EA11-003

FORD

1-20-2012

Appendix B

Peer Vehicles: 2009-2012 Ford F-250/F-350/F-450/F-550 Vehicles with Common Rail Diesel Engine

Subject Condition: High Pressure Fuel Pump Failure; Metallic Debris/Contamination in the Fuel System; General Allegations of Fuel Pump Failure (i.e., The Specific Fuel Pump is not Identified); or All Other Allegations of Fuel System Failures or Malfunctions Resulting in Engine Stall

OWNER REPORTS

As the agency is aware, within FCSD's North American Customer Service Operations, there is a Customer Relationship Center (CRC) that is responsible for facilitating communication between customers, dealerships and Ford Motor Company. Among other things, the CRC handles telephonic, electronic, and written inquiries, suggestions, informational requests, and concerns ("contacts") from Ford and Lincoln-Mercury vehicle owners about their vehicles or sales and service experience. The contacts are handled by CRC customer service representatives who enter a summary of the customer contact into a database known as CuDL (Customer Data Link). Certain contacts, such as letters from customers, are entered into the CuDL database. Those that were entered into the earlier MORS II system were also microfilmed. More recently, the records in MORS III/CuDL are imaged and stored electronically.

The CRC assigns to each vehicle-related contact report a "symptom code" or category that generally characterizes the nature of the customer contact or vehicle concern, as described by the owner. The CRC does not undertake to confirm the accuracy of the description provided by the owner; they simply record what is reported. Therefore, given the complexity of the modern motor vehicle, it is Ford's experience that a significant percentage of owner contacts do not contain sufficient information to make a technical assessment of the condition of the vehicle or the cause of the event reported. Accordingly, although MORS contact reports may be useful in identifying potential problems and trends, the records are not the empirical equivalent of confirmed incidents and/or dealership's diagnosis. In the interest of responding promptly to this inquiry, Ford has not undertaken to gather the electronic images related to these contacts because of the largely duplicative nature of the information contained in the images, as well as the time and the burden associated with locating and producing those documents. The pertinent information related to those contacts generally would be included in the contact reports obtained from the CuDL system. To the extent that those documents exist, they are characterized in the comments of MORS III contact reports. Upon request, Ford will attempt to locate any specific items that are of interest to the agency.

In responding to this information request, Ford electronically searched CuDL using the following criteria:

Peer Vehicles: 2009-2012 model year Ford F-250/F-350/F-450/F-550 vehicles with 6.4L or 6.7L common rail diesel engines manufactured for sale or lease in the United States, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa and the Virgin Islands.

Date Parameters: January 1, 2008 through October 7, 2011 (the date of this inquiry)

Types of Contacts: All, including suspended data, canceled contacts and inquiries

MORS III Symptom Codes:

Symptom Category	Symptom Code	Symptom Description
Engine	4012xx	Oil System Contamination
Engine	4015xx	Oil System Level Indicator
Engine	4041xx	Fuel System Leaks
Engine	4042xx	Fuel System Odor
Engine	4043xx	Fuel System Noise
Driveability	602xxx	Hard Start
Driveability	603xxx	Cranks/No Start
Driveability	606xxx	No Start
Driveability	607xxx	Stalls/Quits
Driveability	608xxx	Runs Rough
Driveability	609xxx	Misses
Driveability	610xxx	Buck/Jerk
Driveability	611xxx	Hesitation/Stumble
Driveability	612xxx	Surge
Driveability	613xxx	Backfires
Driveability	614xxx	Lack/Loss of Power
Driveability	618xxx	Rolling Idle
Driveability	621xxx	Diesels/Engine Run-On
Driveability	622xxx	Poor Fuel Economy
Driveability	6982xx	Indicator Check Engine

MORS III Reason Codes:

Reason Code	Description
07xx	All legal reason codes

LEGAL CONTACTS

Beginning in early 2008, most consumer complaints and all legal claim processing has been centralized in OGC within the Consumer Litigation team. A transition has occurred such that all legal contacts (including those formerly handled by "Litigation Prevention") are coordinated through this team.

Prior to the transition, there was a Consumer Affairs Department within FCSD that managed customer concerns, which could not be resolved by the Customer Relationship Center (CRC). Among other things, the Consumer Affairs Department had a section, known as "Litigation Prevention," that handled a variety of informal (i.e., non-litigation) claims, such as property damage claims or attorney demand claims.

The Litigation Prevention section had been centralized in the Consumer Affairs Department since 1995, in Dearborn, Michigan. Prior to that time, Litigation Prevention personnel operated on a regional basis. For matters that the Litigation Prevention section handled, there were typically paper files that reflected the handling, investigation and resolution of property damage claims.

The claims, known as "Legal Contacts" are entered into the CuDL database that the CRC uses to enter other customer communications. When a customer contact is designated as a Legal Contact, it is so indicated near the top of the contact report.

FIELD REPORTS

Within FCSD, there is a Vehicle Service & Programs Office that has overall responsibility for vehicle service and technical support activities, including the administration of field actions. That Office is the primary source within Ford of vehicle concern information originating from Ford and Lincoln-Mercury dealerships, field personnel, and other sources. The information is maintained in a database known as the Common Quality Indicator System (CQIS). The CQIS database includes reports compiled from more than 40 Company sources (e.g., Company-owned vehicle surveys, service technicians, field service and quality engineers, and technical hot line reports, etc.) providing what is intended to be a comprehensive concern identification resource. As with MORS contact reports, CQIS reports are assigned a "symptom code" or category that generally reflects the nature of the concern.

In responding to this information request, Ford electronically searched CQIS using the following criteria:

Peer Vehicles: 2009-2012 model year Ford F-250/F-350/F-450/F-550 vehicles with 6.4L or 6.7L common rail diesel engines manufactured for sale or lease in the United States, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa and the Virgin Islands.

Date Parameters: January 1, 2008 through October 7, 2011 (the date of this inquiry)

CQIS Symptom Codes:

Symptom Category	Symptom Code	Symptom Description
Driver Aides & Information	227Bxx	Warning Indicators/Messages/Chimes, Diesel Fluid
Driver Aides & Information	227Qxx	Warning Indicators/Messages/Chimes, Service Engine Soon (Engine Image)
Driver Aides & Information	227Wxx	Warning Indicators/Messages/Chimes, Water In Fuel
Start/Run/Move	4403xx	Starting, Cranks Won't Start
Start/Run/Move	4412xx	Running, Overheats
Start/Run/Move	4413xx	Running, Smoke From Exhaust
Start/Run/Move	4414xx	Running, Engine Won't Shut Off
Start/Run/Move	446188	Fluids, Engine Oil, Contamination
Start/Run/Move	446587	Fluids, Fuel, Visible Leak
Start/Run/Move	446588	Fluids, Fuel, Contamination
Start/Run/Move	446688	Fluids, Urea, Contamination
Start/Run/Move	4472xx	Odor, Fuel
Driving Performance	550xxx	Runs Rough
Driving Performance	551xxx	Idle Quality
Driving Performance	552xxx	Stalls/Quits
Driving Performance	553xxx	Backfires
Driving Performance	554xxx	Lack/Loss of Power
Driving Performance	556xxx	Poor Fuel Economy
Driving Performance	557xxx	Hesitates/Stumble

Driving Performance	558xxx	Engine Surge
Safe & Secure	8871xx	Burn/Melted, Underhood
Safe & Secure	8881xx	Visible Flame, Underhood
Safe & Secure	8891xx	Smoke/Odor, Underhood

Base Part Numbers:
9A543 Fuel Injection Pump Assy

OASIS MESSAGES

FCSD is responsible for communicating a variety of vehicle and service information, such as warranty information for up to the past 360 days, Extended Service Plan part coverage information, and technical repair information, to North American Ford and Lincoln-Mercury dealers. This information is communicated primarily through OASIS, which serves as an electronic link between Ford Motor Company and the dealers. OASIS covers all North American Ford and Lincoln-Mercury cars and light trucks, and medium and heavy-duty Ford trucks, for the ten most current model years. Technical diagnostic and repair information on OASIS is contained in Special Service Messages (SSMs) and Technical Service Bulletin (TSBs) titles and brief summaries. It should be noted that dealers cannot access brief summaries.

SSMs and TSB titles are coded in OASIS by model year and vehicle line, and may be coded to other specific vehicle attributes (body style, engine code, or vehicle identification number) and one or more OASIS Service Code(s). The dealers with access to OASIS usually search for information on the database by entering a VIN and the applicable Service Codes. SSMs and TSB titles that become inactive or superseded continue to be accessible by Ford employees, but no longer are accessible by the dealers. Dealers also are able to determine the recalls applicable to a particular vehicle by searching a particular VIN in OASIS. Recall information available on OASIS cannot be searched by Service Codes.

In 1998, the OASIS system was upgraded from the "OASIS 2" system to the new "Global OASIS." At that time, OASIS 2 was removed from service and is no longer used to communicate with dealers. During the upgrade, inactive information (such as inactive SSMs or superseded TSB titles) was not transferred to Global OASIS.

In responding to this information request, Ford searched Global OASIS for active, inactive, and superceded TSB titles and SSMs using the following search criteria:

Peer Vehicles: 2009-2012 model year Ford F-250/F-350/F-450/F-550 vehicles with 6.4L or 6.7L common rail diesel engines manufactured for sale or lease in the United States, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa and the Virgin Islands.

Date Parameters: January 1, 2008 through October 7, 2011 (the date of this inquiry)

OASIS Service Codes:

Symptom Category	Symptom Code	Symptom Description
Driver Aides & Information	227Bxx	Warning Indicators/Messages/Chimes, Diesel Fluid
Driver Aides & Information	227Qxx	Warning Indicators/Messages/Chimes, Service Engine Soon (Engine Image)

Driver Aides & Information	227Wxx	Warning Indicators/Messages/Chimes, Water In Fuel
Start/Run/Move	4403xx	Starting, Cranks Won't Start
Start/Run/Move	4412xx	Running, Overheats
Start/Run/Move	4413xx	Running, Smoke From Exhaust
Start/Run/Move	4414xx	Running, Engine Won't Shut Off
Start/Run/Move	446188	Fluids, Engine Oil, Contamination
Start/Run/Move	446587	Fluids, Fuel, Visible Leak
Start/Run/Move	446588	Fluids, Fuel, Contamination
Start/Run/Move	446688	Fluids, Urea, Contamination
Start/Run/Move	4472xx	Odor, Fuel
Driving Performance	550xxx	Runs Rough
Driving Performance	551xxx	Idle Quality
Driving Performance	552xxx	Stalls/Quits
Driving Performance	553xxx	Backfires
Driving Performance	554xxx	Lack/Loss of Power
Driving Performance	556xxx	Poor Fuel Economy
Driving Performance	557xxx	Hesitates/Stumble
Driving Performance	558xxx	Engine Surge
Safe & Secure	8871xx	Burn/Melted, Underhood
Safe & Secure	8881xx	Visible Flame, Underhood
Safe & Secure	8891xx	Smoke/Odor, Underhood

OASIS 2 and Global OASIS are not capable of performing electronic word searches, so the search results are reviewed manually to determine their applicability to the alleged defect in the subject vehicles.

The OASIS database also contains Broadcast Messages. Typically, these messages are directed to all dealerships and either are notifications of new SSMs/TSBs, or announcements with non-technical information (for example, "the Dealer Hotline will be closed today"). Broadcast Messages cannot be searched by OASIS service codes, and can be retrieved only while active (approximately 2 to 4 days). Ford has not undertaken to search for Broadcast Messages because Ford expects that any responsive information obtained with such a search generally would be non-substantive in nature or duplicative of the information obtained with the TSB title and SSM search described above.

INTERNAL SERVICE MESSAGES

FCSD, as part of its technical support activities, maintains fleet and technical telephone "hotlines." During the early stages of Ford's efforts to identify and resolve potential vehicle concerns, hotline personnel may draft Internal Service Messages (ISMs) on CQIS for their internal use. The ISMs are assigned a CQIS "symptom code" or category that generally reflects the nature of the concern. An ISM can form the basis for an oral response over the technical hotline to an inquiry from an individual dealer or fleet technician. The ISMs, however, are not made available electronically to fleets and dealers. Therefore, although ISMs are not "issued" to dealers like OASIS messages, Ford is construing this request broadly to include ISMs that may be related to the alleged defect in the subject vehicles.

In responding to this information request, Ford searched CQIS for active ISMs using the following search criteria:

Peer Vehicles: 2009-2012 model year Ford F-250/F-350/F-450/F-550 vehicles with 6.4L or 6.7L common rail diesel engines manufactured for sale or lease in the United States, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa and the Virgin Islands.

Date Parameters: January 1, 2008 through October 7, 2011 (the date of this inquiry)

CQIS Symptom Codes:

Symptom Category	Symptom Code	Symptom Description
Driver Aides & Information	227Bxx	Warning Indicators/Messages/Chimes, Diesel Fluid
Driver Aides & Information	227Qxx	Warning Indicators/Messages/Chimes, Service Engine Soon (Engine Image)
Driver Aides & Information	227Wxx	Warning Indicators/Messages/Chimes, Water In Fuel
Start/Run/Move	4403xx	Starting, Cranks Won't Start
Start/Run/Move	4412xx	Running, Overheats
Start/Run/Move	4413xx	Running, Smoke From Exhaust
Start/Run/Move	4414xx	Running, Engine Won't Shut Off
Start/Run/Move	446188	Fluids, Engine Oil, Contamination
Start/Run/Move	446587	Fluids, Fuel, Visible Leak
Start/Run/Move	446588	Fluids, Fuel, Contamination
Start/Run/Move	446688	Fluids, Urea, Contamination
Start/Run/Move	4472xx	Odor, Fuel
Driving Performance	550xxx	Runs Rough
Driving Performance	551xxx	Idle Quality
Driving Performance	552xxx	Stalls/Quits
Driving Performance	553xxx	Backfires
Driving Performance	554xxx	Lack/Loss of Power
Driving Performance	556xxx	Poor Fuel Economy
Driving Performance	557xxx	Hesitates/Stumble
Driving Performance	558xxx	Engine Surge
Safe & Secure	8871xx	Burn/Melted, Underhood
Safe & Secure	8881xx	Visible Flame, Underhood
Safe & Secure	8891xx	Smoke/Odor, Underhood

The CQIS database in which the ISMs reside is not capable of performing word searches, so the search results were reviewed manually to determine their applicability to the alleged defect in the subject vehicles.

FIELD REVIEW COMMITTEE

Ford's Field Review Committee reviews all potential field service actions, including safety recalls and customer satisfaction programs, and recommends appropriate actions to corporate management. A Vehicle Service & Programs representative serves as Secretary to the Field Review Committee. Following approval of a field service action, the Vehicle Service & Programs Office prepares and launches the action. A representative copy of the communication to Ford's dealers, fleets, and Regional offices announcing the field service action is maintained in the Field Review Committee files.

WARRANTY

Ford's Analytical Warranty System (AWS) contains warranty claims and vehicle information for model years 1991 and forward for North America, and model years 1992 and forward for Europe. Ford searched AWS for potentially responsive reports using the following search criteria:

Peer Vehicles: 2009-2012 model year Ford F-250/F-350/F-450/F-550 vehicles with 6.4L or 6.7L common rail diesel engines manufactured for sale or lease in the United States, District of Columbia, Puerto Rico, Northern Mariana Islands, Guam, American Samoa and the Virgin Islands.

Date Parameters: January 1, 2008 through October 7, 2011 (the date of this inquiry)

Base Part Numbers:

9A543	Fuel Injection Pump Assy
6007	Engine Assy
6006	Engine Assy/Bare (2009 & 2010 Model Year only)

Warranty Code Lists:

Customer Concern Codes:

Customer Concern Code	Customer Concern Code Description
A02	STEREO/RADIO RECEPTION
A04	STEREO/RADIO SOUND QUALITY
A06	SPEAKERS
A07	OTHER AUDIO TROUBLES
A16	CD PLAYER
A17	CASSETTE PLAYER
A18	FAMILY ENTERTAINMENT SYSTEM TROUBLES
A25	SPEED CONTROL ENGAGEMENT TROUBLES
A26	SPEED CONTROL DISENGAGEMENT TROUBLES
A27	SPEED CONTROL DOESN`T MAINTAIN A CONSISTENT SPEED
A34	HORN TROUBLES
A35	COMPASS/THERMOMETER TROUBLES
A37	SPEEDOMETER TROUBLES
A40	TIRE PRESSURE MONITORING TROUBLES
A59	TRIP COMP./NAVIGATION SYSTEMS TROUBLES
A60	SATELLITE DIGITAL AUDIO REC SYSTEM TROUBLES
A86	CELLULAR PHONE TROUBLES
A87	CIGARETTE LIGHTER/POWERPOINT TROUBLES
A88	WIRING TROUBLES
A96	CCC RE-MAP - MAINTENANCE
A97	CCC RE-MAP - DAMAGE
A98	CCC RE-MAP - OTHER
A99	ADMINISTRATIVE (PARTS RETURN/ETC.)
B01	BODY PANEL DENTS, DINGS
B02	BODY PANEL FITS POORLY
B05	BODY PANEL HARD TO OPEN
B06	BUMPER DENTS/DINGS

B07	BUMPER FITS POORLY
B09	BODY PANEL/HINGE SQUEAK/RATTLE
B15	BODY PANEL HARD TO CLOSE
B19	OTHER BODY PANEL TROUBLES (NOT INCLUDING TRIM)
B43	LOOSE, POOR FIT, WARPED, WRINKLED
B44	TEARS, SNAGS, CRACKS - DOOR PANEL
B45	FADED, DISCOLORED - DOOR PANEL
B47	BLISTERED/BUBBLED/PEELED - DOOR PANEL
B50	SPLIT SEAMS - DOOR PANEL
B53	LOOSE, POOR FIT, WARPED, WRINKLED IP/DASHBOARD
B54	LOOSE,POOR FIT,WARPED,WRINKLED-CENTER FLR CONSOLE
B62	MOLDINGS,EXTERIOR TRIM CORRODED
B63	MLDGS/EXT.TRIM LOOSE/MISSING
B64	MLDGS/EXT.TRIM POORLY ALIGNED OR FIT
B65	WHEEL/HUBCAP TROUBLES
B66	OTHER EXTERIOR TRIM TROUBLES
B69	OTHER BUMPER TROUBLES
B73	LOOSE, POOR FIT, WARPED, WRINKLED
B74	LOOSE, POOR FIT, WARPED, WRINKLED-CARPET/FLOOR MAT
B75	LOOSE,POOR FIT,WARPED,WRINKLED-TRNK&CARGO INTERIOR
B78	INTERIOR ODOR
B81	TEARS, SNAGS, CRACKS - IP/DASHBOARD
B82	FADED, DISCOLORED - IP/DASHBOARD
B84	BLISTERED/BUBBLED/PEELED - IP/DASHBOARD
B85	GLOVEBOX DOOR GAPS,FIT POOR,DIFFICULT TO OPN/CLOSE
B91	TEARS, SNAGS, CRACKS - CENTER FLOOR CONSOLE
B92	FADED, DISCOLORED - CENTER FLOOR CONSOLE
B94	BLISTERED/BUBBLED/PEEDED - CENTER FLOOR CONSOLE
B95	OTHER INSTRUMENT PANEL/CONSOLE TROUBLES
C01	A/C SLOW TO COOL
C02	A/C NOT COLD ENOUGH
C03	HEATER-SLOW TO HEAT
C04	HEATER-NOT HOT ENOUGH
C05	A/C DOES NOT WORK
C07	HEATER-DOES NOT WORK
C09	HEATER, DEFROSTER OR A/C NOISE
C12	W`SHIELD DEFROST/DEFOGGING DOES NOT WORK
C15	SIDE WINDOW DEFROST/DEFOGGING DOES NOT WORK
C19	REGISTER/VENT ADJUSTMENT TROUBLES
C20	OTHER TEMPERATURE CONTROL TROUBLES
C21	WINDSHIELD DEF SLOW TO CLEAR/UNEVEN CLEARING
C22	SIDE WINDOW DEF SLOW TO CLEAR/UNEVEN CLEARING
C23	BACK WINDOW DEF SLOW TO CLEAR/UNEVEN CLEARING
C24	A/C WATER LEAK/CONDENSATION TROUBLES
C25	DEAD BATTERY
C26	WEAK OR LOW ELECTRICAL POWER
C27	POWER SUPPLY TROUBLES
C30	A/C HEATER/DEFROSTER ODOR
C50	OTHER STEERING/HANDLING AND RIDE TROUBLES

D02	ENGINE WOULD NOT START
D03	ENGINE DIFFICULT OR SLOW TO START
D10	ENGINE IDLES TOO SLOW
D11	ENGINE IDLES TOO FAST
D13	ENGINE IDLES ROUGH
D21	ENGINE STALLS
D35	EXCESSIVE FUEL CONSUMPTION
D36	ENGINE HESITATES/SURGES WHEN ACCELERATING
D41	ENGINE HESITATES/SURGES AT STEADY SPEED
D42	POOR PERFORMANCE/LACKS POWER
D50	OTHER ENGINE TROUBLES
E19	ENGINE BELT SLIPPING/SQUEALING
E20	ENGINE BELT OFF/FRAYED/COMING APART/BROKEN
E23	ENGINE OVERHEATS/RADIATOR TROUBLES
E26	EXCESSIVE OIL CONSUMPTION
E29	'CHECK ENGINE' LIGHT TROUBLE
E40	ELECTRONIC MODULE TROUBLES
E41	UNUSUAL EXHAUST SYSTEM ODOR
E42	UNUSUAL EXHAUST SYSTEM NOISE
E43	EXHAUST SYSTEM RUST/CORROSION/APPEARANCE
E65	SLOW FUEL TANK FILL/SPITBACK
E68	FUEL TANK LEAK/ODOR
E69	LOW OIL PRESSURE
F04	THIN/NO PAINT (EXCLUDES TRIM/BUMPER)
F05	SAGS/RUNS IN PAINT (EXCLUDES TRIM/BUMPER)
F06	PEELED PAINT (EXCLUDES TRIM/BUMPER)
F07	BUBBLES/BLISTERS IN PAINT
F10	PAINT SPRAY OVER BODY FINISH
F11	BODY RUST/CORROSION (NOT PERFORATION,EXCL BUMPER)
F12	STAINED/SPOTTED PAINT (EXCLUDES TRIM/BUMPER)
F13	FADED/DULL PAINT (EXCLUDES TRIM/BUMPER)
F15	DETAIL PAINT OR TAPE STRIPE COMING OFF (EXCL BMPR)
F19	CHIPPED/SCRATCHED PAINT
F20	DIRT IN PAINT (EXCLUDES TRIM/BUMPER)
F25	RUST PERFORATION
F30	UNEVEN COLOR/COLOR DIFFERENT BETWEEN BODY PANELS
F33	BUMPER FADED/DULL PAINT
F34	BMPR-SAGS/RUNS
F35	BMPR-THIN/NO PAINT
F36	BMPR-STAINED/SPOTTED
F37	BMPR-DIRT IN PAINT
F38	BMPR-UNEVEN COLOR/COLOR DIFF.
F39	BUMPER RUST/CORROSION
F41	BUMPER PEELED PAINT
F99	INSUFFICIENT FLUID
G02	GLASS BROKEN/CHIPPED/CRACKED/DISTORTED
G05	WINDOW OPENING, CLOSING TROUBLES-MANUAL
G07	WINDOW OPENING, CLOSING TROUBLES-POWER
G09	WINDOW SQUEAK/RATTLE/SCRAPE
G30	ODOMETER TROUBLES
G31	ENGINE TEMP GAGE TROUBLES
G32	INST CLUST/MESSAGE CENTER TROUBLES
H02	BRAKES GRAB OR LOCK-UP

