2004 ENGINE PERFORMANCE

Engine Controls (Introduction) - 4.2L - Bravada, Envoy & TrailBlazer

SPECIFICATIONS

TEMPERATURE VS RESISTANCE

Temperature vs Resistance

Â°C	Â°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450

Â°C	Â°F	OHMS
-20	-4	28680
-30	-22	52700
-40	-40	100700

ALTITUDE VS BAROMETRIC PRESSURE

Altitude vs Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

IGNITION SYSTEM SPECIFICATIONS

Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-5-3-6-2-4	
Spark Plug Torque	18 N.m	13 lb ft
Spark Plug Gap	1.08 mm	0.0425 in
Spark Plug Type	AC 41-981	

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
Accelerator Pedal Position (APP) Sensor Bolt	10 N.m	89 lb in
Air Cleaner Cover/Resonator Retaining Screw	4 N.m	35 lb in
Air Cleaner Lower Housing/Washer Solvent Tank Assembly Nut	15 N.m	11 lb ft

Application	Specifications	
	Metric	English
Air Cleaner Outlet Duct Clamp	4 N.m	35 lb in
Air Cleaner Outlet Resonator Bolt	6 N.m	53 lb in
Camshaft Position (CMP) Sensor Bolt	10 N.m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N.m	89 lb in
Engine Coolant Temperature (ECT) Sensor	16 N.m	12 lb ft
EVAP Canister Bracket Bolt	20 N.m	15 lb ft
EVAP Canister Purge Solenoid Bracket Bolt	25 N.m	18 lb ft
Fuel Fill Hose Clamp	2.5 N.m	22 lb in
Fuel Fill Pipe Bracket Nut	10 N.m	89 lb in
Fuel Fill Pipe Ground Strap Bolt	10 N.m	89 lb in
Fuel Filter Bracket Screw	1.5 N.m	13 lb in
Fuel Pipe Assembly Bracket Bolt	3.75 N.m	33 lb in
Fuel Pressure Regulator Screw	8 N.m	71 lb in
Fuel Rail Bolt	10 N.m	89 lb in
Fuel Tank Strap Bolt	32 N.m	24 lb ft
Heated Oxygen Sensor (HO2S)	41 N.m	30 lb ft
Ignition Coil Bolt	10 N.m	89 lb in
Knock Sensor (KS)	25 N.m	18 lb ft
Powertrain Control Module (PCM) Connector End Bolt	8 N.m	71 lb in
Powertrain Control Module (PCM) Mounting Stud	6 N.m	53 lb in
Powertrain Control Module (PCM) Retaining Bolt	10 N.m	89 lb in
Powertrain Control Module (PCM) Retaining Nut	10 N.m	89 lb in
Spark Plug	17-23 N.m	13-16 lb ft
Throttle Body Bolt	10 N.m	89 lb in

DIAGNOSTIC TROUBLE CODE (DTC) TYPE DEFINITIONS

Emissions Related DTCs

Action Taken When the DTC Sets - Type A

The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Action Taken When the DTC Sets - Type B

The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.

Conditions for Clearing the MIL/DTC - Type A or Type B

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- Use a scan tool in order to clear the MIL and the DTC.

Non-Emissions Related DTCs

Action Taken When the DTC Sets - Type C

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC - Type C

- A last test failed, or current DTC, clears when the diagnostic runs and passes.
- Use a scan tool in order to clear the DTC.

Conditions for Clearing the DTC - Type X

This DTC is available in the PCM software, but has been disabled, or turned OFF. In this case, the diagnostic does not run, no DTCs are stored, and the MIL does not illuminate. Type X DTCs are used primarily for export vehicles that do not require MIL illumination or DTC storing.

DIAGNOSTIC TROUBLE CODE (DTC) TYPE(S)

Diagnostic Trouble Code (DTC) Type(s)

DTC	All RPOs
P0013	B
P0014	B
P0068	A
P0106	B
P0107	A
P0108	A
P0112	B
P0113	B
P0117	B
P0118	B
P0120	A
P0122	A
P0123	A
P0125	B
P0128	B
P0130	B
P0131	B
P0132	B
P0133	B
P0134	B
P0135	B
P0136	B
P0137	B
P0138	B
P0140	B
P0141	B

DTC	All RPOs
P0171	B
P0172	B
P0201	B
P0202	B
P0203	B
P0204	B
P0205	B
P0206	B
P0218	C
P0220	A
P0222	A
P0223	A
P0300	B
P0301	B
P0302	B
P0303	B
P0304	B
P0305	B
P0306	B
P0326	B
P0327	B
P0332	B
P0335	B
P0336	B
P0340	B
P0341	B
P0410	B
P0420	A
P0442	A Domestic Only
P0446	A
P0452	B
P0453	B
P0455	A
P0461	C
P0462	C
P0463	C
P0495	B
P0496	A
P0502	B
P0503	B
P0506	B
P0507	A
P0530	C
P0562	C

DTC	All RPOs
P0563	C
P0567	C
P0568	C
P0601	A
P0602	A
P0604	A
P0606	A
P0607	C
P0621	C
P0622	C
P0641	A
P0651	A
P0705	C
P0711	C
P0712	C
P0713	C
P0719	C
P0724	C
P0740	B
P0741	B
P0742	B
P0748	C
P0751	B
P0752	B
P0753	B
P0756	A
P0757	B
P0758	A
P0785	B
P1137	B
P1138	B
P1171	C
P1380	C
P1381	C
P1516	A
P1574	C
P1621	A
P1630	C
P1631	C
P1680	A
P1681	A
P1682	C
P1810	B
P2101	A
P2119	C

DTC	All RPOs
P2120	A
P2122	A
P2123	A
P2125	A
P2127	A
P2128	A
P2135	A
P2138	A
P2176	A

SCHEMATIC AND ROUTING DIAGRAMS

EMISSION HOSE ROUTING DIAGRAM

Fig. 1: Emission Hose Routing Diagram
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Throttle Body
2	To EVAP canister
3	EVAP canister purge valve
4	Preplenum resonator
5	Fuel pressure regulator

EVAPORATIVE EMISSIONS (EVAP) HOSE ROUTING DIAGRAM

Fig. 2: EVAP Hose Routing Diagram
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	EVAP Canister Purge Solenoid Valve
2	EVAP Canister
3	Fuel Fill Neck/Fill Cap
4	Rollover Valve/Fuel Tank Pressure (FTP) Sensor
5	Fuel Tank
6	EVAP Canister Vent Solenoid Valve
7	Vent Hose/Pipe
8	EVAP Vapor Pipe
9	EVAP Purge Pipe
10	EVAP Service Port

FUEL HOSE/PIPES ROUTING DIAGRAM

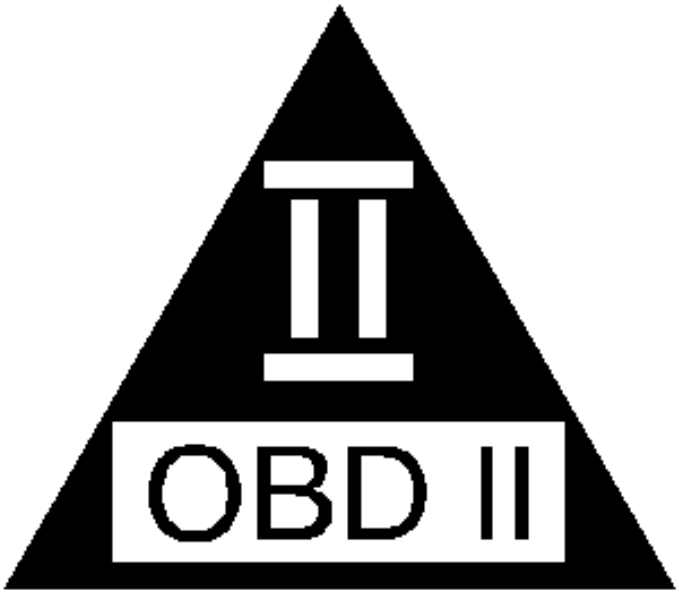
Fig. 3: Fuel Hose/Pipes Routing Diagram
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Compartment Fuel Pipes

Callout	Component Name
2	Fuel Return Pipe
3	Fuel Feed Pipe
4	Fuel Filter

ENGINE CONTROLS SCHEMATIC ICONS

Engine Controls Schematic Icons

Icon	Icon Definition
	**NOTE:** **The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.**

ENGINE CONTROLS SCHEMATICS

Fig. 4: Power, Ground, Serial Data, and MIL Schematic
Courtesy of GENERAL MOTORS CORP.

Fig. 5: 5-Volt and Low Reference Schematic
Courtesy of GENERAL MOTORS CORP.

Fig. 6: Engine Data Sensors - Pressure and Temperature Schematic
Courtesy of GENERAL MOTORS CORP.

Fig. 7: Engine Data Sensors Schematic - Oxygen Sensors
Courtesy of GENERAL MOTORS CORP.

Fig. 8: Engine Data Sensors Schematic - Throttle Actuator Controls and VSS
Courtesy of GENERAL MOTORS CORP.

Fig. 9: Ignition Controls Schematic - Ignition System
Courtesy of GENERAL MOTORS CORP.

Fig. 10: Ignition Controls Schematic - Sensors
Courtesy of GENERAL MOTORS CORP.

Fig. 11: Fuel Controls Schematic - Fuel Pump Controls and Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

Fig. 12: Fuel Controls Schematic - EVAP Controls
Courtesy of GENERAL MOTORS CORP.

Fig. 13: Device Controls (K18) Schematic
Courtesy of GENERAL MOTORS CORP.

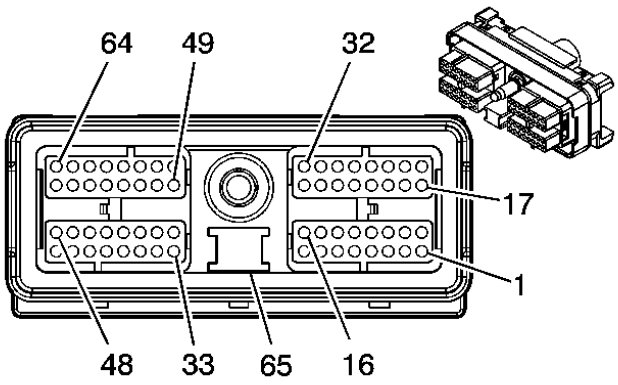
Fig. 14: Controlled/Monitored Subsystem References Schematic
Courtesy of GENERAL MOTORS CORP.

Fig. 15: Transmission Control References Schematic - A/T
Courtesy of GENERAL MOTORS CORP.

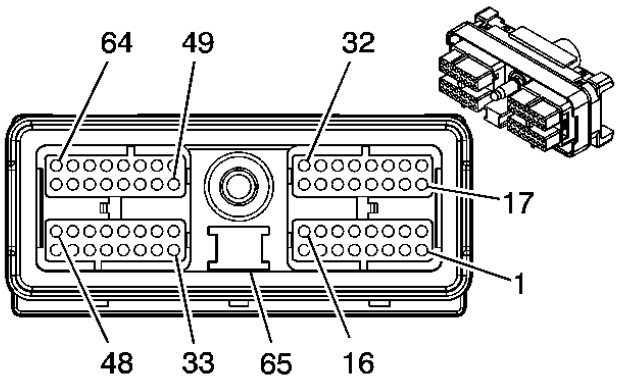
COMPONENT LOCATOR

POWERTRAIN CONTROL MODULE (PCM) CONNECTORS

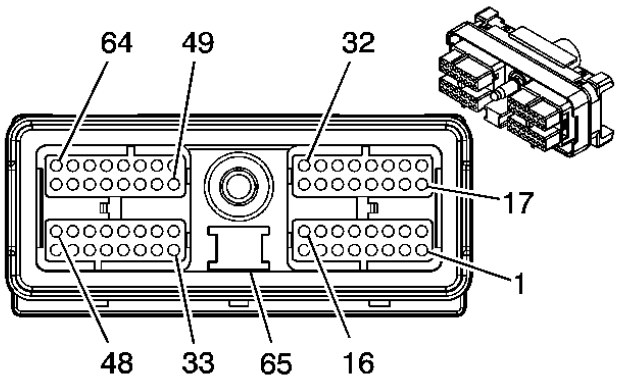
Powertrain Control Module (PCM) C1 Connector End View



Connector Part Information	• 15354782 • 65-Way F (BU)		
Pin	**Wire Color**	**Circuit No.**	**Function**
1	L-BU	1162	APP Sensor 2 Signal
2	D-BU	1161	APP Sensor 1 Signal
3	L-BU	1320	Stop Lamp Supply Voltage
4	GY/BK	1694	4WD Low Signal (NP8)
5	GY/BK	87	Cruise Control Resume/Accel Switch Signal
6	D-BU	84	Cruise Control Set/Coast Switch Signal
7	BN/WH	419	MIL Control
8	OG/BK	510	Low Reference
9	-	-	Not Used
10	BN	1271	Low Reference
11	PU	1272	Low Reference

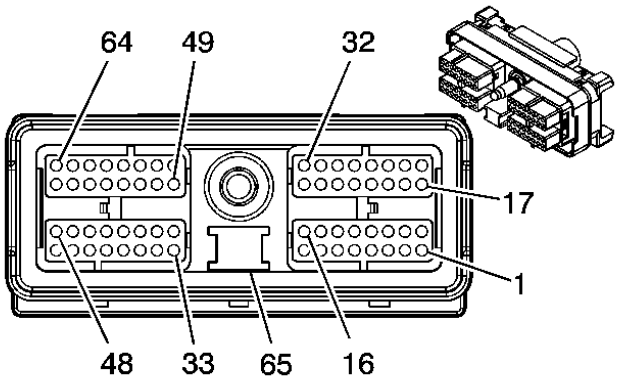


Connector Part Information		• **15354782** • **65-Way F (BU)**	
Pin	**Wire Color**	**Circuit No.**	**Function**
12	BK	2759	Low Reference
13	BK	2760	Low Reference
14	BK	2751	Low Reference
15-16	-	-	Not Used
17	GY	397	Cruise Control On Switch Signal
18	-	-	Not Used
19	PK	439	Ignition 1 Voltage
20	OG	440	Battery Positive Voltage
21	PK	1020	Ignition 0 Voltage
22	PU	1589	Fuel Level Sensor Signal - Primary
23-24	-	-	Not Used
25	YE/BK	1827	Vehicle Speed Signal
26-27	-	-	Not Used
28	PU	420	TCC Brake/Cruise Control Release Switch Signal
29	D-GN	1433	PNP Switch Signal
30	TN	472	IAT Sensor Signal
31	PU	806	Crank Voltage
32	D-GN/WH	817	Vehicle Speed Signal
33-40	-	-	Not Used
41	RD/BK	380	A/C Refrigerant Pressure Sensor Signal
42	D-GN/WH	459	A/C Compressor Clutch Relay Control
43	D-BU	2364	Cooling Fan Speed Signal
44	BN	436	Air Pump Relay Control (K18)
45-47	-	-	Not Used
48	YE/BK	625	Starter Enable Relay Control
49	WH	121	Engine Speed Signal
50-53	-	-	Not Used
54	GY	2700	5-Volt Reference



Connector Part Information	• **15354782** • **65-Way F (BU)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
55	WH/BK	1164	5-Volt Reference
56	-	-	Not Used
57	WH/BK	2366	Cooling Fan Clutch Control
58	YE	710	Class 2 Serial Data
59	D-GN	1049	Class 2 Serial Data
60	GY	2365	Low Reference
61	D-GN	890	Fuel Tank Pressure Sensor Signal
62	GY	2709	5-Volt Reference
63	TN	1274	5-Volt Reference
64-65	-	-	Not Used

Powertrain Control Module (PCM) C2 Connector End View

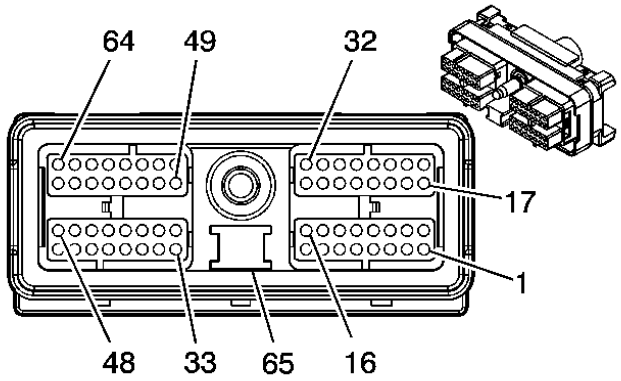


Connector Part Information	• **15354781** • **65-Way F (D-GY)**		
Pin	**Wire Color**	**Circuit No.**	**Function**

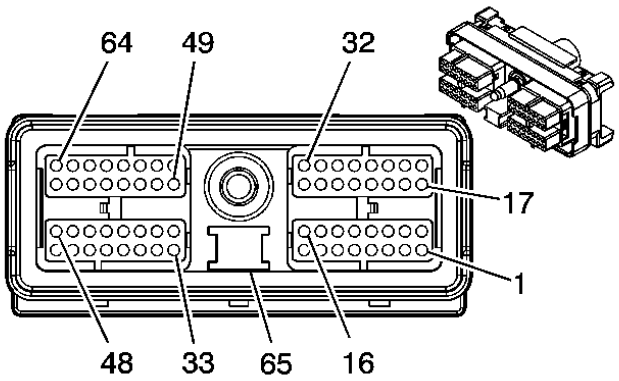
1	PU	574	Low Reference
2	L-GN/BK	822	VSS Low Signal
3	D-GN/WH	465	Fuel Pump Relay Control - Primary
4	L-BU/WH	1229	Pressure Control Solenoid Valve Low Control
5	RD/BK	1228	Pressure Control Solenoid Valve High Control
6	YE/BK	846	Fuel Injector 6 Control
7	BK/WH	845	Fuel Injector 5 Control
8	L-BU/BK	844	Fuel Injector 4 Control
9	YE	573	CKP Sensor Signal
10	PU/WH	821	VSS High Signal
11	TN/BK	464	Delivered Torque Signal
12	OG/BK	463	Requested Torque Signal
13	-	-	Not Used
14	BK	1744	Fuel Injector 1 Control
15	L-GN/BK	1745	Fuel Injector 2 Control
16	PK/BK	1746	Fuel Injector 3 Control
17	WH	1310	EVAP Canister Vent Solenoid Control
18	TN/WH	1669	HO2S Low Signal - Bank 1 Sensor 2
19	YE	410	ECT Sensor Signal
20	D-GN/WH	428	EVAP Canister Purge Solenoid Control
21	-	-	Not Used
22	BN	418	TCC PWM Solenoid Valve Control
23	PU/WH	1665	HO2S High Signal - Bank 1 Sensor 1
24	-	-	Not Used
25	L-GN	432	MAP Sensor Signal
26	PU/WH	1668	HO2S High Signal - Bank 1 Sensor 2
27	WH	687	3-2 Shift Solenoid Valve Control
28	BK/WH	771	Transmission Range Switch Signal A
29	TN/BK	231	Oil Pressure Switch Signal
30	BK/WH	1423	HO2S Heater Low Control - Bank 1 Sensor 2
31	D-GN	676	HO2S Heater Low Control - Bank 1 Sensor 1
32	TN	1664	HO2S Low Signal - Bank 1 Sensor 1
33	-	-	Not Used
34	L-BU/WH	2126	IC 6 Control
35	L-BU	2123	IC 3 Control
36	-	-	Not Used
37	TN/BK	422	TCC Solenoid Valve Control
38	-	-	Not Used
39	BN	2198	Camshaft Position Solenoid Actuator High Control
40	D-GN	2125	IC 5 Control
41	D-GN/WH	2124	IC 4 Control
42	RD/WH	2122	IC 2 Control

43	-	-	Not Used
44	PU	2121	IC 1 Control
45-50	-	-	Not Used
51	GY	23	Generator Field Duty Cycle Signal
52-53	-	-	Not Used
54	OG/BK	469	Low Reference
55-56	-	-	Not Used
57	YE/BK	1223	2-3 Shift Solenoid Valve Control
58	BK	2761	Low Reference
59	L-GN	1222	1-2 Shift Solenoid Valve Control
60-61	-	-	Not Used
62	BK	2199	Low Reference
63	-	-	Not Used
64	GY	2704	5-Volt Reference
65	BK	450	Ground

Powertrain Control Module (PCM) C3 Connector End View



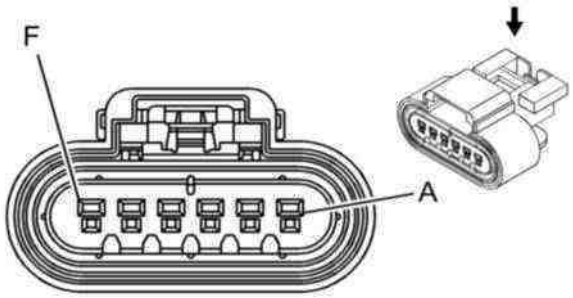
Connector Part Information	• **15354780** • **65-Way F (WH)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
1	D-BU	496	KS 1 Signal
2	RD	225	Generator Turn On Signal
3	GY	2701	5-Volt Reference
4-7	-	-	Not Used
8	BK	2762	Low Reference
9	L-BU	1876	Knock Sensor 2 Signal
10	D-BU	1225	Transmission Fluid Pressure Switch Signal B
11	-	-	Not Used
12	YE	772	Transmission Range Switch Signal B
13	WH	776	Transmission Range Switch Signal P
14	PU	421	Air Solenoid Relay Control (K18)



