

Fig. 2 Vehicle Identification Number Plate Location

marking indicating the strength of the material in the fastener as outlined below. Metric cross recess screws are identified by a Posidriv or Type 1A cross recess as shown in Figure 8. Either a Phillips head or Type 1A cross recess screwdriver can be used in Posidriv recess screw heads, but Type 1A cross recess screwdrivers will perform better.

NOTICE: Most metric fasteners have a blue color coating. However, this should not be used as a positive way of identifying as some metric fasteners are not color coated.

General Motors Engineering Standards, along with other North American Industries, have adopted a portion of the standard metric fastener sizes defined by ISO (International Standards Organization). This was done to reduce the number of fastener sizes used and yet retain the best strength qualities in each thread size. For example, the customary 1/4-20 and 1/4-28 screws are replaced by the metric M6.0 X 1 screw which has nearly the same diameter and 25.4 threads per inch. The thread pitch is in between the customary coarse and fine thread pitches.

Metric and customary thread notation differ slightly. The difference is shown in Figure 9.

FASTENER STRENGTH IDENTIFICATION

Most commonly used metric fastener strength property classes are 9.8 and 10.9 with the class identification embossed on the head of each bolt. Customary (inch) strength classes range from grade 2 to 8 with radial line identification embossed on each bolt head (i.e., grade 7 bolt will exhibit 5 embossed radial lines on the bolt head). Some metric nuts will be marked with single digit strength identification numbers on the nut face. Figure 12 shows the different strength markings.

When replacing metric fasteners, be careful to use bolts and nuts of the same strength or greater than the original fasteners (the same number marking or higher). It is also important to select replacement fasteners of the correct size. Correct replacement bolts and nuts are available through the parts division. Many metric fasteners available in the after-market parts channels were designed to metric standards of countries other than the United States. These fasteners may be of a lower strength, different thread pitch and may not have

the numbered head marking system. The metric fasteners used on GM products are designed to new, international standards that may not be used by some nondomestic bolt and nut suppliers. In general, except for special applications, the common sizes and pitches are:

M 6.0 X 1
M 10 X 1.5

M 8 x 1.25
M 12 X 1.75
M 14 X 2

PREVAILING TORQUE FASTENERS

A prevailing torque nut is designed to develop an interference between the nut and bolt threads. This is most often accomplished by distortion of the top of an all-metal nut or by using a nylon patch on the threads in the middle of the hex flat. A nylon insert may also be used as a method of interference between nut and bolt threads (Fig. 11).

A prevailing torque bolt is designed to develop an interference between bolt and nut threads, or the threads of a tapped hole. This is accomplished by distorting some of the threads or by using a nylon patch or adhesive (Fig. 11).

RECOMMENDATIONS FOR FASTENER REUSE:

1. Clean, unrusted prevailing torque nuts and bolts may be reused as follows:
 - a. Clean dirt and other foreign material off nut or bolt.
 - b. Inspect nut or bolt to insure there are no cracks, elongation, or other signs of abuse or overtightening. (If there is any doubt, replace with a new prevailing torque fastener of equal or greater strength.)
 - c. Lightly coat bolt & nut with engine oil. Assemble parts and hand start nut or bolt.
 - d. Observe that before fastener seats, it develops torque per the chart in Figure 10. (If there is any doubt, replace with a new prevailing torque fastener of equal or greater strength.)
 - e. Tighten fastener to torque specified in appropriate section of this manual.
2. Bolts and nuts which are rusty or damaged should be replaced with new parts of equal or greater strength.

VEHICLE LIFTING PROCEDURES

NOTICE: When jacking or lifting vehicle from frame side rails, be certain lift pads do not contact catalytic converter as damage to converter will result.

Many dealer service facilities and service stations are equipped with a type of automotive hoist which must bear upon some part of the frame in order to lift the vehicle. Figures 14 and 15 indicate the recommended areas for hoist contact for Pontiac Sunbird models.

If any other hoist methods are used, special care must be used not to damage the fuel tank, filler neck, exhaust system or underbody.

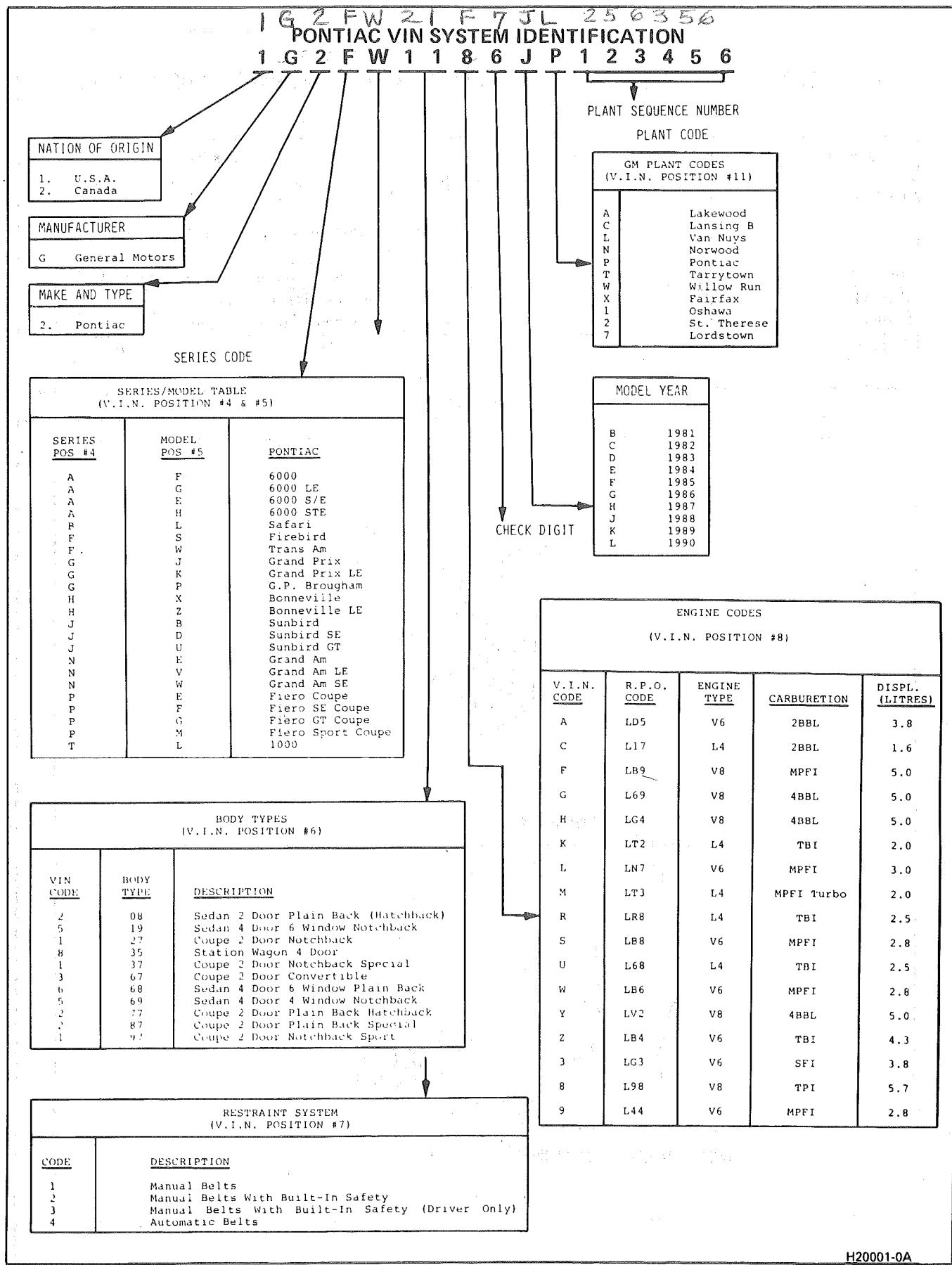


Fig. 3 Vehicle Identification Number Data

H20001-0A

VEHICLE COMPONENT IDENTIFICATION NUMBER LOCATION

Component	Type	Location
Transmission	Automatic	Refer to Fig. 0A-6.
	5-Speed (77mm)	Drivers side, metal tag attached to extension housing bolt
Rear Axle Number	All	On right or left axle tube adjacent to carrier
Generator	All	On top drive end frame
Starter	All	Stamped on outer case, toward rear
Battery	All	On cell cover segment, top of battery

Fig. 0A4 -- Component I.D. Location

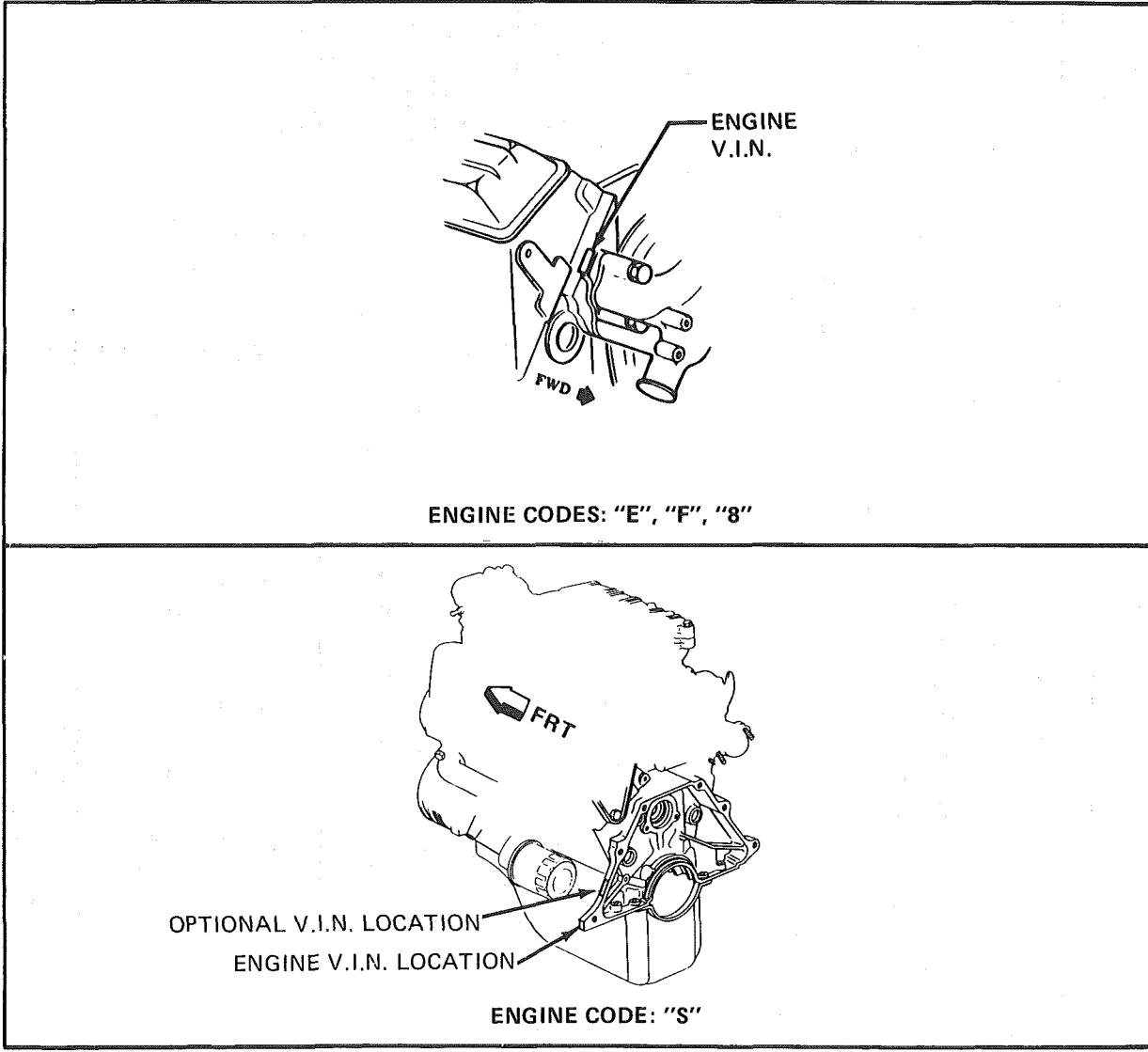


Fig. 0A-5 -- Engine V.I.N. Location

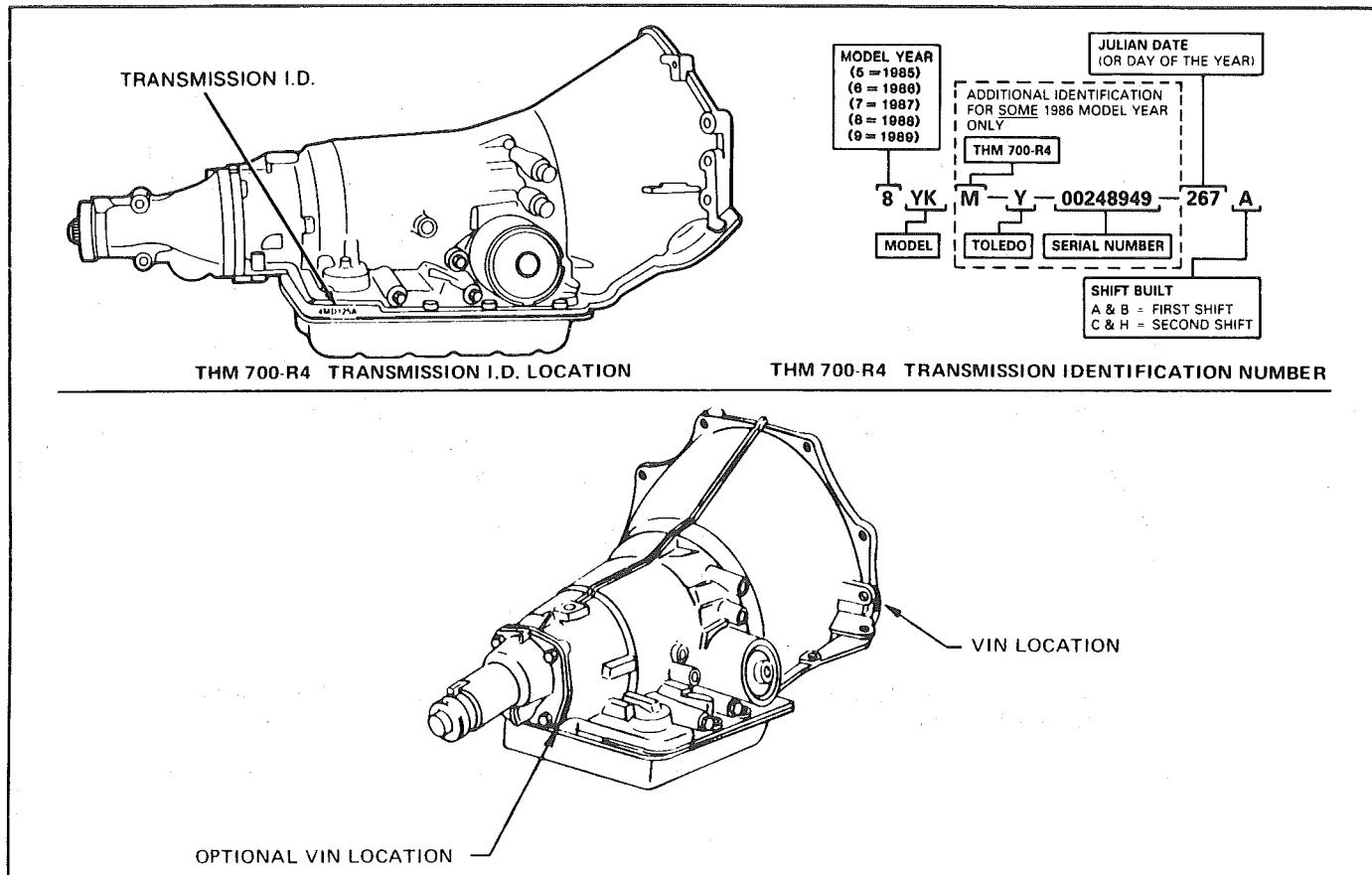


Fig. 0A-6 -- Transmission VIN Location

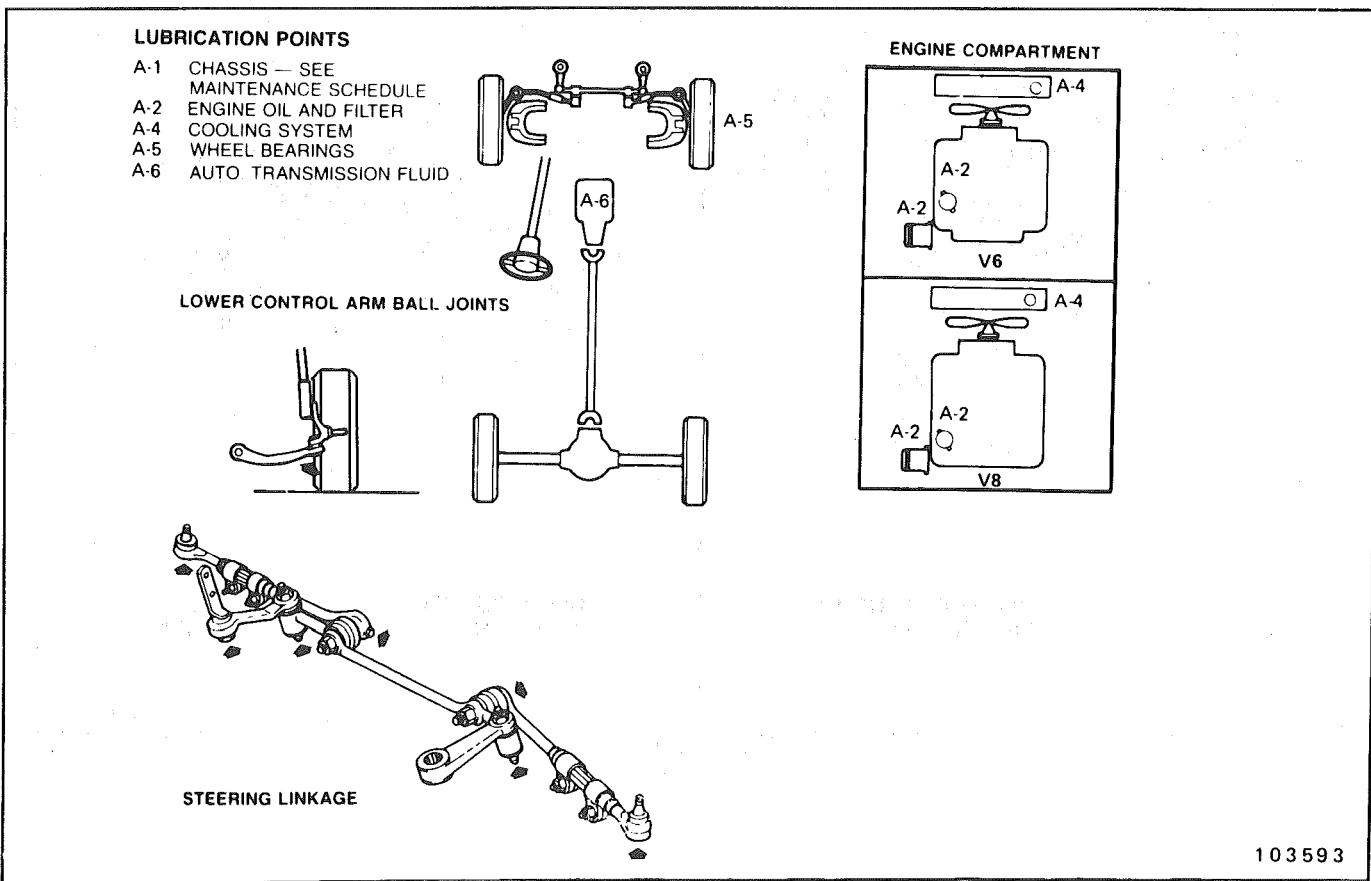
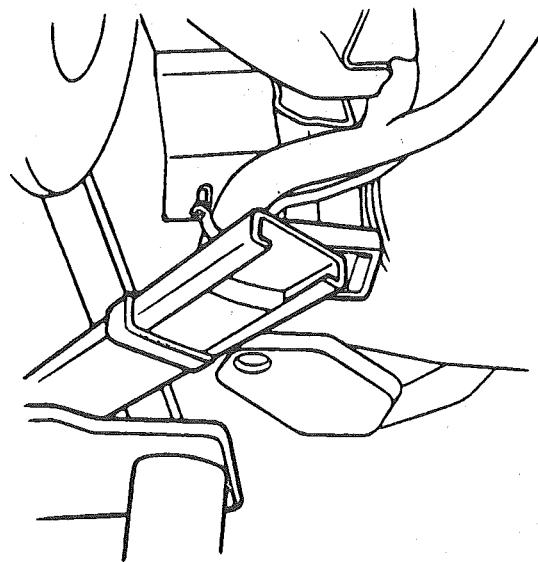
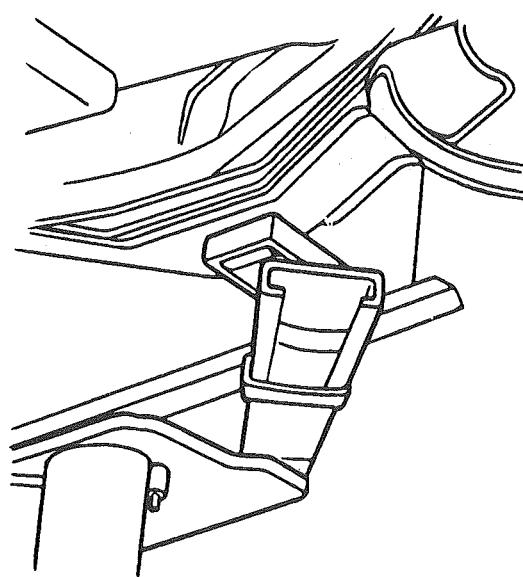


