start-up and when an extended time lapse occurs between vehicle usage.

Slow Acceleration Test
To carry out this test, proceed as follows:

- Slowly accelerate to the speed where the reported concern occurs. Note the vehicle speed, the engine rpm and, if possible, determine the vibration frequency.
- Attempt to identify from what part of the vehicle the concern is coming.
- Attempt to identify the source of the concern.
- Proceed as necessary.

Heavy Acceleration Test
To carry out this test, proceed as follows:

- Accelerate hard from 0-64 km/h (0-40 mph).
- Decelerate in a lower gear.
- The concern is torque related if duplicated while carrying out this test.
- Proceed as necessary.

Neutral Coast Down Speed Test
To carry out this test, proceed as follows:

- Drive at a higher rate of speed than where the concern occurred when carrying out the Slow Acceleration Test.
- Place the transmission in NEUTRAL and coast down past the speed where the concern occurs.
- The concern is vehicle speed-related if duplicated while carrying out this test. This eliminates the engine and the torque converter as sources.
- If the concern was not duplicated while carrying out this test, carry out the Downshift Speed Test to verify if the concern is engine speed related.
- Proceed as necessary.

Downshift Speed Test
To carry out this test, proceed as follows:

- Shift into a lower gear than the gear used when carrying out the Slow Acceleration Test.
- Drive at the engine rpm where the concern occurs.

DIAGNOSIS AND TESTING (Continued)

- The concern is engine speed related if duplicated while carrying out this test. This eliminates the tires, wheels, brakes and the suspension components as sources.
- If necessary, repeat this test using other gears and NEUTRAL to verify the results.
- Proceed as necessary.

Steering Input Test
To carry out this test, proceed as follows:

- Drive at the speed where the concern occurs, while making sweeping turns in both directions.
- If the concern goes away or gets worse, the wheel bearings, hubs, U-joints (contained in the axles of 4WD applications), and tire tread wear are all possible sources.
- Proceed as necessary.

Brake Test
To carry out this test, proceed as follows:

- Warm the brakes by slowing the vehicle a few times from 80-32 km/h (50-20 mph) using light braking applications. At highway speeds of 89-97 km/h (50-60 mph), apply the brake using a light pedal force.
- Accelerate to 89-97 km/h (55-60 mph).
- Lightly apply the brakes and slow the vehicle to 30 km/h (20 mph).
- A brake vibration noise can be felt in the steering wheel, seat or brake pedal. A brake noise can be heard upon brake application and diminish when the brake is release.

Road Test Over Bumps
To carry out this test, proceed as follows:

- Drive the vehicle over a bump or rough surface one wheel at a time to determine if the noise is coming from the front or the back and the left or the right side of the vehicle.
- Proceed as necessary.

Neutral Engine Run-up (NERU) Test
To carry out this test, proceed as follows:

- Install a tachometer.
- Increase the engine rpm up from an idle to approximately 4000 rpm while in PARK on front wheel drive vehicles with automatic transmissions, or NEUTRAL for all other vehicles. Note the engine rpm and, if possible, determine the vibration frequency.
- Attempt to identify what part of the vehicle the concern is coming from.
- Attempt to identify the source of the concern.
- Proceed as necessary.

Drive Engine Run-up (DERU) Load Test
To carry out this test, proceed as follows:

- ⚠ **WARNING: Block the front and rear wheels, and apply the parking brake and the service brake, or injury to personnel can result.**

⚠ **CAUTION: Do not carry out the Engine Load Test for more than five seconds or damage to the transmission or transaxle can result.**
Block the front and rear wheels.

- Apply the parking brake and the service brake.
- Install a tachometer.
- Shift the transmission into DRIVE, and increase and decrease the engine rpm between an idle to approximately 2000 rpm. Note the engine rpm and, if possible, determine the vibration frequency.
- Repeat the test in REVERSE.
- If the vibration/noise is duplicated when carrying out this test, inspect the engine and transmission or transaxle mounts.
- If the concern is definitely engine speed-related, carry out the Engine Accessory Test to narrow down the source.
- Proceed as necessary.

DIAGNOSIS AND TESTING (Continued)

Engine Accessory Test
To carry out this test, proceed as follows:

- ⚠ **WARNING: Block the front and rear wheels, and apply the parking brake and the service brake, or injury to personnel can result.**

⚠ **CAUTION: Limit engine running time to one minute or less with belts removed or serious engine damage will result.**

Note: A serpentine drive belt decreases the usefulness of this test. In these cases, use a vibration analyzer, such as the EVA, to pinpoint accessory vibrations. An electronic listening device, such as an EngineEAR, will also help to identify noises from specific accessories.
Remove the accessory drive belts.

- Increase the engine rpm to where the concern occurs.
- If the vibration/noise is duplicated when carrying out this test, the belts and accessories are not sources.
- If the vibration/noise was not duplicated when carrying out this test, install each accessory belt, one at a time, to locate the source.

Vehicle Cold Soak Procedure
To carry out this procedure, proceed as follows:

- Test preparations include matching customer conditions (if known). If not known, document the test conditions: gear selection and engine rpm. Monitor the vibration/noise duration with a watch for up to three minutes.
- Park the vehicle where testing will occur. The vehicle must remain at or below the concern temperature (if known) for 6-8 hours.
- Before starting the engine, conduct a visual inspection under the hood.
- Turn the key on, but do not start the engine. Listen for the fuel pump, anti-lock brake system (ABS) and air suspension system noises.
- Start the engine.
- ⚠ **CAUTION: Never probe moving parts.**

  Isolate the vibration/noise by carefully listening. Move around the vehicle while listening to find the general location of the vibration/noise. Then, search for a more precise location by using a stethoscope or EngineEAR.
- Refer to Idle Noise/Vibration in the Symptom Chart to assist with the diagnosis.

6: Check OASIS/TSBs/Repair History

After verifying the customer concern, check for OASIS reports, TSBs and the vehicle repair history for related concerns. If information relating to a diagnosis/repair is found, carry out the procedure(s) specified in that information.

If no information is available from these sources, carry out the vehicle preliminary inspection to eliminate any obvious faults.

7: Diagnostic Procedure

Qualifying the concern by the particular sensation present can help narrow down the concern. Always use the ‘‘symptom’’ to ‘‘system’’ to ‘‘component’’ to ‘‘cause’’ diagnosis technique. This diagnostic method divides the problem into related areas to correct the customer concern.

- Verify the ‘‘symptom’’.
- Determine which ‘‘system(s)’’ can cause the ‘‘symptom’’.
  - — If a vibration concern is vehicle speed related, the tire and wheel rpm/frequency or driveshaft frequency should be calculated.
  - — If a vibration concern is engine speed related, the engine, engine accessory or engine firing frequencies should be calculated.
- After determining the ‘‘system’’, use the diagnostic tools to identify the worn or damaged ‘‘components’’.
- After identifying the ‘‘components’’, try to find the ‘‘cause’’ of the failure.

Once the concern is narrowed down to a symptom/condition, proceed to NVH Condition and Symptom Categories.

NVH Condition and Symptom Categories

Operating Condition—Vehicle is Not Moving

1. Static operation
   - Noise occurs during part/system functioning. GO to **Symptom Chart — Squeak and Rattle**.
2. While cranking
   1 Grinding or whine, differential ring gear or starter motor pinion noise. GO to **Symptom Chart — Engine Noise/Vibration**.

DIAGNOSIS AND TESTING (Continued)

2 Rattle. Exhaust hanger, exhaust heat shield or A/C line noise. GO to **Symptom Chart — Squeak and Rattle**.

3 Vibration. Acceptable condition.

3. At idle
   - Idle noise. GO to **Symptom Chart — Idle Noise/Vibration**.
   - Idle vibration or shake. GO to **Symptom Chart — Idle Noise/Vibration**.
4. During Gear Selection
   1 Vehicle parked on a steep incline. Acceptable noise.
   2 Vehicle parked on a flat surface. GO to **Symptom Chart — Driveline Noise/Vibration**.
   3 Vehicle with a manual transmission. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.

Operating Condition—Vehicle is Moving

1. Depends more on how the vehicle is operated
   1 Speed related
   - Related to vehicle speed
     — Pitch increases with vehicle speed. GO to **Symptom Chart — Tire Noise/Vibration**.
     — Noise occurs at specific vehicle speed. A high-pitch noise (whine). GO to **Symptom Chart — Drivline Noise/Vibration**.
     — Loudness proportional to vehicle speed. Low-frequency noise at high speeds, noise and loudness increase with speed. GO to **Symptom Chart — Driveline Noise/Vibration**.
     — A low-pitched noise (drumming). GO to **Symptom Chart — Engine Noise/Vibration**.
     — Vibration occurs at a particular speed (mph) regardless of acceleration or deceleration. GO to **Symptom Chart — Tire Noise/Vibration**.
     — Noise varies with wind/vehicle speed and direction. GO to **Symptom Chart — Air Leak and Wind Noise**.
   - Related to engine speed.
     — Noise varies with engine rpm. GO to **Symptom Chart — Engine Noise/Vibration**.
     — Vibration occurs at a particular speed (mph) regardless of engine speed (rpm).

   2 Acceleration
   - Wide open throttle (WOT)
     — Engine induced contact between components. Inspect and repair as necessary.
     — Noise is continuous throughout WOT. Exhaust system or engine ground out. GO to **Symptom Chart — Engine Noise/Vibration**.
   - Light/moderate acceleration
     — Tip-in moan. Engine/exhaust noise. GO to **Symptom Chart — Engine Noise/Vibration**.
     — Knock-type noise. GO to **Symptom Chart — Engine Noise/Vibration**.
     — Driveline shudder. GO to **Symptom Chart — Driveline Noise/Vibration**.
     — Engine vibration. GO to **Symptom Chart — Engine Noise/Vibration**.

   3 Turning noise. GO to **Symptom Chart —Steering Noise/Vibration**.

   4 Braking.
   - Clicking sound is signaling ABS is active. Acceptable ABS sound.
   - A continuous grinding/squeal. GO to **Symptom Chart — Brake Noise/Vibration**.
   - Brake vibration/shudder. GO to **Symptom Chart — Brake Noise/Vibration**.

   5 Clutching.
   - A noise occurring during clutch operation. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.
   - Vibration. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.

DIAGNOSIS AND TESTING (Continued)

6 Shifting
- Noise or vibration condition related to the transmission (automatic). GO to **Symptom Chart — Transmission (Automatic) Noise/Vibration**.
- Noise or vibration related to the transmission (manual). GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.

7 Engaged in four-wheel drive. GO to **Symptom Chart — Transmission (Manual) and Transfer Case Noise/Vibration**.

8 Cruising speeds
- Accelerator pedal vibration. GO to **Symptom Chart — Engine Noise/Vibration**.
- Driveline vibration. GO to **Symptom Chart — Driveline Noise/Vibration**.
- A shimmy or shake. GO to **Symptom Chart — Tire Noise/Vibration**.

9 Driving at low/medium speeds
- A wobble or shudder. GO to **Symptom Chart — Tire Noise/Vibration**.

2. Depends more on where the vehicle is operated

1 Bump/pothole, rough road or smooth road. GO to **Smyptom Chart — Suspension Noise/Vibration**.
- Noise is random or intermittent occurring from road irregularities. GO to **Symptom Chart — Squeak and Rattle**.
- Noise or vibration changes from one road surface to another. Normal sound changes.
- Noise or vibration associated with a hard/firm ride. GO to **Smyptom Chart — Suspension Noise/Vibration**.

Symptom Charts

Symptom Chart — Air Leak and Wind Noise

Condition	Possible Source	Action
• Air leak around door perimeter	• Loose fit seal.	• PINCH the seal carrier to improve retention on the seal flange.
	• Seal installed incorrectly.	• REINSTALL the seal.
	• Door misaligned.	• REALIGN the door. CHECK door gaps and fit in the door opening and ADJUST as necessary.
	• Scuff plate installed incorrectly.	• REINSTALL the scuff plate.
	• Seal or seal push pins damaged.	• INSTALL a new seal.
• Air leak around glass run	• Door glass misaligned.	• ADJUST the door glass.
	• Glass run installed incorrectly.	• ADJUST the glass run. INSERT foam in the glass run carrier.
	• Leak path behind glass run.	• INSTALL foam rope behind the glass run.
	• Glass run channel spread wide.	• PINCH the glass run channel to reduce the size of the opening.
	• Blow-out clip bent or contacting door glass.	• ADJUST the blow-out clip or INSTALL a new glass run/blow-out clip molding assembly.
	• Glass run damaged.	• INSTALL a new glass run.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Air Leak and Wind Noise (Continued)

Condition	Possible Source	Action
• Air leak at inner belt line	• Belt line seal installed incorrectly on flange. • Belt line seal integrated with door trim installed incorrectly (no glass contact). • No contact with side glass. • No contact with glass runs at both ends of belt line seal. • Belt line seal damaged.	• ADJUST the seal. (Do not bend the flange.) • REINSTALL the door trim. • ADJUST the door glass. • ADJUST the belt line seal or ADD foam at the seal ends. • INSTALL a new seal.
• Air leak at outer belt line	• Belt line seal installed incorrectly on flange (no glass contact). • Belt line seal does not contact the glass. • No contact with glass runs at both ends of belt line seal. • Belt line seal damaged.	• ADJUST the seal. • ADJUST the door glass. • ADJUST the belt line seal/ADD foam at the seal ends. • INSTALL a new seal.
• Draft at inner door handle/speaker opening	• Hole in watershield. • Watershield misaligned. • Exterior door handle seal misaligned/damaged.	• SEAL the hole with a suitable tape. • REALIGN the watershield. INSTALL a new watershield if the pressure sensitive adhesive fails. • REALIGN or INSTALL a new seal as necessary.
• Wind noise from side view mirror	• Outside mirror housing misaligned. • Mirror sail gasket folded/misaligned. • Mirror housing trim cap installed incorrectly. • Air leak through mirror housing hinge. • Inner sail trim installed incorrectly. • Inner sail gasket/barrier installed incorrectly. • Air path through wiring bundle/fastener access holes. • Exposed fastener access hole on mirror housing/sail.	• REALIGN with the edges shingled correctly and no gaps. • REINSTALL with the gasket unfolded and aligned correctly. • REINSTALL with the edges shingled to the air flow. • Fully ENGAGE the mirror into its operating position/USE foam to block the air path through the hinge. • REINSTALL the sail trim/ADJUST the door trim. • REINSTALL the trim cover with the gasket/barrier aligned correctly. • BLOCK the air path(s) with foam/tape. • INSTALL a new cap if it is missing.
• Air leak around perimeter of fixed glass	• Gaps in the sealant bead. • Air traveling up windshield molding along A-pillar. • Windshield/backlite misaligned or not installed correctly. • Rear hood seal at base of windshield misaligned/damaged.	• APPLY approved sealant. • INSTALL foam rope the full length of the A-pillar. • REINSTALL the windshield/backlite. • REALIGN or INSTALL a new seal as necessary.
• Air leak at cowl	• Cowl gasket misaligned/damaged.	• REALIGN or INSTALL a new seal as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Air Leak and Wind Noise (Continued)

Condition	Possible Source	Action
• Air leak around liftgate perimeter	• Loose fit seal. • Seal misaligned. • Liftgate misaligned. • Scuff plate misaligned. • Seal or seal push pins damaged.	• PINCH the seal carrier to improve retention on the seal flange or INSERT foam in the carrier. • REINSTALL the seal. • REALIGN the liftgate. CHECK the liftgate fit in the body opening and ADJUST as necessary. • REINSTALL the scuff plate. • INSTALL a new seal.
• Air leak around the liftgate flip window perimeter	• Loose fit seal. • Seal misaligned. • Glass misaligned. • Seal damaged.	• PINCH the seal carrier to improve the retention to the seal flange. • REINSTALL the seal. • REALIGN the glass. • INSTALL a new seal.
• Wind noise from antenna	• Shape of antenna. • Air leak around antenna cable access hole.	• INSTALL an antenna boot or a spiral antenna. • INSPECT the antenna access hole grommet. REPAIR as necessary.
• Air leak from closed roof opening panel	• Seal installed incorrectly. • Roof opening panel glass/door misaligned. • Roof opening panel damaged.	• REINSTALL the seal. • REALIGN the roof opening panel glass/door. • INSTALL a new roof opening panel.
• Buffeting from an open roof opening panel	• Wind deflector inoperative/damaged. • Wind deflector height incorrect.	• REPAIR or INSTALL a new wind deflector as necessary. • ADJUST the wind deflector higher.
• Wind noise created by airflow over or behind body panels	• Fender splash shield misaligned. • Body panel misaligned (exposed edge). • Hood misaligned (front margin). • Front grille edge noise.	• REALIGN the fender splash shield. • REALIGN the appropriate body panel. • CHECK hood gaps and fit. ADJUST the hood as necessary. • APPLY foam in the hollow areas behind the louvers.
• Wind noise created by grille opening panel	• Grille relationship to leading edge on hood. • Sharp edges due to material imperfections.	• ADJUST the grille opening panel forward to eliminate wind noise. • REMOVE the sharp edges (no damage to visible surface).
• Wind noise from air extractor	• Air extractor housing seated incorrectly. • Air extractor housing or flaps damaged.	• REINSTALL the air extractor housing. • INSTALL a new air extractor.
• Air leak at top of A-pillar — vehicles with a convertible top	• Seal at windshield header installed incorrectly. • Seal pinched. • Gap between side rail and header seal at A-pillar.	• REINSTALL the seal. • FILL the seal with foam to reshape it. • ADJUST the J-hook/vinyl top.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Air Leak and Wind Noise (Continued)

