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TROUBLE- SHOOTING

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11-2 TROUBLESHOOTING

Condition

Section/Item Number

The following troubleshooting charts are divided into 7 sections covering engine, drive train, brakes, wheels/tires/steering/suspension, electrical accessories, instruments and gauges, and climate control. The first portion (or index) consists of a list of symptoms, along with section and item numbers. After selecting the appropriate condition, refer to the corresponding diagnostic procedure in the second portion's specified location.

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Condition

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Condition

Section/Item Number

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DIAGNOSTIC PROCEDURES

1. ENGINE

1-A. Engine Starting Problems

Gasoline Engines

1. Engine turns over, but will not start

- a. Check fuel level in fuel tank, add fuel if empty.
- b. Check battery condition and state of charge. If voltage and load test below specification, charge or replace battery.
- c. Check battery terminal and cable condition and tightness. Clean terminals and replace damaged, worn or corroded cables.
- d. Check fuel delivery system. If fuel is not reaching the fuel injectors, check for a loose electrical connector or defective fuse, relay or fuel pump and replace as necessary.
- e. Engine may have excessive wear or mechanical damage such as low cylinder cranking pressure, a broken camshaft drive system, insufficient valve clearance or bent valves.
- f. Check for fuel contamination such as water in the fuel. During winter months, the water may freeze and cause a fuel restriction. Adding a fuel additive may help, however the fuel system may require draining and purging with fresh fuel.
- g. Check for ignition system failure. Check for loose or shorted wires or damaged ignition system components. Check the spark plugs for excessive wear or incorrect electrode gap. If the problem is worse in wet weather, check for shorts between the spark plugs and the ignition coils.
- h. Check the engine management system for a failed sensor or control module.

2. Engine does not turn over when attempting to start

- a. Check the battery state of charge and condition. If the dash lights are not visible or very dim when turning the ignition key on, the battery has either failed internally or discharged, the battery cables are loose, excessively corroded or damaged, or the alternator has failed or internally shorted, discharging the battery. Charge or replace the battery, clean or replace the battery cables, and check the alternator output.
- b. Check the operation of the neutral safety switch. On automatic transmission vehicles, try starting the vehicle in both Park and Neutral. On manual transmission vehicles, depress the clutch pedal and attempt to start. On some vehicles, these switches can be adjusted. Make sure the switches or wire connectors are not loose or damaged. Replace or adjust the switches as necessary.
- c. Check the starter motor, starter solenoid or relay, and starter motor cables and wires. Check the ground from the engine to the chassis. Make sure the wires are not loose, damaged, or corroded. If battery voltage is present at the starter relay, try using a remote starter to start the vehicle for test purposes only. Replace any damaged or corroded cables, in addition to replacing any failed components.
- d. Check the engine for seizure. If the engine has not been started for a long period of time, internal parts such as the rings may have rusted to the cylinder walls. The engine may have suffered

internal damage, or could be hydro-locked from ingesting water. Remove the spark plugs and carefully attempt to rotate the engine using a suitable breaker bar and socket on the crankshaft pulley. If the engine is resistant to moving, or moves slightly and then binds, do not force the engine any further before determining the problem.

3. Engine stalls immediately when started

- a. Check the ignition switch condition and operation. The electrical contacts in the run position may be worn or damaged. Try restarting the engine with all electrical accessories in the off position. Sometimes turning the key on an off will help in emergency situations, however once the switch has shown signs of failure, it should be replaced as soon as possible.
- b. Check for loose, corroded, damaged or shorted wires for the ignition system and repair or replace.
- c. Check for manifold vacuum leaks or vacuum hose leakage and repair or replace parts as necessary.
- d. Measure the fuel pump delivery volume and pressure. Low fuel pump pressure can also be noticed as a lack of power when accelerating. Make sure the fuel pump lines are not restricted. The fuel pump output is not adjustable and requires fuel pump replacement to repair.
- e. Check the engine fuel and ignition management system. Inspect the sensor wiring and electrical connectors. A dirty, loose or damaged sensor or control module wire can simulate a failed component.
- f. Check the exhaust system for internal restrictions.

4. Starter motor spins, but does not engage

- a. Check the starter motor for a seized or binding pinion gear.
- b. Remove the flywheel inspection plate and check for a damaged ring gear.

5. Engine is difficult to start when cold

- a. Check the battery condition, battery state of charge and starter motor current draw. Replace the battery if marginal and the starter motor if the current draw is beyond specification.
- b. Check the battery cable condition. Clean the battery terminals and replace corroded or damaged cables.
- c. Check the fuel system for proper operation. A fuel pump with insufficient fuel pressure or clogged injectors should be replaced.
- d. Check the engine's tune-up status. Note the tune-up specifications and check for items such as severely worn spark plugs; adjust or replace as needed. On vehicles with manually adjusted valve clearances, check for tight valves and adjust to specification.
- e. Check for a failed coolant temperature sensor, and replace if out of specification.
- f. Check the operation of the engine management systems for fuel and ignition; repair or replace failed components as necessary.

11-8 TROUBLESHOOTING

6. Engine is difficult to start when hot

- a. Check the air filter and air intake system. Replace the air filter if it is dirty or contaminated. Check the fresh air intake system for restrictions or blockage.
- b. Check for loose or deteriorated engine grounds and clean, tighten or replace as needed.
- c. Check for needed maintenance. Inspect tune-up and service related items such as spark plugs and engine oil condition, and check the operation of the engine fuel and ignition management system.

Diesel Engines

1. Engine turns over but won't start

- a. Check engine starting procedure and restart engine.
- b. Check the glow plug operation and repair or replace as necessary.
- c. Check for air in the fuel system or fuel filter and bleed the air as necessary.
- d. Check the fuel delivery system and repair or replace as necessary.
- e. Check fuel level and add fuel as needed.
- f. Check fuel quality. If the fuel is contaminated, drain and flush the fuel tank.
- g. Check engine compression. If compression is below specification, the engine may need to be renewed or replaced.
- h. Check the injection pump timing and set to specification.
- i. Check the injection pump condition and replace as necessary.
- j. Check the fuel nozzle operation and condition or replace as necessary.

2. Engine does not turn over when attempting to start

- a. Check the battery state of charge and condition. If the dash lights are not visible or very dim when turning the ignition key on, the battery has either failed internally or discharged, the battery cables are loose, excessively corroded or damaged, or the alternator has failed or internally shorted, discharging the battery. Charge or replace the battery, clean or replace the battery cables, and check the alternator output.
- b. Check the operation of the neutral safety switch. On automatic transmission vehicles, try starting the vehicle in both Park and Neutral. On manual transmission vehicles, depress the clutch pedal and attempt to start. On some vehicles, these switches can be adjusted. Make sure the switches or wire connectors are not loose or damaged. Replace or adjust the switches as necessary.
- c. Check the starter motor, starter solenoid or relay, and starter motor cables and wires. Check the ground from the engine to the chassis. Make sure the wires are not loose, damaged, or corroded. If battery voltage is present at the starter relay, try using a remote starter to start the vehicle for test purposes only. Replace any damaged or corroded cables, in addition to replacing any failed components.
- d. Check the engine for seizure. If the engine has not been started for a long period of time, internal parts such as the rings may have rusted to the cylinder walls. The engine may have suffered internal damage, or could be hydro-locked from ingesting water. Remove the injectors and carefully attempt to rotate the engine

using a suitable breaker bar and socket on the crankshaft pulley. If the engine is resistant to moving, or moves slightly and then binds, do not force the engine any further before determining the cause of the problem.

3. Engine stalls after starting

- a. Check for a restriction in the fuel return line or the return line check valve and repair as necessary.
- b. Check the glow plug operation for turning the glow plugs off too soon and repair as necessary.
- c. Check for incorrect injection pump timing and reset to specification.
- d. Test the engine fuel pump and replace if the output is below specification.
- e. Check for contaminated or incorrect fuel. Completely flush the fuel system and replace with fresh fuel.
- f. Test the engine's compression for low compression. If below specification, mechanical repairs are necessary to repair.
- g. Check for air in the fuel. Check fuel tank fuel and fill as needed.
- h. Check for a failed injection pump. Replace the pump, making sure to properly set the pump timing.

4. Starter motor spins, but does not engage

- a. Check the starter motor for a seized or binding pinion gear.
- b. Remove the flywheel inspection plate and check for a damaged ring gear.

1-B. Engine Running Conditions

Gasoline Engines

1. Engine runs poorly, hesitates

- a. Check the engine ignition system operation and adjust if possible, or replace defective parts.
- b. Check for restricted fuel injectors and replace as necessary.
- c. Check the fuel pump output and delivery. Inspect fuel lines for restrictions. If the fuel pump pressure is below specification, replace the fuel pump.
- d. Check the operation of the engine management system and repair as necessary.

2. Engine lacks power

- a. Check the engine's tune-up status. Note the tune-up specifications and check for items such as severely worn spark plugs; adjust or replace as needed. On vehicles with manually adjusted valve clearances, check for tight valves and adjust to specification.
- b. Check the air filter and air intake system. Replace the air filter if it is dirty or contaminated. Check the fresh air intake system for restrictions or blockage.
- c. Check the operation of the engine fuel and ignition management systems. Check the sensor operation and wiring. Check for low fuel pump pressure and repair or replace components as necessary.
- d. Check the throttle linkage adjustments. Check to make sure the linkage is fully opening the throttle. Replace any worn or defective bushings or linkages.

- e. Check for a restricted exhaust system. Check for bent or crimped exhaust pipes, or internally restricted mufflers or catalytic converters. Compare inlet and outlet temperatures for the converter or muffler. If the inlet is hot, but outlet cold, the component is restricted.
- f. Check for a loose or defective knock sensor. A loose, improperly torqued or defective knock sensor will decrease spark advance and reduce power. Replace defective knock sensors and install using the recommended torque specification.
- g. Check for engine mechanical conditions such as low compression, worn piston rings, worn valves, worn camshafts and related parts. An engine which has severe mechanical wear, or has suffered internal mechanical damage must be rebuilt or replaced to restore lost power.
- h. Check the engine oil level for being overfilled. Adjust the engine's oil level, or change the engine oil and filter, and top off to the correct level.
- i. Check for an intake manifold or vacuum hose leak. Replace leaking gaskets or worn vacuum hoses.
- j. Check for dragging brakes and replace or repair as necessary.
- k. Check tire air pressure and tire wear. Adjust the pressure to the recommended settings. Check the tire wear for possible alignment problems causing increased rolling resistance, decreased acceleration and increased fuel usage.
- l. Check the octane rating of the fuel used during refilling, and use a higher octane rated fuel.

3. Poor fuel economy

- a. Inspect the air filter and check for any air restrictions going into the air filter housing. Replace the air filter if it is dirty or contaminated.
- b. Check the engine for tune-up and related adjustments. Replace worn ignition parts, check the engine ignition timing and fuel mixture, and set to specifications if possible.
- c. Check the tire size, tire wear, alignment and tire pressure. Large tires create more rolling resistance, smaller tires require more engine speed to maintain a vehicle's road speed. Excessive tire wear can be caused by incorrect tire pressure, incorrect wheel alignment or a suspension problem. All of these conditions create increased rolling resistance, causing the engine to work harder to accelerate and maintain a vehicle's speed.
- d. Inspect the brakes for binding or excessive drag. A sticking brake caliper, overly adjusted brake shoe, broken brake shoe return spring, or binding parking brake cable or linkage can create a significant drag, brake wear and loss of fuel economy. Check the brake system operation and repair as necessary.

