

ENGINE

CONTENTS

Engine General Description	Section 6
3.4 Liter V6 Engine On-Vehicle Service	Section 6A2A
3.4 Liter V6 Engine Unit Repair	Section 6A2B
5.7 Liter V8 Engine On-Vehicle Service	Section 6A3A
5.7 Liter V8 Engine Unit Repair	Section 6A3B
Cooling and Radiator	Section 6B
Engine Fuel	Section 6C
Engine Electrical	Section 6D
Battery	Section 6D1
Cranking System	Section 6D2
Charging System	Section 6D3
Ignition System	Section 6D4
Engine Wiring	Section 6D5
Driveability and Emissions – General Information	Section 6E
Driveability and Emissions – Fuel Injection (Port) (3.4L)	Section 6E3 (3.4L)
Driveability and Emissions – Fuel Injection (Port) (5.7L)	Section 6E3 (5.7L)
Exhaust System	Section 6F

SECTION 6

ENGINE GENERAL DESCRIPTION

CAUTION: This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to CAUTIONS in Section 9J under "ON-VEHICLE SERVICE" and the SIR Component and Wiring Location view in Section 9J before performing service on or around SIR components or wiring. Failure to follow CAUTIONS could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

CONTENTS

Description of Section 6	6-2	Low or No Oil Pressure	6-4
Section 6A – Engine Mechanical	6-2	Engine Noise Diagnosis	6-4
Section 6B – Cooling and Radiator	6-2	Main Bearing Noise	6-4
Section 6C – Engine Fuel	6-2	Connecting Rod Bearing Noise	6-4
Section 6D – Engine Electrical	6-2	Timing Gear or Chain and Sprocket Noises	6-4
Section 6E – Driveability and Emissions –		Piston Noises	6-4
General Information	6-2	Valve Mechanism or Valve Train Noises	6-5
Section 6F – Exhaust System	6-2	Flywheel Noises (Automatic Transmission)	6-5
General Information	6-2	Engine Knock Diagnosis	6-5
Cleanliness and Care	6-2	Knocks Cold and Continues for Two to Three	
General Information on Engine Service	6-2	Minutes and Increases with Torque	6-5
Engine Performance Diagnosis	6-3	Heavy Knock Hot with Torque Applied	6-5
Engine Mechanical Diagnosis	6-3	Light Knock Hot	6-6
Excessive Oil Loss	6-3	Knocks on Initial Start-Up but Only Lasts	
Oil Leak Diagnosis	6-3	a Few Seconds	6-6
Finding the Leak	6-3	Knocks at Idle Hot	6-6
Repairing the Leak	6-3	Engine Compression Test	6-6

ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

DESCRIPTION OF SECTION 6

SECTION 6A – ENGINE MECHANICAL

This section contains information on the mechanical parts of the engine, such as the block, crankshaft, pistons, valve train, and camshaft. Overhaul procedures, removal and replacement procedures, and specifications are also covered. The specific subsections are:

- 6A2A – 3.4 Liter V6 Engine On-Vehicle Service
- 6A2B – 3.4 Liter V6 Engine Unit Repair
- 6A3A – 5.7 Liter V8 Engine On-Vehicle Service
- 6A3B – 5.7 Liter V8 Engine Unit Repair

SECTION 6B – COOLING AND RADIATOR

Engine cooling system components such as the radiator, water pump, hoses, thermostat, and cooling fan, are covered in this section.

SECTION 6C – ENGINE FUEL

This section contains information on all the parts of the fuel system except the Throttle Body Injection (TBI) unit itself. Items covered are: fuel tank, fuel pump, fuel filter, and fuel lines.

SECTION 6D – ENGINE ELECTRICAL

Items covered in this section are the battery, generator, starter, distributor, engine wire harness, spark plugs and wires.

Ignition system diagnosis can be found in the appropriate 6E Section as a “C-4” chart.