Condition	Possible Source	Action
• Air leak at rear quarter glass (division bar) — vehicles with a convertible top	• No contact between front side glass and quarter glass division bar.	• ADJUST the front side glass regulator and the rear quarter glass regulator.
• Air leak or wind noise from top of side glass — vehicles with a convertible top	• Gap between side rail and vinyl top. • Seal at windshield header installed incorrectly. • Seal damaged between side rail and vinyl top. • Vinyl top damaged.	• ADD additional foam tape to seal between the side rail and the vinyl top. • REINSTALL the seal. • INSTALL a new seal. • INSPECT the vinyl top. INSTALL a new vinyl top as necessary.
• Air leak or wind noise at windshield header — vehicles with a convertible top	• Vinyl top not flush with header. • Seal at windshield header installed incorrectly. • Header seal not flush with header.	• ADJUST the J-hook to lower the top to achieve a flush condition. • REINSTALL the seal. • REINSTALL the seal.
• Convertible top flapping with the top up	• Vinyl top contacting interior headliner.	• Working from front to back, INSTALL a 6.35 mm (0.25 in) foam sheet between the headliner and the vinyl top at the suspected area. Allow a clearance of 50 mm (2 in) - 75 mm (3 in) away from the roof bows and the side rails.
• Noise from roof rack	• Roof rack rails or crossbars loose. • Roof rack fasteners missing. • Roof rack crossbars installed backward. • Roof rack rub strips partially lifting from roof. • Roof rack gaskets loose or misaligned.	• TIGHTEN the fasteners. • INSTALL the approved fasteners. • REINSTALL the crossbars. • REAPPLY adhesive or fasteners or INSTALL new rub strips as necessary. • REINSTALL the gasket.
• Wind noise from bug shield/exterior windshield sun visor	• Turbulence created by location and shape.	• REMOVE per customer direction if it is a dealer installed option.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Brake Noise/Vibration

Condition	Possible Source	Action
• Rattling noise	• Caliper mounting bolts loose. • Damaged or worn caliper pins or retainers. • Missing or damaged anti-rattle clips or springs. • Loose brake disc shield.	• CHECK the caliper bolts. TIGHTEN to specifications. • CHECK the caliper pins and retainers for lubrication and correct fit. LUBRICATE or INSTALL new components as necessary. • CHECK the brake pads for missing clips or broken springs. INSTALL new components as necessary. • TIGHTEN the brake disc shield bolts to specification. REFER to the appropriate workshop manual for the service procedures.
• Clicking noise—with brakes applied with ABS brakes	• ABS hydraulic control unit.	• Acceptable condition.
• Squealing noise—occurs on first (morning) brake application.	• Disc brake pads.	• Acceptable condition. Caused by humidity and low disc brake pad temperature.
• Squealing noise—a continuous squeal	• Disc brake pads or linings worn below minimum thickness.	• INSTALL new disc brake pads. REFER to the appropriate workshop manual for the service procedures.
• Squealing noise—an intermittent squeal brought on by cold, heat, water, mud or snow	• Disc brake pad.	• Acceptable condition.
• Groaning noise—occurs at low speeds with brake lightly applied (creeping).	• Disc brake pads.	• Acceptable condition.
• Grinding noise—continuous	• Disc brake pads or linings worn below minimum thickness.	• INSPECT the disc brake pads, brake discs/drums and attaching hardware for damage. REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
• Moaning noise	• Brake linings contaminated with grease or oil.	• INSPECT the brake pads and shoes for contamination. REPAIR or INSTALL new components as necessary.
• Brake vibration/shudder—occurs when brakes are applied	• Uneven disc or drum wear. • Uneven disc brake pad or lining transfer. • Suspension components.	• GO to Pinpoint Test A.
• Brake vibration/shudder—occurs when the brake pedal is released	• Brake drag.	• INSPECT the disc brake pads or linings for premature wear. REPAIR or INSTALL a new caliper or wheel cylinder as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration

Condition	Possible Source	Action
• Axle howling or whine—front or rear axle	• Axle lubricant low.	• CHECK the lubricant level. FILL the axle to specification.
	• Axle housing damage.	• INSPECT the axle housing for damage. REPAIR or INSTALL a new axle as necessary.
	• Damaged or worn wheel bearings or axle bearings.	• CHECK for abnormal wheel bearing play or roughness. Refer to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary.
	• Damaged or worn differential ring and pinion.	• INSPECT the ring and pinion ring for abnormal wear patterns or broken teeth. INSTALL a new ring and pinion as necessary.
	• Damaged or worn differential side or pinion bearings.	• CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary.
	• Damaged or worn differential side gears and pinion gears.	• DISASSEMBLE the differential carrier. INSPECT the side and pinion gears for abnormal wear patterns or broken teeth. INSTALL new gears as necessary.
• Driveline clunk—loud clunk when shifting from reverse to drive	• Incorrect axle lubricant level.	• CHECK the lubricant level. FILL the axle to specification.
	• Excessive backlash in the axle or transmission.	• CARRY OUT a total backlash check. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn pinion bearings.	• CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary
	• Damaged or worn universal joints (U-joints).	• INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary.
	• Loose suspension components.	• INSPECT the suspension for damage or wear. REPAIR or INSTALL new components as necessary.
	• Broken powertrain mounts.	• INSPECT the powertrain mounts. CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section. INSTALL new mounts as necessary.
	• Idle speed too high.	• CHECK for the correct idle speed. REFER to the appropriate workshop manual for the specifications.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration (Continued)

Condition	Possible Source	Action
• Driveline clunk—occurs as the vehicle starts to move forward following a stop	• Worn or galled driveshaft slip-yoke splines.	• CLEAN and INSPECT the splines of the yoke for a worn or galled condition. INSTALL a new yoke as necessary.
	• Worn or galled driveshaft and coupling shaft splines.	• CLEAN and INSPECT the splines of the driveshaft and coupling shaft for a worn or galled condition. INSTALL a new driveshaft assembly as necessary.
	• Loose rear leaf spring U-bolts.	• CHECK the U-bolts for loose nuts. TIGHTEN to specification. REFER to the appropriate workshop manual for the service procedures.
• Driveline clunk (FWD vehicles)—occurs during acceleration or from cruise to coast/deceleration	• Damaged or worn inboard constant velocity (CV) joint.	• INSPECT the inboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary. REFER to the appropriate workshop manual for the service procedures.
• Driveline clunk (4WD vehicles)—occurs during shift-on-the-fly engagement	• Clutch relay • Shift motor • Transfer case • GEM	• CHECK the 4WD engagement system. REPAIR or INSTALL as necessary. REFER to the appropriate workshop manual for the service and diagnostic procedures.
• Clicking, popping or grinding—occurs while vehicle is turning	• Inadequate or contaminated lubrication in the (CV) joints.	• CHECK the CV boots and joints for wear or damage. REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Another component contacting the halfshaft	• CHECK the halfshafts and the area around the halfshafts. REPAIR as necessary.
	• Brake components.	• INSPECT the front brakes for wear or damage. REPAIR as necessary.
	• Steering components.	• INSPECT the drag link, inner and outer tie-rods or idler arm for wear or damage. REPAIR as necessary.
	• Suspension components.	• INSPECT the upper and lower ball joints for wear or damage. REPAIR as necessary.
	• Damaged or worn wheel bearings	• CHECK for abnormal wheel bearing play or roughness. Refer to Wheel Bearing Check in this section. ADJUST or INSTALL new wheel bearings as necessary.
• Clicking or snapping—occurs when accelerating around a corner	• Damaged or worn outboard CV joint.	• INSPECT the outboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration (Continued)

Condition	Possible Source	Action
• High pitched chattering—noise from the rear axle when the vehicle is turning	• Incorrect or contaminated lubricant.	• CHECK the vehicle by driving in tight circles (5 clockwise, 5 counterclockwise). FLUSH and REFILL with the specified rear axle lubricant and friction modifier as necessary.
	• Damaged or worn differential (differential side gears and pinion gears).	• DISASSEMBLE the differential assembly. INSPECT the differential case, pin and gears for wear or damage. REPAIR or INSTALL a new differential as necessary.
• Buzz—buzzing noise is the same at cruise or coast/deceleration	• Damaged or worn tires.	• CHECK for abnormal tire wear or damage. INSTALL a new tire as necessary.
	• Incorrect driveline angles.	• CHECK for correct driveline angles. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedure.
• Rumble or boom—noise occurs at coast/deceleration, usually driveshaft speed related and noticeable over a wide range of speeds	• Driveshaft is out-of-balance.	• CHECK the driveshaft for damage, missing balance weights or undercoating. Using the EVA, CHECK the driveshaft balance. CARRY OUT a driveline vibration test. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.
	• U-joints binding or seized.	• ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Excessive pinion flange runout.	• CARRY OUT a runout check. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedure.
• Grunting—normally associated with a shudder experienced during acceleration from a dead stop	• Driveshaft slip yoke binding.	• CLEAN and LUBRICATE the male and female splines.
	• Loose rear spring U-bolts.	• INSPECT the rear suspension. TIGHTEN the U-bolt nuts to specification. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration (Continued)

Condition	Possible Source	Action
• Howl—can occur at various speeds and driving conditions. Affected by acceleration and deceleration.	• Incorrect ring and pinion contact, incorrect bearing preload or gear damage.	• CHECK the ring and pinion and bearings for damage. INSPECT the ring and pinion wear pattern. REFER to Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. ADJUST or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
• Chuckle—heard at coast/deceleration. Also described as a knock.	• Incorrect ring and pinion contact or by damaged teeth on the coast side of the ring and pinion.	• CHECK the ring and pinion for damage. INSPECT the ring and pinion wear pattern. REFER to Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. ADJUST or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
• Knock—noise occurs at various speeds. Not affected by acceleration or deceleration.	• Gear tooth damage to the drive side of the ring and pinion. • Excessive axle shaft end play. (Vehicles with integral axles).	• CHECK the differential case and ring and pinion for damage. INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures. • CHECK the axle end play using a dial indicator. INSTALL a new axle shaft or side gears as necessary. REFER to the appropriate workshop manual for the service procedures.
• Scraping noise—a continuous low pitched noise starting at low speeds	• Worn or damaged pinion bearings.	• CHECK the pinion bearings. INSTALL new pinion bearings as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration (Continued)

Condition	Possible Source	Action
• Driveline shudder—occurs during acceleration from a slow speed or stop	• Rear drive axle assembly mispositioned.	• CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary.
	• Loose rear spring U-bolts	• INSPECT the U-bolts. TIGHTEN the U-bolt nuts to specification. REFER to the appropriate workshop manual for the service prcedures.
	• Incorrect or high CV joint operating angle.	• CHECK vehicle ride height is within limits. REPAIR as necessary.
	• Damaged or worn front suspension components.	• CHECK for a loose stabilizer bar, damaged or loose strut/strut bushings or loose or worn ball joints. INSPECT the steering linkage for wear or damage. REPAIR or INSTALL new components as necessary.
	• Driveline angles out of specification.	• CHECK for correct driveline angles. REPAIR as necessary. REFER to the appropriate workshop manual.
	• U-joints binding or seized.	• ROTATE the driveshaft and CHECK for rough operation or seized U-joints. INSTALL new U-joints as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Binding, damaged or galled splines on the driveshaft slip-yoke	• CLEAN and INSPECT the splines of the slip-yoke, driveshaft and coupling shaft for a worn, damaged or galled condition. INSTALL a new slip-yoke or driveshaft assembly as necessary. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Driveline Noise/Vibration (Continued)

Condition	Possible Source	Action
• Driveline vibration—occurs at cruising speeds	• U-joints are worn.	• CHECK for wear or incorrect seating. INSTALL new U-joints as necessary.
	• Worn or damaged driveshaft center bearing support.	• CHECK the insulator for damage or wear. ROTATE the driveshaft and CHECK for rough operation. INSTALL a new center bearing support as necessary.
	• Loose axle pinion flange bolts	• INSPECT the axle pinion flange. TIGHTEN the pinion flange bolts to specification.REFER to the appropriate workshop manual for the service procedure.
	• Excessive axle pinion flange runout.	• CARRY OUT a Runout Check. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.
	• Driveshaft is out-of-balance.	• CHECK the driveshaft for damage, missing balance weights or undercoating. CHECK driveshaft balance. CARRY OUT a driveline vibration test. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.
	• Binding or damaged splines on the driveshaft slip-yoke	• CLEAN and INSPECT the splines of the slip-yoke, driveshaft and coupling shaft for wear or damage. INSTALL a new slip-yoke or driveshaft assembly as necessary. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.
	• Driveshaft runout.	• CARRY OUT a Runout Check. REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.
	• Incorrect lateral and radial tire/wheel runout.	• INSPECT the tire and wheels. MEASURE tire runouts. REPAIR or INSTALL new components as necessary.
	• Driveline angles out of specification.	• CHECK for correct driveline angles. REPAIR as necessary. REFER to the appropriate workshop manual.
	• Incorrectly seated CV joint in the front wheel hub.	• CHECK the outer CV joint for correct seating into the hub. REPAIR as necessary. REFER to the appropriate workshop manual.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Engine Noise/Vibration

Condition	Possible Source	Action
• Grinding noise—occurs during engine cranking	• Incorrect starter motor mounting.	• INSPECT the starter motor for correct mounting. REPAIR as necessary.
	• Starter motor.	• CHECK the starter motor. REPAIR or INSTALL a new starter motor as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Incorrect starter motor drive engagement.	• INSPECT the starter motor drive and flywheel for wear or damage. INSTALL a new starter motor drive or flywheel as necessary. REFER to the appropriate workshop manual for the service procedures.
• Engine ticking noise	• Fuel injector. • Fuel line. • Oil pump. • Valve lifter. • Belt tensioner. • Water pump. • Obstruction of cooling fan.	• GO to Pinpoint Test B.
• Engine drumming noise—normally accompanied by vibration	• Powertrain mount.	• CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section.
	• Damaged or misaligned exhaust system.	• INSPECT the exhaust system for loose or broken clamps and brackets. CARRY OUT Exhaust System Neutralizing in this section.
• Whistling noise—normally accompanied with poor idle condition	• Air intake system.	• CHECK the air intake ducts, air cleaner, throttle body and vacuum hoses for leaks and correct fit. REPAIR or ADJUST as necessary.
• Clunking noise	• Water pump has excessive end play or imbalance.	• CHECK the water pump for excessive end play. INSPECT the water pump with the drive belt off for imbalance. INSTALL a new water pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Generator has excessive end play.	• CHECK the generator for excessive end play. REPAIR or INSTALL a new generator. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Engine Noise/Vibration (Continued)

Condition	Possible Source	Action
• Pinging noise	• Exhaust system leak.	• INSPECT the exhaust system for leaks. REPAIR as necessary.
	• Gasoline octane too low.	• VERIFY with customer the type of gasoline used. CORRECT as necessary.
	• Knock sensor operation.	• CHECK the knock sensor. INSTALL a new knock sensor as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Incorrect spark timing.	• CHECK the spark timing. REPAIR as necessary.
	• High operating temperature.	• INSPECT cooling system for leaks. CHECK the coolant level. REFILL as necessary. CHECK the coolant for the correct mix ratio. DRAIN and REFILL as needed. CHECK engine operating temperature is within specifications. REPAIR as necessary.
	• Foul-out spark plug.	• CHECK the spark plugs. REPAIR or INSTALL new spark plugs as necessary.
	• Catalytic converter.	• Acceptable noise.
• Knocking noise—light knocking noise, also described as piston slap. Noise is most noticeable when engine is cold with light to medium acceleration. Noise disappears as engine warms.	• Excessive clearance between the piston and the cylinder wall.	• Engine cold and at high idle. Using an EngineEAR, pull a spark plug or fuel injector connector until the noise goes away. CARRY OUT a cylinder bore clearance to piston check. INSTALL a new piston. REFER to the appropriate workshop manual for the service procedures.
• Knocking noise—light double knock or sharp rap sound. Occurs mostly with warm engine at idle or low speeds in DRIVE. Increases in relation to engine load. Associated with poor lubrication history.	• Excessive clearance between the piston and the piston pin.	• INSTALL a new piston or piston pin. REFER to the appropriate workshop manual for the service procedures.
• Knocking noise—light knocking noise is most noticeable when engine is warm. Noise tends to decrease when vehicle is coasting or in neutral.	• Excessive clearance between the connecting rod bearings and the crankshaft.	• Engine warm and at idle. Using an EngineEAR, PULL a spark plug or fuel injector connector until the noise goes away. INSTALL new bearings. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Engine Noise/Vibration (Continued)