Connector Part Information	• **15354780** • **65-Way F (WH)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
15	-	-	Not Used
16	BK/WH	1704	Low Reference
17	PK	839	Ignition 1 Voltage
18	RD	631	12-Volt Reference
19	RD	1226	Transmission Fluid Pressure Switch Signal C
20	GY	773	Transmission Range Switch Signal C
21	PK	1224	Transmission Fluid Pressure Switch Signal A
22	YE/BK	1227	TFT Sensor Signal
23	GY	1716	Low Reference
24	-	-	Not Used
25	BN	582	TAC Motor Control - 2
26	YE	581	TAC Motor Control - 1
27	-	-	Not Used
28	D-GN	485	TP Sensor 1 Signal
29	PK/BK	632	Low Reference
30	PU	486	TP Sensor 2 Signal
31	GY	2303	Low Reference
32-48	-	-	Not Used
49	L-BU/BK	1688	5-Volt Reference
50	-	-	Not Used
51	BN/WH	633	CMP Sensor Signal
52-57	-	-	Not Used
58	PU	114	Low Oil Pressure Switch Signal
59	BK	2752	Low Reference
60	GY	597	5 Volt Reference
61-65	-	-	Not Used

ENGINE CONTROLS CONNECTORS

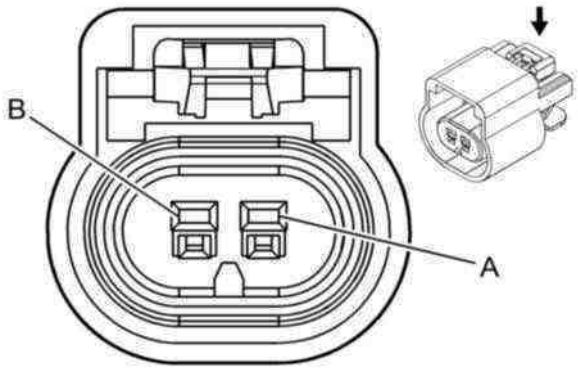
Accelerator Pedal Position (APP) Sensor Connector End View



Connector Part Information	• 15326830 • 6-Way F GT 150 Sealed (BK)

Pin	Wire Color	Circuit No.	Function
A	PU	1272	Low Reference
B	L-BU	1162	APP Sensor 2 Signal
C	TN	1274	5-Volt Reference
D	BN	1271	Low Reference
E	D-BU	1161	APP Sensor 1 Signal
F	WH/BK	1164	5-Volt Reference

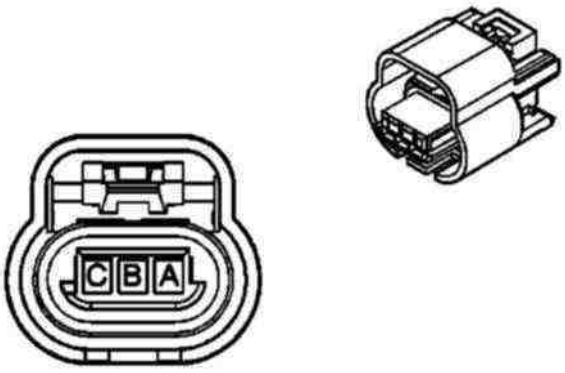
Camshaft Actuator Solenoid Assembly Connector End View



Connector Part Information	• 15326801 • 2-Way F GT 150 Series (BK)

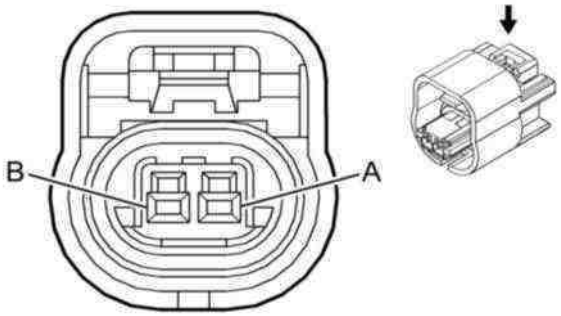
Pin	Wire Color	Circuit No.	Function
A	BN	2198	Camshaft Position Solenoid Actuator High Control
B	BK	2199	Low Reference

Camshaft Position (CMP) Sensor Connector End View



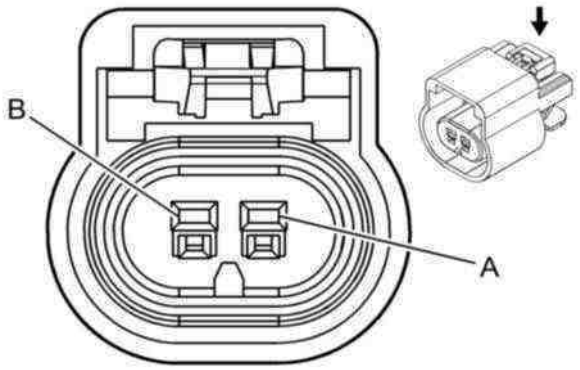
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	RD	631	12-Volt Reference
B	BN/WH	633	CMP Sensor Signal
C	PK/BK	632	Low Reference

Crankshaft Position (CKP) Sensor Connector End View



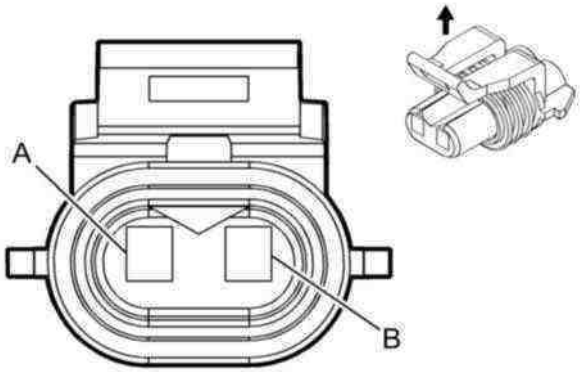
Connector Part Information	• 15336004 • 2-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PU	574	Low Reference
B	YE	573	CKP Sensor Signal

Engine Coolant Temperature (ECT) Sensor Connector End View



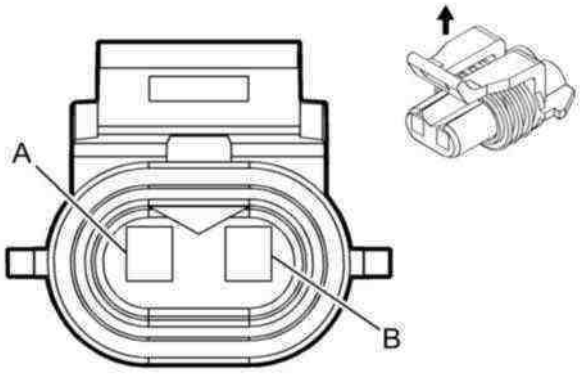
Connector Part Information		• 15326801 • 2-Way F GT 150 Series (BK)	
Pin	**Wire Color**	**Circuit No.**	**Function**
A	YE	410	ECT Sensor Signal
B	BK	2761	Low Reference

Evaporative Emission (EVAP) Canister Purge Solenoid Connector End View



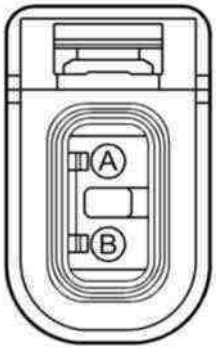
Connector Part Information		• 12052643 • 2-Way F Metri-Pack 150 Series Sealed (RD)	
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	239	Ignition 1 Voltage
B	D-GN/WH	428	EVAP Canister Purge Solenoid Control

Evaporative Emission (EVAP) Canister Vent Solenoid Connector End View



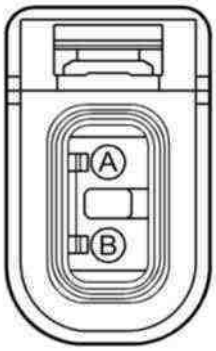
Connector Part Information	• 12052643 • 2-Way F Metri-Pack 150 Series Sealed (RD)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	239	Ignition 1 Voltage
B	WH	1310	EVAP Canister Vent Solenoid Control

Fuel Injector 1 Connector End View



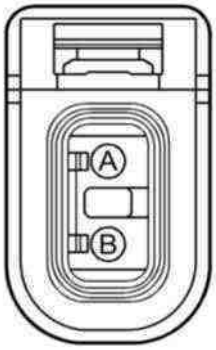
Connector Part Information	• 15326181 • 2-Way F MIC/P 064 Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	BK	1744	Fuel Injector 1 Control

Fuel Injector 2 Connector End View



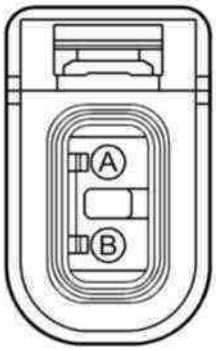
Connector Part Information	• 15326181 • 2-Way F MIC/P 064 Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	L-GN/BK	1745	Fuel Injector 2 Control

Fuel Injector 3 Connector End View



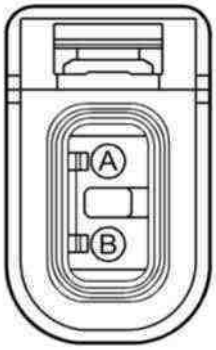
Connector Part Information	• 15326181 • 2-Way F MIC/P 064 Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	PK/BK	1746	Fuel Injector 3 Control

Fuel Injector 4 Connector End View



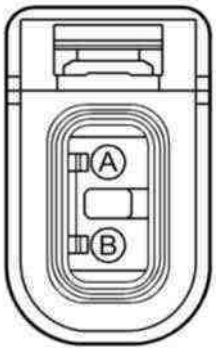
Connector Part Information	• 15326181 • 2-Way F MIC/P 064 Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	L-BU/BK	844	Fuel Injector 4 Control

Fuel Injector 5 Connector End View



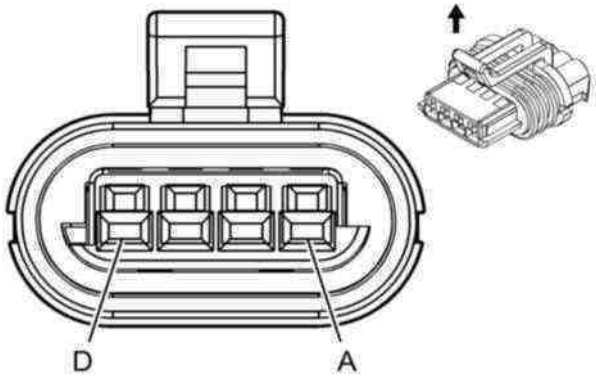
Connector Part Information	• 15326181 • 2-Way F MIC/P 064 Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	BK/WH	845	Fuel Injector 5 Control

Fuel Injector 6 Connector End View



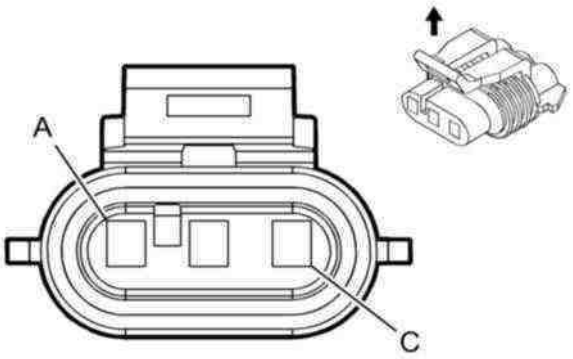
Connector Part Information	• **15326181** • **2-Way F MIC/P 064 Sealed (BK)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	YE/BK	846	Fuel Injector 6 Control

Fuel Pump and Sender Assembly Connector End View



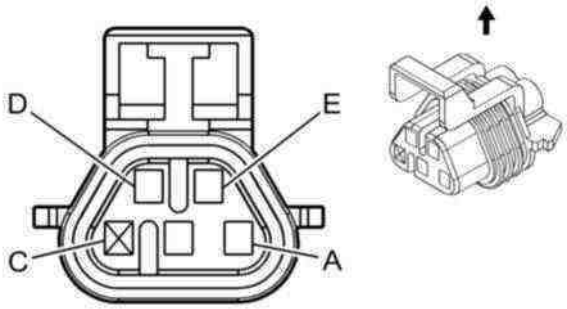
Connector Part Information	• **15354716** • **4-Way F GT 150 Sealed 3.2 X 4.0 (BK)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PU	1589	Fuel Level Sensor Signal - Primary
B	GY	120	Fuel Pump Supply Voltage
C	BK	2450	Ground
D	OG/BK	510	Low Reference

Fuel Tank Pressure (FTP) Sensor Connector End View



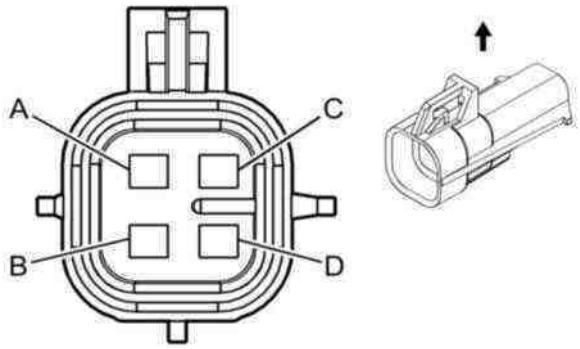
Connector Part Information	• 12059595 • 3-Way F Metri-Pack 150 Series Sealed (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	BK	2759	Low Reference
B	D-GN	890	Fuel Tank Pressure Sensor Signal
C	GY	2709	5-Volt Reference

Heated Oxygen Sensor (HO2S) 1 Connector End View



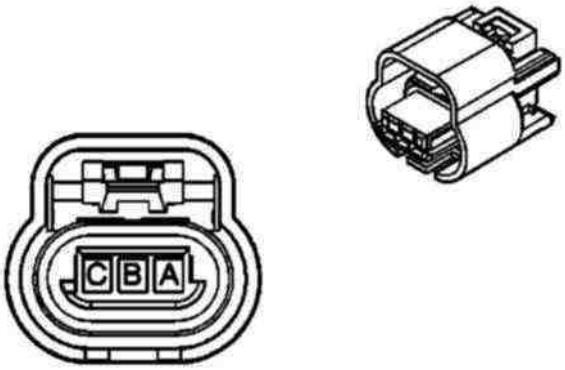
Connector Part Information	• 12160482 • 4-Way F Metri-Pack 150 Series Sealed (GY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	TN	1664	HO2S Low Signal - Bank 1 Sensor 1
B	PU/WH	1665	HO2S High Signal - Bank 1 Sensor 1
C	-	-	Unavailable
D	PK	539	Ignition 1 Voltage
E	D-GN	676	HO2S Heater Low Control - Bank 1 Sensor 1

Heated Oxygen Sensor (HO2S) 2 Connector End View



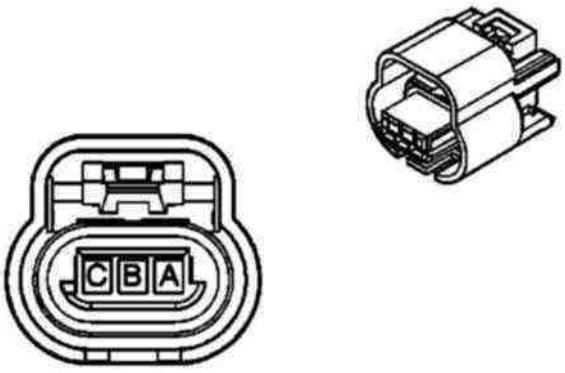
Connector Part Information	• **12160825** • **4-Way M Metri-Pack 150 Series (BK)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	TN/WH	1669	HO2S Low Signal - Bank 1 Sensor 2
B	PU/WH	1668	HO2S High Signal - Bank 1 Sensor 2
C	BK/WH	1423	HO2S Heater Low Control - Bank 1 Sensor 2
D	PK	539	Ignition 1 Voltage

Ignition Coil 1 Connector End View



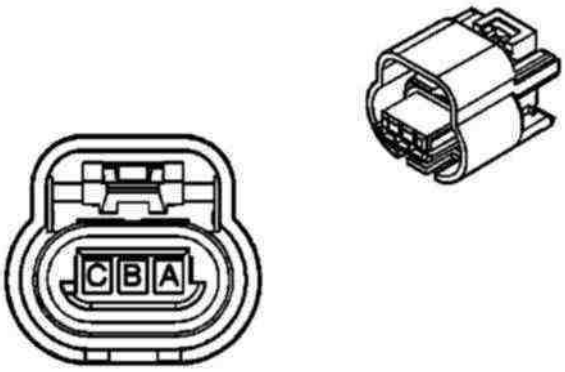
Connector Part Information	• **15355370** • **3-Way F GT 150 Sealed 3.2 X 4.0 (BK)**		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	PU	2121	IC 1 Control
C	BK	550	Ground

Ignition Coil 2 Connector End View



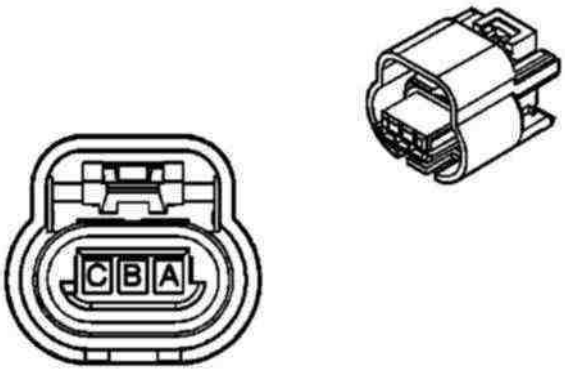
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	RD/WH	2122	IC 2 Control
C	BK	550	Ground

Ignition Coil 3 Connector End View



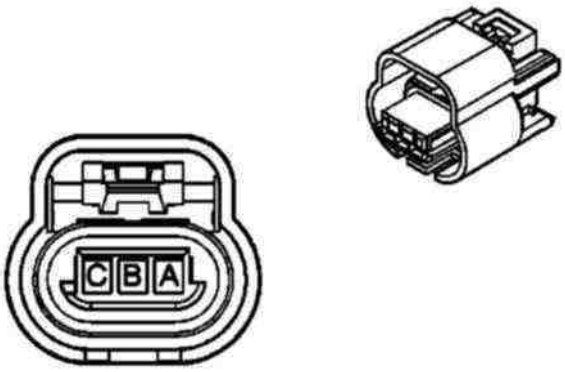
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	L-BU	2123	IC 3 Control
C	BK	550	Ground

Ignition Coil 4 Connector End View



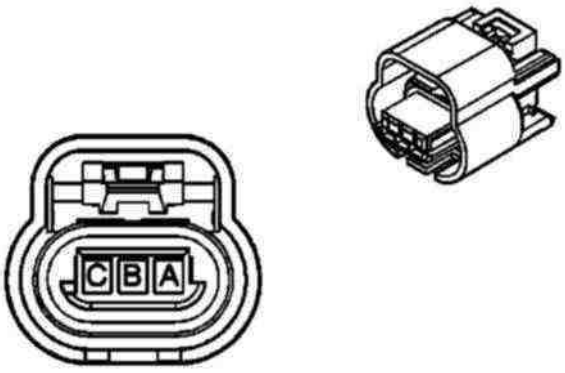
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	D-GN/WH	2124	IC 4 Control
C	BK	550	Ground

Ignition Coil 5 Connector End View



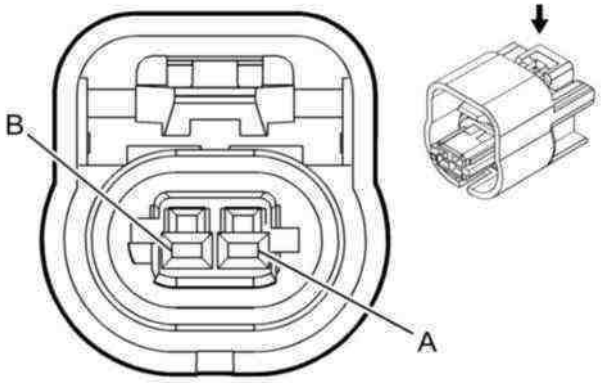
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	D-GN	2125	IC 5 Control
C	BK	550	Ground