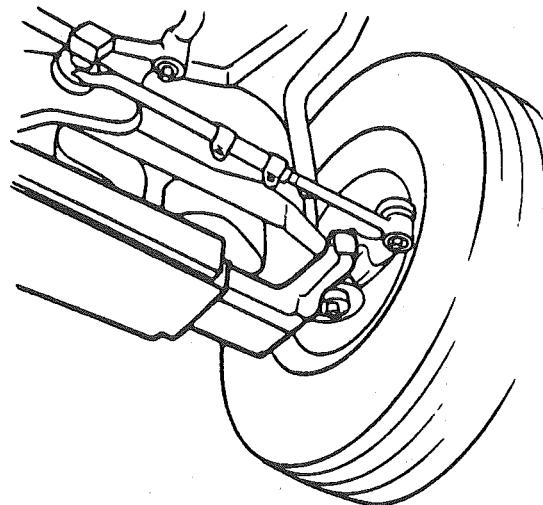
Fig. OA-7 Typical Lubrication Points



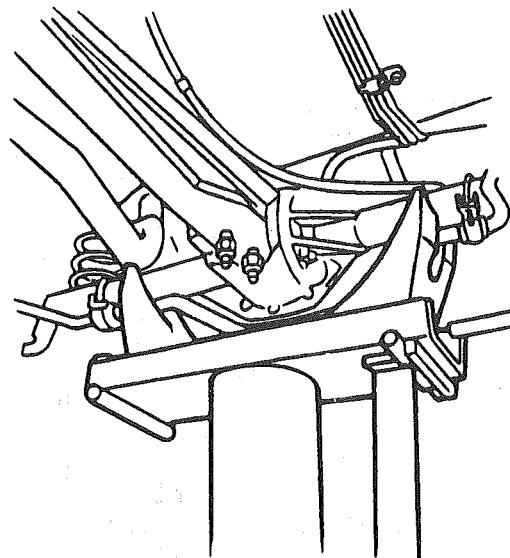
USING FRAME CONTACT HOIST
REARWARD OF FRONT TIRE



USING FRAME CONTACT HOIST
FORWARD OF REAR TIRE



USING SUSPENSION CONTACT HOIST
LIFTING ON REAR AXLE



USING SUSPENSION CONTACT HOIST
UNDER FRONT LOWER CONTROL ARM

520016-0A

Fig. 8 Vehicle Lifting Points "F" Model

APPROXIMATE CAPACITIES

Fuel Tank	Metric	U.S.
Fuel Injected Models	60.2L	15.9 Gal.

CRANKCASE

Engine Code	Engine	Metric	U.S.
S	2.8L V6	3.8L*	4.0 Qts.*
E,F,8	5.0L V8 Oil Change Oil and Filter Change	3.8L 4.7L	4.0 Qts. 5.0 Qts.

*Approximate capacity with or without oil filter change.

Crankcase capacities shown are approximate refill capacities. After refill, recheck oil as outlined in the Owner's Manual.

COOLING SYSTEM

Engine Code	Engine	Metric	U.S.
S	2.8L V6 Without A/C With A/C	11.7L 11.7L	12.5 Qts. 12.5 Qts.
E	5.0L V8 Without A/C With A/C	14.5L 14.8L	15.3 Qts. 15.6 Qts.
F,8	5.0L V8 Without A/C With A/C	16.1L 16.1L	17.0 Qts. 17.0 Qts.

Fig. OA-9 Fluid Capacities

USE OF METRIC AND CUSTOMARY NUTS, BOLTS AND SCREWS

Some vehicles present special service requirements to the technician due to the use of both metric and customary (inch) type nuts, bolts and screws. Many are metric and some are very close in dimension to customary nuts, bolts and screws in the inch system. Mismatched or incorrect nuts, bolts and screws can result in damage, malfunction or possible personal injury. Nuts, bolts and screws removed from the vehicle should be saved for re-use whenever possible. If they are not re-usable, care should be taken to select a replacement that matches the original.

General Motors Engineering Standards have adopted a portion of the standard metric fastener sizes defined by SI (Systeme International). This was done to reduce the number of sizes used and yet retain the best strength characteristics in each thread size. For example, the customary 1/4-20 and 1/4-28 screws are replaced by the metric M6.3 x 1 screw which has nearly the same diameter and 25.4 threads per inch. The thread pitch is in between the customary coarse and fine thread pitches.

Metric and customary thread notation differ slightly. The difference is illustrated below.

CUSTOMARY	METRIC
1/4	M6.3
Thread Major	Thread Major
Diameter	Diameter
in Inches	in Millimeters
20	1
Number of	Distance
Threads	Between Threads
per Inch	in Millimeters

Care should be taken when servicing the vehicle to guard against cross threading or improper retention due to interchanged metric and inch nuts and bolts.

When obtaining metric or customary nuts, bolts, and screws locally for servicing the vehicle, care must be exercised in selecting parts that are equivalent to the original parts in dimensions, strength, and pitch of threads.

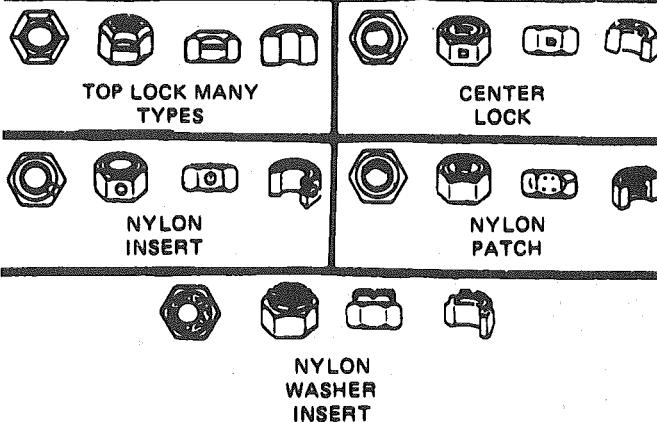
Fig. 0A-10 -- Metric Information, Chart A

REUSE OF PREVAILING TORQUE NUT(S) AND BOLT(S)

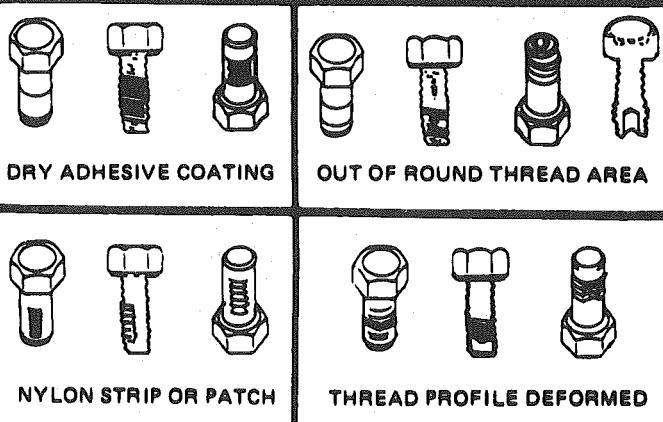
PREVAILING TORQUE NUTS ARE THOSE NUTS WHICH INCORPORATE A SYSTEM TO DEVELOP AN INTERFERENCE BETWEEN NUT AND BOLT THREADS. INTERFERENCE IS MOST COMMONLY ACHIEVED BY DISTORTING TOP OF ALL-METAL NUT, BUT ALSO MAY BE ACHIEVED BY DISTORTING AT MIDDLE OF HEX FLAT, BY NYLON PATCH ON THREADS, BY NYLON WASHER INSERT AT TOP OF NUT AND BY NYLON INSERT THROUGH NUT.

PREVAILING TORQUE BOLTS ARE THOSE BOLTS WHICH INCORPORATE A SYSTEM TO DEVELOP AN INTERFERENCE BETWEEN BOLT AND NUT OR TAPPED HOLE THREADS. INTERFERENCE IS ACHIEVED BY DISTORTING SOME OF THE THREADS (SEVERAL METHODS EXIST), BY APPLYING A NYLON PATCH OR STRIP OR BY ADHESIVE COATING ON THREADS.

PREVAILING TORQUE NUTS



PREVAILING TORQUE BOLTS



RECOMMENDATIONS FOR REUSE

A. CLEAN, UNRUSTED PREVAILING TORQUE BOLTS AND NUTS MAY BE REUSED AS FOLLOWS:

1. CLEAN DIRT AND OTHER FOREIGN MATERIAL OFF NUT AND BOLT.
2. INSPECT BOLT AND NUT TO ASSURE THERE ARE NO CRACKS, ELONGATION OR OTHER SIGNS OF ABUSE OR OVERTIGHTENING. LIGHTLY LUBRICATE THREADS. (IF ANY DOUBT, REPLACE WITH NEW PREVAILING TORQUE FASTENER OF EQUAL OR GREATER STRENGTH.)
3. ASSEMBLE PARTS AND START BOLT OR NUT.
4. OBSERVE THAT BEFORE FASTENER SEATS, IT DEVELOPS PREVAILING TORQUE PER CHART BELOW. (IF ANY DOUBT, INSTALL NEW PREVAILING TORQUE FASTENER OF EQUAL OR GREATER STRENGTH).
5. TIGHTEN TO TORQUE SPECIFIED IN SERVICE MANUAL.

B. BOLTS AND NUTS WHICH ARE RUSTY OR DAMAGED SHOULD BE REPLACED WITH NEW PARTS OF EQUAL OR GREATER STRENGTH.

METRIC SIZES

	6 & 6.3	8	10	12	14	16	20	
NUTS AND ALL METAL BOLTS	N·m	0.4	0.8	1.4	2.2	3.0	4.2	7.0
	In. Lbs.	4.0	7.0	12	18	25	35	57
ADHESIVE OR NYLON COATED BOLTS	N·m	0.4	0.6	1.2	1.6	2.4	3.4	5.6
	In. Lbs.	4.0	5.0	10	14	20	28	46

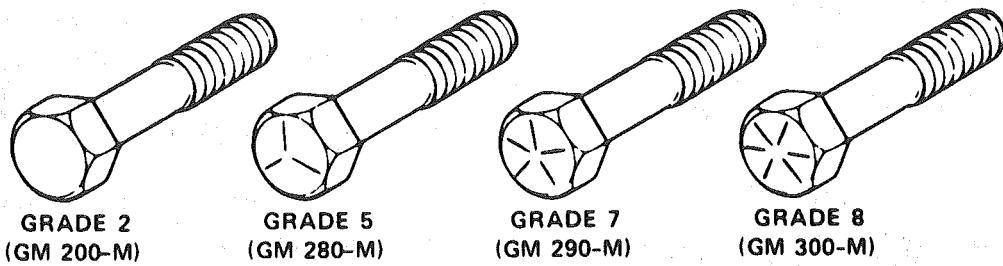
INCH SIZES

	.250	.312	.375	.437	.500	.562	.625	.750	
NUTS AND ALL METAL BOLTS	N·m	0.4	0.6	1.4	1.8	2.4	3.2	4.2	6.2
	In. Lbs.	4.0	5.0	12	15	20	27	35	51
ADHESIVE OR NYLON COATED BOLTS	N·m	0.4	0.6	1.0	1.4	1.8	2.6	3.4	5.2
	In. Lbs.	4.0	5.0	9.0	12	15	22	28	43

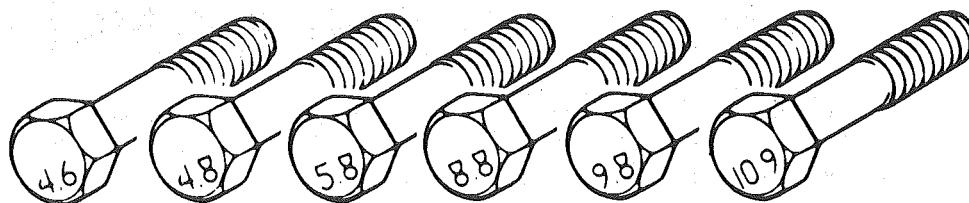
Fig. 0A-11 -- Metric Information, Chart B

METRIC BOLT AND NUT IDENTIFICATION

Common metric fastener strength property classes are 9.8 and 10.9 with the class identification embossed on the head of each bolt. Customary (inch) strength classes range from grade 2 to 8 with line identification embossed on each bolt head. Markings correspond to two lines less than the actual grade (i.e. grade 7 bolt will exhibit 5 embossed lines on the bolt head). Some metric nuts will be marked with single digit strength identification numbers on the nut face. The following figure illustrates the different strength markings.



Customary (inch) bolts - Identification marks correspond to bolt strength - Increasing numbers represent increasing strength.

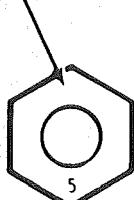


Metric Bolts - Identification class numbers correspond to bolt strength - Increasing numbers represent increasing strength.

MANUFACTURERS IDENTIFICATION



NUT STRENGTH IDENTIFICATION



POZIDRIV SCREW HEAD

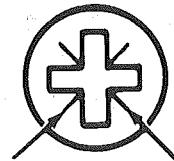


Fig. 0A-12 -- Metric Information, Chart C

SI METRIC-CUSTOMARY CONVERSION TABLE

Multiply	by	to get equivalent number of:	Multiply	by	to get equivalent number of:
		LENGTH			ACCELERATION
Inch	25.4	millimeters (mm)	Foot/sec ²	0.304	meter/sec ² (m/s ²)
Foot	0.304	meters (m)	Inch/sec ²	0.025	meter/sec ²
Yard	0.914	meters			
Mile	1.609	kilometers (km)			
		AREA			TORQUE
Inch ²	645.2	millimeters ² (mm ²)	Pound-inch	0.112	newton-meters (N·m)
	6.45	centimeters ² (cm ²)	Pound-foot	1.355	newton-meters
Foot ²	0.092	meters ² (m ²)			
Yard ²	0.836	meters ²			
		VOLUME			POWER
Inch ³	16 387.	mm ³	Horsepower	0.746	kilowatts (kW)
	16.387	cm ³			
	0.016	liters (l)			
Quart	0.946	liters			
Gallon	3.785	liters			
Yard ³	0.764	meters ³ (m ³)			
		MASS			PRESSURE OR STRESS
Pound	0.453	kilograms (kg)	Inches of mercury	3.377	kilopascals (kPa)
Ton	907.18	kilograms (kg)	Pounds/sq. in.	6.895	kilopascals
Ton	0.907	tonne (t)			
		FORCE			ENERGY OR WORK
Kilogram	9.807	newtons (N)	BTU	1 055.	joules (J)
Ounce	0.278	newtons	Foot-pound	1.355	joules
Pound	4.448	newtons	Kilowatt-hour	3 600 000. or 3.6x10 ⁶	joules (J = one W's)
		TEMPERATURE			LIGHT
Degree Fahrenheit	(°F-32) ÷ 1.8	degree Celsius (C)	Foot candle	10.764	lumens/meter ² (lm/m ²)
					FUEL PERFORMANCE
			Miles/gal	0.425	kilometers/liter (km/l)
			Gal/mile	2.352	liters/kilometer (l/km)
					VELOCITY
			Miles/hour	1.609	kilometer/hr. (km/h)

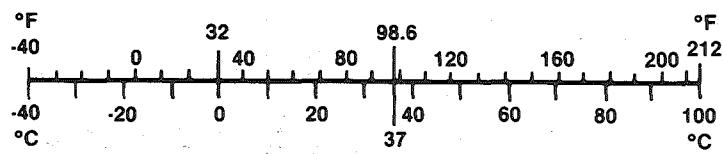


Fig. 0A-13--Metric Information, Chart D

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric MM.	Fractions	Decimal In.	Metric MM.
1/6401562539688	33/64515625	13.09687
1/320312579375	17/3253125	13.49375
3/64046875	1.19062	35/64546875	13.89062
1/160625	1.58750	9/165625	14.28750
5/64078125	1.98437	37/64578125	14.68437
3/3209375	2.38125	19/3259375	15.08125
7/64109375	2.77812	39/64609375	15.47812
1/8125	3.1750	5/8625	15.87500
9/64140625	3.57187	41/64640625	16.27187
5/3215625	3.96875	21/3265625	16.66875
11/64171875	4.36562	43/64671875	17.06562
3/161875	4.76250	11/166875	17.46250
13/64203125	5.15937	45/64703125	17.85937
7/3221875	5.55625	23/3271875	18.25625
15/64234375	5.95312	47/64734375	18.65312
1/4250	6.35000	3/4750	19.05000
17/64265625	6.74687	49/64765625	19.44687
9/3228125	7.14375	25/3278125	19.84375
19/64296875	7.54062	51/64796875	20.24062
5/163125	7.93750	13/168125	20.63750
21/64328125	8.33437	53/64828125	21.03437
11/3234375	8.73125	27/3284375	21.43125
23/64359375	9.12812	55/64859375	21.82812
3/8375	9.52500	7/8875	22.22500
25/64390625	9.92187	57/64890625	22.62187
13/3240625	10.31875	29/3290625	23.01875
27/64421875	10.71562	59/64921875	23.41562
7/164375	11.11250	15/169375	23.81250
29/64453125	11.50937	61/64953125	24.20937
15/3246875	11.90625	31/3296875	24.60625
31/64484375	12.30312	63/64984375	25.00312
1/2500	12.70000	1	1.00	25.40000