H04	PARKING BRAKE TROUBLES
H05	EXCESSIVE BRAKE PEDAL EFFORT REQUIRED
H06	VEHICLE PULLS LEFT WHILE BRAKING
H07	VEHICLE PULLS RIGHT WHILE BRAKING
H15	BRAKE PEDAL SPONGY
H16	BRAKES TOO SENSITIVE
H19	BRAKE-ABS WARNING LIGHT TROUBLES
H20	OTHER BRAKE TROUBLES (INCLUDING AIR BRAKES)
H21	STEERING HAS EXCESSIVE FREE PLAY/WANDER
H22	STEERING REQUIRES EXTRA OR UNEVEN EFFORT
H24	STRG WHL SPOKES NOT CORRECTLY POSITIONED WHEN FRNT
H25	CONSTANT PULL TO LEFT
H26	CONSTANT PULL TO RIGHT
H39	TRACTION CONTROL/ADVANCE TRAC WARNING LIGHT TROUBLES
H44	HARSH RIDE
H45	MUSHY RIDE
H50	STEERING GEAR/PUMP TROUBLES
H62	IMPROPER TIRE WEAR
J03	SUN/MOON/T-TOP/CONVERTIBLE ROOF FITS POORLY
J04	SUN/MOON/T-TOP/CONVERTIBLE DIFFICULT TO OPN/CLS
K01	TRANSFER CASE TROUBLES
K02	AXLE WHINE/HOWL/GROAN
K03	AXLE VIBRATION/SHAKE
L06	EXT. DOOR LOCK CONTROLS-MANUAL
L07	EXT. DOOR LOCK CONTROLS-POWER
L08	EXTERIOR DOOR HANDLE TROUBLES
L10	FUEL-FILLER DOOR TROUBLES
L13	IGNITION SWITCH TROUBLES
L14	ANTI-THEFT/ALARM SYSTEM TROUBLES
L15	OTHER LOCK/MECHANISM TROUBLES
L16	INT. DOOR LOCK CONTROLS - MANUAL
L17	INT. DOOR LOCK CONTROLS - POWER
L18	INTERIOR DOOR HANDLE TROUBLES
L19	DOOR AJAR WARNING LIGHT TROUBLES
L20	REMOTE/KEYLESS ENTRY TROUBLES
L22	HEADLAMP AIM/ALIGNMENT
L23	KEY TROUBLES
L25	LIGHTS NOT WORKING-INTERIOR
L26	LIGHTS NOT WORKING-EXTERIOR
L29	OTHER LIGHTING TROUBLES (INCL. LEAKS/CONDENSATION)
L30	TURN SIGNAL TROUBLES
L63	BRAKE FLUID LEAK
L65	ENGINE LEAKS OIL
L68	POWER STEERING FLUID LEAK
L69	FUEL GAUGE TROUBLES
L72	TRANSMISSION/CLUTCH FLUID LEAKS
L85	UNDETERMINED ENGINE LEAK
L87	COOLANT LEAK
L88	FRONT/REAR AXLE OR DRIVESHAFT LEAKS
M05	EXTERIOR MIRROR TROUBLES
M06	INTERIOR MIRROR TROUBLES
M10	OTHER MIRROR TROUBLES
N11	UNUSUAL ENGINE NOISE AT IDLE

N12	UNUSUAL ENGINE NOISE WHILE DRIVING
N17	BRAKES NOISY
N18	UNUSUAL TRANSMISSION NOISE
N22	VEHICLE VIBRATES WHEN DRIVING BELOW 45 MPH
N23	STEERING WHEEL VIBRATION/SHIMMY BELOW 45 MPH
N24	STEERING WHEEL VIBRATION/SHIMMY ABOVE 45 MPH
N25	VEHICLE VIBRATES WHEN DRIVING ABOVE 45 MPH
N27	VIBRATION OR SHUDDER WHILE BRAKING
N30	OVERHEAD CONSOLE SQUEAK/RATTLE
N31	CENTER FLOOR CONSOLE SQUEAK/RATTLE
N32	GLOVE BOX DOOR SQUEAK/RATTLE
N33	INSTRUMENT PANEL/DASHBOARD SQUEAK/RATTLE
N40	FRONT SIDE DOOR SQUEAK/RATTLE
N41	REAR SIDE DOOR SQUEAK/RATTLE
N42	TRUNK,H`BACK,T`GATE,REAR CARGO DOOR SQUEAK/RATTLE
N43	SUN/MOON,T-TOP,CONVERTIBLE ROOF SQUEAK/RATTLE
N50	SQUEAK/RATTLE VEHICLE EXTERIOR-FRONT
N51	SQUEAK/RATTLE VEHICLE EXTERIOR-REAR
N57	STEERING COLUMN/WHEEL SQUEAK/RATTLE
N58	STEERING NOISY
N59	OTHER SQUEAK/RATTLE (EXCLUDING WIND NOISE)
P01	DIFFICULT TO OPERATE SHIFT LEVER,CHANGE GEARS
P09	OTHER MANUAL TRANSMISSION TROUBLES
P22	CLUTCH CHATTERS/GRABS/SLIPS/JERKS
P23	CLUTCH REQUIRES TOO MUCH OR UNEVEN EFFORT
P24	OTHER CLUTCH TROUBLES
P31	MANUAL-4-WHEEL/ALL WHEEL DRIVE TROUBLES
P51	DIFFICULT TO OPERATE SHIFT LEVER
P59	OTHER AUTOMATIC TRANSMISSION TROUBLES
P66	SHIFTS ROUGH OR JERKY WHILE DRIVING
P67	SHIFTS OCCUR TOO EARLY, TOO LATE, TOO OFTEN
P68	TRANSMISSION SHIFTS ROUGH OR JERKY FROM PARK
P69	GEAR CHANGES TAKE TOO LONG TO COMPLETE
P82	AUTOMATIC - 4-WHEEL/ALL -WHEEL DRIVE TROUBLES
P83	NO FORWARD/REVERSE MOVEMENT IN GEAR
R01	WATER LEAK AROUND WINDSHIELD
R02	WATER LEAK AROUND FRONT SIDE DOOR/WINDOW
R03	WATER LEAK AROUND REAR SIDE DOOR/WINDOW
R04	WATER LEAK AROUND BACK WINDOW
R05	WATER LEAK AROUND SLIDING REAR WINDOW
R06	WATER LEAK AROUND TRUNK/HATCHBK/LIFTGT/RR CARGO DR
R08	WATER LEAK AROUND NON-SLIDING REAR WINDOW
R09	WATER LEAK AROUND SUN/MOON/CONVERTIBLE/T-TOP ROOF
R10	OTHER WATER LEAKS (SEALING ISSUES ONLY)
R21	WIND NOISE AROUND WINDSHIELD
R22	WIND NOISE AROUND FRONT SIDE DOOR/WINDOW
R23	WIND NOISE AROUND REAR SIDE DOOR/WINDOW
R24	WIND NOISE AROUND BACK WINDOW
R25	WIND NOISE AROUND SLIDING REAR WINDOW
R26	WIND NOISE AROUND TRUNK/HATCHBK/LIFTGT/RR CARGO DR
R29	WIND NOISE AROUND SUN/MOON/CONVERTIBLE/T-TOP ROOF
R30	OTHER WIND NOISE TROUBLES (TURBULENCE)
R31	OTHER GASKET/SEALING TROUBLES

S03	FRONT SEAT LOOSE
S04	REAR SEAT LOOSE
S06	SEAT ADJUSTMENT OPERATION - FRONT MANUAL CNTRL
S07	SEAT ADJUSTMENT OPERATION - REAR SEAT
S08	SEAT LOOSE THIRD ROW
S09	FRONT SEAT SQUEAK/RATTLE
S15	SEAT ADJUSTMENT OPERATION TROUBLE-FRONT POWER CNTL
S17	REAR SEAT SQUEAK/RATTLE
S21	SEAT BELT SOILED/DIRTY
S25	SEAT BELT COIL/UNCOIL TROUBLES
S26	SEAT BLT BUC LATCHING TROUBLES
S27	STEERING WHEEL TRIM APPEARANCE
S38	AIR BAG (SRS) TROUBLES
S39	AIR BAG WARNING LIGHT TROUBLES
S40	OTHER RESTRAINT TROUBLES
S50	LOOSE, POOR FIT, WARPED, WRINKLED-SEAT UPHOLSTERY
S52	TEARS, SNAGS, CRACKS - SEAT UPHOLSTERY
S53	FADED, DISCOLORED - SEAT UPHOLSTERY
S55	SPLIT SEAMS - SEAT UPHOLSTERY
S56	HEATED/COOLED SEAT TROUBLES
T02	TEARS, SNAGS, CRACKS - ROOF LINING MATERIAL
T03	FADED, DISCOLORED - ROOF LINING MATERIAL
T12	TEARS, SNAGS, CRACKS - CARPET/FLOOR COVERING
T13	FADED DISCOLORED - CARPET/FLOOR COVERING
T15	SPLITTING SEAMS - CARPET/FLOOR COVERING
T22	TEARS, SNAGS, CRACKS - TRUNK/CARGO INTERIOR
T50	CUPHOLDER TROUBLES
T51	SUN VISOR TROUBLES
T52	ASHTRAY TROUBLES
T53	INTERIOR MOLDINGS FIT POORLY
T54	MISSING - INTERIOR MOLDINGS
T55	INT FASTENERS - LOOSE, MISSING, POOR FIT, WARPED
TA1	ENTIRE OR PARTIAL TREAD SEPARATION FROM TIRE
TA3	BUBBLE/BULGE(S) IN SIDEWALL
TA4	SPLITS/CRACKS IN SIDEWALL/TREAD
TA5	TIRE TREAD CHUNKS MISSING
TB2	FLAT TIRE (SELF-SEALING TIRES ONLY)
TB3	VEHICLE VIBRATION (OUT OF ROUND WILL NOT BALANCE)
TB6	SLOW LEAKS / VALUE STEM TROUBLES
TB7	PREMATURE TREAD WEAR
TB8	PULLS/DRIFTS
TC8	OTHER TIRE COSMETIC
W03	FRONT WINDSHIELD WASHER TROUBLES
W04	REAR WINDOW WASHER TROUBLES
W05	FRONT WIPER TROUBLE
W06	REAR WINDOW WIPERS TROUBLES
W10	OTHER WIPER/WASHER TROUBLES (INCLUDING LEAKS)

Condition Codes:

53	Air in System	33	Loose Part
B5	Battery Acid / Fluid Damage	25	Missing Fastener
02	Bent / Buckled / Kinked	39*	Missing Part
01	Broken / Cracked	28	Open Circuit
46	Burned Out	D9	Out of Balance
91	Burrs, Sharp Edges	13	Out of Round
30	Chafed, Excessive Wear, Frayed	B4	Pinched / Damaged Wire
70	Chipped / Scratched	55	Plugged / Restricted
X2	Connection Poor / Not Made	P1	Polish Repair (Paint)
49	Contaminated / Foreign	X1	Poor Ground
D7	Corrosion (Perforation)	05	Poor Metal Finishing
X7	Crossed Wire (Wire Harness)	D1	Porosity
X4	Damaged Terminal	68	Sealer Missing / Skipped
06	Dents / Dings	31	Sewing failure / Split Seams
34	Distorted / Wrinkled / Wavy	79	Special Code: Use Only as Instructed
42	Does Not Operate Properly	P2	Spot Repair (Paint)
D8	Failed Gasket / Seal	P3	Spray Panel Repair (Paint)
D4	Flaw in Material	04	Software Revision / Flash Module
82	Freight / Postage / Maintenance	41	Sticks / Binds / Grabs
69	Frozen / Seized / Binding	A8	Stone Pecking
17	Hole Incomplete, Out of Position or Omitted	C2	Stripped / Cross-threaded Fastener
12	Improper Assembly	14	Surface Rough / Uneven
07	Improperly Adjusted / Fits Poorly	81	Tarnished / Faded
43	Improperly Routed	87	Teeth Damage
16	Incorrect Size	P4	Thick / Cracked (Paint)
C8	Industrial / Environmental Fallout	63	Weak / Soft / Sagged (Insufficient Pressure)
51	Insufficient Fluid (Pre-delivery only)	61	Weld Defective / Broken
95	Insulation Damage	W6	Wheel Alignment Out of Specification
V3	Kinked / Cut / Mis-routed Vacuum Line	38*	Wrong Part
24	Loose Fastener		

FCS-8572-04

*Program code MVC requires these codes

Revised and effective July 30, 2004

EA11-003

FORD

1-20-2012

Appendix E

Extended Warranty Coverage for Base Part # 9A543 (High Pressure Fuel Pump Assembly)

NEW Contract Coverage

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
BASECARE	3 Years	48000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X
	5 Years	36000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	6 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	7 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X

NEW Contract Counts

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
BASECARE	3 Years	48000	0	1	3	0	0
		100000	2	14	21	16	0
		125000	0	0	0	6	0
	4 Years	48000	0	5	1	0	0
		60000	0	2	1	4	0
		75000	0	1	1	2	1
		100000	3	23	47	82	3
		125000	0	0	0	10	2
		150000	0	0	0	0	1
	5 Years	36000	0	0	1	0	0
		60000	0	2	3	7	0
		75000	0	6	9	5	4
		100000	10	92	156	127	3
		125000	0	0	0	15	2
	6 Years	48000	0	1	0	0	0
		60000	0	1	1	1	1
		75000	2	40	48	58	1
		100000	1	69	45	67	1
		125000	0	0	0	7	0
	7 Years	48000	0	1	0	1	0
		60000	0	0	1	1	0
		75000	0	1	1	5	2
		100000	1	3	8	13	3
		125000	0	0	0	8	0
		150000	0	0	0	0	2

			2009 - 2012 F-Series 250/350/450/550 Diesel				
	Coverage		Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
EXTRACARE	3 Years	48000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	5 Years	36000	X	X	X	X	X
		48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		200000	X	X	X	X	X
	6 Years	36000	X	X	X	X	X
		48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	7 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X

			2009 - 2012 F-Series 250/350/450/550 Diesel				
	Coverage		Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
EXTRACARE	3 Years	48000	0	0	1	1	0
		75000	0	4	2	2	1
		100000	0	14	21	19	3
		125000	0	0	0	9	4
	4 Years	48000	0	0	2	1	0
		60000	0	1	1	0	1
		75000	0	2	4	2	2
		100000	1	24	37	36	0
		125000	0	0	0	23	1
	5 Years	36000	0	0	1	0	0
		48000	0	0	2	0	0
		60000	0	9	18	16	4
		75000	5	13	29	31	7
		100000	0	60	182	236	12
		125000	0	0	0	32	4
		200000	0	0	0	5	0
	6 Years	36000	0	0	0	1	0
		48000	0	0	0	0	1
		60000	0	4	9	9	0
		75000	0	38	84	89	4
		100000	2	65	168	133	8
		125000	0	0	0	33	4
	7 Years	48000	0	1	0	1	0
		60000	0	9	4	10	0
		75000	0	10	29	46	7
		100000	0	12	35	45	4
		125000	0	0	0	22	5
		150000	0	0	0	0	2

			2009 - 2012 F-Series 250/350/450/550 Diesel				
	Coverage		Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
PREMIUMCARE	3 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X
	5 Years	36000	X	X	X	X	X
		48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X
	6 Years	36000	X	X	X	X	X
		48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X
	7 Years	36000	X	X	X	X	X
		48000	X	X	X	X	X
		60000	X	X	X	X	X
		75000	X	X	X	X	X
		100000	X	X	X	X	X
		125000	X	X	X	X	X
		150000	X	X	X	X	X

			2009 - 2012 F-Series 250/350/450/550 Diesel				
	Coverage		Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
PREMIUMCARE	3 Years	48000	0	2	11	4	2
		60000	0	14	23	32	4
		75000	1	26	40	61	6
		100000	0	188	567	334	25
		125000	0	0	0	336	34
	4 Years	48000	0	4	7	18	4
		60000	0	10	31	49	5
		75000	0	27	84	104	14
		100000	2	412	1004	829	66
		125000	0	0	0	728	63
		150000	0	0	0	0	8
	5 Years	36000	0	5	13	11	0
		48000	0	1	18	27	1
		60000	0	115	344	413	38
		75000	2	269	622	710	73
		100000	8	1244	3131	3090	309
		125000	0	0	0	1122	94
		150000	0	0	0	0	3
	6 Years	36000	0	5	13	21	0
		48000	0	18	38	59	6
		60000	1	170	418	460	53
		75000	4	501	1290	1491	136
		100000	2	710	1895	2588	275
		125000	0	0	0	798	73
		150000	0	0	0	0	3
	7 Years	36000	0	28	34	62	6
		48000	0	32	97	120	8
		60000	0	103	317	420	54
		75000	4	163	431	718	61
		100000	1	417	1173	1382	132
		125000	0	0	0	559	55
		150000	0	0	0	0	1

Used Contract Coverage

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
BASECARE	2 Years	24000	X	X	X	X	X
	3 Years	36000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
	4 Years	60000	X	X	X	X	X
	5 Years	60000	X	X	X	X	X

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
EXTRACARE	2 Years	24000	X	X	X	X	X
	3 Years	36000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
	5 Years	60000	X	X	X	X	X

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
PREMIUMCARE	1 Year	12000	X	X	X	X	X
	2 Years	24000	X	X	X	X	X
	3 Years	36000	X	X	X	X	X
	3 Years	48000	X	X	X	X	X
	4 Years	36000	X	X	X	X	X
	4 Years	48000	X	X	X	X	X
	4 Years	60000	X	X	X	X	X
	5 Years	60000	X	X	X	X	X

Used Contract Counts

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
BASECARE	2 Years	24000	0	0	0	1	0
	3 Years	36000	0	0	3	7	2
	4 Years	48000	0	0	4	13	2
	4 Years	60000	0	0	0	0	1
	5 Years	60000	0	0	0	10	1

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
EXTRACARE	2 Years	24000	0	0	0	10	0
	3 Years	36000	0	0	4	18	5
	4 Years	48000	0	0	3	24	1
	5 Years	60000	0	0	0	14	1

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
PREMIUMCARE	1 Year	12000	0	0	0	1	0
	2 Years	24000	0	0	2	8	1
	3 Years	36000	0	1	5	68	13
	3 Years	48000	0	0	0	0	4
	4 Years	36000	0	0	0	0	2
	4 Years	48000	0	0	11	76	6
	4 Years	60000	0	0	0	0	7
	5 Years	60000	0	0	0	110	13

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
DIESELCARE	7 Years	200000	X	X	X	X	X

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
DIESELCARE	7 Years	200000	4	201	593	727	43

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
DIESELCARE+	7 Years	200000	X	X	X	X	X

	Coverage		2009 - 2012 F-Series 250/350/450/550 Diesel Plan Years				
	Time	Miles	2007	2009	2010	2011	2012
DIESELCARE+	7 Years	200000	13	816	1389	2677	210

EA11-003

FORD

1-20-2012

Appendix F1

EA11-003
Appendix F1

Article Number: 20662
Article Type: S
Global Concern Number:
Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	02/12/2009	02/12/2013
WD	***	02/12/2009	02/12/2013

Title:

1999-2009 MULTIPLE VEHICLES - DIESEL ENGINE FUEL CONDITIONER

Text:

SOME 1999-2009 F-SUPER DUTY, E-SERIES, EXCURSION, F650/750, AND LCF VEHICLES EQUIPPED WITH A DIESEL ENGINE MAY EXHIBIT LOW POWER, POOR FUEL ECONOMY, FUEL GELLING IN COLD WEATHER (A HIGHER OCCURRENCE OF FUEL GELLING MAY OCCUR WITH THE USE OF BIO-DIESEL BLENDED FUELS), EXCESSIVE WHITE SMOKE ON COLD START, HARD START, OR COKING OF COMPONENTS EXPOSED TO EXHAUST. THESE CONDITIONS MAY BE DUE TO POOR FUEL QUALITY. IF NO ROOT CAUSE IS FOUND DURING NORMAL DIAGNOSTICS, ADVISE THE CUSTOMER TO USE A DIFFERENT BRAND OF FUEL. USE OF A NON ALCOHOL ADDITIVE CAN IMPROVE CETANE LEVELS, SUCH AS "DIESEL CETANE BOOST AND PERFORMANCEIMPROVER" MOTORCRAFT PM-22-A (PM-22-B CAN). COLD FLOW PERFORMANCE CAN BE IMPROVED WITH "DIESEL FUEL ANTI-GEL AND PERFORMANCE IMPROVER" MOTORCRAFT PM-23-A(PM-23-B CAN).

Vehicles:

1999-2009	E-SERIES (00016)
2000-2005	EXCURSION (00126)
1999-2009	F-SERIES SUPER DUTY (00028)
2005-2009	LOW CAB FORWARD (00168)
1999-2009	MEDIUM TRUCK (00067)

Symptom Code:

400000	ENGINE
404000	ENGINE FUEL SYSTEM CONCERNS
600000	DRIVEABILITY
601000	DRIVE-STARTING
602300	DRIVEABILITY HARD START/LONG START
603300	DRIVEABILITY NO START
606000	DRIVE-PERFORMANCE
607000	DRIVEABILITY STALLS/QUITS
608000	DRIVEABILITY RUNS ROUGH
609000	DRIVEABILITY MISSES
611000	DRIVEABILITY HESITATION/STUMBLE
612000	DRIVEABILITY SURGE
614000	DRIVEABILITY LACK/LOSS OF POWER
698298	DRIVEABILITY MALFUNCTION INDICATOR LAMP - MIL

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Start/Run/Move				4*****
Start/Run/Move	Starting			440***
Start/Run/Move	Starting	Cranks Won't Start		4403**
Start/Run/Move	Starting	Cranks Won't Start	Always	440302
Start/Run/Move	Running			441***
Start/Run/Move	Running	Smoke From Exhaust		4413**
Start/Run/Move	Running	Smoke From Exhaust	White	441385
Driving Performance				5*****
Driving Performance	Runs Rough			550***
Driving Performance	Runs Rough	Acceleration		5502**
Driving Performance	Runs Rough	Acceleration	Always	550202
Driving Performance	Poor Fuel Economy			556***
Driving Performance	Poor Fuel Economy	Combined		556C**
Driving Performance	Poor Fuel Economy	Combined	Loaded	556C41
Driving Performance	Engine Surge			558***
Driving Performance	Engine Surge	Acceleration		5582**
Driving Performance	Engine Surge	Acceleration	Always	558202

EA11-003
Appendix F1

Article Number: 21410
Article Type: S
Global Concern Number:
Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	07/19/2010	07/16/2014
WD	***	07/19/2010	07/16/2014

Title:

2008-2010 F250-F550 6.4L - RUNS ROUGH, SMOKES, NO START DUE TO GASOLINE OR ALCOHOL IN THE FUEL

Text:

SOME F250-F550 6.4L EQUIPPED VEHICLES MAY EXHIBIT A RUNS ROUGH, WHITE SMOKE, NO START CONCERN. THIS CONCERN MAY BE CAUSED BY THE FUEL BEING CONTAMINATED WITH GASOLINE OR ALCOHOL. GASOLINE/ALCOHOL LACK THE LUBRICITY OF DIESEL FUEL AND WILLCAUSE FUEL SYSTEM FAILURE. IF GASOLINE OR ALCOHOL IS FOUND IN THE FUEL, THE COMPLETE HIGH PRESSURE FUEL SYSTEM WILL NEED TO BE REPLACED PER THE PCED, SECTION 4 (HARD START/NO START DIAGNOSTICS PROCEDURES), STEP 28. GASOLINE OR ALCOHOL CONTAMINATION IS NOT A WARRANTABLE REPAIR. IF THE OWNER OF THE VEHICLE DENIES THE REPAIR, AN INFORMATION-ONLY CUDL SHOULD BE OPENED AND A WARRANTY CANCELLATION REQUEST FORM SHOULD BE SUBMITTED. THE REMAINDER OF THE FACTORY WARRANTY WILL BE REINSTATED ONCE THE REPAIR IS COMPLETED AND THE WARRANTY REINSTATEMENT FORMS ARE SUBMITTED.