4. Engine runs on (diesels) when turned off

- a. Check for idle speed set too high and readjust to specification.
- b. Check the operation of the idle control valve, and replace if defective.
- c. Check the ignition timing and adjust to recommended settings. Check for defective sensors or related components and replace if defective.
- d. Check for a vacuum leak at the intake manifold or vacuum hose and replace defective gaskets or hoses.
- e. Check the engine for excessive carbon build-up in the combus-

- tion chamber. Use a recommended decarbonizing fuel additive or disassemble the cylinder head to remove the carbon.
- f. Check the operation of the engine fuel management system and replace defective sensors or control units.
- g. Check the engine operating temperature for overheating and repair as necessary.

5. Engine knocks and pings during heavy acceleration, and on steep hills

- a. Check the octane rating of the fuel used during refilling, and use a higher octane rated fuel.
- b. Check the ignition timing and adjust to recommended settings. Check for defective sensors or related components and replace if defective.
- c. Check the engine for excessive carbon build-up in the combustion chamber. Use a recommended decarbonizing fuel additive or disassemble the cylinder head to remove the carbon.
- d. Check the spark plugs for the correct type, electrode gap and heat range. Replace worn or damaged spark plugs. For severe or continuous high speed use, install a spark plug that is one heat range colder.
- e. Check the operation of the engine fuel management system and replace defective sensors or control units.
- f. Check for a restricted exhaust system. Check for bent or crimped exhaust pipes, or internally restricted mufflers or catalytic converters. Compare inlet and outlet temperatures for the converter or muffler. If the inlet is hot, but outlet cold, the component is restricted.

6. Engine accelerates, but vehicle does not gain speed

- a. On manual transmission vehicles, check for causes of a slipping clutch. Refer to the clutch troubleshooting section for additional information.
- b. On automatic transmission vehicles, check for a slipping transmission. Check the transmission fluid level and condition. If the fluid level is too high, adjust to the correct level. If the fluid level is low, top off using the recommended fluid type. If the fluid exhibits a burning odor, the transmission has been slipping internally. Changing the fluid and filter may help temporarily, however in this situation a transmission may require overhauling to ensure long-term reliability.

Diesel Engines

1. Engine runs poorly

- a. Check the injection pump timing and adjust to specification.
- b. Check for air in the fuel lines or leaks, and bleed the air from the fuel system.
- c. Check the fuel filter, fuel feed and return lines for a restriction and repair as necessary.
- d. Check the fuel for contamination, drain and flush the fuel tank and replenish with fresh fuel.

2. Engine lacks power

- a. Inspect the air intake system and air filter for restrictions and, if necessary, replace the air filter.
- b. Verify the injection pump timing and reset if out of specification.

- c. Check the exhaust for an internal restriction and replace failed parts.
- d. Check for a restricted fuel filter and, if restricted, replace the filter.
- e. Inspect the fuel filler cap vent. When removing the filler cap, listen for excessive hissing noises indicating a blockage in the fuel filler cap vents. If the filler cap vents are blocked, replace the cap.
- f. Check the fuel system for restrictions and repair as necessary.
- g. Check for low engine compression and inspect for external leakage at the glow plugs or nozzles. If no external leakage is noted, repair or replace the engine.

ENGINE PERFORMANCE TROUBLESHOOTING HINTS

When troubleshooting an engine running or performance condition, the mechanical condition of the engine should be determined *before* lengthy troubleshooting procedures are performed.

The engine fuel management systems in fuel injected vehicles rely on electronic sensors to provide information to the engine control unit for precise fuel metering. Unlike carburetors, which use the incoming air speed to draw fuel through the fuel metering jets in order to provide a proper fuel-to-air ratio, a fuel injection system provides a specific amount of fuel which is introduced by the fuel injectors into the intake manifold or intake port, based on the information provided by electronic sensors.

The sensors monitor the engine's operating temperature, ambient temperature and the amount of air entering the engine, engine speed and throttle position to provide information to the engine control unit, which, in turn, operates the fuel injectors by electrical pulses. The sensors provide information to the engine control unit using low voltage electrical signals. As a result, an unplugged sensor or a poor electrical contact could cause a poor running condition similar to a failed sensor.

When troubleshooting a fuel related engine condition on fuel injected vehicles, carefully inspect the wiring and electrical connectors to the related components. Make sure the electrical connectors are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts should not be used, as they could leave a surface film or damage the insulation of the wiring.

The engine electrical system provides the necessary electrical power to operate the vehicle's electrical accessories, electronic control units and sensors. Because engine management systems are sensitive to voltage changes, an alternator which over or under-charges could cause engine running problems or component failure. Most alternators utilize internal voltage regulators which cannot be adjusted and must be replaced individually or as a unit with the alternator.

Ignition systems may be controlled by, or linked to, the engine fuel management system. Similar to the fuel injection system, these ignition systems rely on electronic sensors for information to determine the optimum ignition timing for a given engine speed and load. Some ignition systems no longer allow the ignition timing to be adjusted. Feedback from low voltage electrical sensors provide information to the control unit to determine the amount of ignition advance. On these systems, if a failure occurs the failed component must be replaced. Before replacing suspected failed electrical com-

ponents, carefully inspect the wiring and electrical connectors to the related components. Make sure the electrical connectors are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts should be avoided, as they could leave a surface film or damage the insulation of the wiring.

1-C. Engine Noises, Odors and Vibrations

1. Engine makes a knocking or pinging noise when accelerating

- a. Check the octane rating of the fuel being used. Depending on the type of driving or driving conditions, it may be necessary to use a higher octane fuel.
- b. Verify the ignition system settings and operation. Improperly adjusted ignition timing or a failed component, such as a knock sensor, may cause the ignition timing to advance excessively or prematurely. Check the ignition system operation and adjust, or replace components as needed.
- c. Check the spark plug gap, heat range and condition. If the vehicle is operated in severe operating conditions or at continuous high speeds, use a colder heat range spark plug. Adjust the spark plug gap to the manufacturer's recommended specification and replace worn or damaged spark plugs.

2. Starter motor grinds when used

- a. Examine the starter pinion gear and the engine ring gear for damage, and replace damaged parts.
- b. Check the starter mounting bolts and housing. If the housing is cracked or damaged replace the starter motor and check the mounting bolts for tightness.

3. Engine makes a screeching noise

- a. Check the accessory drive belts for looseness and adjust as necessary.
- b. Check the accessory drive belt tensioners for seizing or excessive bearing noises and replace if loose, binding, or excessively noisy.
- c. Check for a seizing water pump. The pump may not be leaking; however, the bearing may be faulty or the impeller loose and jammed. Replace the water pump.

4. Engine makes a growling noise

- a. Check for a loose or failing water pump. Replace the pump and engine coolant.
- b. Check the accessory drive belt tensioners for excessive bearing noises and replace if loose or excessively noisy.

5. Engine makes a ticking or tapping noise

- a. On vehicles with hydraulic lash adjusters, check for low or dirty engine oil and top off or replace the engine oil and filter.
- b. On vehicles with hydraulic lash adjusters, check for collapsed lifters and replace failed components.
- c. On vehicles with hydraulic lash adjusters, check for low oil pressure caused by a restricted oil filter, worn engine oil pump, or oil pressure relief valve.

- d. On vehicles with manually adjusted valves, check for excessive valve clearance or worn valve train parts. Adjust the valves to specification or replace worn and defective parts.
- e. Check for a loose or improperly tensioned timing belt or timing chain and adjust or replace parts as necessary.
- f. Check for a bent or sticking exhaust or intake valve. Remove the engine cylinder head to access and replace.

6. Engine makes a heavy knocking noise

- a. Check for a loose crankshaft pulley or flywheel; replace and torque the mounting bolt(s) to specification.
- b. Check for a bent connecting rod caused by a hydro-lock condition. Engine disassembly is necessary to inspect for damaged and needed replacement parts.
- c. Check for excessive engine rod bearing wear or damage. This condition is also associated with low engine oil pressure and will require engine disassembly to inspect for damaged and needed replacement parts.

7. Vehicle has a fuel odor when driven

- a. Check the fuel gauge level. If the fuel gauge registers full, it is possible that the odor is caused by being filled beyond capacity, or some spillage occurred during refueling. The odor should clear after driving an hour, or twenty miles, allowing the vapor canister to purge.
- b. Check the fuel filler cap for looseness or seepage. Check the cap tightness and, if loose, properly secure. If seepage is noted, replace the filler cap.
- c. Check for loose hose clamps, cracked or damaged fuel delivery and return lines, or leaking components or seals, and replace or repair as necessary.
- d. Check the vehicle's fuel economy. If fuel consumption has increased due to a failed component, or if the fuel is not properly ignited due to an ignition related failure, the catalytic converter may become contaminated. This condition may also trigger the check engine warning light. Check the spark plugs for a dark, rich condition or verify the condition by testing the vehicle's emissions. Replace fuel fouled spark plugs, and test and replace failed components as necessary.

8. Vehicle has a rotten egg odor when driven

- a. Check for a leaking intake gasket or vacuum leak causing a lean running condition. A lean mixture may result in increased exhaust temperatures, causing the catalytic converter to run hotter than normal. This condition may also trigger the check engine warning light. Check and repair the vacuum leaks as necessary.
- b. Check the vehicle's alternator and battery condition. If the alternator is overcharging, the battery electrolyte can be boiled from the battery, and the battery casing may begin to crack, swell or bulge, damaging or shorting the battery internally. If this has occurred, neutralize the battery mounting area with a suitable baking soda and water mixture or equivalent, and replace the alternator or voltage regulator. Inspect, service, and load test the battery, and replace if necessary.

9. Vehicle has a sweet odor when driven

- a. Check for an engine coolant leak caused by a seeping radiator cap, loose hose clamp, weeping cooling system seal, gasket or cooling system hose and replace or repair as needed.
- b. Check for a coolant leak from the radiator, coolant reservoir, heater control valve or under the dashboard from the heater core, and replace the failed part as necessary.
- c. Check the engine's exhaust for white smoke in addition to a sweet odor. The presence of white, steamy smoke with a sweet odor indicates coolant leaking into the combustion chamber. Possible causes include a failed head gasket, cracked engine block or cylinder head. Other symptoms of this condition include a white paste build-up on the inside of the oil filler cap, and softened, deformed or bulging radiator hoses.

10. Engine vibrates when idling

- a. Check for loose, collapsed, or damaged engine or transmission mounts and repair or replace as necessary.
- b. Check for loose or damaged engine covers or shields and secure or replace as necessary.

11. Engine vibrates during acceleration

- a. Check for missing, loose or damaged exhaust system hangers and mounts; replace or repair as necessary.
- b. Check the exhaust system routing and fit for adequate clearance or potential rubbing; repair or adjust as necessary.

1-D. Engine Electrical System

1. Battery goes dead while driving

- a. Check the battery condition. Replace the battery if the battery will not hold a charge or fails a battery load test. If the battery loses fluid while driving, check for an overcharging condition. If the alternator is overcharging, replace the alternator or voltage regulator. (A voltage regulator is typically built into the alternator, necessitating alternator replacement or overhaul.)
- b. Check the battery cable condition. Clean or replace corroded cables and clean the battery terminals.
- c. Check the alternator and voltage regulator operation. If the charging system is over or undercharging, replace the alternator or voltage regulator, or both.
- d. Inspect the wiring and wire connectors at the alternator for looseness, a missing ground or defective terminal, and repair as necessary.
- e. Inspect the alternator drive belt tension, tensioners and condition. Properly tension the drive belt, replace weak or broken tensioners, and replace the drive belt if worn or cracked.