Specific subsections are:

- 6D – Engine Electrical
- 6D1 – Battery
- 6D2 – Cranking System
- 6D3 – Charging System
- 6D4 – Ignition System
- 6D5 – Engine Wiring

SECTION 6E – DRIVEABILITY AND EMISSIONS – GENERAL INFORMATION

This section covers emission control systems, general information, and diagnostic procedures which will lead to repairing performance and driveability related problems. Emission components are covered, as well as removal and replacement procedures. Instructions on use of special tools are also given. Specific subsections are:

- 6E – Driveability and Emissions – General Information
- 6E3 (3.4L) – Driveability and Emissions – Fuel Injection (Port) (3.4L)
- 6E3 (5.7L) – Driveability and Emissions – Fuel Injection (Port) (5.7L)

SECTION 6F – EXHAUST SYSTEM

This section has information on all exhaust system parts, such as tailpipes, mufflers, and the catalytic converter.

GENERAL INFORMATION

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wiring harness or other electrical parts.

GENERAL INFORMATION ON ENGINE SERVICE

Important

THE FOLLOWING INFORMATION ON ENGINE SERVICE SHOULD BE NOTED CAREFULLY, AS IT IS IMPORTANT IN PREVENTING DAMAGE AND IN CONTRIBUTING TO RELIABLE ENGINE PERFORMANCE.

When raising or supporting the engine for any reason, do not use a jack under the oil pan. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause it to be bent against the pump screen resulting in a damaged oil pick-up unit.

When working on the engine, remember that the 12-volt electrical system is capable of causing short circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected at the battery.

Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow that intake passage into the cylinder and cause extensive damage when the engine is started.

IN THE MECHANICAL PROCEDURES DESCRIBED IN THIS SECTION, REFERENCES WILL BE MADE TO THE REMOVAL OF EQUIPMENT SUCH AS POWER STEERING PUMP, AIR CONDITIONING COMPRESSOR, ETC.

SHOULD IT BECOME NECESSARY TO REMOVE ANY SUCH ITEM TO PERFORM OTHER SERVICES, REFER TO THE APPROPRIATE SECTION OF THIS SERVICE MANUAL FOR SPECIFIC INFORMATION.

ENGINE PERFORMANCE DIAGNOSIS

Engine performance diagnosis procedures are covered in Section 6E and should be consulted for diagnosis of any driveability, emissions, or "Service Engine Soon" light complaint.

Refer to:

- SECTION 6E – Driveability and Emissions – General Information
- SECTION 6E3 (3.4L) – Driveability and Emissions – Fuel Injection (Port) (3.4L)
- SECTION 6E3 (5.7L) – Driveability and Emissions – Fuel Injection (Port) (5.7L)

ENGINE MECHANICAL DIAGNOSIS

The following diagnostic information covers common problems and possible causes. When the proper diagnosis is made, the problem should be corrected by adjustment, repair or part replacement as required. Refer to the appropriate section of the manual for these procedures.

EXCESSIVE OIL LOSS

Excessive oil consumption, not due to leaks, is the use of 2 quarts (1.9L) or more of engine oil within 2,000 miles or 3 200 kilometers.

- External oil leaks. Tighten bolts and/or replace gaskets and seals as necessary.
- Improper reading of oil level indicator (dipstick). Check oil with vehicle on a level surface and allow adequate drain-down time.
- Improper oil viscosity. Use recommended SAE viscosity for prevailing temperatures. Refer to SECTION 0B for engine oil specifications.
- Continuous high speed driving, and/or severe usage such as trailer hauling, will normally cause decreased oil mileage.
- Crankcase ventilation system malfunctioning.
- Valve guides and/or valve stem seals worn, or seals omitted. Ream guides and install oversize service valves and/or new valve stem seals.
- Piston rings broken, improperly installed, worn, or not seated. Allow adequate time for rings to seat. Replace broken or worn rings as necessary.
- Piston improperly installed or misfitted.

OIL LEAK DIAGNOSIS

Most oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedure may help in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid, determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.