Fig. 0A-14 -- Metric Information, Chart E

LIST OF AUTOMOTIVE ABBREVIATIONS WHICH MAY BE USED IN THIS MANUAL

A - Ampere(s)	EFF - Early Fuel Evaporation	OHC - Overhead Cam
A-6 - Axial 6 Cyl. A/C Compressor	EFI - Electronic Fuel Injection	OL - Open Loop
A/C - Air Conditioning	EGR - Exhaust Gas Recirculation	OXY - Oxygen
ACC - Automatic Climate Control	ELC - Electronic Level Control	PAIR - Pulse Air Injection Reaction System
Adj. - Adjust	EMF - Electromotive Force	PB - Power Brakes
A.F - Air Fuel (As in Air Fuel Ratio)	EMR - Electronic Module Retard	PCV - Positive Crankcase Ventilation
AIR - Air Injection Reaction System	EOS - Exhaust Oxygen Sensor	PECV - Power Enrichment Control Valve
ALC - Automatic Level Control	ESC - Electronic Spark Control	P N - Park, Neutral
ALCL - Assembly Line Communications Link	EST - Electronic Spark Timing	PROM - Programmable, Read Only Memory
Alt. - Altitude	ETC - Electronic Temperature Control	PS - Power Steering
APT - Adjustable Part Throttle	ETCC - Electronic Touch Comfort Control	PSI - Pounds Per Square Inch
AT - Automatic Transmission	ETR - Electronically Tuned Receiver	Pt. - Pint
ATC - Automatic Temperature Control	Exh. - Exhaust	PTO - Power Takeoff
ATDC - After Top Dead Center	FMVSS - Federal Motor Vehicle Safety Standards	Qt. - Quart
BARO - Barometric Absolute Pressure Sensor	Ft. Lb. - Foot Pounds (Torque)	R - Resistance
Bat. - Battery	FWD - Front Wheel Drive	R-4 - Radial Four Cyl. A/C Compressor
Bat. + - Positive Terminal	4WD - Four Wheel Drive	RF - Right Front
Bbl. - Barrel	4x4 - Four Wheel Drive	RPM - Revolutions Per Minute
BHP - Brake Horsepower	HD - Heavy Duty	RR - Right Rear
BP - Back Pressure	HEI - High Energy Ignition	RTV - Room Temperature Vulcanizing (Sealer)
BTDC - Before Top Dead Center	Hg. - Mercury	RVR - Response Vacuum Reducer
Cat. Conv. - Catalytic Converter	Hi. Alt. - High Altitude	RWD - Rear Wheel Drive
CC - Catalytic Converter	HVAC - Heater-Vent-Air Conditioning	SAE - Society of Automotive Engineers
- Cubic Centimeter	HVACM - Heater-Vent-Air Conditioning Module	SI - System International
- Converter Clutch	HVM - Heater-Vent-Module	Sol. - Solenoid
CCC - Computer Command Control	IAC - Idle Air Control	TAC - Thermostatic Air Cleaner
C-4 - Computer Controlled Catalytic Converter	IC - Integrated Circuit	TACH - Tachometer
CB - Citizens Band (Radio)	ID - Identification	TBI - Throttle Body Injection
CCOT - Cycling Clutch (Orifice) Tube	- Inside Diameter	TCC - Transmission Converter Clutch
CCP - Controlled Canister Purge	ILC - Idle Load Compensator	TCS - Transmission Controlled Spark
C.E. - Check Engine	I/P - Instrument Panel	TDC - Topdead Center
CEAB - Cold Engine Airbleed	ISC - Idle Speed Control	TPS - Throttle Position Sensor
CEMF - Counter Electromotive Force	km - Kilometers	TURB - Turbocharger
CID - Cubic Inch Displacement	km/hr - Kilometers Per Hour	T/V - Throttle Valve
CLOOP - Closed Loop	KV - Kilovolts (Thousands of Volts)	TVBV - Turbocharger Vacuum Bleed Valve
CLCC - Closed Loop Carburetor Control	km/L - Kilometers Liter (mpg)	TVRS - Television & Radio Suppression
CLTBI - Closed Loop Throttle Body Injection	kPa - Kilopascals	TVS - Thermal Vacuum Switch
Conv. - Converter	L - Liter	UJT - Universal Joint
CP - Canister Purge	L-4 - Four Cylinder In-Line (Engine)	V - Volt(s)
Cu. In. - Cubic Inch	L-6 - Six Cylinder In-Line (Engine)	V-6 - Six Cylinder Engine - Arranged in a "V"
CV - Constant Velocity	LF - Left Front	V-8 - Eight Cylinder Engine - Arranged in a "V"
Cyl. - Cylinder(s)	LR - Left Rear	Vac. - Vacuum
DBB - Dual Bed Bead	Man. Vac. - Manifold Vacuum	VATS - Vehicle Anti-Theft System
DBM - Dual Bed Monolith	MAP - Manifold Absolute Pressure	VIN - Vehicle Identification Number
DEFI - Digital Electronic Fuel Injection	MAT - Manifold Air Temperature Sensor	VIR - Valves in Receiver
DFI - Digital Fuel Injection	M/C - Mixture Control	VSS - Vehicle Speed Sensor
Diff. - Differential	MPG - Miles Per Gallon	VMV - Vacuum Modulator Valve
Distr. - Distributor	MPH - Miles Per Hour	W - With
EAC - Electric Air Control Valve	MT - Manual Transmission	WB - Wheel Base
EAS - Electric Air Switching Valve	N·m - Newton Metres (Torque)	W/O - Without
ECC - Electronic Comfort Control	OD - Outside Diameter	WOT - Wide Open Throttle
ECM - Electronic Control Module		X-Valve - Expansion Valve
ECS - Emission Control System		
ECU - Engine Calibration Unit		
EEC - Evaporative Emission Control		
EEVIR - Evaporator Equalized Valves in Receiver		

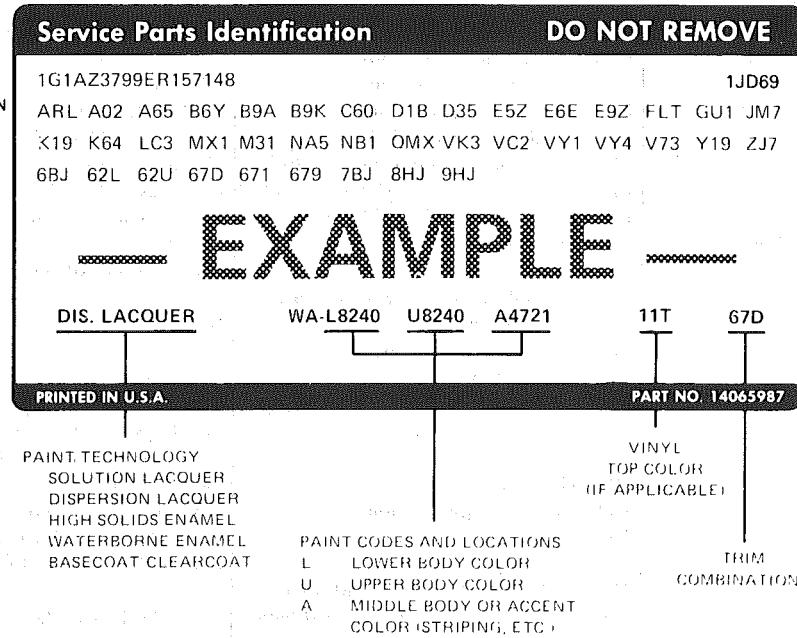
Fig. 0A-15 -- Common Abbreviations

SERVICE PARTS IDENTIFICATION LABEL

The Service Parts Identification Label provides identification of vehicle equipment to assist in servicing and determining replacement parts. Included on this label will be regular production options (RPO's) as well as standard and mandatory options. The label will be af-

fixed to the inside of each passenger car vehicle at the assembly plant.

For additional information on the Service Parts Identification Label, see a GM Parts Catalog.



LABEL LOCATION

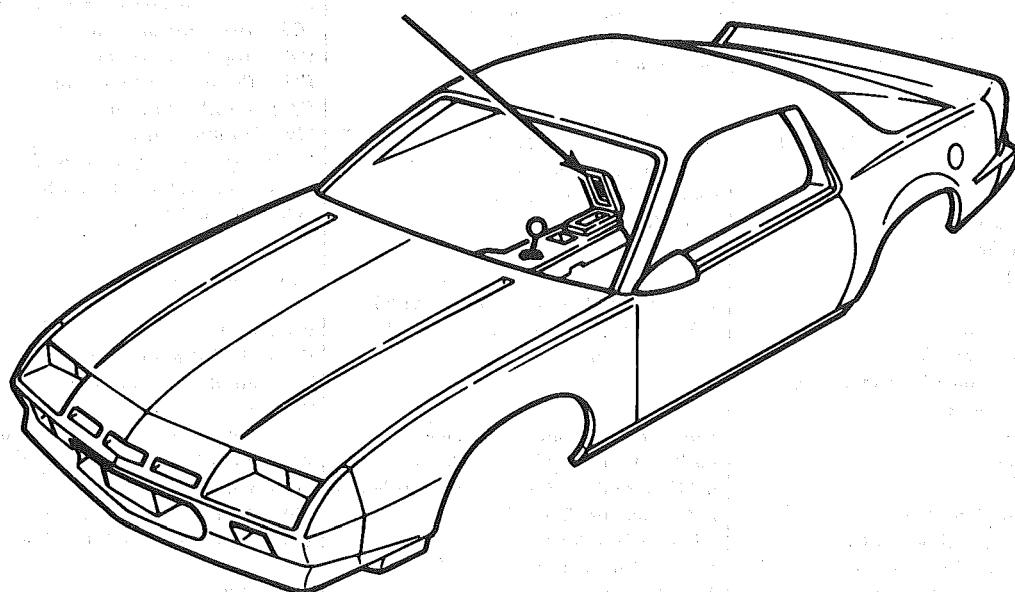


Fig. OA-16 Service Parts Identification Label

6E3 - Fuel Injection (Ported)

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 wire harness or other electrical parts.

ENGINE SERVICE

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

IN THE MECHANICAL PROCEDURES DESCRIBED IN THIS SECTION, GENERALLY NO REFERENCES WILL BE MADE TO THE REMOVAL OF OPTIONAL EQUIPMENT SUCH AS POWER STEERING PUMP, AIR CONDITIONING COMPRESSOR, ETC.

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

ENGINE PERFORMANCE DIAGNOSIS**INTRODUCTION**

Engine Performance Diagnosis procedures are guides that will lead to the most probable causes of engine performance complaints. They cover the components of the fuel, ignition, and mechanical systems that could cause a particular complaint, and then outline repairs in a logical sequence.

It is important to determine if the "Service Engine Soon" light is "ON," or has come "ON" for a short interval while driving. If the "Service Engine Soon" light has come "ON," the Computer Command Control System or DECS should be checked for stored "Trouble Codes" (See Diagnostic Circuit Check, Section 6E, for the engine you are working on) which may indicate the cause for the performance complaint. Each Symptom is defined, and it is important that the correct one be selected, based on the complaints reported or found. The definition of each symptom is included with the symptom.

The words used may not be what you are used to in all cases, but because these terms have been used

interchangeably for so long, it was necessary to decide on the most common usage and then define them. If the definition is not understood, and the exact Symptom is not used, the Diagnostic procedure will not work.

It is important to keep two facts in mind:

1. The procedures are written to diagnose problems on cars that have "run well at one time" and that time and wear have created the condition.
2. All possible causes cannot be covered, particularly with regard to emission controls. If doing the work prescribed does not correct the complaint, then either the wrong Symptom was used, or a more detailed analysis will have to be made.

All of the Symptoms can be caused by worn out or defective parts such as Spark Plugs, Ignition Wiring, etc. If time and/or mileage indicate that parts should be replaced, it is recommended that it be done.

Refer to:

- Section 6E - Driveability and Emissions

- Bent connecting rod.

HEAVY KNOCK HOT WITH TORQUE APPLIED

- Broken balancer, or pulley hub. Replace parts as necessary.
- Loose torque converter bolts.
- Accessory belts too tight or nicked. Replace and/or tension to specs as necessary.
- 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 (See Section 6D or 6E). Check engine timing and fuel quality.
- Loose torque converter bolts.
- Exhaust leak at manifold. Tighten bolts and/or replace gasket.
- Excessive rod bearing clearance. Replace bearings as necessary.

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

- Noisy mechanical fuel pump. Replace pump.
- Improper oil viscosity. Install proper oil viscosity for expected temperatures. See Owner's Manual.
- 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.

- Excessive crankshaft end clearance. Replace crankshaft thrust bearing.
- Excessive front main bearing clearance. Replace worn parts.

KNOCKS AT IDLE HOT

- Loose or worn drive belts. Tension and/or replace as necessary.
- A/C Compressor or generator bearing. Replace as necessary.
- Noisy mechanical fuel pump. Replace pump.
- Valve train. Replace parts as necessary.
- Improper oil viscosity. Install proper viscosity oil for expected temperature. See Owner's Manual.

- Excessive piston pin clearance. Ream and install oversize pins. (VIN R and 2) or replace piston and pin.
- Connecting rod alignment. Check and replace rods as necessary.
- Insufficient piston to bore clearance. Hone bore and fit new piston.
- Loose crankshaft balancer. Torque and/or replace worn parts.
- Piston pin offset to wrong side. Install correct piston.

ENGINE OVERHEATS

1. Coolant system leak, oil cooler system leak, or coolant recovery system not operating. Check for leaks and correct as required. Check coolant recovery tank, hose and radiator cap.
2. Belt slipping or damaged. Replace tensioner, or belt, as required.
3. Thermostat stuck closed. Check and replace if required.
4. Electrical cooling fan operation. See the ELECTRICAL TROUBLESHOOTING MANUAL.
5. Head gasket leaking. Check and repair as required.

VALVE TRAIN

A very simple ball pivot-type train is used. Motion is transmitted from the camshaft through the hydraulic lifter and push rod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker-arm ball is retained by a nut.

HYDRAULIC VALVE LIFTERS

Hydraulic Valve Lifters are used to keep all parts of the valve train in constant contact.

The hydraulic lifter assembly consists of: a roller, the lifter body, which rides in the cylinder block boss, a plunger, a push rod seat, a metering valve, a plunger spring, a check ball and spring, a check ball retainer and a push rod seat retainer.

When the lifter is riding on the low point of the cam, the plunger spring keeps the plunger and push rod seat in contact with the push rod.

When the lifter body begins to ride up the cam lobe, the check ball cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit, pushing up the push rod and opening the valve.

As the lifter body rides down the other side of the cam, the plunger follows with it until the valve closes. The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the push rod. The ball check valve will

then move off its seat and the lifter reservoir will remain full.

INTAKE MANIFOLD

The intake manifold for those engines with carburetors are made of cast iron or aluminum double level design for efficient fuel distribution. An Exhaust Gas Recirculation (EGR) port is also cast into the manifold for the mixture of exhaust gases with the fuel air mixture.

The intake manifold for those vehicles equipped with PFI is a cast aluminum unit. It centrally supports a fuel rail with 8 fuel injectors.

EXHAUST MANIFOLDS

Two cast iron exhaust manifolds are used to direct exhaust gases from the combustion chambers to the exhaust system. The left hand side manifold receives a heat shield that is used to route heated air to the air cleaner, for better fuel vaporization during warm-up.

COMBUSTION CHAMBERS

Combustion Chambers are cast to insure uniform shape for all cylinders. Spark plugs are located between the intake and exhaust valves. The contoured wedge shape of the combustion chamber minimizes the possibility of detonation, facilitates breathing and provides swirling turbulence for smooth, complete combustion.

ENGINE LUBRICATION

Full pressure lubrication through a full flow oil filter, is furnished by a gear-type oil pump. The distributor, driven by a helical gear on the camshaft, drives the oil pump. The main oil gallery feeds oil,

through drilled passages, to the camshaft and crankshaft to lubricate the bearings. The valve lifter oil gallery feeds the valve lifters which, through hollow push rods, feed the individually mounted rocker arms.