2. Battery goes dead overnight

- a. Check the battery condition. Replace the battery if the battery will not hold a charge or fails a battery load test.
- b. Check for a voltage draw, such as a trunk light, interior light or glove box light staying on. Check light switch position and operation, and replace if defective.
- c. Check the alternator for an internally failed diode, and replace the alternator if defective.

1-E. Engine Cooling System

1. Engine overheats

- Check the coolant level. Set the heater temperature to full hot and check for internal air pockets, bleed the cooling system and inspect for leakage. Top off the cooling system with the correct coolant mixture.
- Pressure test the cooling system and radiator cap for leaks. Check for seepage caused by loose hose clamps, failed coolant hoses, and cooling system components such as the heater control valve, heater core, radiator, radiator cap, and water pump. Replace defective parts and fill the cooling system with the recommended coolant mixture.
- On vehicles with electrically controlled cooling fans, check the cooling fan operation. Check for blown fuses or defective fan motors, temperature sensors and relays, and replace failed components.
- Check for a coolant leak caused by a failed head gasket, or a porous water jacket casting in the cylinder head or engine block. Replace defective parts as necessary.
- Check for an internally restricted radiator. Flush the radiator or replace if the blockage is too severe for flushing.
- Check for a damaged water pump. If coolant circulation is poor, check for a loose water pump impeller. If the impeller is loose, replace the water pump.

2. Engine loses coolant

- Pressure test the cooling system and radiator cap for leaks. Check for seepage caused by loose hose clamps, failed coolant hoses, and cooling system components such as the heater control valve, heater core, radiator, radiator cap, and water pump. Replace defective parts and fill the cooling system with the recommended coolant mixture.
- Check for a coolant leak caused by a failed head gasket, or a porous water jacket casting in the cylinder head or engine block. Replace defective parts as necessary.

3. Engine temperature remains cold when driving

- Check the thermostat operation. Replace the thermostat if it sticks in the open position.
- On vehicles with electrically controlled cooling fans, check the cooling fan operation. Check for defective temperature sensors and stuck relays, and replace failed components.
- Check temperature gauge operation if equipped to verify proper operation of the gauge. Check the sensors and wiring for defects, and repair or replace defective components.

4. Engine runs hot

- Check for an internally restricted radiator. Flush the radiator or replace if the blockage is too severe for flushing.
- Check for a loose or slipping water pump drive belt. Inspect the drive belt condition. Replace the belt if brittle, cracked or damaged. Check the pulley condition and properly tension the belt.
- Check the cooling fan operation. Replace defective fan motors, sensors or relays as necessary.
- Check temperature gauge operation if equipped to verify proper

operation of the gauge. Check the sensors and wiring for defects, and repair or replace defective components.

- Check the coolant level. Set the heater temperature to full hot, check for internal air pockets, bleed the cooling system and inspect for leakage. Top off the cooling system with the correct coolant mixture. Once the engine is cool, recheck the fluid level and top off as needed.

NOTE: The engine cooling system can also be affected by an engine's mechanical condition. A failed head gasket or a porous casting in the engine block or cylinder head could cause a loss of coolant and result in engine overheating.

Some cooling systems rely on electrically driven cooling fans to cool the radiator and use electrical temperature sensors and relays to operate the cooling fan. When diagnosing these systems, check for blown fuses, damaged wires and verify that the electrical connections are fully connected, clean and not physically damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts could leave a film or damage the insulation of the wiring.

1-F. Engine Exhaust System

1. Exhaust rattles at idle speed

- Check the engine and transmission mounts and replace mounts showing signs of damage or wear.
- Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
- Check for internal damage to mufflers and catalytic converters. The broken pieces from the defective component may travel in the direction of the exhaust flow and collect and/or create a blockage in a component other than the one which failed, causing engine running and stalling problems. Another symptom of a restricted exhaust is low engine manifold vacuum. Remove the exhaust system and carefully remove any loose or broken pieces, then replace any failed or damaged parts as necessary.
- Check the exhaust system clearance, routing and alignment. If the exhaust is making contact with the vehicle in any manner, loosen and reposition the exhaust system.

2. Exhaust system vibrates when driving

- Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
- Check the exhaust system clearance, routing and alignment. If the exhaust is making contact with the vehicle in any manner, check for bent or damaged components and replace, then loosen and reposition the exhaust system.
- Check for internal damage to mufflers and catalytic converters. The broken pieces from the defective component may travel in the direction of the exhaust flow and collect and/or create a blockage in a component other than the one which failed, causing engine running and stalling problems. Another symptom of a restricted exhaust is low engine manifold vacuum. Remove the exhaust system and carefully remove any loose or broken pieces, then replace any failed or damaged parts as necessary.

3. Exhaust system hangs too low

- Check the exhaust hangers, brackets and mounts. Replace broken, missing or damaged mounts.
- Check the exhaust routing and alignment. Check and replace bent or damaged components. If the exhaust is not routed properly, loosen and reposition the exhaust system.

4. Exhaust sounds loud

- Check the system for looseness and leaks. Check the exhaust pipes, clamps, flange bolts and manifold fasteners for tightness. Check and replace any failed gaskets.

- Check and replace exhaust silencers that have a loss of efficiency due to internally broken baffles or worn packing material.
- Check for missing mufflers and silencers that have been replaced with straight pipes or with non-original equipment silencers.

NOTE: Exhaust system rattles, vibration and proper alignment should not be overlooked. Excessive vibration caused by collapsed engine mounts, damaged or missing exhaust hangers and misalignment may cause surface cracks and broken welds, creating exhaust leaks or internal damage to exhaust components such as the catalytic converter, creating a restriction to exhaust flow and loss of power.

2. DRIVE TRAIN**2-A. Automatic Transmission****1. Transmission shifts erratically**

- Check and if not within the recommended range, add or remove transmission fluid to obtain the correct fluid level. Always use the recommended fluid type when adding transmission fluid.
- Check the fluid level condition. If the fluid has become contaminated, fatigued from excessive heat or exhibits a burning odor, change the transmission fluid and filter using the recommended type and amount of fluid. A fluid which exhibits a burning odor indicates that the transmission has been slipping internally and may require future repairs.
- Check for an improperly installed transmission filter, or missing filter gasket, and repair as necessary.
- Check for loose or leaking gaskets, pressure lines and fittings, and repair or replace as necessary.
- Check for loose or disconnected shift and throttle linkages or vacuum hoses, and repair as necessary.

2. Transmission will not engage

- Check the shift linkage for looseness, wear and proper adjustment, and repair as necessary.
- Check for a loss of transmission fluid and top off as needed with the recommended fluid.
- If the transmission does not engage with the shift linkage correctly installed and the proper fluid level, internal damage has likely occurred, requiring transmission removal and disassembly.

3. Transmission will not downshift during heavy acceleration

- On computer controlled transmissions, check for failed sensors or control units and repair or replace defective components.
- On vehicles with kickdown linkages or vacuum servos, check for proper linkage adjustment or leaking vacuum hoses or servo units.

NOTE: Many automatic transmissions use an electronic control module, electrical sensors and solenoids to control transmission shifting. When troubleshooting a vehicle with this type of system, be sure the electrical connectors are fully connected, clean and not physically

damaged. If necessary, clean the electrical contacts using electrical contact cleaner. The use of cleaning agents not specifically designed for electrical contacts could leave a film or damage the insulation of the wiring.

2-B. Manual Transmission**1. Transmission grinds going into forward gears while driving**

- Check the clutch release system. On clutches with a mechanical or cable linkage, check the adjustment. Adjust the clutch pedal to have 1 inch (25mm) of free-play at the pedal.
- If the clutch release system is hydraulically operated, check the fluid level and, if low, top off using the recommended type and amount of fluid.
- Synchronizers worn. Remove transmission and replace synchronizers.
- Synchronizer sliding sleeve worn. Remove transmission and replace sliding sleeve.
- Gear engagement dogs worn or damaged. Remove transmission and replace gear.

2. Transmission jumps out of gear

- Shift shaft detent springs worn. Replace shift detent springs.
- Synchronizer sliding sleeve worn. Remove transmission and replace sliding sleeve.
- Gear engagement dogs worn or damaged. Remove transmission and replace gear.
- Crankshaft thrust bearings worn. Remove engine and crankshaft, and repair as necessary.

3. Transmission difficult to shift

- Verify the clutch adjustment and, if not properly adjusted, adjust to specification.
- Synchronizers worn. Remove transmission and replace synchronizers.
- Pilot bearing seized. Remove transmission and replace pilot bearing.
- Shift linkage or bushing seized. Disassemble the shift linkage, replace worn or damaged bushings, lubricate and reinstall.

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4. Transmission leaks fluid

- a. Check the fluid level for an overfilled condition. Adjust the fluid level to specification.
- b. Check for a restricted transmission vent or breather tube. Clear the blockage as necessary and check the fluid level. If necessary, top off with the recommended lubricant.
- c. Check for a porous casting, leaking seal or gasket. Replace defective parts and top off the fluid level with the recommended lubricant.

2-C. Clutch

1. Clutch slips on hills or during sudden acceleration

- a. Check for insufficient clutch pedal free-play. Adjust clutch linkage or cable to allow about 1 inch (25mm) of pedal free-play.
- b. Clutch disc worn or severely damaged. Remove engine or transmission and replace clutch disc.
- c. Clutch pressure plate is weak. Remove engine or transmission and replace the clutch pressure plate and clutch disc.
- d. Clutch pressure plate and/or flywheel incorrectly machined. If the clutch system has been recently replaced and rebuilt, or refurbished parts have been used, it is possible that the machined surfaces decreased the clutch clamping force. Replace defective parts with new replacement parts.

2. Clutch will not disengage, difficult to shift

- a. Check the clutch release mechanism. Check for stretched cables, worn linkages or failed clutch hydraulics and replace defective parts. On hydraulically operated clutch release mechanisms, check for air in the hydraulic system and bleed as necessary.
- b. Check for a broken, cracked or fatigued clutch release arm or release arm pivot. Replace defective parts and properly lubricate upon assembly.
- c. Check for a damaged clutch hub damper or damper spring. The broken parts tend to become lodged between the clutch disc and the pressure plate. Disassemble clutch system and replace failed parts.
- d. Check for a seized clutch pilot bearing. Disassemble the clutch assembly and replace the defective parts.
- e. Check for a defective clutch disc. Check for warpage or lining thicknesses larger than original equipment.

3. Clutch is noisy when the clutch pedal is pressed

- a. Check the clutch pedal stop and pedal free-play adjustment for excessive movement and adjust as necessary.
- b. Check for a worn or damaged release bearing. If the noise ceases when the pedal is released, the release bearing should be replaced.
- c. Check the engine crankshaft axial play. If the crankshaft thrust bearings are worn or damaged, the crankshaft will move when pressing the clutch pedal. The engine must be disassembled to replace the crankshaft thrust bearings.

4. Clutch pedal extremely difficult to press

- a. Check the clutch pedal pivots and linkages for binding. Clean and lubricate linkages.