2. At what point is the fluid leaking from? After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper. After a few minutes, the approximate location of the leak should be found by the drippings on the paper.
3. Visually check around the suspected component. Check around all gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent. Clean the area well, then dry the area. Operate the vehicle for several miles at normal operating temperature and varying speeds. After operating the vehicle, visually check the suspected component. If leak still cannot be located, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component. The leak path to the source should be found by tracing the white powder surface.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour specified amount of dye into leaking component.
2. Operate the vehicle under normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check to be sure that the following conditions are correct as they may cause a leak.

Gaskets

Inspect

- Fluid level/pressure is too high.
- Crankcase ventilation system malfunctioning.
- Improperly tightened fasteners or dirty/damaged threads.
- Warped flanges or sealing surface.
- Scratches, burrs or other damage to the sealing surface.
- Damaged or worn gasket.

- Cracking or porosity of the component.
- Improper sealant used (where applicable).

Seals

- Fluid level/pressure is too high.
- Crankcase ventilation system malfunctioning.
- Damaged seal bore (scratched, burred or nicked).
- Damaged or worn seal.
- Improper installation.
- Cracks in components.
- Shaft surface scratched, nicked or damaged.
- Loose or worn bearing causing excess seal wear.

LOW OR NO OIL PRESSURE

- Low oil level. Fill to full mark on oil level indicator.
- Slow idle speed.
- Incorrect or malfunctioning oil pressure switch.
- Incorrect or malfunctioning oil pressure gage. Replace with proper gage.
- Improper oil viscosity or diluted oil. Install oil of proper viscosity for expected temperature, or install new oil if diluted with moisture or unburned fuel mixtures.
- Oil pump worn or dirty.
- Plugged oil filter.
- Oil pickup screen loose or plugged.
- Hole in oil pickup tube.
- Excessive bearing clearance. Replace if necessary.
- Cracked, porous or plugged oil galleries. Repair or replace block.
- Gallery plugs missing or misinstalled. Install plugs or repair as necessary.
- Camshaft worn, or poorly machined. Replace camshaft.

ENGINE NOISE DIAGNOSIS

There are four steps to diagnosing engine noise. You must determine:

1. Type of noise.
2. Under which operating conditions it exists.
3. At what rate, and at what location in the engine.
4. Compare sounds in other engines to make sure the condition is not normal.

Identify the type of noise, for example, a light rattle or a low rumble. Determine the exact operating conditions under which the noise appears.

Remember, engine noises are generally synchronized to either speed (caused by the crankshaft, connecting rods or pistons) or one-half engine speed (valve train noises). Try to determine the rate at which the noise is occurring.

MAIN BEARING NOISE

Damaged or worn main bearing noise is revealed by dull thuds or knocks which happen on every engine revolution, and this noise is loudest when the engine is under heavy load.

Excessive crankshaft end play is indicated by an intermittent rap or knock sharper than a worn main bearing. Causes of main bearing noises include:

- Low oil pump pressure.
- Thin, diluted or dirty oil and/or filter.
- Excessive main bearing clearance.
- Excessive crankshaft end play.
- Out-of-round crankshaft journals.
- Excessive belt tension.
- Loose crankshaft pulley.
- Loose flywheel or torque converter.
- Loose main bearing cap.

CONNECTING ROD BEARING NOISE

A damaged or worn connecting rod bearing will produce knock under all speeds. During the early stages of wear, connecting rod noise may be confused with piston slap or loose wrist pins. Connecting rod knock noise increases in volume with engine speed and is at its loudest on deceleration. Causes of connecting rod bearing noise include:

- Excessive bearing clearance.
- Worn crankshaft connecting rod journal.
- Thin, diluted or dirty oil and/or filter.
- Low oil pressure.
- Crankshaft connecting rod journals out-of-round.
- Misaligned connecting rod.
- Connecting rod bolts not properly torqued.
- Wrong bearing inserts or misaligned bearing half.