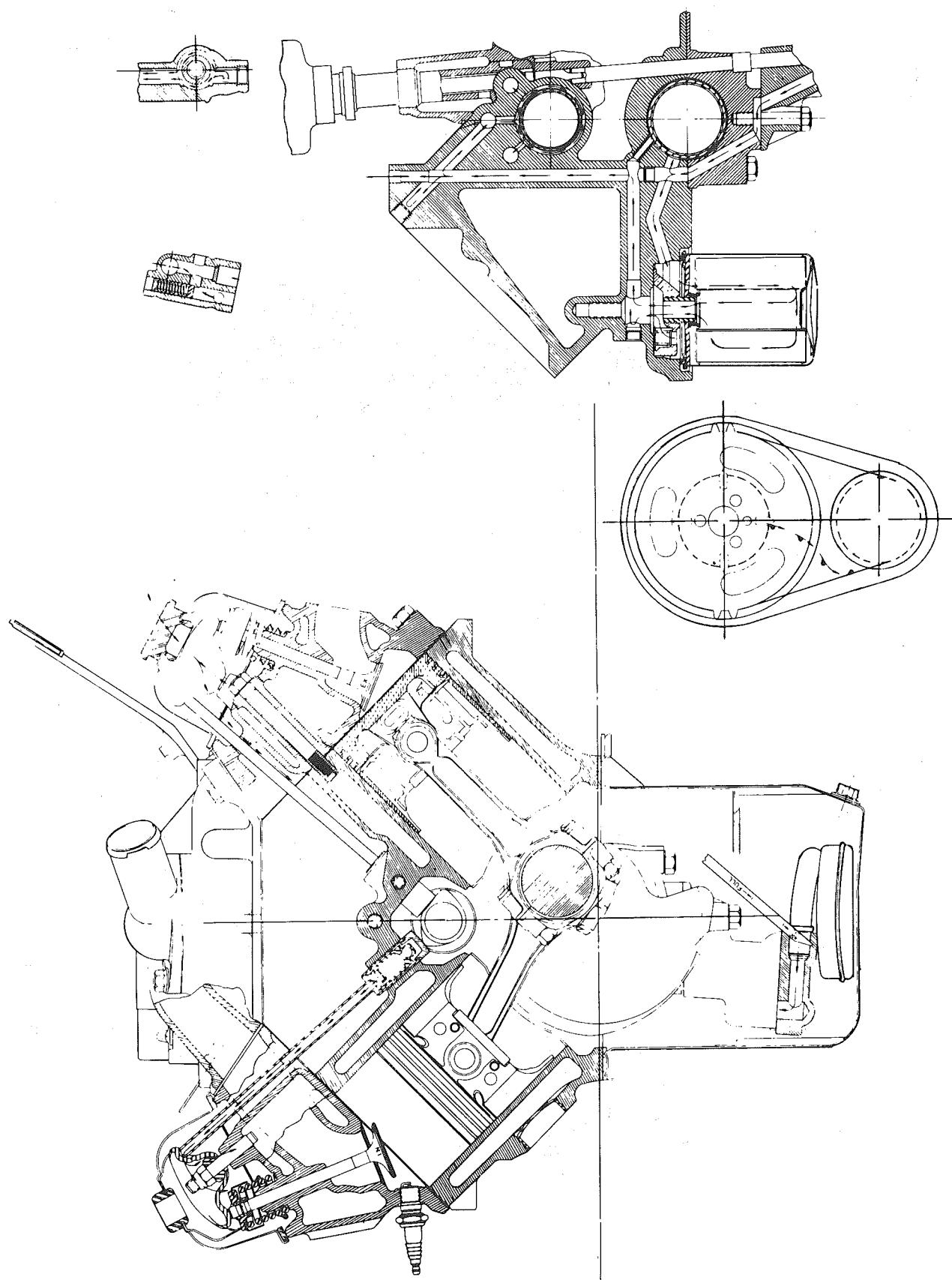


Fig. 6A3-1 Small V-8 Engine Lubrication

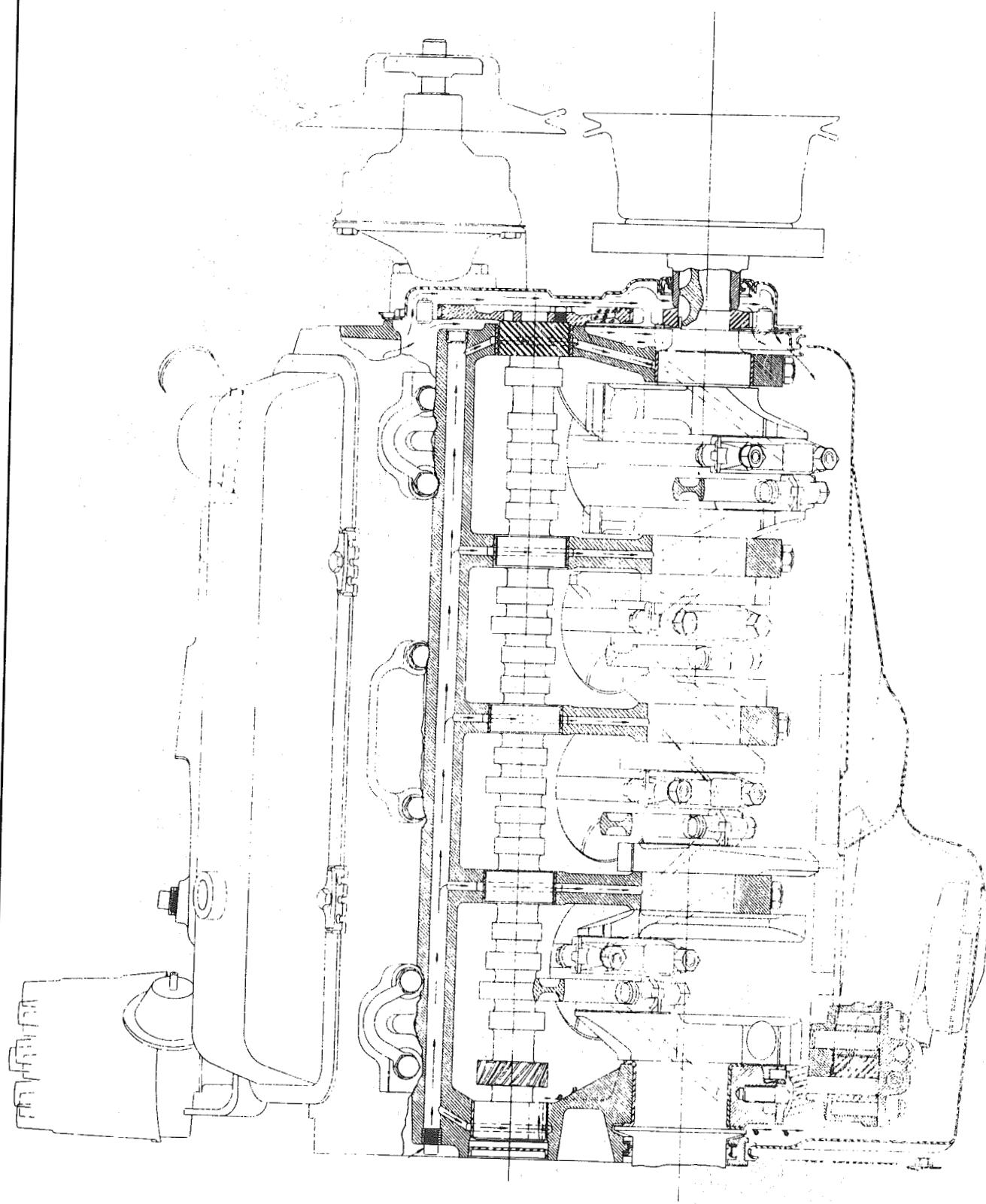


Fig. 6A3-2 Small V-8 Engine Lubrication

ON-VEHICLE SERVICE

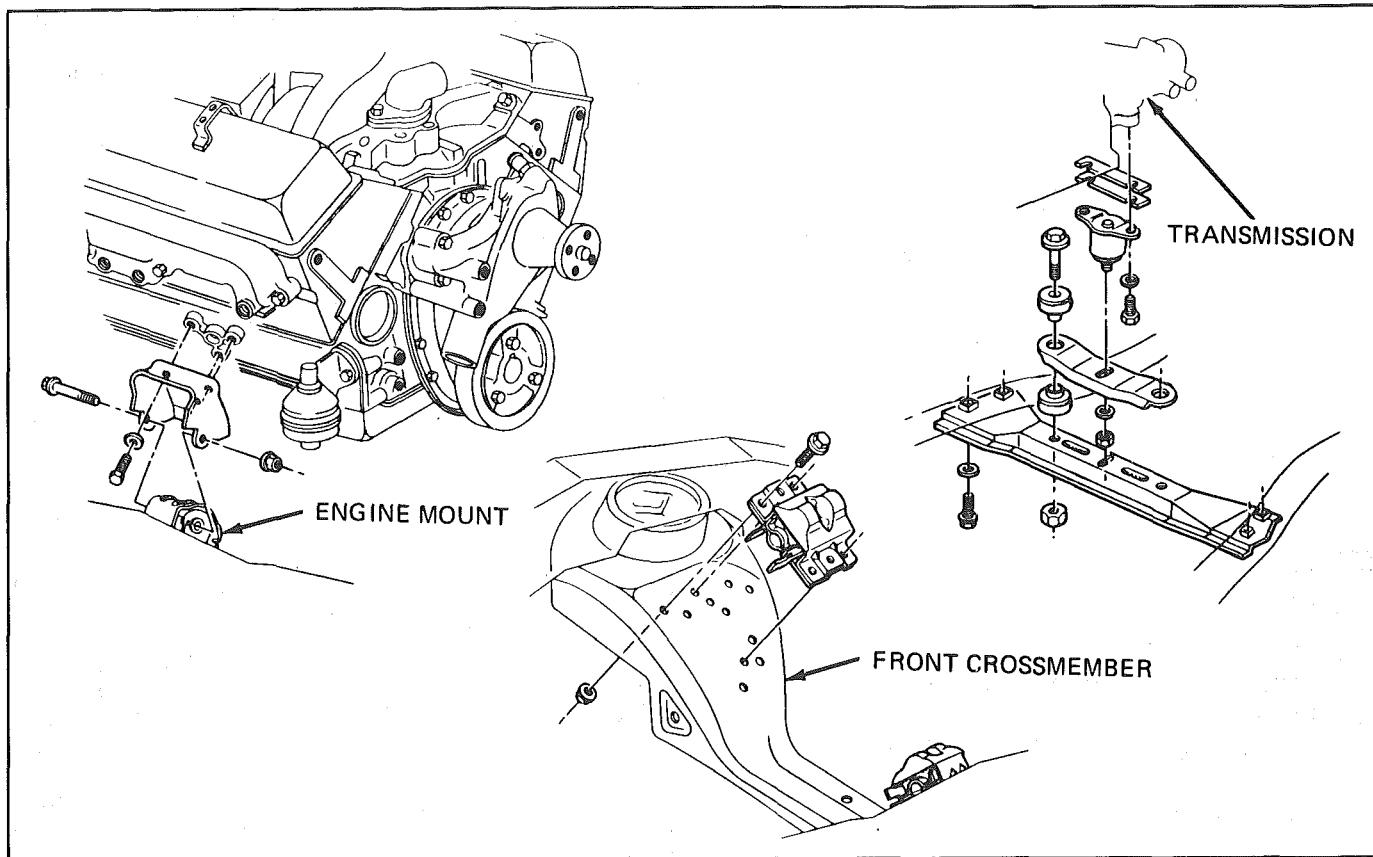


Fig. 6A3-3 Engine Mounts

POWERTRAIN MOUNTS

Engine mounts (fig. 6A3-3) are the non-adjustable type and seldom require service. Broken or deteriorated mounts should be replaced immediately, because of the added strain placed on other mounts and drive line components.

Checking Engine Mounts**Front Mount**

Raise the engine to remove weight from the mounts and to place a slight tension in the rubber. Observe both mounts while raising engine. If an engine mount exhibits:

- a. Hard rubber surface covered with heat check cracks;
- b. Rubber separated from a metal plate of the mount;
- c. Rubber split through center

replace the mount. If there is relative movement between a metal plate of the mount and its attaching points, lower the engine on the mounts and tighten the screws or nuts attaching the mount to the engine, frame, or bracket.

Rear Mount

Raise the vehicle on a hoist. Push up and pull down on the transmission tailshaft while observing the transmission mount. If the rubber separates from the metal plate of the mount or if the tailshaft moves up but not down (mount bottomed out) replace the

mount. If there is relative movement between a metal plate of the mount and its attaching point, tighten the screws or nuts attaching the mount to the transmission or crossmember.

Front Mount Replacement

1. Remove mount retaining bolt from below frame mounting bracket.
2. Raise front of engine and remove mount-to-engine bolts and remove mount. Raise engine only enough for sufficient clearance. Check for interference between rear of engine and cowl panel.
3. Replace mount to engine and lower engine into place.
4. Install retaining bolt and torque all bolts to specifications.

Rear Mount Replacement

1. Support transmission weight to relieve rear mounts.
2. Remove crossmember-to-mount nuts.
3. Remove mount-to-transmission bolts, raise transmission, then remove mount.
4. Install new mount on transmission.
5. While lowering transmission, align mount to crossmember.
6. Torque bolts to specifications.

SECTION B SYMPTOMS

TABLE OF CONTENTS

Before Starting	Page B-1
Intermittents	Page B-2
Hard Start	Page B-2
Surges and/or Chuggle	Page B-3
Lack of Power, Sluggish, or Spongy	Page B-3
Detonation/Spark Knock	Page B-4
Hesitation, Sag, Stumble	Page B-4
Cuts Out, Misses	Page B-4
Poor Fuel Economy	Page B-5
Rough, Unstable, or Incorrect Idle, Stalling	Page B-5
Excessive Exhaust Emissions or Odors	Page B-6
Dieseling, Run-On	Page B-6
Backfire.....	Page B-6
CHART B-1, Restricted Exhaust System Check - All Engines	Page B-7

BEFORE STARTING

Before using this section you should have performed the DIAGNOSTIC CIRCUIT CHECK.

Verify the customer complaint, and locate the correct SYMPTOM below. Check the items indicated under that symptom.

If the ENGINE CRANKS BUT WILL NOT RUN, see CHART A-3.

Several of the following symptom procedures call for a careful visual (physical) check.

The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time.

This check should include:

- Vacuum hoses for splits, kinks, and proper connections, as shown on Emission Control Information label.
- Air leaks at throttle body mounting and intake manifold.
- Ignition wires for cracking, hardness, proper routing, and carbon tracking.
- Wiring for proper connections, pinches, and cuts.

The following symptoms cover several engines. To determine if a particular system or component is used, refer to the ECM wiring diagrams for application.

SURGES AND/OR CHUGGLE

Definition: Engine power variation, under steady throttle or cruise. Feels like the car speeds up and slows down, with no change in the accelerator pedal.

- Use a "Scan" tool to make sure reading of VSS matches vehicle speedometer. See "Special Information", Section "6E".
- **CHECK:**
 - For intermittent EGR at idle. See appropriate CHART C-7.
 - Ignition timing. See Emission Control Information label.
 - Inline fuel filter for dirt or restriction.
 - Fuel pressure. See CHART A-7.
 - Generator output voltage. Repair if less than 9, or more than 16 volts.
 - TCC Operation. CHART C-8A.
- Inspect oxygen sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.
- Remove spark plugs. Check for cracks, wear, improper gap, burned electrodes, or heavy deposits. Also, check condition of the rest of the ignition system.

LACK OF POWER, SLUGGISH, OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed, when accelerator pedal is pushed down part way.

- Compare customer's car to similar unit. Make sure the customer's car has an actual problem.
- Remove air cleaner and check air filter for dirt, or for being plugged. Replace as necessary.
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated, by switching the injector connectors. If the problem remains with the original injector, after switching the connector, then the injector is defective. Replace the injector. If the problem moves with the injector connector, then the problem is an improper signal in the injector circuits, see CHART A-3.
- **CHECK:**
 - Ignition timing. See Emission Control Information label.
 - For restricted fuel filter, contaminated fuel or improper fuel pressure. See CHART A-7.
 - ECM Grounds.
 - EGR operation for being open, or partly open, all the time - CHART C-7.
 - Generator output voltage. Repair if less than 9, or more than 16 volts.
 - Engine valve timing and compression.
 - Engine, for proper or worn camshaft. See Section "6A".
 - Transmission torque converter operation. See Section "7A".
 - Secondary ignition voltage.
 - Proper operation of ESC. See Section "C5".
- Check exhaust system for restriction. See CHART B-1.

CHART B-1

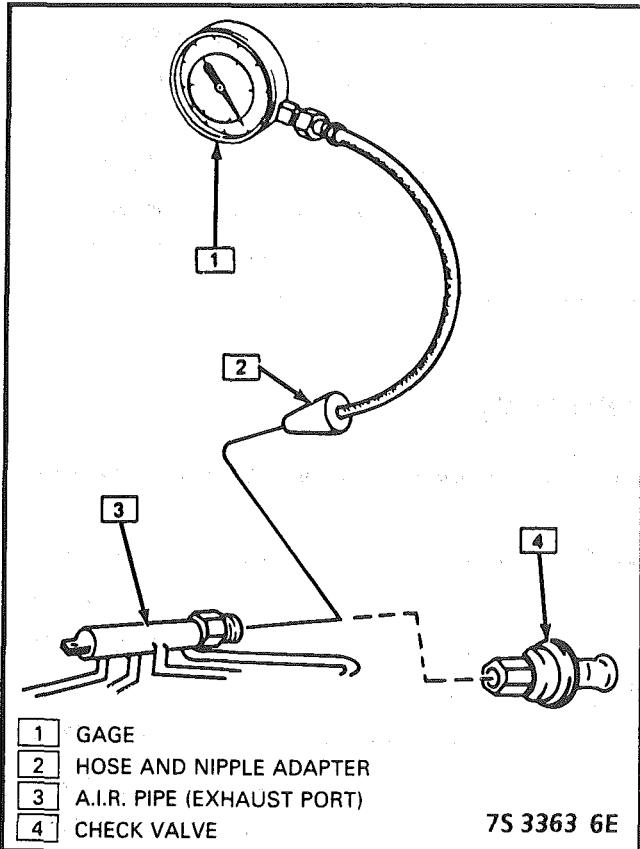
RESTRICTED EXHAUST SYSTEM CHECK

ALL ENGINES

Proper diagnosis for a restricted exhaust system is essential before any components are replaced. Either of the following procedures may be used for diagnosis, depending upon engine or tool used:

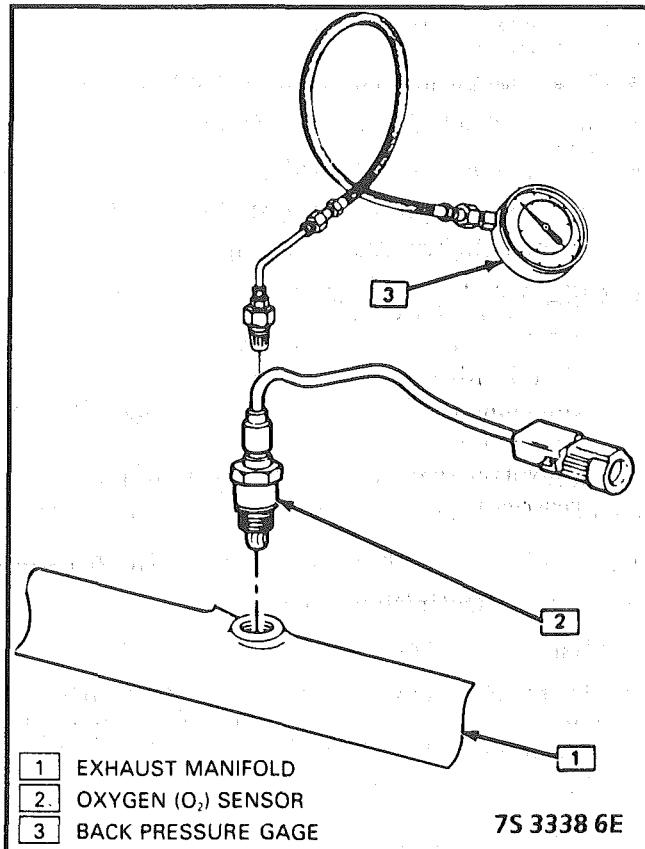
CHECK AT A. I. R. PIPE:

1. Remove the rubber hose at the exhaust manifold A.I.R. pipe check valve. Remove check valve.
2. Connect a fuel pump pressure gauge to a hose and nipple from a Propane Enrichment Device (J26911) (see illustration).
3. Insert the nipple into the exhaust manifold A.I.R. pipe.



OR **CHECK AT O₂ SENSOR:**

1. Carefully remove O₂ sensor.
2. Install Borroughs Exhaust Backpressure Tester (BT 8515 or BT 8603) or equivalent in place of O₂ sensor (see illustration).
3. After completing test described below, be sure to coat threads of O₂ sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.



DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gauge. Reading should not exceed 1 1/4 psi (8.6 kPa).
2. Accelerate engine to 2000 RPM and observe gauge. Reading should not exceed 3 psi (20.7 kPa).
3. If the backpressure, at either RPM, exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, a restricted catalytic converter should be suspected and replaced using current recommended procedures.

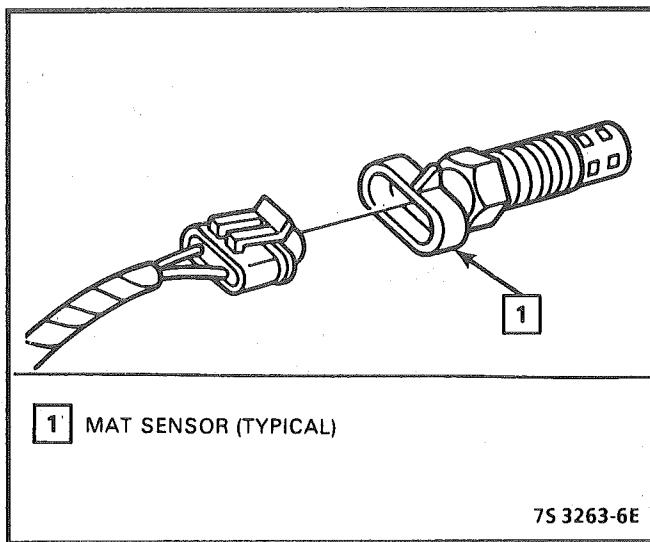


Figure C1-5 - MAT Sensor - Typical

When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5-volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel.

The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33 or Code 34.

Manifold Air Temperature (MAT) Sensor

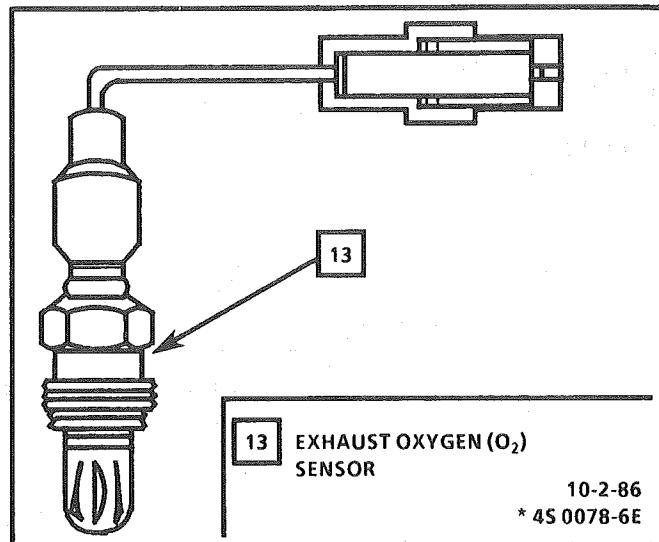
The manifold air temperature sensor (MAT) is a thermistor, a resistor which changes value based on the temperature of air entering the engine. Low temperature produces a high resistance (100,000 ohms at -40°C / -40°F), while high temperature causes low resistance (70 ohms at 130°C / 226°F). The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the intake air is cold and low when the air is hot. By measuring the voltage, the ECM knows the manifold air temperature.

The MAT sensor is also used to control spark timing and to delay EGR when intake air is cold.

A failure in the MAT sensor circuit should set either a Code 23 or Code 25.

Oxygen (O_2) Sensor

The exhaust oxygen sensor is mounted in the exhaust system where it can monitor the oxygen content of the exhaust gas stream.

Figure C1-6 - Exhaust Oxygen (O_2) Sensor

The oxygen content in the exhaust reacts with the oxygen sensor to produce a voltage output. This voltage ranges from approximately .1 volts (high O_2 - lean mixture) to .9 volts (low O_2 - rich mixture).

By monitoring the voltage output of the O_2 sensor, the ECM will know what fuel mixture command to give to the injector (lean mixture - low voltage - rich command, rich mixture - high voltage - lean command). This voltage can be measured with a digital voltmeter having at least 10 Meg Ohms input impedance. Use of standard shop type voltmeters will result in very inaccurate readings.

The O_2 sensor, if open, should set a Code 13. A shorted sensor circuit should set a Code 44. A high voltage in the circuit should set a Code 45. When any of these codes are set, the car should run in the "Open Loop" mode.

Throttle Position Sensor (TPS)

The throttle position sensor (TPS) is connected to the throttle shaft on the TBI unit (see Figure C1-7). It is a potentiometer with one end connected to 5 volts from the ECM and the other to ground. A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately .5 volts). As the throttle valve opens, the output increases so that, at wide-open throttle, the output voltage should be approximately 5 volts.

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand). If the sensor CKT is open, the ECM will set a Trouble Code 22. If the circuit is shorted, the ECM will think the vehicle is at WOT, and a Trouble Code 21 will be set.

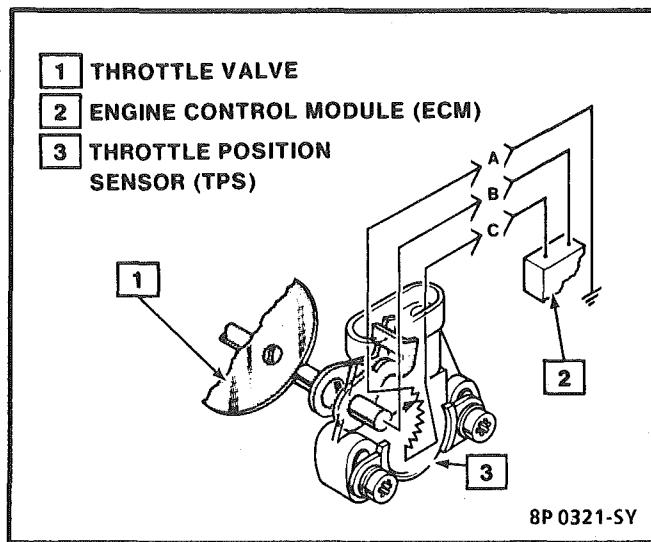


Figure C1-7 - Throttle Position Sensor (Typical)

A broken or loose TPS can cause intermittent bursts of fuel from the injector, and an unstable idle, because the ECM thinks the throttle is moving. Once a trouble code is set, the ECM will use an artificial value for TPS, and some vehicle performance will return.

On all engines, the TPS is not adjustable. The ECM uses the reading at idle for the zero reading, so no adjustment is necessary.