- b. On cable actuated clutch systems, check the cable routing and condition. Replace kinked, frayed, damaged or corroded cables and check cable routing to avoid sharp bends. Check the engine ground strap for poor conductivity. If the ground strap is marginal, the engine could try to ground itself via the clutch cable, causing premature failure.
- c. On mechanical linkage clutches, check the linkage for binding or misalignment. Lubricate pivots or linkages and repair as necessary.
- d. Check the release bearing guide tube and release fork for a lack of lubrication. Install a smooth coating of high temperature grease to allow smooth movement of the release bearing over the guide tube.

5. Clutch pedal remains down when pressed

- a. On mechanical linkage or cable actuated clutches, check for a loose or disconnected link.
- b. On hydraulically actuated clutches, check the fluid level and check for a hydraulic leak at the clutch slave or master cylinder, or hydraulic line. Replace failed parts and bleed clutch hydraulic system. If no leakage is noted, the clutch master cylinder may have failed internally. Replace the clutch master cylinder and bleed the clutch hydraulic system.

6. Clutch chatters when engaging

- a. Check the engine flywheel for warpage or surface variations and replace or repair as necessary.
- b. Check for a warped clutch disc or damaged clutch damper hub. Remove the clutch disc and replace.
- c. Check for a loose or damaged clutch pressure plate and replace defective components.

NOTE: The clutch is actuated either by a mechanical linkage, cable or a clutch hydraulic system. The mechanical linkage and cable systems may require the clutch pedal free-play to be adjusted as the clutch disc wears. A hydraulic clutch system automatically adjusts as the clutch wears and, with the exception of the clutch pedal height, no adjustment is possible.

2-D. Differential and Final Drive

1. Differential makes a low pitched rumbling noise

- a. Check fluid level type and amount. Replace the fluid with the recommended type and amount of lubricant.
- b. Check the differential bearings for wear or damage. Remove the bearings, inspect the drive and driven gears for wear or damage, and replace components as necessary.

2. Differential makes a howling noise

- a. Check fluid level type and amount. Replace the fluid with the recommended type and amount of lubricant.
- b. Check the differential drive and driven gears for wear or damage, and replace components as necessary.

2-E. Transfer Assembly**All Wheel and Four Wheel Drive Vehicles****1. Leaks fluid from seals or vent after being driven**

- Fluid level overfilled. Check and adjust transfer case fluid level.
- Check for a restricted breather or breather tube, clear and check the fluid level and top off as needed.
- Check seal condition and replace worn, damaged, or defective seals. Check the fluid level and top off as necessary.

2. Makes excessive noise while driving

- Check the fluid for the correct type of lubricant. Drain and refill using the recommended type and amount of lubricant.
- Check the fluid level. Top off the fluid using the recommended type and amount of lubricant.
- If the fluid level and type of lubricant meet specifications, check for internal wear or damage. Remove assembly and disassemble to inspect for worn, damaged, or defective components.

3. Jumps out of gear

- Stop vehicle and make sure the unit is fully engaged.
- Check for worn, loose or an improperly adjusted linkage. Replace and/or adjust linkage as necessary.
- Check for internal wear or damage. Remove assembly and disassemble to inspect for worn, damaged, or defective components.

2-F. Driveshaft**Rear Wheel, All Wheel and Four Wheel Drive Vehicles****1. Clunking noise from center of vehicle shifting from forward to reverse**

- Worn universal joint. Remove driveshaft and replace universal joint.

2. Excessive vibration from center of vehicle when accelerating

- Worn universal joint. Remove driveshaft and replace universal joint.
- Driveshaft misaligned. Check for collapsed or damaged engine and transmission mounts, and replace as necessary.
- Driveshaft bent or out of balance. Replace damaged components and reinstall.
- Driveshaft out of balance. Remove the driveshaft and have it balanced by a competent professional, or replace the driveshaft assembly.

NOTE: Most driveshafts are linked together by universal joints; however, some manufacturers use Constant Velocity (CV) joints or rubber flex couplers.

2-G. Axles**All Wheel and Four Wheel Drive Vehicles****1. Front or rear wheel makes a clicking noise**

- Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles

- rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.
- Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.

2. Front or rear wheel vibrates with increased speed

- Check for a bent rim and replace, if damaged.
- Check the tires for balance or internal damage and replace if defective.
- Check for a loose, worn or damaged wheel bearing and replace if defective.
- Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.

Front Wheel Drive Vehicles**3. Front wheel makes a clicking noise**

- Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.
- Check for a loose, damaged or worn Constant Velocity (CV) joint and replace if defective.

4. Rear wheel makes a clicking noise

- Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.

Rear Wheel Drive Vehicles**5. Front or rear wheel makes a clicking noise**

- Check for debris such as a pebble, nail or glass in the tire or tire tread. Carefully remove the debris. Small rocks and pebbles rarely cause a puncture; however, a sharp object should be removed carefully at a facility capable of performing tire repairs.

6. Rear wheel shudders or vibrates

- Check for a bent rear wheel or axle assembly and replace defective components.
- Check for a loose, damaged or worn rear wheel bearing and replace as necessary.

2-H. Other Drive Train Conditions**1. Burning odor from center of vehicle when accelerating**

- Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. For additional information on brake related odors, refer to section 3-A, condition number 9.
- On vehicles with a manual transmission, check for a slipping clutch. For possible causes and additional information, refer to section 2-C, condition number 1.

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- c. On vehicles with an automatic transmission, check the fluid level and condition. Top off or change the fluid and filter using the recommended replacement parts, lubricant type and amount. If the odor persists, transmission removal and disassembly will be necessary.

2. Engine accelerates, but vehicle does not gain speed

- a. On vehicles with a manual transmission, check for a slipping or

damaged clutch. For possible causes and additional information refer to section 2-C, condition number 1.

- b. On vehicles with an automatic transmission, check the fluid level and condition. Top off or change the fluid and filter using the recommended replacement parts, lubricant type and amount. If the slipping continues, transmission removal and disassembly will be necessary.

3. BRAKE SYSTEM

3-A. Brake System Troubleshooting

1. Brake pedal pulsates or shimmies when pressed

- a. Check wheel lug nut torque and tighten evenly to specification.
- b. Check the brake rotor for trueness and thickness variations. Replace the rotor if it is too thin, warped, or if the thickness varies beyond specification. Some rotors can be machined; consult the manufacturer's specifications and recommendations before using a machined brake rotor.
- c. Check the brake caliper or caliper bracket mounting bolt torque and inspect for looseness. Torque the mounting bolts and inspect for wear or any looseness, including worn mounting brackets, bushings and sliding pins.
- d. Check the wheel bearing for looseness. If the bearing is loose, adjust if possible, otherwise replace the bearing.

2. Brakes make a squealing noise

- a. Check the brake rotor for the presence of a ridge on the outer edge; if present, remove the ridge or replace the brake rotor and brake pads.
- b. Check for debris in the brake lining material, clean and reinstall.
- c. Check the brake linings for wear and replace the brake linings if wear is approaching the lining wear limit.
- d. Check the brake linings for glazing. Inspect the brake drum or rotor surface and replace, along with the brake linings, if the surface is not smooth or even.
- e. Check the brake pad or shoe mounting areas for a lack of lubricant or the presence of surface rust. Clean and lubricate with a recommended high temperature brake grease.

3. Brakes make a grinding noise

- a. Check the brake linings and brake surface areas for severe wear or damage. Replace worn or damaged parts.
- b. Check for a seized or partially seized brake causing premature or uneven brake wear, excessive heat and brake rotor or drum damage. Replace defective parts and inspect the wheel bearing condition, which could have been damaged due to excessive heat.

4. Vehicle pulls to one side during braking

- a. Check for air in the brake hydraulic system. Inspect the brake hydraulic seals, fluid lines and related components for fluid leaks. Remove the air from the brake system by bleeding the brakes. Be sure to use fresh brake fluid that meets the manufacturer's recommended standards.
- b. Check for an internally restricted flexible brake hydraulic hose. Replace the hose and flush the brake system.

- c. Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. Overhaul or replace failed parts and flush the brake system.
- d. Check the vehicle's alignment and inspect for suspension wear. Replace worn bushings, ball joints and set alignment to the manufacturer's specifications.
- e. If the brake system uses drum brakes front or rear, check the brake adjustment. Inspect for seized adjusters and clean or replace, then properly adjust.

5. Brake pedal feels spongy or has excessive travel

- a. Check the brake fluid level and condition. If the fluid is contaminated or has not been flushed every two years, clean the master cylinder reservoir, and bleed and flush the brakes using fresh brake fluid that meets the manufacturer's recommended standards.
- b. Check for a weak or damaged flexible brake hydraulic hose. Replace the hose and flush the brake system.
- c. If the brake system uses drum brakes front or rear, check the brake adjustment. Inspect for seized adjusters and clean or replace, then properly adjust.

6. Brake pedal feel is firm, but brakes lack sufficient stopping power or fade

- a. Check the operation of the brake booster and brake booster check valve. Replace worn or failed parts.
- b. Check brake linings and brake surface areas for glazing and replace worn or damaged parts.
- c. Check for seized hydraulic parts and linkages, and clean or replace as needed.

7. Vehicle has excessive front end dive or locks rear brakes too easily

- a. Check for worn, failed or seized brake proportioning valve and replace the valve.
- b. Check for a seized, disconnected or missing spring or linkage for the brake proportioning valve. Replace missing parts or repair as necessary.

8. Brake pedal goes to floor when pressed and will not pump up

- a. Check the brake hydraulic fluid level and inspect the fluid lines and seals for leakage. Repair or replace leaking components, then bleed and flush the brake system using fresh brake fluid that meets the manufacturer's recommended standards.

- b. Check the brake fluid level. Inspect the brake fluid level and brake hydraulic seals. If the fluid level is ok, and the brake hydraulic system is free of hydraulic leaks, replace the brake master cylinder, then bleed and flush the brake system using fresh brake fluid that meets the manufacturer's recommended standards.

9. Brakes produce a burning odor

- a. Check for a seizing brake hydraulic component such as a brake caliper. Check the caliper piston for surface damage such as rust, and measure for out-of-round wear and caliper-to-piston clearance. Overhaul or replace failed parts and flush the brake system.
- b. Check for an internally restricted flexible brake hydraulic hose. Replace the hose and flush the brake system.
- c. Check the parking brake release mechanism, seized linkage or cable, and repair as necessary.

BRAKE PERFORMANCE TROUBLESHOOTING HINTS

Brake vibrations or pulsation can often be diagnosed on a safe and careful test drive. A brake vibration which is felt through the brake

pedal while braking, but not felt in the steering wheel, is most likely caused by brake surface variations in the rear brakes. If both the brake pedal and steering wheel vibrate during braking, a surface variation in the front brakes, or both front and rear brakes, is very likely.

A brake pedal that pumps up with repeated use can be caused by air in the brake hydraulic system or, if the vehicle is equipped with rear drum brakes, the brake adjusters may be seized or out of adjustment. A quick test for brake adjustment on vehicles with rear drum brakes is to pump the brake pedal several times with the vehicle's engine not running and the parking brake released. Pump the brake pedal several times and continue to apply pressure to the brake pedal. With pressure being applied to the brake pedal, engage the parking brake. Release the brake pedal and quickly press the brake pedal again. If the brake pedal pumped up, the rear brakes are in need of adjustment. Do not compensate for the rear brake adjustment by adjusting the parking brake, this will cause premature brake lining wear.