TIMING GEAR OR CHAIN AND SPROCKET NOISES

Engines designed with timing gears, or those equipped with timing chain and sprockets, can produce different noises. The most common noise is a high frequency, light knocking sound. This sound will generally be the same in intensity whether the engine is idling, operating at high speeds, or under load. Causes of timing gear or chain and sprocket noises include:

- Worn timing chain and/or gears.
- Misaligned gears.
- Excessive backlash.
- Damaged tooth.
- Gear or sprocket loose on shaft.
- Too much end play in the camshaft or crankshaft.

PISTON NOISES

Piston pin, piston, and connecting rod noises are hard to separate. A loose piston pin, for example, causes a sharp double knock usually heard when the engine is idling, or during sudden acceleration then deceleration of the engine. A piston pin that has been improperly fitted will emit a light ticking noise that is more noticeable with no load on the engine.

Excessive piston-to-cylinder bore clearance will cause piston slap noise. The noise is similar to a metallic knock, as if the piston were "slapping" the cylinder wall during its stroke. As with most engine noises, understanding the cause of the noise will help you imagine what the noise sounds like. An indication of piston slap is a decrease in noise as the engine warms up. When the engine is cold, the piston-to-bore clearance is greater and piston slap will be louder. Causes of piston noises include:

- Worn or loose piston pin or bushing.
- Improper fit of pin.
- Excessive piston-to-cylinder bore clearance (piston slap).
- Lack of lubrication.
- Carbon deposits on top of piston striking cylinder head.
- Worn or broken piston ring land.
- Broken or cracked piston.
- Misaligned connecting rods.
- Worn or damaged rings.
- Worn or out-of-round cylinder walls.
- Excessive ring land clearance.
- Insufficient ring-end gap clearance.
- Piston 180 degrees out of position.
- Incorrect piston cam grind.

VALVE MECHANISM OR VALVE TRAIN NOISES

A light tapping at one-half engine speed, or any varying frequency, can indicate a valve train problem. These tapping noises increase with engine speed.

Before attempting to judge valve train noises, thoroughly warm up the engine. This will bring all engine components to a normal state of expansion. Also, run the engine at various speeds and listen for engine noise with the hood closed while sitting in the driver's seat.

If the valve mechanism is abnormally noisy, remove the rocker arm covers and use an engine stethoscope to determine which valves or valve train parts are causing the noise.

CAUTION: This procedure is not recommended on engines with stainless steel exhaust manifolds because manifold temperature will exceed the flash point of the oil causing a fire with possible personal injury.

Causes of valve mechanism noises include:

- Broken or weak valve spring(s).
- Sticking or warped valves.
- Bent pushrods.
- Dirty, stuck, worn or defective valve lifters.
- Damaged or improperly machined camshaft lobes.
- Insufficient or poor oil supply to valve train (low oil pressure).
- Excessive valve stem-to-guide clearance.
- Worn valve guides.

- Worn rocker arms or pushrods.
- Broken rocker arm studs.
- Loose or worn rocker arm attachments.
- Missing or mispositioned lifter guides (roller lifter engines).

FLYWHEEL NOISES (AUTOMATIC TRANSMISSION)

A loose or cracked flywheel will produce an irregular thud or click. To test for a loose or cracked flywheel, operate the vehicle at approximately 20 mph (32 km/h) and shut off the engine. If a thud is heard, the flywheel may be loose or damaged. This type of thud is loudest on deceleration.

Loose torque converter-to-flywheel or flywheel-to-crankshaft bolts will sound similar to bearing knock. This condition produces several raps during quick acceleration on a free running engine. Depending on the idle smoothness, when the transmission is in gear, the noise may or may not appear. Check the torque converter-to-flywheel and flywheel-to-crankshaft bolts before attempting to investigate any bearing-related knock.

NOTICE: Be sure the converter-to-flywheel bolts are not too long. Converter bolts that are too long may dimple the torque converter clutch surface causing a shudder condition.

ENGINE KNOCK DIAGNOSIS

Noises in engines are sometimes characteristic of the design. Compare the sounds in other engines to make sure the condition is not normal.