Knock Sensor

The knock sensor is mounted in the engine block. When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal, which is sent to the ESC module.

See Section "C5" for further information on the electronic spark control (ESC) system.

Park/Neutral Switch (Auto Only)

The park/neutral (P/N) switch indicates to the ECM when the transmission is in park or neutral. This information is used for the TCC, and the IAC valve operation.

! Important

Vehicle should not be driven with park/neutral switch disconnected as idle quality will be affected and a possible false Code 24 VSS.

See Section "8A" for more information on the P/N switch, which is part of the neutral/start and backup light switch assembly.

Crank Signal

The ECM looks at the starter solenoid to tell when the engine is cranking. It uses this to tell when the car is in the Starting Mode.

If this signal is not available, car may be hard to start in extremely cold weather.

A/C Request Signal

This signal tells the ECM that the A/C selector switch is turned "ON", and that the pressure cycling switch is closed. The ECM uses this to adjust the idle speed when the air conditioning is working.

Vehicle Speed Sensor (VSS)

The vehicle speed sensor (VSS) sends a pulsing voltage signal to the ECM, which the ECM converts to miles per hour. This sensor mainly controls the operation of the TCC system. See "TCC System" for more information.

Distributor Reference Signal

The distributor sends a signal to the ECM to tell it both engine rpm and crankshaft position. See "EST System" for further information.

Power Steering Pressure Switch (PSPS)

This switch tells the ECM that the vehicle is in a parking maneuver. The ECM uses this information to compensate for the additional engine load by moving the IAC valve. The ECM will, also, turn "OFF" the A/C clutch when high pressure is detected.

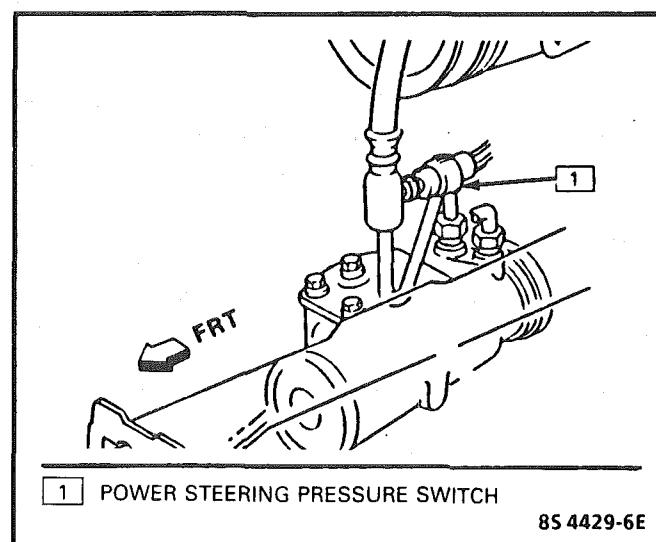


Figure C1-8 - Power Steering Pressure Switch (PSPS)

THROTTLE BODY INJECTION (TBI) UNIT Replacement (Figure C2-18)

Remove or Disconnect

1. THERMAC hose from engine fitting.
2. Electrical connectors to IAC valve, TPS and fuel injectors.
3. Grommet with wires from throttle body.
4. Throttle linkage, return spring(s) transmission control cable and cruise control (wherever applicable).
5. Vacuum hoses (noting position of hoses) and bracket.
6. Fuel inlet and return lines (use back-up wrench J-29698-A or BT-8251-A). Discard o-rings from nuts.
7. TBI mounting hardware.
8. TBI flange (manifold mounting) gasket and discard.

NOTICE: Stuff manifold opening with a rag to prevent material from entering engine, and remove old gasket material from surface of intake manifold.

Inspect

- Intake manifold bore for loose parts and foreign material, etc.
- Intake manifold sealing surface for cleanliness.

Install or Connect

1. New TBI flange (manifold mounting) gasket.
2. TBI with mounting hardware.

Tighten

- Hardware to, 16.5 N·m (12 lb. ft.).
- 3. New o-rings on fuel line nuts.
- 4. Fuel inlet and outlet lines.

Tighten

- To 23 N·m (17 lb. ft.). (Use back-up wrench J-29698-A or BT-8251-A to keep TBI nuts from turning.)
- 5. Vacuum hoses and bracket.
- 6. Throttle linkage, return spring(s) transmission control cable and cruise control (wherever applicable).
- 7. Grommet with wire harness to throttle body.
- 8. Electrical connectors, making sure connectors are fully seated and latched.
- 9. Check to see if accelerator pedal is free by depressing pedal to the floor and releasing while engine is "OFF".

10. With engine "OFF," and ignition "ON," check for leaks around fuel line nuts.
11. Start engine and check for fuel leaks.

FUEL HOSE/PIPE ASSEMBLIES

Materials

Fuel Lines. These are welded steel tubes, meeting GM Specification 124-M, or its equivalent. The fuel feed line is 3/8" diameter, and the fuel return line is 5/16" diameter. Do not use copper or aluminum tubing to replace steel tubing. Those materials do not have satisfactory durability to withstand normal vehicle vibration.

Clamps. These are stainless steel, screw band type clamps, #249472, or equivalent.

Coupled Hose. These are not to be repaired and are replaced only as an assembly.

Uncoupled Hose. Use only reinforced fuel resistant hose, made of "fluroelastomer" material. Do not use a hose within 4 inches (100 mm) of any part of the exhaust system, or within 10 inches (254 mm) of the catalytic converter. The hose's inside diameter must match the outside diameter of the steel tubing.

Fuel Line Repair

1. Cut a piece of fuel hose 4 inches (100 mm) longer than the section of line to be removed. If more than 6 inches (152 mm) is to be removed, use a combination of steel pipe and hose. The hose length should not be more than 10 inches total.
2. Cut a section of pipe to be replaced, with a tube cutter. Use the first step of a double flaring tool to form a bead on the ends of the pipe and also, on the new section of pipe, if used.
3. Slide the hose clamps onto the pipe and push the hose 2 inches (51 mm) onto each portion of the fuel pipe. Tighten a clamp on each side of the repair.
4. Secure fuel line to the frame.

FUEL PUMP RELAY (Figure C2-19)

The fuel pump relay is mounted in the engine compartment. Other than checking for loose connectors, the only service possible is replacement.

OIL PRESSURE SWITCH (Figure C2-20)

The oil pressure switch is mounted on the engine. This switch is a parallel power supply, with the fuel pump relay, and will provide battery voltage to the fuel pump, after approximately 28 kPa (4 psi) oil pressure is reached.

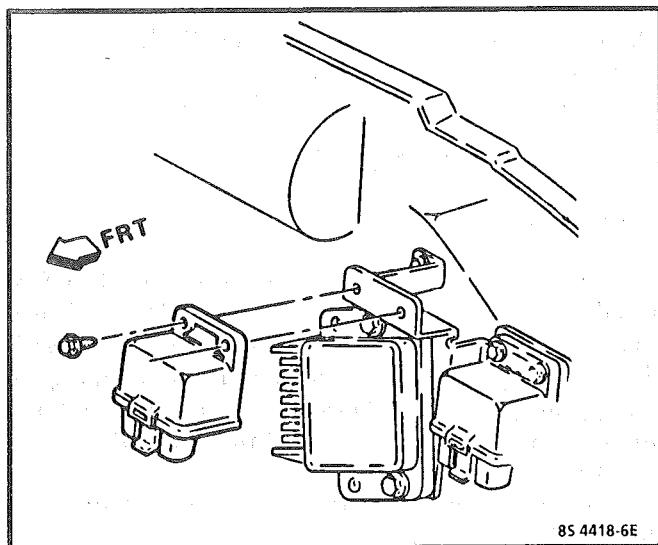


Figure C2-19 - Fuel Pump Relay

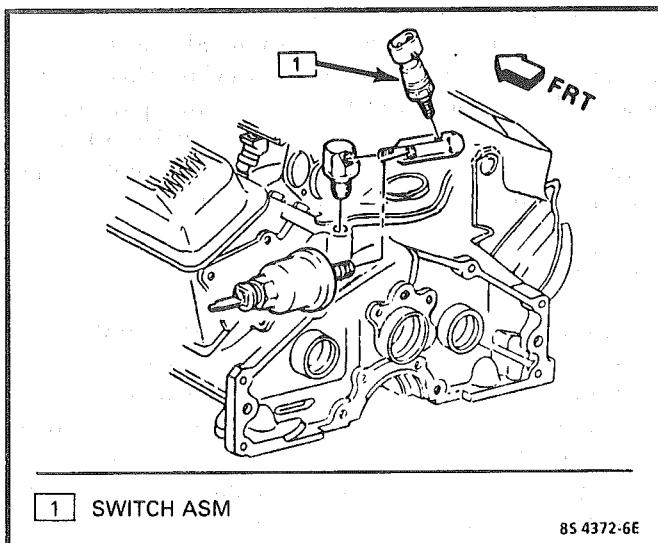


Figure C2-20 - Oil Pressure Switch

PARTS INFORMATION

PART NAME	GROUP
Meter Kit, Fuel.....	3.734
Injector Kit, Fuel.....	3.774
Pump, Fuel (In Tank).....	3.900
Relay, Fuel Pump.....	3.900
Switch, Oil Press.....	1.800
Throttle Body Injection Unit.....	3.725
Control Kit, Idle Air Valve.....	3.820

BLANK

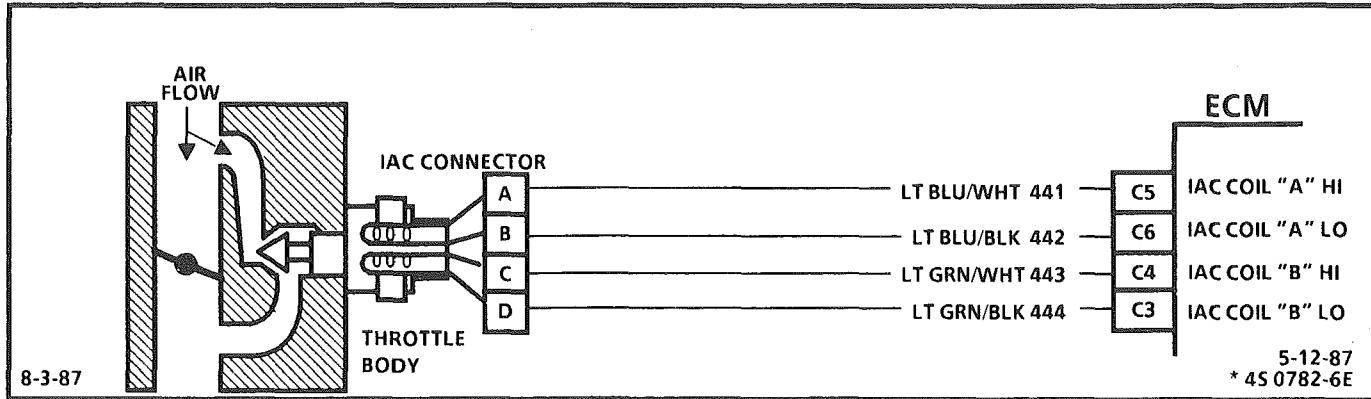


CHART C-2C

IDLE AIR CONTROL (IAC) VALVE CHECK 5.0L (VIN E) "F" SERIES (TBI)

Circuit Description:

The ECM controls idle rpm with the IAC valve. To increase idle rpm, the ECM moves the IAC valve out, allowing more air to pass by the throttle plate. To decrease rpm, it moves the IAC valve in, reducing air flow by the throttle plate. A "Scan" tool will read the ECM commands to the IAC valve in counts. The higher the counts, the more air allowed (higher idle). The lower the counts, the less air allowed (lower idle).

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Continue with test, even if engine will not idle. If idle is too low, "Scan" will display 80 or more counts, or steps. If idle is high, it will display "0" counts. Occasionally, an erratic or unstable idle may occur. Engine speed may vary 200 rpm, or more, up and down. Disconnect IAC. If the condition is unchanged, the IAC is not at fault.
2. When the engine was stopped, the IAC Valve retracted (more air) to a fixed "Park" position for increased air flow and idle speed during the next engine start. A "Scan" will display 100 or more counts. When performing this test, immediately note rpm on start up, because, on a warm engine, the rpm will decrease rapidly.
3. Be sure to disconnect the IAC valve prior to this test. The test light will confirm the ECM signals by a steady or flashing light on all circuits.
4. There is a remote possibility that one of the CKTs is shorted to voltage, which would have been indicated by a steady light. Disconnect ECM and turn the ignition "ON" and probe terminals to check for this condition.

Diagnostic Aids:

A slow unstable idle may be caused by a system problem that cannot be overcome by the IAC. "Scan" counts will be above 60 counts, if too low, and "0" counts, if engine speed is too high.

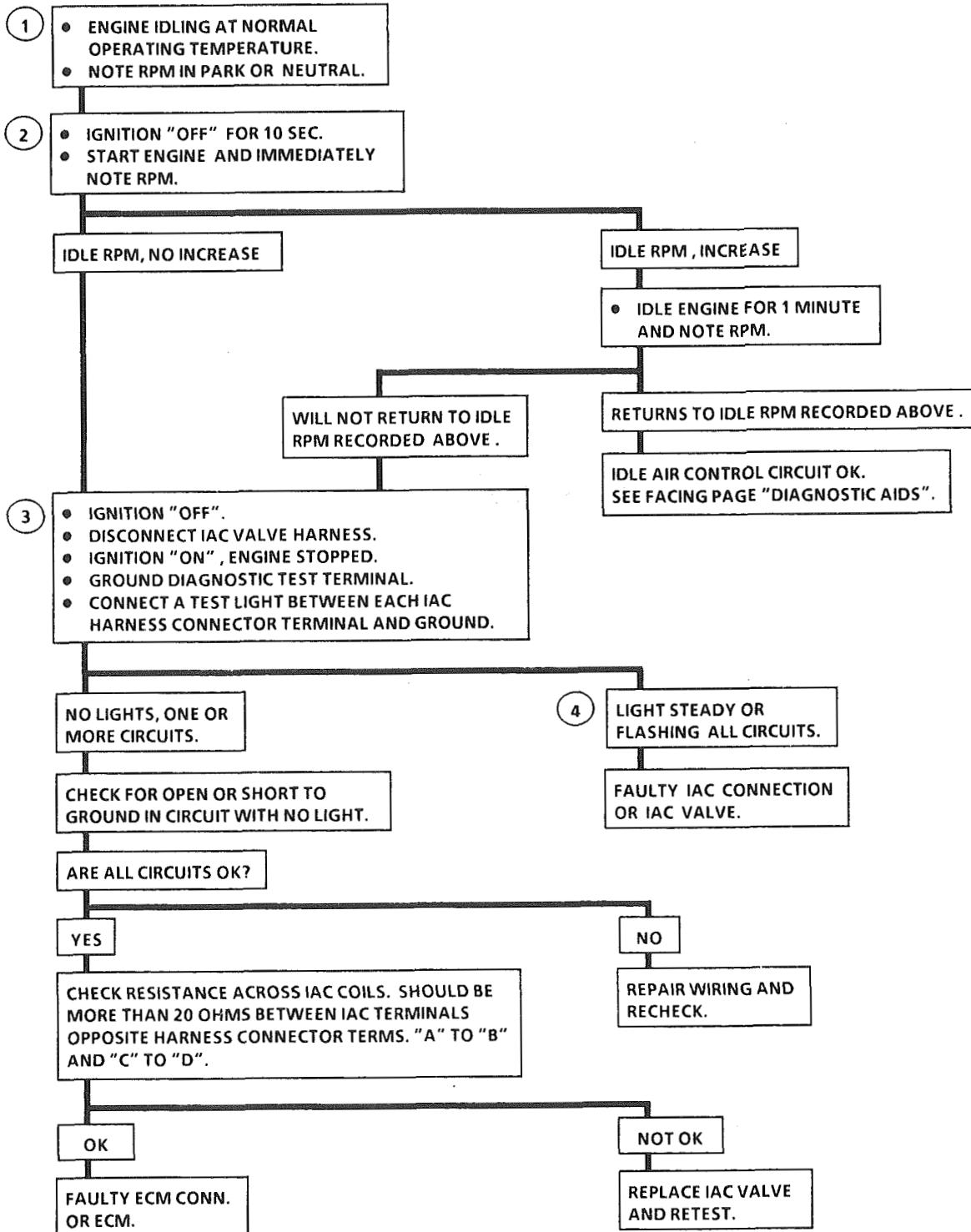
If idle is too high, stop engine. Ignition "ON". Ground diagnostic terminal. Wait 30 seconds for IAC to seat, then, disconnect IAC. Unground

diagnostic terminal and start engine. If idle speed is above 450 rpm in drive, locate and correct vacuum leak. If rpm is less than 450 rpm, adjust minimum idle speed, or correct other conditions, which may affect idle. refer to Rough Unstable or Incorrect Idle, in Symptoms, Section "B".

- System too lean (High Air/Fuel Ratio)
Idle speed may be too high or too low. Engine speed may vary up and down, disconnecting IAC does not help. May set Code 44.
"Scan" and/or Voltmeter will read an oxygen sensor output less than 300 mv (.3 volts). Check for low regulated fuel pressure or water in fuel. A lean exhaust, with an oxygen sensor output fixed above 800 mv (.8 volts), will be a contaminated sensor, usually silicone. This may also set a Code 45.
- System too rich (Low Air/Fuel Ratio)
Idle speed too low. "Scan" counts usually above 80. System obviously rich and may exhibit black smoke exhaust.
"Scan" tool and/or Voltmeter will read an oxygen sensor signal fixed above 800 mv (.8 volts).
Check:
 - High fuel pressure
 - Injector leaking or sticking
- Throttle Body. Remove IAC and inspect bore for foreign material or evidence of IAC valve dragging the bore.
- If above are all OK, refer to "Rough, Unstable, Incorrect Idle or Stalling", in Symptoms, Section "B".

CHART C-2C

IDLE AIR CONTROL (IAC) VALVE CHECK 5.0L (VIN E) "F" SERIES (TBI)



CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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SECTION C3

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS)

CONTENTS

GENERAL DESCRIPTION	C3-1	DIAGNOSIS	C3-2
PURPOSE	C3-1	VISUAL CHECK OF CANISTER	C3-2
VAPOR CANISTER	C3-1	CANISTER PURGE SOLENOID	C3-2
EVAPORATIVE EMISSION SYSTEM	C3-1	ON-CAR SERVICE	C3-2
IN-TANK PRESSURE CONTROL VALVE ..	C3-2	FUEL VAPOR CANISTER R/R	C3-2
RESULTS OF INCORRECT OPERATION	C3-2	CANISTER HOSES.....	C3-2
		PARTS INFORMATION	C3-2

GENERAL DESCRIPTION

PURPOSE

The basic evaporative emission control system (EECS) used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage device (canister) to hold the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process.

VAPOR CANISTER

Gasoline vapors from the fuel tank flow into the tube labeled tank. Any liquid fuel goes into a reservoir in the bottom of the canister to protect the integrity of the carbon bed above (Figure C3-1). These vapors are absorbed into the carbon. The canister is purged when the engine is running above idle speed. Ambient air is allowed into the canister through the air tube in the top. The air mixes with the vapor and the mixture is drawn into the intake manifold.

EVAPORATIVE EMISSION SYSTEM

The canister is equipped with a normally closed (N/C) solenoid to control canister purge. The ECM operates the solenoid which controls vacuum to the purge valve in the charcoal canister. Under cold engine or idle conditions, the solenoid is turned "OFF" by the ECM, which closes the solenoid and blocks vacuum to the canister purge valve.

The ECM turns "ON" the solenoid valve and allows purge when:

- Engine is warm.
- After the engine has been running a specified time.
- Above a specified road speed.
- Above a specified throttle opening.