Ignition Coil 6 Connector End View



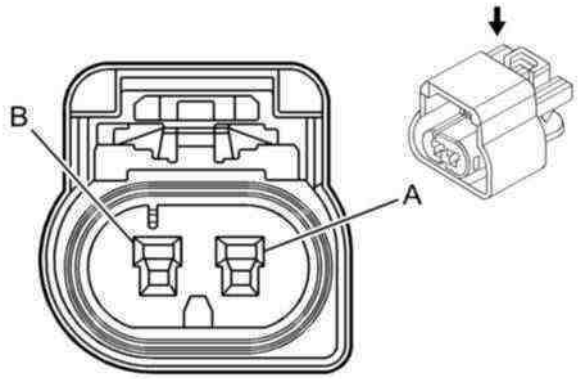
Connector Part Information	• 15355370 • 3-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK	439	Ignition 1 Voltage
B	L-BU/WH	2126	IC 6 Control
C	BK	550	Ground

Intake Air Temperature (IAT) Sensor Connector End View



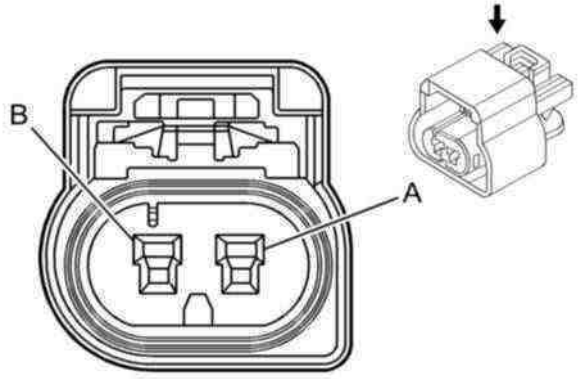
Connector Part Information	• 15335987 • 2-Way F GT 150 Sealed 3.2 X 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	TN	472	IAT Sensor Signal
B	BK	2760	Low Reference

Knock Sensor (KS) 1 Front Connector End View



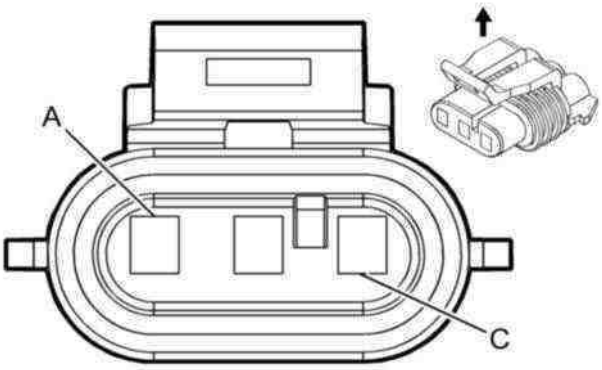
Connector Part Information	• 15339014 • 2-Way F GT 150 SLD (WH)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	D-BU	496	KS 1 Signal
B	GY	1716	Low Reference

Knock Sensor (KS) 2 Rear Connector End View



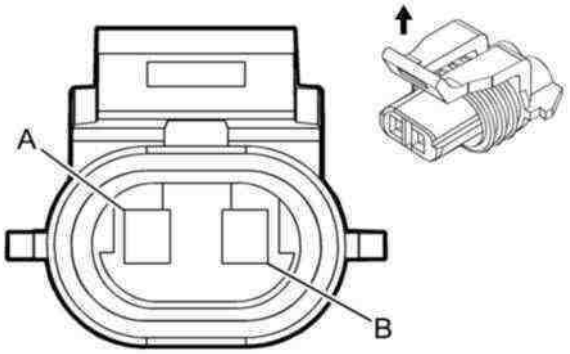
Connector Part Information	• 15339014 • 2-Way F GT 150 SLD (WH)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	L-BU	1876	Knock Sensor 2 Signal
B	GY	2303	Low Reference

Manifold Absolute Pressure (MAP) Sensor Connector End View



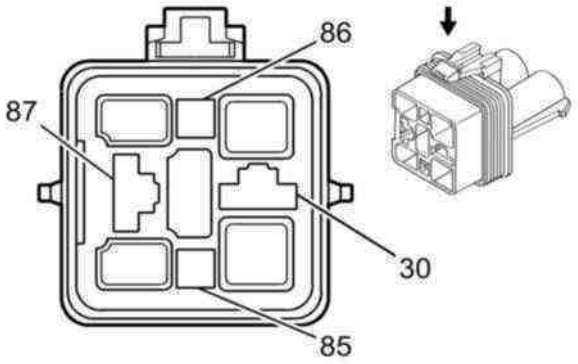
Connector Part Information	• 12129946 • 3-Way F Metri-Pack 150 Series Sealed (GY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	OG/BK	469	Low Reference
B	L-GN	432	MAP Sensor Signal
C	GY	2704	5-Volt Reference

Secondary Air Injection (AIR) Pump (K18) Connector End View



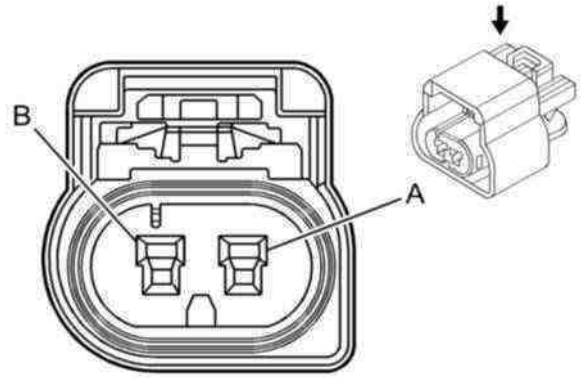
Connector Part Information	• 12147067 • 2-Way F DUCON 6.3 Sealed (GY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	RD	78	Air Pump Supply Voltage
B	BK	2450	Ground

Secondary Air Injection (AIR) Pump Relay (K18) Connector End View



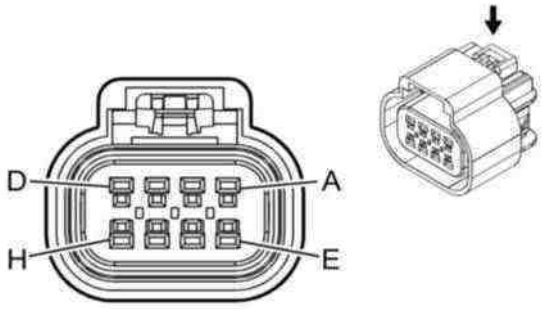
Connector Part Information	• 12129946 • 4-Way F 280 Series Metri-Pack Sealed (GY)		
Pin	**Wire Color**	**Circuit No.**	**Function**
30	RD	1042	Battery Positive Voltage
85	BN	436	Air Pump Relay Control
86	PK	739	Ignition 1 Voltage
87	RD	78	Air Pump Supply Voltage

Secondary Air Injection (AIR) Solenoid (K18) Connector End View



Connector Part Information	• 15374222 • 2-Way F GT 150 SLD (WH)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	PK/BK	415	Air Sol Fuse Supply Voltage
B	BK	350	Ground

Throttle Body Connector End View



Connector Part Information	• 15326835 • 8-Way F GT 150 Sealed 4.0 (BK)		
Pin	**Wire Color**	**Circuit No.**	**Function**
A	D-GN	485	TP Sensor 1 Signal
B	L-BU/BK	1688	5-Volt Reference
C	BK	2752	Low Reference
D	PU	486	TP Sensor 2 Signal
E	YE	581	TAC Motor Control - 1
F	BN	582	TAC Motor Control - 2
G	GY	2701	5-Volt Reference
H	BK/WH	1704	Low Reference

ENGINE CONTROLS COMPONENT VIEWS

Fig. 16: Engine Controls Component Views
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Throttle Actuator Control (TAC), Throttle Body
2	Intake Air Temperature (IAT) Sensor
3	Manifold Absolute Pressure (MAP) Sensor

Fig. 17: Engine Controls Component Views - With Air Duct Removed
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Ignition Coil #1
2	Ignition Coil #2
3	Ignition Coil #3
4	Ignition Coil #4
5	Ignition Coil #5
6	Ignition Coil #6
7	C104

Fig. 18: Engine Controls Component Views, Left Front
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Coolant Temperature (ECT) Sensor
2	Engine Harness
3	PCM C1
4	PCM C2
5	Powertrain Control Module (PCM) C3

Fig. 19: Engine Controls Component Views, Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Crankshaft Position (CKP) Sensor
2	Knock Sensor (KS) 2
3	Knock Sensor (KS) 1
4	Evaporative Emission (EVAP) Canister Purge Solenoid

Fig. 20: Engine Controls Component Views, Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Coolant Temperature (ECT) Sensor Connector

Fig. 21: Engine Controls Component Views, Right Front
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Camshaft Position (CMP) Sensor
2	Camshaft Actuator Solenoid Assembly

Fig. 22: Engine Controls Component Views, Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) 1

Fig. 23: Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) 2

Fig. 24: Automatic Transmission Component Views
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Automatic Transmittion
2	Vehicle Speed Sensor (VSS)

Fig. 25: Accelerator Pedal Position Sensor (APP)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Accelerator Pedal Position (APP) Sensor

Fig. 26: Fuel Tank Component Views
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Fuel Pump and Sender Assembly
2	Fuel Tank
3	Evaporative Emission (EVAP) Canister Vent Solenoid
4	Fuel Tank Pressure (FTP) Sensor

REPAIR INSTRUCTIONS

POWERTRAIN CONTROL MODULE (PCM) REPLACEMENT

Service of the powertrain control module (PCM) should normally consist of either replacement of the PCM or electrically erasable programmable read only memory (EEPROM) programming. If the diagnostic procedures call for the PCM to be replaced, the PCM should be inspected first to see if the correct part is being used. If the correct part is being used, remove the faulty PCM and install the new service PCM.

IMPORTANT: To prevent internal PCM damage, the ignition must be OFF when disconnecting or reconnecting power to the PCM. For example, when working with a battery cable, PCM pigtail, PCM fuse, or jumper cables.

IMPORTANT: Remove any debris from the PCM connector surfaces before servicing the PCM. Inspect the PCM module connector gaskets when diagnosing or replacing the PCM. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the PCM.

Removal Procedure

IMPORTANT: It is necessary to record the remaining engine oil life. If the replacement module is not programed with the remaining engine oil life, the engine oil life will default to 100%. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5000 km (3,000 mi) from the last engine oil change.

1. Using a scan tool, retrieve the percentage of remaining engine oil. Record the remaining engine oil life.

   Fig. 27: View Of PCM Assembly
   Courtesy of GENERAL MOTORS CORP.

2. Loosen the PCM harness connector bolts (4) from the center of the PCM harness connectors.

NOTE: **In order to prevent internal damage to the PCM, the ignition must be OFF when disconnecting or reconnecting the PCM connector.**

3. Remove the PCM harness connectors (2) from the PCM (1).
4. Remove the PCM retaining bolts (3) and nuts (6).

NOTE: Refer to PCM and ESD Notice in Cautions and Notices.

5. Slide the PCM (1) away from the intake manifold past the mounting studs (5) and remove PCM from the vehicle.
6. Remove the PCM mounting studs (5) from the intake manifold ONLY if replacing the studs.

Installation Procedure

NOTE: Refer to Fastener Notice in Cautions and Notices.

Fig. 28: View Of PCM Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the PCM mounting studs (5) to the intake manifold, if removed.

   Tighten: Tighten the studs to 6 N.m (53 lb in).

2. Install the PCM (1) onto the studs (5).
3. Install the PCM retaining bolts (3).

   Tighten: Tighten the bolts to 8 N.m (71 lb in).

4. Install the PCM retaining nuts (6).

   Tighten: Tighten the nuts to 8 N.m (71 lb in).

5. Install the PCM harness connectors (2) to the PCM body.
6. Tighten the PCM harness connector retaining bolts (4).

   Tighten: Tighten the bolts to 8 N.m (71 lb in).

7. If a new PCM is being installed, the PCM must be programmed. Refer to **Service Programming System (SPS)** in Programming.

CKP SYSTEM VARIATION LEARN PROCEDURE

1. Install a scan tool.
2. Monitor the powertrain control module (PCM) for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to **Diagnostic Trouble Code (DTC) List** for the applicable DTC.
3. Select the crankshaft position variation learn procedure with a scan tool.
4. The scan tool instructs you to perform the following:
   1. Accelerate to wide open throttle (WOT).
   2. Release throttle when fuel cut-off occurs.
   3. Observe fuel cut-off for applicable engine.
   4. Engine should not accelerate beyond calibrated RPM value.
   5. Release throttle immediately if value is exceeded.
   6. Block drive wheels.

7. Set parking brake.
8. DO NOT apply brake pedal.
9. Cycle ignition from OFF to ON.
10. Apply and hold brake pedal.
11. Start and idle engine.
12. Turn the A/C OFF.

    Vehicle must remain in Park or Neutral.

    The scan tool monitors certain component signals to determine if all the conditions are met to continue with the procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool monitors the following components:

    - Crankshaft position (CKP) sensors activity-If there is a CKP sensor condition, refer to the applicable DTC.
    - Camshaft position (CMP) signal activity-If there is a CMP signal condition, refer to the applicable DTC.
    - Engine coolant temperature (ECT)-If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

IMPORTANT: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

5. Enable the CKP system variation learn procedure with the scan tool and perform the following:
    - Accelerate to WOT
    - Release throttle when fuel cut-off occurs
    - Test in progress
6. The scan tool displays Learn Status: Learned this ignition. If the scan tool indicates that DTC P0315 ran and passed, the CKP variation learn procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, refer to **DTC P0315** . If any other DTCs set, refer to **Diagnostic Trouble Code (DTC) List** for the applicable DTC.
7. Turn OFF the ignition for 30 seconds after the learn procedure is completed successfully.

The CKP system variation learn procedure is also required when the following service procedures have been performed, regardless of whether or not DTC P0315 is set:

- An engine replacement
- A PCM replacement
- A harmonic balancer replacement
- A crankshaft replacement
- A CKP sensor replacement
- Any engine repairs which disturb the crankshaft to CKP sensor relationship.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR REPLACEMENT

Removal Procedure

NOTE: **Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.**

1. Turn the engine OFF.

CAUTION: **Refer to Battery Disconnect Caution in Cautions and Notices.**

2. Disconnect the negative battery terminal.
3. Drain coolant below the level of the ECT sensor. Refer to **Draining and Filling Cooling System (LL8)** or **Draining and Filling Cooling System (LM4)** in Engine Cooling.

Fig. 29: Disconnecting/Connecting ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the ECT sensor electrical connector (1).
5. Remove the drive belt and the generator. Refer to **Generator Replacement (4.2L Engine)** or **Generator Replacement (5.3L Engine)** in Engine Electrical.

Fig. 30: Removing/Installing ECT Sensor
Courtesy of GENERAL MOTORS CORP.

6. Carefully remove the ECT sensor (1).

Installation Procedure

NOTE: **Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.**

NOTE: **Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.**

1. If installing the original sensor or a new sensor without sealant, apply thread sealer P/N 12346004 or equivalent.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

Fig. 31: Removing/Installing ECT Sensor
Courtesy of GENERAL MOTORS CORP.

2. Install the ECT sensor.

Tighten: Tighten the ECT sensor to 16 N.m (12 lb ft).

Fig. 32: Disconnecting/Connecting ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the ECT electrical connector (1).
4. Install the generator and the drive belt. Refer to **Generator Replacement (4.2L Engine)** or **Generator Replacement (5.3L Engine)** in Engine Electrical.
5. Connect the negative battery terminal.
6. Refill the engine coolant. Refer to **Draining and Filling Cooling System (LL8)** or **Draining and Filling Cooling System (LM4)** in Engine Cooling.

INTAKE AIR TEMPERATURE (IAT) SENSOR REPLACEMENT

Removal Procedure

Fig. 33: Disconnecting/Connecting IAT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. Remove the IAT sensor (1) from the air duct with a twisting and pulling motion.

Installation Procedure

Fig. 34: Disconnecting/Connecting IAT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Install the IAT sensor (1) to the air duct with a pushing and twisting motion.
2. Reconnect the IAT sensor electrical connector.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR REPLACEMENT

Removal Procedure

1. Turn OFF the ignition.

Fig. 35: Disconnecting/Connecting MAP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.

Fig. 36: View Of MAP Sensor & Retainer
Courtesy of GENERAL MOTORS CORP.

3. Press the retainer locking tabs inward, then pull the retainer (1) up to remove it.
4. Remove the MAP sensor (2).
5. Inspect the MAP sensor seal for damage, and replace as necessary.

Installation Procedure

Fig. 37: View Of MAP Sensor & Retainer
Courtesy of GENERAL MOTORS CORP.

1. Install the MAP sensor (2).
2. Install the MAP sensor retainer (1).

Fig. 38: Disconnecting/Connecting MAP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - POSITION 1

Tools Required

J 39194-B Heated Oxygen Sensor Wrench. See **Special Tools and Equipment**.

Removal Procedure

NOTE: **Refer to Heated Oxygen Sensor (HO2S) Resistance Learn Reset Notice in Cautions and Notices.**

NOTE: **Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**

Fig. 39: Removing/Installing HO2S
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

NOTE: **Refer to Excessive Force and Oxygen Sensor Notice in Cautions and Notices.**

2. Remove the HO2S (2) using a **J 39194-B** . See **Special Tools and Equipment**.

Installation Procedure

IMPORTANT: Use special anti-seize compound on the heated oxygen sensor threads. The compound consists of graphite suspended in fluid and glass beads. The graphite burns away, but the glass beads remain, making the sensor easier to remove. New service sensors already have the compound applied to the threads. If you remove an oxygen sensor and if for any reason you must install the same oxygen sensor, apply the anti-seize compound to the threads before reinstallation.

Fig. 40: Removing/Installing HO2S
Courtesy of GENERAL MOTORS CORP.

1. Coat the threads of the heated oxygen sensor with the anti-seize compound P/N 5613695, or the equivalent if necessary.

NOTE: **Refer to Component Fastener Tightening Notice in Cautions and Notices.**

2. Install the heated oxygen sensor (2) using a **J 39194-B** . See **Special Tools and Equipment**.

   Tighten: Tighten the HO2S to 41 N.m (30 lb ft).

3. Connect the HO2S electrical connector (1).

HEATED OXYGEN SENSOR REPLACEMENT - POSITION 2

Tools Required

J 39194-B Heated Oxygen Sensor Wrench. See Special Tools and Equipment.

Removal Procedure

NOTE: **Refer to Heated Oxygen Sensor (HO2S) Resistance Learn Reset Notice in Cautions and Notices.**

NOTE: **Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**

Fig. 41: Removing/Installing HO2S
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

NOTE: **Refer to Excessive Force and Oxygen Sensor Notice in Cautions and Notices.**

3. Remove the HO2S (2) using a **J 39194-B** . See Special Tools and Equipment.

Installation Procedure

IMPORTANT: Use special anti-seize compound on the heated oxygen sensor threads. The compound consists of graphite suspended in fluid and glass beads. The graphite burns away, but the glass beads remain, making the sensor easier to remove. New or service sensors already have the compound applied to the threads. If you remove an oxygen sensor and if for any reason you must reinstall the same oxygen sensor, apply the anti-seize compound to the threads before reinstallation.

Fig. 42: Removing/Installing HO2S
Courtesy of GENERAL MOTORS CORP.

1. Coat the threads of the heated oxygen sensor with the anti-seize compound P/N 5613695, or the equivalent if necessary.

NOTE: **Refer to Component Fastener Tightening Notice in Cautions and Notices.**

2. Install the heated oxygen sensor (2) using a **J 39194-B** . See Special Tools and Equipment.

   Tighten: Tighten the HO2S to 41 N.m (30 lb ft).

3. Connect the HO2S electrical connector (1).
4. Lower the vehicle.

ACCELERATOR PEDAL POSITION (APP) SENSOR REPLACEMENT

Removal Procedure

Fig. 43: Removing/Installing APP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the accelerator pedal position (APP) sensor electrical connector.
2. Remove the APP sensor retaining fasteners.
3. Remove the APP sensor (2) from the vehicle.

Installation Procedure

Fig. 44: Removing/Installing APP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the APP sensor (2) to vehicle.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the APP sensor retaining fasteners (1).

   Tighten: Tighten the retaining fasteners to 10 N.m (89 lb in).

3. Connect the APP sensor electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

Fig. 45: View Of Throttle Control Module
Courtesy of GENERAL MOTORS CORP.

1. Remove the resonator assembly. Refer to **Air Cleaner Outlet Resonator Replacement**.
2. Remove the evaporative emission (EVAP) canister purge line from the throttle body.
3. Disconnect the throttle body electrical connector.
4. Remove the throttle body assembly retaining bolts (1).
5. Remove the throttle body assembly (2) and the gasket from the intake manifold.
6. Clean the gasket surface.

Installation Procedure

Fig. 46: View Of Throttle Control Module
Courtesy of GENERAL MOTORS CORP.

1. Install the throttle body assembly (2) to the intake manifold with the gasket.
2. Add sealer GM P/N 12346004 (Canadian P/N 10953480) to the throttle control module bolt threads.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the throttle body assembly retaining bolts (1).

   Tighten: Tighten the bolts to 10 N.m (89 lb in).

4. Connect the throttle body electrical connector.
5. Install the EVAP canister purge line to the throttle body.

6. Install the resonator assembly. Refer to **Air Cleaner Outlet Resonator Replacement**.

FUEL PRESSURE RELIEF PROCEDURE

CAUTION: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

NOTE: Do not perform this test for more than 2 minutes in order to prevent damaging the catalytic converter.