To test a vacuum brake booster, pump the brake pedal several times with the vehicle's engine off. Apply pressure to the brake pedal and then start the engine. The brake pedal should move downward about one inch (25mm).

4. WHEELS, TIRES, STEERING AND SUSPENSION

4-A. Wheels and Wheel Bearings

1. Front wheel or wheel bearing loose

All Wheel and Four Wheel Drive Vehicles

- a. Torque lug nuts and axle nuts to specification and recheck for looseness.
- b. Wheel bearing worn or damaged. Replace wheel bearing.

Front Wheel Drive Vehicles

- a. Torque lug nuts and axle nuts to specification and recheck for looseness.
- b. Wheel bearing worn or damaged. Replace wheel bearing.
- c. Wheel bearing out of adjustment. Adjust wheel bearing to specification; if still loose, replace.

Rear Wheel Drive Vehicles

- a. Wheel bearing out of adjustment. Adjust wheel bearing to specification; if still loose, replace.
- b. Torque lug nuts to specification and recheck for looseness.
- c. Wheel bearing worn or damaged. Replace wheel bearing.

2. Rear wheel or wheel bearing loose

All Wheel and Four Wheel Drive Vehicles

- a. Torque lug nuts and axle nuts to specification and recheck for looseness.
- b. Wheel bearing worn or damaged. Replace wheel bearing.

Front Wheel Drive Vehicles

- a. Wheel bearing out of adjustment. Adjust wheel bearing to specification; if still loose, replace.

- b. Torque lug nuts to specification and recheck for looseness.
- c. Wheel bearing worn or damaged. Replace wheel bearing.

Rear Wheel Drive Vehicles

- a. Torque lug nuts to specification and recheck for looseness.
- b. Wheel bearing worn or damaged. Replace wheel bearing.

4-B. Tires

1. Tires worn on inside tread

- a. Check alignment for a toed-out condition. Check and set tire pressures and properly adjust the toe.
- b. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment.

2. Tires worn on outside tread

- a. Check alignment for a toed-in condition. Check and set tire pressures and properly adjust the toe.
- b. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment.

3. Tires worn unevenly

- a. Check the tire pressure and tire balance. Replace worn or defective tires and check the alignment; adjust if necessary.
- b. Check for worn shock absorbers. Replace failed components, worn or defective tires and check the alignment; adjust if necessary.
- c. Check the alignment settings. Check and set tire pressures and properly adjust the alignment to specification.
- d. Check for worn, damaged or defective suspension components. Replace defective parts and adjust the alignment to specification.

4-C. Steering

1. Excessive play in steering wheel

- Check the steering gear free-play adjustment and properly adjust to remove excessive play.
- Check the steering linkage for worn, damaged or defective parts. Replace failed components and perform a front end alignment.
- Check for a worn, damaged, or defective steering box, replace the steering gear and check the front end alignment.

2. Steering wheel shakes at cruising speeds

- Check for a bent front wheel. Replace a damaged wheel and check the tire for possible internal damage.
- Check for an unevenly worn front tire. Replace the tire, adjust tire pressure and balance.
- Check the front tires for hidden internal damage. Tires which have encountered large pot holes or suffered other hard blows may have sustained internal damage and should be replaced immediately.
- Check the front tires for an out-of-balance condition. Remove, spin balance and reinstall. Torque all the wheel bolts or lug nuts to the recommended specification.
- Check for a loose wheel bearing. If possible, adjust the bearing, or replace the bearing if it is a non-adjustable bearing.

3. Steering wheel shakes when braking

- Refer to section 3-A, condition number 1.

4. Steering wheel becomes stiff when turned

- Check the steering wheel free-play adjustment and reset as needed.
- Check for a damaged steering gear assembly. Replace the steering gear and perform a front end alignment.
- Check for damaged or seized suspension components. Replace defective components and perform a front end alignment.

4-D. Suspension

1. Vehicle pulls to one side

- Tire pressure uneven. Adjust tire pressure to recommended settings.
- Tires worn unevenly. Replace tires and check alignment settings.
- Alignment out of specification. Align front end and check thrust angle.
- Check for a dragging brake and repair or replace as necessary.

2. Vehicle is very bouncy over bumps

- Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.
- Check for seized shock absorbers or strut assemblies and replace as necessary.

NOTE: When one shock fails, it is recommended to replace front or rear units as pairs.

3. Vehicle leans excessively in turns

- Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.
- Check for missing, damaged, or worn stabilizer links or bushings, and replace or install as necessary.

4. Vehicle ride quality seems excessively harsh

- Check for seized shock absorbers or strut assemblies and replace as necessary.
- Check for excessively high tire pressures and adjust pressures to vehicle recommendations.

5. Vehicle seems low or leans to one side

- Check for a damaged, broken or weak spring. Replace defective parts and check for a needed alignment.
- Check for seized shock absorbers or strut assemblies and replace as necessary.
- Check for worn or leaking shock absorbers or strut assemblies and replace as necessary.

4-E. Driving Noises and Vibrations

Noises

1. Vehicle makes a clicking noises when driven

- Check the noise to see if it varies with road speed. Verify if the noise is present when coasting or with steering or throttle input. If the clicking noise frequency changes with road speed and is not affected by steering or throttle input, check the tire treads for a stone, piece of glass, nail or another hard object imbedded into the tire or tire tread. Stones rarely cause a tire puncture and are easily removed. Other objects may create an air leak when removed. Consider having these objects removed immediately at a facility equipped to repair tire punctures.
- If the clicking noise varies with throttle input and steering, check for a worn Constant Velocity (CV-joint) joint, universal (U-joint) or flex joint.

2. Vehicle makes a clunking or knocking noise over bumps

- A clunking noise over bumps is most often caused by excessive movement or clearance in a suspension component. Check the suspension for soft, cracked, damaged or worn bushings. Replace the bushings and check the vehicle's alignment.
- Check for loose suspension mounting bolts. Check the tightness on subframe bolts, pivot bolts and suspension mounting bolts, and torque to specification.
- Check the vehicle for a loose wheel bearing. Some wheel bearings can be adjusted for looseness, while others must be replaced if loose. Adjust or replace the bearings as recommended by the manufacturer.
- Check the door latch adjustment. If the door is slightly loose, or the latch adjustment is not centered, the door assembly may create noises over bumps and rough surfaces. Properly adjust the door latches to secure the door.

3. Vehicle makes a low pitched rumbling noise when driven

- A low pitched rumbling noise is usually caused by a drive train related bearing and is most often associated with a wheel bearing which has been damaged or worn. The damage can be caused by excessive brake temperatures or physical contact with a pot hole or curb. Sometimes the noise will vary when turning. Left hand turns increase the load on the vehicle's right side, and right turns load the left side. A failed front wheel bearing may also cause a slight steering wheel vibration when turning. A bearing which exhibits noise must be replaced.
- Check the tire condition and balance. An internally damaged tire may cause failure symptoms similar to failed suspension parts. For diagnostic purposes, try a known good set of tires and replace defective tires.

4. Vehicle makes a squeaking noise over bumps

- Check the vehicle's ball joints for wear, damaged or leaking boots. Replace a ball joint if it is loose, the boot is damaged and leaking, or the ball joint is binding. When replacing suspension parts, check the vehicle for alignment.
- Check for seized or deteriorated bushings. Replace bushings that are worn or damaged and check the vehicle for alignment.
- Check for the presence of sway bar or stabilizer bar bushings which wrap around the bar. Inspect the condition of the bushings and replace if worn or damaged. Remove the bushing bracket and apply a thin layer of suspension grease to the area where the bushings wrap around the bar and reinstall the bushing brackets.

5. ELECTRICAL ACCESSORIES

5-A. Headlights

1. One headlight only works on high or low beam

- Check for battery voltage at headlight electrical connector. If battery voltage is present, replace the headlight assembly or bulb if available separately. If battery voltage is not present, refer to the headlight wiring diagram to troubleshoot.

2. Headlight does not work on high or low beam

- Check for battery voltage and ground at headlight electrical connector. If battery voltage is present, check the headlight connector ground terminal for a proper ground. If battery voltage and ground are present at the headlight connector, replace the headlight assembly or bulb if available separately. If battery voltage or ground is not present, refer to the headlight wiring diagram to troubleshoot.
- Check the headlight switch operation. Replace the switch if the switch is defective or operates intermittently.

3. Headlight(s) very dim

- Check for battery voltage and ground at headlight electrical connector. If battery voltage is present, trace the ground circuit for the headlamp electrical connector, then clean and repair as necessary.

Vibrations

5. Vehicle vibrates when driven

- Check the road surface. Roads which have rough or uneven surfaces may cause unusual vibrations.
- Check the tire condition and balance. An internally damaged tire may cause failure symptoms similar to failed suspension parts. For diagnostic purposes, try a known good set of tires and replace defective tires immediately.
- Check for a worn Constant Velocity (CV-joint) joint, universal (U-joint) or flex joint and replace if loose, damaged or binding.
- Check for a loose, bent, or out-of-balance axle or drive shaft. Replace damaged or failed components.

NOTE: Diagnosing failures related to wheels, tires, steering and the suspension system can often times be accomplished with a careful and thorough test drive. Bearing noises are isolated by noting whether the noises or symptoms vary when turning left or right, or occur while driving a straight line. During a left hand turn, the vehicle's weight shifts to the right, placing more force on the right side bearings, such that if a right side wheel bearing is worn or damaged, the noise or vibration should increase during light-to-heavy acceleration. Conversely, on right hand turns, the vehicle tends to lean to the left, loading the left side bearings.

Knocking noises in the suspension when the vehicle is driven over rough roads, railroad tracks and speed bumps indicate worn suspension components such as bushings, ball joints or tie rod ends, or a worn steering system.

If the voltage at the headlight electrical connector is significantly less than the voltage at the battery, refer to the headlight wiring diagram to troubleshoot and locate the voltage drop.

5-B. Tail, Running and Side Marker Lights

1. Tail light, running light or side marker light inoperative

- Check for battery voltage and ground at light's electrical connector. If battery voltage is present, check the bulb socket and electrical connector ground terminal for a proper ground. If battery voltage and ground are present at the light connector, but not in the socket, clean the socket and the ground terminal connector. If battery voltage and ground are present in the bulb socket, replace the bulb. If battery voltage or ground is not present, refer to the wiring diagram to troubleshoot for an open circuit.
- Check the light switch operation and replace if necessary.

2. Tail light, running light or side marker light works intermittently

- Check the bulb for a damaged filament, and replace if damaged.
- Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.

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- c. Check for loose, damaged or corroded wires and electrical terminals, and repair as necessary.
- d. Check the light switch operation and replace if necessary.

3. Tail light, running light or side marker light very dim

- a. Check the bulb and bulb socket for corrosion and clean or replace the bulb and socket.
- b. Check for low voltage at the bulb socket positive terminal or a poor ground. If voltage is low, or the ground marginal, trace the wiring to, and check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
- c. Check the light switch operation and replace if necessary.

5-C. Interior Lights

1. Interior light inoperative

- a. Verify the interior light switch location and position(s), and set the switch in the correct position.
- b. Check for battery voltage and ground at the interior light bulb socket. If battery voltage and ground are present, replace the bulb. If voltage is not present, check the interior light fuse for battery voltage. If the fuse is missing, replace the fuse. If the fuse has blown, or if battery voltage is present, refer to the wiring diagram to troubleshoot the cause for an open or shorted circuit. If ground is not present, check the door switch contacts and clean or repair as necessary.