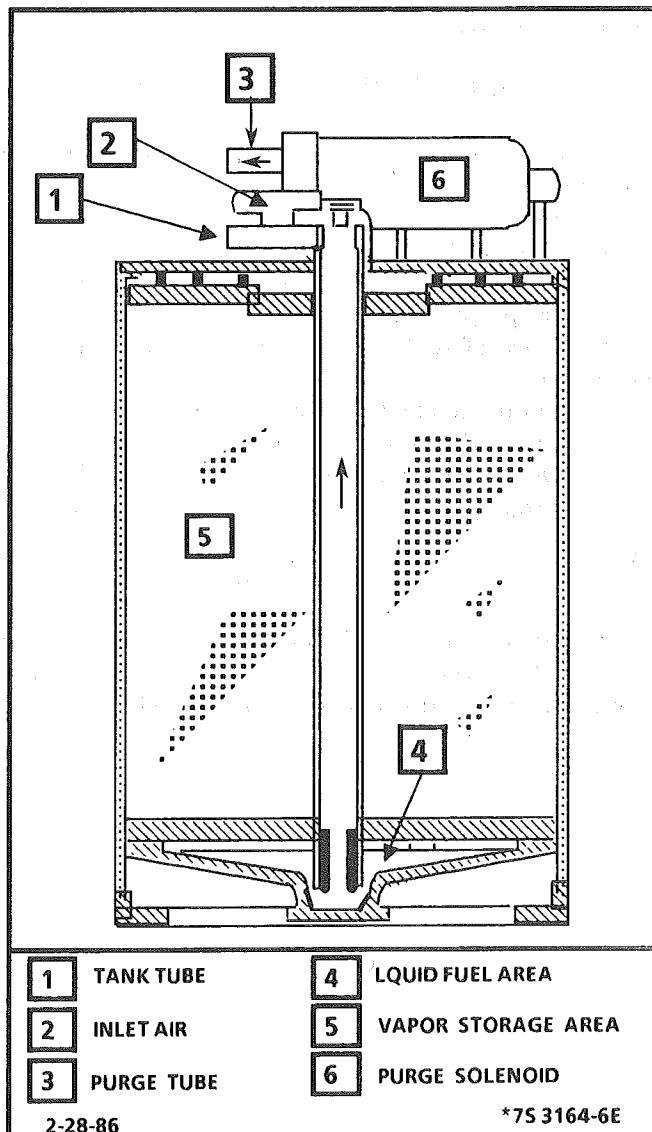


Figure C3-1 - Inverted Function Vapor Canister - With Encapsulated Purge Solenoid

This is an ECM feedback system that increases purge until the ECM senses a rich condition from the oxygen sensor. The purge is then regulated until the ECM no longer receives a rich signal from the O₂ sensor. This system uses an in-tank pressure control valve to control the flow of vapors from the fuel tank to the canister.

IN-TANK PRESSURE CONTROL VALVE

The in-tank pressure control valve, a combination roll-over, integral pressure and vacuum relief valve, is located with the fuel sending unit in the fuel tank. When vapor pressure in the tank exceeds 1" Hg (5 kPa) the valve opens and allows vapors to vent to the canister and then be purged. When the tank pressure drops below the opening point of the valve it will close, keeping vapors in the fuel tank. The valve provides vacuum relief to protect against vacuum build up in the fuel tank and roll-over protection to prevent liquid fuel from entering the canister during normal driving maneuvers.

RESULTS OF INCORRECT OPERATION

Poor idle, stalling and poor driveability can be caused by:

- Inoperative purge solenoid.
- Damaged canister.
- Hoses split, cracked and, or not connected to the proper tubes.

Evidence of fuel loss or fuel vapor odor can be caused by:

- Liquid fuel leaking from fuel lines.
- Cracked or damaged canister.
- Disconnected, misrouted, kinked, deteriorated or damaged vapor hoses, or control hoses.

DIAGNOSIS

The canister purge solenoid operation is covered in CHART C-3 at the end of this section. A failure in the solenoid or connections may result in a Code 26.

VISUAL CHECK OF CANISTER

Cracked or damaged , replace canister.

ON-CAR SERVICE**FUEL VAPOR CANISTER****↔ Remove or Disconnect**

1. Hoses from canister. Mark hoses to install on new canister.
2. Canister.

↔ Install or Connect

1. Canister as removed.
2. Hoses. Make sure connections are correct.

CANISTER HOSES

Refer to Vehicle Emission Control Information Label for routing of canister hoses.

PARTS INFORMATION

PART NAME	GROUP
Canister, Fuel Vapor	3.130

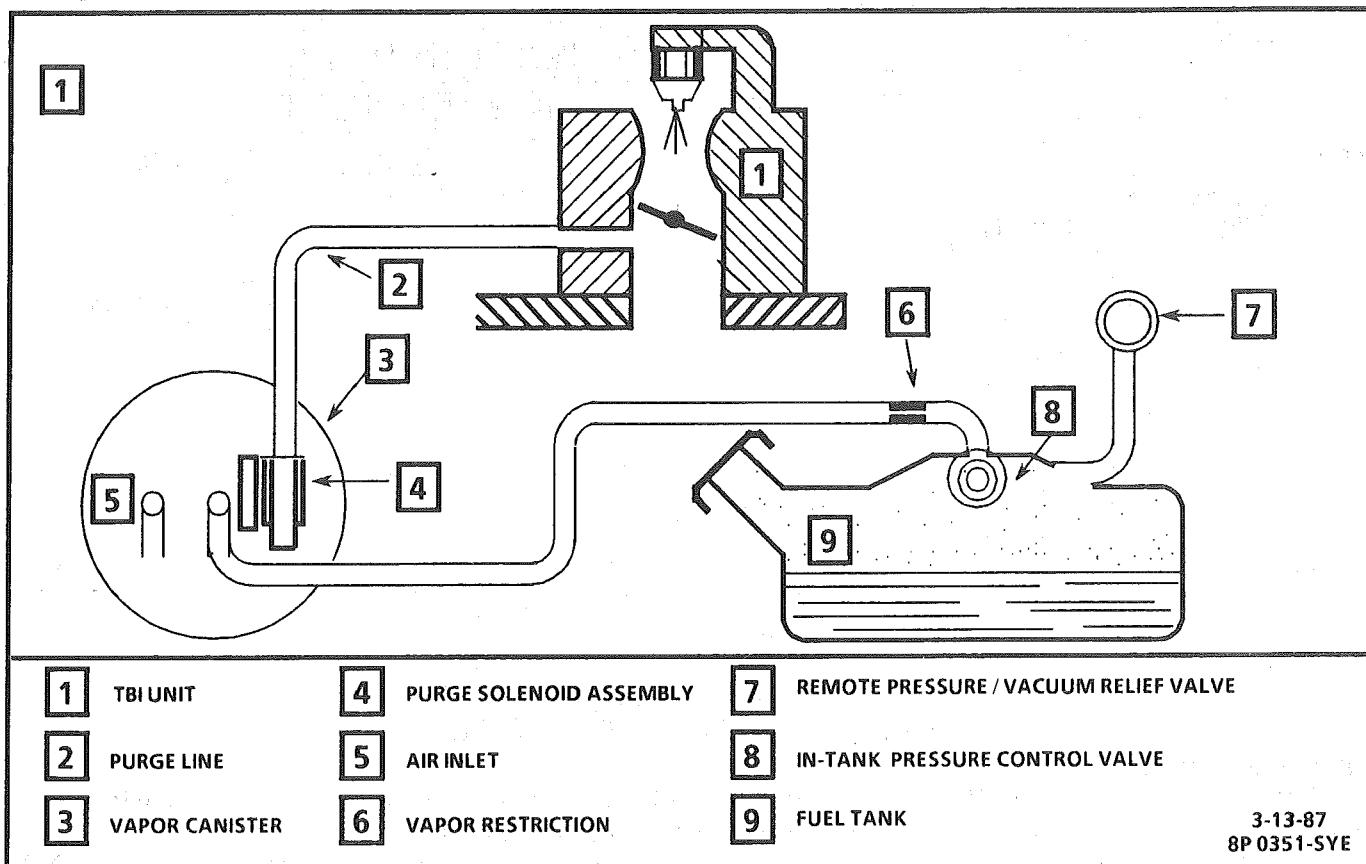


Figure C3-2 - Evaporative Emissions Control System Schematic 5.0L VIN E

SECTION B - SYMPTOMS**5.0L (VIN F) & 5.7L (VIN 8)**

Table of Contents	B-1
Before Starting	B-1
Intermittents	B-2
Hard Start	B-2
Hesitation, Sag, Stumble	B-3
Surges and/or Chuggle	B-3
Lack of Power, Sluggish, or Spongy	B-4
Detonation/Spark Knock	B-4
Cuts Out, Misses	B-5
Backfire	B-5
Poor Fuel Economy	B-6
Dieseling, Run-On	B-6
Rough, Unstable, or Incorrect Idle, Stalling	B-6
Excessive Exhaust Emissions or Odors	B-7
Restricted Exhaust System Check Chart B-1	B-8

FUNCTIONAL CHECKS/**DIAGNOSTIC CHARTS****5.0L (VIN F) & 5.7L (VIN 8)**

Park/Neutral Switch Chart C-1A	C1-10
Injector Balance Test Chart C-2A	C2-18
Idle Air Control Chart C-2C	C2-20
Canister Purge Valve Check Chart C-3	C3-4
Ignition System Check Chart C-4	C4-4
Electronic Spark Control System Check Chart C-5	C5-4
AIR Management Check Chart C-6	C6-6
Exhaust Gas Recirculation (EGR) Check Chart C-7	C7-4
Automatic Transmission Converter Clutch (TCC) Chart C-8A	C8-6
Manual Transmission Shift Light Diagnosis Chart C-8B	C8-10
Cooling Fan Control Circuit Diagnosis Chart C-12	C12-2

SECTION C - COMPONENT SYSTEMS**5.0L (VIN F) & 5.7L (VIN 8)**

Table of Contents	C-1
-------------------------	-----

SECTION C1 - 5.0L (VIN F) & 5.7L (VIN 8)**ELECTRONIC CONTROL MODULE (ECM) & SENSORS****GENERAL DESCRIPTION** C1-1

ELECTRONIC CONTROL MODULE

MEM-CAL

ECM Function	C1-1
INFORMATION SENSORS	C1-2
Engine Coolant Temperature Sensor ..	C1-2
MAF Sensor	C1-2
MAT Sensor	C1-2
Oxygen (O ₂) Sensor	C1-3
Throttle Position Sensor	C1-3
Knock Sensor	C1-3
Vehicle Speed Sensor	C1-3
Park/Neutral Switch (Auto Only)	C1-3
A/C "ON" Signal	C1-4
Distributor Reference Signal	C1-4
DIAGNOSIS	C1-4
ECM	C1-4
MEM-CAL	C1-4
ECM INPUTS	C1-4
Coolant Temperature Sensor	C1-5
MAF Sensor	C1-5
MAT Sensor	C1-5
Oxygen (O ₂) Sensor	C1-5
TPS	C1-5
VSS	C1-5
P/N Switch	C1-5
A/C Request Signal	C1-5
Reference Signal	C1-5
ON-CAR SERVICE	C1-5
ELECTRONIC CONTROL MODULE	C1-5
ECM or MEM-CAL REPLACEMENT	C1-6
Functional Check	C1-7
COOLANT SENSOR	C1-7
MAF SENSOR	C1-8
MAF SENSOR POWER & BURN-OFF RELAY ..	C1-8
OXYGEN SENSOR	C1-8
THROTTLE POSITION SENSOR	C1-8
PARK/NEUTRAL SWITCH	C1-9
PARTS INFORMATION	C1-9
Park/Neutral Switch Chart C-1	C1-10

SECTION C2 - 5.0L (VIN F) & 5.7L (VIN 8)**FUEL CONTROL SYSTEM****GENERAL DESCRIPTION** C2-1

PURPOSE

MODES OF OPERATION

Starting Mode

Clear Flood Mode

Run Mode

Acceleration Mode

Deceleration Mode

Battery Voltage Correction Mode

Fuel Cutoff Mode

FUEL CONTROL SYSTEM

Basic System Operation

Throttle Body Unit

Fuel Rail

Fuel Injectors

Pressure Regulator

IAC Valve

SECTION B

SYMPTOMS

TABLE OF CONTENTS

Before Starting	Page B-1
Intermittents	Page B-2
Hard Start	Page B-2
Hesitation, Sag, Stumble	Page B-3
Surges and/or Chuggle	Page B-3
Lack of Power, Sluggish, or Spongy	Page B-4
Detonation/Spark Knock	Page B-4
Cuts Out, Misses	Page B-5
Backfire.....	Page B-5
Poor Fuel Economy	Page B-6
Dieseling, Run-On.....	Page B-6
Rough, Unstable, or Incorrect Idle, Stalling	Page B-6
Excessive Exhaust Emissions or Odors	Page B-7
Restricted Exhaust System Check (Chart B-1)	Page B-8

BEFORE STARTING

Before using this section you should have performed the DIAGNOSTIC CIRCUIT CHECK and found out that:

1. The ECM and "Service Engine Soon" light are operating.
2. There are no trouble codes stored, or there is a trouble code but no "Service Engine Soon" light.

Verify the customer complaint, and locate the correct SYMPTOM below. Check the items indicated under that symptom.

If the ENGINE CRANKS BUT WILL NOT RUN, see CHART A-3.

Several of the symptom procedures below call for a careful visual check. This check should include:

- ECM grounds for being clean and tight.
 - Vacuum hoses for splits, kinks, and proper connections, as shown on Emission Control Information label.
 - Air leaks at throttle body mounting and intake manifold.
 - Air leaks between MAF sensor and throttle body.
 - Ignition wires for cracking, hardness, proper routing, and carbon tracking.
 - Wiring for proper connections, pinches, and cuts.
- The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time.

CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK

ALL ENGINES

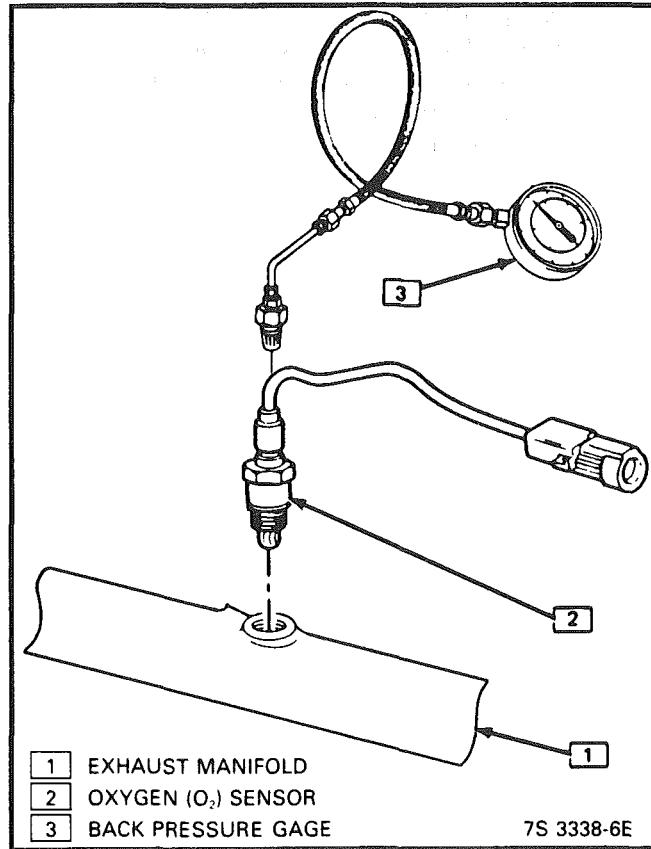
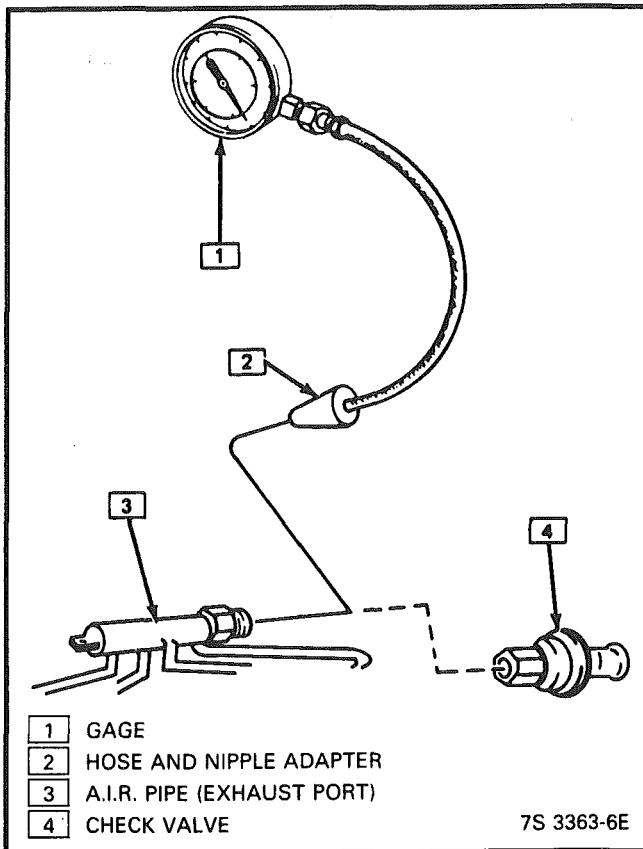
Proper diagnosis for a restricted exhaust system is essential before any components are replaced. Either of the following procedures may be used for diagnosis, depending upon engine or tool used:

CHECK AT A. I. R. PIPE:

1. Remove the rubber hose at the exhaust manifold A.I.R. pipe check valve. Remove check valve.
2. Connect a fuel pump pressure gauge to a hose and nipple from a Propane Enrichment Device (J26911) (see illustration).
3. Insert the nipple into the exhaust manifold A.I.R. pipe.

OR CHECK AT O₂ SENSOR:

1. Carefully remove O₂ sensor.
2. Install Borroughs Exhaust Backpressure Tester (BT 8515 or BT 8603) or equivalent in place of O₂ sensor (see illustration).
3. After completing test described below, be sure to coat threads of O₂ sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.



DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gauge. Reading should not exceed $1 \frac{1}{4}$ psi (8.6 kPa).
2. Accelerate engine to 2000 RPM and observe gauge. Reading should not exceed 3 psi (20.7 kPa).
3. If the backpressure, at either RPM, exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, a restricted catalytic converter should be suspected and replaced using current recommended procedures.

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SECTION B

SYMPTOMS

TABLE OF CONTENTS

Before Starting	Page B-1
Intermittents	Page B-2
Hard Start	Page B-2
Hesitation, Sag, Stumble	Page B-3
Surges and/or Chuggle	Page B-3
Lack of Power, Sluggish, or Spongy	Page B-4
Detonation/Spark Knock	Page B-4
Cuts Out, Misses	Page B-5
Backfire.....	Page B-5
Poor Fuel Economy	Page B-6
Dieseling, Run-On	Page B-6
Rough, Unstable, or Incorrect Idle, Stalling	Page B-6
Excessive Exhaust Emissions or Odors	Page B-7
Restricted Exhaust System Check (Chart B-1)	Page B-8

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Before using this section you should have performed the DIAGNOSTIC CIRCUIT CHECK and found out that:

1. The ECM and "Service Engine Soon" light are operating.
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 - Ignition wires for cracking, hardness, proper routing, and carbon tracking.
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CHART B-1

RESTRICTED EXHAUST SYSTEM CHECK

ALL ENGINES

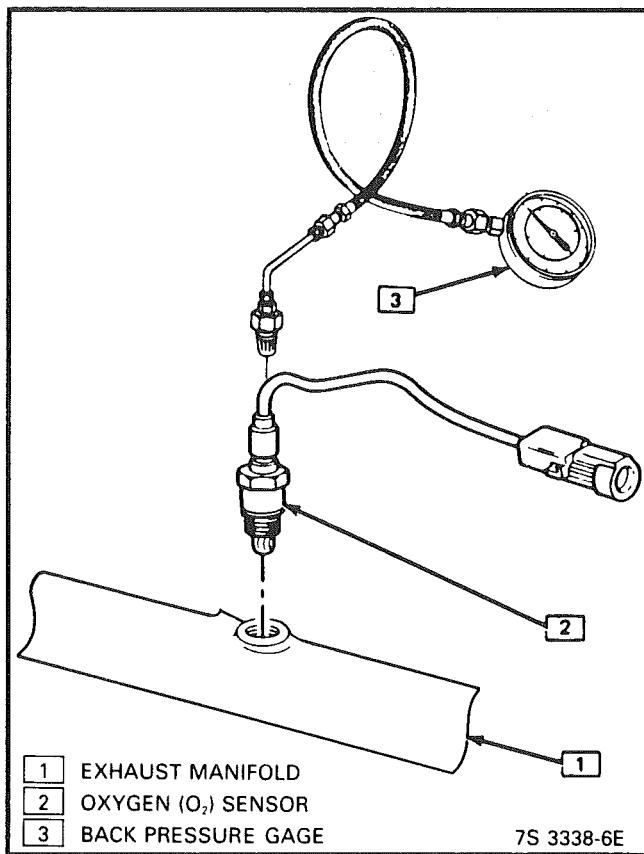
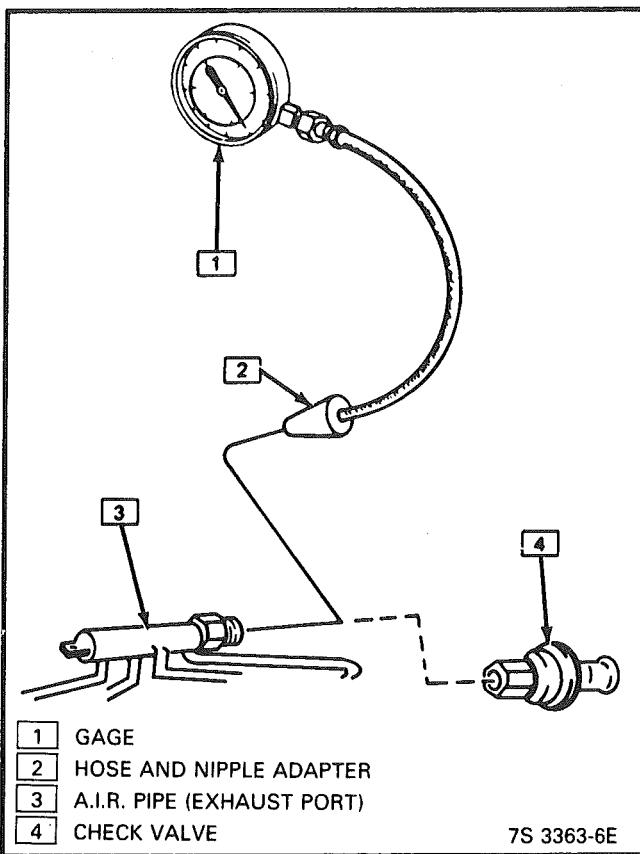
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3. Insert the nipple into the exhaust manifold A.I.R. pipe.