KNOCKS COLD AND CONTINUES FOR TWO TO THREE MINUTES AND INCREASES WITH TORQUE

- Flywheel contacting splash shield. Reposition splash shield.
- Loose or broken balancer or drive pulleys. Tighten or replace as necessary.
- Excessive piston-to-bore clearance. Replace piston.
- Bent connecting rod.
- Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock which disappears in 1.5 minutes should be considered acceptable.

HEAVY KNOCK HOT WITH TORQUE APPLIED

- Broken balancer or pulley hub. Replace parts as necessary.
- Loose torque converter bolts.
- Exhaust system grounded. Reposition as necessary.
- Flywheel cracked.
- Excessive main bearing clearance. Replace as necessary.
- Excessive rod bearing clearance. Replace as necessary.

LIGHT KNOCK HOT

- Detonation or spark knock. Check operation of EST or ESC. Refer to SECTION 6E3. Check engine timing and fuel quality.
- Loose torque converter bolts. Tighten bolts.
- Exhaust leak at manifold. Tighten bolts and/or replace manifold.
- Excessive rod bearing clearance. Replace bearings as necessary.

KNOCKS ON INITIAL START-UP BUT ONLY LASTS A FEW SECONDS

- Improper oil viscosity. Install proper oil viscosity for expected temperatures. Refer to SECTION 0B for engine oil specifications.
- Hydraulic lifter bleed down. Clean, test and replace as necessary.
 - When the engine is stopped, some valves will be open. Spring pressure against lifters will tend to bleed lifter down. Attempts to repair should be made only if the problem is consistent.
 - An engine that is operated for only short periods between start-ups may have lifter noise that lasts for a few minutes. This is a normal condition.
- Excessive crankshaft end clearance. Replace crankshaft thrust bearing.
- Excessive front main bearing clearance. Replace worn parts.

KNOCKS AT IDLE HOT

- A/C compressor or generator bearing. Replace as necessary.
- Valve train. Replace parts as necessary.
- Improper oil viscosity. Install proper viscosity oil for expected temperature. Refer to SECTION 0B for engine oil specifications.
- Excessive piston pin clearance. Replace piston and pin.
- Connecting rod alignment. Check and replace rods as necessary.
- Loose crankshaft balancer. Torque and/or replace worn parts.
- Piston pin offset to wrong side. Install correct piston.

ENGINE COMPRESSION TEST

A compression pressure test is performed on the engine cylinders to determine the condition of the rings, valves and head gasket.

 Remove or Disconnect

1. Run engine until it reaches normal operating temperature. Battery must be at or near full charge.

2. Turn engine off.
3. Two-wire terminal connector from distributor.
4. Spark plugs from all cylinders.
5. Air duct or air cleaner from throttle body.
 - Block throttle plate in open position.

**Measure**

- Engine compression.
 - A. Install compression gage firmly to cylinder spark plug hole.
 - B. Have a helper crank the engine through at least four compression strokes in the cylinder being tested and check the readings on the gage at each stroke. Record the results.
 - C. Disconnect gage.
 - D. Repeat compression test for each cylinder.

**Inspect**

- Record compression readings from all cylinders. The lowest reading should not be less than 70 percent of the highest and no cylinder reading should be less than 689 kPa (100 psi).
- Problem areas can be identified as follows:
 - Normal – Compression builds up quick and evenly to specified compression on each cylinder.
 - Piston Rings – Compression is low on first stroke and tends to build up on following strokes, but does not reach normal. Compression improves considerably with the addition of oil. Use approximately three squirts from a plunger type oiler.
 - Valves – Compression is low on first stroke and it does not tend to build up in following strokes. Compression does not improve much with the addition of oil. Use approximately three squirts from a plunger type oiler.
 - Head Gaskets – Leaking head gaskets give nearly the same test results as valve problems but may be recognized by engine coolant in the crankcase. Head gasket leakage between two cylinders will give low readings on both cylinders.

**Install or Connect**

1. Remove block from throttle plate.
2. Air duct or air cleaner to throttle body.
3. Spark plugs.
4. Two-wire terminal connector to distributor.