Vehicles:

2008-2010 F-SERIES SUPER DUTY (00028)

Symptom Code:

400000 ENGINE
403000 ENGINE EXHAUST SYSTEM CONCERNS
600000 DRIVEABILITY
601000 DRIVE-STARTING
602300 DRIVEABILITY HARD START/LONG START
606000 DRIVE-PERFORMANCE
608000 DRIVEABILITY RUNS ROUGH
609000 DRIVEABILITY MISSES

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Start/Run/Move				4*****
Start/Run/Move	Starting			440***
Start/Run/Move	Starting	No Crank		4401**
Start/Run/Move	Starting	No Crank	Always	440102
Start/Run/Move	Running			441***
Start/Run/Move	Running	Smoke From Exhaust		4413**
Start/Run/Move	Running	Smoke From Exhaust	White	441385
Driving Performance				5*****
Driving Performance	Runs Rough			550***
Driving Performance	Runs Rough	Acceleration		5502**
Driving Performance	Runs Rough	Acceleration	Always	550202
Driving Performance	Runs Rough	Cruise/ Steady Speed		5503**
Driving Performance	Runs Rough	Cruise/ Steady Speed	Always	550302
Driving Performance	Lack/Loss of Power			554***
Driving Performance	Lack/Loss of Power	Acceleration		5542**
Driving Performance	Lack/Loss of Power	Acceleration	Always	554202
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed		5543**
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed	Always	554302

Article Number: 21820
Article Type: S
Global Concern Number: 103-2011-0041
Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	03/30/2011	03/30/2021
WD	***	03/30/2011	03/30/2021

Title:

2011 F-SUPER DUTY EQUIPPED WITH 6.7L DIESEL ENGINE - POOR QUALITY DIESEL, GASOLINE OR OTHER NON-DIESEL FUELS ADDED TO THE FUEL TANK - SERVICE TIP

Text:

2011 F-SUPER DUTY VEHICLES EQUIPPED WITH A 6.7L DIESEL ENGINE WHICH HAVE EXPERIENCED FUEL SYSTEM CONTAMINATION MAY HAVE DAMAGED FUEL SYSTEM COMPONENTS INCLUDING THE HIGH PRESSURE (HP) PUMP AND FUEL INJECTORS. FUEL AND ADDITIVES WHICH DO NOT MEET THE MINIMUM LUBRICATION, COOLING AND ANTI-CORROSION PROPERTIESREQUIRED BY THE HIGH PRESSURE FUEL SYSTEM COMPONENTS MAY CAUSE SYMPTOMS INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING: CRANK/NO START, LONG CRANK/HARD START, ROUGH RUN, LOW POWER, ENGINE KNOCKING, EXHAUST SMOKE AND/OR FUEL RAIL PRESSURE (FRP) SLOW TO BUILD. TO HELP WITH THE DIAGNOSIS AND REPAIR OF CONCERNS DUE TO FUEL CONTAMINATION, A JOB AID HAS BEEN DEVELOPED AND IS NOW AVAILABLE ON THE PTS WEBSITE UNDER THE SERVICE TIPS TAB.

Vehicles:

2011 F-SERIES SUPER DUTY (00028)

Symptom Code:

200000 ELECTRICAL
206000 ELECTRICAL WARNING INDICATORS
400000 ENGINE
403000 ENGINE EXHAUST SYSTEM CONCERNS
404000 ENGINE FUEL SYSTEM CONCERNS
497000 ENGINE NOISE CONCERNS
600000 DRIVEABILITY
601000 DRIVE-STARTING
602300 DRIVEABILITY HARD START/LONG START
603300 DRIVEABILITY NO START
606000 DRIVE-PERFORMANCE
607000 DRIVEABILITY STALLS/QUITS
607400 DRIVEABILITY STALLS/QUITS AT IDLE
607500 DRIVEABILITY STALLS/QUITS - ACCELERATION
607600 DRIVEABILITY STALLS/QUITS - CRUISE
607700 DRIVEABILITY STALLS/QUITS - DECELERATION
608000 DRIVEABILITY RUNS ROUGH
608400 DRIVEABILITY RUNS ROUGH AT IDLE
608500 DRIVEABILITY RUNS ROUGH - ACCELERATION
608600 DRIVEABILITY RUNS ROUGH - CRUISE
609000 DRIVEABILITY MISSES
609400 DRIVEABILITY MISSES AT IDLE
609500 DRIVEABILITY MISSES - ACCELERATION
609600 DRIVEABILITY MISSES - CRUISE
610000 DRIVEABILITY BUCK/JERK
610500 DRIVEABILITY BUCK/JERK - ACCELERATION
610600 DRIVEABILITY BUCK/JERK - CRUISE
610700 DRIVEABILITY BUCK/JERK - DECELERATION
611000 DRIVEABILITY HESITATION/STUMBLE
611500 DRIVEABILITY HESITATION/STUMBLE - ACCELERATION
614000 DRIVEABILITY LACK/LOSS OF POWER
614500 DRIVEABILITY LACK/LOSS OF POWER - ACCELERATION
614600 DRIVEABILITY LACK/LOSS OF POWER - CRUISE
698298 DRIVEABILITY MALFUNCTION INDICATOR LAMP - MIL
P1140

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Driver Aides & Information				2*****
Driver Aides & Information	Warning Indicators/Messages/Chimes			227***
Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)		227Q**

Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)	Stays On	227Q68
Start/Run/Move				4*****
Start/Run/Move	Starting			440***
Start/Run/Move	Starting	No Crank		4401**
Start/Run/Move	Starting	No Crank	Always	440102
Start/Run/Move	Starting	Cranks Won't Start		4403**
Start/Run/Move	Starting	Cranks Won't Start	Always	440302
Start/Run/Move	Starting	Cranks Won't Start	Intermittent	440339
Driving Performance				5*****
Driving Performance	Runs Rough			550***
Driving Performance	Runs Rough	Acceleration		5502**
Driving Performance	Runs Rough	Acceleration	Always	550202
Driving Performance	Runs Rough	Acceleration	Intermittent	550239
Driving Performance	Runs Rough	Cruise/ Steady Speed		5503**
Driving Performance	Runs Rough	Cruise/ Steady Speed	Always	550302
Driving Performance	Runs Rough	Cruise/ Steady Speed	Intermittent	550339
Driving Performance	Lack/Loss of Power			554***
Driving Performance	Lack/Loss of Power	Acceleration		5542**
Driving Performance	Lack/Loss of Power	Acceleration	Always	554202
Driving Performance	Lack/Loss of Power	Acceleration	Intermittent	554239
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed		5543**
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed	Always	554302
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed	Intermittent	554339
Driving Performance	Hesitates/Stumble			557***
Driving Performance	Hesitates/Stumble	Acceleration		5572**
Driving Performance	Hesitates/Stumble	Acceleration	Always	557202
Driving Performance	Hesitates/Stumble	Acceleration	Intermittent	557239
Driving Performance	Hesitates/Stumble	Cruise/ Steady Speed		5573**
Driving Performance	Hesitates/Stumble	Cruise/ Steady Speed	Always	557302
Driving Performance	Hesitates/Stumble	Cruise/ Steady Speed	Intermittent	557339

GCQIS Report Entry / Maintenance

GCQIS Technical Service Detail

Close Print Help

ArticleType : SSM **ArticleNumber :** 21847 **Entered Date :** 04/06/2011 **Times Recommended :** 2

Date is displayed in **MM/DD/CCYY format**

SOME 2011 F-SUPER DUTY EQUIPPED WITH 6.7L DIESELS MAY EXHIBIT HARD START, LACK OF POWER OR RUNS ROUGH CONDITION WITH MALFUNCTION INDICATOR LIGHT(MIL) AND DIAGNOSTIC TROUBLE CODE (DTC) P0087 DUE TO FUEL GELLING IN COLD AMBIENT TEMPERATURE. :

SOME 2011 F-SUPER DUTY EQUIPPED WITH 6.7L DIESELS MAY EXHIBIT HARD START, LACK OF POWER OR RUNS ROUGH CONDITION WITH MALFUNCTION INDICATOR LIGHT(MIL) AND DIAGNOSTIC TROUBLE CODE(DTC) P0087 DUE TO FUEL GELLING IN COLD AMBIENT TEMPERATURES. PLEASE NOTE THAT BIO-DIESEL BLENDED FUELS HAVE A HIGHER OCCURRENCEOF FUEL GELLING DURING COLDER AMBIENT TEMPERATURES AND SHOULD NOT BE USED AT ANYRATING ABOVE B20 (20%). IF NO ROOT CAUSE IS DETERMINED AFTER NORMAL PCED DIAGNOSTICS, RECOMMEND THAT THE CUSTOMER USES A DIFFERENT BRAND OF FUEL, THAT HAS BEEN SEASONABLY ADJUSTED FOR THE AMBIENT TEMPERATURE. CUSTOMERS MAY ALSO BENEFIT BY USING MOTORCRAFT PM-23-A (US), PM-23B (CANADA) DIESEL FUEL ANTI-GEL AND PERFORMANCE IMPROVER. REFER TO THE VEHICLES OWNER GUIDE DIESEL SUPPLEMENT FOR ADDITIONAL DETAILS.

Requester:
Technical Service Detail
Server: ECCWS686

Ford Proprietary, Private

14-Dec-2011
Retention: None

GCQIS Report Entry / Maintenance

GCQIS Technical Service Detail

Close Print Help

ArticleType : SSM **ArticleNumber :** 21851 **Entered Date :** 04/12/2011 **Times Recommended :** 0

Date is displayed in **MM/DD/CCYY format**

STARTING WITH MAY 2006 PRODUCTION, VEHICLES EQUIPPED WITH 6.0L OR 6.4 DIESEL ENGINES HAVE THE HFCM FILTERS MARKED ''FF'' ON THE FILTER END CAP. THIS IS AN INDICATION THE FILTER IS A FIRST FIT. :

STARTING WITH MAY 2006 PRODUCTION, VEHICLES EQUIPPED WITH 6.0L OR 6.4 DIESEL ENGINES HAVE THE HFCM FILTERS MARKED "FF" ON THE FILTER END CAP. THIS IS AN INDICATION THE FILTER IS A FIRST FIT. FIRST FIT FILTERS ARE EITHER THE ORIGINAL FILTER FROM PRODUCTION AT THE ASSEMBLY PLANT, OR FROM WHEN THE HFCM IS REPLACED AS A COMPLETE ASSEMBLY IN SERVICE ON PRIOR MODEL YEAR 6.0L VEHICLES. FUEL FILTERS SHOULD BE CHANGED EVERY 15,000 MILES OR SOONER,DEPENDING ON USAGE AND FUEL QUALITY. REFER TO THE "DIESEL OWNER'S GUIDE SUPPLEMENT" FOR PROPER FUEL FILTER MAINTENANCE INTERVALS.

Requester: 14-Dec-2011
Technical Service Detail **Ford Proprietary, Private** **Retention:** None
Server: ECCWS686

EA11-003
Appendix F1

Article Number: 22002
Article Type: S
Global Concern Number: 103-2011-1883
Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	08/10/2011	08/10/2015

Title:

2011 F-SUPER DUTY - 6.7L DIESELS - VARIOUS DRIVABILITY SYMPTOMS - BUILT ON OR BEFORE 7/25/2011

Text:

SOME 2011 F-SUPER DUTY EQUIPPED WITH 6.7L DIESEL BUILT ON OR BEFORE 7/25/2011 MAY EXHIBIT VARIOUS DRIVABILITY SYMPTOMS.(SUCH AS FALSE DTC'S AND DEF LEVEL INDICATION, HIGH PRESSURE PUMP NOISES). THERE HAS BEEN A CALIBRATION UPDATE TO CORRECT THESE SYMPTOMS. THE POWERTRAIN CONTROL MODULE (PCM) SHOULD BE REPROGRAMMED TO THE LATEST CALIBRATION LEVEL BEFORE COMPONENTS ARE REPLACED OR REPAIRED. REFER TO APPLICABLE TECHNICAL SERVICE BULLETIN (TSB) 6.7L CALIBRATION UPDATE FOR VARIOUS ISSUES.

Vehicles:

2011 F-SERIES SUPER DUTY (00028)

Symptom Code:

200000 ELECTRICAL
206000 ELECTRICAL WARNING INDICATORS
400000 ENGINE

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Driver Aides & Information				2*****
Driver Aides & Information	Warning Indicators/Messages/Chimes			227***
Driver Aides & Information	Warning Indicators/Messages/Chimes	Diesel Fluid		227B**
Driver Aides & Information	Warning Indicators/Messages/Chimes	Diesel Fluid	Inoperative	227B38
Driver Aides & Information	Warning Indicators/Messages/Chimes	Diesel Fluid	Stays On	227B68

Article Number: 22100
Article Type: S
Global Concern Number: 103-2010-0041
Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	11/03/2011	11/03/2015

Title:

2011-2012 F-SUPER DUTY - 6.7L - FUEL SYSTEM REPAIR/REPLACEMENT DUE TO FUEL SYSTEM CONTAMINATION

Text:

SOME 2011-2012 F-SUPER DUTY VEHICLES EQUIPPED THE 6.7L POWERSTROKE DIESEL ENGINEMAY EXHIBIT THE FOLLOWING CONDITIONS: CRANK NO START; LONG CRANK HARD START; RUNS ROUGH; LOW POWER; ENGINE KNOCKING; EXHAUST SMOKE; OR FRP SLOW TO BUILD. THESE CONCERNS MAY BE CAUSED BY CONTAMINATED FUEL. REFER TO THE 6.7L DIESEL FUELSYSTEM CONTAMINATION DIAGNOSIS AND SERVICE PROCEDURE JOB AID AVAILABLE ON PTS ORFMCDEALER.COM. REPAIRS MADE TO FUEL SYSTEMS DAMAGED FROM CONTAMINATED FUEL ARE NOT WARRANTABLE AND MAY BE SUBJECT TO CHARGEBACK.

Vehicles:

2011-2012 F-SERIES SUPER DUTY (00028)

Symptom Code:

400000	ENGINE
404000	ENGINE FUEL SYSTEM CONCERNS
497000	ENGINE NOISE CONCERNS
600000	DRIVEABILITY
601000	DRIVE-STARTING
602300	DRIVEABILITY HARD START/LONG START
603300	DRIVEABILITY NO START
606000	DRIVE-PERFORMANCE
607000	DRIVEABILITY STALLS/QUITS
607400	DRIVEABILITY STALLS/QUITS AT IDLE
607500	DRIVEABILITY STALLS/QUITS - ACCELERATION
607600	DRIVEABILITY STALLS/QUITS - CRUISE
607700	DRIVEABILITY STALLS/QUITS - DECELERATION
608000	DRIVEABILITY RUNS ROUGH
608400	DRIVEABILITY RUNS ROUGH AT IDLE
608500	DRIVEABILITY RUNS ROUGH - ACCELERATION
608600	DRIVEABILITY RUNS ROUGH - CRUISE
609000	DRIVEABILITY MISSES
609400	DRIVEABILITY MISSES AT IDLE
609500	DRIVEABILITY MISSES - ACCELERATION
609600	DRIVEABILITY MISSES - CRUISE
614000	DRIVEABILITY LACK/LOSS OF POWER
614500	DRIVEABILITY LACK/LOSS OF POWER - ACCELERATION
614600	DRIVEABILITY LACK/LOSS OF POWER - CRUISE
698298	DRIVEABILITY MALFUNCTION INDICATOR LAMP - MIL

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Driver Aides & Information				2*****
Driver Aides & Information	Warning Indicators/Messages/Chimes			227***
Driver Aides & Information	Warning Indicators/Messages/Chimes	Diesel Fluid		227B**
Driver Aides & Information	Warning Indicators/Messages/Chimes	Diesel Fluid	Stays On	227B68
Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)		227Q**
Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)	Stays On	227Q68
Start/Run/Move				4*****
Start/Run/Move	Starting			440***
Start/Run/Move	Starting	Cranks Won't Start		4403**
Start/Run/Move	Starting	Cranks Won't Start	Always	440302
Start/Run/Move	Running			441***
Start/Run/Move	Running	Smoke From Exhaust		4413**
Start/Run/Move	Running	Smoke From Exhaust	White	441385
Start/Run/Move	Fluids			446***

Start/Run/Move	Fluids	Fuel		4465**
Start/Run/Move	Fluids	Fuel	Contamination	446588
Driving Performance				5*****
Driving Performance	Stalls/Quits			552***
Driving Performance	Stalls/Quits	Acceleration		5522**
Driving Performance	Stalls/Quits	Acceleration	Always	552202
Driving Performance	Stalls/Quits	Cruise/ Steady Speed		5523**
Driving Performance	Stalls/Quits	Cruise/ Steady Speed	Always	552302
Driving Performance	Lack/Loss of Power			554***
Driving Performance	Lack/Loss of Power	Acceleration		5542**
Driving Performance	Lack/Loss of Power	Acceleration	Always	554202
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed		5543**
Driving Performance	Lack/Loss of Power	Cruise/ Steady Speed	Always	554302

Article Number: 22176

Article Type: S

Global Concern Number: 103-2012-0001

Market(s):

Area Code	Geo Sales Area	Date of Activation	Date of Deactivation
NA	***	01/06/2012	07/06/2012

Title:

6.7L DIESEL - DIAGNOSTIC TROUBLE CODE (DTC) P2269 (WATER IN FUEL CONDITION)

Text:

2011-2012 F-SUPER DUTY VEHICLES EQUIPPED WITH A 6.7L DIESEL ENGINE MAY EXPERIENCE DTC P2269. CURRENTLY DTC P2269 IS NOT LISTED IN THE POWER-TRAIN CONTROL/EMISSIONS DIAGNOSTICS (PC/ED). FOLLOW PIN POINT TEST "O" TO DIAGNOSE THECONCERN. THE PC/ED IS CURRENTLY BE UPDATED TO REFLECT THIS CHANGE. PLEASE MONITOR OASIS FOR FUTURE UPDATES.

Vehicles:

2011-2012 F-SERIES SUPER DUTY (00028)

Symptom Code:

400000 ENGINE
404000 ENGINE FUEL SYSTEM CONCERNS
600000 DRIVEABILITY
698298 DRIVEABILITY MALFUNCTION INDICATOR LAMP - MIL
P2269

Global Customer Symptom Codes:

Category	Q1	Q2	Q3	Full Code
Driver Aides & Information				2*****
Driver Aides & Information	Warning Indicators/Messages/Chimes			227***
Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)		227Q**
Driver Aides & Information	Warning Indicators/Messages/Chimes	Service Engine Soon (Engine Image)	Stays On	227Q68
Driver Aides & Information	Warning Indicators/Messages/Chimes	Water In Fuel		227W**
Driver Aides & Information	Warning Indicators/Messages/Chimes	Water In Fuel	Stays On	227W68
Start/Run/Move				4*****
Start/Run/Move	Fluids			446***
Start/Run/Move	Fluids	Fuel		4465**
Start/Run/Move	Fluids	Fuel	Contamination	446588

WIF LIGHT ON—NO DRIVABILITY SYMPTOMS WATER IN AFT FUEL TANK DUE TO SNOW AND ICE BUILD UP IN FUEL TANK VENT AREA—6.4L, 6.0L, AND 7.3L DIESEL ENGINE

TSB 09-14-4

FORD:
1999-2010 F-350, F-450, F-550

This article supersedes TSB **07-24-4** to update the vehicle model years and Service Procedure.

ISSUE

Some 1999-2010 vehicles equipped with a 6.4L, 6.0L, or 7.3L diesel engine and a 40-gallon (151.4L) fuel tank behind the rear axle, may exhibit water in the fuel tank. This is due to snow and ice accumulating around the mushroom vent cap, melting, and being pulled into the tank through the mushroom cap.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

Typically only 1-2 ounces of water will get into the tank if the above condition is present and will be caught by the horizontal fuel conditioning module (HFCM). Symptoms for this issue are Water In Fuel (WIF) light on, this concern has not resulted in any drivability concerns. The FCM/HFCM acts as a primary fuel filter/water separator which removes both water and impurities from the fuel. The engine-mounted fuel filter and the FCM/HFCM filter should be changed at the recommended service interval. Refer to the scheduled maintenance information in this supplement for more information. Draining of the WIF module assembly should be done whenever the warning light comes on and is the responsibility of the owner.

This procedure is not applicable to rain, road splash or incomplete chassis cabs sitting in storage. The vent will only ingest water if the vent is surrounded by ice or snow.

1. Remove the existing mushroom cap installed on the vent port of the fuel tank and discard.
2. Install the hose end of the new vent line assembly onto the vent port and secure with the constant tension clamp.
3. Route the new vent line assembly forward, on top of the tank, to the number 5 crossmember, and under the fuel lines (Figure 1).

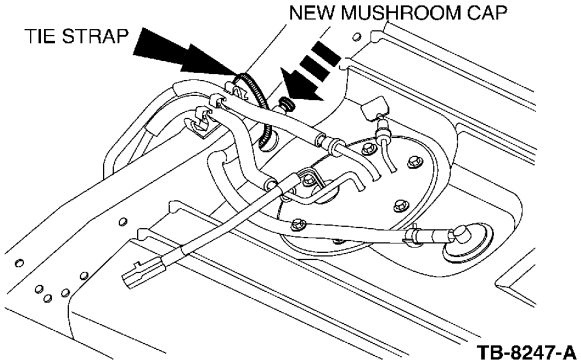


Figure 1 - Article 09-14-4

4. Secure the end of the new vent line assembly to the crossmember with the tie strap, at the large circular hole in the middle of the vehicle.
5. Install the new mushroom cap at the end of the vent line. Be sure the cap is positioned horizontally to prevent water from collecting in the cap.

PART NUMBER	PART NAME
5C3Z-9S327-A	Vent Kit

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford, Lincoln, or Mercury dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company's on-line technical resources.

Copyright © 2009 Ford Motor Company Online Publication Date July 7, 2009

TSB 09-14-4 (Continued)

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
MT091404	Use SLTS Operations If Available; Claim Additional Diagnosis Or Labor Performed As Actual Time	Actual Time

DEALER CODING

BASIC PART NO.	CONDITION CODE
9S327	49

6.7L—CALIBRATION UPDATE—VARIOUS ISSUES—BUILT ON OR BEFORE 4/11/2011

TSB 11-4-21

FORD:
2011 F-250, F-350, F-450, F-550

This article supersedes TSB **11-3-23** to add additional calibration content.

ISSUE
Some 2011 F-Super Duty vehicles equipped with a 6.7L engine and built on or before 4/11/2011 may exhibit malfunction indicator light (MIL) on with diagnostic trouble codes (DTC's) P0401, P0402, P009A if driven at highway speeds with a snow plow attached, P164A if idled for extended periods in colder ambient temperatures, 2-3 transmission shift flares, harsh/inconsistent transmission shifting during transmission fluid warm up and tip-in events at low speeds or when coming to a stop. Refer to the Calibration Content for additional details.

ACTION
Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

Reprogram the powertrain control module (PCM) and the transmission control module (TCM) to the latest calibration using IDS release 72.03 and higher. This new calibration is not included in the VCM 2011.3 DVD. Calibration files may also be obtained at www.motorcraft.com.

NOTE
PLEASE ADVISE THE CUSTOMER THAT THIS VEHICLE IS EQUIPPED WITH AN ADAPTIVE TRANSMISSION SHIFT STRATEGY WHICH ALLOWS THE VEHICLE'S COMPUTER TO LEARN THE TRANSMISSION'S UNIQUE PARAMETERS AND IMPROVE SHIFT QUALITY. WHEN THE ADAPTIVE STRATEGY IS RESET, THE COMPUTER WILL BEGIN A RE-LEARNING PROCESS. THIS RE-LEARNING PROCESS MAY RESULT IN FIRMER THAN NORMAL UPSHIFTS AND DOWNSHIFTS FOR SEVERAL DAYS.