OR CHECK AT O₂ SENSOR:

1. Carefully remove O₂ sensor.
2. Install Borroughs Exhaust Backpressure Tester (BT 8515 or BT 8603) or equivalent in place of O₂ sensor (see illustration).
3. After completing test described below, be sure to coat threads of O₂ sensor with anti-seize compound P/N 5613695 or equivalent prior to re-installation.



DIAGNOSIS:

1. With the engine idling at normal operating temperature, observe the exhaust system backpressure reading on the gauge. Reading should not exceed 1 1/4 psi (8.6 kPa).
2. Accelerate engine to 2000 RPM and observe gauge. Reading should not exceed 3 psi (20.7 kPa).
3. If the backpressure, at either RPM, exceeds specification, a restricted exhaust system is indicated.
4. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
5. If there are no obvious reasons for the excessive backpressure, a restricted catalytic converter should be suspected and replaced using current recommended procedures.

DRIVEABILITY AND EMISSIONS 5.0L (VIN F) & 5.7L (VIN 8) 6E3-B-9

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N.O. - NORMALLY OPEN - State of relay contacts or solenoid plunger when no voltage is applied.

NO_x - NITROGEN, OXIDES OF - One of the pollutants found in engine exhaust.

O₂ - OXYGEN (Sensor) - Monitors the oxygen content of the exhaust system and generates a voltage signal to the ECM.

O/L or O/LOOP - OPEN LOOP - Describes ECM fuel control without use of oxygen sensor information.

OUTPUT - Result of a function typically controlled by the ECM.

OXYGEN SENSOR, EXHAUST - Device that detects the amount of oxygen (O₂) in the exhaust stream.

P.A.I.R - PULSE AIR INJECTION REACTOR system - pulsed air directed into engine to reduce exhaust emissions.

PCV - POSITIVE CRANKCASE VENTILATION - Prevent fumes in crankcase from passing into atmosphere.

PFI - PORT FUEL INJECTION

P/N - PARK/NEUTRAL

PORT - EXHAUST OR INTAKE PORT

PROM - PROGRAMABLE READ ONLY MEMORY - an electronic term used to describe the engine calibration unit.

RPM - REVOLUTIONS PER MINUTE - A measure of rotational speed.

RVB - REAR VACUUM BRAKE - is used to control choke operation during cold engine conditions.

SELF-DIAGNOSTIC CODE - The ECM can detect malfunctions in the system. If a malfunction occurs, the ECM turns on the "Service Engine Soon" light. A diagnostic code can be obtained from the ECM through the "Service Engine Soon" light, or by use of a "Scan" tool. This code will indicate the area of the malfunction.

SES - SERVICE ENGINE SOON LIGHT - Lights when a malfunction occurs in Computer Command Control system.

TACH - TACHOMETER

TBI - THROTTLE BODY INJECTION (Unit) - is controlled by the ECM to supply precise air/fuel mixture into the intake manifold.

TCC - TRANSMISSION / TRANSAXLE CONVERTER CLUTCH - ECM controlled solenoid in transmission which positively couples the transmission to the engine.

THERMAC - THERMOSTATIC AIR CLEANER - provides preheated air to intake manifold to provide better driveability when engine is cold.

TPS - THROTTLE POSITION SENSOR - Device that tells the ECM the throttle position.

TVS - THERMAL VACUUM SWITCH - Used to control vacuum in relationship to engine temperature.

V - VOLT

V-6 - SIX CYLINDER ENGINE - Two banks of cylinders, arranged in a "V".

V-8 - EIGHT CYLINDER ENGINE - Two banks of cylinders, arranged in a "V".

VACUUM - Negative pressure; less than atmospheric pressure.

VACUUM, MANIFOLD - Vacuum source in manifold below throttle plate.

VACUUM, PORTED - A vacuum source above (atmospheric side) of closed throttle plate.

VAC SENSOR - Abbreviation for differential pressure sensor which is a vacuum sensor.

VIN - VEHICLE IDENTIFICATION NUMBER

VSS - VEHICLE SPEED SENSOR - Sensor which sends vehicle speed information to the ECM.

WASTEGATE - A means of controlling the amount of boost available for a Turbo charged engine.

WOT - WIDE OPEN THROTTLE

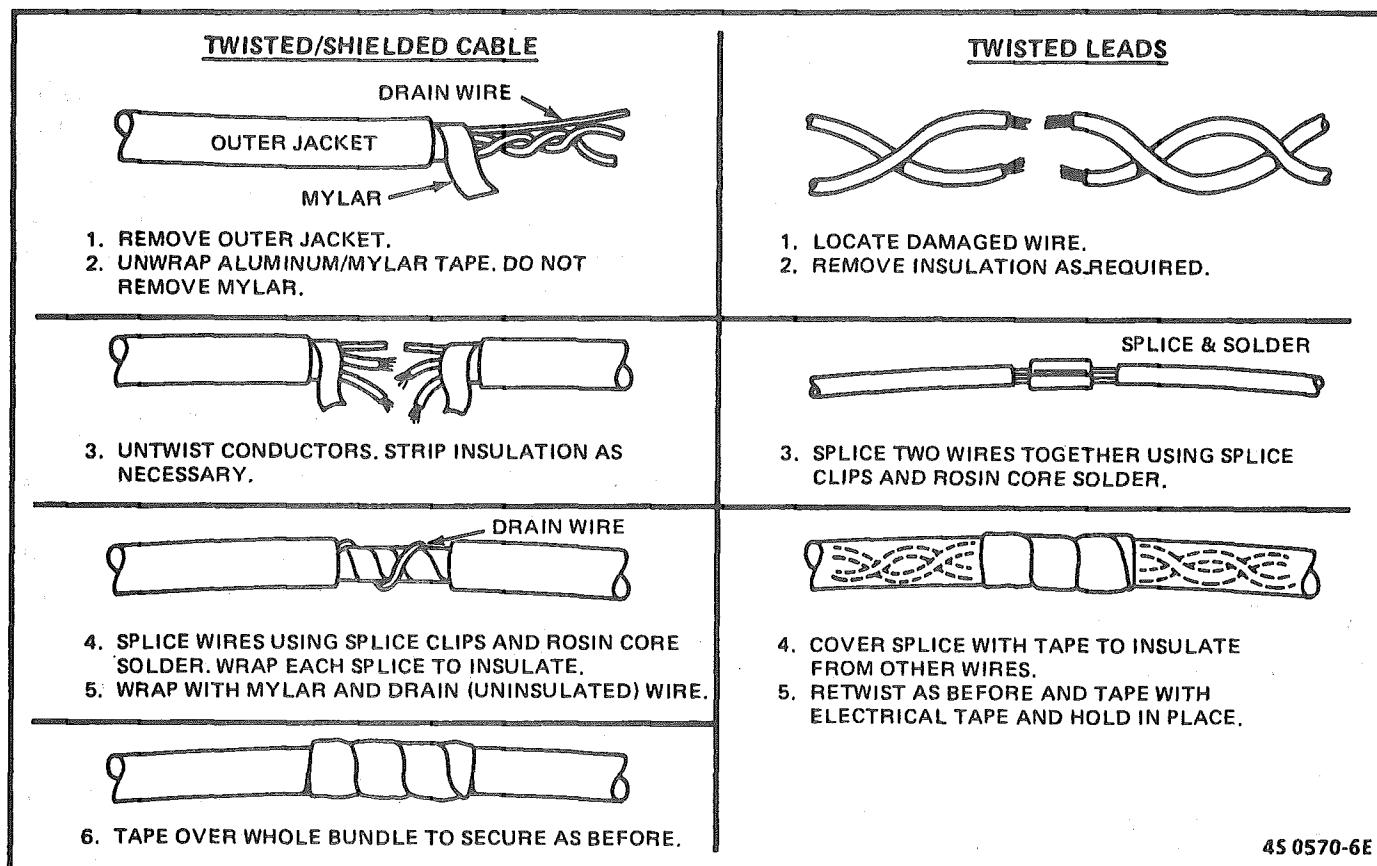
WIRING HARNESS SERVICE

The ECM wire harness electrically connects the ECM to the various solenoids, switches, and sensors in vehicle engine compartment. The ECM is located inside the vehicle passenger compartment.

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

GENERAL

Molded-on connectors (like Metri-Pack) require complete replacement of the connector. This means splicing a new connector assembly into the harness.



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Figure 5 - Wire Harness Repair

WIRE HARNESS

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use wire with high temperature insulation only. See Figure 5 for instructions.

With the low current and voltage levels found in the system, it is important that the best possible bond at all wire splices be made by soldering the splices as shown.

Use care when probing the connector or replacing terminals in them. It is possible to short between opposite terminals. If this happens to the wrong terminal pair, it is possible to damage certain components. Always use jumper wires between connectors for circuit checking. **NEVER** probe through the Weather-Pack seals or insulation. Even microscopic damage or holes may result in eventual water intrusion, corrosion and/or component or circuit failure.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may correct the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three

connectors look similar but are serviced differently. Replacement connectors and terminals are listed in Group 8.965 of the Standard Parts Catalog.

CONNECTORS

Weather-Pack

Some connectors used with an ECM are called Weather-Pack. Figure 6 shows a Weather-Pack terminal and the tool (J-28742, BT-8234-A or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed and, unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge type flap provides a backup, or secondary locking feature for the connector.

They are used to improve the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-pack connections cannot be replaced with standard connections. Instructions are provided with Weather-pack connector and terminal packages.

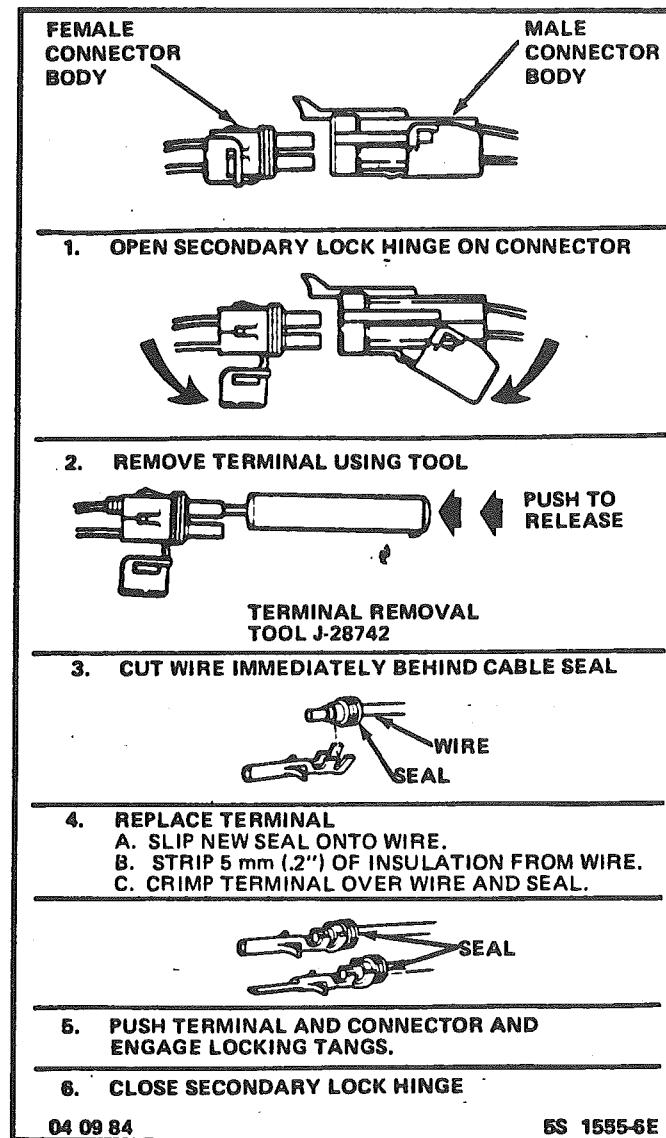


Figure 6 - Weather-Pack Terminal Repair

Compact Three

The compact three connector, which looks similar to a Weather-pack connector, is not sealed and is used where resistance to the environment is not required. This type of connector most likely is used at the air control solenoid. Use the standard method when repairing a terminal. Do not use the Weather-pack terminal tool J-28742.

Metri-Pack Series 150 - Terminal Removal

Some connectors used to connect various sensors to the ECM harness use terminals called "Metri-Pack" (Figure 7). These may be used at the Coolant Sensors as well as at ignition modules.

They are also called "Pull-To-Seat" terminals because, to install a terminal on a wire the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire, and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire,
2. Insert tool (3) BT-8518 or J 35689, or equivalent, as shown in insert "A" and "B" to release the terminal locking tang (2).
3. Push the wire and terminal out through the connector.

If you are reusing the terminal, reshape the locking tang (2).

Micro-Pack

Some connectors used on harness to connect to the ECM are called Micro-Pack (Figure 8). Terminal replacement requires the use of special tool J-33095, BT-8234-A or equivalent.

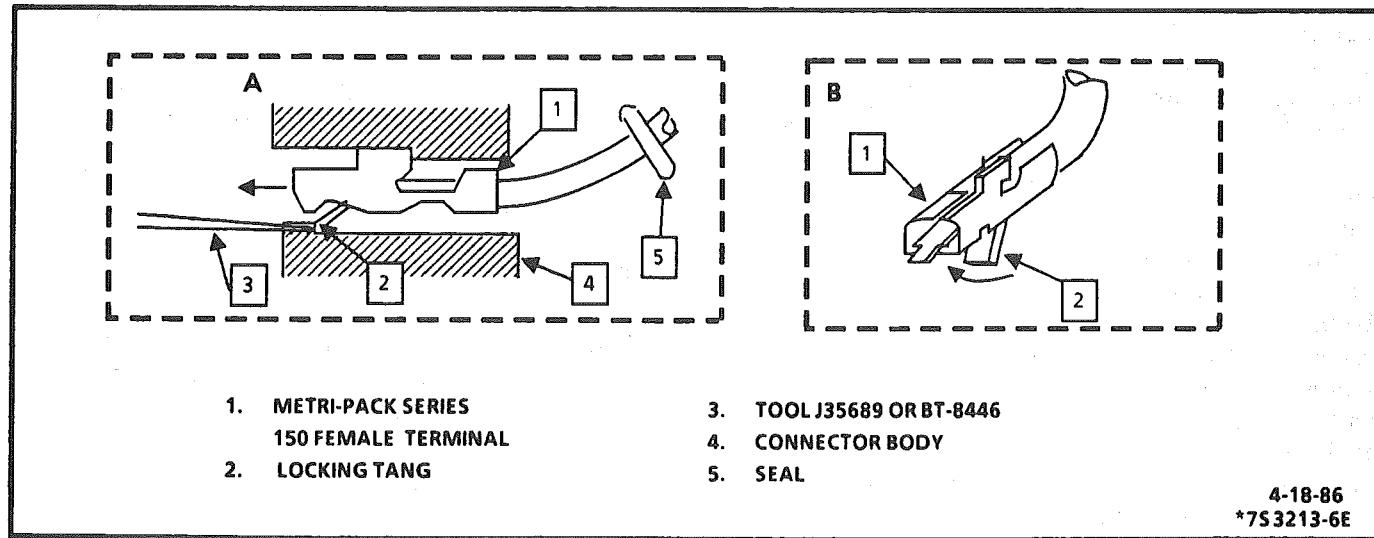


Figure 7 - Metri-Pack Series 150 Terminal Removal

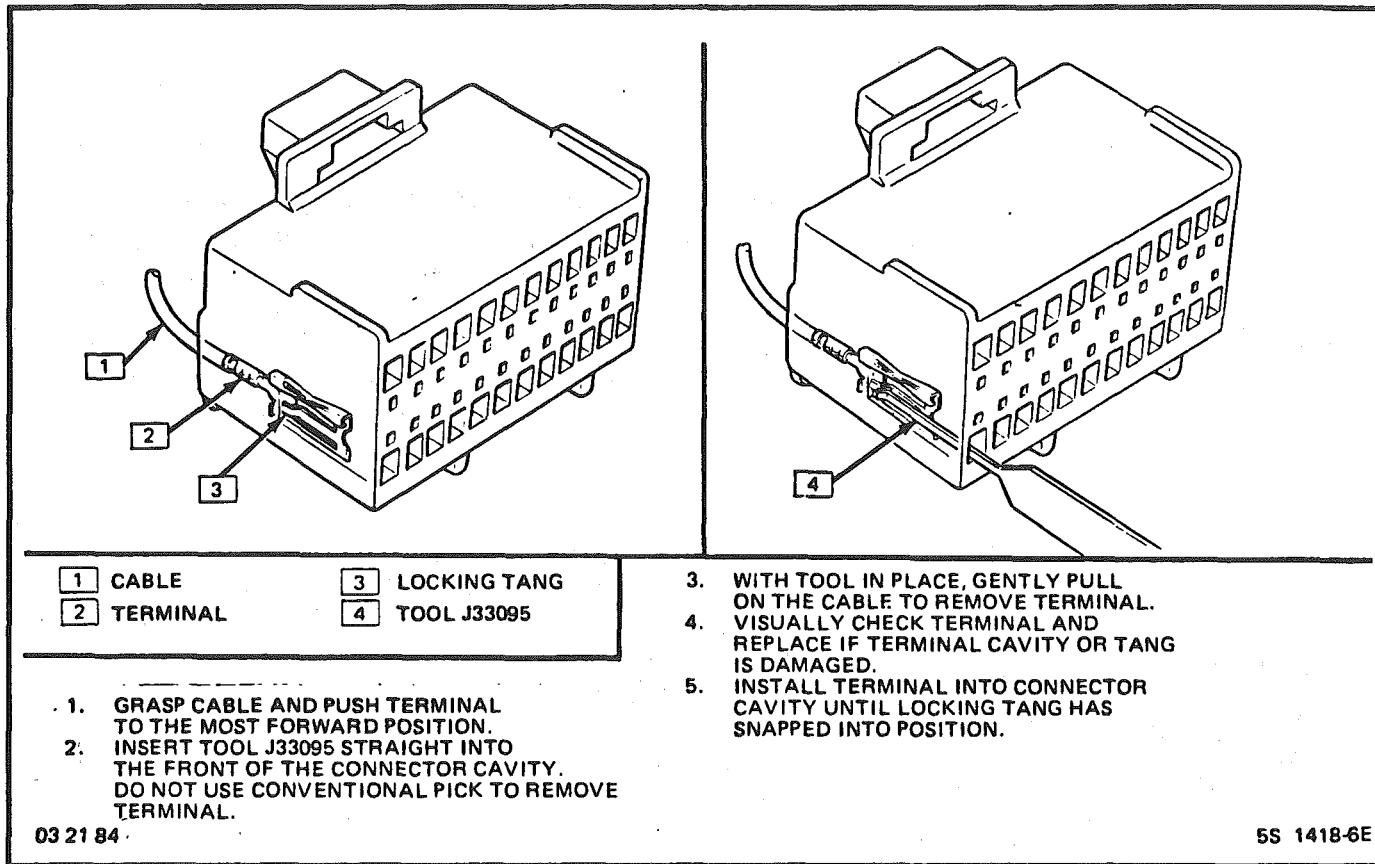
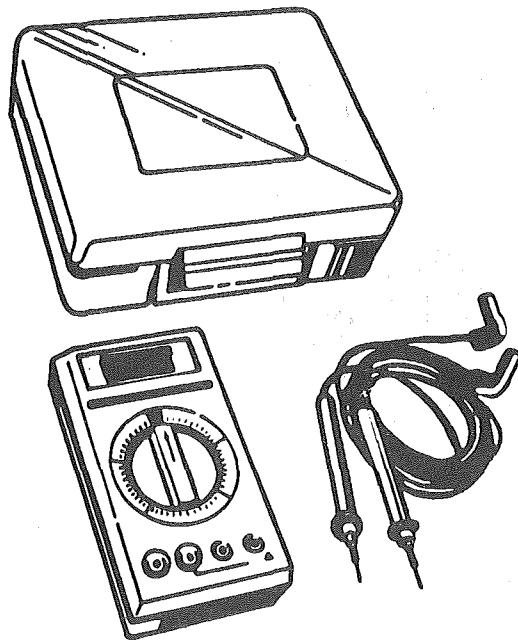


Figure 8 - Micro-Pack Terminal Replacement

TOOLS NEEDED TO SERVICE THE SYSTEM

The system requires an ALDL read-out ("Scan") tool, tachometer, test light, ohmmeter, digital voltmeter with 10 megohms impedance (J-29125A, J-34029A or equivalent), vacuum gage and jumper wires for diagnosis. A test light or voltmeter must be used when specified in the procedures. They must NOT be interchanged. See Figures 9 through 13 for Special Tools needed to diagnosis or repair a system. For more complete information on the operation of these tools, see the manufacturer's instructions.