Fig. 47: Locating Fuel Pump Relay
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pump relay (1) from the junction box (2).
2. Crank the engine.
3. Allow the engine to start and stall.
4. Crank the engine for an additional 3 seconds to ensure the relief of any remaining fuel pressure.
5. Disconnect the negative battery cable in order to avoid re-pressurizing the fuel system. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
6. Install the fuel pump relay (1) to the junction box (2).
7. Tighten the fuel filler cap.

FUEL PRESSURE GAGE INSTALLATION AND REMOVAL

Tools Required

J 34730-1A Fuel Pressure Gage. See **Special Tools and Equipment**.

Installation Procedure

CAUTION: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

IMPORTANT: Due to an access hole in the fuel tank shield, removal of the shield should not be necessary to access the fuel pressure service connection.

2. Only if necessary remove the fuel tank shield. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.

3. Remove the fuel pressure service connection cap, located near the fuel filter.

Fig. 48: Identifying Fuel Pressure Gauge J 34730-1A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

4. Install the **J 34730-1A** fuel pressure gage to the fuel pressure service connection, located near the fuel filter. See **Special Tools and Equipment**.
5. Turn ON the ignition.

CAUTION: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

6. Place the bleed hose of the fuel pressure gage into an approved gasoline container.
7. Open the bleed valve on the fuel pressure gage in order to bleed the air from the fuel pressure gage.
8. Command the fuel pump ON with a scan tool.
9. Close the bleed valve on the fuel pressure gage.
10. Inspect for fuel leaks.

Removal Procedure

1. Place the fuel pressure gage bleed hose into an approved container and open the bleed valve to bleed fuel system pressure.
2. Place a shop towel under the fuel pressure gage adaptor fitting to catch any remaining fuel spillage.

Fig. 49: Identifying Fuel Pressure Gauge J 34730-1A
Courtesy of GENERAL MOTORS CORP.

3. Remove the **J 34730-1A** from the pressure gage fitting. See **Special Tools and Equipment**.
4. Drain any fuel remaining in the fuel pressure gage into an approved container.
5. install the fuel pressure service connection cap.
6. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
7. Install the fuel tank shield if removed. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.

QUICK CONNECT FITTING(S) SERVICE (METAL COLLAR)

Tool Required

J 37088-A Fuel Line Disconnect Tool Set. See **Special Tools and Equipment**.

Removal Procedure

Fig. 50: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief Procedure**.
2. Remove the retainer from the quick-connect fitting.

Fig. 51: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

Fig. 52: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Choose the correct tool from the **J 37088-A** for the size of the fitting. See **Special Tools and Equipment**. Insert the tool into the female connector, then push inward in order to release the locking tabs.

Fig. 53: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

5. Pull the connection apart.

NOTE: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

Fig. 54: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.
This will ensure proper reconnection and prevent a possible fuel leak.
During normal operation, the O-rings located in the female

connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

Fig. 55: Assembling Connectors (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

Fig. 56: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

Fig. 57: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Install the retainer to the quick-connect fitting.

QUICK CONNECT FITTING(S) SERVICE (PLASTIC COLLAR)

Removal Procedure

CAUTION: Refer to Gasoline/Gasoline Vapors Caution in Cautions and Notices.

Fig. 58: Identifying Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Push Down TI (5)

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief Procedure**.

Fig. 59: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Safety Glasses Caution in Cautions and Notices.

NOTE: Refer to Fuel and Evaporative Emission (EVAP) Hose/Pipe Connection Cleaning Notice in Cautions and Notices.

2. Using compressed air, blow any dirt out of the quick-connect fitting.

Fig. 60: Squeezing Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick connect fitting release tabs.

Fig. 61: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

4. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

Fig. 62: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.

Fig. 63: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab does not move, try pressing the tab in from the opposite side. The tab will only move in one direction.

Fig. 64: Releasing Push Down TI Style Connectors
Courtesy of GENERAL MOTORS CORP.

7. This step applies to the Push Down TI style connectors ONLY. Release the fitting by pressing on the tab indicated by arrow.

Fig. 65: Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Relieving Fuel Pressure Caution in Cautions and Notices.

8. Pull the connection apart.

Installation Procedure

Fig. 66: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fuel Pipe Fitting Caution in Cautions and Notices.

1. Apply a few drops of clean engine oil to the male connection end.

Fig. 67: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

Fig. 68: Ensuring Secure Connection
Courtesy of GENERAL MOTORS CORP.

3. Once installed, pull on both sides of the quick-connect fitting in order to make sure the connection is secure.

FUEL FILTER REPLACEMENT

Removal Procedure

IMPORTANT: Inspect the fuel tank internally and clean the fuel tank if you find a restricted fuel filter. Refer to **Fuel System Cleaning**.

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief Procedure**.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

IMPORTANT: Due to an access hole in the fuel tank shield, removal of the shield should not be necessary to access the fuel filter.

3. Only if necessary remove the fuel tank shield. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.

NOTE: **Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:**

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

IMPORTANT: The quick connect retaining clips will remain with the fuel filter.

4. Disconnect the quick connect fittings from the fuel filter. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Cap the fuel pipes in order to prevent possible fuel system contamination.

Fig. 69: Removing/Installing Fuel Filter
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel filter bracket screw (2).
7. Remove the fuel filter (1) from the bracket.

Installation Procedure

Fig. 70: Removing/Installing Fuel Filter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: New quick connect retaining clips will be supplied with OEM replacement fuel filters (1).

1. Install the fuel filter (1) into the bracket. Ensure that the fuel filter inlet tube is engaged in the fuel tank bracket orientation slot (5).

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

2. Install the fuel filter bracket screw (2). Ensure that the fuel tank bracket orientation key (4) is engaged in the strap (3) slot.

   Tighten: Tighten the screw to 1.5 N.m (13 lb in).

3. Remove the caps from the fuel pipes.
4. Connect the quick connect fittings to the fuel filter. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Lower the vehicle.
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
7. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
8. Inspect for leaks.
   1. Turn ON the ignition, with the engine OFF for 2 seconds.
   2. Turn OFF the ignition for 10 seconds.
   3. Turn ON the ignition, with the engine OFF.
   4. Inspect for fuel leaks.
9. Only if previously removed, install the fuel tank shield. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
10. Lower the vehicle.

FUEL TANK DRAINING PROCEDURE

Fig. 71: Identifying Fuel Pipe/Hose Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: **Refer to Gasoline/Gasoline Vapors Caution in Cautions and Notices.**

CAUTION: **Refer to the Battery Disconnect Caution in Cautions and Notices.**

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
3. Loosen the fuel fill hose clamp (1).
4. Disconnect the fuel fill hose (2) from the fuel tank.
5. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK REPLACEMENT (TRAILBLAZER, ENVOY, BRAVADA, RAINIER)

Removal Procedure

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief Procedure**.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

3. Remove the frame brace. Refer to **Frame Brace Replacement (TrailBlazer, Envoy, Bravada)** or **Frame Brace Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
4. Remove the fuel tank shield, if equipped. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
5. Drain the fuel tank. Refer to **Fuel Tank Draining Procedure**.

Fig. 72: Locating Fuel Tank Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel tank pressure sensor electrical connector (3).
7. Disconnect the evaporative emission (EVAP) vent valve electrical connector (2).

Fig. 73: Disconnecting/Connecting EVAP Vapor & Vent Valve Pipes
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the EVAP vapor pipe (4) from the EVAP canister (3).
9. Disconnect the EVAP vent valve pipe (2) from the EVAP canister (3).

Fig. 74: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel return pipe and the fuel feed pipe (1). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
11. Cap the fuel and EVAP pipes in order to prevent possible fuel system contamination.

Fig. 75: Removing/Installing Fuel Tank
Courtesy of GENERAL MOTORS CORP.

12. With the aid of an assistant, support the fuel tank.

NOTE: **Refer to Damage to Fuel Tank Straps Notice in Cautions and Notices.**

13. Remove the fuel tank strap attaching bolts.
14. Remove the fuel tank straps.
15. Carefully lower the fuel tank.
16. Disconnect the fuel sender electrical connector.
17. Remove the fuel tank.
18. Place the fuel tank in a suitable work area.
19. If the fuel tank is not being replaced, go to the Installation Procedure.

Disassembly Procedure

Fig. 76: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the EVAP vent valve (1). Refer to **Evaporative Emission (EVAP) Canister Vent Solenoid Valve Replacement**.
2. Remove the fuel filter (7). Refer to **Fuel Filter Replacement**.

3. Disconnect the fuel feed and return pipes from the fuel sender (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Remove the fuel feed and return pipes from the retaining clip (6).
5. Remove the EVAP vent valve pipe.
6. Disconnect the EVAP vapor pipe from the fill limiter vent valve (3), and the front and rear rollover valves (2, 5).
7. Remove the EVAP vapor pipes.
8. Remove the fuel sender assembly (4) from the fuel tank. Refer to **Fuel Sender Assembly Replacement**.

Assembly Procedure

Fig. 77: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel sender assembly (4) to the fuel tank. Refer to **Fuel Sender Assembly Replacement**.
2. Connect the EVAP vapor pipe to the fill limiter vent valve (3) and the front and rear rollover valve (2, 5). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Install the EVAP vent valve pipe.
4. Connect the fuel feed and return pipes to the fuel sender (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Install the fuel feed and return pipes to the retaining clip (6).
6. Install the fuel filter (7). Refer to **Fuel Filter Replacement**.
7. Install the EVAP vent valve (1). Refer to **Evaporative Emission (EVAP) Canister Vent Solenoid Valve Replacement**.

Installation Procedure

Fig. 78: Removing/Installing Fuel Tank
Courtesy of GENERAL MOTORS CORP.

1. With the aid of an assistant, position and support the fuel tank.
2. Connect the fuel sender electrical connector.
3. Install the fuel tank straps.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

4. Install the fuel tank strap attaching bolts.

   Tighten: Tighten the bolts to 32 N.m (24 lb ft).

Fig. 79: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

5. Remove the caps from the fuel and EVAP pipes.
6. Connect the fuel return pipe and the fuel feed pipe (1). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

Fig. 80: Disconnecting/Connecting EVAP Vapor & Vent Valve Pipes
Courtesy of GENERAL MOTORS CORP.

7. Connect the EVAP vent valve pipe (2) to the EVAP canister (3).
8. Connect the EVAP vapor pipe (4) to the EVAP canister (3).

Fig. 81: Locating Fuel Tank Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

9. Connect the fuel pressure sensor electrical connector (3).
10. Connect the EVAP vent valve electrical connector (2).

Fig. 82: Identifying Fuel Pipe/Hose Components
Courtesy of GENERAL MOTORS CORP.

11. Connect the fuel fill hose (2) to the fuel tank.

    Tighten: Tighten the fuel fill hose clamp (1) to 2.5 N.m (22 lb in).

12. Lower the vehicle.
13. Refill the fuel tank.
14. Install the fuel filler cap.
15. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
16. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
17. Inspect for leaks.
    1. Turn ON the ignition, with the engine OFF for 10 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
18. Install the fuel tank shield, if equipped. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
19. Install the frame brace. Refer to **Frame Brace Replacement (TrailBlazer, Envoy, Bravada)** or **Frame Brace Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
20. Lower the vehicle.

FUEL TANK REPLACEMENT (TRAILBLAZER EXT, ENVOY XL, ENVOY XUV)

Removal Procedure

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief Procedure**.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
3. Remove the frame brace. Refer to **Frame Brace Replacement (TrailBlazer, Envoy, Bravada)** or **Frame Brace Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
4. Remove the fuel tank shield, if equipped. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
5. Drain the fuel tank. Refer to **Fuel Tank Draining Procedure**.

Fig. 83: View Of Fuel Tank & Related Components
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel tank pressure sensor electrical connector (3).
7. Disconnect the evaporative emission (EVAP) vent valve electrical connector (2).

Fig. 84: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel return pipe, the fuel feed pipe and the EVAP purge pipe (1). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
9. Cap the fuel and EVAP pipes in order to prevent possible fuel system contamination.

Fig. 85: Removing/Installing Fuel Tank
Courtesy of GENERAL MOTORS CORP.

10. With the aid of an assistant, support the fuel tank.

NOTE: **Refer to Damage to Fuel Tank Straps Notice in Cautions and Notices.**

11. Remove the fuel tank strap attaching bolts (1).
12. Remove the fuel tank straps (2).
13. Carefully lower the fuel tank.

Fig. 86: View Of Fuel Tank & Related Components
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the fuel sender electrical connector (1).
15. Remove the fuel tank.
16. Place the fuel tank in a suitable work area.
17. If the fuel tank is not being replaced, go to the Installation Procedure.

Disassembly Procedure

Fig. 87: Locating EVAP Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the EVAP vent valve (1). Refer to **Evaporative Emission (EVAP) Canister Vent Solenoid Valve Replacement**.
2. Remove the fuel filter (8). Refer to **Fuel Filter Replacement**.
3. Disconnect the fuel feed and return pipes from the fuel sender (5). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Remove the fuel feed and return pipes from the retaining clip (7).
5. Remove the EVAP vent valve pipe.
6. Disconnect the EVAP vapor pipe from the fill limiter vent valve (4), and the front and rear rollover valves (2, 6).
7. Remove the EVAP vapor pipes.
8. Remove the fuel sender assembly (5) from the fuel tank. Refer to **Fuel Sender Assembly Replacement**.

9. Remove the EVAP canister (3) Refer to **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** or **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer, Envoy, Bravada, Rainier)**.

Assembly Procedure

Fig. 88: Locating EVAP Components
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP canister (3) Refer to **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** or **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer, Envoy, Bravada, Rainier)**.
2. Install the fuel sender assembly (5) to the fuel tank. Refer to **Fuel Sender Assembly Replacement**.
3. Connect the EVAP vapor pipe to the fill limiter vent valve (4) and the front and rear rollover valve (2, 6). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Install the EVAP vent valve pipe.
5. Connect the fuel feed and return pipes to the fuel sender (5). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
6. Install the fuel feed and return pipes to the retaining clip (7).
7. Install the fuel filter (8). Refer to **Fuel Filter Replacement**.
8. Install the EVAP vent valve (1). Refer to **Evaporative Emission (EVAP) Canister Vent Solenoid Valve Replacement**.

Installation Procedure

Fig. 89: View Of Fuel Tank & Related Components
Courtesy of GENERAL MOTORS CORP.

1. With the aid of an assistant, position and support the fuel tank.
2. Connect the fuel sender electrical connector (1).

Fig. 90: Removing/Installing Fuel Tank
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel tank straps (2).

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

4. Install the fuel tank strap attaching bolts (1).

Tighten: Tighten the bolts to 32 N.m (24 lb ft).

Fig. 91: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

5. Remove the caps from the fuel and EVAP pipes.
6. Connect the fuel return pipe, the fuel feed pipe and the EVAP purge pipe (1). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

Fig. 92: View Of Fuel Tank & Related Components
Courtesy of GENERAL MOTORS CORP.

7. Connect the fuel tank pressure sensor electrical connector (3).
8. Connect the EVAP vent valve electrical connector (2).

Fig. 93: Identifying Fuel Pipe/Hose Components
Courtesy of GENERAL MOTORS CORP.

9. Connect the fuel fill hose (2) to the fuel tank.

   Tighten: Tighten the fuel fill hose clamp (1) to 2.5 N.m (22 lb in).

10. Lower the vehicle.
11. Refill the fuel tank.
12. Install the fuel filler cap.
13. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
14. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
15. Inspect for leaks.
    1. Turn ON the ignition, with the engine OFF for 10 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
16. Install the fuel tank shield, if equipped. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
17. Install the frame brace. Refer to **Frame Brace Replacement (TrailBlazer, Envoy, Bravada)** or **Frame Brace Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.
18. Lower the vehicle.

FUEL TANK PRESSURE SENSOR REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
2. Disconnect the fuel tank pressure harness connector.
3. Remove the fuel tank pressure sensor.

Installation Procedure

1. Install the new fuel tank pressure sensor seal.
2. Install the fuel tank pressure sensor.
3. Connect the fuel tank sensor harness connector.
4. Lower the vehicle.

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

Fig. 94: Identifying Fuel Tank Module
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel sender assembly. Refer to **Fuel Sender Assembly Replacement**.
2. Disconnect the fuel pump electrical connector.
3. Remove the retaining clip from the fuel level sensor connector.
4. Disconnect the electrical connector from under the fuel sender cover.
5. Remove the sensor retaining clip.
6. Squeeze the locking tangs and remove the fuel level sensor (3).

Installation Procedure

Fig. 95: Identifying Fuel Tank Module
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel level sensor (3).
2. Install the sensor retaining clip.
3. Connect the electrical connector to the fuel level sensor.
4. Install the retaining clip to the fuel level sensor electrical connector.
5. Connect the fuel pump electrical connector.
6. Install the fuel sender assembly. Refer to **Fuel Sender Assembly Replacement**.

FUEL SENDER ASSEMBLY REPLACEMENT

Tools Required

J 44402 Fuel Tank Sending Unit Wrench. See **Special Tools and Equipment**.

Removal Procedure

Fig. 96: Removing/Installing Fuel Sender Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

NOTE: **Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.**

2. Use the **J 44402** to remove the fuel sender assembly retaining ring. See **Special Tools and Equipment**.
3. Remove the fuel sender assembly and the seal. Discard the seal.

CAUTION: **Drain the fuel from the fuel sender assembly into an approved container in order to reduce the risk of fire and personal injury. Never store the fuel in an open container.**

4. Clean the fuel sender sealing surfaces.

Installation Procedure

Fig. 97: Removing/Installing Fuel Sender Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: In order to reduce the risk of fire and personal injury that may result from a fuel leak, always replace the fuel sender gasket when reinstalling the fuel sender assembly.

IMPORTANT: The fuel pump strainer must be in a horizontal position when the fuel sender is installed in the tank. When installing the fuel sender assembly, assure that the fuel pump strainer does not block full travel of the float arm.

1. Install the new seal on the fuel tank.
2. Install the fuel sender assembly into the fuel tank.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Use the **J 44402** to install the fuel sender assembly retaining ring. See **Special Tools and Equipment**.
4. Install the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

FUEL HOSE/PIPES REPLACEMENT - FILTER TO ENGINE

Removal Procedure

CAUTION: Refer to Fuel and EVAP Pipe Caution in Cautions and Notices.

CAUTION: Refer to Gasoline/Gasoline Vapors Caution in Cautions and Notices.

1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief Procedure**.

Fig. 98: View Of PCM Assembly
Courtesy of GENERAL MOTORS CORP.

2. Remove the powertrain control module (PCM) retaining bolts (3) and nuts (6).
3. Slide the PCM off of the studs (5) and position the PCM out of the way.

Fig. 99: View Of Engine Coolant Temperature Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the engine coolant temperature sensor electrical connector.

Fig. 100: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fuel and Evaporative Emission (EVAP) Hose/Pipe Connection Cleaning Notice in Cautions and Notices.

5. Disconnect the fuel feed (1) and fuel return (2) pipes from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
6. Disconnect the EVAP purge pipe (5) from the EVAP canister purge valve.
7. Disconnect the integral clip (3) from the wire harness bracket.

Fig. 101: Positioning Fuel Pipes Above PCM Studs
Courtesy of GENERAL MOTORS CORP.

8. Position the fuel feed and return pipes (1) above the PCM studs
9. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
10. Use the following procedure with two wheel drive (2WD):
    1. Remove the transmission support. Refer to **Transmission Support Replacement** in Frame and Underbody.
    2. Lower the transmission slightly.

    Fig. 102: Removing/Installing EVAP/Fuel Pipe Assembly From Transmission
    Courtesy of GENERAL MOTORS CORP.

    3. Remove the EVAP/fuel hose/pipe assembly retaining bolt (3) from the transmission.
    4. Disengage the EVAP/fuel hose/pipe assembly from the clip at the rear of the transmission.
11. Use the following procedure with four wheel drive (4WD):
    1. Remove the transfer case. Refer to **Transfer Case Assembly Replacement** in Transfer Case - NVG 126-NP4 or **Transfer Case Assembly Replacement (TrailBlazer, Envoy)** in Transfer Case - NVG 226-NP8 depending on the model of transfer case the vehicle is equipped with.
    2. Remove the transmission support. Refer to **Transmission Support Replacement** in Frame and Underbody.
    3. Lower the transmission slightly.

    Fig. 103: Removing/Installing EVAP/Fuel Pipe Assembly From Transmission
    Courtesy of GENERAL MOTORS CORP.

    4. Remove the EVAP/fuel hose/pipe assembly retaining bolt (3) from the transmission.
    5. Remove the EVAP/fuel hose/pipe assembly from the clip at the rear of the transmission.

Fig. 104: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

12. Remove the EVAP/fuel hose/pipe assembly (4) from the fuel pipe clip at the rear of the engine.
13. Disconnect the EVAP purge pipe at the fuel tank. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

Fig. 105: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the chassis fuel return pipe (1) from the fuel tank fuel return pipe. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
15. Disconnect the chassis fuel feed pipe (3) from the fuel filter. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
16. Remove the EVAP/fuel hose/pipe assembly.