The Calibration Update Contains Improvement Actions And Enhancements:

- DTC P0401 (exhaust gas recirculation (EGR) flow insufficient detected)
- DTC P0402 (exhaust gas recirculation (EGR) flow excessive detected)
- DTC P009A (intake air temperature/ambient air temperature correlation) if driven at highway speeds with a snow plow attached
- False DTC P164A (O2 sensor positive current trim circuit performance) if idled for extended periods in colder ambient temperature
- 2-3 transmission shift flares
- Harsh/inconsistent transmission shifting during transmission fluid warm up
- Improved shift feel for tip-in events at low speed or when coming to a stop

Previously Released Calibration Content

Previously released calibration content included in IDS software release 69.07 and higher contained improvement actions and enhancements to address the following:

Calibration Content Vehicles Built On Or Before 11/5/2010

- Delayed manual upshifts from 1st to 2nd gear when in Select Shift mode while going down a grade
- Harsh/delayed 1-2 upshift and downshift
- Harsh 2-3 upshift on first drive away of day after vehicle soak
- DEF warning messages won't reset after refilling DEF tank with Key On Engine Running
- Modified vehicles for rail applications, that will not re-engage PTO operation or speedometer inoperative after riding on the tracks with the front wheels off the ground
- VSOUT signal inoperable from customer access circuits under dash

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford or Lincoln dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company's on-line technical resources.

TSB 11-4-21 (Continued)

- DTC P2463 or P246C (DPF restriction) and DTC P2459 (DPF regeneration frequency) - adds increased ability to perform manual regeneration at higher load values when performing system diagnostics

Calibration Content - Vehicles Built On Or Before 08/23/2010

- False DTC P132B (turbocharger/supercharger boost control A performance)
- False DTC P0299 (turbocharger/supercharger A under-boost condition)
- False DTC P050E (cold start engine exhaust temperature too low)
- False DTC P06EA (NOX sensor processor performance (bank 1, sensor 1)
- DTC P249C (SCR time to closed loop) - improved diagnostics and reporting
- DTC P249F (excessive time to enter closed loop DPF regeneration control) - improved diagnostics and reporting
- False DTC P0884 (PCM/TCM power input signal intermittent)
- DTC(s) and freeze frame data being erased in the PCM when running KOEO, KOER, Datalogger, Active Commands or any other guided diagnostics with IDS
- False P0731 (gear 1 incorrect ratio)
- False P0732 (gear 2 incorrect ratio)
- False P0733 (gear 3 incorrect ratio)
- False P0734 (gear 4 incorrect ratio)
- False P0735 (gear 5 incorrect ratio)
- False P0729 (gear 6 incorrect ratio)
- Low speed/load engine surge
- Abrupt engine shutdown feel
- HP fuel pump knocking noise at idle
- Delayed DEF level indication after refill event
- Harsh/bumpy transmission upshifts/downshifts
- Delayed/harsh transmission engagement feel between R-D and D-R shifts
- Transmission gear hunting during speed control operation when climbing grades or climbing hills, particularly while towing
- Erratic transmission operation after descending grades while in 1st gear
- Flashes/delays of current gear indication when using SelectShift mode
- Added Brake Over Accelerator (BOA) feature - reduces engine power during off-idle driving when both the accelerator and brake pedals are applied simultaneously
- Added SelectShift memory feature so the SelectShift gear display comes back on whenever going back into drive if the vehicle was turned off while SelectShift mode was still activated
- Added engine protection feature from overspeed when descending long grades while towing and in manual gear ranges (forces transmission upshifts at 4000 RPM)
- Increased torque - during hill assist operation - (see Owner Guide for additional system operation)
- PTO operational enhancements - (applicable to vehicles equipped with optional PTO)

- Automatic secondary electronic idle controller (SEIC) turns on at engine start if the switch is in the on position

- Engine coolant temperature to operate PTO lowered to -7 °C (+20 °F)

- Improved RPM control with SEIC controllers

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
110421A	2011 F-Super Duty 6.7L: Check DTCs, Reprogram The PCM And TCM (Do Not Use With Any Other Labor Operations)	0.6 Hr.

DEALER CODING

	CONDITION CODE
BASIC PART NO.	
RECALEM	04

6.4L—LACKS POWER—DTC P0088 | TSB 11-4-22

FORD:
2008-2010 F-250, F-350, F-450, F-550

This article supersedes TSB **11-4-15** to update the Service Labor Time Standards.

ISSUE

Some F-Super Duty 250-550 vehicles equipped with a 6.4L diesel engine may exhibit a lack of power concern with an intermittent diagnostic trouble code (DTC) P0088; at full operating temperature during moderate to heavy acceleration.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

Intermittent P0088 diagnostics:

1. Check all continues memory DTCs. Is DTC P0088 the only code present?
   a. No - do not continue with this procedure. Refer to the Powertrain Control/Emission Diagnostics (PC/ED) to diagnose this concern.
   b. Yes - continue to Step 2
2. Replace the high pressure pump (HPP). Refer to Workshop Manual (WSM), Section 303-04C for HPP replacement.
   a. Both the fuel volume control valve (VCV) and fuel pressure control valve (PCV) adaptive learning parameters must be reset after a HPP replacement. Refer to PC/ED, Section 4, Hard Start/No Start Diagnostic Subroutines step 7 to reset adaptive tables.

PART NUMBER	PART NAME
8C3Z-9A543-B	High Pressure Fuel Pump

OTHER APPLICABLE ARTICLES: 10-20-10

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
110422A	2008-2010 F-Super Duty 6.4L Regular Cab: Check DTCs And Replace the HPP Includes Time For Prior Approval, Remove And Install Cab, And Reset Both VCV And PCV Adaptive Learning (Do Not Use with Any Other Labor Operation Except For Other Applicable TSB Articles)	8.9 Hrs.
110422A	2008-2010 F-Super Duty 6.4L Super And Crew Cab: Check DTCs And Replace the HPP Includes Time For Prior Approval, Remove And Install Cab, And Reset Both VCV And PCV Adaptive Learning (Do Not Use with Any Other Labor Operation Except For Other Applicable TSB Articles)	9.1 Hrs.

DEALER CODING

BASIC PART NO.	CONDITION CODE
9A543	42

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford or Lincoln dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company's on-line technical resources.

Copyright © 2011 Ford Motor Company Online Publication Date April 27, 2011

6.7L DIESEL—RUNS ROUGH/CRANKS NO START—DIAGNOSTIC TROUBLE CODES (DTC) P1291 AND/OR P1292—BUILT ON OR BEFORE 5/18/2011

TSB 11-6-10

FORD:
2011 F-250, F-350, F-450, F-550

ISSUE

Some F-Super Duty vehicles equipped with a 6.7L engine built on or before 5/18/2011 may experience diagnostic trouble code (DTC) P1291 and/or P1292 due to an internally shorted fuel injector. This concern may be caused by gelled diesel fuel restricting the fuel injector return hose. There is a new fuel injector return hose available which will reduce the occurrence of shorted injectors due to fuel gelling.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

1. Inspect the engine wiring harness (12B637) for wire chafes near the exhaust gas recirculation (EGR) cooler. Was a chafe present?
   a. No - continue to Step 2
   b. Yes - repair as necessary. For vehicles built on or before 5/26/2010, bend the metal EGR cooler gasket tab eyelet rearward, flush with the cooler housing.
2. Electrically disconnect each fuel injector for the suspect code(s) (DTC P1291 for injectors 1, 4, 6 and 7; DTC P1292 for injectors 2, 3, 5 and 8). Once the injectors are unplugged, check for continuity between the injector electrical pins and the injector bodies. Is continuity present?
   a. No - this procedure does not apply; follow the appropriate pinpoint test per the Powertrain Control/Emissions Diagnosis (PC/ED) Manual to resolve this concern.
   b. Yes - replace all eight (8) fuel injectors and the injector return hose. Refer to Workshop Manual, Section 303-04C.

PART NUMBER	PART NAME
BC3Z-9A564-A	Leak Off Line
BC3Z-9H529-A	Fuel Injector (Cylinders 1, 2, 7, 8)
BC3Z-9H529-B	Fuel Injector (Cylinders 3, 4, 5, 6)

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
110610A	2011 F-Super Duty 6.7L Single Rear Wheel: Inspect Engine Wiring Harness Test And Replace The Fuel Injectors, And The Injector Return Hose	4.4 Hrs.
110610B	2011 F-Super Duty 6.7L Dual Rear Wheel: Inspect Engine Wiring Harness, Test And Replace The Fuel Injectors And The Injector Return Hose	4.7 Hrs.
MT110610	Claim Actual Time For Engine Wire Harness Repairs	Actual Time

DEALER CODING

BASIC PART NO.	CONDITION CODE
9A564	42

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford or Lincoln dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company's on-line technical resources.

Copyright © 2011 Ford Motor Company Online Publication Date June 14, 2011

6.7L—CALIBRATION UPDATE—VARIOUS ISSUES—BUILT ON OR BEFORE 7/25/2011

TSB 11-8-24

FORD:
2011 F-Super Duty

This article supersedes TSB **11-4-21** to update the Issue Statement and Service Procedure.

ISSUE

Some 2011 F-Super Duty vehicles equipped with a 6.7L engine and built on or before 7/25/2011 may exhibit malfunction indicator lamp (MIL) with diagnostic trouble code (DTC) P0884. Refer to the Calibration Content for additional calibration updates.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

Reprogram the powertrain control module (PCM) and the transmission control module (TCM) to the latest calibration using IDS release 74.03 and higher. This new calibration is not included in the VCM 2011.7 DVD. Calibration files may also be obtained at www.motorcraft.com.

NOTE

PLEASE ADVISE THE CUSTOMER THAT THIS VEHICLE IS EQUIPPED WITH AN ADAPTIVE TRANSMISSION SHIFT STRATEGY WHICH ALLOWS THE VEHICLE'S COMPUTER TO LEARN THE TRANSMISSION'S UNIQUE PARAMETERS AND IMPROVE SHIFT QUALITY. WHEN THE ADAPTIVE STRATEGY IS RESET, THE COMPUTER WILL BEGIN A RE-LEARNING PROCESS. THIS RE-LEARNING PROCESS MAY RESULT IN FIRMER THAN NORMAL UPSHIFTS AND DOWNSHIFTS FOR SEVERAL DAYS.

The Calibration Update Contains Improvement Actions And Enhancements To Address The Following:

- False DTC P0884 (PCM/TCM power input signal intermittent)

Previously Released - Calibration Content

Previously released calibration content included in IDS software release 69.07 and higher contained improvement actions and enhancements to address the following::

Calibration Content - Vehicles Built On Or Before 5/31/2010

- DTC P0134 O2 sensor circuit no activity detected (bank 1, sensor 1)

Calibration Content - Vehicles Built On Or Before 4/11/2010

- DTC P0401 (exhaust gas recirculation (EGR) flow insufficient detected)
- DTC P0402 (exhaust gas recirculation (EGR) flow excessive detected)
- DTC P009A (intake air temperature/ambient air temperature correlation) if driven at highway speeds with a snow plow attached
- Harsh/inconsistent transmission shifting during transmission fluid warm up
- Improved shift feel for tip-in events at low speed or when coming to a stop

Calibration Content - Vehicles Built On Or Before 11/5/2010

- Delayed manual upshifts from 1st to 2nd gear when in Select Shift mode while going down a grade
- Harsh/delayed 1-2 upshift and downshift
- DEF warning messages won't reset after refilling DEF tank with Key On Engine Running
- Modified vehicles for rail applications, that will not re-engage PTO operation or speedometer inoperative after riding on the tracks with the front wheels off the ground
- VSOUT signal inoperable from customer access circuits under dash

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford or Lincoln dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company's on-line technical resources.

TSB 11-8-24 (Continued)

- DTC P2463 or P246C (DPF restriction) and DTC P2459 (DPF regeneration frequency) - adds increased ability to perform manual regeneration at higher load values when performing system diagnostics

Calibration Content - Vehicles Built On Or Before 08/23/2010

- False DTC P132B (turbocharger/supercharger boost control A performance)
- False DTC P0299 (turbocharger/supercharger A under-boost condition)
- False DTC P050E (cold start engine exhaust temperature too low)
- False DTC P06EA (NOX sensor processor performance (bank 1, sensor 1)
- DTC P249C (SCR time to closed loop) - improved diagnostics and reporting
- DTC P249F (excessive time to enter closed loop DPF regeneration control) - improved diagnostics and reporting
- DTC(s) and freeze frame data being erased in the PCM when running KOEO, KOER, Datalogger, Active Commands or any other guided diagnostics with IDS
- False P0731 (gear 1 incorrect ratio)
- False P0732 (gear 2 incorrect ratio)
- False P0733 (gear 3 incorrect ratio)
- False P0734 (gear 4 incorrect ratio)
- False P0735 (gear 5 incorrect ratio)
- False P0729 (gear 6 incorrect ratio)
- Low speed/load engine surge
- Abrupt engine shutdown feel
- HP fuel pump knocking noise at idle
- Delayed DEF level indication after refill event
- Harsh/bumpy transmission upshifts/downshifts
- Delayed/harsh transmission engagement feel between R-D and D-R shifts
- Transmission gear hunting during speed control operation when climbing grades or climbing hills, particularly while towing
- Erratic transmission operation after descending grades while in 1st gear
- Flashes/delays of current gear indication when using SelectShift mode
- Added Brake Over Accelerator (BOA) feature - reduces engine power during off-idle driving when both the accelerator and brake pedals are applied simultaneously
- Added SelectShift memory feature so the SelectShift gear display comes back on whenever going back into drive if the vehicle was turned off while SelectShift mode was still activated
- Added engine protection feature from overspeed when descending long grades while towing and in manual gear ranges (forces transmission upshifts at 4000 RPM)
- Increased torque - during hill assist operation - (see Owner Guide for additional system operation)
- PTO operational enhancements - (applicable to vehicles equipped with optional PTO)

- Automatic secondary electronic idle controller (SEIC) turns on at engine start if the switch is in the on position

- Engine coolant temperature to operate PTO lowered to -7 °C (+20 °F)

- Improved RPM control with SEIC controllers

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
110824A	2011 F-Super Duty 6.7L: Check DTCs, Reprogram The PCM And TCM (Do Not Use With Any Other Labor Operations)	0.6 Hr.

DEALER CODING

	CONDITION CODE
BASIC PART NO.	
RECALEM	04

6.7L DIESEL—RUNS ROUGH/ENGINE CRANKS-NO START—DTCS P1291 AND/OR P1292

TSB 11-10-10

FORD:
2011-2012 F-Super Duty

This article supersedes TSB **11-6-10** to update the vehicle model years, Issue Statement, Service Procedure, Service Labor Time Standards and Part List.

ISSUE

Some 2011-2012 F-Super Duty vehicles equipped with a 6.7L engine may exhibit diagnostic trouble codes (DTC) P1291 and/or P1292 due to an internally shorted fuel injector. An internal short in a fuel injector may be caused by the fuel being contaminated with diesel exhaust fluid (DEF), or by fuel gelling.

ACTION

Follow the Service Procedure steps to correct the condition.

SERVICE PROCEDURE

1. Remove the fuel conditioning module mounted filter. Refer to Workshop Manual (WSM), Section 310-01.
2. Allow the filter and filter bowl to dry for two hours. Did the filter and or filter bowl turn white? (Figures 1 and 2)



Figure 1 - Article 11-10-10



Figure 2 - Article 11-10-10

   a. No - proceed to Step 3.
   b. Yes - Do not continue with this article. Fuel contamination is non-warrantable. The concern was caused by the fuel being contaminated with DEF. The complete high pressure fuel system and diesel fuel control module (DFCM) will need to be replaced. The base fuel system will need to be flushed. Refer to WSM, Section 303-04C for fuel system replacement.

3. Inspect the engine wiring harness (12B637) for wire chafes near the EGR cooler. Was a chafe present? (Figure 3)

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by “do-it-yourselfers”. Do not assume that a condition described affects your car or truck. Contact a Ford or Lincoln dealership to determine whether the Bulletin applies to your vehicle. Warranty Policy and Extended Service Plan documentation determine Warranty and/or Extended Service Plan coverage unless stated otherwise in the TSB article.The information in this Technical Service Bulletin (TSB) was current at the time of printing. Ford Motor Company reserves the right to supercede this information with updates.The most recent information is available through Ford Motor Company’s on-line technical resources.

Copyright © 2011 Ford Motor Company Online Publication Date October 10, 2011

TSB 11-10-10 (Continued)

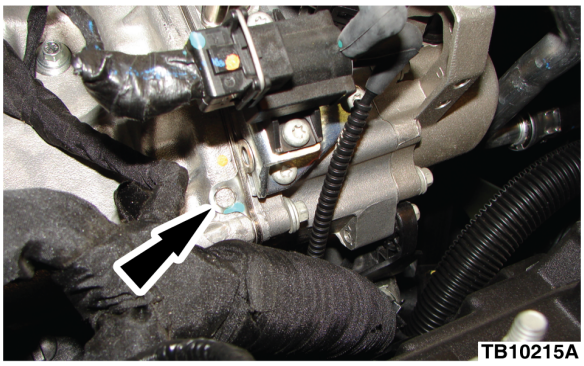


Figure 3 - Article 11-10-10

a. No - proceed to Step 4.

b. Yes - repair as necessary. Vehicles built on or before 5/26/2010: position the metal EGR cooler gasket tab eyelet rearward and flush with the cooler housing. Release vehicle.

4. Electrically disconnect each fuel injector for the suspect DTC P1291 injectors 1, 4, 6, 7 and/or DTC P1292 injectors 2, 3, 5, 8.

5. Check for continuity between the injector electrical pins and the injector body, is continuity present?

a. No - do not continue with this article, Refer to Powertrain Control/Emission Diagnostics (PC/ED) Manual for normal diagnostics.

b. Yes - replace all eight (8) fuel injectors and the injector return hose. Refer to WSM, Section 303-04C.

PART NUMBER	PART NAME
BC3Z-9A564-A	Injector Return Hose
BC3Z-9H529-A	Fuel injector (Cylinders 1, 2, 7, 8)
BC3Z-9H529-B	Fuel injector (Cylinders 3, 4, 5, 6)

WARRANTY STATUS: Eligible Under Provisions Of New Vehicle Limited Warranty Coverage And Emissions Warranty Coverage
IMPORTANT: Warranty coverage limits/policies are not altered by a TSB. Warranty coverage limits are determined by the identified causal part.

OPERATION	DESCRIPTION	TIME
111010A	2011-2012 F-Super Duty 6.7L Single Rear Wheel: Inspect Fuel Conditioning Module, Engine Wiring Harness, Test And Replace The Fuel Injectors, And The Injector Return Hose	4.7 Hrs.
111010B	2011-2012 F-Super Duty 6.7L Dual Rear Wheel: Inspect Fuel Conditioning Module, Engine Wiring Harness Test And Replace The Fuel Injectors, And The Injector Return Hose	4.9 Hrs
MT111010	Claim Actual Time For Engine Wire Harness Repairs	Actual Time

DEALER CODING

BASIC PART NO.	CONDITION CODE
9A564	42

EA11-003

FORD

1-20-2012

Appendix F2

EA11-003 Appendix F2

GCQIS Report Entry/Maintenance

GCQIS Technical Service Detail

Close Print Help

ArticleType : ISM **ArticleNumber :** 10-10-005 **Entered Date :** 10/07/2010 **Times Recommended :** 0

Date is displayed in **MM/DD/CCYY format**

6.7L HPP FUEL LEAK :

SOME 6.7 DIESELS MAY EXHIBIT A FUEL LEAK IN THE VALLEY. THE LEAK MAY BE DUE TO A DAMAGED PUMP SHAFT SEAL.

HIGH PRESSURE PUMPS (HPP) BUILT BETWEEN 7/12/10 AND 8/18/10 ARE SUSPECT AND SHOULD FALL WITHIN A VEHICLE BUILD DATE RANGE OF APPROXIMATELY 7/22/10 - 9/15/10.

THE DAMAGED SEAL WILL CAUSE AN EXTERNAL FUEL LEAK INTO THE ENGINE VALLEY THROUGH THE WEEP HOLE ON THE BOTTOM OF THE PUMP. PLEASE PERFORM NORMAL DIAGNOSTICS TO IDENTIFY THE LOCATION OF THE LEAK. IF THE DEALER STATES THE LEAK IS FROM THE MOUNTING AREA, SUSPECT THE SEAL IS LEAKING OUT OF THE WEEP HOLE AND CHECK THE VEHICLE AND PUMP BUILD DATES TO SEE IF THEY FALL INTO THE SUSPECT BUILD DATE RANGE. HPP PUMP REPLACEMENT IS REQUIRED TO CORRECT THE CONDITION.

AUTHOR: TLUSARDI (313)248 9543

Requester: Technical Service Detail
Server: ECCWS686

Ford Proprietary, Private

16-Nov-2011
Retention: None

EA11-003

FORD

1-20-2012

Appendix F3

Michael A. Berardi
Director
Service Engineering Operations
Ford Customer Service Division

Ford Motor Company
P. O. Box 1904
Dearborn, Michigan 48121

March 7, 2011

TO: All U.S. Ford and Lincoln Mercury Dealers

SUBJECT: **DEMONSTRATION / DELIVERY HOLD - Customer Satisfaction Program 11B23**
Certain 2008-2010 Model Year F-Super Duty Vehicles Equipped with a 6.4L Diesel Engine
Powertrain Control Module Recalibration

PROGRAM TERMS

This program will be in effect through March 31, 2012. There is no mileage limit for this program.

AFFECTED VEHICLES

Certain 2008-2010 model year F-Super Duty vehicles equipped with a 6.4L diesel engine built at the Kentucky Truck Assembly Plant from June 13, 2006 through February 5, 2010. Certain 2008-2009 model year F-Super Duty vehicles equipped with a 6.4L diesel engine built at the Cuautitlan Assembly Plant from December 5, 2006 through December 16, 2008. Affected vehicles are identified in OASIS. In addition, for a list of vehicles assigned to your dealership, visit https://web.fsavinlists.dealerconnection.com. This information will be available on March 7, 2011.

REASON FOR THIS PROGRAM

In some of the affected vehicles, customers could experience one or a combination of the following symptoms: illuminated Malfunction Indicator Light or Wrench Light, runs rough, reduced power, excessive smoke from the exhaust, fuel smell from the crankcase, coolant loss, and/or unusual engine noise. These symptoms could be caused by concerns that may eventually result in significant engine damage and a lengthy, costly service repair. Ford has developed calibration improvements to the Powertrain Control Module (PCM) with improved fault detection capabilities that allows the vehicle to quickly detect and react to issues before damage occurs.

SERVICE ACTION

Before demonstrating or delivering any of the vehicles involved in this program, dealers are to reprogram the Powertrain Control Module. This service must be performed on all affected vehicles at no charge to the vehicle owner. At the completion of this repair, dealership service management is to provide a copy of the "Customer Information Sheet" that is posted with this bulletin to the vehicle owner.

OWNER NOTIFICATION MAILING SCHEDULE

Owner Letters are expected to be mailed the week of March 7, 2011. Dealers should repair any affected vehicles that arrive at their dealerships, whether or not the customer has received a letter.