2. Interior light works intermittently

- a. Check the bulb for a damaged filament, and replace if damaged.
- b. Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.
- c. Check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
- d. Check the door and light switch operation, and replace if necessary.

3. Interior light very dim

- a. Check the bulb and bulb socket for corrosion, and clean or replace the bulb and socket.
- b. Check for low voltage at the bulb socket positive terminal or a poor ground. If voltage is low, or the ground marginal, trace the wiring to, and check for loose, damaged or corroded wires and electrical terminals; repair as necessary.
- c. Check the door and light switch operation, and replace if necessary.

5-D. Brake Lights

1. One brake light inoperative

- a. Press the brake pedal and check for battery voltage and ground at the brake light bulb socket. If present, replace the bulb. If either battery voltage or ground is not present, refer to the wiring diagram to troubleshoot.

2. Both brake lights inoperative

- a. Press the brake pedal and check for battery voltage and ground at the brake light bulb socket. If present, replace both bulbs. If

battery voltage is not present, check the brake light switch adjustment and adjust as necessary. If the brake light switch is properly adjusted, and battery voltage or the ground is not present at the bulb sockets, or at the bulb electrical connector with the brake pedal pressed, refer to the wiring diagram to troubleshoot the cause of an open circuit.

3. One or both brake lights very dim

- a. Press the brake pedal and measure the voltage at the brake light bulb socket. If the measured voltage is close to the battery voltage, check for a poor ground caused by a loose, damaged, or corroded wire, terminal, bulb or bulb socket. If the ground is bolted to a painted surface, it may be necessary to remove the electrical connector and clean the mounting surface, so the connector mounts on bare metal. If battery voltage is low, check for a poor connection caused by either a faulty brake light switch, a loose, damaged, or corroded wire, terminal or electrical connector. Refer to the wiring diagram to troubleshoot the cause of a voltage drop.

5-E. Warning Lights

1. Warning light(s) stay on when the engine is started

Ignition, Battery or Alternator Warning Light

- a. Check the alternator output and voltage regulator operation, and replace as necessary.
- b. Check the warning light wiring for a shorted wire.

Check Engine Light

- a. Check the engine for routine maintenance and tune-up status. Note the engine tune-up specifications and verify the spark plug, air filter and engine oil condition; replace and/or adjust items as necessary.
- b. Check the fuel tank for low fuel level, causing an intermittent lean fuel mixture. Top off fuel tank and reset check engine light.
- c. Check for a failed or disconnected engine fuel or ignition component, sensor or control unit and repair or replace as necessary.
- d. Check the intake manifold and vacuum hoses for air leaks and repair as necessary.
- e. Check the engine's mechanical condition for excessive oil consumption.

Anti-Lock Braking System (ABS) Light

- a. Check the wheel sensors and sensor rings for debris, and clean as necessary.
- b. Check the brake master cylinder for fluid leakage or seal failure and replace as necessary.
- c. Check the ABS control unit, pump and proportioning valves for proper operation; replace as necessary.
- d. Check the sensor wiring at the wheel sensors and the ABS control unit for a loose or shorted wire, and repair as necessary.

Brake Warning Light

- a. Check the brake fluid level and check for possible leakage from the hydraulic lines and seals. Top off brake fluid and repair leakage as necessary.

- b. Check the brake linings for wear and replace as necessary.
- c. Check for a loose or shorted brake warning light sensor or wire, and replace or repair as necessary.

Oil Pressure Warning Light

- a. Stop the engine immediately. Check the engine oil level and oil filter condition, and top off or change the oil as necessary.
- b. Check the oil pressure sensor wire for being shorted to ground. Disconnect the wire from the oil pressure sensor and with the ignition in the ON position, but not running, the oil pressure light should not be working. If the light works with the wire disconnected, check the sensor wire for being shorted to ground. Check the wire routing to make sure the wire is not pinched and check for insulation damage. Repair or replace the wire as necessary and recheck before starting the engine.
- c. Remove the oil pan and check for a clogged oil pick-up tube screen.
- d. Check the oil pressure sensor operation by substituting a known good sensor.
- e. Check the oil filter for internal restrictions or leaks, and replace as necessary.

WARNING: If the engine is operated with oil pressure below the manufacturer's specification, severe (and costly) engine damage could occur. Low oil pressure can be caused by excessive internal wear or damage to the engine bearings, oil pressure relief valve, oil pump or oil pump drive mechanism.

Before starting the engine, check for possible causes of rapid oil loss, such as leaking oil lines or a loose, damaged, restricted, or leaking oil filter or oil pressure sensor. If the engine oil level and condition are acceptable, measure the engine's oil pressure using a pressure gauge, or determine the cause for the oil pressure warning light to function when the engine is running, before operating the engine for an extended period of time. Another symptom of operating an engine with low oil pressure is the presence of severe knocking and tapping noises.

Parking Brake Warning Light

- a. Check the brake release mechanism and verify the parking brake has been fully released.
- b. Check the parking brake light switch for looseness or misalignment.
- c. Check for a damaged switch or a loose or shorted brake light switch wire, and replace or repair as necessary.

2. Warning light(s) flickers on and off when driving

Ignition, Battery or Alternator Warning Light

- a. Check the alternator output and voltage regulator operation. An intermittent condition may indicate worn brushes, an internal short, or a defective voltage regulator. Replace the alternator or failed component.
- b. Check the warning light wiring for a shorted, pinched or damaged wire and repair as necessary.

Check Engine Light

- a. Check the engine for required maintenance and tune-up status. Verify engine tune-up specifications, as well as spark plug, air filter and engine oil condition; replace and/or adjust items as necessary.
- b. Check the fuel tank for low fuel level causing an intermittent lean fuel mixture. Top off fuel tank and reset check engine light.
- c. Check for an intermittent failure or partially disconnected engine fuel and ignition component, sensor or control unit; repair or replace as necessary.
- d. Check the intake manifold and vacuum hoses for air leaks, and repair as necessary.
- e. Check the warning light wiring for a shorted, pinched or damaged wire and repair as necessary.

Anti-Lock Braking System (ABS) Light

- a. Check the wheel sensors and sensor rings for debris, and clean as necessary.
- b. Check the brake master cylinder for fluid leakage or seal failure and replace as necessary.
- c. Check the ABS control unit, pump and proportioning valves for proper operation, and replace as necessary.
- d. Check the sensor wiring at the wheel sensors and the ABS control unit for a loose or shorted wire and repair as necessary.

Brake Warning Light

- a. Check the brake fluid level and check for possible leakage from the hydraulic lines and seals. Top off brake fluid and repair leakage as necessary.
- b. Check the brake linings for wear and replace as necessary.
- c. Check for a loose or shorted brake warning light sensor or wire, and replace or repair as necessary.

Oil Pressure Warning Light

- a. Stop the engine immediately. Check the engine oil level and check for a sudden and rapid oil loss, such as a leaking oil line or oil pressure sensor, and repair or replace as necessary.
- b. Check the oil pressure sensor operation by substituting a known good sensor.
- c. Check the oil pressure sensor wire for being shorted to ground. Disconnect the wire from the oil pressure sensor and with the ignition in the ON position, but not running, the oil pressure light should not be working. If the light works with the wire disconnected, check the sensor wire for being shorted to ground. Check the wire routing to make sure the wire is not pinched and check for insulation damage. Repair or replace the wire as necessary and recheck before starting the engine.
- d. Remove the oil pan and check for a clogged oil pick-up tube screen.

Parking Brake Warning Light

- a. Check the brake release mechanism and verify the parking brake has been fully released.
- b. Check the parking brake light switch for looseness or misalignment.
- c. Check for a damaged switch or a loose or shorted brake light switch wire, and replace or repair as necessary.

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3. Warning light(s) inoperative with ignition on, and engine not started

- a. Check for a defective bulb by installing a known good bulb.
- b. Check for a defective wire using the appropriate wiring diagram(s).
- c. Check for a defective sending unit by removing and then grounding the wire at the sending unit. If the light comes on with the ignition on when grounding the wire, replace the sending unit.

5-F. Turn Signal and 4-Way Hazard Lights

1. Turn signals or hazard lights come on, but do not flash

- a. Check for a defective flasher unit and replace as necessary.

2. Turn signals or hazard lights do not function on either side

- a. Check the fuse and replace, if defective.
- b. Check the flasher unit by substituting a known good flasher unit.
- c. Check the turn signal electrical system for a defective component, open circuit, short circuit or poor ground.

3. Turn signals or hazard lights only work on one side

- a. Check for failed bulbs and replace as necessary.
- b. Check for poor grounds in both housings and repair as necessary.

4. One signal light does not work

- a. Check for a failed bulb and replace as necessary.
- b. Check for corrosion in the bulb socket, and clean and repair as necessary.
- c. Check for a poor ground at the bulb socket, and clean and repair as necessary.

5. Turn signals flash too slowly

- a. Check signal bulb(s) wattage and replace with lower wattage bulb(s).

6. Turn signals flash too fast

- a. Check signal bulb(s) wattage and replace with higher wattage bulb(s).
- b. Check for installation of the correct flasher unit and replace if incorrect.

7. Four-way hazard flasher indicator light inoperative

- a. Verify that the exterior lights are functioning and, if so, replace indicator bulb.
- b. Check the operation of the warning flasher switch and replace if defective.

8. Turn signal indicator light(s) do not work in either direction

- a. Verify that the exterior lights are functioning and, if so, replace indicator bulb(s).
- b. Check for a defective flasher unit by substituting a known good unit.

9. One turn signal indicator light does not work

- a. Check for a defective bulb and replace as necessary.

- b. Check for a defective flasher unit by substituting a known good unit.

5-G. Horn

1. Horn does not operate

- a. Check for a defective fuse and replace as necessary.
- b. Check for battery voltage and ground at horn electrical connections when pressing the horn switch. If voltage is present, replace the horn assembly. If voltage or ground is not present, refer to Chassis Electrical coverage for additional troubleshooting techniques and circuit information.

2. Horn has an unusual tone

- a. On single horn systems, replace the horn.
- b. On dual horn systems, check the operation of the second horn. Dual horn systems have a high and low pitched horn. Unplug one horn at a time and recheck operation. Replace the horn which does not function.
- c. Check for debris or condensation build-up in horn and verify the horn positioning. If the horn has a single opening, adjust the opening downward to allow for adequate drainage and to prevent debris build-up.

5-H. Windshield Wipers

1. Windshield wipers do not operate

- a. Check fuse and replace as necessary.
- b. Check switch operation and repair or replace as necessary.
- c. Check for corroded, loose, disconnected or broken wires and clean or repair as necessary.
- d. Check the ground circuit for the wiper switch or motor and repair as necessary.

2. Windshield wiper motor makes a humming noise, gets hot or blows fuses

- a. Wiper motor damaged internally; replace the wiper motor.
- b. Wiper linkage bent, damaged or seized. Repair or replace wiper linkage as necessary.

3. Windshield wiper motor operates, but one or both wipers fail to move

- a. Windshield wiper motor linkage loose or disconnected. Repair or replace linkage as necessary.
- b. Windshield wiper arms loose on wiper pivots. Secure wiper arm to pivot or replace both the wiper arm and pivot assembly.