Fig. 106: EVAP/Fuel Hose/Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the position of the EVAP/fuel hose/pipe assembly clips before disassembly.

17. Remove the EVAP/fuel hose/pipe assembly retaining clips.
18. Remove the fuel feed (1), fuel return (2), or EVAP purge (3) pipe to be replaced.

Installation Procedure

Fig. 107: EVAP/Fuel Hose/Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

1. Place the new fuel feed (1), fuel return (2), or EVAP purge (3) pipe with the remaining pipes in the EVAP/fuel hose/pipe assembly.
2. Install the EVAP/fuel hose/pipe assembly clips as noted during disassembly.
3. Position the EVAP/fuel hose/pipe assembly along the engine and transmission.

Fig. 108: Disconnecting/Connecting Fuel Pipes
Courtesy of GENERAL MOTORS CORP.

4. Connect the chassis fuel feed pipe (3) to the fuel filter.
5. Connect the engine chassis fuel return pipe (1) to the fuel tank fuel return pipe.
6. Connect the EVAP purge pipe at the fuel tank. Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.

Fig. 109: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

7. Install the EVAP/fuel hose/pipe assembly (4) to the fuel pipe clip at the rear of the engine.
8. Use the following procedure with two wheel drive (2WD):

Fig. 110: Removing/Installing EVAP/Fuel Pipe Assembly From Transmission
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP/fuel hose/pipe assembly into the clip at the rear of the transmission.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

2. Position the EVAP/fuel hose/pipe assembly against the transmission and install the retaining bolt (3) through the EVAP/fuel hose/pipe assembly strap into the transmission.

Tighten: Tighten the bolt to 3.75 N.m (33 lb in).

3. Raise the transmission to the normal installed position.
4. Install the transmission support. Refer to **Transmission Support Replacement** in Frame and Underbody.

9. Use the following procedure with four wheel drive (4WD):

Fig. 111: Removing/Installing EVAP/Fuel Pipe Assembly From Transmission
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP/fuel hose/pipe assembly into the clip at the rear of the transmission.
2. Position the fuel EVAP/fuel hose/pipe assembly against the transmission and install the retaining bolt (3) through the EVAP/fuel hose/pipe assembly strap into the transmission.

   Tighten: Tighten the bolt to 3.75 N.m (33 lb in).

3. Raise the transmission to the normal installed position.
4. Install the transmission support. Refer to **Transmission Support Replacement** in Frame and Underbody.
5. Install the transfer case. Refer to **Transfer Case Assembly Replacement** in Transfer Case - NVG 126-NP4 or **Transfer Case Assembly Replacement (TrailBlazer, Envoy)** in Transfer Case - NVG 226-NP8 depending on the model of transfer case the vehicle is equipped with.

10. Lower the vehicle.

Fig. 112: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

11. Connect the EVAP purge pipe (5) to the EVAP canister purge valve.
12. Connect the integral clip (3) to the wire harness bracket.
13. Connect the fuel feed (1) and fuel return (2) pipes to the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.

Fig. 113: View Of Engine Coolant Temperature Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the engine coolant temperature sensor electrical connector.

Fig. 114: View Of PCM Assembly
Courtesy of GENERAL MOTORS CORP.

15. Install the PCM onto the studs (5).
16. Install the PCM retaining bolts (3).

    Tighten: Tighten the bolts to 8 N.m (71 lb in).

17. Install the PCM retaining nuts (6).

    Tighten: Tighten the nuts to 8 N.m (71 lb in).

18. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
19. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.

20. Install the fuel tank shield, if equipped. Refer to **Fuel Tank Shield Replacement (TrailBlazer, Envoy)** or **Fuel Tank Shield Replacement (TrailBlazer EXT, Envoy XL)** in Frame and Underbody.

FUEL HOSES/PIPES REPLACEMENT - FILTER TO TANK

Removal Procedure

CAUTION: Refer to Fuel and EVAP Pipe Caution in Cautions and Notices.

CAUTION: Refer to Gasoline/Gasoline Vapors Caution in Cautions and Notices.

NOTE: Refer to Fuel and Evaporative Emission (EVAP) Hose/Pipe Connection Cleaning Notice in Cautions and Notices.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

Fig. 115: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel feed pipe from the fuel sender assembly (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Disconnect the fuel feed pipe from the fuel filter (7). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Disconnect the fuel return pipe from the fuel sender assembly (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
5. Disengage the fuel pipe clip (6) at the front of the fuel tank.
6. Remove the fuel pipes.

Installation Procedure

Fig. 116: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

1. Connect the fuel return pipe to the fuel sender assembly (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
2. Connect the fuel feed pipe to the fuel filter (7). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
3. Connect the fuel feed pipe to the fuel sender assembly (4). Refer to **Quick Connect Fitting(s) Service (Plastic Collar)**.
4. Install the fuel pipe clip (6) to the fuel pipes at the front of the fuel tank.
5. Install the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

FUEL FILLER HOSE REPLACEMENT

Removal Procedure

Fig. 117: Removing/Installing Fuel Fill Pipe Housing
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel fill cap.
2. Remove the fuel fill pipe housing.

Fig. 118: Removing/Installing Fuel Fill Pipe Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

3. Remove the fuel fill pipe bracket nut (2).
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 119: Removing/Installing Fuel Fill Pipe Ground Strap
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel fill pipe ground strap bolt (3).

Fig. 120: Identifying Fuel Pipe/Hose Components
Courtesy of GENERAL MOTORS CORP.

6. Loosen the fuel hose clamp (1).
7. Separate the fuel hose (2) from the tank.
8. Cap the open end of the fuel tank.
9. Remove the push pin fastener (5).
10. Remove the fuel filler pipe from the vehicle.

Installation Procedure

Fig. 121: Identifying Fuel Pipe/Hose Components
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel filler pipe to the vehicle.
2. Install the push pin fastener (5).
3. Uncap the fuel tank.
4. Install the fuel hose (2) to the tank.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

5. Tighten the fuel fill hose clamp (1).

Tighten: Tighten the clamp to 2.5 N.m (22 lb in).

Fig. 122: Removing/Installing Fuel Fill Pipe Ground Strap
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel fill pipe ground strap bolt (3).

Tighten: Tighten the bolt to 10 N.m (89 lb in).

7. Lower the vehicle.

Fig. 123: Removing/Installing Fuel Fill Pipe Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

8. Install the fuel fill pipe bracket nut (2).

Tighten: Tighten the nut to 10 N.m (89 lb in).

Fig. 124: Removing/Installing Fuel Fill Pipe Housing
Courtesy of GENERAL MOTORS CORP.

9. Install the fuel fill pipe housing.
10. Install the fuel fill cap.

FUEL SYSTEM CLEANING

1. Remove the fuel sender assembly. Refer to **Fuel Sender Assembly Replacement**.
2. Inspect the fuel pump inlet for dirt and debris. Replace the fuel pump if you find dirt or debris in the fuel pump inlet.

IMPORTANT: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water mixture in accordance with all applicable local, state, and federal laws and regulations.

3. Flush the fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening. Rock the tank to be sure that removal of the water from the tank is complete.
5. Install the fuel sender assembly. Refer to **Fuel Sender Assembly Replacement**.

FUEL RAIL ASSEMBLY REPLACEMENT

Removal Procedure

Fig. 125: Disconnecting/Connecting Fuel Pressure Regulator Vacuum Line
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement** in Engine Mechanical.
3. Before removal, clean the fuel rail assembly and the cylinder head with a spray type engine cleaner, GM X-30A or equivalent, if necessary. Follow the package instructions. Do not soak the fuel rail in liquid cleaning solvent.
4. Disconnect the fuel pressure regulator vacuum line.

Fig. 126: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the fuel feed and return pipes (1, 2) from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
6. Disconnect the fuel injector harness in-line connector.

Fig. 127: Removing/Installing Fuel Rail
Courtesy of GENERAL MOTORS CORP.

7. Remove the fuel rail attaching bolts.

NOTE:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel**

rail after the fuel rail is removed in order to avoid damaging the fuel rail components.

- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

8. Remove the fuel rail assembly.

Fig. 128: View Of Fuel Injector, Clip & O-Rings
Courtesy of GENERAL MOTORS CORP.

9. Remove the injector lower O-ring seal (4) from the spray tip end of each injector (3).
10. Discard the O-ring seals.
11. If the fuel rail is not being replaced, go to the Installation Procedure.

Disassembly Procedure

1. Remove the fuel injectors. Refer to **Fuel Injector Replacement**.
2. Remove the fuel pressure regulator. Refer to **Fuel Pressure Regulator Replacement**.
3. Remove the fuel injector harness from the fuel rail.

Assembly Procedure

1. Install the fuel injector harness to the fuel rail.
2. Install the fuel pressure regulator. Refer to **Fuel Pressure Regulator Replacement**.
3. Install the fuel injectors. Refer to **Fuel Injector Replacement**.

Installation Procedure

Fig. 129: View Of Fuel Injector, Clip & O-Rings
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the new lower injector O-ring seals (4) with clean engine oil.
2. Install the new O-ring seals (4) on the spray tip end of each injector (3).

Fig. 130: Removing/Installing Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel rail assembly.

NOTE: **Refer to the Fastener Notice in Cautions and Notices.**

4. Install the fuel rail attaching bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

Fig. 131: Fuel Feed And Fuel Return Pipes (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

5. Connect the fuel feed and return pipes (1, 2) to the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
6. Connect the fuel injector electrical connectors.

Fig. 132: Disconnecting/Connecting Fuel Pressure Regulator Vacuum Line
Courtesy of GENERAL MOTORS CORP.

7. Connect the fuel pressure regulator vacuum line.
8. Install the intake manifold. Refer to **Intake Manifold Replacement** in Engine Mechanical.
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
10. Inspect for leaks.
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.

FUEL PRESSURE REGULATOR REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief Procedure**.
2. Remove the air cleaner outlet resonator. Refer to **Air Cleaner Outlet Resonator Replacement**.
3. Disconnect the engine wiring harness from the retaining clips at the front of the engine.

Fig. 133: Disconnecting/Connecting Fuel Pressure Regulator Vacuum Line
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the fuel pressure regulator vacuum line.
5. Clean any dirt from the fuel pressure regulator and the surrounding area.
6. Disconnect the fuel return pipe. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
7. Remove the fuel return pipe retainer.
8. Remove the fuel pressure regulator retainer.
9. Remove the fuel pressure regulator.
10. Inspect the regulator filter screen for contamination. If contaminated, replace the fuel pressure regulator.

Installation Procedure

Fig. 134: Disconnecting/Connecting Fuel Pressure Regulator Vacuum Line
Courtesy of GENERAL MOTORS CORP.

1. Install the regulator filter.
2. Install the new O-ring on the fuel pressure regulator.
3. Lubricate the fuel pressure regulator O-ring with clean engine oil.
4. Push the fuel pressure regulator into the regulator housing on the fuel rail.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

5. Install the fuel pressure regulator retainer.

Tighten: Tighten the regulator retainer screw to 8 N.m (71 lb in).

6. Install the fuel return pipe retainer.

   Tighten: Tighten the return pipe retainer screw to 8 N.m (71 lb in).

7. Connect the fuel return pipe. Refer to **Quick Connect Fitting(s) Service (Metal Collar)**.
8. Connect the fuel pressure regulator vacuum line.
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure** in Engine Electrical.
10. Inspect for leaks.
    1. Turn ON the ignition for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition.
    4. Inspect for fuel leaks.
11. Install the engine wiring harness into the retaining clips at the front of the engine.
12. Install the air intake resonator. Refer to **Air Cleaner Outlet Resonator Replacement**.

FUEL INJECTOR REPLACEMENT

Removal Procedure

Fig. 135: View Of Fuel Injector, Clip & O-Rings
Courtesy of GENERAL MOTORS CORP.

NOTE: **Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.**

IMPORTANT: The engine oil may be contaminated with fuel if the fuel injectors are leaking.

1. Remove the fuel rail assembly. Refer to **Fuel Rail Assembly Replacement**.
2. Disconnect the fuel injector harness connector from the fuel injectors.
3. Remove the injector retainer clip (1).
4. Remove the fuel injector (3) from the fuel rail.
5. Discard the injector retainer clip (1).
6. Remove the injector O-ring seals (2, 4) from both ends of the injector. Discard the O-ring seals.

Installation Procedure

Fig. 136: Locating Fuel Injector ID Number
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When ordering new fuel injectors, be sure to order the correct injector for the application being serviced.

The fuel injector assembly (1) is stamped with a part number identification (2). A four digit build date code (3) indicates the month (4), day (5), year (6), and the shift (7) that built the injector.

Fig. 137: View Of Fuel Injector, Clip & O-Rings
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the new injector O-ring seals (2, 4) with clean engine oil.
2. Install the new injector O-ring seals on the injector.
3. Install a new retainer clip (1) on the injector.
4. Push the fuel injector into the fuel rail injector socket with the electrical connector facing outward. The retainer clip locks on to a flange on the fuel rail injector socket.
5. Install the fuel rail assembly. Refer to **Fuel Rail Assembly Replacement**.

FUEL INJECTOR CLEANING PROCEDURE

Tools Required

- **J 37287** Fuel Line Shut-Off Adapters. See **Special Tools and Equipment**.
- **J 35800-A** Fuel Injector Cleaner. See **Special Tools and Equipment**.
- J 42873-1 3/8 Fuel Line Shut-Off Valve
- J 42873-2 5/16 Return Pipe Shut-Off Valve
- **J 42964-1** 3/8 Fuel Pipe Shut-Off Valve
- **J 42964-2** 5/16 Fuel Pipe Shut-Off Valve

NOTE:

- **GM Top-Engine Cleaner is the only injector cleaning agent recommended. Do not use other cleaning agents, as they may contain methanol which can damage fuel system components.**
- **Under NO circumstances should the top engine cleaner be added to the vehicles fuel tank, as it may damage the fuel pump and other system components.**
- **Do not exceed a 10 percent cleaning solution concentration. Higher concentrations may damage fuel system components. Testing has demonstrated that exceeding the 10 percent cleaning solution concentration does not improve the effectiveness of this procedure.**

IMPORTANT: Vehicles with less than 160 km (100 mi) on the odometer should not have the injectors cleaned. These vehicles should have the injectors replaced.

IMPORTANT: During this procedure you will need a total of 960 ml (32.4 oz) of cleaning solution. That is 2 tanks of solution for the **J 35800-A** . See **Special Tools and Equipment**. Other brands of tools may have a different capacity and would therefore require more or less tanks to complete the procedure. You must use all 960 ml (32.4 oz) of solution to ensure complete injector cleaning.

Fig. 138: Identifying Fuel Injector Cleaner
Courtesy of GENERAL MOTORS CORP.

1. Obtain **J 35800-A** (2). See **Special Tools and Equipment**.

IMPORTANT: Make sure the valve at the bottom of the canister (3) is closed.

2. For US dealers, empty 2 pre-measured GM Top-Engine Cleaner containers, 24 ml (0.812 oz) each, GM P/N 12346535, into the **J 35800-A** . See **Special Tools and Equipment**.
3. For Canadian dealers, measure and dispense 48 ml (1.62 oz) of Top-Engine Cleaner, Canadian P/N 992872, into the **J 35800-A** . See **Special Tools and Equipment**.
4. If you are using any other brand of tank you will need a total of 96 ml (3.24 oz) of Top-Engine Cleaner mixed with 864 ml (29.16 oz) of regular unleaded gasoline.
5. Fill the injector cleaning tank with regular unleaded gasoline. Be sure to follow all additional instructions provided with the tool.
6. Electrically disable the vehicle fuel pump by removing the fuel pump relay and disconnecting the oil pressure switch connector, if equipped.
7. Disconnect the fuel feed and return line, if equipped, at the fuel rail. Plug the fuel feed and return line, if equipped, coming off the fuel rail with **J 37287** , or **J 42964-1** , and **J 42964-2** or J 42873-1 , and J 42873-2 as appropriate for the fuel system.
8. Connect the **J 35800-A** to the vehicle fuel rail. See **Special Tools and Equipment**.
9. Pressurize the **J 35800-A** to 510 kPa (75 psi). See **Special Tools and Equipment**.
10. Start and idle the engine until it stalls due to lack of fuel. This should take approximately 15-20 minutes.
11. Disconnect **J 35800-A** from the fuel rail. See **Special Tools and Equipment**.
12. Reconnect the vehicle fuel pump relay and oil pressure switch connector, if equipped.
13. Remove **J 37287** or **J 42964-1** , and **J 42964-2** or J 42873-1 , and J 42873-2 and reconnect the vehicle fuel feed and return lines.
14. Start and idle the vehicle for an additional 2 minutes to ensure residual injector cleaner is flushed from the fuel rail and fuel lines.
15. Repeat steps 1-5 of the Injector Balance Test, and record the fuel pressure drop from each injector.
16. Subtract the lowest fuel pressure drop from the highest fuel pressure drop. If the value is 15 kPa (2 psi) or less, no additional action is required. If the value is greater than 15 kPa (2 psi), replace the injector with the lowest fuel pressure drop.
17. Add one ounce of Port Fuel Injector Cleaner, GM P/N 12345104 (Canadian P/N 10953467), to the vehicle fuel tank for each gallon of gasoline estimated to be in the fuel tank. Instruct the customer to add the reminder of the bottle of Port Fuel Injector Cleaner to the vehicle fuel tank at the next fill-up.
18. Advise the customer to change brands of fuel and to add GM Port Fuel Injector Cleaner every 5 000 km (3,000 mi). GM Port Fuel Injector Cleaner contains the same additives that the fuel companies are removing from the fuel to reduce costs. Regular use of GM Port Fuel Injector Cleaner should keep the customer from having to repeat the injector cleaning procedure.
19. Road test the vehicle to verify that the customer concern has been corrected.

EVAPORATIVE EMISSION (EVAP) CANISTER PURGE SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 139: Disconnecting/Connecting EVAP Canister Purge Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the harness electrical connector (2) from the evaporative emission (EVAP) canister purge valve (1).
3. Disconnect the EVAP purge pipe from the EVAP canister purge valve.
4. Disconnect the engine vacuum pipe from the EVAP canister purge valve.

Fig. 140: Removing/Installing EVAP Canister Purge Valve
Courtesy of GENERAL MOTORS CORP.

5. Remove the purge valve (2) from the purge valve mounting bracket.
6. If replacing the purge valve bracket, remove the attaching bolt (1) and purge valve bracket.

Installation Procedure

Fig. 141: Removing/Installing EVAP Canister Purge Valve
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

1. If replacing the purge bracket, install the purge valve bracket and the attaching bolt (1).

   Tighten: Tighten the purge valve mounting bracket attaching bolt to 10 N.m (89 lb in).

2. Install purge valve (2) on to the purge valve mounting bracket.
3. Connect the EVAP purge pipe to the EVAP canister purge valve.
4. Connect the engine vacuum pipe to the EVAP canister purge valve.

Fig. 142: Disconnecting/Connecting EVAP Canister Purge Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the electrical harness connector (2) to the EVAP canister purge valve (1).
6. Lower the vehicle.

EVAPORATIVE EMISSION (EVAP) CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 143: Locating Fuel Tank Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the harness connector (2) from the evaporative emission (EVAP) canister vent valve.

Fig. 144: Removing/Installing EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the EVAP vent pipe (3) from the EVAP canister vent valve (1).
4. Disengage the bracket retaining tab (2) and remove the EVAP canister vent valve.

Installation Procedure

Fig. 145: Removing/Installing EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP canister vent valve (1) on the bracket (2).
2. Inspect for proper retention of the EVAP vent valve (1) on the bracket (2).
3. Connect the EVAP vent pipe (3) to the EVAP canister vent valve (1).

Fig. 146: Locating Fuel Tank Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Connect the harness connector (2) to the EVAP canister vent valve.
5. Lower the vehicle.

EVAPORATIVE EMISSION (EVAP) HOSES/PIPES REPLACEMENT - CANISTER/FUEL TANK (VENT PIPE)

Removal Procedure

CAUTION: Refer to Fuel and EVAP Pipe Caution in Cautions and Notices.

NOTE: Refer to Fuel and Evaporative Emission (EVAP) Hose/Pipe Connection Cleaning Notice in Cautions and Notices.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

Fig. 147: Removing/Installing EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the evaporative emission (EVAP) vent pipe (3) from the EVAP canister vent valve (1).
3. Remove the EVAP vent pipe from the fuel tank retainers.

Installation Procedure

Fig. 148: Removing/Installing EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP vent pipe to the fuel tank retainers.
2. Connect the EVAP vent pipe (3) to the EVAP canister vent valve (1).
3. Install the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

EVAPORATIVE EMISSION (EVAP) HOSES/PIPES REPLACEMENT - CANISTER/FUEL TANK (VAPOR PIPE)

Removal Procedure

CAUTION: Refer to Fuel and EVAP Pipe Caution in Cautions and Notices.