© Copyright 2011 Ford Motor Company

ATTACHMENTS

Attachment I: Administrative Information
Attachment II: Labor Allowances and Parts Ordering Information
Attachment III: Technical Information
Customer Information Sheet
Owner Notification Letter

QUESTIONS & ASSISTANCE

Special Service Support Center (Dealer Assistance Only) 1-800-325-5621

Sincerely,

Michael A. Berardi

© Copyright 2011 Ford Motor Company

ATTACHMENT I
Page 1 of 2

DEMONSTRATION / DELIVERY HOLD - Customer Satisfaction Program 11B23
Certain 2008-2010 Model Year F-Super Duty Vehicles Equipped with a 6.4L Diesel Engine
Powertrain Control Module Recalibration

OASIS ACTIVATED?

Yes, OASIS will be activated on March 7, 2011.

FSA VIN LIST ACTIVATED?

Yes, FSA VIN list will be available through https://web.fsavinlists.dealerconnection.com by March 7, 2011. Owner names and addresses will be available by March 14, 2011.

NOTE: Your FSA VIN list may contain owner names and addresses obtained from motor vehicle registration records. The use of such motor vehicle registration data for any purpose other than in connection with this program is a violation of law in several states, provinces, and countries. Accordingly, you must limit the use of this listing to the follow-up necessary to complete this service action.

STOCK VEHICLES

Correct all affected units in your new vehicle inventory before delivery.

SOLD VEHICLES

- Owners of affected vehicles will be directed to dealers for repairs.
- Immediately contact any of your affected customers whose vehicles are not on your VIN list but are identified in OASIS. Give the customer a copy of the Owner Notification Letter (when available) and schedule a service date.
- Correct other affected vehicles identified in OASIS which are brought to your dealership.

TITLE BRANDED / SALVAGED VEHICLES

Affected title branded and salvaged vehicles are eligible for this service action.

RELATED DAMAGE

If a related damage condition exists that you believe to be caused by the covered condition, call the Special Service Support Center to request approval **prior** to the repair of any related damage. Requests for approval after completion of the repair will not be granted. Ford Motor Company reserves the right to deny coverage for related damage in cases where the vehicle owner has not had this service action performed on a timely basis.

© Copyright 2011 Ford Motor Company

DEMONSTRATION / DELIVERY HOLD - Customer Satisfaction Program 11B23
Certain 2008-2010 Model Year F-Super Duty Vehicles Equipped with a 6.4L Diesel Engine
Powertrain Control Module Recalibration

ADDITIONAL LABOR TIME

- If a condition exists that requires additional labor to complete the repair, call the Special Service Support Center to request approval **prior** to performing any additional labor. Requests for approval after completion of the repair will not be granted.
- If you encounter aftermarket equipment or modifications to the vehicle which might prevent the repair of the covered condition, call the Special Service Support Center.

OWNER REFUNDS

Refunds are not authorized for this program.

RENTAL VEHICLES

With proper parts ordering and service appointment scheduling, rental vehicles should not be required. However, if you have a unique circumstance which may require a rental vehicle, please contact the Special Service Support Center at 1-800-325-5621.

CLAIMS PREPARATION AND SUBMISSION

- Enter claims using Direct Warranty Entry (DWE).
- Refer to ACESII manual for claims preparation and submission information.
- Related damage must be claimed on a repair line that is separate from the repair line on which the FSA is claimed. Related damage requires prior approval from the Special Service Support Center.
- "MT" labor should be submitted on a separate repair line with the related damage flag checked. "MT" labor requires prior approval from the Special Service Support Center.
- PROGRAM TERMS: This program will be in effect through March 31, 2012. There is no mileage limit for this program.

© Copyright 2011 Ford Motor Company

ATTACHMENT II
Page 1 of 1

DEMONSTRATION / DELIVERY HOLD - Customer Satisfaction Program 11B23
Certain 2008-2010 Model Year F-Super Duty Vehicles Equipped with a 6.4L Diesel Engine
Powertrain Control Module Recalibration

LABOR ALLOWANCES

Description	Labor Operation	Labor Time
Reprogram the Powertrain Control Module, Transmission Control Module, and Instrument Cluster (if needed) - Automatic Transmission	11B23B	0.5 Hour(s)
Reprogram the Powertrain Control Module and Instrument Cluster (if needed) – Manual Transmission	11B23C	0.4 Hour(s)

PARTS REQUIREMENTS / ORDERING INFORMATION

Parts are not required to complete this repair.

© Copyright 2011 Ford Motor Company

DEMONSTRATION / DELIVERY HOLD — CUSTOMER SATISFACTION PROGRAM 11B23 CERTAIN 2008-2010 MODEL YEAR F-SUPER DUTY VEHICLES EQUIPPED WITH A 6.4L DIESEL ENGINE — POWERTRAIN CONTROL MODULE RECALIBRATION

OVERVIEW

In some of the affected vehicles, customers could experience one or a combination of the following symptoms: illuminated Malfunction Indicator Light (MIL) or Wrench Light, runs rough, reduced power, excessive smoke from the exhaust, fuel smell from the crankcase, coolant loss, and/or unusual engine noise. These symptoms could be caused by concerns that may eventually result in significant engine damage and a lengthy, costly service repair. Dealers are to reprogram the Powertrain Control Module (PCM), and if applicable the Transmission Control Module (TCM) and Instrument Cluster (IC).

SERVICE PROCEDURE

Module Reprogramming

NOTE: Reprogram appropriate vehicle modules before performing diagnostics and clear all Diagnostic Trouble Codes (DTCs) after programming. For DTCs generated after reprogramming, follow normal diagnostic service procedures.

1. Connect a battery charger to maintain battery charge during this reprogramming procedure.
2. Reprogram the PCM to the latest calibration using Integrated Diagnostic System (IDS) release 71.04 and higher. Calibration files may also be obtained at www.motorcraft.com. When reprogramming the PCM on automatic transmission equipped vehicles, the TCM will also be automatically reprogrammed to the latest level.
3. Using the IDS, check the IC to verify it has the latest calibration installed. If the IC does not have the latest calibration installed, it will need to be reprogrammed to bring it up to the latest calibration.

Important Information For Module Programming

NOTE: When programming or reprogramming a module, use the following basic checks to ensure programming completes without errors.

- Make sure the battery is fully charged before carrying out the programming steps and connect IDS/scan tool to a power source.
- Inspect Vehicle Communication Module (VCM) and cables for any damage, make sure scan tool connections are not interrupted during programming.
- A hardwired internet connection is strongly recommended.
- Turn off all unnecessary accessories (radio, heated/cooled seats, head lamps, interior lamps, HVAC system, etc.), close doors.
- Disconnect/depower any aftermarket accessories (remote start, alarm, power inverter, CB radio, etc.).
- Follow all scan tool on-screen instructions carefully.
- Disable IDS/scan tool sleep mode, screensaver, hibernation modes.
- Create all sessions Key On Engine Off (KOEO). Starting the vehicle before creating a session will cause errors within the programming inhale process.

CPR © 2011 FORD MOTOR COMPANY
DEARBORN, MICHIGAN 48121
02/2011

Recovering a PCM/Smart Junction Box (SJB) when programming has resulted in a blank module:
NEVER DELETE THE ORIGINAL SESSION!

1. Obtain the original IDS that was used when the programming error occurred during Module Reprogramming (MR) or Programmable Module Installation (PMI).
2. Disconnect the VCM from the data link connector (DLC) and the IDS.
3. Reconnect the VCM to IDS and then connect to the DLC. Once reconnected, the VCM icon should appear in the corner of the IDS screen. If it does not, troubleshoot the IDS to VCM connection.
4. Locate the ORIGINAL vehicle session when programming failed. This should be the last session used in most cases. If not, use the session created on the date that the programming failed.

NOTE: If the original session is not listed in the previous session list, click the "Recycle bin" icon at the lower right of the previous session screen. This will load any deleted sessions and allow you to look through them. Double-click the session to restore it.

5. Once the session is loaded, the failed process should resume automatically.
6. If programming does not resume automatically, proceed to the Module Programming menu and select the previously attempted process, Programmable Module Installation (PMI) or Module Reprogramming.
7. Follow all on-screen prompts/instructions.
8. Near the end of programming, the IDS will prompt you to select certain parameters. It is important to make a selection for ALL parameters listed. If the correct selection is already highlighted, you must still choose that selection before clicking the "Tick" mark to complete the configuration.
9. The last screen on the IDS may list additional steps required to complete the programming process. Make sure all applicable steps listed on the screen are followed in order.

NOTE: AUTOMATIC VEHICLES ONLY: Please advise the customer that this vehicle is equipped with an adaptive transmission shift strategy which allows the vehicle's computer to learn the transmission's unique parameters and improve shift quality. When the adaptive strategy is reset, the computer will begin a relearning process. This relearning process may result in firmer than normal upshifts and downshifts for several days.

NOTE: Remind dealership service management that they must provide a copy of the Customer Information Sheet to the vehicle owner.

CPR © 2011 FORD MOTOR COMPANY
DEARBORN, MICHIGAN 48121
02/2011



Ford Motor Company
Ford Customer Service Division
P. O. Box 1904
Dearborn, Michigan 48121

March 2011

Customer Satisfaction Program 11B23

Mr. John Sample
123 Main Street
Anywhere, USA 12345

Your Vehicle Identification Number: 12345678901234567

At Ford Motor Company, it has been our goal for more than 100 years to provide customers with high-quality, dependable products. In order to maintain these standards, Ford Motor Company is providing a no-charge Customer Satisfaction Program (Program Number 11B23) for your vehicle, with the Vehicle Identification Number shown above.

Why are we providing this service?

In order to avoid potentially time consuming and costly service repairs, Ford has developed calibration improvements to the Powertrain Control Module (PCM) for your vehicle with improved fault detection capabilities. This will allow the vehicle to quickly detect and react to issues before significant damage occurs. Some examples include water-in-fuel reduced power mode, engine coolant temperature monitoring, over-full engine oil level, and proper circulation within the engine oil cooler. Your dealer will provide more detailed information after the service is complete.

What will Ford and your dealer do?

In the interest of customer satisfaction, Ford Motor Company has authorized your dealer to reprogram the Powertrain Control Module free of charge (parts and labor) under the terms of this program.

This Customer Satisfaction Program will be in effect until March 31, 2012 regardless of mileage. Coverage is automatically transferred to subsequent owners.

How long will it take?

The time needed for this repair is less than one-half day. However, due to service scheduling requirements, your dealer may need your vehicle for a longer period of time

What should you do?

Please call your dealer without delay and request a service date for Customer Satisfaction Program 11B23. Provide the dealer with the Vehicle Identification Number (VIN) of your vehicle. The VIN is printed near your name at the beginning of this letter.

If you do not already have a servicing dealer, you can access www.Fordowner.com for dealer addresses, maps, and driving instructions.

© Copyright 2011 Ford Motor Company

Ford Motor Company wants you to have this service action completed on your vehicle. The vehicle owner is responsible for making arrangements to have the work completed. Ford Motor Company can deny coverage for any vehicle damage that may result from the failure to have this service action performed on a timely basis. Therefore, please have this service action performed as soon as possible.

What if you no longer own this vehicle?

If you no longer own this vehicle, and have an address for the current owner, please forward this letter to the new owner.

You received this notice because our records, which are based primarily on state registration and title data, indicate that you are the current owner.

Can we assist you further?

If you have difficulties getting your vehicle repaired promptly and without charge, please contact your dealership's Service Manager for assistance.

RETAIL OWNERS: If you still have concerns, please contact the Ford Motor Company Customer Relationship Center at 1-866-436-7332 and one of our representatives will be happy to assist you. For the hearing impaired call 1-800-232-5952 (TDD). Representatives are available Monday through Friday: 8:00AM - 5:00PM (Your Local Time).

If you wish to contact us through the Internet, our address is: www.Fordowner.com

FLEET OWNERS: If you still have concerns, please contact the Fleet Customer Information Center at 1-800-34-FLEET, Option #3 and one of our representatives will be happy to assist you. Representatives are available Monday through Friday: 8:00AM - 5:00PM (Your Local Time).

Or you may contact us through the Internet at www.fleet.ford.com.

MOTORHOME OWNERS: If you still have concerns, please contact the Motorhome Customer Assistance Center toll free at 1-866-906-9811. Representatives are available 24 hours a day.

Thank you for your attention to this important matter.

Ford Customer Service Division

© Copyright 2011 Ford Motor Company

11B23 Calibration Update
6.4L Diesel Engine
Customer Information Sheet

Your vehicle's Powertrain Control Module (PCM) has been updated with improved fault detection capabilities to minimize engine related repair costs. Below is a list of enhanced warning features in the new update:

- Water In Fuel Reduced Power Mode
- Engine Coolant Temperature Monitoring
- Overfilled Crankcase Detection (excessive oil level)
- Oil Cooler Efficiency Detection
- Turbocharger Overboost Detection

When a fault is detected in these areas, the PCM may implement the following:

- Wrench Light Illumination
- Reduce the Engine Power (limp home operation)
- Instrument Cluster Displays "reduced engine power"

If the vehicle exhibits one of these symptoms, you should return to your dealer for service. Refer to the Owner Guide for more information.

We understand that it may be inconvenient to take your vehicle in for service due to a warning light or limp-home operation. However, these warnings will help to avoid potential engine damage and time consuming, costly service repairs.

Also, if your Instrument Cluster Message Center was not updated previously, it may now display new powertrain status information.

Automatic transmission equipped vehicles only: Your vehicle is equipped with an adaptive transmission shift strategy which allows the vehicle's computer to learn the transmission's unique parameters and improve shift quality. When your PCM is updated, the adaptive strategy is reset and the computer will begin a re-learning process. This re-learning process may result in firmer than normal up shifts and downshifts for several days.

Thank you for having Customer Satisfaction Program 11B23 completed on your vehicle.

© Copyright 2011 Ford Motor Company

EA11-003

FORD

1-20-2012

Appendix F4

Water in Fuel / Non-Warrantable Fuel System Repair Job Aid

Introduction

Returned 6.4L fuel system components have shown that water in fuel is a major contributor to metal debris in the high and low pressure fuel systems. Water in fuel may cause rust and corrosion to form within the fuel systems. Fuel system failure due to water is not eligible for warranty coverage. Water may enter the fuel system for a variety of reasons, some of which are listed below:

- Insufficient fuel filter maintenance
- Use of filters that do not meet or exceed Ford Motor Company specifications
- Insufficient Water in Fuel (WIF) separator maintenance (Refer to Owner Guide, Diesel Supplement)
- Failure to act upon WIF warning light/message in the instrument cluster
- Use of non-approved fuels (e.g. bio-diesel exceeding 5%)
- Use of aftermarket fuel additives that do not meet or exceed Ford Motor Company specifications
- Water in fuel content that exceeds American Society for Testing of Materials (ASTM) standards

Preliminary Inspection Points

The following are recommended system inspection points for evidence of water in fuel. These preliminary inspections cannot be used as a sole indicator to determine fuel system warranty eligibility.

- Secondary fuel filter housing—filter removed (Figures 1-4)
- Visual appearance of fuel from the secondary filter housing
    - Standing water (Figure 5)
    - Cloudy—emulsified water and fuel (Figure 6)
- Primary and Secondary fuel filters

Insufficient fuel filter maintenance may affect the ability of the fuel system to separate water from fuel.
The WIF warning lamp/message function is based on water accumulation within the Horizontal Fuel Conditioning Module (HFCM) water reservoir triggering the WIF sensor.

Rust and Corrosion in Secondary Fuel Filter Housing

Figure 1



Figure 2



Figure 3



Figure 4



Water-in-Fuel Contamination

Figure 5



Figure 6



Primary and Secondary Fuel Filters – Insufficient Maintenance

Figure 7



Figure 8



Inspection of the Internal Transfer Pump

The Internal Transfer Pump (ITP) is located inside the High Pressure Fuel Injection Pump. Physical inspection of the ITP for rust or corrosion is required to determine fuel system warranty eligibility. Rust/corrosion within the ITP is confirmation of fuel system damage due to water/contaminated fuel. Fuel system damage due to water/contaminated fuel is not eligible for warranty coverage. Refer to Warranty and Policy Manual for additional information.

ITP Inspection Procedure

1. Remove the High Pressure Fuel Injection Pump. Refer to WSM, Section 303-04.
2. Place the pump assembly on a bench with the ITP cover facing up. (Figure 9)
3. Remove the 3 fasteners (6mm hex) and the ITP cover.

Figure 9



NOTE: The ITP cover should only be removed for inspection when the high pressure fuel injection pump has been confirmed to be failed and the high pressure fuel system contaminated with debris, per Powertrain Control/Emissions Diagnosis (PC/ED) manual, Hard Start/No Start diagnostic procedure, step 28.

4. Inspect surfaces under the ITP cover for evidence of rust/corrosion to determine if pump has been damaged by water contamination. (Figures 10-13)

Corrosion under the Internal Transfer Pump Cover

Figure 10

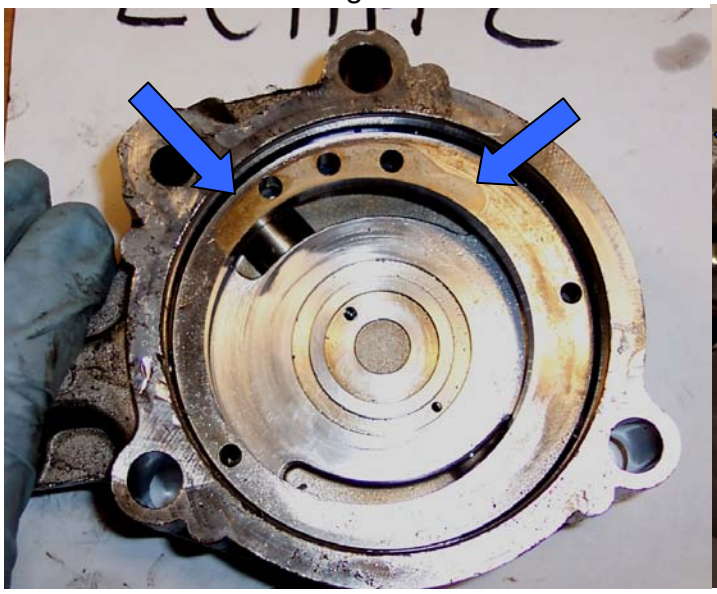


Figure 11

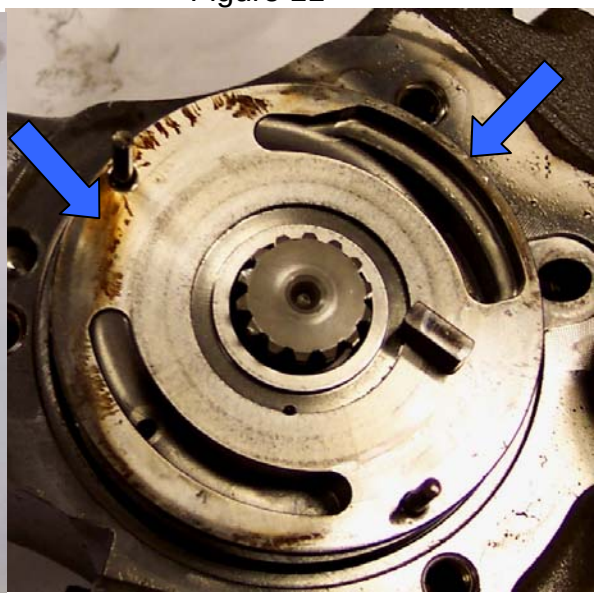


Figure 12

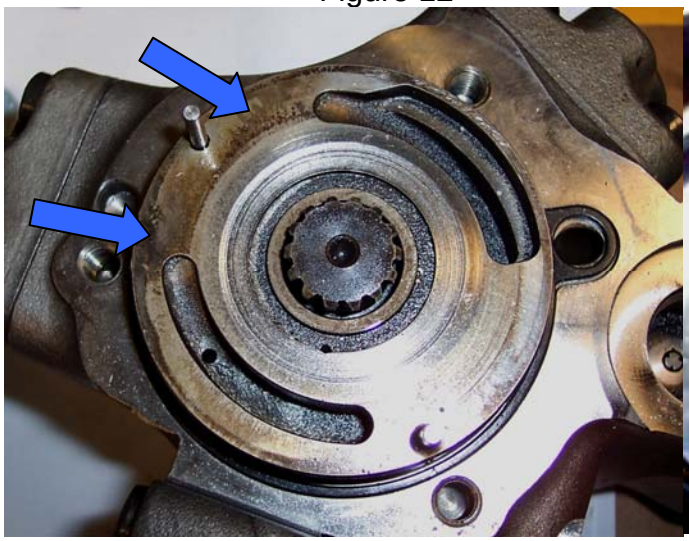


Figure 13



Fuel system components to be <u>replaced</u> when rust/corrosion is found in the ITP inspection:

Part Number (Qty)	Part Common Name	* Kit contains
9A543 (1)	High Pressure Pump assy	N/A
9G805 * (1)	High Pressure Pump gasket kit	▪ High pressure pump gaskets ▪ High pressure pump-to-fuel rail manifold fuel lines
9N103 (1)	Fuel Cooler assy	N/A
9H529 * (8)	Fuel Injector kit	▪ Fuel injector ▪ Jumper tube ▪ Fuel injector gaskets
8C3Z- 9T287-CA * (1)	LH and RH Fuel Rail Manifold kit	▪ LH fuel rail manifold ▪ RH fuel rail manifold
9N184 * (1)	Fuel Filter kit	▪ Primary fuel filter ▪ Secondary fuel filter
9G756 (1)	Fuel Pressure Sensor	N/A
9C330 (1)	Fuel supply line	N/A
9C148	Secondary fuel filter housing	N/A

<u>9G282 HFCM to be inspected and replaced</u> if there is visible metal debris <u>in</u> the HFCM during <u>filter</u> replacement or visible metal debris in the fuel tank.

Fuel system components to be <u>flushed and re-used</u> when rust/corrosion is found in the ITP inspection:

NOTE: Low pressure lines are to be flushed unless rust is found within the line. Rust inside a low pressure line requires line replacement.

Part Number	Part Common Name	* Kit contains
9B337 A/B	Low pressure return lines	N/A
9N104	Low pressure return lines	N/A
9C273	Low pressure return lines	N/A
9002	Fuel Tank (Inspect interior)	N/A

Water in Fuel Light/Message Operation

Overview

The Water in Fuel warning monitors a level of water accumulated in the Horizontal Fuel Control Module (HFCM) using the Water in Fuel sensor. Water is separated within the HFCM by the primary fuel filter. The indication of an amount of water in the HFCM can take the form of a Water in Fuel light in the instrument cluster, or Water in Fuel warning message – depending on vehicle build level. The actual activation of the Water in Fuel warning (light or message) is controlled by the Powertrain Control Module (PCM) through an integrated strategy to prevent false Water in Fuel warnings due to normal fuel slosh in the HFCM.

Vehicles with calibrations before IDS release 71.04

- The PCM monitors the Water in Fuel sensor and other inputs to determine that an amount of water is present in the HFCM.
- The PCM communicates with the instrument cluster to activate the Water in Fuel warning (light/message), and stores a P2269 code in continuous memory.
- There are no PCM directed changes to vehicle driveability if a Water in Fuel monitor condition is met.

Vehicles with calibrations from IDS release 71.04 and greater

For vehicles with updated calibrations, there are new Water in Fuel fault detection capabilities added that will be noticeable to owners.

- If a Water in Fuel monitor condition is met and not addressed (within 60 minutes or 60 miles) by draining the HFCM, the vehicle will exhibit the following:
  - Wrench Light Illumination
  - Engine power will be reduced
  - Instrument Cluster Displays "Reduced Engine Power"
  - Once the Water in Fuel monitor condition is corrected, the vehicle will return to normal operation.
- A Water in Fuel monitor has been added to detect water build-up during extended idle (2-4 hours).
  - If a Water in Fuel monitor condition is met, a visible warning (Water in Fuel light/Water in Fuel message/Wrench Light) will be displayed. The vehicle will then operate in a reduced Engine Power (reduced torque) mode.
  - Once the Water in Fuel monitor condition is corrected, the vehicle will return to normal operation.