Condition	Possible Source	Action
• Knocking—deep knocking noise. Noise is most noticeable when engine is warm, at lower rpm and under a light load and then at float.	• Worn or damaged crankshaft main bearings.	• CARRY OUT DERU test. CHECK for noise with vehicle at operating temperature, during medium to heavy acceleration. CHECK at idle with injector disconnected, noise does not change. INSTALL new main bearings. REFER to the appropriate workshop manual for the service procedures.
• Knocking noise—occurs mostly with warm engine at light/medium acceleration	• Spark plugs. • Carbon accumulation in combustion chamber.	• CHECK the spark plug for damage or wear. INSTALL new spark plugs as necessary. • REMOVE carbon from combustion chamber.
• Whine or moaning noise	• Air intake system. • Generator electrical field or bearings.	• CHECK the air cleaner and ducts for correct fit. INSPECT the air intake system for leaks or damage. REPAIR as necessary. • CARRY OUT generator load test. REPAIR or INSTALL a new generator as necessary. REFER to the appropriate workshop manual for the service procedures.
• Drone type noise	• Exhaust system. • A/C compressor. • Powertrain mounts.	• CARRY OUT the Exhaust System Neutralizing in this section. REPAIR as necessary. • CHECK for noise with vehicle at constant speeds. CYCLE the compressor on and off and listen for a change in pitch. REPAIR as necessary. • CARRY OUT the Powertrain/Drivetrain Mount Neutralizing in this section.
• Sputter type noise—noise worse when cold, lessens or disappears when vehicle is at operating temperature	• Damaged or worn exhaust system components.	• INSPECT the exhaust system for leaks or damage. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Engine Noise/Vibration (Continued)

Condition	Possible Source	Action
• Rattling noise—noise from the upper engine (valve train). Worse when engine is cold.	• Low oil level.	• CHECK oil level. FILL as necessary.
	• Thin or diluted oil.	• INSPECT the oil for contamination. If oil is contaminated, CHECK for the source. REPAIR as necessary. CHANGE the oil and filter.
	• Low oil pressure.	• CARRY OUT an oil pressure test. If not within specifications, REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn rocker arms/fulcrums or followers.	• CARRY OUT a valve train analysis. INSTALL new valve train components as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn valve guides.	• CARRY OUT a valve train analysis. INSTALL new valve guides as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Excessive runout of valve seats on the valve face.	• CARRY OUT a valve seat runout test. INSPECT the valve face and seat. INSTALL new valves as necessary. REFER to the appropriate workshop manual for the service procedures.
• Rattling noise—from the bottom of the vehicle	• Loose muffler shields or catalytic converter shields.	• CHECK the exhaust system for loose shields. REPAIR as necessary.
• Thumping noise—from the bottom of the vehicle, worse at acceleration	• Exhaust pipe/muffler grounded to chassis.	• CHECK the exhaust system to chassis clearance. CHECK the exhaust system hangers for damage. REPAIR as necessary.
• Whoosh—occurs during light vehicle acceleration. Heard inside the vehicle.	• Throttling late, creating turbulence transmitted through the plastic manifold.	• CHECK for leaks or missing seal in the dash panel.
• Engine vibration—increases intensity as engine rpm is increased	• Engine out-of-balance.	• CARRY OUT NERU test. ROTATE torque converter, 120° for 3 bolt and 180° for 4 bolt. INSPECT torque converter pilot outer diameter to crankshaft pilot inner diameter.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart — Engine Noise/Vibration (Continued)

Condition	Possible Source	Action
• Engine vibration—is felt with increases and decreases in engine rpm	• Strain on exhaust mounts.	• CARRY OUT the Exhaust System Neutralizing procedure in this section. REPAIR as necessary.
	• Damaged or worn powertrain/drivetrain mounts	• CHECK the powertrain/drivetrain mounts for damage. CARRY OUT the Powertrain/Drivetrain Mount Neutralizing in this section. REPAIR as necessary.
	• Engine or transmission grounded to chassis.	• INSPECT the powertrain/drivetrain for correct clearances. REPAIR as necessary.
• Engine vibration—vibration felt at all times	• Excessive engine pulley runout.	• CARRY OUT Engine Accessory Test. INSTALL a new engine pulley as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn accessory component.	• CARRY OUT Engine Accessory Test. REPAIR or INSTALL a new component as necessary.
• Accelerator pedal vibration—felt through the pedal as a buzz	• Throttle cable loose or misrouted.	• INSPECT the throttle cable. REPAIR as necessary.
• Engine vibration—mostly at coast/neutral coast. Condition improves with vehicle accelerating.	• Combustion instability.	• CHECK the ignition system. INSTALL new components as necessary.
• Engine vibration or shudder—occurs with light to medium acceleration above 56 km/h (35 mph)	• Worn or damaged spark plugs.	• INSPECT the spark plugs for cracks, high resistance or broken insulator. INSTALL a new spark plug(s) as necessary.
	• Plugged fuel injector.	• REPAIR or INSTALL a new injector as necessary.
	• Damaged spark plug wire.	• INSPECT the spark plug wires for damage. INSTALL a new spark plug wire(s) as necessary.
	• Contaminated fuel.	• INSPECT the fuel for contamination. DRAIN the fuel system and refill.
	• Worn or damaged torque converter.	• CHECK the torque converter. INSTALL a new torque converter as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Idle Noise/Vibration

Condition	Possible Source	Action
• Idle speed air control valve (ISACV) moan — occurs on throttle tip-out	• ISACV is contaminated with oil.	• GO to Component Tests in this section.
• Front engine accessory drive (FEAD) belt chirp — occurs at idle or high idle, cold or hot. Most common occurrence is during humid weather.	• FEAD belt worn, or pulley is misaligned or loose.	• INSPECT for loose or misaligned pulleys. CHECK the drive belt for wear or damage. INSTALL new pulley(s)/FEAD or drive belt, as necessary. REFER to the appropriate workshop manual for the service procedures.
• Front engine accessory drive (FEAD) bearing hoot — occurs at idle or high idle in cold temperatures of approximately +4°C (+40°F) or colder at first start of the day	• FEAD idler or tensioner pulley bearing is experiencing stick/slip between ball bearings and bearing race.	• GO to Pinpoint Test C.
• Power steering moan — occurs at high idle and possibly at idle during the first cold start of the day in temperatures of approximately -18°C (0°F) or colder. Noise can even be a severe screech for less than one minute in very cold temperatures of approximately -29°C (-20°F) or colder.	• High fluid viscosity, or plugged reservoir screen in power steering reservoir starves pump causing cavitation.	• GO to Pinpoint Test D.
• Generator whine — during high electrical loads at idle or high idle, a high pitch whine or moan is emitted from the generator	• Generator electrical field noise.	• Using an EngineEAR, PROBE near the generator housing. LISTEN for changes in the noise level while changing electrical loads (i.e. rear defrost, headlamps etc.). CARRY OUT a generator load test. If the system passes the load test, the noise is from the generator bearings, INSTALL new bearings. If the system fails the load test, INSTALL a new generator.
• Engine-driven cooling fan moan — occurs during the first start of the day. It is most objectionable near idle speeds up to 2000 rpm. The noise increases with rpm.	• The viscous cooling fan clutch engages until the fluid in the clutch reaches normal operating temperature, causing the fan to fully engage.	• GO to Pinpoint Test E.
• Drumming noise — occurs inside the vehicle during idle or high idle, hot or cold. Very low-frequency drumming is very rpm dependent.	• Exhaust system vibration excites the body resonances inducing interior noise. • Engine vibration excites the body resonances inducing interior noise.	• GO to Pinpoint Test F.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Idle Noise/Vibration (Continued)

Condition	Possible Source	Action
• Hissing noise — occurs during idle or high idle that is apparent with the hood open	• Vacuum leak or idle speed air control valve (ISACV) flow noise. • Vehicles with a plastic intake manifold.	• Use the Ultrasonic Leak Detector/EngineEAR to locate the source. Scan the air intake system from the inlet to each cylinder intake port. DISCARD the leaking parts, and INSTALL a new component. • Acceptable condition. Some plastic manifolds exhibit this noise, which is the effect of the plastic manifold.
• Automatic transmission buzz or hiss	• Incorrect driveline angles. • Worn or damaged main control solenoids or valves.	• CHECK for correct driveline angles. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures. • Using a transmission tester, activate the solenoids to duplicate sound. INSTALL new components as necessary.
• Manual Transmission Clutch throw-out bearing whine. A change in noise pitch or loudness while depressing the clutch pedal.	• Worn throw-out bearing.	• INSTALL a new throw-out bearing. REFER to the appropriate workshop manual for the service procedures.
• Heating, vacuum and air conditioning (HVAC) system chirp — most audible inside the vehicle. Listen for a change in noise pitch or loudness while changing the HVAC system blower speed.	• Damaged or worn HVAC blower bearing.	• INSTALL a new blower motor. REFER to the appropriate workshop manual for the service procedures.
• Air conditioning (A/C) clutch ticking — occurs when the compressor clutch engages	• Acceptable noise. • Incorrect air gap.	• LISTEN to the clutch to determine if the noise occurs with clutch engagement. A small amount of noise is acceptable. If the noise is excessive, CHECK the A/C clutch air gap. INSPECT the A/C clutch for wear or damage. INSTALL a new clutch as necessary. REFER to the appropriate workshop manual for the service procedures.
• Intermittent rattle, or scraping/rubbing noise	• Loose exhaust heat shield(s). • Wiring, hose or other part interfering with front engine accessory drive (FEAD) drive belt or pulley.	• INSPECT the exhaust system for loose parts using a glove or clamps to verify cause. REPAIR as necessary. • INSPECT FEAD system closely verifying there is adequate clearance to all rotating components. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Idle Noise/Vibration (Continued)

Condition	Possible Source	Action
• Engine ticking or knocking noise — occurs during idle or high idle during the first cold start of the day	• Piston noise or valvetrain noise (bled down lifter/lash adjuster).	• GO to Pinpoint Test G.
• A continuous, speed-dependent rattle from the engine — occurs during idle or high idle during the first cold start of the day and disappears as the engine warms up	• Piston noise or valvetrain noise (bled down lifter/lash adjuster).	• GO to Pinpoint Test G.
• Idle vibration—a low-frequency vibration (5-20 Hz) or mild shake that is felt through the seat/floorpan.	• Cylinder misfire. • Engine or torque converter out of balance.	• Using the NGS, CHECK the ignition system. CARRY OUT a cylinder power test. REFER to the appropriate workshop manual for the service procedures. • VERIFY the torque converter to crankshaft pilot clearance is correct, REPAIR as necessary. RE-INDEX the torque converter on the flex plate by 120° on a 3 bolt converter or 180° for a 4 bolt converter. REFER to the appropriate workshop manual for the service procedures. RETEST the vehicle.
• Idle vibration—a high-frequency vibration (20-80 Hz) or buzz, that is felt through the steering wheel or seat	• Exhaust system mounts bound up. • Body mounts loose. • Power steering lines grounded out.	• VERIFY concern occurs at engine firing frequency. CHECK that the exhaust system vibrates at the same frequency as the engine. ADD 9-14 km (20-30 lb.) to the tail pipe to test, CARRY OUT Exhaust System Neutralizing in this section. • INSPECT the body mounts. CARRY OUT a Neutral Engine Run-Up (NERU) Test. REPAIR as necessary • INSPECT that the power steering lines are not contacting the chassis or each other. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Squeak and Rattle

Condition	Possible Source	Action
• Squeak—heard inside the vehicle when closing/opening the door	• Insufficient lubrication on the door hinge or check strap. • Internal door components loose, rubbing or misaligned.	• LUBRICATE the hinge or check strap. • CHECK the inside of the door. TIGHTEN or ALIGN as necessary. USE the Rotunda Squeak and Rattle Kit to isolate any rubbing components.
• Squeak—heard inside the vehicle when closing/opening the window	• Worn or damaged glass run/channel.	• REPAIR or INSTALL a new glass run/channel.
• Squeak—heard outside of vehicle when closing/opening the door	• Exhaust shield rubbing against the chassis or exhaust pipe.	• CHECK the exhaust system. REPAIR as necessary.
• Squeak—occurs with initial brake pedal application	• Disc brake pads.	• Under certain conditions, asbestos free pads can generate a squeak noise. This noise is normal and does not indicate a concern.
• Squeak—a constant noise that occurs with brake pedal applications	• Damaged or worn disc brake pads.	• INSPECT the pads for oil, grease or brake fluid contamination. CHECK for glazed linings. A brake disc with hard spots will also cause a squeak type noise.
• Squeak—noise occurs over bumps or when turning	• Worn control arm bushings. • Worn or damaged shock absorber/strut.	• INSPECT the control arm bushings. Spray with lubricant and CARRY OUT a ‘‘bounce test’’ to determine which bushing. • INSPECT the shock absorber for damage. CARRY OUT a ‘‘bounce test’’ to isolate the noise. INSTALL a new shock absorber/strut as necessary.
• Rattle—heard when closing/opening the door or window	• Loose internal door mechanism, bracket or attachment.	• REPEAT the motion or CARRY OUT a ‘‘tap test’’ to duplicate the noise. INSPECT the door for loose components. TIGHTEN loose components or USE the Rotunda Squeak and Rattle Kit to isolate any rattling components.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Squeak and Rattle (Continued)

Condition	Possible Source	Action
• Squeak or rattle—heard inside the vehicle over rough roads/bumps	• Misaligned glove compartment door/hinge.	• ALIGN the glove compartment door.
	• Instrument panel trim loose or misaligned.	• INSPECT the instrument panel trim for missing or loose clips or screws. REPAIR as necessary.
	• Loose interior component or trim.	• CARRY OUT a ‘‘touch test’’. ELIMINATE the noise by pressing or pulling on interior trim and components. USE the Rotunda Squeak and Rattle Kit to isolate any rattling/squeaking components.
• Squeak or rattle—noise with a vibration concern	• Damaged or worn body mounts.	• INSPECT the upper and lower absorbers and washers for damage or wear. CHECK the body mount brackets for damage. CHECK the nuts and bolts are tightened to specifications. TIGHTEN as necessary.
	• Damaged or worn sub-frame mounts.	• INSPECT the upper and lower absorbers for damage or wear. CHECK the sub-frame for damage. CHECK the nuts and bolts are tightened to specifications. TIGHTEN as necessary.