NOTE: **Refer to Fuel and Evaporative Emission (EVAP) Hose/Pipe Connection Cleaning Notice in Cautions and Notices.**

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

Fig. 149: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the evaporative emission (EVAP) vapor pipe at the fill limiter vent valve (3).
3. Disconnect the EVAP vapor pipe from the front rollover valve (5).
4. Remove the front retaining clip (6) from the fuel and EVAP pipes and remove the EVAP vapor pipe.
5. Disconnect the EVAP vapor pipe from the fill limiter vent valve (3).
6. Disconnect the EVAP vapor pipe from the rear rollover valve (2).
7. Remove the EVAP vapor pipe.

Installation Procedure

Fig. 150: Identifying Fuel Tank Components
Courtesy of GENERAL MOTORS CORP.

1. Connect the fuel tank vapor pipe to the rear rollover valve (2).
2. Connect the fuel tank vapor pipe to the fill limiter vent valve (3).
3. Connect the EVAP vapor pipe to the fill limiter vent valve (3).
4. Install the front clip (6) to the fuel and EVAP pipes at the front of the fuel tank.
5. Connect the EVAP vapor pipe to the front rollover valve (5).
6. Install the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)**.

EVAPORATIVE EMISSION (EVAP) HOSES/PIPES REPLACEMENT - ENGINE/CHASSIS

Removal Procedure

Fig. 151: EVAP/Fuel Hose/Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the EVAP/fuel hose/pipe assembly. Refer to **Fuel Hose/Pipes Replacement - Filter to Engine**.
2. Remove the EVAP purge pipe (3) from the EVAP/fuel hose/pipe assembly.

Installation Procedure

Fig. 152: EVAP/Fuel Hose/Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

1. Place the new EVAP purge pipe (3) in the EVAP/fuel hose/pipe assembly.
2. Install the EVAP/fuel hose/pipe assembly. Refer to **Fuel Hose/Pipes Replacement - Filter to Engine**.

EVAPORATIVE EMISSION (EVAP) CANISTER REPLACEMENT (TRAILBLAZER EXT, ENVOY XL, ENVOY XUV)

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
2. Remove the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** in Engine Controls - 4.2L.

   Fig. 153: Removing/Installing EVAP Canister
   Courtesy of GENERAL MOTORS CORP.

3. Disconnect the evaporative emission (EVAP) vapor pipe (2) from the EVAP canister.
4. Disconnect the EVAP vent pipe (1) from the EVAP canister.
5. Disconnect the EVAP purge pipe from the EVAP canister. The purge pipe is the small pipe next to the vapor pipe (2).

   IMPORTANT: Do not pry against the surface of the evaporative emissions canister. This could damage the canister.

6. Remove the EVAP canister from the tabs of the canister bracket by inserting a flat head screwdriver into the center slots of the tabs as indicated in the illustration.

   Fig. 154: Removing EVAP Canister From Bracket
   Courtesy of GENERAL MOTORS CORP.

7. Pry the canister away from the tabs as indicated in the illustration.
8. Slide the canister away from the single tab side to disengage the EVAP canister from the bracket.

Installation Procedure

IMPORTANT: Considerable force may be necessary to install the EVAP canister into the two tab side.

1. Slide the EVAP canister into the single tab side and press the canister into the two tab side.

   Ensure the tabs have completely engaged.

   Fig. 155: Removing/Installing EVAP Canister
   Courtesy of GENERAL MOTORS CORP.

2. Connect the EVAP purge pipe to the EVAP canister. The purge pipe is the small pipe next to the vapor pipe (2).
3. Connect the EVAP vent pipe (1) to the EVAP canister.
4. Connect the EVAP vapor pipe (2) to the EVAP canister.
5. Install the fuel tank. Refer to **Fuel Tank Replacement (TrailBlazer, Envoy, Bravada, Rainier)** or **Fuel Tank Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** in Engine Controls - 4.2L.
6. Lower the vehicle.

EVAPORATIVE EMISSION (EVAP) CANISTER REPLACEMENT (TRAILBLAZER, ENVOY, BRAVADA, RAINIER)

Removal Procedure

1. Remove the spare tire. Reference the owners manual for additional information if needed.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 156: Disconnecting/Connecting EVAP Canister Pipes
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the evaporative emission (EVAP) vapor pipe (1) from the EVAP canister.
4. Disconnect the EVAP purge pipe (2) from the EVAP canister.
5. Disconnect the EVAP vent pipe (3) from the EVAP canister.

Fig. 157: Removing/Installing EVAP Canister Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

6. Remove the bolts (1) from the EVAP mounting bracket (2).
7. Remove the EVAP canister and bracket assembly from the vehicle.

Fig. 158: Removing/Installing EVAP Canister From Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolt (1) attaching the EVAP canister (3) to the mounting bracket (2).
9. Remove the EVAP canister (3) from the mounting bracket (2).

Fig. 159: Removing/Installing EVAP Canister Retaining Bracket
Courtesy of GENERAL MOTORS CORP.

10. Remove the EVAP retaining bracket (2) from the EVAP canister (3) by releasing the retaining bracket clip (1) from the EVAP canister (3).

Installation Procedure

Fig. 160: Removing/Installing EVAP Canister Retaining Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the EVAP retaining bracket (2) to the EVAP canister (3) ensuring the retaining bracket clip (1) is fully engaged.

Fig. 161: Removing/Installing EVAP Canister From Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

2. Install the EVAP canister (3) to the mounting bracket (2).

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

3. Install the bolt (1) attaching the EVAP canister (3) to the mounting bracket (2).

Tighten: Tighten the bolt to 20 N.m (15 lb ft).

Fig. 162: Removing/Installing EVAP Canister Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

4. Install the EVAP canister and bracket assembly to the vehicle.
5. Install the bolts (1) to the EVAP mounting bracket (2).

   Tighten: Tighten the bolts to 20 N.m (15 lb ft).

   Fig. 163: Disconnecting/Connecting EVAP Canister Pipes
   Courtesy of GENERAL MOTORS CORP.

6. Connect the evaporative emission (EVAP) vapor pipe (1) to the EVAP canister.
7. Connect the EVAP purge pipe (2) to the EVAP canister.
8. Connect the EVAP vent pipe (3) to the EVAP canister.
9. Lower the vehicle.
10. Install the spare tire. Reference the owners manual for additional information if needed.

EVAPORATIVE EMISSION (EVAP) SYSTEM CLEANING

Tools Required

J 41413 EVAP Pressure and Purge Station

Inspection Procedure

NOTE: **Refer to Clean, Dry, Low Pressure Gas Source Notice in Cautions and Notices.**

IMPORTANT: Do not perform this procedure unless instructed by an evaporative emission (EVAP) diagnostic.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission (EVAP) Canister Purge Solenoid Valve Replacement**.
3. Lightly tap the EVAP canister purge valve on a clean hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
   - If no carbon particles are found, install the EVAP canister purge valve and continue with the EVAP cleaning procedure.
   - If carbon particles are found during the inspection procedure, continue with the EVAP cleaning procedure.
   - If you were instructed to replace the EVAP canister purge valve, and no carbon particles are found, return to the EVAP diagnostic procedure. Do not perform the EVAP cleaning procedure.

EVAP Cleaning Procedure

1. Remove the EVAP canister. Refer to **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** or **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer, Envoy, Bravada, Rainier)**.
2. Turn OFF the main valve on the J 41413 .
3. Disconnect the hose from the diagnostic station pressure regulator.
4. Using a section of vacuum hose, connect one end to the diagnostic station pressure regulator.
5. Connect the other end of the vacuum hose to the canister side of the purge pipe.

6. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
7. If the nitrogen does not dislodge the carbon particles, replace the purge pipe. Refer to **Evaporative Emission (EVAP) Hoses/Pipes Replacement - Engine/Chassis**.
8. Return the J 41413 to its original condition.
9. Install a new EVAP canister. Refer to **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer EXT, Envoy XL, Envoy XUV)** or **Evaporative Emission (EVAP) Canister Replacement (TrailBlazer, Envoy, Bravada, Rainier)**.
10. Install a new EVAP canister purge valve. Refer to **Evaporative Emission (EVAP) Canister Purge Solenoid Valve Replacement**.
11. Lower the vehicle.
12. Continue with the published service manual diagnostic trouble code (DTC) procedure.

IGNITION COIL(S) REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet resonator. Refer to **Air Cleaner Outlet Resonator Replacement**.

Fig. 164: Disconnecting/Connecting Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the ignition coil connectors (1) from the ignition coils.
3. Remove the retaining bolts (2) from the ignition coils.

Fig. 165: Removing/Installing Ignition Coils
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coils (1) from the engine.

Installation Procedure

Fig. 166: Removing/Installing Ignition Coils
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the ignition coil seals are properly seated to the valve cover.

1. Install the ignition coil (1).

Fig. 167: Disconnecting/Connecting Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the ignition coil retaining bolts (2).

Tighten: Tighten the ignition coil retaining bolts to 10 N.m (89 lb in).

3. Replace the ignition coil connectors (1).
4. Install the air cleaner outlet resonator. Refer to **Air Cleaner Outlet Resonator Replacement**.

SPARK PLUG INSPECTION

Spark Plug Usage

1. Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to **Ignition System Specifications** for the correct spark plug.
2. Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
   - Spark plug fouling-Colder plug
   - Pre-ignition causing spark plug and/or engine damage-Hotter plug

Spark Plug Inspection

Fig. 168: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

1. Inspect the terminal post (1) for damage.
   - Inspect for a bent or broken terminal post (1).
   - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.

Fig. 169: Identifying Points For Inspecting Spark Plug For Flashover Or Carbon Tracking Soot
Courtesy of GENERAL MOTORS CORP.

2. Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
   - Inspect the spark plug boot for damage.
   - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.

Fig. 170: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS CORP.

3. Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

Fig. 171: Cutaway/Discription View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

4. Inspect for evidence of improper arcing.
   - Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
   - Inspect for the correct spark plug torque. Refer to **Ignition System Specifications**. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
   - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
   - Inspect for a broken or worn side electrode (3).
   - Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.

- A rattling sound indicates internal damage.
- A loose center electrode (4) reduces the spark intensity.

- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
- Inspect for excessive fouling.

5. Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

1. Normal operation-Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
2. Carbon fouled-Dry, fluffy black carbon, or soot caused by the following conditions:
   - Rich fuel mixtures
     - Leaking fuel injectors
     - Excessive fuel pressure
     - Restricted air filter element
     - Incorrect combustion
   - Reduced ignition system voltage output
     - Weak coils
     - Worn ignition wires
     - Incorrect spark plug gap
   - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
3. Deposit fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

Removal Procedure

1. Turn OFF the ignition switch.
2. Remove the ignition coils. Refer to **Ignition Coil(s) Replacement**.

NOTE: **Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.**

NOTE: **Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.**

Fig. 172: Removing/Installing Spark Plugs
Courtesy of GENERAL MOTORS CORP.

3. Remove the spark plugs from the engine.

Installation Procedure

NOTE: **Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.**

NOTE: **Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gage to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.**

1. Measure the spark plug gap on the spark plugs to be installed. Compare the measurement to the gap specifications. Refer to **Ignition System Specifications**. Correct as necessary.

NOTE: **Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.**

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

Fig. 173: Removing/Installing Spark Plugs
Courtesy of GENERAL MOTORS CORP.

2. Install the spark plugs to the engine.

   Tighten: Tighten the spark plugs to 18 N.m (13 lb ft).

3. Install the ignition coils. Refer to **Ignition Coil(s) Replacement**.

CRANKSHAFT POSITION (CKP) SENSOR REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 174: Removing/Installing CKP Sensor
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the crankshaft position (CKP) sensor harness connector.
3. Remove the CKP sensor retaining bolt.
4. Remove the CKP sensor from the engine block.

Installation Procedure

IMPORTANT: Inspect the sensor O-ring for the following conditions:

- Any wear
- Any cracks
- Any leakage

Replace the O-ring if necessary. Lubricate the new 0-ring with engine oil before installation.

NOTE: Refer to Fastener Notice in Cautions and Notices.

Fig. 175: Removing/Installing CKP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the CKP sensor into the engine block.

   Tighten: Tighten the bolt to 10 N.m (89 lb in).

2. Install the CKP sensor retaining bolt.
3. Connect the CKP sensor harness connector.
4. Lower the vehicle.
5. Perform the **CKP System Variation Learn Procedure**.

CAMSHAFT POSITION (CMP) SENSOR REPLACEMENT

Removal Procedure

Fig. 176: Removing/Installing CMP Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft position (CMP) sensor electrical connector (1).
2. Remove the CMP sensor retaining bolt.

Installation Procedure

Fig. 177: Removing/Installing CMP Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the camshaft position (CMP) sensor.

   Tighten: Tighten the CMP sensor bolt to 10 N.m (89 lb in).

2. Install the CMP sensor electrical connector (1).

CAMSHAFT POSITION (CMP) ACTUATOR SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement** in Engine Mechanical.
2. Remove the 3 power steering pump bolts and move the pump out of the way. Refer to **Power Steering Pump Replacement (5.3L)** or **Power Steering Pump Replacement**

(4.2L) in Power Steering Systems.

3. Disconnect the camshaft position actuator solenoid electrical connector.

Fig. 178: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft position actuator solenoid retaining bolt (3).
5. Remove the camshaft position actuator solenoid (2) from the engine block.
6. Clean debris from the hole (1).

Installation Procedure

1. Install a new O-ring on the camshaft position actuator solenoid.
2. Lubricate the hole (1) with engine oil.

Fig. 179: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the camshaft position actuator solenoid (2) and bolt (3).

Tighten: Tighten the bolt to 10 N.m (89 lb in).

4. Connect the camshaft position actuator solenoid electrical connector.
5. Install the power steering pump and bolts. Refer to **Power Steering Pump Replacement (5.3L)** or **Power Steering Pump Replacement (4.2L)** in Power Steering Systems.
6. Install the drive belt. Refer to **Drive Belt Replacement** in Engine Mechanical.

KNOCK SENSOR (KS) REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 180: Removing/Installing Knock Sensors
Courtesy of GENERAL MOTORS CORP.

2. Remove the knock sensor harness connector (4).
3. Remove the knock sensor retaining bolt (3).
4. Remove the appropriate knock sensor (1 or 2).

Installation Procedure

Fig. 181: Removing/Installing Knock Sensors
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Component Fastener Tightening Notice in Cautions and Notices.

1. Install the knock sensor (1 or 2) and the bolt (3).

Tighten: Tighten the sensor to 25 N.m (18 lb ft).

2. Connect the knock sensor harness connector (4).
3. Lower the vehicle.

SECONDARY AIR INJECTION (AIR) PUMP REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 182: Removing/Installing AIR Pump
Courtesy of GENERAL MOTORS CORP.

2. Disconnect both the air inlet and air outlet pipes from the secondary air injection (AIR) reaction pump.
3. Remove the electrical relay from the AIR pump bracket.
4. Disconnect the electrical connector from the AIR pump.
5. Remove the 3 bolts securing the AIR pump bracket to the vehicle frame.
6. Remove the AIR pump from the vehicle.

Installation Procedure

Fig. 183: Removing/Installing AIR Pump
Courtesy of GENERAL MOTORS CORP.

1. Install the AIR pump to the vehicle.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

2. Install the 3 bolts securing the AIR pump bracket to the vehicle frame.

Tighten: Tighten the bolts to 20 N.m (15 lb ft).

3. Connect the electrical connector to the AIR pump.
4. Install the electrical relay to the AIR pump bracket.

IMPORTANT: Ensure the air inlet and air outlet pipes are clean and clear of any debris before connecting to the AIR pump.

5. Connect both the air inlet and air outlet pipe to the AIR pump.
6. Lower the vehicle.

SECONDARY AIR INJECTION (AIR) SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement**.

Fig. 184: Disconnecting/Connecting Electrical Connector & Air Outlet Pipe From AIR Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector from the secondary air injection (AIR) reaction solenoid valve.

3. Disconnect the AIR pump air outlet pipe from the AIR solenoid valve.

Fig. 185: Removing/Installing AIR Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

4. Remove the nut (1) securing the transmission fluid level indicator tube (2) to the AIR solenoid valve.
5. Remove the transmission fluid level indicator tube (2) from the AIR solenoid valve stud (3).
6. Remove the 2 AIR solenoid valve studs (3).
7. Remove the AIR solenoid valve (4) and the gasket (5) from the engine.

Installation Procedure

Fig. 186: Removing/Installing AIR Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the AIR solenoid valve (4) and the gasket (5) to the engine.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

2. Install the 2 AIR solenoid valve studs (3).

Tighten: Tighten the studs to 25 N.m (18 lb ft).

3. Install the transmission fluid level indicator tube (2) to the AIR solenoid valve stud (3).
4. Install the nut (1) securing the transmission fluid level indicator tube (2) to the AIR solenoid valve.

Tighten: Tighten the nut to 10 N.m (89 lb in).

Fig. 187: Disconnecting/Connecting Electrical Connector & Air Outlet Pipe From AIR Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Connect the AIR pump air outlet pipe to the AIR solenoid valve.
6. Connect the electrical connector to the AIR solenoid valve.
7. Install the air cleaner outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement**.

SECONDARY AIR INJECTION (AIR) PIPE REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 188: Disconnecting/Connecting Air Inlet & Outlet Pipes From AIR Pump
Courtesy of GENERAL MOTORS CORP.

2. Disconnect both the air inlet and air outlet pipe from the secondary air injection reaction (AIR) pump.
3. Lower the vehicle.

Fig. 189: Removing/Installing AIR Pipe From Cylinder Head
Courtesy of GENERAL MOTORS CORP.

4. Remove the cylinder head. Refer to **Cylinder Head Replacement** in Engine Mechanical - 4.2L.
5. Remove the bolt and fir-tree fasteners securing the AIR pipe to the cylinder head.

Installation Procedure

Fig. 190: Removing/Installing AIR Pipe From Cylinder Head
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the bolt and fir-tree fasteners securing the AIR pipe to the cylinder head.

   Tighten: Tighten the bolt to 10 N.m (89 lb in).

2. Install the cylinder head. Refer to **Cylinder Head Replacement** in Engine Mechanical - 4.2L.
3. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

Fig. 191: Disconnecting/Connecting Air Inlet & Outlet Pipes From AIR Pump
Courtesy of GENERAL MOTORS CORP.

4. Connect both the air inlet and air outlet pipe to the AIR pump.
5. Lower the vehicle.

AIR CLEANER ELEMENT REPLACEMENT

Removal Procedure

1. Remove the radiator support diagonal brace if applicable. Refer to **Brace Replacement - Radiator Support Diagonal** in Body Front End.

Fig. 192: Disconnecting/Connecting AIR Pump Inlet Hose From Air Cleaner
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the secondary air injection (AIR) reaction pump inlet hose from the air cleaner air outlet duct.

Fig. 193: Disassembling/Assembling Air Cleaner Housing
Courtesy of GENERAL MOTORS CORP.

3. Loosen the 3 air cleaner housing retaining screws (1).
4. Remove the air cleaner housing (2).
5. Lift the air cleaner element (6) and air outlet duct (3) from the lower air cleaner housing/washer solvent tank assembly (4).
6. Remove the air cleaner element (6) from the air outlet duct (3) with a twisting and pulling motion.
7. Inspect the entire assembly for dust, debris, or water. Clean or replace as necessary.

Installation Procedure

Fig. 194: Disassembling/Assembling Air Cleaner Housing
Courtesy of GENERAL MOTORS CORP.

1. Install the air cleaner element (6) onto the air outlet duct (3) with a twisting and pushing motion.
2. Install the air cleaner element (6) and air outlet duct (3) into the lower air cleaner housing/washer solvent tank assembly (4).

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

IMPORTANT: Ensure the air inlet duct (5) is properly positioned in the lower air cleaner housing/washer solvent tank assembly (4) before installing the air cleaner housing (2).

3. Install the air cleaner housing (2).

Tighten: Tighten the 3 air cleaner housing retaining screws (1) to 4 N.m (35 lb in).

Fig. 195: Disconnecting/Connecting AIR Pump Inlet Hose From Air Cleaner
Courtesy of GENERAL MOTORS CORP.

4. Connect the AIR pump inlet hose to the air cleaner air outlet duct.
5. Install the radiator support diagonal brace if applicable. Refer to **Brace Replacement - Radiator Support Diagonal** in Body Front End.

AIR CLEANER ASSEMBLY REPLACEMENT

Removal Procedure

Fig. 196: Disassembling/Assembling Air Cleaner Housing
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner cover/resonator (2) then position the air cleaner element (6) and air outlet duct (3) out of the way. Refer to **Air Cleaner Element Replacement**.
2. Remove the air inlet duct (5) from the lower air cleaner housing/washer solvent tank assembly (4).

Fig. 197: Locating Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the following electrical connectors:
   - Windshield washer pump (1)
   - Headlamp washer pump (2), if equipped
   - Low solvent level sensor (4)
   - Lift gate washer pump (6), if equipped
4. Remove the washer solvent level sensor wire harness from the wire harness retaining clips (3, 5).