6.7L Diesel Fuel System Contamination Diagnosis and Service Procedure Job Aid

(Revised September, 2011)

Fuel system contamination on 6.7L diesel engines can damage the fuel system components including the High Pressure (HP) fuel injection pump and fuel injectors. Engine operation on fuels and additives that do not meet the lubrication, cooling and anti-corrosion properties required by the HP fuel system components may cause symptoms including, but not limited to, the following:

- Crank No Start
- Long Crank/Hard Start
- Runs Rough
- Low Power
- Engine Knocking
- Exhaust Smoke
- Fuel Rail Pressure (FRP) slow to build

Follow the appropriate service procedure depending on whether the engine has been started with contaminated fuel, or not.

NOTE: *Failure to follow these procedures may result in fuel system and/or engine damage and may require vehicle warranty cancellation submission. Repairs required due to the use of improper fluids and fuel are not covered by the New Vehicle Limited Warranty. See Warranty and Policy Manual and Customer Information Guide for details.*

NOTE: *The most common sources of contaminated fuel are:*

- *Auxiliary vehicle mounted tanks*
- *Local storage tanks*
- *Other infrequently used fuel sources*
- *Refueling errors (i.e. Diesel Exhaust Fluid (DEF) or gasoline introduced into the fuel tank)*

The best action that can be taken to avoid concerns with the fuel system is to ensure vehicles are only fueled from sources with known quality diesel fuels verified to be free from water and other contaminants.

Fuel Quality Verification/Indicators

1. Using an appropriate container, obtain a fuel sample from the Diesel Fuel Conditioning Module (DFCM) water drain. Refer to the vehicle Owner Guide for additional information, if necessary.

2. Let fuel sample sit for 10-15 minutes.

3. Visually inspect fuel sample to help determine type of contamination. Refer to the Fuel Contamination Table and Reference Photos to further aid in determining type of fuel contamination. See Figure 8 for an example of DEF-contaminated fuel.

4. Remove the DFCM fuel filter cover and the primary fuel filter element.

5. Allow both filter and cover to dry for 2 hours.

6. Visually inspect for formation of white crystals as listed below and as shown in the Reference Photos. White crystal formation is an indicator of DEF contamination.

    a) DFCM filter cover (Figures 9 and 10)
        - Separation of DEF and fuel upon DFCM cover removal (non-warrantable contamination example)
        - DEF crystal growth after 2 hours dry time (non-warrantable contamination example)

b) Primary Fuel Filter Element After 2 Hours Dry Time (Figure 11)
DEF crystal growth (non-warrantable contamination example)

c) Secondary Fuel Filter Ports After 2 Hours Dry Time (Figure 12)
DEF crystal growth on ports (non-warrantable contamination example)

d) DFCM Upper Housing After 2 Hours Dry Time (Figure 13)
DEF crystal growth (non-warrantable contamination example)

If DEF contamination is found at the primary fuel filter, filter cap or housing, discontinue inspections and perform procedure A.

7. If fuel sample is acceptable and no white crystal formation is found, proceed to step 8—component inspections.

8. Component inspections for corrosion

NOTE: *Removal of fuel system components may be required to further determine contamination type and extent of system damage.*

a) Key Components and Locations (Figures 1 & 2)
1 – Pressure Control Valve (PCV)
2 – Volume Control Valve (VCV)
3 – High Pressure Pump Outlet Ports
4 – High Pressure Pump Overflow Valve

b) PCV (Figure 3)
A – PCV valve with corrosion (non-warrantable corrosion example)
B – PCV valve with no corrosion (normal appearance)

c) VCV (Figure 4)
A – VCV with rust particle contamination (non-warrantable rust contamination example)
B – Corrosion and rust on VCV outlet ring (non-warrantable corrosion example)
C – Crystal growth from DEF contamination after 2-hour dry time (non-warrantable contamination example)

d) High Pressure Pump Outlet Ports (Figure 5)
Corrosion on high pressure pump outlet port bore (non-warrantable corrosion example)

e) High Pressure Pump Overflow Valve (Figures 6 & 7)
Corrosion on high pressure pump overflow valve ports (non-warrantable corrosion example)

9. If fuel tank has been contaminated with gasoline, Diesel Exhaust Fluid (DEF), or any other non-diesel fluid and engine has been started, perform 'Procedure A'.

10. If fuel tank has been contaminated with gasoline, DEF, or any other non-diesel fluid and engine has NOT been started, perform 'Procedure B'.

11. Perform Fuel System Bleeding – Diesel Engine, in order to get the engine started. Refer to Workshop Manual (WSM), Section 310-00.

12. Change engine oil and replace oil filter.

13. Using a scan tool, perform High Pressure Fuel System Test to check system for leaks. Repair as necessary.

Procedure A – Fuel Contaminated, Engine Started

1. Drain fuel tank completely by removing the tank and cleaning to prevent the possibility of reintroducing contamination. (Dispose of contaminated fuel in accordance with local laws and regulations.)
2. Fill fuel tank with fresh, clean, good quality diesel fuel.

NOTE: *Leave original fuel filters, HP injection pump, fuel lines, fuel rails and injectors in place until flushing procedure is completed to prevent contamination of replacement components.*

3. Using an appropriate container, drain DFCM of any residual liquids.
4. Perform Fuel System Flush. Refer to **Procedure C**, below.

NOTE: *The DFCM must be inspected during filter replacement to verify no low pressure fuel system damage. If DEF contamination is present, the DFCM must be replaced.*

5. Replace both fuel filters (primary and secondary).
6. Replace ALL High Pressure fuel system components;

- High Pressure Fuel Pump
- Engine mounted high pressure fuel lines
- Both high pressure fuel rails
- Eight fuel injectors
- Low pressure fuel injector return hose assembly
- Fuel delivery pressure switch (located on the engine low pressure line near the secondary fuel filter)

NOTE: *All remaining low pressure fuel lines can be reused if no physical damage is present.*

Procedure B – Fuel Contaminated, Engine NOT Started

1. Drain fuel tank completely by removing the tank and cleaning to prevent the possibility of reintroducing contamination. (Dispose of contaminated fuel in accordance with local laws and regulations.)
2. Fill fuel tank with fresh, clean, good quality diesel fuel.
3. Using an appropriate container, drain DFCM of any residual liquids.

NOTE: *The DFCM must be inspected during filter replacement to verify no low pressure fuel system damage.*

4. Replace both fuel filters (primary and secondary).
5. Perform Fuel System Flush. Refer to Procedure C, below.)

Procedure C – Fuel System Flush

1. Remove the rear Fuel Cooler Line that returns to the fuel tank at the fuel cooler.
2. Install a 3-foot length of 3/8-inch diameter fuel hose over the fuel cooler nipple.
3. Place the open end of the hose into a suitable container.
4. Use Scan Tool Active Commands or cycle the key to activate the low pressure fuel pump to flush the lines.

Contamination Reference Table

NOTE: Fuel contamination can be, but is not limited to, dirt/debris, water, biodiesel (greater than 20%), incorrect fuel additives, gasoline, kerosene, DEF, etc.

NOTE: Current fuel samples obtained from the vehicle may not be reflective of the vehicle's previous fuel quality levels and should not be used as the 'sole' indicator of fuel quality.

Contaminant	Symptom	Effect	Indicator
Gasoline / Ethanol / Kerosene / Alternative Fuels	Crank no start, poor driveability, low fuel pressure on HP and/or low pressure (LP) side, engine combustion knock	Premature HP pump and fuel injector wear, debris, NO rust/corrosion, distortion of materials	Fuel sample, odor, fuel aeration Note: The elastomeric valves in the tank Diesel fuel Delivery Module (DDM) can distort with aggressive fuels (aggressive biodiesel, gasoline or ethanol blends) and result in increased air in fuel and poor low fuel level system performance.
Water	Crank no start, reduced power mode, poor driveability	Premature HP pump and injector wear, debris, rust/corrosion	Fuel sample, corrosion as shown in Figures 3-7 (can have water damage throughout system if large enough quantity is ingested)
Excessive Biodiesel (Greater than 20%)	Low fuel pressure on HP and/or LP side, poor driveability	Premature HP pump and injector wear, debris, rust/corrosion, bacterial/ fungus growth	Rust/corrosion as shown in Figures 3-7 due to increased water content (excessive biodiesel decreases water separation capability), bacterial/fungus growth, aeration. Note: The elastomeric valves in the tank DDM can distort with aggressive fuels (aggressive biodiesel, gasoline or ethanol blends) and result in increased air in fuel and poor low fuel level system performance.
Incorrect Fuel Additives (alcohol based and other)	Low fuel pressure on HP and/or LP side, poor driveability	Premature HP pump and fuel injector wear, may have rust/corrosion, or only debris	Rust/Corrosion if water emulsifies and prevents fuel, water separation
Insufficient Maintenance of Fuel Filters	Crank no start, reduced power mode, poor driveability, low fuel pressure on HP and/or LP side	Premature HP pump and fuel injector wear, HP or LP pump noise or failure, debris, may have rust/corrosion, decreased efficiency of water separation/plugged filters/ collapsed filters	Rust/corrosion as shown in Figures 3-7 due to increased water content, HP pump damage due to debris, factory filters installed beyond service interval (TIP: Factory secondary filter is a 3-port type. Service replacement is a 2-port type), collapsed or water-laden primary filter
DEF	Crank no start, reduced power mode, poor driveability	Premature HP pump and fuel injector wear, debris, pitting/corrosion, distortion of materials, plugged fuel injector return line	Fuel sample, odor, white crystal residue on components when dried
Foreign Materials (sand, dirt, metallic particles, etc)	Crank no start, fuel pump noise	Low fuel pressure, HP or LP pump failure	Noise from DFCM, debris on VCV inlet screen or inside HP pump