Symptom Chart—Steering Noise/Vibration

Condition	Possible Source	Action
• Steering grunt or shudder — occurs when turning into or out of a turn at low speeds (temperature sensitive)	• Steering gear or power steering hoses.	• GO to Steering Gear Grunt/Shudder Test component test in this section.
• Steering System clonk—hydraulic knocking sound	• Air in the steering hydraulic system.	• PURGE the air from the system. REFER to the appropriate workshop manual for the service procedures. CHECK for leaks in the system.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Steering Noise/Vibration (Continued)

Condition	Possible Source	Action
• Power steering pump moan — loud humming noise occurs when the steering wheel is rotated to the stop position. Produces a 120-600 Hz frequency that changes with rpm.	• Power steering hose grounded out to chassis.	• INSPECT the power steering hoses. REPAIR as necessary.
	• Aerated fluid.	• PURGE the air from the system. REFER to the appropriate workshop manual for the service procedures. CHECK for leaks in the system.
	• Steering gear isolators.	• INSPECT the isolators for wear or damage. REPAIR as necessary.
	• Low fluid.	• CHECK the fluid level. REFILL as necessary.
	• Power steering pump brackets loose or misaligned.	• CHECK bolts, brackets and bracket alignment. TIGHTEN bolts to specification. REPAIR or INSTALL new brackets as necessary.
• Steering gear clunk — occurs only while cornering over a bump (can be temperature sensitive)	• Steering gear.	• INSPECT the steering gear for loose mounting bolts. TIGHTEN as necessary.
• Feedback (rattle, chuckle or knocking noise in the steering gear) — a condition where roughness is felt in the steering wheel when the vehicle is driven over rough surfaces	• Column intermediate/flexible shaft joints damaged or worn.	• INSTALL a new intermediate/flexible shaft. REFER to the appropriate workshop manual for the service procedures.
	• Loose, damaged or worn tie-rod ends.	• TIGHTEN the nuts to specification or INSTALL new tie-rod ends as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Steering gear insulators or mounting bolts loose or damaged.	• TIGHTEN the bolts or INSTALL new bolts as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Steering column intermediate shaft bolts are loose.	• TIGHTEN the bolts to specification.
	• Steering column damaged or worn.	• REPAIR or INSTALL a new steering column as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Loose suspension bushings, bolts or ball joints.	• INSPECT the suspension system. TIGHTEN or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Steering Noise/Vibration (Continued)

Condition	Possible Source	Action
• Feedback (nibble at the steering wheel) — a condition where slight rotational movement is felt in the steering wheel when the vehicle is driven over rough or grooved surfaces	• Lateral runout in the tire or wheel. • Yoke spring in the steering gear.	• GO to Pinpoint Test H. • CHECK TSBs for revised yoke spring for applicable vehicles.
• Front end accessory drive belt (FEAD) squeal/chirp—when rotating the steering wheel from stop to stop	• Loose or worn FEAD belt.	• ADJUST or INSTALL a new accessory belt as necessary. REFER to the appropriate workshop manual for the service procedures.
• Power steering gear hiss	• Steering column intermediate/flexible shaft-to-steering gear is binding or misaligned. • Grounded or loose steering column boot at the dash panel. • Damaged or worn steering gear input shaft and valve.	• REPAIR or INSTALL a new intermediate/flexible shaft as necessary. REFER to the appropriate workshop manual for the service procedures. • REPAIR as necessary. • REPAIR or INSTALL a new steering gear as necessary. REFER to the appropriate workshop manual for the service procedures.
• Steering column rattle.	• Loose bolts or attaching brackets. • Loose, worn or insufficiently lubricated column bearings. • Steering shaft insulators damaged or worn. • Intermediate/flexible shaft compressed or extended.	• TIGHTEN the bolts to specifications. • LUBRICATE or INSTALL new steering column bearings as necessary. REFER to the appropriate workshop manual for the service procedures. • INSTALL new insulators. REFER to the appropriate workshop manual for the service procedures. • INSPECT the rubber spider coupling for damage. INSTALL a new intermediate/flexible shaft. REFER to the appropriate workshop manual for the service procedures.
• Steering column squeak or cracks	• Insufficient lubricated steering shaft bushings. • Loose or misaligned steering column shrouds. • Steering wheel rubbing against steering column shrouds. • Insufficient lubricated speed control slip ring. • Upper or lower bearing sleeve out of position.	• LUBRICATE the steering shaft and shaft tube seals. • TIGHTEN or ALIGN the steering column shrouds. • REPOSITION the steering column shrouds. • LUBRICATE the speed control slip ring. • REPOSITION the bearing sleeves.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Steering Noise/Vibration (Continued)

Condition	Possible Source	Action
• Power steering pump noisy	• Incorrect assembly of components.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Imperfections on the outside diameter or end surface of the power steering pump rotor.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn power steering pump rotor splines.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• A crack on the inner surface of the power steering pump cam.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Interference between the power steering pump rotor and cam.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn power steering pump rotor and pressure plates.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
• Power steering pump swish noise	• Power steering fluid flow into the bypass valve of the pump valve housing with fluid temperature below 54°C (130°F).	• Acceptable condition.
• Power steering pump whine noise	• Aerated fluid.	• PURGE the air from the system. REFER to the appropriate workshop manual for the service procedures. CHECK for a leak in the system.
	• Damaged power steering pump cam.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged valve cover O-ring seal.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.
• Power steering pump clicking (mechanical) noise	• Power steering pump rotor slippers too long, excessive rotor slipper-to-slot clearance or damaged or worn rotor assembly.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Steering Noise/Vibration (Continued)

Condition	Possible Source	Action
• Power steering pump clatter noise	• Damaged corners on the outside diameter or the power steering rotor or distorted rotor slipper ring.	• REPAIR or INSTALL a new power steering pump as necessary. REFER to the appropriate workshop manual for the service procedures.

Symptom Chart—Suspension Noise/Vibration

Condition	Possible Source	Action
• Squeak or grunt—noise from the front suspension, occurs more in cold ambient temperatures. More noticeable over rough roads or when turning.	• Front stabilizer bar insulators.	• Under these conditions, the noise is acceptable. CHECK TSBs for applicable vehicle.
• Clunk—noise from the front suspension, occurs in and out of turns	• Loose front struts or shocks.	• INSPECT for loose nuts or bolts. TIGHTEN to specifications. REFER to the appropriate workshop manual for the specifications.
• Clunk—noise from the rear suspension, occurs when shifting from reverse to drive	• Loose rear suspension components.	• INSPECT for loose or damaged rear suspension components. REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the specifications.
• Click or pop—noise from the front suspension. More noticeable over rough roads or over bumps	• Worn or damaged ball joints.	• CARRY OUT a ball joint inspection. INSTALL new ball joints or control arms as necessary. REFER to the appropriate workshop manual for the service procedures.
• Click or pop (FWD vehicles)—noise occurs when vehicle is turning	• Worn or damaged ball joints.	• CARRY OUT a ball joint inspection. INSTALL new ball joints or control arms as necessary. REFER to the appropriate workshop manual for the service procedures.
• Click or snap—occurs when accelerating around a corner	• Damaged or worn outboard CV joint.	• INSPECT the outboard CV joint and boot. REPAIR or INSTALL a new CV joint as necessary.
• Front suspension noise—a squeak, creak or rattle noise. Occurs mostly over bumps or rough roads.	• Steering components. • Loose or bent front struts or shock absorbers. • Damaged spring or spring mounts. • Damaged or worn control/radius arm bushings. • Worn or damaged stabilizer bar bushings or links.	• GO to Pinpoint Test H.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Suspension Noise/Vibration (Continued)

Condition	Possible Source	Action
• Rear suspension noise—a squeak, creak or rattle noise. Occurs mostly over bumps or rough roads.	• Loose or bent rear shock absorbers. • Damaged spring or spring mounts. • Damaged or worn control arm bushings. • Worn or damaged stabilizer bar bushings or links.	• GO to Pinpoint Test I.
• Shudder—occurs during acceleration from a slow speed or stop	• Rear drive axle assembly mispositioned. • Incorrect or high CV joint operating angle. • Damaged or worn front suspension components.	• CHECK the axle mounts and the rear suspension for damage or wear. REPAIR as necessary. • CHECK vehicle ride height is within limits. REPAIR as necessary. • CHECK for a loose stabilizer bar, damaged or loose strut/strut bushings or loose or worn ball joints. INSPECT the steering linkage for wear or damage. REPAIR or INSTALL new components as necessary.
• Shimmy—most noticeable on coast/deceleration. Also hard steering condition.	• Excessive positive caster.	• CHECK the caster alignment angle. CORRECT as necessary. REFER to the appropriate workshop manual or the service procedures.

Symptom Chart—Tire Noise/Vibration

Condition	Possible Source	Action
• Tire noise—hum/moan at constant speeds	• Abnormal wear patterns.	• SPIN the tire and CHECK for tire wear. INSTALL a new tire as necessary. INSPECT for damaged/worn suspension components. CARRY OUT wheel alignment.
• Tire noise—noise tone lowers as the vehicle speed is lowered	• Out-of-balance tire.	• BALANCE the tire and road test. INSTALL a new tire as necessary.
• Tire noise — ticking noise, changes with speed	• Nail puncture or stone in tire tread	• INSPECT the tire. REPAIR as necessary.
• Wheel and tire—vibration and noise concern is directly related to vehicle speed and is not affected by acceleration, coasting or decelerating	• Damaged or worn tire.	• GO to Pinpoint Test J.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Tire Noise/Vibration (Continued)

Condition	Possible Source	Action
• Tire wobble or shudder — occurs at lower speeds	• Damaged wheel bearings.	• SPIN the tire and CHECK for abnormal wheel bearing play or roughness. ADJUST or INSTALL new wheel bearings as necessary.
	• Damaged wheel.	• INSPECT the wheel for damage. INSTALL a new wheel as necessary.
	• Damaged or worn suspension components.	• INSPECT the suspension components for wear or damage. REPAIR as necessary.
	• Loose wheel nuts.	• CHECK the wheel nuts. TIGHTEN to specification.
	• Damaged or uneven tire wear.	• SPIN the tire and CHECK for abnormal tire wear or damage. INSTALL a new tire as necessary.
• Tire shimmy or shake— occurs at lower speeds	• Wheel/tire out of balance.	• BALANCE the wheel/tire assembly.
	• Uneven tire wear.	• CHECK for abnormal tire wear. INSTALL a new tire as necessary.
	• Excessive radial runout of wheel or tire.	• CARRY OUT a radial runout test of the wheel and tire. INSTALL a new tire as necessary.
	• Worn or damaged wheel studs or elongated stud holes.	• INSPECT the wheel studs and wheels. INSTALL new components as necessary.
	• Excessive lateral runout of the wheel or tire.	• CARRY OUT a lateral runout test of the wheel and tire. CHECK the wheel, tire and hub. REPAIR or INSTALL new components as necessary.
	• Foreign material between the brake disc and hub or in the brake disc fins.	• CLEAN the mounting surfaces of the brake disc and hub. CHECK the brake disc fins for material.
• High speed shake or shimmy—occurs at high speeds	• Excessive wheel hub runout. • Damaged or worn tires. • Damaged or worn wheel bearings. • Worn or damaged suspension or steering linkage components. • Brake disc or drum imbalance.	• GO to Pinpoint Test K.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration

Condition	Possible Source	Action
• Clutch rattling noise—occurs with clutch engaged, noise changes/disappears with clutch pedal depressed	• Flywheel bolts, clutch housing bolts or clutch pressure plate bolts loose.	• TIGHTEN the bolts to specifications. CHECK the bolts for damage.
• Clutch squeaking noise—noise is heard when the clutch is operated. Vehicle moves slowly or creeps when the clutch is disengaged. Can also be difficult to shift into first and reverse gear.	• Pilot bearing seized or damaged.	• INSTALL a new pilot bearing. REFER to the appropriate workshop manual for the service procedures.
• Clutch squeaking noise—occurs with clutch pedal depressed/released	• Worn clutch pedal shaft or bushings.	• INSPECT the clutch pedal for wear or damage. REPAIR as necessary.
• Clutch whirring/rattle noise—occurs when clutch pedal is depressed	• Worn, damaged or misaligned clutch release bearing.	• INSTALL a new clutch release bearing. REFER to the appropriate workshop manual for the service procedures.
• Clutch grating/grinding noise—occurs when clutch pedal is depressed	• Clutch pressure plate fingers bent or worn. • Contact surface of clutch release bearing worn or damaged.	• INSPECT the clutch pressure plate release fingers. INSTALL a new pressure plate as necessary. REFER to the appropriate workshop manual for the service procedures. • INSTALL a new clutch release bearing. REFER to the appropriate workshop manual for the service procedures.
• Clutch chatter—a small amount of noise when clutch pedal is released at initial take-off.	• Clutch engagement.	• Acceptable operating condition.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)

Condition	Possible Source	Action
• Clutch chatter/grabs—in some cases a shudder is felt. Occurs with clutch pedal depressed/released.	• Damaged or worn powertrain/driveline mounts.	• INSPECT the powertrain/drivetrain mounts. CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section. INSTALL new mounts as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Binding or dragging plunger of the clutch master cylinder or slave cylinder.	• CHECK the master and slave cylinder operation. INSPECT the components for damage or wear. INSTALL a new master or slave cylinder as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Grease or oil on the clutch disc facing.	• CHECK the input shaft seal and rear main oil seal. REPAIR as necessary. INSTALL a new clutch disc. REFER to the appropriate workshop manual for the service procedures.
	• Clutch disc surface glazed or damaged.	• INSPECT the clutch disc surface for a glazed, hardened or damage condition. CARRY OUT a disc check. INSTALL a new clutch disc as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn clutch pressure plate.	• INSPECT the clutch pressure plate for wear or damage. INSTALL a new clutch pressure plate as necessary.
	• Flywheel surface damaged or glazed.	• INSPECT the flywheel for damage or wear. CARRY OUT a flywheel runout check. INSTALL a new flywheel as necessary. REFER to the appropriate workshop manual for the service procedures.
• Clutch chatter noise—noise when clutch pedal is released at initial take-off. Clutch is hard to engage and disengage.	• Pilot bearing worn, damaged or not correctly aligned in bore.	• INSPECT the clutch pressure plate release fingers for uneven wear, clutch components burnt or a seized pilot bearing. INSTALL a new pilot bearing as necessary. REFER to the appropriate workshop manual for the service procedures.
• Clutch vibration	• Loose flywheel bolts. • Damaged or loose clutch pressure plate. • Excessive flywheel runout.	• GO to Pinpoint Test L.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)

Condition	Possible Source	Action
• Transmission rattling/clattering noise—noise at idle or on light acceleration from a stop. Gear selection difficult.	• Gearshift lever joint worn or damaged. • Gearshift lever loose. • Gearshift linkage rods worn or damaged.	• INSTALL a new gearshift lever. REFER to the appropriate workshop manual for the service procedures. • TIGHTEN the bolts to specification. REFER to the appropriate workshop manual for the service procedures. • CHECK the linkage bushings for wear. INSTALL new linkage rods as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission rattling/clattering noise—occurs in neutral or in gear, at idle	• Incorrect fluid level or fluid quality.	• CHECK that the transmission is filled to the correct level and with the specified fluid. REFER to the appropriate workshop manual for the fluid type.
• Transmission rattling/clattering noise—noise at idle in neutral	• Worn or rough reverse idler gear. • Rough running engine, cylinder misfire. • Excessive backlash in gears • Worn countershaft gears.	• CHECK the reverse idler gear. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures. • CHECK the ignition system. CARRY OUT a cylinder power test. REFER to the appropriate workshop manual for the service procedures. • CHECK the gear backlash. ADJUST as necessary. REFER to the appropriate workshop manual for the service procedures. • REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission whine—a mild whine at extreme speeds or high rpm	• Rotating gears/geartrain.	• Acceptable noise.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)

Condition	Possible Source	Action
• Transmission whine—a high pitched whine, also described as a squeal	• Transmission gears are worn (high mileage vehicle).	• Result of normal gear wear. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Mismatched gear sets.	• INSPECT the gear sets for an uneven wear pattern on the face of the gear teeth. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn transmission bearing.	• INSPECT the transmission bearings. INSTALL new bearings as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission growling/humming—noise occurs in the forward gears. The noise is more prominent when the gear is loaded. The problem gear can be located as the noise occurs in a specific gear position.	• Gear is cracked, chipped or rough.	• INSPECT the transmission gears for damage or wear. INSTALL new gears as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission hissing—noise in neutral or in forward gears. As bearings wear or break up, the noise changes to a thumping noise.	• Damaged or worn bearings.	• INSPECT the transmission bearings. INSTALL new bearings as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission knocking/thudding—noise at low speeds in forward gears	• Bearings with damaged balls or rollers or with pitted and spalled races.	• INSPECT the transmission bearings. INSTALL new bearings as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transmission rumble/growl—noise at higher speeds in forward gears, more pronounced in a coast/deceleration condition.	• Incorrect driveline angle.	• CHECK the driveline angle. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Driveshaft out of balance or damaged.	• CHECK the driveshaft for damage, missing balance weights or undercoating. Using the EVA, CHECK the driveshaft balance. CARRY OUT a driveline vibration test. For additional information, REFER to the appropriate workshop manual for the service procedure. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Manual) and Transfer Case Noise/Vibration (Continued)