HIGH IMPEDANCE MULTIMETER
(DIGITAL VOLTMETER-DVM)
J34029-A

VOLTMETER - Voltage Position Measures amount of voltage. When connected in parallel to an existing circuit. A digital voltmeter with 10 meg ohm input impedance is used because this type of meter will not load down the circuit and result in faulty readings. Some circuits require accurate low voltage readings, and some circuits in the ECM have a very high resistance.

AMMETER - When used as ammeter, this meter also accurately measures extremely low current flow. Refer to meter instructions for more information.

- Selector must be set properly for both function and range. DC is used for most automotive measurements.

OHMMETER - Measures resistance of circuit directly in ohms. Refer to meter for more information.

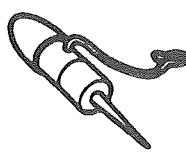
- OL Display in all ranges indicates open circuit.
- Zero display in all ranges indicates a short circuit.
- Intermittent connection in circuit may be indicated by digital reading that will not stabilize on circuit.
- Range Switch.
 - 200Ω - Reads ohms directly
 - 2K, 20K, 200KΩ - Reads ohms in thousands
 - 2M and 20MΩ - Reads ohms in millions



J23738

VACUUM PUMP (20 IN. HG. MINIMUM)

Use gage to monitor manifold engine vacuum and the hand pump to check vacuum sensors, solenoids and valves.



J34142-A

UNPOWERED TEST LIGHT

Used to check wiring for complete circuit and short to ground or voltage.



TACHOMETER

Use inductive trigger signal pickup type to check RPM.

SECTION 6F

EXHAUST SYSTEM

CAUTION: Exhaust system components should have enough clearance from the underbody to

avoid overheating and possible damage to the passenger compartment carpets.

CONTENTS

General Description	6F-1
Exhaust Pipe	6F-1
Muffler	6F-1
Resonator	6F-1

Hanger	6F-1
Clamp	6F-1
Catalytic Converter	6F-1

GENERAL DESCRIPTION

When inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to avoid possible overheating of the floor pan and possible damage to the passenger compartment insulation and trim materials.

Check complete exhaust system and nearby body areas and trunk lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the trunk or passenger compartment. Dust or water in the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately. To help insure continued integrity, the exhaust system pipe rearward of the muffler must be replaced whenever a new muffler is installed.

EXHAUST PIPE

The exhaust manifold to crossover pipe connections are of the ball type, thus eliminating the need for gaskets.

MUFFLER

The mufflers are a tri-flow design. Some muffler installations have a slot in the inlet and/or outlet pipe which indexes to a key (tab) welded on the exhaust and/or tail pipe to help maintain alignment.

RESONATOR

A resonator is used on some series exhaust systems. It allows the use of mufflers with less back pressure and provides for optimum tuning characteristics of the exhaust system.

HANGER

Two types of hangers are used to support the exhaust system. One type is a conventional rubber strap and the second type is a "rubber block." The rubber block type provides a rigid hanger along with a feature that continues to support the exhaust system in the event a rubber insulator block is broken.

The installation of exhaust system supports is very important as improperly installed supports can cause annoying vibrations which are difficult to diagnose.

CLAMP

Two methods are used for connecting exhaust system slip joins, (1) clamp and (2) weld. When servicing a welded connection it should be cut and the new connection clamped when installing replacement parts. Also, coat slip joints with exhaust system sealer before assembling (Fig. 1).

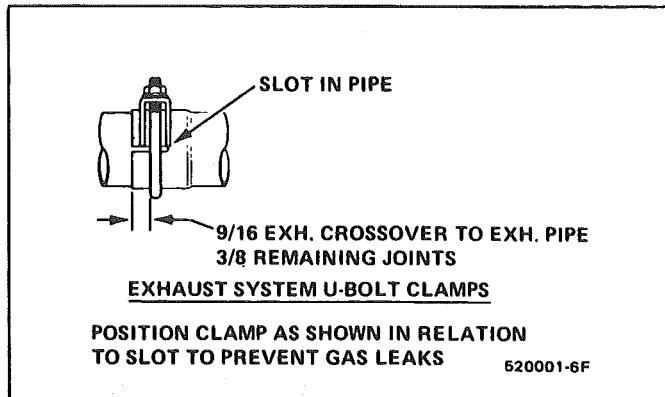


Fig. 1 Installation of Exhaust System Clamp

CATALYTIC CONVERTER

The catalytic converter is an emission control device added to the exhaust system to reduce pollutants from the exhaust gas stream.

NOTICE: THE CATALYTIC CONVERTER REQUIRES THE USE OF UNLEADED FUEL ONLY.

Periodic maintenance of the exhaust system is not required, however, if the car is raised for other service, it is advisable to check the general condition of the catalytic converter, pipes and mufflers.

Three different converter designs are used in combination with two different types of catalyst.

Converter Designs:

6F-2 EXHAUST SYSTEM

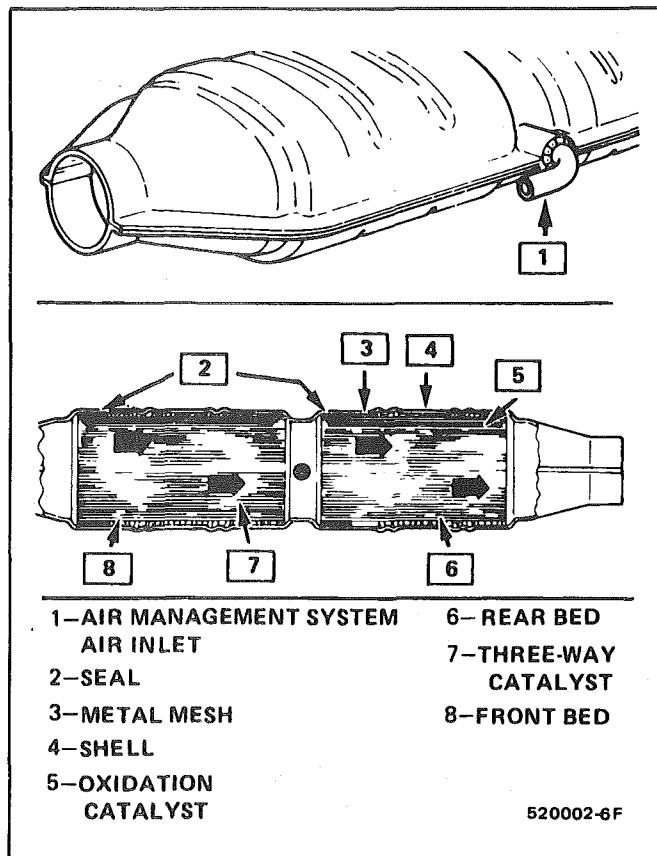


Fig. 2 Dual Bed Monolith

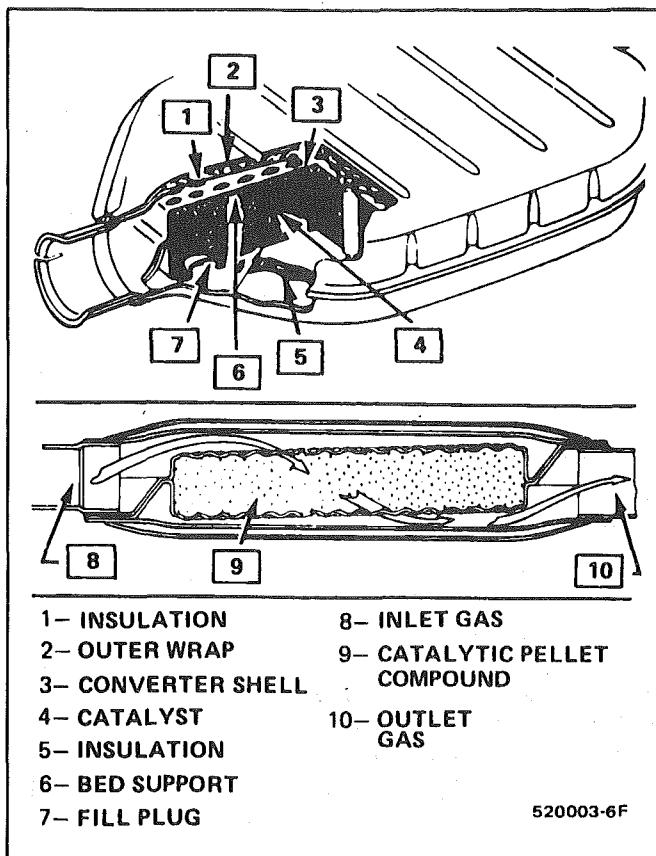


Fig. 3 Single Bed Pellet

Dual Bed Monolith
Single Bed Pellet
Dual Bed Pellet

Catalyst Types:
Oxidation Catalyst
Three-Way (Reduction) Catalyst

The oxidation catalyst is coated with a catalytic material containing platinum and palladium which lowers levels of hydrocarbon (HC) and carbon monoxide (CO). The catalyst coating on the three-way (reduction) catalyst contains platinum and rhodium which lowers levels of oxide of nitrogen (NOX) as well as hydrocarbons (HC) and carbon monoxide (CO).

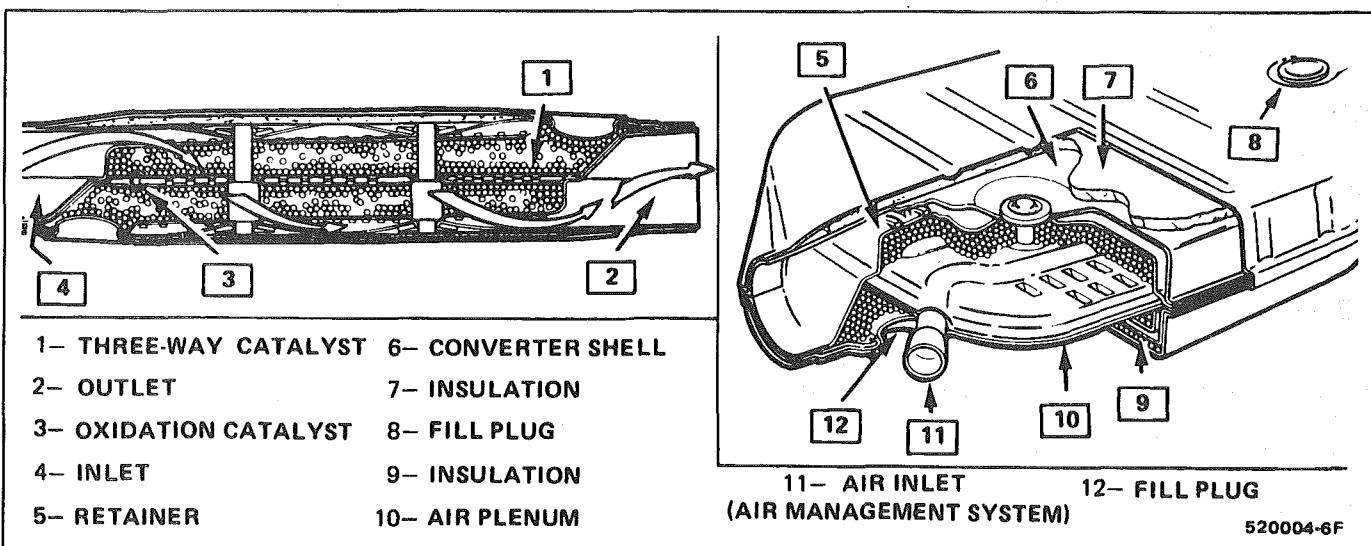


Fig. 4 Dual Bed Pellet

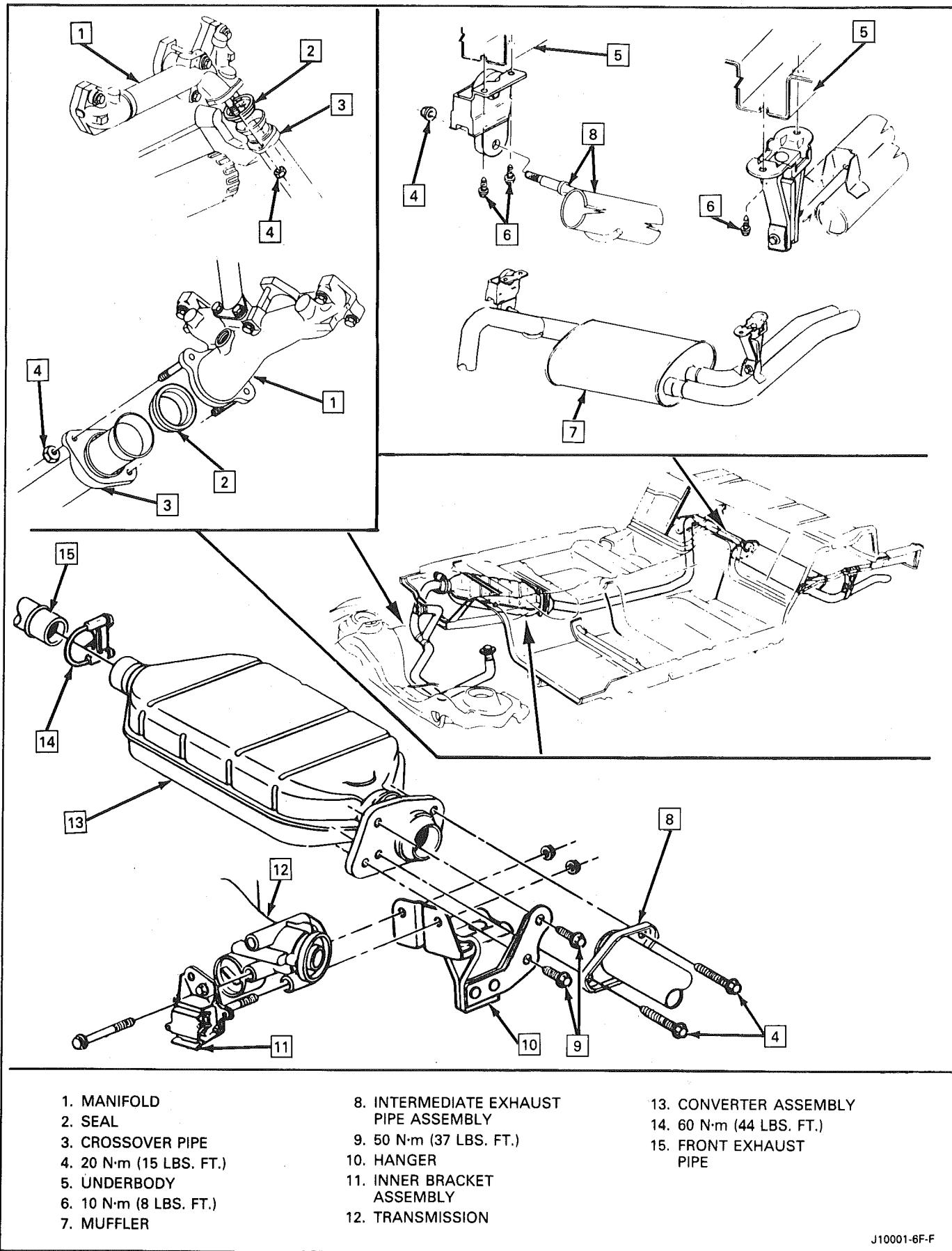


Fig. 5 Exhaust System — V.I.N. S

6F-4 EXHAUST SYSTEM

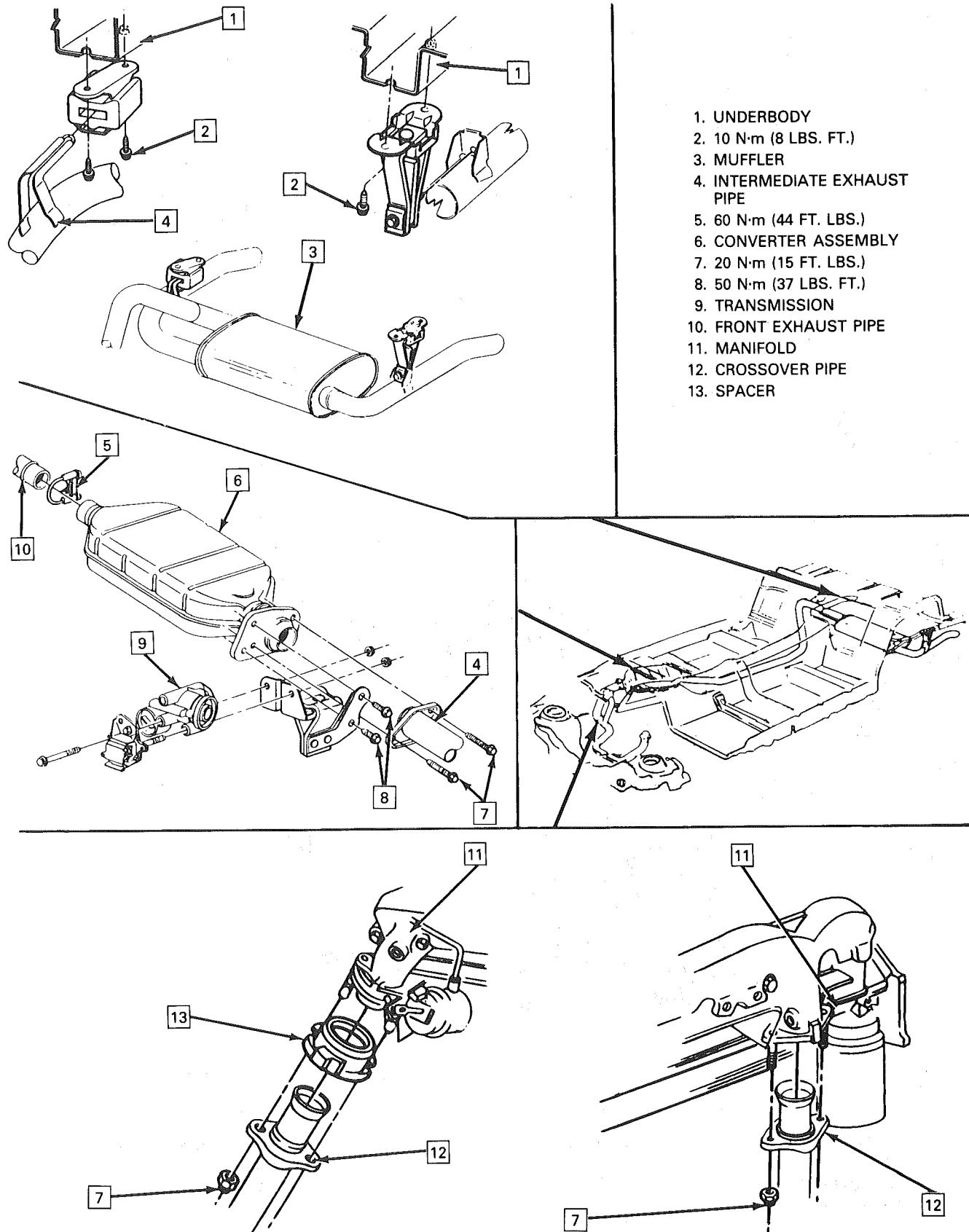


Fig. 6 Exhaust System — V.I.N. F, E and 8

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