Location of Inspection Points

Figure 1

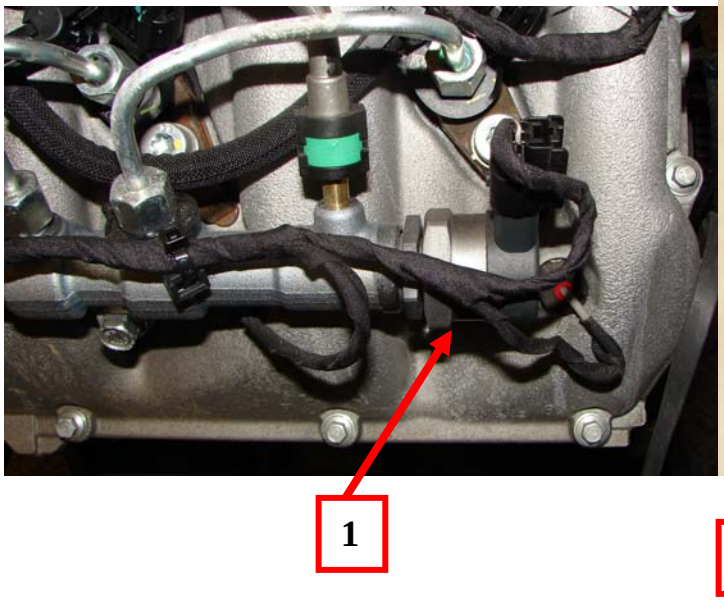


Figure 2

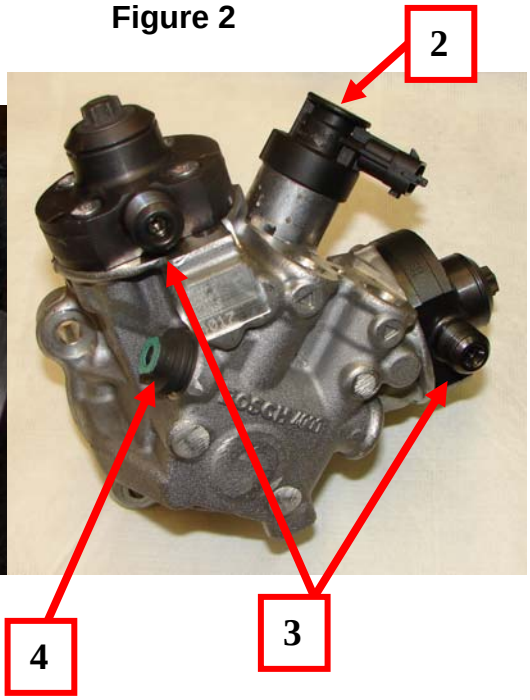


Figure 3

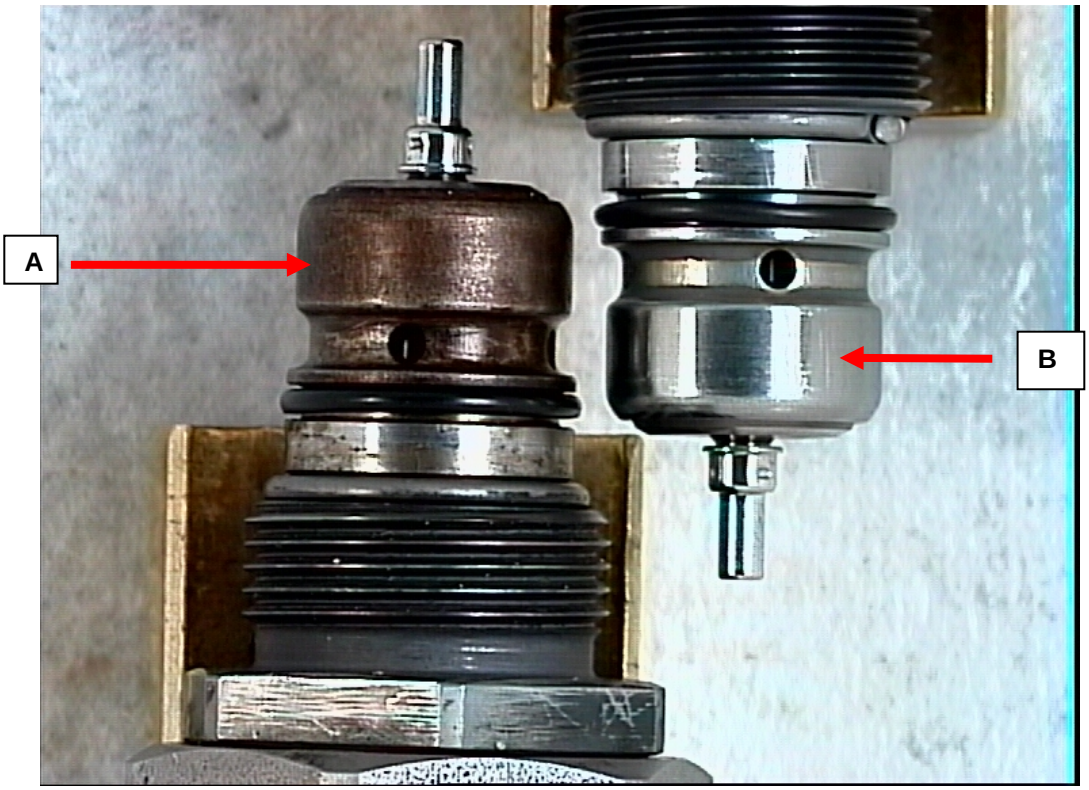


Figure 4

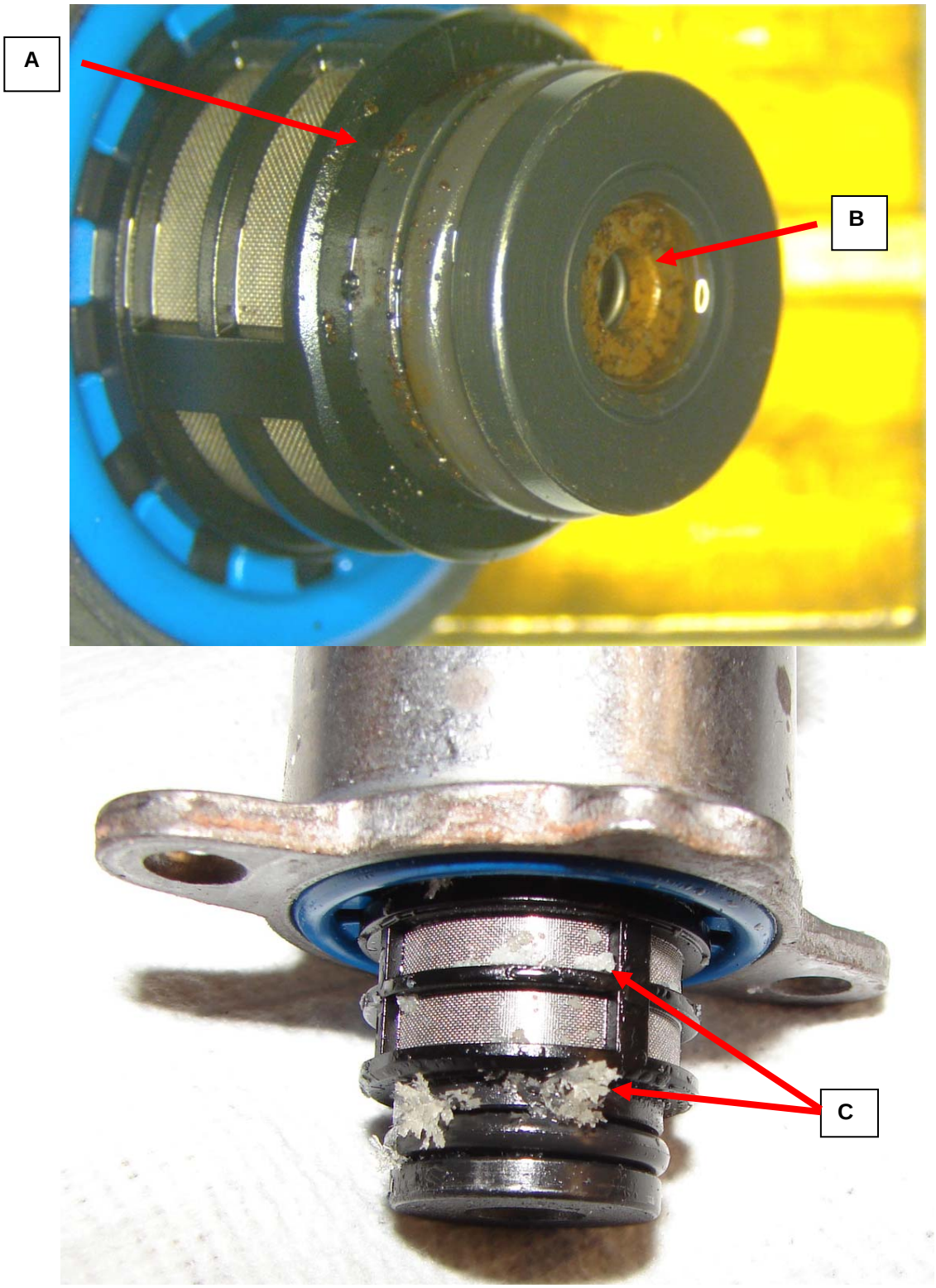


Figure 5



Figure 6



Figure 7

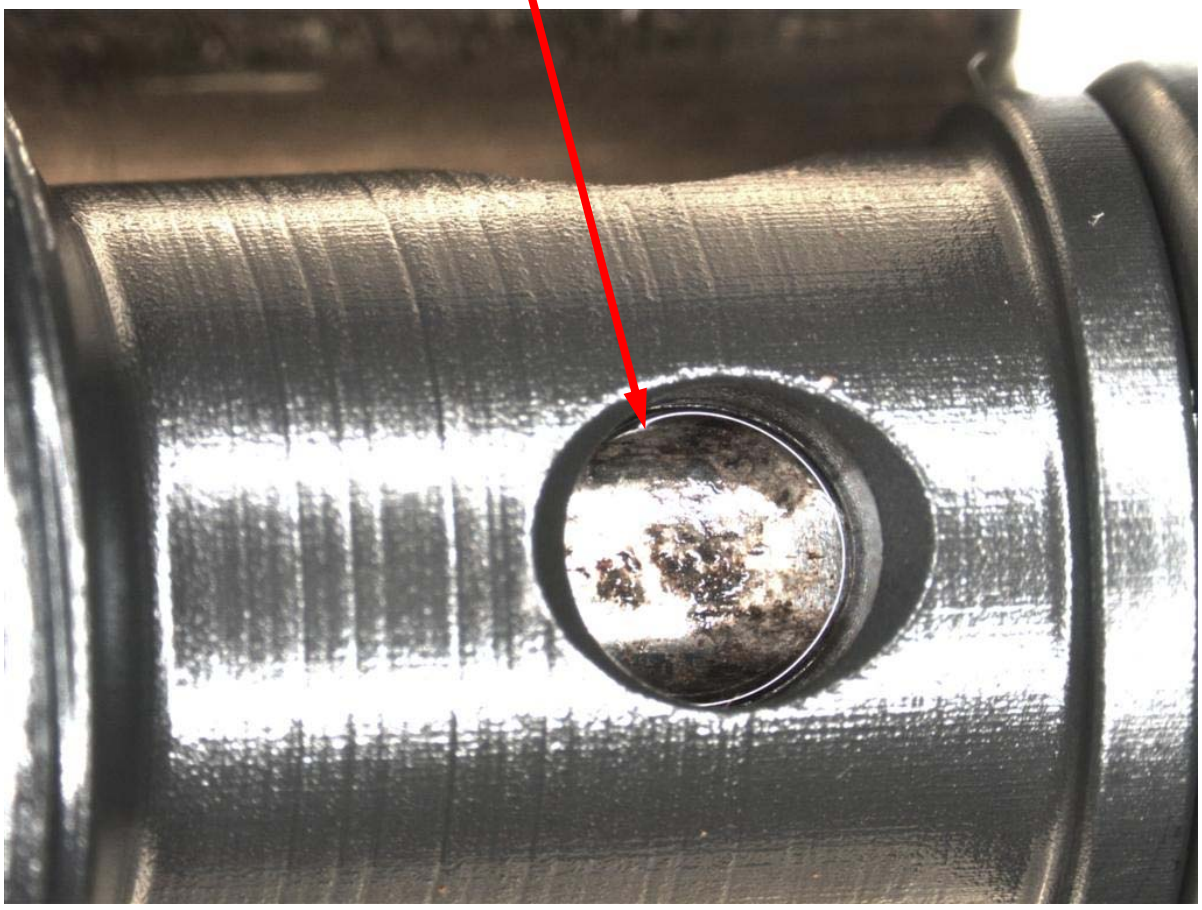


Figure 8



Figure 9

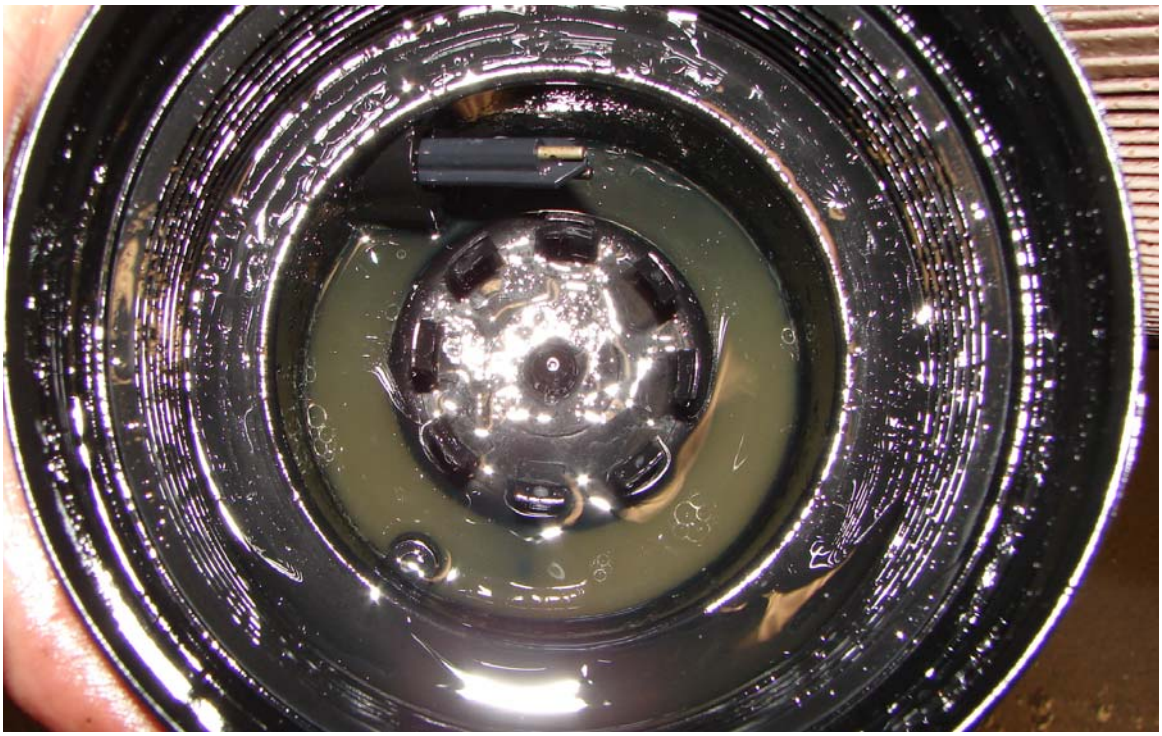


Figure 10



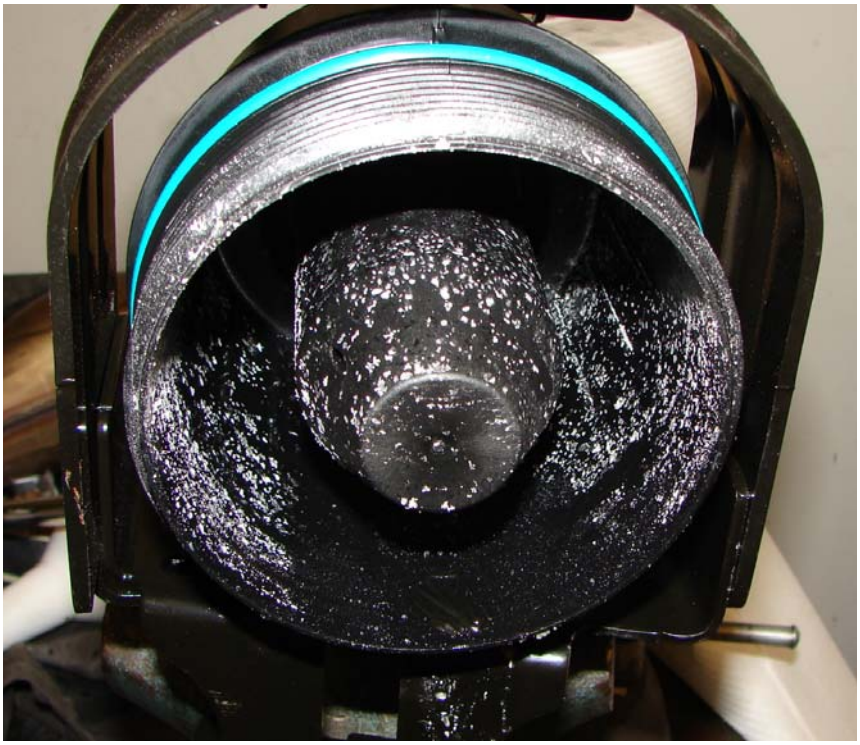
Figure 11



Figure 12



Figure 13



WARRANTY ACTION NOTICE #10-2011

Dealer Installed Trailer Brake Controllers

2011 F-150
Article 10-A-2011

A review of warranty claims has found that dealers are claiming for re-programming of the instrument cluster under warranty. Instructions for Dealer installation include IC re-programming as part of the installation process.

Per the W&P Manual – page 8, - Dealership Supervision Responsibility – It is service Managers responsibility to insure the latest service publications (in this case the instruction sheet) are followed.

Category: Chassis / Brakes

Do: Properly install trailer brake controllers per the instruction sheet provided

Don't: Submit a warranty claim for reprogramming the instrument cluster.

6.7L Powerstroke Diesel Engine Fuel Contamination

2011 F-Super Duty
Article 10-B-2011

A review of warranty claims and returned parts has found that some dealers have replaced 6.7L Powerstroke Diesel Engine fuel system components (including the High Pressure fuel injection pump and fuel injectors) due to damage caused by contaminated fuel. The most common sources of contaminated fuel are:

- Auxiliary vehicle mounted tanks
- Local storage tanks
- Other infrequently used fuel sources
- Refueling errors (i.e. Diesel Exhaust Fluid (DEF) or Gasoline introduced into the fuel tank)

The 6.7L Diesel Fuel System Contamination Diagnosis and Service Procedure Job Aid (Revised September 2011) provides diagnostic and service procedures to determine if fuel system contamination is present.

Category: Powertrain / Diesel Engine

Do: Follow 6.7L Diesel Fuel System Contamination Diagnosis and Service Procedure Job Aid procedures if fuel system contamination is suspect before replacing fuel system components.

Don't: Replace fuel system components under warranty for damage caused by fuel contamination or improper fluids.

EA11-003

FORD

1-20-2012

Appendix I

2009 - 2012 F-250/F-350/F-450/F-550 Diesel High Pressure Fuel Pump
Part Change Log

	A	B	C	D		E		F		G
				Original		Modified		Disposition of Original Parts		
Model and Model Year	Date Incorporated Into Vehicle Production	Description of Change	Reasons for Change	Ford Engineering Part Number	Ford Service Part Number	Ford Engineering Part Number	Ford Service Part Number	Withdrawn from Ford Production Inventory	Effective Date	Modified Component Service Part Availability Date
2011 Model Year F-250/F-350/F-450/F-550	Job #1, 2011	New Bosch high pressure fuel pump	New 6.7L common rail diesel engine	8C34-9A543-BA	8C3Z-9A543-B	BC3Q-9B395-CB	BC3Z-9A543-A	Yes	Job 2010, Last	Job #1, 2011

EA11-003

FORD

1-20-2012

Appendix J

	SERVICE PART NUMBER	8C3Z-9A543-B		BC3Z-9A543-A	
	ENGINEERING PART NUMBER	8C34-9A543-BA		BC3Q-9B395-CB	
	PART NAME	FUEL INJECTION PUMP ASY		FUEL INJECTION PUMP ASY	
YEAR	MONTH	PART SALES		PART SALES	
		UNITED STATES	CANADA	UNITED STATES	CANADA
2011	OCT	1115	132	60	8
	SEPT	2151	209	61	5
	AUG	2337	208	66	8
	JULY	2043	229	54	13
	JUN	2120	290	40	12
	MAY	2378	241	24	5
	APR	1857	90	31	1
	MAR	1476	98	20	5
	FEB	1051	103	17	2
	JAN	609	147	15	2
	YTD	17137	1747	388	61
2010	DEC	1173	74	17	5
	NOV	1104	87	6	3
	OCT	1570	108	15	4
	SEPT	1502	110	1	5
	AUG	1793	409	6	2
	JULY	1730	143	7	2
	JUN	1285	139	4	0
	MAY	1299	110	4	0
	APR	1349	75	2	0
	MAR	878	67	4	0
	FEB	420	47	0	0
	JAN	495	60	0	0
	TOTAL	14598	1429	66	21
2009	DEC	582	59		
	NOV	971	87		
	OCT	984	26		
	SEPT	1087	64		
	AUG	1033	80		
	JULY	874	79		
	JUN	889	75		
	MAY	644	53		
	APR	529	40		
	MAR	472	62		
	FEB	396	55		
	JAN	391	67		
	TOTAL	8852	747		
2008	DEC	508			
	NOV	476			
	OCT	516			
	TOTAL	4491			
2007	TOTAL	1661			

SERVICE PART NUMBER	8C3Z-9A543-B	BC3Z-9A543-A
ENGINEERING PART NUMBER	8C34-9A543-BA	BC3Q-9B395-CB
PART NAME	FUEL INJECTION PUMP ASY	FUEL INJECTION PUMP ASY
MODEL AND MODEL YEAR USAGE	2008 THRU 2010 MODEL YEAR F-SERIES OVER 8500 GVW WITH 6.4L DIESEL ENGINE	2011 THRU 2012 MODEL YEAR F-SUPER DUTY WITH 6.7L DIESEL ENGINE
SUPPLIER NAME	BLUE DIAMOND PARTS LLC	ROBERT BOSCH CORP
SUPPLIER ADDRESS	751 INTERNATIONAL DRIVE FRANKLIN, IN 46131	6555 FULTON INDUSTRIAL BLVD-S100 ATLANTA, GA 30336
SUPPLIER CONTACT NAME	MANDY YOUNG	JAMES KUTCHES
SUPPLIER CONTACT TITLE	SUPERVISOR	
SUPPLIER CONTACT PHONE NUMBER	317-346-3202	708-865-5452

EA11-003

FORD

1-20-2012

Appendix K1

6.4L Power Stroke® Diesel Engine



2008 "F" SERIES SUPER DUTY

• Engine Description • Systems Overview • Component Location • Technician Tips •

FORWARD

This publication is intended to provide technicians and service personnel with an overview of technical advancements in the 6.4L POWER STROKE® DIESEL Engine. The information contained in this publication will supplement information contained in available service literature.

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as, the personal safety of the individual performing the work. This manual provides general directions for accomplishing service repair work with tested, effective techniques. Following the directions will assure reliability. There are numerous variations in the procedures; techniques, tools, parts for servicing vehicles and the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that they do not compromise their personal safety or the vehicle integrity by their choice of methods, tools or parts.

The following list contains some general WARNINGS that you should follow when you work on a vehicle.

Always wear safety glasses for eye protection.

Always perform work in a well ventilated area.

Use safety stands whenever a procedure requires you to be under the vehicle.

Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.

Never perform any service to the engine with the air cleaner removed and the engine running unless a turbocharger compressor inlet shield is installed.

Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.

Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.

Keep yourself and your clothing away from moving parts when the engine is running, especially the fan, belts, and the turbocharger compressor.

To prevent serious burns, avoid contact with hot metal parts such as the radiator, turbocharger pipes, exhaust manifold, tail pipe, catalytic converter and muffler.

Do not smoke while working on the vehicle.

To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.

Keep hands and other objects clear of the radiator fan blades.

This page intentionally left blank

TABLE OF CONTENTS

OVERVIEW 6
Features 6
Horsepower & Torque 6
Specifications 7
Identification 8

COMPONENT LOCATIONS 9
Features 14

COOLING SYSTEM 16
Internal Coolant Flow 16
External Coolant Flow 17
Coolant Pump 19

LUBRICATION SYSTEM 21
Base Engine Flow 21
System Flow 22

FUEL SUPPLY SYSTEM 28
System Flow 29

AIR MANAGEMENT SYSTEM 33
System Flow 34
Series Sequential Turbocharger 36
EGR 39

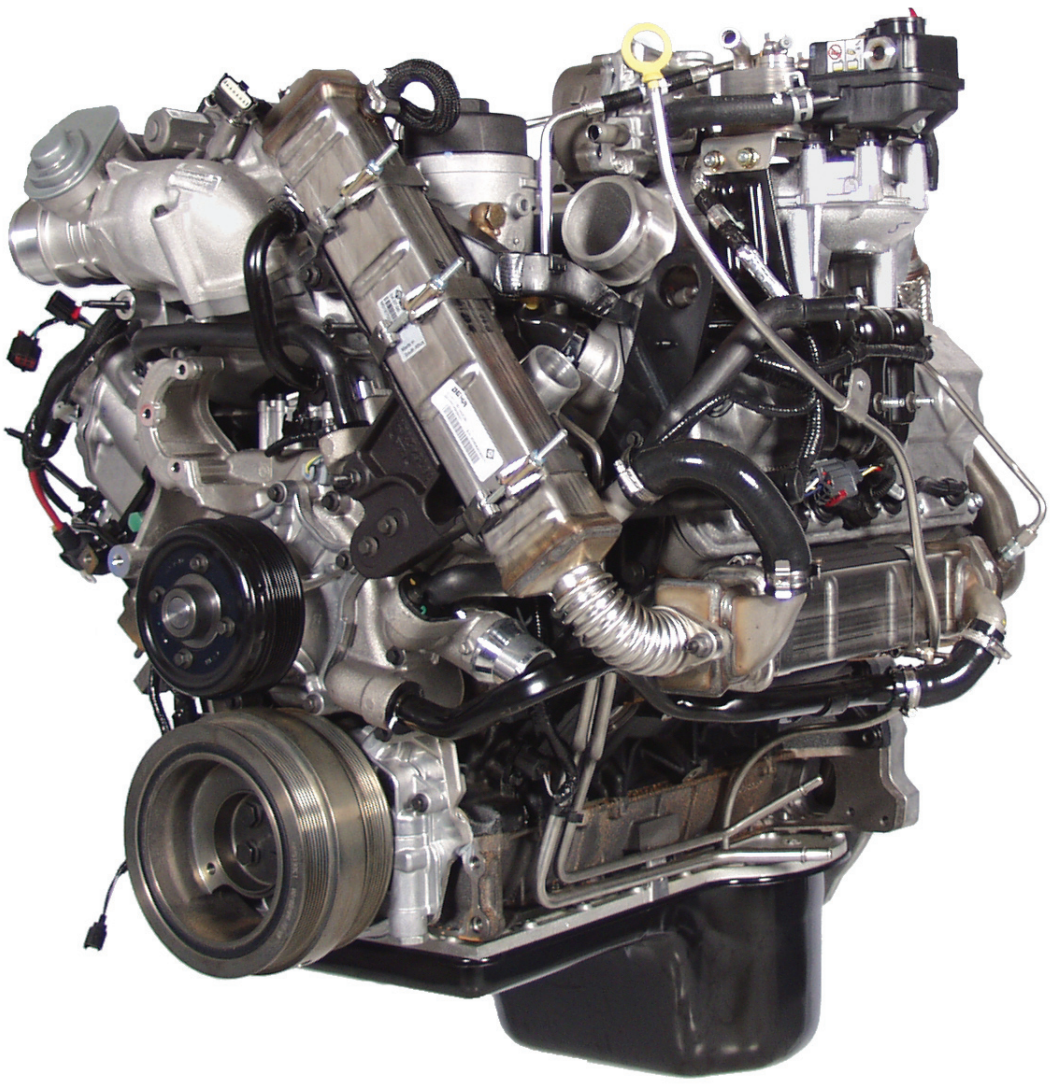
FUEL MANAGEMENT SYSTEM 41
System Flow 42
High Pressure Fuel Injection Pump Flow 43
Piezo Fuel Injectors 45
Stages of Injection 47

ELECTRICAL COMPONENTS 51
Sensors 52
Control Devices 68
Glow Plug Control Module (GPCM) 70

UNIQUE SERVICE PROCEDURES 73

APPENDIX 81
Torque Charts 82
Wiring Diagram 88
Diagnostic Trouble Codes (DTC's) 90

This page intentionally left blank



6.4L Power Stroke® Diesel

Direct Injection Turbocharged Diesel Engine

6.4L POWER STROKE® DIESEL OVERVIEW

6.4L Power Stroke Diesel Overview

- This publication is not intended to replace the Service Manual but to introduce the 6.4L Power Stroke® Diesel Engine.

6.4L Power Stroke Diesel Direct Injected Turbocharged Diesel Engine Overview

- Engine Features
- Horsepower & Torque
- Engine Specifications
- Physical ID
- Labeling

1

Engine Features

- The 6.4L Power Stroke Diesel has been designed to meet the tougher emissions standards set by the government.
- The 6.4L Power Stroke Diesel has been designed to meet the customers' expectations of high horsepower and torque over a wide RPM range.
- Meeting the more stringent customer and regulated demands are accomplished in part by: High Pressure Common Rail Fuel System, Series Sequential Turbocharger System, 4 valves per cylinder, and a dual timing system.

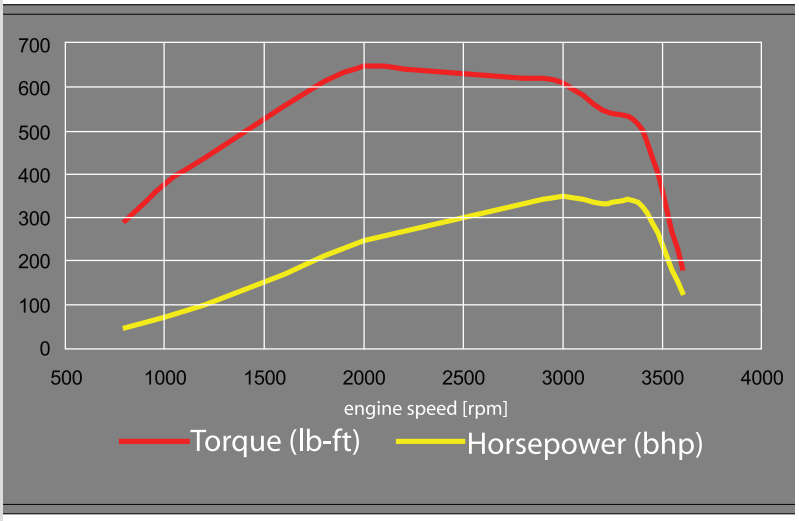
Engine Features

- High Pressure Common Rail Fuel System
- Series Sequential Turbocharger
- 4 Valves per Cylinder
- Rear Gear Train
- Dual Timing System

2

Horsepower & Torque

- The 6.4L Power Stroke Diesel creates 350 horsepower at 3000rpm and 650 lb/ft of torque at 2000rpm.

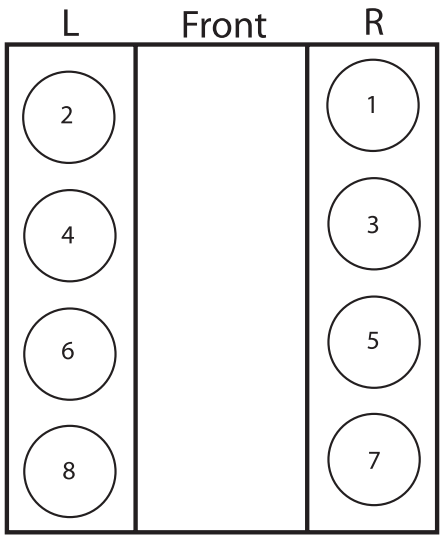


3

6.4L POWER STROKE® DIESEL OVERVIEW

6.4L Power Stroke Diesel Specifications

Engine Type	Diesel, 4 Cycle
Configuration	4 OHV/1 Cam-in-Crankcase-V8
Displacement	390 cu. in. (6.4L)
Bore & Stroke	3.87 X 4.134 (98.2 X 105 mm)
Compression Ratio	17.5:1
Aspiration	Series Sequential Turbo with CAC
Rated Power @ RPM	350 @ 3000 RPM
Peak Torque @ RPM	650 @ 2000 RPM
Engine Rotation, Facing Flywheel	Counter Clockwise
Combustion System	High Pressure Common Rail Direct Injection
Total Engine Weight (auto with oil)	1130 lb. (498.95 kg)
Coolant Flow (to radiator)	125 gal/min (473 L/min) @ 3000 RPM
Air Flow @ RPM (compressor inlet)	744 CFM (21.1 m3/min) @ 3000 RPM
Exhaust Flow @ RPM (engine outlet)	1962 CFM (55.6 m3/min) @ 3000 RPM
Oil Flow @ RPM	13 gal/min (59 L/min) @ 3000 RPM
Cooling System Capacity (engine only)	25.3 qts (24 L)
Lube System Capacity (including filter)	15 qts. (14.2 L)
Firing Order	1-2-7-3-4-5-6-8



Specifications

- The cylinders of the 6.4L Power Stroke Diesel are numbered from the front on the right side 1,3,5,7 and from the front on the left side 2,4,6,8.

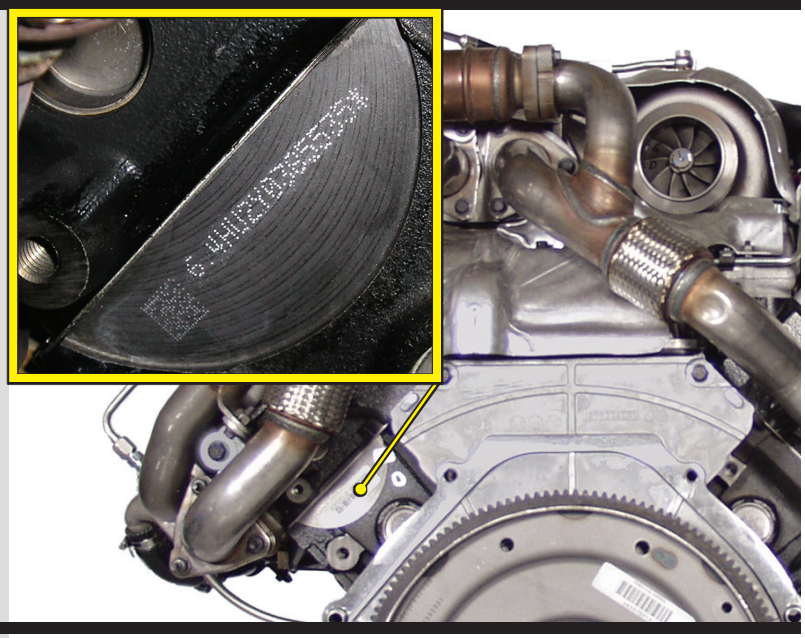
6.4L POWER STROKE® DIESEL OVERVIEW

Engine Serial Number

- The engine serial number is located on the left rear corner of the crank case on a half moon machined surface.
- A white sticker is placed over this number during production, this sticker was removed for illustration purposes.
- 6.4 - is the engine family identifier.
- HU2Y - is a manufacturing designator

Ex: HU2Y or HU2U “Y designates Huntsville, AL and U designates Indianapolis, IN”

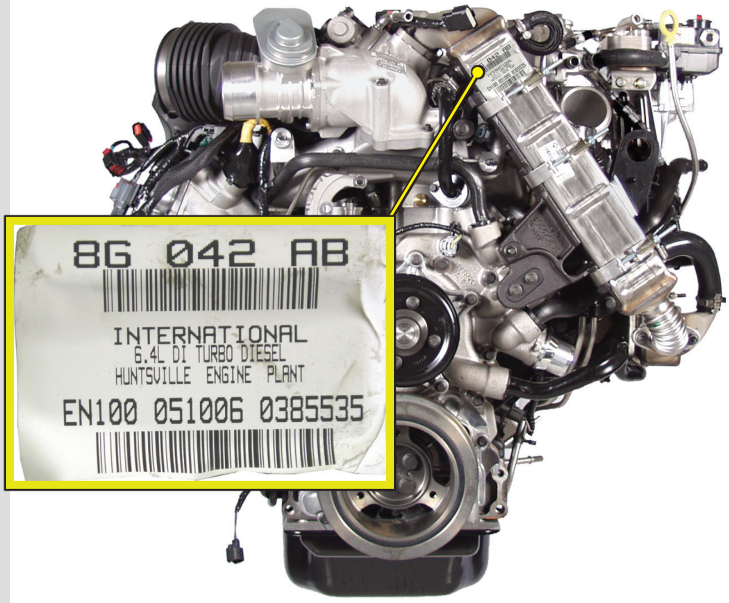
- 0385535 - is a sequential build number