Condition	Possible Source	Action
• Transmission rumble/growl—noise at all speeds in forward gears, more pronounced in a heavy acceleration condition	• Damaged or worn transmission bearing or gears (high mileage vehicles).	• CHECK transmission fluid for excessive metal particles. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedure.
• Transfer case whine—noise at all ranges	• Incorrect fluid level or fluid quality.	• CHECK that the transfer case is filled to the correct level and with the specified fluid. REFER to the appropriate workshop manual for the fluid type.
	• Worn oil pump.	• DISASSEMBLE the transfer case. CHECK the oil pump for wear or damage. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Under-inflated or oversized tires.	• CONFIRM that the tires and wheels are correct for the vehicle. CHECK that the tire inflation pressures are correct. REFER to the appropriate workshop manual for the specifications.
• Transfer case growl/rumble—noise at all ranges (A small amount of planetary noise can be heard when the transfer case is operated in low range.)	• Damaged or worn bearings or planetary gear.	• DISASSEMBLE the transfer case. CHECK the bearings or planetary gear for wear or damage. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transfer case scraping/grating—noise at all ranges	• Excessively stretched drive chain hitting the case.	• DISASSEMBLE the transfer case. CHECK the drive chain for wear or damage. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transfer case howl/hum—noise at all ranges or high range only	• Worn or damaged sun (input) gear, clutch pack (intermediate) gear or output shaft gear.	• DISASSEMBLE the transfer case. CHECK the gears for wear or damage. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transfer case howl/hum—noise at low range only	• Worn or damaged intermediate gear and sliding gears (clutch pack).	• DISASSEMBLE the transfer case. CHECK the gears for wear or damage. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
• Transfer case vibration—vibration felt with vehicle in 4WD	• Transfer case mounting. • Driveshaft out of balance. • Excessive pinion flange runout.	• GO to Pinpoint Test M.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Automatic) Noise/Vibration

Condition	Possible Source	Action
• Rattle—occurs at idle or at light acceleration from a stop	• Damaged engine or transmission mounts.	• CHECK the powertrain/drivetrain mounts for damage. CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section.
	• A loose front pipe heat shield.	• REPAIR or INSTALL a new heat shield as necessary.
	• Loose inspection plate or dust cover plate. • Loose flex plate to converter nuts.	• CHECK for loose bolts. TIGHTEN to specifications. • CHECK for loose nuts. TIGHTEN to specifications.
• Whine—pitch increases with vehicle speed. Starts in first and second gear, decreases or goes away at higher gears.	• Damaged or worn low one-way clutch. • Damaged or worn intermediate one-way clutch. • Friction elements. • Damaged or worn planetary or sun gear.	• INSPECT the transmission for wear or damage. REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
• Whine—the pitch changes with engine speed.	• A worn or damaged FEAD component.	• CARRY OUT the Engine Accessory Test. REPAIR or INSTALL new components as necessary.
	• Incorrect fluid level.	• CHECK that the transmission is filled to the correct level. ADD fluid as necessary. REFER to the appropriate workshop manual for the fluid type.
	• Partially blocked filter.	• INSPECT the filter. CLEAN or INSTALL a new filter as necessary.
	• Worn or damaged torque converter.	• CARRY OUT the torque converter service and replacement check. REFER to the appropriate workshop manual for the service procedures.
	• Worn or damaged front pump.	• INSPECT the front pump. INSTALL a new front pump as necessary. REFER to the appropriate workshop manual for the service procedures.
• Whine—pitch changes with vehicle speed	• Speedometer cable or gears.	• REPAIR or INSTALL new cables or gears as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Automatic) Noise/Vibration (Continued)

Condition	Possible Source	Action
• Whine/moan type noise—pitch increases or changes with vehicle speed	• Damaged engine or transmission mount.	• CHECK the powertrain/drivetrain mounts for damage. CARRY OUT Powertrain/Drivetrain Mount Neutralizing in this section.
	• U-joints worn or damaged.	• INSPECT the U-joints for wear or damage. INSTALL new U-joints as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn differential ring and pinion.	• INSPECT the differential ring and pinion for damage. CARRY OUT the Checking Tooth Contact Pattern and Condition of the Ring and Pinion component test in this section. REPAIR or INSTALL a new differential ring and pinion as necessary.
	• Planetary gears nicked or chipped.	• CHECK the planetary gears for damage. INSTALL new components as necessary.
• Whistle—noise is high pitched, constant. Changes in pitch with throttle position.	• Hydraulic pressure in the main control.	• INSPECT the main control. REPAIR or INSTALL new components as necessary.
	• Incorrect band/clutch apply pressure.	• CARRY OUT the line pressure tests. REPAIR or INSTALL components as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn or damaged torque converter.	• CARRY OUT the torque converter service and replacement check. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Automatic) Noise/Vibration (Continued)

Condition	Possible Source	Action
• Clunk—occurs when shifting from PARK to a drive or reverse position.	• Damaged powertrain mounts.	• INSPECT the powertrain mounts for damage. INSTALL new mounts as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Damaged or worn pinion bearings.	• CHECK for abnormal bearing play or roughness. INSTALL new bearings as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn or galled driveshaft slip yoke splines.	• CLEAN and INSPECT the splines of the yoke. INSTALL a new slip yoke as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn friction elements or excessive clutch pack end plate play.	• INSPECT the transmission for wear. CHECK that all end play and clearances are within specification. REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.
• Bump—occurs when shifting from PARK to a drive or reverse position. Similar to Clunk but with no sound.	• Initial gear engagement.	• Acceptable condition.
• Buzz or hiss	• Incorrect driveline angles.	• CHECK for correct driveline angles. REPAIR as necessary. REFER to the appropriate workshop manual for the service procedures.
	• Worn or damaged main control solenoids or valves.	• Using a transmission tester, ACTIVATE the solenoids to duplicate sound. INSTALL new components as necessary.
• Vibration—a high frequency (20-80 Hz) that is felt through the seat or gear shifter. Changes with engine speed.	• Transmission cooler lines grounded out.	• CHECK the transmission cooler lines. REPAIR as necessary.
	• Flywheel to torque converter nuts loose.	• CHECK the flywheel nuts. TIGHTEN to specification. REFER to the appropriate workshop manual for the service procedures.
	• Fluid filler tube grounded out.	• CHECK the fluid filler tube. REPAIR as necessary.
	• Shift cable incorrectly routed, grounded out or loose.	• CHECK the shift cable. REPAIR as necessary.

DIAGNOSIS AND TESTING (Continued)

Symptom Chart—Transmission (Automatic) Noise/Vibration (Continued)

Condition	Possible Source	Action
• Shutter or chatter—occurs with light to medium acceleration from low speeds or a stop	• Electrical inputs/outputs. • Vehicle wiring harness. • Incorrect inputs/outputs from the powertrain control module (PCM), digital transmission range (TR) sensor, brake pedal position (BPP) sensor, throttle position (TP) sensor, transmission speed sensor (TSS), output speed shaft (OSS) sensor or the torque converter clutch (TCC).	• CARRY OUT a Torque Converter Clutch Operation Test. RUN on-board diagnostics or self-test. REFER to the Powertrain Control/Emissions Diagnosis Manual[1] for diagnosis and testing of the powertrain control system. CLEAR the DTC's, road test and rerun on-board diagnostics or self-test.

Pinpoint Tests

The pinpoint tests are a step-by-step diagnostic process designed to determine the cause of a condition. It may not always be necessary to follow a pinpoint test to its conclusion. Carry out only the steps necessary to correct the condition. Then, test the system for normal operation. Sometimes, it is necessary to remove various vehicle components to gain access to the component requiring testing. For additional information, REFER to the appropriate Workshop Manual section for removal and installation procedures. Reinstall all components after verifying system operation is normal.

Pinpoint Test A: BRAKE VIBRATION/SHUDDER DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
A1 ROAD TEST THE VEHICLE—LIGHT BRAKING	
	1 Check that the wheel and tires are correct for the vehicle. Inspect the tires for abnormal wear patterns. 2 Road test the vehicle. Warm the brakes by slowing the vehicle a few times from 80-32 km/h (50 to 20 mph) using light braking applications. At highway speeds of 89-97 km/h (55-60 mph), apply the brake using a light pedal force. • Is there a vibration/shudder felt in the steering wheel, seat or brake pedal? → **Yes** GO to **A4**. → **No** GO to **A2**.

(Continued)

1 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test A: BRAKE VIBRATION/SHUDDER DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
A2 ROAD TEST THE VEHICLE—MODERATE TO HEAVY BRAKING	
	1 Road test the vehicle. At highway speeds of 89-97 km/h (55-60 mph), apply the brake using a moderate to heavy pedal force. • Is there a vibration/shudder? → **Yes** For vehicles with ABS, GO to **A3**. For vehicles with standard brakes, GO to **A4**. → **No** Vehicle is OK. VERIFY condition with customer. TEST the vehicle for normal operation.
A3 NORMAL ACTUATION OF THE ABS SYSTEM DIAGNOSIS	
	1 During moderate to heavy braking, noise from the hydraulic control unit (HCU) and pulsation in the brake pedal can be observed. Pedal pulsation coupled with noise during heavy braking or on loose gravel, bumps, wet or snowy surfaces is acceptable and indicates correct functioning of the ABS system. Pedal pulsation or steering wheel nibble whose frequency is proportioned to the vehicle speed indicates a concern with a brake or suspension component. • Is the vibration/shudder vehicle speed sensitive? → **Yes** GO to **A5**. → **No** The brake system is operating correctly.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test A: BRAKE VIBRATION/SHUDDER DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
A4 APPLICATION OF THE PARKING BRAKE	
	1 **Note:** Begin at the front of the vehicle unless the vibration or shudder has been isolated to the rear. This test is not applicable to vehicles with drum-in-hat type parking brakes. For vehicles with drum-in-hat parking brakes, proceed to the next test. For all other vehicles, apply the parking brake to identify if the problem is in the front or rear brake. At highway speeds of 89-97 km/h (55-60 mph), lightly apply the parking brake until the vehicle slows down. Release the parking brake immediately after the test. • Is there a vibration/shudder? → **Yes** GO to **A7**. → **No** GO to **A5**.
A5 CHECK THE FRONT WHEEL BEARINGS	
	1 Check the front wheel bearings. Refer to Wheel Bearing Check in this section. • Are the wheel bearings OK? → **Yes** GO to **A6** → **No** INSPECT the wheel bearings. ADJUST or REPAIR as necessary. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test A: BRAKE VIBRATION/SHUDDER DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
A6 CHECK THE FRONT SUSPENSION	
	1 Check the front suspension for: • Broken or loose bolts. • Damaged springs. • Worn or damaged upper and lower control arm bushings. • Loose or rough front bearings. • Uneven tire wear. • Are all the suspension components in satisfactory condition? → **Yes** GO to **A7**. → **No** REPAIR or INSTALL new components as necessary. TEST the system for normal operation.
A7 RESURFACE THE FRONT BRAKE DISCS	
	1 ⚠ **CAUTION: Do not use a bench lathe to machine brake discs.** **Note:** Follow the manufacturer's instructions to machine the brake discs. After machining, make sure the brake disc meets the thickness specification. Using the procedure outlined in TSB 98-5a-5, resurface the front brake discs. Road test the vehicle. • Is the vibration/shudder present? → **Yes** GO to **A8**. → **No** Vehicle is OK.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test A: BRAKE VIBRATION/SHUDDER DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
A8 CHECK THE REAR SUSPENSION	
	1 Check the rear suspension for: • Broken or loose bolts. • Damaged or worn springs or spring bushings. • Worn or damaged upper and lower control arm bushings. • Worn or damaged trailing arms. • Loose or rough rear bearings. • Uneven tire wear. • Are all the suspension components in satisfactory condition? → **Yes** GO to **A9**. → **No** REPAIR or INSTALL new components as necessary. TEST the system for normal operation.
A9 RESURFACE THE REAR BRAKE DISC OR DRUM	
	1 ⚠ **CAUTION: Do not use a bench lathe to machine brake discs.** **Note:** Follow the manufacturers instructions to machine the brake discs. After machining, make sure the brake disc meets the thickness specification. Using the procedure outlined in TSB 98-5a-5, resurface the rear brake disc or drums. Road test the vehicle. • Is the vibration/shudder present? → **Yes** Check the front suspension for wear or damage, resurface the front brake discs. Test the system for normal operation. → **No** Vehicle is OK.

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test B: ENGINE TICKING NOISE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
B1 CHECK FOR TICKING NOISE AT THE FUEL RAIL	
	1 Disconnect the first fuel line clip. • Is the ticking noise gone? → **Yes** CHECK for TSB for applicable vehicle. REPAIR as necessary. TEST the system for normal operation. → **No** GO to **B2**.
B2 CHECK FOR TICKING NOISE AT THE FUEL INJECTOR	
	1 Using an EngineEAR, listen at the fuel injectors by placing a probe on each injector. To isolate the faulty injector, disconnect the injector electrical connector and listen for the noise. • Is the fuel injector the source of the ticking noise? → **Yes** INSTALL a new fuel injector. TEST the system for normal operation. → **No** GO to **B3**.
B3 CHECK THE BELT TENSIONER FOR TICKING NOISE	
	1 INSPECT the front engine accessory drive (FEAD). CHECK for the belt tensioner bottoming at end of travel or not at end of stroke. 2 Using an EngineEAR, listen at the belt tensioner. • Is the belt tensioner the source of the noise? → **Yes** INSTALL a new belt tensioner. TEST the system for normal operation. → **No** GO to **B4**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test B: ENGINE TICKING NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
B4 CHECK THE WATER PUMP FOR TICKING NOISE	
	1 Using an EngineEAR, listen at the water pump for ticking noise. • Is the water pump the source of the noise? → **Yes** INSTALL a new water pump. TEST the system for normal operation. → **No** GO to **B5**.
B5 CHECK FOR AN OBSTRUCTION OF THE COOLING FAN	
	1 Inspect the cooling fan for obstructions. 2 Check the cooling fan and shroud for wear or damage. • Was there an obstruction or does the cooling fan show signs of damage? → **Yes** REPAIR or INSTALL a new cooling fan. TEST the system for normal operation. → **No** GO to **B6**.
B6 CHECK THE OIL PUMP FOR TICKING NOISE	
	1 CHECK the oil pump using EngineEARs and probe at the oil filter adapter to verify the oil pump as a source. • Is the oil pump the source of the noise? → **Yes** INSTALL a new oil pump. TEST the system for normal operation. → **No** GO to **B7**.

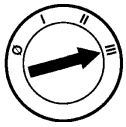
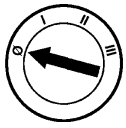
(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test B: ENGINE TICKING NOISE DIAGNOSIS (Continued)

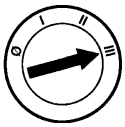
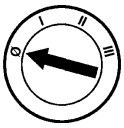
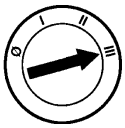
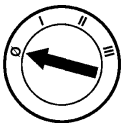
TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
B7 CHECK VALVE LIFTERS OR LASH ADJUSTERS FOR CORRECT OPERATION	
	1 CHECK valve lifter/ lash adjuster for correct operation, using EngineEARs. • Are the valve lifters/ lash adjusters operating correctly? → **Yes** VERIFY customer concern. CONDUCT a diagnosis of other suspect components. → **No** INSTALL a new valve lifter/lash adjuster(s). TEST the system for normal operation.

Pinpoint Test C: FRONT ENGINE ACCESSORY DRIVE (FEAD) BEARING HOOT DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
C1 CHECK THE FEAD IDLER AND TENSIONER PULLEY BEARINGS	
	1 Carry out the Vehicle Cold Soak Procedure in this section.
2 	
	3 Place an EngineEAR probe directly on the pulley center post or bolt to verify which bearing is making the noise.
4 	
	• Is either bearing making the noise? → **Yes** INSTALL a new pulley/idler. CARRY OUT the Vehicle Cold Soak Procedure and TEST the system for normal operation. → **No** CONDUCT a diagnosis on other suspect FEAD components.

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test D: POWER STEERING MOAN DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
D1 CHECK THE POWER STEERING SYSTEM	
	1 Carry out the Vehicle Cold Soak Procedure in this section.
2 	
	3 Turn the steering wheel while the noise is occurring and listen for changes in sound pitch or loudness.
4 	
	• Does the sound pitch or loudness change while turning the steering wheel? → **Yes** GO to **D2**. → **No** CONDUCT a diagnosis on other suspect FEAD components.
D2 VERIFY THE SOURCE	
1 	
	2 Place an EngineEAR probe near the power steering pump/reservoir while the noise is occurring. While an assistant turns the steering wheel, listen for changes in sound pitch or loudness.
3 	

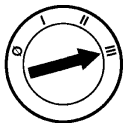
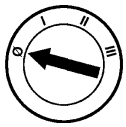
(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test D: POWER STEERING MOAN DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
D2 VERIFY THE SOURCE (Continued)	
	• Does the sound pitch or loudness change while turning the steering wheel? → **Yes** VERIFY that the supply tube to the pump is unobstructed. CHECK the fluid condition and level. DRAIN the fluid and REFILL. CARRY OUT the Vehicle Cold Soak Procedure and TEST the system for normal operation. → **No** Normal system operation.