Fig. 198: Disconnecting/Connecting Headlight Washer Hose
Courtesy of GENERAL MOTORS CORP.

5. If applicable, disconnect the headlamp washer hose from the headlamp washer pump located on the lower air cleaner housing/washer solvent tank. Cap the headlamp washer

pump outlet fitting to prevent loss of washer solvent.

Fig. 199: Removing/Installing Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the washer pump hoses (3) and plug the washer pump outlet ports to prevent loss of washer solvent.
7. Remove the 2 air cleaner housing/washer solvent tank assembly retaining nuts (1) from the mounting studs.
8. Lift the lower air filter housing/washer solvent tank assembly (2) off of the studs and remove the assembly.

Installation Procedure

Fig. 200: Removing/Installing Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the lower air filter housing/washer solvent tank assembly (2) onto the mounting studs.
2. Connect the washer pump hoses (3) to the washer pumps.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the 2 air cleaner housing/washer solvent tank assembly retaining nuts (1) to the mounting studs.

   Tighten: Tighten the nuts to 15 N.m (11 lb ft).

Fig. 201: Disconnecting/Connecting Headlight Washer Hose
Courtesy of GENERAL MOTORS CORP.

4. If applicable, Connect the headlamp washer hose to the headlamp washer pump located on the lower air cleaner housing/washer solvent tank.

Fig. 202: Locating Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Connect the following electrical connectors:
   - Windshield washer pump (1)
   - Headlamp washer pump (2), if equipped
   - Low solvent level sensor (4)
   - Lift gate washer pump (6), if equipped
6. Install the washer solvent level sensor wire harness to the wire harness retaining clips (3, 5).

Fig. 203: Disassembling/Assembling Air Cleaner Housing
Courtesy of GENERAL MOTORS CORP.

7. Install the air inlet duct (5) to the lower air cleaner housing/washer solvent tank assembly (4).
8. Install the air cleaner element (6) and air outlet duct (3) to the lower air cleaner housing/washer solvent tank assembly.
9. Install the air cleaner cover/resonator (2). Refer to **Air Cleaner Element Replacement**.

AIR CLEANER OUTLET RESONATOR REPLACEMENT

Removal Procedure

Fig. 204: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

1. Loosen the air cleaner outlet duct and air cleaner outlet resonator clamps (2).
2. Disconnect the electrical connector from the intake air temperature (IAT) sensor (1).
3. Disconnect the air cleaner outlet duct from the air cleaner outlet resonator.
4. Disconnect the fuel pressure regulator vacuum supply from the air cleaner outlet resonator.

Fig. 205: Removing/Installing Air Cleaner Outlet Resonator Assembly
Courtesy of GENERAL MOTORS CORP.

5. Remove the two air cleaner outlet resonator to engine bolts (4).
6. Disconnect the crankcase ventilation hose (1) from the valve cover port (2).
7. Remove the air cleaner outlet resonator assembly (5) from the engine.

Installation Procedure

Fig. 206: Removing/Installing Air Cleaner Outlet Resonator Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the air cleaner outlet resonator assembly (5) to the engine making sure of the following:
   - The crankcase ventilation hose (1) is connected to the valve cover port (2).
   - The air cleaner outlet resonator (5) is properly fit to the throttle body assembly.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

2. Install the two air cleaner outlet resonator to engine bolts (4).

Tighten: Tighten the resonator to engine bolts to 6 N.m (53 lb in).

Fig. 207: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

3. Connect the fuel pressure regulator vacuum supply to the air cleaner outlet resonator.
4. Connect the air cleaner outlet duct to the air cleaner outlet resonator.
5. Connect the electrical connector to the intake air temperature (IAT) sensor (1).
6. Properly position the air cleaner outlet duct and air cleaner outlet resonator clamps (2).

Tighten: Tighten the clamps (2) to 4 N.m (35 lb in).

AIR CLEANER RESONATOR OUTLET DUCT REPLACEMENT

Removal Procedure

1. Remove the air cleaner element. Refer to **Air Cleaner Element Replacement**.

Fig. 208: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector from the intake air temperature (IAT) sensor (1).
3. Loosen the air cleaner outlet duct clamp (2) on the air cleaner side of the air cleaner outlet resonator (3).
4. Remove the air cleaner outlet duct.
5. If replacing the air cleaner outlet duct, remove the IAT sensor. Refer to **Intake Air Temperature (IAT) Sensor Replacement**.

Installation Procedure

1. If the IAT sensor was previously removed, install the IAT sensor into the air cleaner outlet duct. Refer to **Intake Air Temperature (IAT) Sensor Replacement**.

Fig. 209: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

2. Install the air cleaner outlet duct onto the air cleaner outlet resonator (3).
3. Install the air cleaner element. Refer to **Air Cleaner Element Replacement**.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

4. Properly position the air cleaner outlet duct clamp (2) on the air cleaner side of the air cleaner outlet resonator (3).

   Tighten: Tighten the clamp (2) to 4 N.m (35 lb in).

5. Connect the electrical connector to the IAT sensor (1).

DESCRIPTION AND OPERATION

POWERTRAIN CONTROL MODULE (PCM) DESCRIPTION

Powertrain

The powertrain has electronic controls to reduce exhaust emissions while maintaining excellent driveability and fuel economy. The powertrain control module (PCM) is the control center of this system. The PCM monitors numerous engine and vehicle functions. The PCM constantly looks at the information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The PCM also performs the diagnostic tests on various parts of the system. The PCM can recognize operational problems and alert the driver via the malfunction indicator lamp (MIL). When the PCM detects a malfunction, the PCM stores a diagnostic trouble code (DTC). The problem area is identified by the particular DTC that is set. The control module supplies a buffered voltage to various sensors and switches. Review the components and wiring diagrams in order to determine which systems are controlled by the PCM.

The following are some of the functions that the PCM controls:

- The engine fueling
- The ignition control (IC)
- The knock sensor (KS) system

- The evaporative emissions (EVAP) system
- The secondary air injection (AIR) system (if equipped)
- The exhaust gas recirculation (EGR) system
- The automatic transmission functions
- The generator
- The A/C clutch control
- The cooling fan control

Powertrain Control Module Function

The powertrain control module (PCM) constantly looks at the information from various sensors and other inputs and controls systems that affect vehicle performance and emissions. The PCM also performs diagnostic tests on various parts of the system. The PCM can recognize operational problems and alert the driver via the malfunction indicator lamp (MIL). When the PCM detects a malfunction, the PCM stores a diagnostic trouble code (DTC). The problem area is identified by the particular DTC that is set. The control module supplies a buffered voltage to various sensors and switches. The input and output devices in the PCM include analog-to-digital converters, signal buffers, counters, and output drivers. The output drivers are electronic switches that complete a ground or voltage circuit when turned on. Most PCM controlled components are operated via output drivers. The PCM monitors these driver circuits for proper operation and, in most cases, can set a DTC corresponding to the controlled device if a problem is detected.

Malfunction Indicator Lamp (MIL) Operation

The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL will display as either SERVICE ENGINE SOON or one of the following symbols when commanded ON:

Fig. 210: MIL Symbol On Instrument Cluster
Courtesy of GENERAL MOTORS CORP.

Fig. 211: Check Engine Light Symbol
Courtesy of GENERAL MOTORS CORP.

The MIL indicates that an emissions related fault has occurred and vehicle service is required.

The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.
- The MIL remains illuminated after the engine is started if the control module detects a fault. A diagnostic trouble code (DTC) is stored any time the control module illuminates the MIL due to an emissions related fault. The MIL turns OFF after three consecutive ignition cycles in which a Test Passed has been reported for the diagnostic test that originally caused the MIL to illuminate.
- The MIL flashes if the control module detects a misfire condition which could damage the catalytic converter.
- When the MIL is illuminated and the engine stalls, the MIL will remain illuminated as long as the ignition is ON.

- When the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition is cycled OFF and then ON.

Trip

A trip is an interval of time during which the diagnostic test runs. A trip may consist of only a key cycle to power up the powertrain control module (PCM), allow the diagnostic to run, then cycle the key off to power down the PCM. A trip may also involve a PCM power up, meeting specific conditions to run the diagnostic test, then powering down the PCM. The definition of a trip depends upon the diagnostic. Some diagnostic tests run only once per trip (i.e., catalyst monitor) while other tests run continuously during each trip (i.e., misfire).

Warm-Up Cycle

The powertrain control module (PCM) uses warm-up cycles to run some diagnostics and to clear any diagnostic trouble codes (DTCs). A warm-up cycle occurs when the engine coolant temperature increases 22Â°C (40Â°F) from the start-up temperature. The engine coolant must also achieve a minimum temperature of 71Â°C (160Â°F). The PCM counts the number of warm-up cycles in order to clear the malfunction indicator lamp (MIL). The PCM will clear the DTCs when 40 consecutive warm-up cycles occur without a malfunction.

Diagnostic Trouble Codes (DTCs)

The powertrain control module (PCM) is programmed with test routines that test the operation of the various systems the PCM controls. Some tests monitor internal PCM functions. Many tests are run continuously. Other tests run only under specific conditions, referred to as Conditions for Running the DTC. When the vehicle is operating within the conditions for running a particular test, the PCM monitors certain parameters and determines if the values are within an expected range. The parameters and values considered outside the range of normal operation are listed as Conditions for Setting the DTC. When the Conditions for Setting the DTC occur, the PCM executes the Action Taken When the DTC Sets. Some DTCs alert the driver via the malfunction indicator lamp (MIL) or a message. Other DTCs do not trigger a driver warning, but are stored in memory. The PCM also saves data and input parameters when most DTCs are set. This data is stored in the Freeze Frame and/or Failure Records.

The DTCs are categorized by type. The DTC type is determined by the MIL operation and the manner in which the fault data is stored when a particular DTC fails. In some cases there may be exceptions to this structure. Therefore, when diagnosing the system it is important to read the Action Taken When the DTC Sets and the Conditions for Clearing the DTC in the supporting text.

There are different types of DTCs and different actions taken when the DTCs set. Refer to Diagnostic Trouble Code (DTC) Type Definitions for a description of the general characteristics of each DTC type.

DTC Status

When the scan tool displays a DTC, the status of the DTC is also displayed. The following DTC statuses are indicated only when they apply to the DTC that is set.

Fail This Ign. (Fail This Ignition)

Indicates that this DTC failed during the present ignition cycle.

Last Test Fail

Indicates that this DTC failed the last time the test ran.

MIL Request

Indicates that this DTC is currently requesting the malfunction indicator lamp (MIL). This selection will report type B DTCs only when they have requested the MIL (failed twice).

Test Fail SCC (Test Failed Since Code Clear)

Indicates that this DTC that has reported a failure since the last time DTCs were cleared.

History

Indicates that the DTC is stored in the powertrain control module (PCM) History memory. Type B DTCs will not appear in History until they have requested the MIL (failed twice). History will be displayed for all type A DTCs and type B DTCs (which have requested the MIL) that have failed within the last 40 warm-up cycles. Type C DTCs that have failed within the last 40 warm-up cycles will also appear in History.

Not Run SCC (Not Run Since Code Clear)

DTCs will be listed in this category if the diagnostic has not run since DTCs were last cleared. This status is not included with the DTC display since the DTC can not be set if the diagnostic has not run. This information is displayed when DTC Info is requested using the scan tool.

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

Throttle Actuator Control (TAC) Overview

The throttle actuator control (TAC) system uses vehicle electronics and components to calculate and control the position of the throttle blade. This eliminates the need for a mechanical cable attachment from the accelerator pedal to the throttle body. This system also performs the cruise control functions as well.

The TAC system components include, but are not limited to the following:

- The accelerator pedal position (APP) sensors
- The throttle body
- The powertrain control module (PCM)

Each of these components interface together to ensure accurate calculations and control of the throttle position (TP).

Accelerator Pedal Position (APP) Sensor

The APP sensor is mounted on the accelerator pedal assembly. The APP is actually 2 individual APP sensors within 1 housing. There are 2 separate signal, low reference, and 5-volt reference circuits. APP sensor 1 voltage increases as the accelerator pedal is depressed. APP sensor 2 voltage decreases as the accelerator pedal is depressed.

Throttle Body Assembly

The throttle body for the TAC system is similar to a conventional throttle body with several exceptions. One exception being the use of a motor to control the throttle position instead of a

mechanical cable. Another exception is the throttle position (TP) sensor. The TP sensor is mounted in the throttle body assembly. The TP sensor is 2 individual TP sensors within the throttle body assembly. Two separate signal, low reference, and 5-volt reference circuits are used to connect the TP sensors and the PCM. TP sensor 2 signal voltage increases as the throttle opens. TP sensor 1 signal voltage decreases as the throttle opens.

Modes of Operation

Battery Saver Mode

If the powertrain control module (PCM) detects the ignition ON for 10 seconds without the engine running, the PCM will allow the throttle blade to return to the default position. This removes the draw that is present while holding the throttle blade at the calculated idle position.

Reduced Engine Power Mode

When the PCM detects a problem with the TAC system the PCM enters one of the following Reduced Engine Power Modes:

- Acceleration Limiting-The control module will continue to use the accelerator pedal for throttle control, however the vehicle acceleration is limited.
- Limited Throttle Mode-The control module will continue to use the accelerator pedal for throttle control, however the maximum throttle opening is limited.
- Throttle Default Mode-The control module will turn off the throttle actuator.
- Forced Idle Mode-The control module will perform the following actions:
  - Limit engine speed to idle by positioning throttle position, or by controlling fuel and spark if throttle is turned off.
  - Ignore accelerator pedal input.
- Engine Shutdown Mode-The control module will disable fuel and de-energize the throttle actuator.

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Camshaft Position (CMP) Actuator System

The Camshaft Position Actuator system is used for a variety of engine performance enhancements. These enhancements include lower emission output through exhaust gas recirculation control, a wider engine torque range, improved gas millage, and improved engine idle stability. The CMP Actuator system accomplishes this by controlling the amount of intake and exhaust valve overlap.

CMP Actuator System Operation

The CMP Actuator system is controlled by the Powertrain Control Module (PCM). The PCM sends a pulse width modulated 12 volt signal to a Camshaft Position (CMP) Actuator Solenoid in order to control the amount of engine oil flow to a cam Phaser passage. There are two different passages for oil to flow through, a passage for cam advance and a passage for cam retard. The Cam Phaser is attached to a camshaft and is hydraulically operated in order to change the angle of the camshaft relative to crankshaft position. Engine oil pressure, viscosity, temperature and engine oil level can have an adverse affect on cam phaser performance. The PCM calculates the optimum cam position through the following inputs:

- Engine Speed
- Manifold Absolute Pressure (MAP)

- Throttle Position (TP) Indicated Angle
- Crankshaft Position (CKP)
- Camshaft Position (CMP)
- Engine Load.
- Barometric (BARO) Pressure

The Cam Phaser default position is 0 degrees. The PCM uses the following inputs before assuming control of the cam phaser:

- Engine Coolant Temperature (ECT)
- Closed Loop Fuel Control
- Engine Oil Temperature
- Engine Oil Pressure
- Engine Oil Level
- CMP Actuator Solenoid circuit state
- Ignition 1 signal voltage
- Barometric (BARO) Pressure

CMP Actuator Solenoid Circuit Diagnostics

The PCM monitors the control circuits of the CMP Actuator Solenoid for electrical faults. The PCM has the ability to determine if a control circuit is open, shorted high, and shorted low. If the PCM detects a fault with a CMP Actuator Solenoid circuit a Diagnostic Trouble Code (DTC) will set.

CMP Actuator System Performance Diagnostics

The PCM monitors the performance of the CMP Actuator system by monitoring the actual and desired positions of a cam phaser. If the difference between the actual and desired position is more than a calibrated angle for more than a calibrated amount of time, a DTC will set.

FUEL SYSTEM DESCRIPTION

Fuel System Overview

The fuel tank stores the fuel supply. The electric fuel pump supplies fuel through an in-line fuel filter to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pressure regulator maintains the correct fuel pressure to the fuel injection system. A separate pipe returns unused fuel to the fuel tank.

Fuel Tank

The fuel tank stores the fuel supply. The fuel tank is located on the left side of the vehicle. The fuel tank is held in place by 2 metal straps that attach to the frame. The fuel tank is molded from high-density polyethylene.

Fuel Fill Pipe

The fuel fill pipe has a built-in restrictor in order to prevent refueling with leaded fuel.

Fuel Filler Cap

NOTE: If a fuel tank filler cap requires replacement, use only a fuel tank

filler cap with the same features. Failure to use the correct fuel tank filler cap can result in a serious malfunction of the fuel and EVAP system.

The fuel fill pipe has a tethered fuel filler cap. A torque-limiting device prevents the cap from being over-tightened. To install the cap, turn the cap clockwise until you hear audible clicks. This indicates that the cap is correctly torqued and fully seated. A fuel filler cap that is not fully seated may cause a malfunction in the emission system.

Fuel Sender Assembly

Fig. 212: Identifying Fuel Tank Module
Courtesy of GENERAL MOTORS CORP.

The fuel sender assembly consists of the following major components:

- The fuel pump (1)
- The float (2)
- The fuel level sensor (3)

Fuel Level Sensor

Fig. 213: Identifying Fuel Level Sensor
Courtesy of GENERAL MOTORS CORP.

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The control module sends the fuel level information via the Class 2 circuit to the instrument panel cluster (IPC). This information is used for the IPC fuel gage and the low fuel warning indicator, if applicable. The control module also monitors the fuel level input for various diagnostics.

Fuel Pump

The fuel pump is mounted in the fuel sender assembly reservoir. The fuel pump is an electric high-pressure pump. Fuel is pumped to the fuel injection system at a specified flow and pressure. Excess fuel from the fuel injection system returns to the fuel tank through the fuel return pipe. The fuel pump delivers a constant flow of fuel to the engine even during low fuel conditions and aggressive vehicle maneuvers. The control module controls the electric fuel pump operation through a fuel pump relay. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

Fuel Filter

Fig. 214: Cross Sectional View Of Fuel Filter
Courtesy of GENERAL MOTORS CORP.

The fuel filter is located on the fuel feed pipe, between the fuel pump and the fuel injectors. The paper filter element (2) traps particles in the fuel that may damage the fuel injection system. The filter housing (1) is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel injection system. The fuel return pipe carries fuel from the fuel injection system back to the fuel tank. The fuel pipes consist of 2 sections:

- The rear fuel pipe assemblies are located from the top of the fuel tank to the chassis fuel pipes. The rear fuel pipes are constructed of nylon.
- The chassis fuel pipes are located under the vehicle and connect the rear fuel pipes to the fuel injection system. The chassis fuel pipes are constructed of nylon and steel.

Nylon Fuel Pipes

CAUTION: In order to reduce the risk of fire and personal injury observe the following items:

- **Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes**
- **Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.**
- **Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115Â°C (239Â°F) for more than one hour, or more than 90Â°C (194Â°F) for any extended period.**
- **Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)**

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature. There are 3 sizes of nylon pipes used:

- 9.53 mm (3/8 in) ID for the fuel feed
- 7.94 mm (5/16 in) ID for the fuel return
- 12.7 mm (1/2 in) ID for the vent

Heat resistant rubber hose or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, high temperature, or vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

Fuel Pipe O-Rings

O-rings seal the threaded connections in the fuel system. The fuel system O-ring seals are made of special material. Service the O-ring seals with the correct service part.

Fuel Rail Assembly

Fig. 215: Identifying Fuel Rail Assembly
Courtesy of GENERAL MOTORS CORP.

The fuel rail assembly attaches to the cylinder head. The fuel rail assembly performs the following functions:

- Positions the fuel injectors in the cylinder head
- Distributes fuel evenly to the injectors
- Integrates the fuel pressure regulator into the fuel metering system

Fuel Injectors

Fig. 216: Cross Sectional View Of Fuel Injector
Courtesy of GENERAL MOTORS CORP.

The Multec 2 fuel injector assembly is a solenoid device controlled by the control module that meters pressurized fuel to a single engine cylinder. The control module energizes the high-impedance, 12 ohms, injector solenoid (2) to open a normally closed ball valve (3). This allows fuel to flow into the top of the injector, past the ball valve, and through a director plate at the injector outlet. The director plate has four machined holes that control the fuel flow, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. This fine atomization improves fuel economy and emissions.

Fuel Pressure Regulator Assembly

Fig. 217: Cross Sectional View Of Fuel Pressure Regulator Assembly
Courtesy of GENERAL MOTORS CORP.

The fuel pressure regulator is a diaphragm relief valve. The diaphragm has fuel pressure on one side and regulator spring pressure on the other side. The fuel pressure regulator maintains a constant pressure differential across the fuel injectors under all operating conditions.

Fuel Metering Modes of Operation

The control module monitors voltages from several sensors in order to determine how much fuel to give the engine. The control module controls the amount of fuel delivered to the engine by changing the fuel injector pulse width. The fuel is delivered under one of several modes.