4. Windshield wipers will not park

- a. Check the wiper switch operation and verify that the switch properly interrupts the power supplied to the wiper motor.
- b. If the wiper switch is functioning properly, the wiper motor parking circuit has failed. Replace the wiper motor assembly. Operate the wiper motor at least one time before installing the arms and blades to ensure correct positioning, then recheck using the highest wiper speed on a wet windshield to make sure the arms and blades do not contact the windshield trim.

6. INSTRUMENTS AND GAUGES**6-A. Speedometer (Cable Operated)****1. Speedometer does not work**

- Check and verify that the speedometer cable is properly seated into the speedometer assembly and the speedometer drive gear.
- Check the speedometer cable for breakage or rounded-off cable ends where the cable seats into the speedometer drive gear and into the speedometer assembly. If damaged, broken or the cable ends are rounded off, replace the cable.
- Check speedometer drive gear condition and replace as necessary.
- Install a known good speedometer to test for proper operation. If the substituted speedometer functions properly, replace the speedometer assembly.

2. Speedometer needle fluctuates when driving at steady speeds.

- Check speedometer cable routing or sheathing for sharp bends or kinks. Route cable to minimize sharp bends or kinks. If the sheathing has been damaged, replace the cable assembly.
- Check the speedometer cable for adequate lubrication. Remove the cable, inspect for damage, clean, lubricate and reinstall. If the cable has been damaged, replace the cable.

3. Speedometer works intermittently

- Check the cable and verify that the cable is fully installed and the fasteners are secure.
- Check the cable ends for wear and rounding, and replace as necessary.

6-B. Speedometer (Electronically Operated)**1. Speedometer does not work**

- Check the speed sensor pickup and replace as necessary.
- Check the wiring between the speed sensor and the speedometer

for corroded terminals, loose connections or broken wires and clean or repair as necessary.

- Install a known good speedometer to test for proper operation. If the substituted speedometer functions properly, replace the speedometer assembly.

2. Speedometer works intermittently

- Check the wiring between the speed sensor and the speedometer for corroded terminals, loose connections or broken wires and clean or repair as necessary.
- Check the speed sensor pickup and replace as necessary.

6-C. Fuel, Temperature and Oil Pressure Gauges**1. Gauge does not register**

- Check for a missing or blown fuse and replace as necessary.
- Check for an open circuit in the gauge wiring. Repair wiring as necessary.
- Gauge sending unit defective. Replace gauge sending unit.
- Gauge or sending unit improperly installed. Verify installation and wiring, and repair as necessary.

2. Gauge operates erratically

- Check for loose, shorted, damaged or corroded electrical connections or wiring and repair as necessary.
- Check gauge sending units and replace as necessary.

3. Gauge operates fully pegged

- Sending unit-to-gauge wire shorted to ground.
- Sending unit defective; replace sending unit.
- Gauge or sending unit not properly grounded.
- Gauge or sending unit improperly installed. Verify installation and wiring, and repair as necessary.

7. CLIMATE CONTROL**7-A. Air Conditioner****1. No air coming from air conditioner vents**

- Check the air conditioner fuse and replace as necessary.
- Air conditioner system discharged. Have the system evacuated, charged and leak tested by an MVAC certified technician, utilizing approved recovery/recycling equipment. Repair as necessary.
- Air conditioner low pressure switch defective. Replace switch.
- Air conditioner fan resistor pack defective. Replace resistor pack.
- Loose connection, broken wiring or defective air conditioner relay in air conditioning electrical circuit. Repair wiring or replace relay as necessary.

2. Air conditioner blows warm air

- Air conditioner system is discharged. Have the system evacuated, charged and leak tested by an MVAC certified technician,

utilizing approved recovery/recycling equipment. Repair as necessary.

- Air conditioner compressor clutch not engaging. Check compressor clutch wiring, electrical connections and compressor clutch, and repair or replace as necessary.

3. Water collects on the interior floor when the air conditioner is used

- Air conditioner evaporator drain hose is blocked. Clear the drain hose where it exits the passenger compartment.
- Air conditioner evaporator drain hose is disconnected. Secure the drain hose to the evaporator drainage tray under the dashboard.

4. Air conditioner has a moldy odor when used

- The air conditioner evaporator drain hose is blocked or partially re-stricted, allowing condensation to build up around the evapo-

rator and drainage tray. Clear the drain hose where it exits the passenger compartment.

7-B. Heater

1. Blower motor does not operate

- a. Check blower motor fuse and replace as necessary.
- b. Check blower motor wiring for loose, damaged or corroded contacts and repair as necessary.
- c. Check blower motor switch and resistor pack for open circuits, and repair or replace as necessary.
- d. Check blower motor for internal damage and repair or replace as necessary.

2. Heater blows cool air

- a. Check the engine coolant level. If the coolant level is low, top off and bleed the air from the cooling system as necessary and check for coolant leaks.
- b. Check engine coolant operating temperature. If coolant temperature is below specification, check for a damaged or stuck thermostat.

- c. Check the heater control valve operation. Check the heater control valve cable or vacuum hose for proper installation. Move the heater temperature control from hot to cold several times and verify the operation of the heater control valve. With the engine at normal operating temperature and the heater temperature control in the full hot position, carefully feel the heater hose going into and exiting the control valve. If one heater hose is hot and the other is much cooler, replace the control valve.

3. Heater steams the windshield when used

- a. Check for a loose cooling system hose clamp or leaking coolant hose near the engine firewall or under the dash area, and repair as necessary.
- b. Check for the existence of a sweet odor and fluid dripping from the heater floor vents, indicating a failed or damaged heater core. Pressure test the cooling system with the heater set to the fully warm position and check for fluid leakage from the floor vents. If leakage is verified, remove and replace the heater core assembly.

NOTE: On some vehicles, the dashboard must be disassembled and removed to access the heater core.

GLOSSARY

AIR/FUEL RATIO: The ratio of air-to-gasoline by weight in the fuel mixture drawn into the engine.

AIR INJECTION: One method of reducing harmful exhaust emissions by injecting air into each of the exhaust ports of an engine. The fresh air entering the hot exhaust manifold causes any remaining fuel to be burned before it can exit the tailpipe.

ALTERNATOR: A device used for converting mechanical energy into electrical energy.

AMMETER: An instrument, calibrated in amperes, used to measure the flow of an electrical current in a circuit. Ammeters are always connected in series with the circuit being tested.

AMPERE: The rate of flow of electrical current present when one volt of electrical pressure is applied against one ohm of electrical resistance.

ANALOG COMPUTER: Any microprocessor that uses similar (analogous) electrical signals to make its calculations.

ARMATURE: A laminated, soft iron core wrapped by a wire that converts electrical energy to mechanical energy as in a motor or relay. When rotated in a magnetic field, it changes mechanical energy into electrical energy as in a generator.

ATMOSPHERIC PRESSURE: The pressure on the Earth's surface caused by the weight of the air in the atmosphere. At sea level, this pressure is 14.7 psi at 32°F (101 kPa at 0°C).

ATOMIZATION: The breaking down of a liquid into a fine mist that can be suspended in air.

AXIAL PLAY: Movement parallel to a shaft or bearing bore.

BACKFIRE: The sudden combustion of gases in the intake or exhaust system that results in a loud explosion.

BACKLASH: The clearance or play between two parts, such as meshed gears.

BACKPRESSURE: Restrictions in the exhaust system that slow the exit of exhaust gases from the combustion chamber.

BAKELITE: A heat resistant, plastic insulator material commonly used in printed circuit boards and transistorized components.

BALL BEARING: A bearing made up of hardened inner and outer races between which hardened steel balls roll.

BALLAST RESISTOR: A resistor in the primary ignition circuit that lowers voltage after the engine is started to reduce wear on ignition components.

BEARING: A friction reducing, supportive device usually located between a stationary part and a moving part.

BIMETAL TEMPERATURE SENSOR: Any sensor or switch made of two dissimilar types of metal that bend when heated or cooled due to the different expansion rates of the alloys. These types of sensors usually function as an on/off switch.

BLOWBY: Combustion gases, composed of water vapor and unburned fuel, that leak past the piston rings into the crankcase during normal engine operation. These gases are removed by the PCV system to prevent the buildup of harmful acids in the crankcase.

BRAKE PAD: A brake shoe and lining assembly used with disc brakes.

BRAKE SHOE: The backing for the brake lining. The term is, however, usually applied to the assembly of the brake backing and lining.

BUSHING: A liner, usually removable, for a bearing; an anti-friction liner used in place of a bearing.

CALIPER: A hydraulically activated device in a disc brake system, which is mounted straddling the brake rotor (disc). The caliper contains at least one piston and two brake pads. Hydraulic pressure on the piston(s) forces the pads against the rotor.

CAMSHAFT: A shaft in the engine on which are the lobes (cams) which operate the valves. The camshaft is driven by the crankshaft, via a belt, chain or gears, at one half the crankshaft speed.

CAPACITOR: A device which stores an electrical charge.

CARBON MONOXIDE (CO): A colorless, odorless gas given off as a normal byproduct of combustion. It is poisonous and extremely dangerous in confined areas, building up slowly to toxic levels without warning if adequate ventilation is not available.

CARBURETOR: A device, usually mounted on the intake manifold of an engine, which mixes the air and fuel in the proper proportion to allow even combustion.

CATALYTIC CONVERTER: A device installed in the exhaust system, like a muffler, that converts harmful byproducts of combustion into carbon dioxide and water vapor by means of a heat-producing chemical reaction.

CENTRIFUGAL ADVANCE: A mechanical method of advancing the spark timing by using flyweights in the distributor that react to centrifugal force generated by the distributor shaft rotation.

CHECK VALVE: Any one-way valve installed to permit the flow of air, fuel or vacuum in one direction only.

CHOKE: A device, usually a moveable valve, placed in the intake path of a carburetor to restrict the flow of air.

CIRCUIT: Any unbroken path through which an electrical current can flow. Also used to describe fuel flow in some instances.

CIRCUIT BREAKER: A switch which protects an electrical circuit from overload by opening the circuit when the current flow exceeds a predetermined level. Some circuit breakers must be reset manually, while most reset automatically.

COIL (IGNITION): A transformer in the ignition circuit which steps up the voltage provided to the spark plugs.

COMBINATION MANIFOLD: An assembly which includes both the intake and exhaust manifolds in one casting.

COMBINATION VALVE: A device used in some fuel systems that routes fuel vapors to a charcoal storage canister instead of venting them into the atmosphere. The valve relieves fuel tank pressure and allows fresh air into the tank as the fuel level drops to prevent a vapor lock situation.

COMPRESSION RATIO: The comparison of the total volume of the cylinder and combustion chamber with the piston at BDC and the piston at TDC.

CONDENSER: 1. An electrical device which acts to store an electrical charge, preventing voltage surges. 2. A radiator-like device in the air conditioning system in which refrigerant gas condenses into a liquid, giving off heat.

CONDUCTOR: Any material through which an electrical current can be transmitted easily.

CONTINUITY: Continuous or complete circuit. Can be checked with an ohmmeter.

COUNTERSHAFT: An intermediate shaft which is rotated by a mainshaft and transmits, in turn, that rotation to a working part.

CRANKCASE: The lower part of an engine in which the crankshaft and related parts operate.

CRANKSHAFT: The main driving shaft of an engine which receives reciprocating motion from the pistons and converts it to rotary motion.