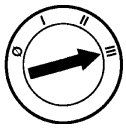
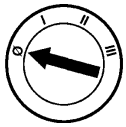
Pinpoint Test E: ENGINE DRIVEN COOLING FAN MOAN DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
E1 CHECK THE ENGINE DRIVEN COOLING FAN AFTER A COLD SOAK	
	1 Carry out the Vehicle Cold Soak Procedure in this section.
2 	
	3 Assess the airflow.
	4 Raise the engine speed to 1500 rpm while listening for the moan to increase in proportion to the airflow.
5 	
	• Does the moan increase in proportion to the airflow? → **Yes** TEST the fan for normal operation. If the fan tests normal, GO to **E2**. Otherwise, REPAIR as necessary. → **No** Normal system operation.

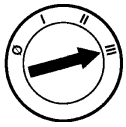
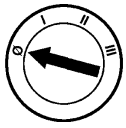
(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test E: ENGINE DRIVEN COOLING FAN MOAN DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
E2 CHECK THE ENGINE DRIVEN COOLING FAN AT NORMAL OPERATING TEMPERATURE	
1  3 	2 Run the engine to normal operating temperature while listening for the moan to stop. • Does the moan stop? → **Yes** Normal clutch operation. → **No** INSTALL a new fan clutch. TEST the system for normal operation.

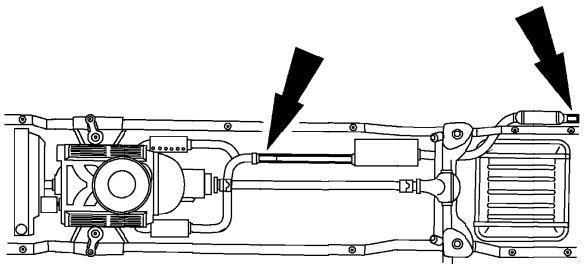
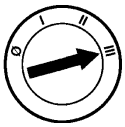
Pinpoint Test F: DRUMMING NOISE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
F1 CHECK THE EXHAUST SYSTEM	
1  3 	2 Increase the engine rpm until the noise is the loudest. Note the engine rpm.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test F: DRUMMING NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
F1 CHECK THE EXHAUST SYSTEM (Continued)	
4  DF1768-A	4 Add approximately 9 kg (20 lb) of weight to the exhaust system. First place the weight at the tail pipe and test, then at the front pipe.
5 	6 Increase the engine rpm and listen for the drumming noise. Note the engine rpm if the noise occurs.
7 	8 Using an EVA, determine the amount of vibration that occurs with the drumming noise. • Is the noise/vibration reduced or eliminated, or does the noise/vibration occur at a different rpm? → **Yes** CARRY OUT Exhaust System Neutralizing in this section. TEST the system for normal operation. → **No** GO to **F2**.

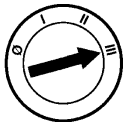
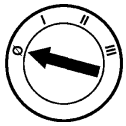
(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test F: DRUMMING NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
F2 POWERTRAIN/DRIVETRAIN MOUNT NEUTRALIZING	
	1 Carry out Powertrain/Drivetrain Mount Neutralizing in this section. Test the system for normal operation. • Is the noise reduced or eliminated? → **Yes** Vehicle OK. TEST the system for normal operation. → **No** CONDUCT diagnosis of other suspect components.

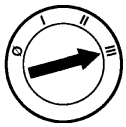
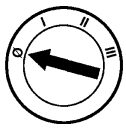
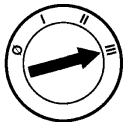
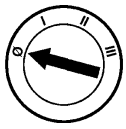
Pinpoint Test G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
G1 CHECK FOR NOISE AT THE VALVE COVERS AND THE FRONT COVERS (OHC ENGINES)	
	1 Carry out the Vehicle Cold Soak Procedure in this section.
2 	
	3 **Note:** For a short-duration ticking noise, multiple engine starts may be necessary. Using an EngineEAR, listen closely at the valve covers and the front covers (OHC engines) by placing the probe near the surface of the valve cover and then on the surface front cover.
4 	
	• Is the noise source apparent? → **Yes** REMOVE the appropriate cover and INSPECT for loose, worn/broken components. REPAIR as necessary. TEST the system for normal operation. → **No** GO to **G2**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
G2 CHECK FOR NOISE AT THE CYLINDER BLOCK	
1  3 	2 Using an EngineEAR, listen closely at the cylinder block by placing a probe on or near each freeze plug. • Is the noise source apparent? → **Yes** REPAIR or INSTALL new components as necessary. → **No** GO to **G3**.
G3 CHECK FOR NOISE WHILE DISCONNECTING EACH FUEL INJECTOR ELECTRICAL CONNECTOR, ONE AT A TIME	
1  3 	2 Disconnect each fuel injector electrical connector, one at a time, to decrease piston force and listen for the noise.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test G: ENGINE TICKING, KNOCKING OR CONTINUOUS RATTLE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
G3 CHECK FOR NOISE WHILE DISCONNECTING EACH FUEL INJECTOR ELECTRICAL CONNECTOR, ONE AT A TIME (Continued)	
	• Is the noise reduced or eliminated? → **Yes** INSTALL a new fuel injector. TEST the system for normal operation. → **No** INSPECT front engine accessory drive (FEAD) or the transmission as a possible source.

Pinpoint Test H: FRONT SUSPENSION NOISE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
H1 ROAD TEST THE VEHICLE	
	1 Test drive the vehicle. 2 During the road test, drive the vehicle over a rough road. Using ChassisEARs, determine from which area/component the noise is originating. • Is there a squeak, creak or rattle noise? → **Yes** GO to **H2**. → **No** The suspension system is OK. CONDUCT a diagnosis on other suspect systems.
H2 INSPECT THE STEERING SYSTEM	
	1 ⚠ **WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.** Raise and support the vehicle. 2 Check the steering system for wear or damage. Carry out a steering linkage test. REFER to the appropriate workshop manual for the service procedure.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test H: FRONT SUSPENSION NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
H2 INSPECT THE STEERING SYSTEM (Continued)	
	3 Inspect the tire wear pattern. Refer to Tire Wear Patterns chart in this section. • Are the steering components worn or damaged? → **Yes** REPAIR the steering system. INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to **H3**.
H3 FRONT SHOCK ABSORBER OR STRUT CHECK	
	1 Check the front shock absorbers/strut mounts for loose bolts or nuts. 2 Check the front shock absorbers/struts for damage. Carry out a shock absorber check. • Are the front shock absorbers/struts loose or damaged? → **Yes** TIGHTEN to specifications if loose. INSTALL new front shock absorbers/struts if damaged. TEST the system for normal operation. → **No** GO to **H4**.
H4 CHECK THE FRONT SPRINGS	
	1 Check the front spring and front spring mounts/brackets for wear or damage. • Are the front springs or spring mounts/brackets worn or damaged? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to **H5**.
H5 CHECK THE CONTROL ARMS/RADIUS ARMS	
	1 Inspect the control arms bushings for wear or damage.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test H: FRONT SUSPENSION NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
H5 CHECK THE CONTROL ARMS/RADIUS ARMS (Continued)	
	2 Inspect for twisted or bent control/radius arm. • Are the control/radius arms damaged or worn? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to **H6**.
H6 CHECK THE STABILIZER BAR/TRACK BAR	
	1 Check the stabilizer/track bar bushings and links for damage or wear. 2 Check the stabilizer/track bar for damage. 3 Check for loose or damaged stabilizer bar isolators or brackets. • Are the stabilizer/track bar components loose, worn or damaged? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** Suspension system OK. CONDUCT diagnosis on other suspect systems.

Pinpoint Test I: REAR SUSPENSION NOISE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
I1 ROAD TEST THE VEHICLE	
	1 Test drive the vehicle.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test I: REAR SUSPENSION NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
I1 ROAD TEST THE VEHICLE (Continued)	
	2 During the road test, drive the vehicle over a rough road. Using ChassisEARs, determine from which area/component the noise is originating. • Is there a squeak, creak or rattle noise? → **Yes** GO to **I2**. → **No** The suspension system is OK. Conduct a diagnosis on other suspect systems.
I2 REAR SHOCK ABSORBER CHECK	
	1 ⚠ **WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.** Raise and support the vehicle. 2 Check the rear shock absorber mounts for loose bolts or nuts. 3 Check the rear shock absorbers for damage. Carry out a shock absorber check. • Are the rear shock absorbers/struts loose or damaged? → **Yes** TIGHTEN to specifications if loose. INSTALL new rear shock absorbers if damaged. TEST the system for normal operation. → **No** GO to **I3**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test I: REAR SUSPENSION NOISE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
I3 CHECK THE REAR SPRINGS	
	1 Check the rear springs and rear spring mounts/brackets for wear or damage. • Are the rear springs or spring mounts/brackets worn or damaged? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to **I4**.
I4 CHECK THE CONTROL ARMS/TRAILING ARMS	
	1 Inspect the control/trailing arm bushings for wear or damage. Check for loose control/trailing arm bolts. 2 Inspect for twisted or bent control/trailing arms. • Are the control/trailing arms loose, damaged or worn? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to **I5**.
I5 CHECK THE STABILIZER BAR/TRACK BAR	
	1 Check the stabilizer/track bar bushings and links for damage or wear. 2 Check the stabilizer/track bar for damage. 3 Check for loose or damaged stabilizer bar isolators or brackets. • Are the stabilizer/track bar components loose, worn or damaged? → **Yes** REPAIR or INSTALL new components as necessary. Test the system for normal operation. → **No** Suspension system OK. CONDUCT diagnosis on other suspect systems.

DIAGNOSIS AND TESTING (Continued)

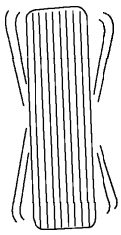
Pinpoint Test J: WHEEL AND TIRE DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
J1 ROAD TEST THE VEHICLE	
	1 **Note:** Wheel or tire vibrations felt in the steering wheel are most likely related to the front wheel or tire. Vibration felt through the seat are most likely related to the rear wheel or tire. This may not always be true, but it can help to isolate the problem to the front or rear of the vehicle. Test drive the vehicle at different speed ranges. 2 During the road test, if the vibration can be eliminated by placing the vehicle in neutral or is affected by the speed of the engine, the cause is not the wheels or tires. • Is there a vibration and noise? → **Yes** GO to **J2**. → **No** The wheel and tires are OK. CONDUCT a diagnosis on other suspect systems.
J2 CHECK THE FRONT WHEEL BEARINGS	
	1 Check the front wheel bearings. Refer to Wheel Bearing Check in this section. • Are the wheel bearings OK? → **Yes** GO to **J3** → **No** INSPECT the wheel bearings. ADJUST or REPAIR as necessary. TEST the system for normal operation.
J3 INSPECT THE TIRES	
	1 Check the tires for missing weights. 2 Check the wheels for damage.

(Continued)

DIAGNOSIS AND TESTING (Continued)

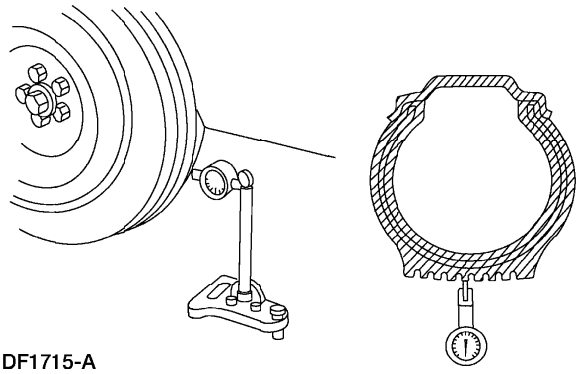
Pinpoint Test J: WHEEL AND TIRE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
J3 INSPECT THE TIRES (Continued)	
	3 Inspect the tire wear pattern. Refer to the Tire Wear Patterns chart in this section. • Do the tires have an abnormal wear pattern? → **Yes** CORRECT the condition that caused the abnormal wear. INSTALL new tire(s). TEST the system for normal operation. → **No** GO to **J4**.
J4 TIRE ROTATION DIAGNOSIS	
1  DF1713-A	1 Spin the tires slowly and watch for signs of lateral runout.
2  DF1714-A	2 Spin the tires slowly and watch for signs of radial runout. • Are there signs of visual runout? → **Yes** GO to **J5**. → **No** CHECK the wheel and tire balance. CORRECT as necessary. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)

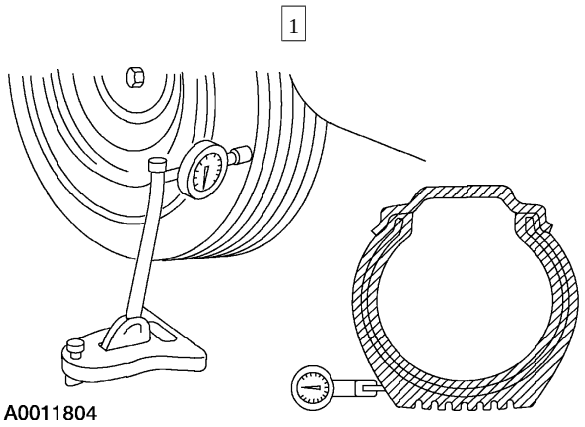
Pinpoint Test J: WHEEL AND TIRE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
J5 RADIAL RUNOUT CHECK ON THE TIRE	
1  DF1715-A	1 Measure the radial runout of the wheel and tire assembly. A typical specification for total radial runout is 0.045 inch. • Is the radial runout within specifications? → **Yes** GO to **J8**. → **No** GO to **J6**.
J6 RADIAL RUNOUT CHECK ON THE WHEEL	
	1 Measure the radial runout of the wheel. A typical specification for total radial runout is 0.045 inch. • Is the radial runout within specifications? → **Yes** INSTALL a new tire. TEST the system for normal operation. → **No** GO to **J7**.
J7 CHECK THE HUB/BRAKE DISC OR DRUM PILOT RUNOUT OR BOLT CIRCLE RUNOUT	
	1 Measure the pilot or bolt circle runout. A typical specification for radial runout is: • Pilot runout— less than 0.15 mm (0.006 inch). • Bolt circle runout— less than 0.38 mm (0.015 inch). • Is the radial runout within specifications? → **Yes** INSTALL a new wheel. TEST the system for normal operation. → **No** REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test J: WHEEL AND TIRE DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
J8 LATERAL RUNOUT CHECK ON THE TIRE	
	1 Measure the lateral runout of the wheel and tire assembly. A typical specification for total lateral runout is 1.14 mm (0.045 inch). • Is the lateral runout within specifications? → **Yes** Wheel and tires OK. CONDUCT diagnosis on other suspect systems. → **No** GO to **J9**.
J9 LATERAL RUNOUT CHECK ON THE WHEEL	
	1 Measure the lateral runout of the wheel. A typical specification for total radial runout is 1.14mm (0.045 inch. • Is the lateral runout within specifications? → **Yes** INSTALL a new tire. TEST the system for normal operation. → **No** GO to **J10**.
J10 CHECK THE FLANGE FACE LATERAL RUNOUT	
	1 Measure the flange face lateral runout. A typical specification for lateral runout is: • Hub/brake disc— less than 0.13 mm (0.005 inch). • Axle shaft— less than 0.25 mm (0.010 inch). • Is the lateral runout within specifications? → **Yes** INSTALL a new wheel. TEST the system for normal operation. → **No** REPAIR or INSTALL new components as necessary. REFER to the appropriate workshop manual for the service procedures.

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test K: HIGH SPEED SHAKE OR SHIMMY DIAGNOSIS

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
K1 CHECK FOR FRONT WHEEL BEARING ROUGHNESS	
	1 Chock the rear wheels. 2 Raise and support the front end of the vehicle so that the front wheel and tire assemblies can spin. Refer to the appropriate workshop manual for the service procedures. 3 Spin the front tires by hand. • Do the wheel bearings feel rough? → **Yes** INSPECT the wheel bearings. REPAIR as necessary. TEST the system for normal operation. → **No** GO to **K2**.
K2 CHECK THE END PLAY OF THE FRONT WHEEL BEARINGS	
	1 Check the end play of the front wheel bearings. Refer to the appropriate workshop manual for the service procedures. • Is the end play OK? → **Yes** GO to **K3**. → **No** ADJUST or REPAIR as necessary. TEST the system for normal operation.
K3 MEASURE THE LATERAL RUNOUT AND THE RADIAL RUNOUT OF THE FRONT WHEELS ON THE VEHICLE	
	1 Measure the lateral runout and the radial runout of the front wheels on the vehicle. Refer to the appropriate workshop manual for the service procedure. • Are the measurements within specifications? → **Yes** GO to **K4**. → **No** INSTALL new wheels as necessary and BALANCE the assembly. TEST the system for normal operation.