Starting Mode

When the ignition is first turned ON, the control module energizes the fuel pump relay for 2 seconds. This allows the fuel pump to build pressure in the fuel system. The control module calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), mass air flow (MAF), manifold absolute pressure (MAP), and throttle position (TP) sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

Clear Flood Mode

If the engine floods, clear the engine by pressing the accelerator pedal down to the floor and then crank the engine. When the TP sensor is at wide open throttle (WOT), the control module reduces the fuel injector pulse width in order to increase the air to fuel ratio. The control module holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the control module returns to the starting mode.

Run Mode

The run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The control module ignores the signal from the heated oxygen sensor (HO2S). The control module calculates the air/fuel ratio based on inputs from the ECT, MAF, MAP, and TP sensors. The system stays in Open Loop until meeting the following conditions:

- The HO2S has varying voltage output, showing that the HO2S is hot enough to operate properly.
- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Specific values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the control module calculates the air/fuel ratio, injector ON time, based upon the signal from various sensors, but mainly from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver pushes on the accelerator pedal, air flow into the cylinders increases rapidly. To prevent possible hesitation, the control module increases the pulse width to the injectors to provide extra fuel during acceleration. This is also known as power enrichment. The control module determines the amount of fuel required based upon the TP, the ECT, the MAP, the MAF, and the engine speed.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The control module monitors the corresponding changes in the TP, the MAP, and the MAF. The control module shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as long, closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converters.

Battery Voltage Correction Mode

When the battery voltage is low, the control module compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The control module cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above red line.
- The vehicle speed is too high, above rated tire speed.
- During an extended, high speed, closed throttle coast down-This reduces emissions and increases engine braking.
- During extended deceleration, in order to prevent damage to the catalytic converters.

Fuel Trim

The control module controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The control module monitors the HO2S signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the injectors based on this signal. The ideal fuel trim values are around 0 percent for both short and long term fuel trim. A positive fuel trim value indicates the control module is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the control module is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fueling. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. A scan tool can be used to monitor the short and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The control module selects the cells based on the engine speed and engine load. If the control module detects an excessively lean or rich condition, the control module will set a fuel trim diagnostic trouble code (DTC).

EVAPORATIVE EMISSION (EVAP) CONTROL SYSTEM DESCRIPTION

EVAP System Operation

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the vapor pipe, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent line and EVAP canister vent solenoid valve to atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the control module will command the EVAP canister purge solenoid valve ON, open, allowing engine vacuum to be applied to the EVAP canister. With the EVAP canister vent solenoid valve OFF, open, fresh air will be drawn through the solenoid valve and vent line to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge pipe and EVAP canister purge solenoid valve into the intake manifold to be consumed during normal combustion. The control module uses several tests to determine if the EVAP system is leaking.

Large Leak Test

This tests for large leaks and blockages in the evaporative emission (EVAP) system. The control module will command the EVAP canister vent solenoid valve ON, closed, and command the EVAP canister purge solenoid valve ON, open, with the engine running, allowing engine vacuum into the EVAP system. The control module monitors the fuel tank pressure (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. The control module then commands the EVAP purge solenoid valve OFF, closed, sealing the system and monitors the vacuum level for decay. If the control module does

not detect that the predetermined vacuum level was achieved, or the vacuum decay rate is more than a calibrated level on 2 consecutive tests, a DTC P0455 will set.

Small Leak Test

If the large leak test passes, the control module will test for small leaks by continuing to monitor the fuel tank pressure (FTP) sensor for a change in voltage over a period of time. If the decay rate is more than a calibrated value, the control module will rerun the test. If the test fails again, a DTC P0442 will set.

Canister Vent Restriction Test

If the evaporative emission (EVAP) vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The control module tests this by commanding the EVAP canister purge solenoid valve ON, open; and commanding the EVAP canister vent solenoid valve OFF, open; and monitoring the fuel tank pressure (FTP) sensor for an increase in vacuum. If vacuum increases more than a calibrated value, DTC P0446 will set.

EVAP Purge Solenoid Valve Leak Test

If the evaporative emission (EVAP) canister purge solenoid valve does not seal properly, fuel vapors could enter the engine at an undesired time, causing driveability concerns. The control module tests for this by commanding the EVAP canister purge solenoid valve OFF, closed; and EVAP canister vent solenoid valve ON, closed; sealing the system, and monitoring the fuel tank pressure (FTP) for an increase in vacuum. If the control module detects that EVAP system vacuum increases above a calibrated value, DTC P0496 will set.

Check Gas Cap Message

The powertrain control module (PCM) sends a class 2 message to the driver information center (DIC) illuminating the Check Gas Cap message when any of the following occur:

- A malfunction in the evaporative emission (EVAP) system and a large leak test fails
- A malfunction in the EVAP system and a small leak test fails

EVAP System Components

The evaporative emission (EVAP) system consists of the following components:

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the control module determines that the vapor can be consumed in the normal combustion process.

EVAP Canister Purge Solenoid Valve

The EVAP canister purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. This normally closed solenoid is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine. The solenoid will also be opened during some portions of the EVAP testing, allowing engine vacuum to enter the EVAP system.

EVAP Canister Vent Solenoid Valve

The EVAP canister vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The control module will command the solenoid closed during some EVAP tests, allowing the system to be tested for leaks.

Fuel Tank Pressure Sensor

The fuel tank pressure (FTP) sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5-volt reference and a ground to the FTP sensor. The FTP sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 volts. As FTP increases, FTP sensor voltage decreases, high pressure equal low voltage. As FTP decreases, FTP voltage increases, low pressure or vacuum equal high voltage.

EVAP Service Port

The EVAP service port is located in the EVAP purge pipe between the EVAP canister purge solenoid valve and the EVAP canister. The service port is identified by a green-colored cap.

ELECTRONIC IGNITION (EI) SYSTEM DESCRIPTION

The electronic ignition (EI) system is responsible for producing and controlling a high energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system consists of a separate ignition coil connected directly to each spark plug, known as coil on plug. These coil assemblies are located in the center of the camshaft cover. The driver modules within each coil assembly are commanded ON/OFF by the powertrain control module (PCM). The PCM primarily uses engine speed and position information from the crankshaft and camshaft position sensors to control the sequence, dwell, and timing of the spark. The EI system consists of the following components:

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor is a permanent magnet generator, known as a variable reluctance sensor. The magnetic field of the sensor is altered by a crankshaft mounted reluctor wheel that has seven machined slots, six of which are equally spaced 60 degrees apart. The seventh slot is spaced 10 degrees after one of the 60 degree slots. The CKP sensor produces seven pulses for each revolution of the crankshaft. The pulse from the 10 degree slot is known as the sync pulse. The sync pulse is used to synchronize the coil firing sequence with the crankshaft position. The CKP sensor is connected to the PCM by a signal circuit and a low reference circuit.

Camshaft Position (CMP) Sensor

The camshaft position (CMP) sensor is triggered by a notched reluctor wheel built into the exhaust camshaft sprocket. The CMP sensor provides six signal pulses every camshaft revolution. Each notch, or feature of the reluctor wheel is of a different size for individual cylinder identification. This means the CMP and CKP signals are pulse width encoded to enable the PCM to constantly monitor their relationship. This relationship is used to determine camshaft actuator position and control its phasing at the correct value. The PCM also uses this signal to identify the compression stroke of each cylinder, and for sequential fuel injection. The CMP sensor is connected to the PCM by a 12-volt, low reference, and signal circuit.

Ignition Coils

Each ignition coil has an ignition 1 feed and a ground. The PCM supplies an ignition control (IC) circuit. Each ignition coil contains a solid state driver module as its primary element. The

PCM signals the coil driver to initiate a firing event by applying the IC circuit voltage for the appropriate time or dwell. When the voltage is removed, the coil fires the spark plug. The coils are current-limited to prevent overloading if the IC current is held high too long. The spark plugs are tipped with platinum for long wear and higher efficiency.

Powertrain Control Module (PCM)

The PCM controls all ignition system functions, and constantly corrects the spark timing. The PCM monitors information from various sensor inputs that include the following:

- The throttle position (TP) sensor
- The engine coolant temperature (ECT) sensor
- The mass air flow (MAF) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors (KS)

Modes of Operation

During normal operation the PCM controls all ignition functions. If either the CKP or CMP sensor signal is lost, the engine will continue to run because the PCM will default to a limp home mode using the remaining sensor input. As mentioned above, each coil is internally protected against damage from excessive voltage. If one or more coils were to fail in this manner, a misfiring condition would result. Diagnostic trouble codes are available to accurately diagnose the ignition system with a scan tool.

KNOCK SENSOR (KS) SYSTEM DESCRIPTION

Purpose

The knock sensor (KS) system enables the control module to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The control module uses the KS system to test for abnormal engine noise that may indicate detonation, also known as spark knock.

Sensor Description

This KS system uses one or two flat response two-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the KS detects. The control module receives the KS signal through a signal circuit. The KS ground is supplied by the control module through a low reference circuit.

The control module learns a minimum noise level, or background noise, at idle from the KS and uses calibrated values for the rest of the RPM range. The control module uses the minimum noise level to calculate a noise channel. A normal KS signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal KS signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses KS signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal KS signal will stay outside of the noise channel or will not be present. KS diagnostics are calibrated to detect faults with the KS circuitry inside the control module, the KS wiring, or the KS voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

SECONDARY AIR INJECTION SYSTEM DESCRIPTION

Secondary Air Injection (AIR) System Description

The Secondary Air Injection (AIR) System reduces exhaust emissions following initial engine start up. This occurs when the engine Start-up coolant temperature is between 3-50Â°C (37-122Â°F) and the intake air temperature (IAT) is more than 1Â°C (32Â°F). The AIR pump will operate until Closed Loop operation is achieved.

The powertrain control module (PCM) activates the AIR system by suppling a ground to the AIR pump relay and AIR solenoid relay simultaneously. This action closes the internal contacts of the AIR pump relay, energizing the AIR pump and also closes the internal contacts of the AIR solenoid relay, energizing the AIR solenoid, opening the shut-off valve. The AIR pump forces pressurized fresh air into the pipes/hoses and past the check valve into the exhaust manifold, accelerating catalyst operation. When the AIR system is inactive, the AIR shut-off valve prevents airflow in either direction.

The AIR system includes the following components:

- The AIR pump

  The AIR pump supplies pressurized, filtered air to the exhaust stream. The AIR pump is a turbine type pump which is permanently lubricated ad requires no periodic maintenance. The AIR pump for the 4.2 liter engine will draw a steady 35-40 amps under normal operation. The AIR pump has an internal circuit breaker to protect the pump from overheating. The circuit breaker is an integral part of the AIR pump.

- The AIR shut-off valve

  The AIR shut-off valve has an electronic solenoid mounted on the valve. The resistance of the solenoid is 4-7 ohms and the current draw is 2-3.5 amps. The solenoid opens the shut-off valve when battery voltage is applied to the valve. Once opened, pressurized air from the AIR pump flows past the check valve and is directed into the bank 1 exhaust manifold through an outlet pipe. The shut-off valve prevents fresh air from being drawn into the exhaust manifold by providing a positive seal when the AIR system is inactive. The solenoid, valve, and outlet pipe are serviced as an assembly.

  IMPORTANT: An audible exhaust noise may be heard at the inlet of the shut-off valve, when the shut-off valve is opened and the AIR pump outlet hose is removed from the shut-off valve.

- The AIR pump relay

  The AIR pump relay supplies high current and battery voltage to the AIR pump. The resistance of the AIR pump relay coil is 55- 68 ohms.

- The AIR solenoid relay

The AIR solenoid relay supplies high current and battery voltage to the AIR solenoid that is an integral part of the shut-off valve. The PCM commands the AIR solenoid relay ON by suppling a ground on the control circuit of the relay. The resistance of the AIR pump relay coil is 80-90 ohms.

- The pipes and hoses

  The pipes/hoses carry the air from the AIR pump past the AIR shut-off valve, and into the exhaust manifold. A pipe connects the shut-off valve to the exhaust manifold. The AIR System also utilizes a hose to carry the filtered air to the inlet of the AIR pump.

- The inlet filter

  The filter utilizes the air filter for the engine. This system draws filtered air directly from the air cleaner assembly.

Results of Incorrect Operation

The PCM can detect an AIR System airflow fault by monitoring the heated oxygen sensor (HO2S) bank 1 sensor 1 during normal engine operation. This is an active test. The PCM will command the AIR system ON during Closed Loop operation to perform this test. The active test will pass or fail based on the response from the HO2S 1. The active test consists of three tests run at 3-second intervals. A decreasing HO2S voltage parameter response indicates that the secondary AIR system is functioning properly. If the PCM does not detect a decreasing response from the HO2S 1, DTC P0410 will set.

AIR INTAKE SYSTEM DESCRIPTION

The air induction system provides contaminant filtration and is equipped with two resonators to filter unwanted induction noise. As the throttle plate is opened, air is drawn into the air filter housing. The air is pulled through the air filter element which provides maximum air filtration without restricting air flow. From the filter element, the air is drawn into the air cleaner outlet duct and past the first air resonator. This resonator is actually the upper half of the air filter housing. Air flows through the duct, past the intake air temperature (IAT), and into the second air resonator that is mounted directly on top of the engine. Air exiting the second resonator flows directly to the throttle body and into the engine.

Fig. 218: Air Cleaner Restriction Indicator
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Reset Button
2	Window

Air Cleaner Restriction Indicator

The air cleaner restriction indicator is located on the intake duct between the air cleaner assembly and the throttle body.

If the area inside of the clear section is green, no air filter service is required. If the area inside the clear section is orange and Change Air Filter appears, replace the air filter.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Special Tools

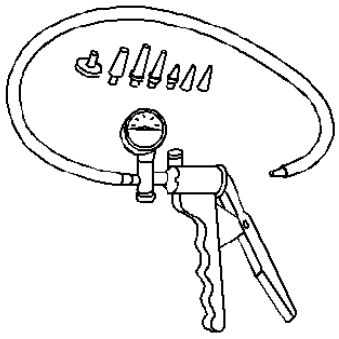
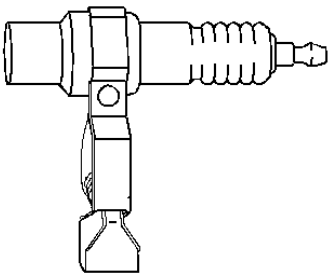
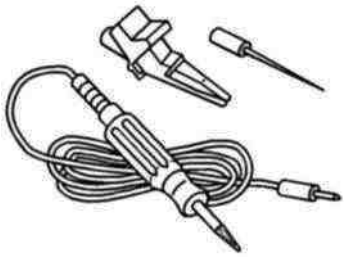
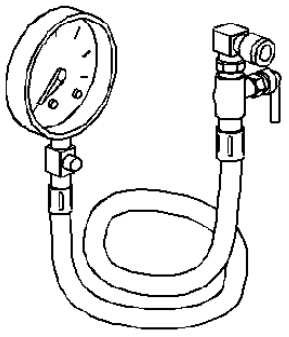
Illustration	Tool Number/Description
	J 23738-A Vacuum Pump
	J 26792 Spark Plug Tester
	J 34142 B Unpowered Test Lamp
	J 34730-1A Fuel Pressure Gage

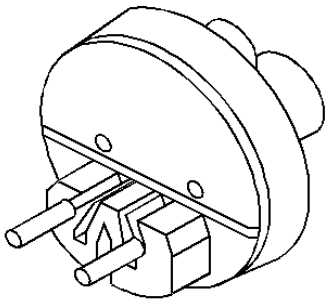
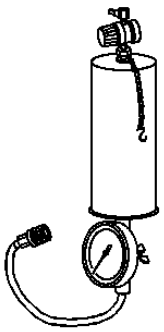
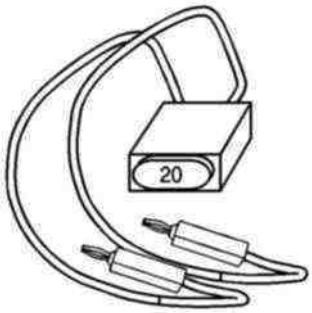
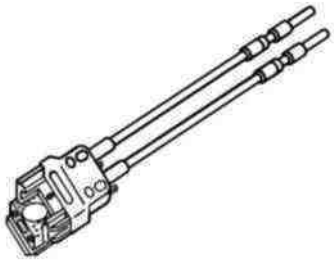
Illustration	Tool Number/Description
	J 34730-405 Injector Test Lamp
	J 35616-A Connector Test Adapter Kit
	J 35800-A Fuel Injector Cleaner
	J 36169-A Fused Jumper Wire
	J 36169-HD Heavy Duty Fused Jumper

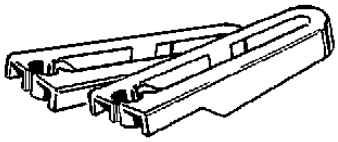
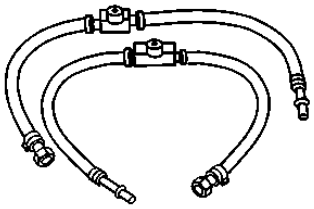
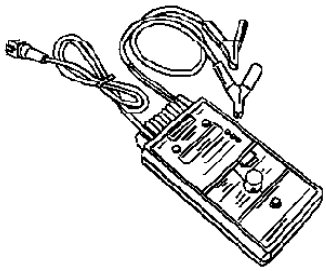
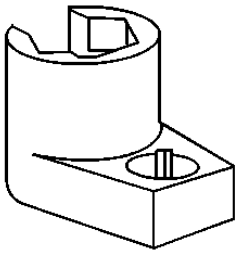
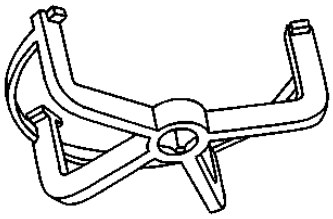
Illustration	Tool Number/Description
	J 37088-A Tool Set, Fuel Line Quick-Connect Separator
	J 37287 Fuel Pipe Shut-Off Adapters
	J 39021 Injector Tester
	J 39194-B Heated Oxygen Sensor Wrench
	J 39765 Fuel Sender Locknut Wrench

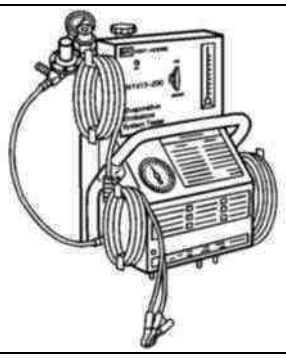
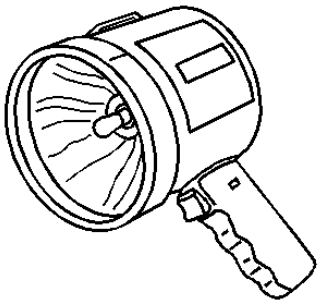
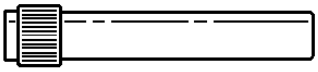
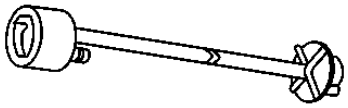
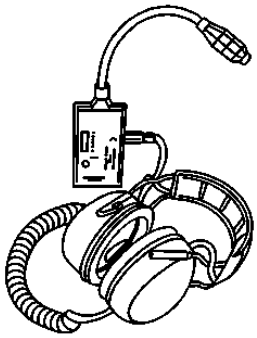
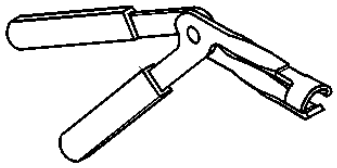
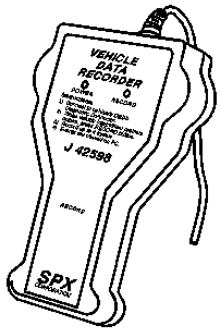
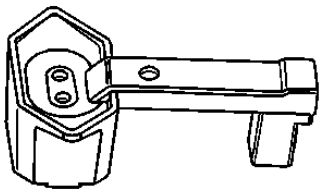
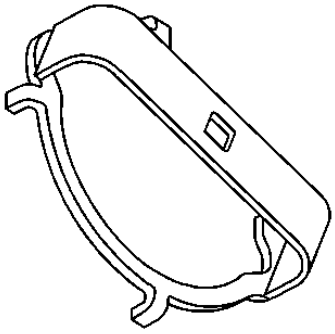
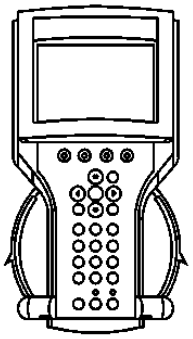
Illustration	Tool Number/Description
	J 41413-200 Evaporative Emissions System Tester (EEST)
	J 41413-SPT High Intensity White Light
	J 41413-VLV EVAP Service Port Vent Fitting
	J 41415-40 Fuel Tank Cap Adapter
	J 41416 Ultrasonic Leak Detector

Illustration	Tool Number/Description
	J 43094 Spark Plug Boot Puller
	J 42598 Vehicle Data Recorder
	J 44175 Fuel Composition Tester
	J 44402 Fuel Tank Sending Unit Wrench
	P/N 7000081 Tech 2 Diagnostic Scan Tool

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