CYLINDER: In an engine, the round hole in the engine block in which the piston(s) ride.

CYLINDER BLOCK: The main structural member of an engine in which is found the cylinders, crankshaft and other principal parts.

CYLINDER HEAD: The detachable portion of the engine, usually fastened to the top of the cylinder block and containing all or most of the combustion chambers. On overhead valve engines, it contains the valves and their operating parts. On overhead cam engines, it contains the camshaft as well.

DEAD CENTER: The extreme top or bottom of the piston stroke.

DETONATION: An unwanted explosion of the air/fuel mixture in the combustion chamber caused by excess heat and compression, advanced timing, or an overly lean mixture. Also referred to as "ping".

DIAPHRAGM: A thin, flexible wall separating two cavities, such as in a vacuum advance unit.

DIESELING: A condition in which hot spots in the combustion chamber cause the engine to run on after the key is turned off.

DIFFERENTIAL: A geared assembly which allows the transmission of motion between drive axles, giving one axle the ability to turn faster than the other.

DIODE: An electrical device that will allow current to flow in one direction only.

DISC BRAKE: A hydraulic braking assembly consisting of a brake disc, or rotor, mounted on an axle, and a caliper assembly containing, usually two brake pads which are activated by hydraulic pressure. The pads are forced against the sides of the disc, creating friction which slows the vehicle.

DISTRIBUTOR: A mechanically driven device on an engine which is responsible for electrically firing the spark plug at a predetermined point of the piston stroke.

DOWEL PIN: A pin, inserted in mating holes in two different parts allowing those parts to maintain a fixed relationship.

DRUM BRAKE: A braking system which consists of two brake shoes and one or two wheel cylinders, mounted on a fixed backing plate, and a brake drum, mounted on an axle, which revolves around the assembly.

DWELL: The rate, measured in degrees of shaft rotation, at which an electrical circuit cycles on and off.

ELECTRONIC CONTROL UNIT (ECU): Ignition module, module, amplifier or igniter. See Module for definition.

ELECTRONIC IGNITION: A system in which the timing and firing of the spark plugs is controlled by an electronic control unit, usually called a module. These systems have no points or condenser.

END-PLAY: The measured amount of axial movement in a shaft.

ENGINE: A device that converts heat into mechanical energy.

EXHAUST MANIFOLD: A set of cast passages or pipes which conduct exhaust gases from the engine.

FEELER GAUGE: A blade, usually metal, of precisely predetermined thickness, used to measure the clearance between two parts.

FIRING ORDER: The order in which combustion occurs in the cylinders of an engine. Also the order in which spark is distributed to the plugs by the distributor.

FLOODING: The presence of too much fuel in the intake manifold and combustion chamber which prevents the air/fuel mixture from firing, thereby causing a no-start situation.

FLYWHEEL: A disc shaped part bolted to the rear end of the crankshaft. Around the outer perimeter is affixed the ring gear. The starter drive engages the ring gear, turning the flywheel, which rotates the crankshaft, imparting the initial starting motion to the engine.

FOOT POUND (ft. lbs. or sometimes, ft. lb.): The amount of energy or work needed to raise an item weighing one pound, a distance of one foot.

FUSE: A protective device in a circuit which prevents circuit overload by breaking the circuit when a specific amperage is present. The device is constructed around a strip or wire of a lower amperage rating than the circuit it is designed to protect. When an amperage higher than that stamped on the fuse is present in the circuit, the strip or wire melts, opening the circuit.

GEAR RATIO: The ratio between the number of teeth on meshing gears.

GENERATOR: A device which converts mechanical energy into electrical energy.

HEAT RANGE: The measure of a spark plug's ability to dissipate heat from its firing end. The higher the heat range, the hotter the plug fires.

HUB: The center part of a wheel or gear.

HYDROCARBON (HC): Any chemical compound made up of hydrogen and carbon. A major pollutant formed by the engine as a byproduct of combustion.

HYDROMETER: An instrument used to measure the specific gravity of a solution.

INCH POUND (inch lbs.; sometimes in.lb. or in. lbs.): One twelfth of a foot pound.

INDUCTION: A means of transferring electrical energy in the form of a magnetic field. Principle used in the ignition coil to increase voltage.

INJECTOR: A device which receives metered fuel under relatively low pressure and is activated to inject the fuel into the engine under relatively high pressure at a predetermined time.

INPUT SHAFT: The shaft to which torque is applied, usually carrying the driving gear or gears.

INTAKE MANIFOLD: A casting of passages or pipes used to conduct air or a fuel/air mixture to the cylinders.

JOURNAL: The bearing surface within which a shaft operates.

KEY: A small block usually fitted in a notch between a shaft and a hub to prevent slippage of the two parts.

MANIFOLD: A casting of passages or set of pipes which connect the cylinders to an inlet or outlet source.

MANIFOLD VACUUM: Low pressure in an engine intake manifold formed just below the throttle plates. Manifold vacuum is highest at idle and drops under acceleration.

MASTER CYLINDER: The primary fluid pressurizing device in a hydraulic system. In automotive use, it is found in brake and hydraulic clutch systems and is pedal activated, either directly or, in a power brake system, through the power booster.

MODULE: Electronic control unit, amplifier or igniter of solid state or integrated design which controls the current flow in the ignition primary circuit based on input from the pick-up coil. When the module opens the primary circuit, high secondary voltage is induced in the coil.

NEEDLE BEARING: A bearing which consists of a number (usually a large number) of long, thin rollers.

OHM: (Ω) The unit used to measure the resistance of conductor-to-electrical flow. One ohm is the amount of resistance that limits current flow to one ampere in a circuit with one volt of pressure.

OHMMETER: An instrument used for measuring the resistance, in ohms, in an electrical circuit.

OUTPUT SHAFT: The shaft which transmits torque from a device, such as a transmission.

OVERDRIVE: A gear assembly which produces more shaft revolutions than that transmitted to it.

OVERHEAD CAMSHAFT (OHC): An engine configuration in which the camshaft is mounted on top of the cylinder head and operates the valve either directly or by means of rocker arms.

OVERHEAD VALVE (OHV): An engine configuration in which all of the valves are located in the cylinder head and the camshaft is located in the cylinder block. The camshaft operates the valves via lifters and pushrods.

OXIDES OF NITROGEN (NOx): Chemical compounds of nitrogen produced as a byproduct of combustion. They combine with hydrocarbons to produce smog.

OXYGEN SENSOR: Use with the feedback system to sense the presence of oxygen in the exhaust gas and signal the computer which can reference the voltage signal to an air/fuel ratio.

PINION: The smaller of two meshing gears.

PISTON RING: An open-ended ring with fits into a groove on the outer diameter of the piston. Its chief function is to form a seal between the piston and cylinder wall. Most automotive pistons have three rings: two for compression sealing; one for oil sealing.

PRELOAD: A predetermined load placed on a bearing during assembly or by adjustment.

PRIMARY CIRCUIT: the low voltage side of the ignition system which consists of the ignition switch, ballast resistor or resistance wire, bypass, coil, electronic control unit and pick-up coil as well as the connecting wires and harnesses.

PRESS FIT: The mating of two parts under pressure, due to the inner diameter of one being smaller than the outer diameter of the other, or vice versa; an interference fit.

RACE: The surface on the inner or outer ring of a bearing on which the balls, needles or rollers move.

REGULATOR: A device which maintains the amperage and/or voltage levels of a circuit at predetermined values.

RELAY: A switch which automatically opens and/or closes a circuit.

RESISTANCE: The opposition to the flow of current through a circuit or electrical device, and is measured in ohms. Resistance is equal to the voltage divided by the amperage.

RESISTOR: A device, usually made of wire, which offers a preset amount of resistance in an electrical circuit.

RING GEAR: The name given to a ring-shaped gear attached to a differential case, or affixed to a flywheel or as part of a planetary gear set.

ROLLER BEARING: A bearing made up of hardened inner and outer races between which hardened steel rollers move.

ROTOR: 1. The disc-shaped part of a disc brake assembly, upon which the brake pads bear; also called, brake disc. 2. The device mounted atop the distributor shaft, which passes current to the distributor cap tower contacts.

SECONDARY CIRCUIT: The high voltage side of the ignition system, usually above 20,000 volts. The secondary includes the ignition coil, coil wire, distributor cap and rotor, spark plug wires and spark plugs.

SENDING UNIT: A mechanical, electrical, hydraulic or electro-magnetic device which transmits information to a gauge.

SENSOR: Any device designed to measure engine operating conditions or ambient pressures and temperatures. Usually electronic in nature and designed to send a voltage signal to an on-board computer, some sensors may operate as a simple on/off switch or they may provide a variable voltage signal (like a potentiometer) as conditions or measured parameters change.

SHIM: Spacers of precise, predetermined thickness used between parts to establish a proper working relationship.

SLAVE CYLINDER: In automotive use, a device in the hydraulic clutch system which is activated by hydraulic force, disengaging the clutch.

SOLENOID: A coil used to produce a magnetic field, the effect of which is to produce work.

SPARK PLUG: A device screwed into the combustion chamber of a spark ignition engine. The basic construction is a conductive core inside of a ceramic insulator, mounted in an outer conductive base. An electrical charge from the spark plug wire travels along the conductive core and jumps a preset air gap to a grounding point or points at the end of the conductive base. The resultant spark ignites the fuel/air mixture in the combustion chamber.

SPLINES: Ridges machined or cast onto the outer diameter of a shaft or inner diameter of a bore to enable parts to mate without rotation.

TACHOMETER: A device used to measure the rotary speed of an engine, shaft, gear, etc., usually in rotations per minute.

THERMOSTAT: A valve, located in the cooling system of an engine, which is closed when cold and opens gradually in response to engine heating, controlling the temperature of the coolant and rate of coolant flow.

TOP DEAD CENTER (TDC): The point at which the piston reaches the top of its travel on the compression stroke.

TORQUE: The twisting force applied to an object.

TORQUE CONVERTER: A turbine used to transmit power from a driving member to a driven member via hydraulic action, providing changes in drive ratio and torque. In automotive use, it links the driveplate at the rear of the engine to the automatic transmission.

TRANSDUCER: A device used to change a force into an electrical signal.

TRANSISTOR: A semi-conductor component which can be actuated by a small voltage to perform an electrical switching function.

TUNE-UP: A regular maintenance function, usually associated with the replacement and adjustment of parts and components in the electrical and fuel systems of a vehicle for the purpose of attaining optimum performance.

TURBOCHARGER: An exhaust driven pump which compresses intake air and forces it into the combustion chambers at higher than atmospheric pressures. The increased air pressure allows more fuel to be burned and results in increased horsepower being produced.

VACUUM ADVANCE: A device which advances the ignition timing in response to increased engine vacuum.

VACUUM GAUGE: An instrument used to measure the presence of vacuum in a chamber.

VALVE: A device which control the pressure, direction of flow or rate of flow of a liquid or gas.

VALVE CLEARANCE: The measured gap between the end of the valve stem and the rocker arm, cam lobe or follower that activates the valve.

VISCOSITY: The rating of a liquid's internal resistance to flow.

VOLTMETER: An instrument used for measuring electrical force in units called volts. Voltmeters are always connected parallel with the circuit being tested.

WHEEL CYLINDER: Found in the automotive drum brake assembly, it is a device, actuated by hydraulic pressure, which, through internal pistons, pushes the brake shoes outward against the drums.

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