(Continued)

DIAGNOSIS AND TESTING (Continued)

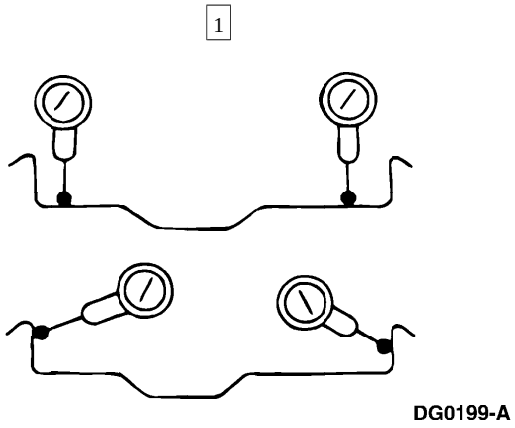
Pinpoint Test K: HIGH SPEED SHAKE OR SHIMMY DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
K4 MEASURE THE LATERAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE	
	1 Measure the lateral runout of the front tires on the vehicle. Refer to the appropriate workshop manual for the service procedures. • Is the runout within specifications? → **Yes** GO to **K5**. → **No** INSTALL new tires as necessary and BALANCE the assembly. TEST the system for normal operation.
K5 MEASURE THE RADIAL RUNOUT OF THE FRONT TIRES ON THE VEHICLE	
	1 Measure the radial runout of the front tires on the vehicle. Refer to the appropriate workshop manual for the service procedures. • Is the runout within specifications? → **Yes** BALANCE the front wheel and tire assemblies. If any tire cannot be balanced, INSTALL a new tire. TEST the system for normal operation. → **No** GO to **K6**.
K6 MATCH MOUNT THE TIRE AND WHEEL ASSEMBLY	
	1 Mark the high runout location on the tire and also on the wheel. Break the assembly down and rotate the tire 180 degrees (halfway around) on the wheel. Inflate the tire and measure the radial runout. • Is the runout within specifications? → **Yes** BALANCE the assembly. TEST the system for normal operation. → **No** If the high spot is not within 101.6 mm (4 inches) of the first high spot on the tire, GO to **K7**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test K: HIGH SPEED SHAKE OR SHIMMY DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
K7 MEASURE THE WHEEL FLANGE RUNOUT	
	1 Dismount the tire and mount the wheel on a wheel balancer. Measure the runout on both wheel flanges. Refer to the appropriate workshop manual for the service procedures. • Is the runout within specifications? → **Yes** LOCATE and MARK the low spot on the wheel. INSTALL the tire, matching the high spot on the tire with the low spot on the wheel. BALANCE the assembly. TEST the system for normal operation. If the condition persists, GO to **K8**. → **No** INSTALL a new wheel. CHECK the runout on the new wheel. If the new wheel is within limits, LOCATE and MARK the low spot. INSTALL the tire, matching the high spot on the tire with the low spot on the wheel. BALANCE the assembly. TEST the system for normal operation. If the condition persists, GO to **K8**.
K8 CHECK FOR VIBRATION FROM THE FRONT OF THE VEHICLE	
⚠ WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Spin the front wheel and tire assemblies with a wheel balancer while the vehicle is raised on a hoist. Feel for vibration in the front fender or while seated in the vehicle. • Is the vibration present? → **Yes** SUBSTITUTE known good wheel and tire assemblies as necessary. TEST the system for normal operation. → **No** GO to **K9**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test K: HIGH SPEED SHAKE OR SHIMMY DIAGNOSIS (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
K9 CHECK FOR VIBRATION FROM THE REAR OF THE VEHICLE	
⚠ WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Chock the front wheels. 2 Raise and support the rear end of the vehicle so that the rear wheel and tire assemblies can spin. Refer to the appropriate workshop manual for the service procedures. 3 Engage the drivetrain and carefully accelerate the drive wheels while checking for vibration. • Is the vibration present? → **Yes** GO to **K10**. → **No** TEST the system for normal operation.
K10 CHECK THE DRIVETRAIN	
⚠ WARNING: If only one drive wheel is allowed to rotate, speed must be limited to 55 km/h (34 mph) using the speedometer reading, since actual wheel speed will be twice that indicated on the speedometer. Exceeding a speed of 55 km/h (34 mph) or allowing the drive wheel to hang unsupported can result in tire disintegration or differential failure, which can cause serious personal injury and extensive vehicle damage.	
	1 Remove the rear wheel and tire assemblies. Refer to the appropriate workshop manual for the service procedures. 2 Secure the brake drums (if so equipped), by installing wheel hub bolt nuts, reversed. 3 Carefully accelerate the drivetrain while checking for vibration. • Is the vibration present? → **Yes** CHECK/TEST the drivetrain and driveline components. TEST the system for normal operation. → **No** SUBSTITUTE known good wheel and tire assemblies as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test L: CLUTCH VIBRATION

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
L1 CHECK ENGINE COMPONENTS FOR GROUNDING	
	1 **Note:** Make sure the clutch is the cause of the vibration concern. The vibration should occur during clutch operation. The clutch can also be difficult to engage or disengage. Eliminate all related systems before checking the clutch components. **Note:** Check the driveline angles and driveshaft runout before disassembling the clutch system. Refer to the appropriate workshop manual for the correct driveline angle specifications. Check the powertrain/drivetrain mounts, exhaust manifolds or other engine components for grounding on the chassis. • Are any mounts or engine components grounded? → **Yes** REPAIR as necessary. TEST the system for normal operation. → **No** GO to **L2**
L2 CHECK THE FEAD	
	1 Remove the FEAD belt. • Does the vibration stop with the FEAD belt removed? → **Yes** DIAGNOSE the front end accessory drive FEAD components. → **No** GO to **L3**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test L: CLUTCH VIBRATION (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
L3 CHECK FOR LOOSE CLUTCH PRESSURE PLATE BOLTS	
	1 Check for loose clutch pressure plate bolts. Inspect the clutch pressure plate for damage or for material between the pressure plate and flywheel. • Are there any loose bolts or damage? → **Yes** TIGHTEN the bolts to specifications or if damaged, INSTALL a new clutch pressure plate. REFER to the appropriate workshop manual for the service procedures. TEST the system for normal operation. → **No** GO to **L4**.
L4 CHECK THE CLUTCH DISC SPRINGS	
	1 Check for worn, broken or loose clutch disc springs. • Are the clutch springs worn, broken or loose? → **Yes** INSTALL a new clutch disc. TEST the system for normal operation. → **No** GO to **L5**.
L5 CHECK THE CLUTCH DISC SPLINES	
	1 Inspect the clutch disc splines for damage or wear. • Is there damage or wear? → **Yes** INSTALL a new clutch disc. TEST the system for normal operation. → **No** GO to **L6**.
L6 CHECK THE FLYWHEEL BOLTS	
	1 Check for loose flywheel bolts. • Are the bolts loose? → **Yes** TIGHTEN the bolts to specifications. TEST the system for normal operation. → **No** GO to **L7**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test L: CLUTCH VIBRATION (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
L7 CHECK THE FLYWHEEL SURFACE	
	1 Inspect the flywheel surface for wear or damage. Check the flywheel runout. • Is there any damage or excessive wear? → **Yes** INSTALL a new flywheel. TEST the system for normal operation. → **No** Clutch system normal. CONDUCT a diagnosis on other suspect systems.

Pinpoint Test M: TRANSFER CASE VIBRATION

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
M1 INSPECT THE TRANSFER CASE	
	1 ⚠ **WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.** Inspect the transfer case for loose or missing mounting bolts. Check for fluid seepage between the transfer case and the transmission. • Are the mounting bolts missing or loose? → **Yes** TIGHTEN to specifications or INSTALL new bolts as necessary. TEST the system for normal operation. → **No** GO to **M2**.
M2 INSPECT THE REAR DRIVESHAFT	
	1 **Note:** Verify that the driveshaft and pinion flange index marks are aligned. Inspect the driveshaft for missing weights, damage or undercoating. 2 Inspect the U-joints for freedom of movement.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test M: TRANSFER CASE VIBRATION (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
M2 INSPECT THE REAR DRIVESHAFT (Continued)	
	3 Check driveshaft runout and, if necessary, check the pinion flange runout. • Is the driveshaft or U-joints worn or damaged or misaligned? → **Yes** REPAIR or INSTALL a new driveshaft as necessary. TEST the system for normal operation. → **No** GO to **M3**.
M3 CHECK THE DRIVELINE ANGLES	
	1 Measure the rear driveshaft and pinion angles. Refer to the appropriate workshop manual for the service procedures. 2 Measure the front driveshaft and pinion angles. Refer to the appropriate workshop manual for the service procedures. • Are the driveline angles incorrect? → **Yes** REPAIR as necessary. TEST the system for normal operation. → **No** GO to **M4**.
M4 INSPECT THE FRONT DRIVESHAFT	
	1 **Note:** Verify that the driveshaft and pinion flange index marks are aligned. Inspect the front driveshaft for missing weights, damage or undercoating. 2 Inspect the U-joints and slip yoke for freedom of movement.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test M: TRANSFER CASE VIBRATION (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
M4 INSPECT THE FRONT DRIVESHAFT (Continued)	
	3 Check driveshaft runout and, if necessary, check the pinion flange runout. • Is the driveshaft or U-joints worn or damaged? → **Yes** REPAIR or INSTALL a new driveshaft as necessary. TEST the system for normal operation. → **No** GO to **M5**.
M5 ROAD TEST WITH THE FRONT DRIVESHAFT ONLY	
	1 **Note:** Index mark the driveshaft to the pinion flange and to the output shaft before removal. Remove the rear driveshaft. 2 Plug the transfer case with an output shaft seal plug. 3 **Note:** Shift the transfer case into 4WD high so the vehicle is driven by the front driveshaft only. Test drive the vehicle. • Is the vibration gone? → **Yes** INSTALL and BALANCE the rear driveshaft. TEST the system for normal operation. → **No** GO to **M6**.

(Continued)

DIAGNOSIS AND TESTING (Continued)

Pinpoint Test M: TRANSFER CASE VIBRATION (Continued)

TEST CONDITIONS	TEST DETAILS/RESULTS/ACTIONS
M6 ROAD TEST WITH THE REAR DRIVESHAFT ONLY	
	1 **Note:** Index mark the front driveshaft to the pinion flange. Remove the front driveshaft. 2 Test drive the vehicle. • Is the vibration gone? → **Yes** INSTALL and BALANCE the front driveshaft. TEST the system for normal operation. → **No** GO to **M7**.
M7 TRANSFER CASE TAIL SHAFT INSPECTION	
	1 Inspect the splines of the output shaft for wear or damage. 2 Inspect the splines of the driveshaft slip yoke for wear or damage. • Are the splines worn or damaged? → **Yes** REPAIR or INSTALL new components as necessary. TEST the system for normal operation. → **No** The transfer case is OK. CONDUCT a diagnosis on other suspect systems.

Component Tests

Idle Speed Air Control Valve (ISACV)

1. Open the hood.
2. **Note:** Key symptom is elevated idle speed while noise is occurring.

   Note: ''Snapping'' the throttle can induce the noise.

   Verify the condition by operating the vehicle for a short time.
3. Inspect the ISACV. If physical evidence of contamination exists, install a new ISACV.
4. While the noise is occurring, either place an EngineEAR probe near the ISACV and the inlet tube, or create a 6.35 mm (0.25 in)-12.7 mm (0.50 in) air gap between the inlet tube and the clean air tube. If the ISACV is making the noise, install a new ISACV.
5. Test the vehicle for normal operation.

Steering Gear Grunt/Shudder Test

1. Start and run the vehicle to operating temperature.
2. Set engine idle speed to 1200 rpm.

DIAGNOSIS AND TESTING (Continued)

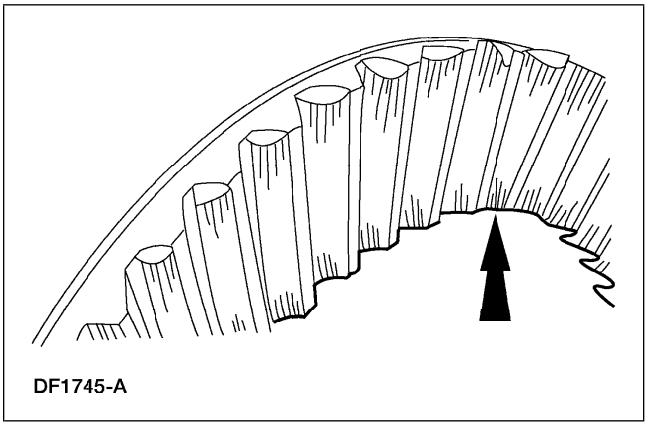
3. ⚠ **CAUTION: Do not hold the steering wheel against the stops for more than three to five seconds at a time. Damage to the power steering pump will occur.**

   Rotate the steering wheel to the RH stop, then turn the steering wheel 90° back from that position. Turn the steering wheel slowly in a 15° to 30° arc.
4. Turn the steering wheel another 90°. Turn the steering wheel slowly in a 15° to 30° arc.
5. Repeat the test with power steering fluid at different temperatures.
6. If a light grunt is heard or a low (50-200 Hz) shudder is present, this is a normal steering system condition.

Checking Tooth Contact Pattern and Condition of the Ring and Pinion

There are two basic types of conditions that will produce ring and pinion noise. The first type is a howl or chuckle produced by broken, cracked, chipped, scored or forcibly damaged gear teeth and is usually quite audible over the entire speed range. The second type of ring and pinion noise pertains to the mesh pattern of the gear pattern. This gear noise can be recognized as it produces a cycling pitch or whine. Ring and pinion noise tends to peak in a narrow speed range or ranges, and will tend to remain constant in pitch.

1. Raise and support the vehicle.
2. Drain the axle lubricant. Refer to the appropriate workshop manual for the draining procedures.
3. Remove the carrier assembly or the axle housing cover depending on the axle type. Refer to the appropriate workshop manual for the service procedures.
4. Inspect the gear set for scoring or damage.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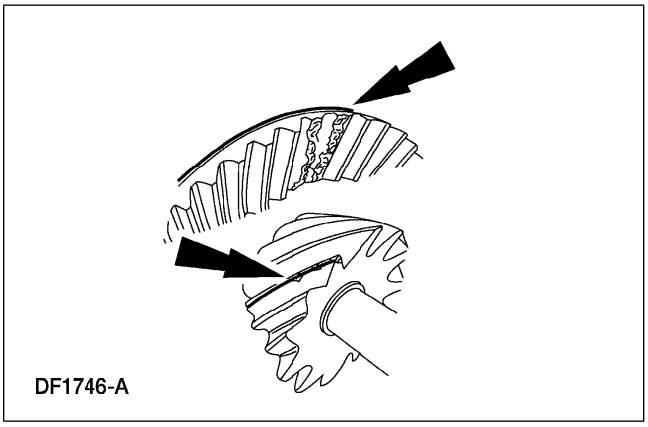
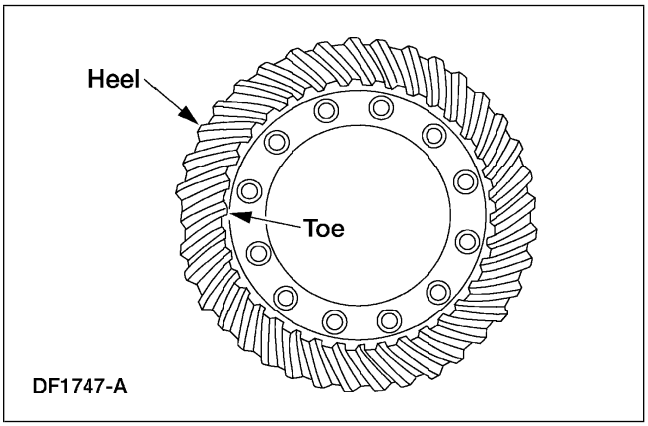

DF1746-A

5. In the following steps, the movement of the contact pattern along the length is indicated as toward the‘‘ heel’’ or ‘‘toe’’ of the differential ring gear.

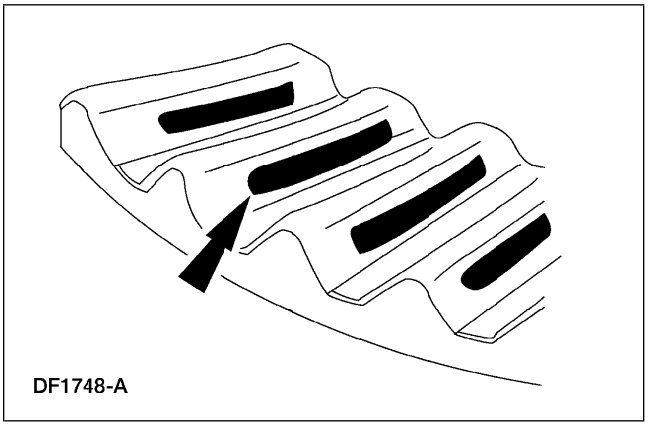


DF1747-A

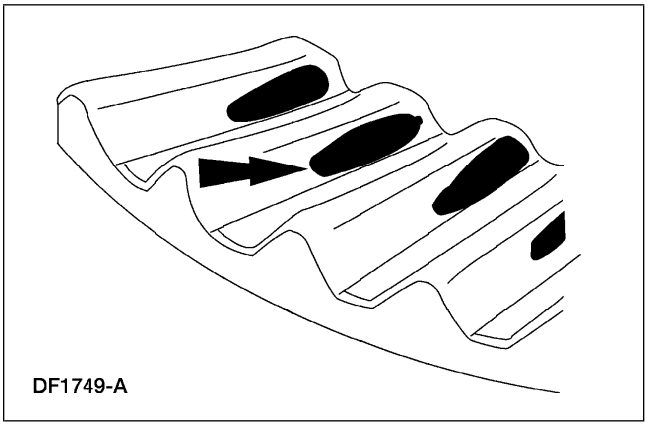
6. Apply a marking compound to a third of the gear teeth on the differential ring gear. Rotate the differential ring gear several complete turns in both directions until a good, clear tooth pattern is obtained. Inspect the contact patterns on the ring gear teeth.

DIAGNOSIS AND TESTING (Continued)

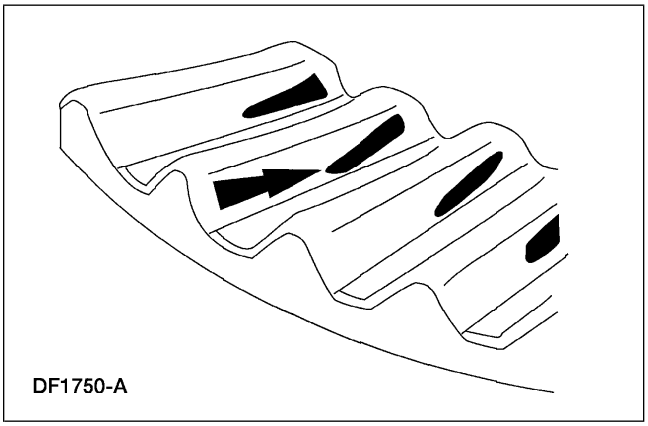
7. A good contact pattern should be centered on the tooth. It can also be slightly toward the toe. There should always be some clearance between the contact pattern and the top of the tooth.
   - Tooth contact pattern shown on the drive side of the gear teeth.



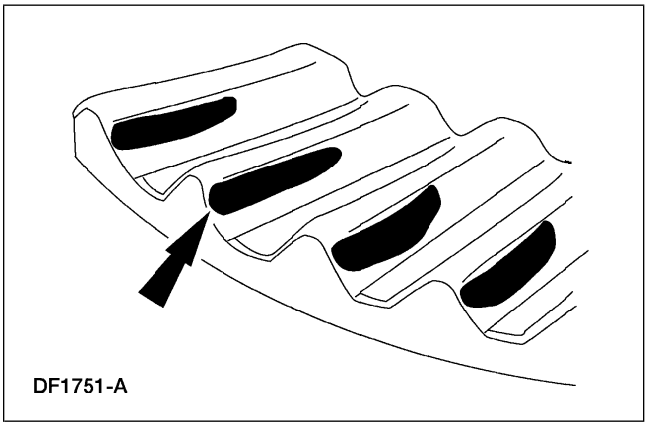
8. A high, thick contact pattern that is worn more toward the toe.
   - Tooth contact pattern shown on the drive side of the gear teeth.
   - The high contact pattern indicates that the drive pinion is not installed deep enough into the carrier.
   - The differential ring gear backlash is correct, a thinner drive pinion shim is needed. A decrease will move the drive pinion toward the differential ring gear.



9. A high, thin contact pattern that is worn toward the toe.
   - Tooth contact pattern shown on the drive side of the gear teeth.
   - The drive pinion depth is correct. Increase the differential ring gear backlash.

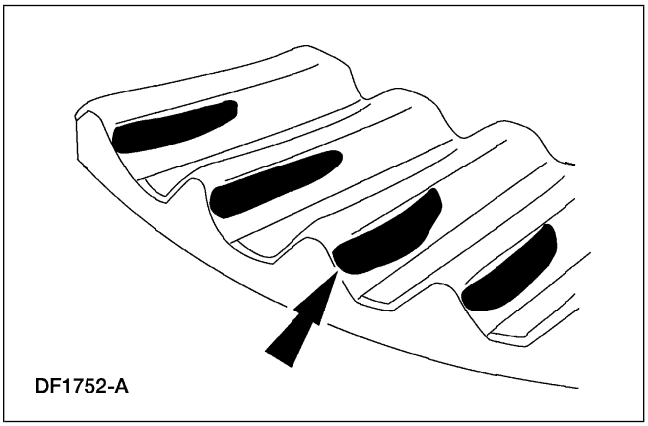


10. A contact pattern that is worn in the center of the differential ring gear tooth toward the heel.
    - Tooth contact pattern shown on the drive side of the gear teeth.
    - The low contact pattern indicates that the drive pinion is installed too deep into the carrier.
    - The differential ring gear backlash is correct. A thicker drive pinion shim is needed.



DIAGNOSIS AND TESTING (Continued)

11. A contact pattern that is worn at the top of the differential ring gear tooth toward the heel.
    - Tooth contact pattern shown on the drive side of the gear teeth.
    - The pinion gear depth is correct. Decrease the differential ring gear backlash.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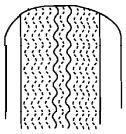
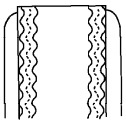
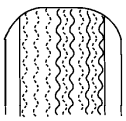
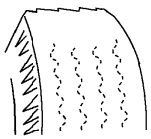
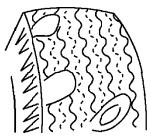
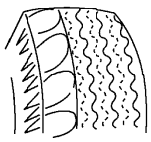
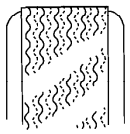
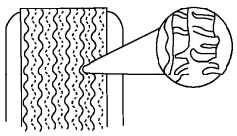
DIAGNOSIS AND TESTING (Continued)

Tire Wear Patterns and frequency calculations

Tire Wear Chart

TIRE WEAR	CONDITION	POSSIBLE CAUSES
	• Rapid wear at both shoulders.	• Tires underinflated. • Worn suspension components. • Excessive cornering speeds. • Lack of rotation.
	• Rapid wear at the center.	• Tires overinflated. • Lack of rotation. • Excessive toe on drive wheels. • Heavy acceleration on drive wheels.
	• Wear at one shoulder.	• Toe adjustment out of specification. • Camber out of specification. • Damaged strut. • Damaged lower control arm.
	• Feather edges.	• Toe adjustment out of specification. • Damaged or worn tie rods. • Damaged spindle or knuckle.
	• Bald spots or cupping.	• Unbalanced wheel. • Excessive radial runout. • Worn strut or shock absorber.
	• Tire scalloped.	• Toe adjustment out of specification. • Camber out of specification. • Worn or damaged suspension components.
	• Wear pattern - FWD vehicles.	• Excessive toe on non-drive wheels. • Lack of rotation.
	• Wear pattern - FWD vehicles. Edge of thread blocks worn.	• Excessive toe on non-drive wheels. • Lack of rotation.

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DIAGNOSIS AND TESTING (Continued)

Wheel and tire NVH concerns are directly related to vehicle speed and are not generally affected by acceleration, coasting or decelerating. Also, out-of-balance wheel and tires can vibrate at more than one speed. A vibration that is affected by the engine rpm, or is eliminated by placing the transmission in NEUTRAL is not related to the tire and wheel. As a general rule, tire and wheel vibrations felt in the steering wheel are related to the front tire and wheel assemblies. Vibrations felt in the seat or floor are related to the rear tire and wheel assemblies. This can initially isolate a concern to the front or rear.

Careful attention must be paid to the tire and wheels. There are several symptoms that can be caused by damaged or worn tire and wheels. Carry out a careful visual inspection of the tires and wheel assemblies. Spin the tires slowly and watch for signs of lateral or radial runout. Refer to the tire wear chart to determine the tire wear conditions and actions.

For a vibration concern, use the vehicle speed to determine tire/wheel frequency and rpm. Calculate tire and wheel rpm and frequency by carrying out and following:

- Measure the diameter of the tire.
- Record the speed at which the vibration occurs.
- Obtain the corresponding tire and wheel rpm and frequency from the Tire Speed and Frequency Chart.
  - — If the vehicle speed is not listed, divide the vehicle speed at which the vibration occurs by 16 (km/h (10 mph). Multiply that number by 16 km/h (10 mph) tire rpm listed for that tire diameter in the chart. Then divide that number by 60. For example: a 40 mph vibration with 835 mm (33 in) tires. 40 ÷10 = 4. Multiply 4 by 105 = 420 rpm. Divide 420 rpm by 60 seconds = 7 Hz at 40mph.

Tire Speed and Frequency Chart

Tire Diameter	Tire RPM/Hz	Tire RPM/Hz	Tire RPM/Hz	Tire RPM/Hz
mm (inch)	@ 16 km/h (10 mph)	@ 80 km/h (50 mph)	@ 97 km/h (60 mph)	@ 113 km/h (70 mph)
483 (19)	182	910/15	1092/18	1274/21
508 (20)	173	865/14	1038/17	1211/20
533 (21)	165	825/14	990/16	1155/19
560 (22)	158	790/13	948/16	1106/18
585 (23)	151	755/13	906/15	1057/18
610 (24)	145	725/12	870/14	1015/17
635 (25)	139	695/12	834/14	973/16
660 (26)	134	670/11	804/13	938/16
685 (27)	129	645/11	774/13	903/15
710 (28)	124	620/10	744/12	868/14
735 (29)	119	595/10	714/12	833/14
760 (30)	115	575/10	690/11	805/13
785 (31)	111	555/9	666/11	777/13
810 (32)	108	540/9	648/11	756/13
835 (33)	105	525/9	630/10	735/12
864 (34)	102	510/8	612/10	714/12

GENERAL PROCEDURES

Powertrain/Drivetrain Mount Neutralizing

⚠ WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.

1. Raise and support the vehicle.
2. Loosen, but do not remove, the powertrain/drivetrain mount fasteners.
3. Lower the vehicle.
4. **⚠ CAUTION: Do not twist or strain the powertrain/drivetrain mounts.**
   Move the vehicle in forward and reverse (2-4 ft).
5. Raise and support the vehicle.
6. Tighten the powertrain/drivetrain mount fasteners.
7. Lower the vehicle.
8. Test the system for normal operation.

Exhaust System Neutralizing

⚠ WARNING: Exhaust gases contain carbon monoxide, which is harmful to health and potentially lethal. Repair exhaust system leaks immediately. Never operate the engine in an enclosed area.

⚠ WARNING: Exhaust system components are hot.

Note: Neutralize the exhaust system to relieve strain on mounts which can be sufficiently bound up to transmit vibration as if grounded.

GENERAL PROCEDURES (Continued)

1. **⚠ WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.**

   ⚠ CAUTION: Make sure the system is warmed up to normal operating temperature, as thermal expansion can be the cause of a strain problem.

   Raise and support the vehicle.

2. Loosen all exhaust hanger attachments and reposition the hangers until they hang free and straight.

3. Loosen all exhaust flange joints.

4. Place a stand to support the muffler parallel to the vehicle frame with the muffler pipe bracket free of stress.

5. Tighten the muffler connection.

6. Tighten all the exhaust hanger clamps and flanges (tighten the exhaust manifold flange joint last).
   - Verify there is adequate clearance to prevent grounding at any point in the system. Make sure that the catalytic converter and heat shield do not contact the frame rails.
   - After neutralization, the rubber in the exhaust hangers should show some flexibility when movement is applied to the exhaust system.
   - With the exhaust system installed securely and cooled, the rear hanger should be angled forward.

7. Lower the vehicle.

8. Test the exhaust system for normal operation.

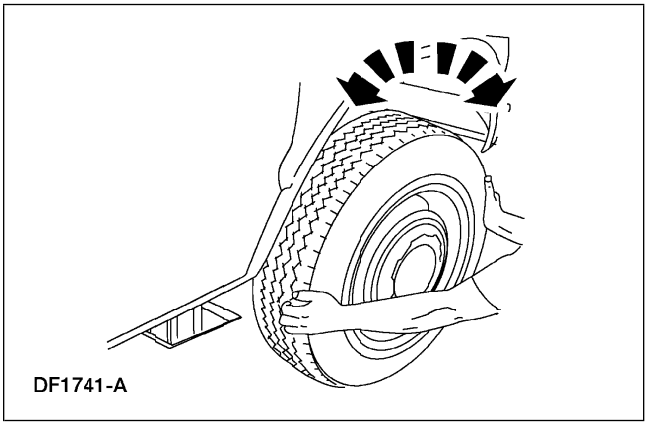
GENERAL PROCEDURES (Continued)

Wheel Bearing Check

1. ⚠ **WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch. Failure to do so can result in unexpected inflation or deflation of the air springs, which can result in shifting of the vehicle during these operations.**

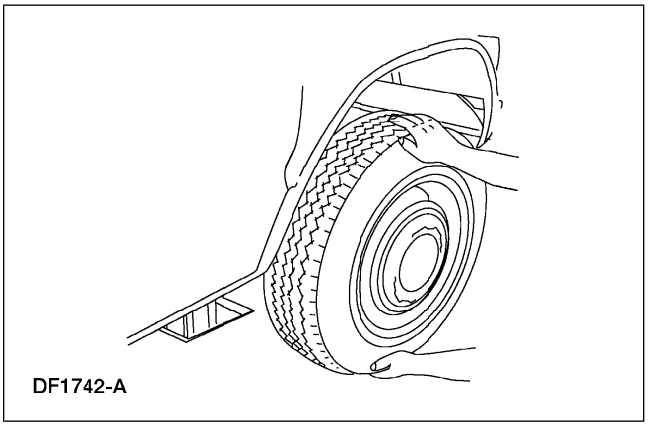
   Raise the vehicle until the front tires are off the floor.

   - Make sure the wheels are in a straight forward position.



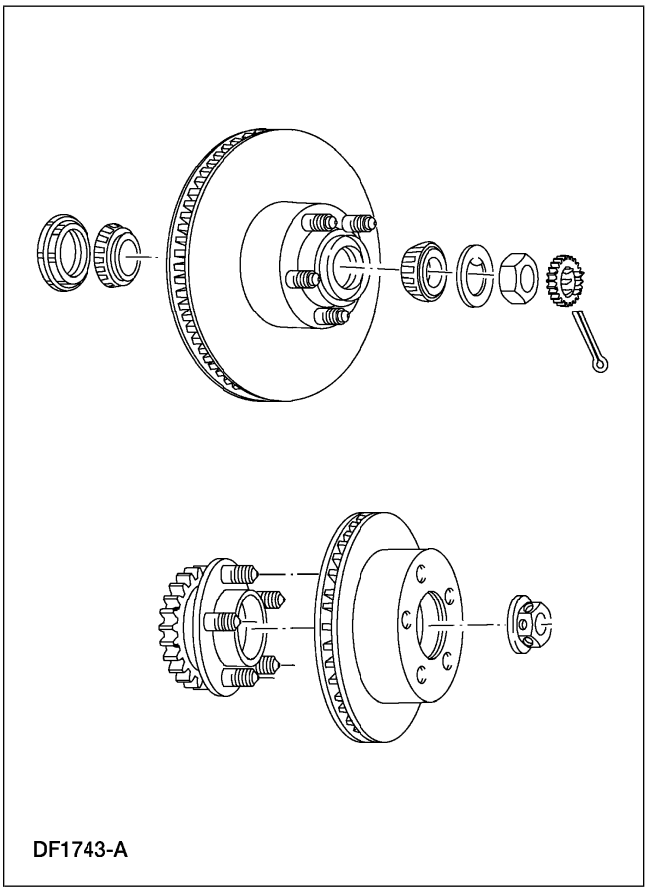
2. **Note:** Make sure the wheel rotates freely and that the brake pads are retraced sufficiently to allow free movement of the tire and wheel assembly.

   Spin the tire by hand to check the wheel bearings for roughness.



3. Grip each front tire at the top and bottom and move the wheel inward and outward while lifting the weight of the tire off the front wheel bearing.

GENERAL PROCEDURES (Continued)



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4. If the tire and wheel (hub) is loose on the spindle, does not rotate freely, or has a rough feeling when spun, carry out one of the following:
   - On vehicles with inner and outer bearings, inspect the bearings and cups for wear or damage. Adjust or install new bearings and cups as necessary.
   - On vehicles with one sealed bearing, install a new wheel hub. Refer to the appropriate workshop manual for the service procedures.