5

Serial Number Label

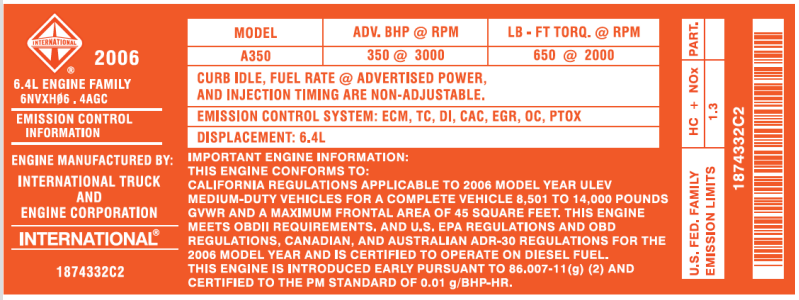
- Located on the top of the vertical EGR cooler.
- States the engine serial number.
  - example at right, “0385535”
- States the engine family.
  - example at right, “6.4L DI turbo diesel”

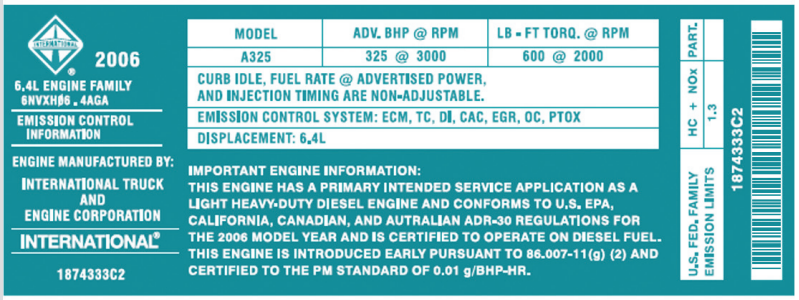


6

Emissions Label

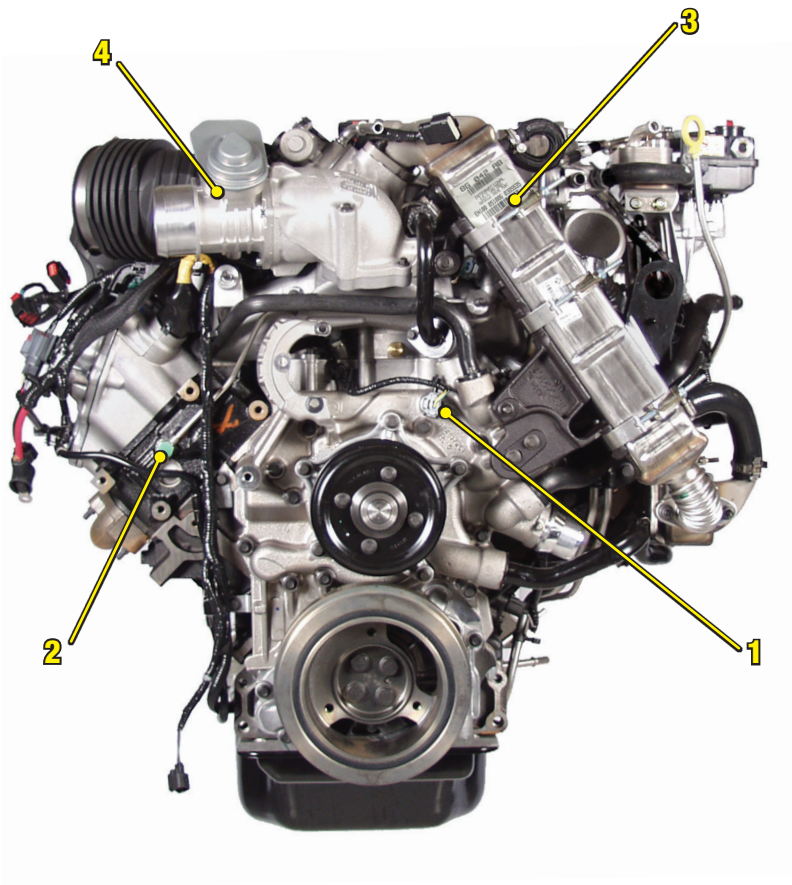
- States the horsepower rating for the engine, programmed in the Engine Control Module (ECM).
- Depicts where the engine meets or exceeds emission standards.
- Shows the engine displacement.
- Is affixed to the right hand valve cover.
- F250/350 labels are red.
- F450/550 labels are blue.





7

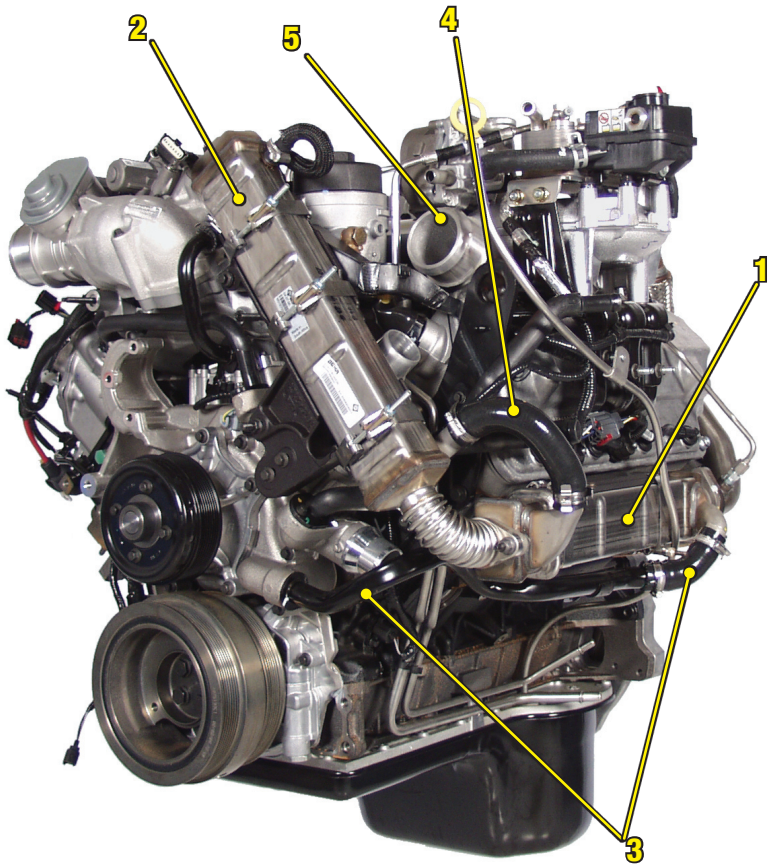
COMPONENT LOCATIONS



Front of Engine

1) ECT Sensor
2) Fuel Return Line
3) EGR Cooler Vertical
4) EGR Throttle

8



Left Front of Engine

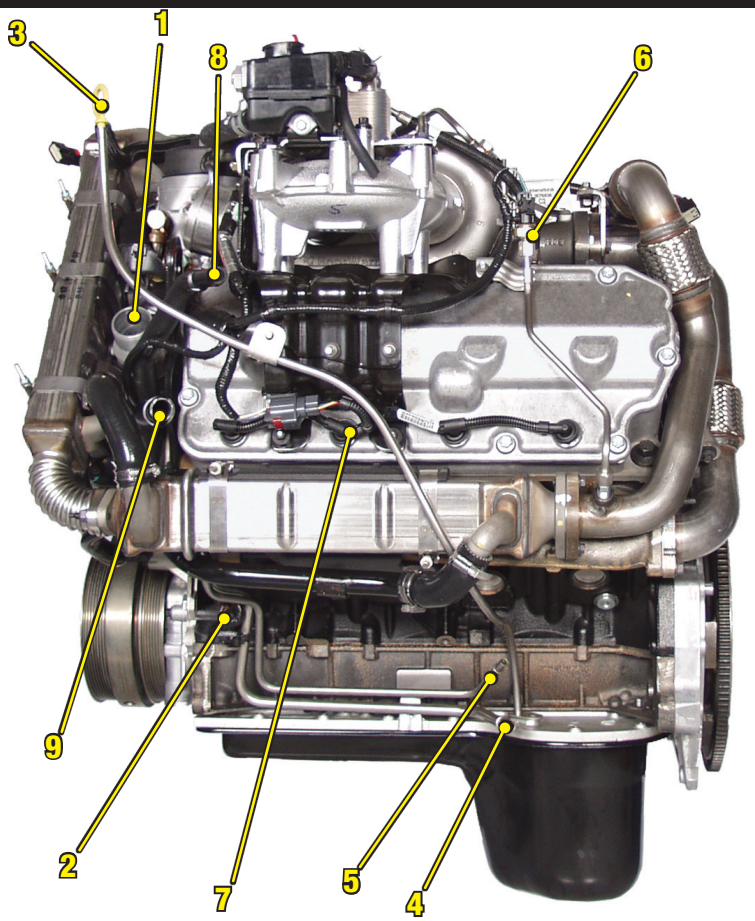
1) EGR Cooler Horizontal
2) EGR Cooler Vertical
3) Coolant Supply for Horizontal Cooler
4) Coolant Supply for Vertical Cooler
5) Turbocharger Outlet

9

COMPONENT LOCATIONS

Left of Engine

1) Thermostat Housing Outlet
2) CMP Sensor
3) Oil Level Gauge
4) Fuel Supply Line
5) Fuel Return Line
6) EP Sensor
7) Glow Plug Harness
8) Heater Return Line
9) Degas Bottle Return Line



10

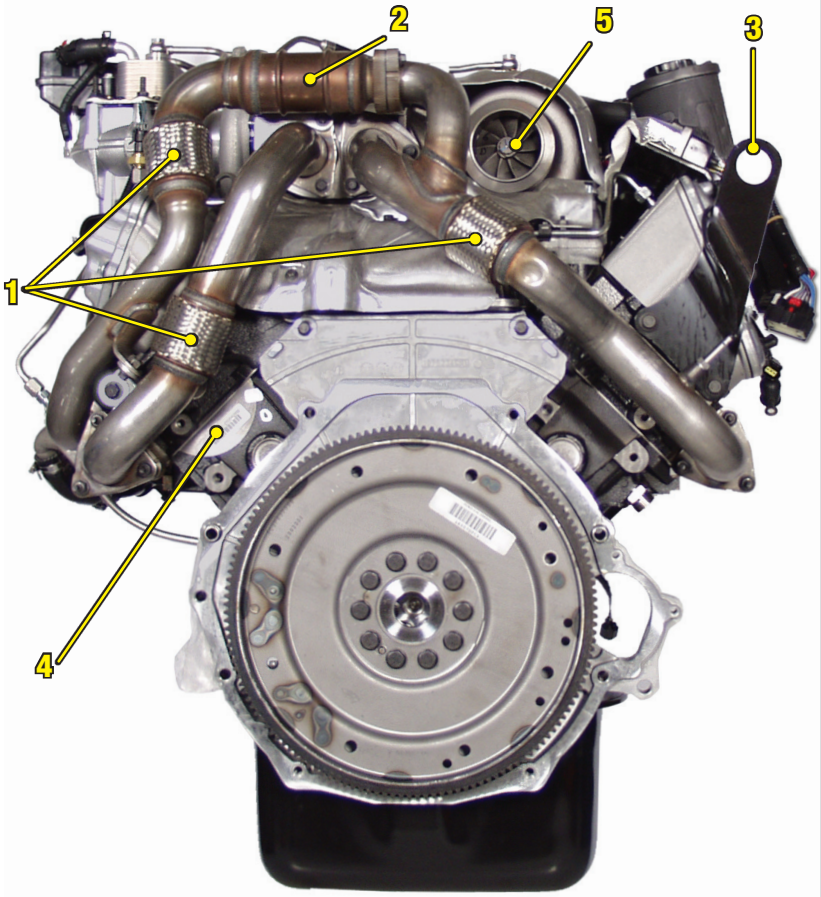
Left Rear of Engine

1) EP Sensor
2) Turbocharger Crossover Tube



11

COMPONENT LOCATIONS



Rear of Engine

1) Exhaust Expansion Joints

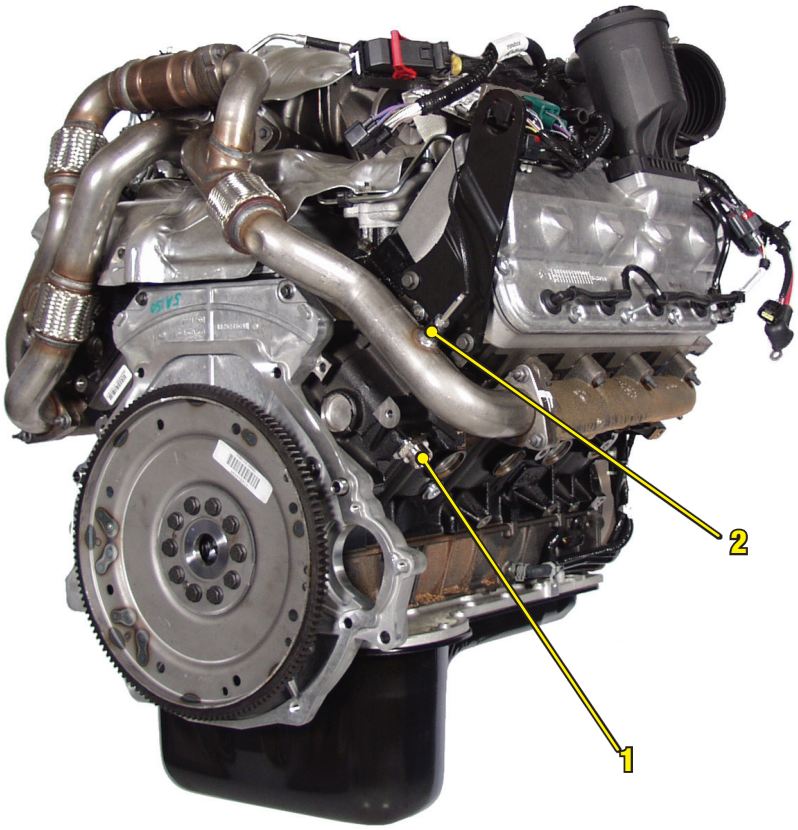
2) Catalyst

3) Lifting Eye

4) Serial Number

5) Turbocharger Outlet to Exhaust System

12



Right Rear of Engine

1) Block Heater

2) EGRT Inlet Sensor

13

COMPONENT LOCATIONS

Right Side of Engine

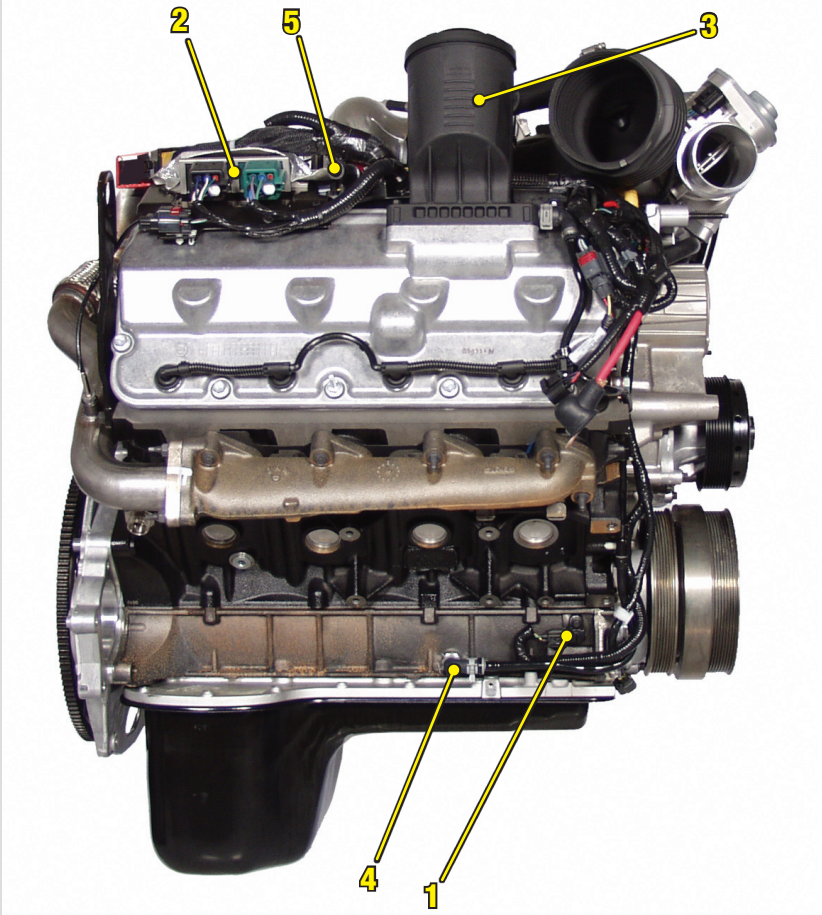
1) CKP Sensor

2) Glow Plug Control Module

3) Crankcase Ventilation/Oil Separator

4) Oil Seperator Drain Tube

5) Heater Supply



14

Right Front of Engine

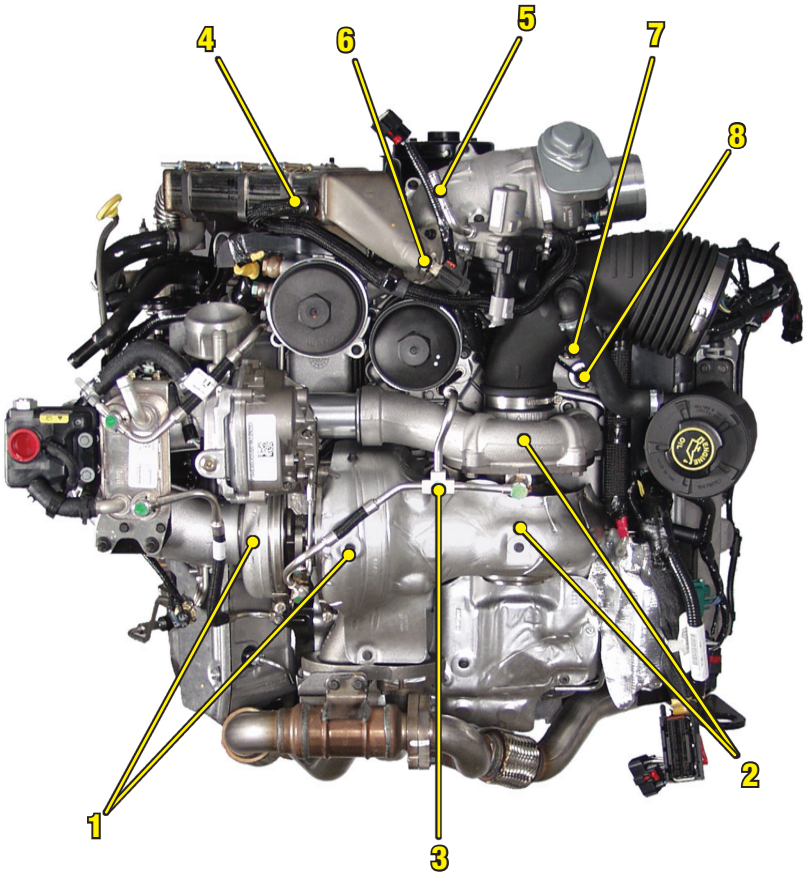
1) Injector Electrical Connector

2) Throttle Body



15

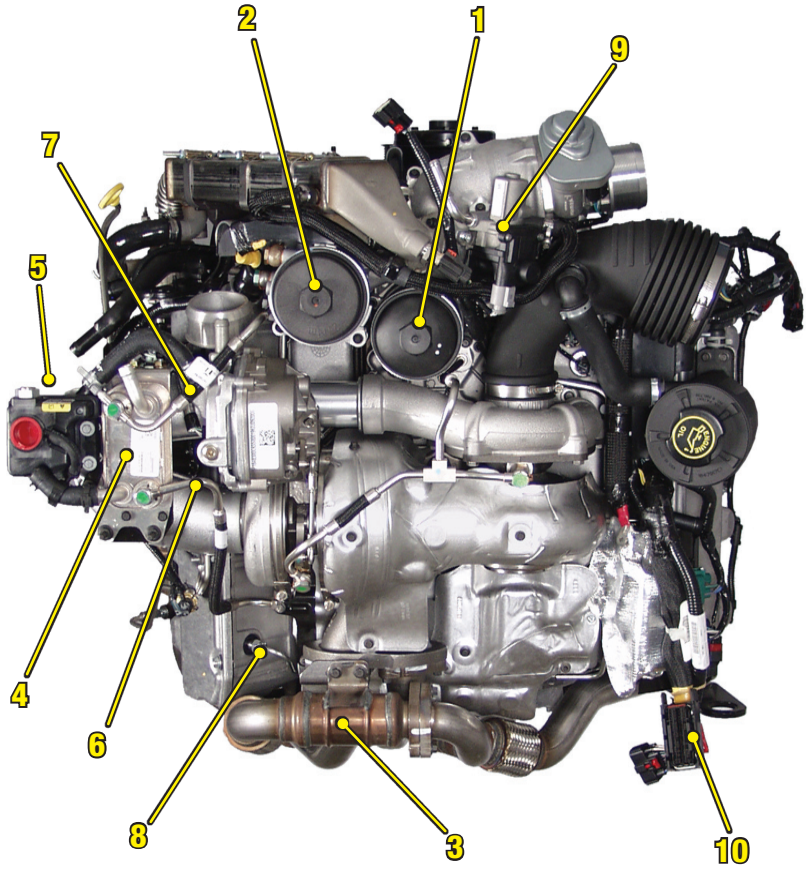
COMPONENT LOCATIONS



Top of Engine

1) High Pressure Turbocharger
2) Low Pressure Turbocharger
3) Turbocharger Oil Supply Line
4) EGR Valve Coolant Supply Port
5) EGR Valve Coolant Return Port/Deaeration Port
6) EGRT Outlet Sensor
7) MAP Sensor
8) IAT 2 Sensor

16



Top of Engine

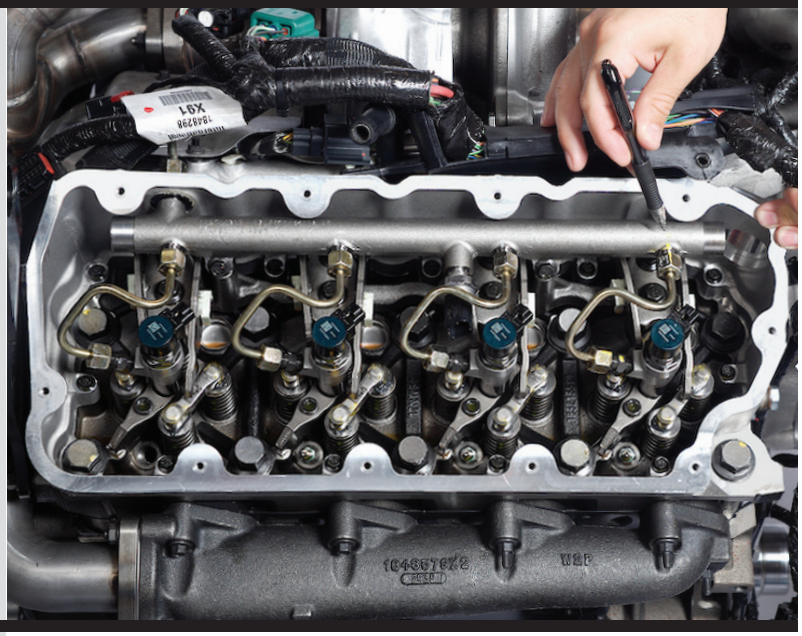
1) Oil Filter
2) Engine Mounted Fuel Filter
3) Catalyst
4) Fuel Cooler
5) Fuel Cooler Coolant Tank
6) Fuel Return Hot (inlet to cooler)
7) Fuel Return Cold (outlet from cooler)
8) LH High Pressure Fuel Line
9) EGR Valve
10) ECM Connection

17

6.4L POWER STROKE® DIESEL OVERVIEW

High Pressure Common Rail Fuel System

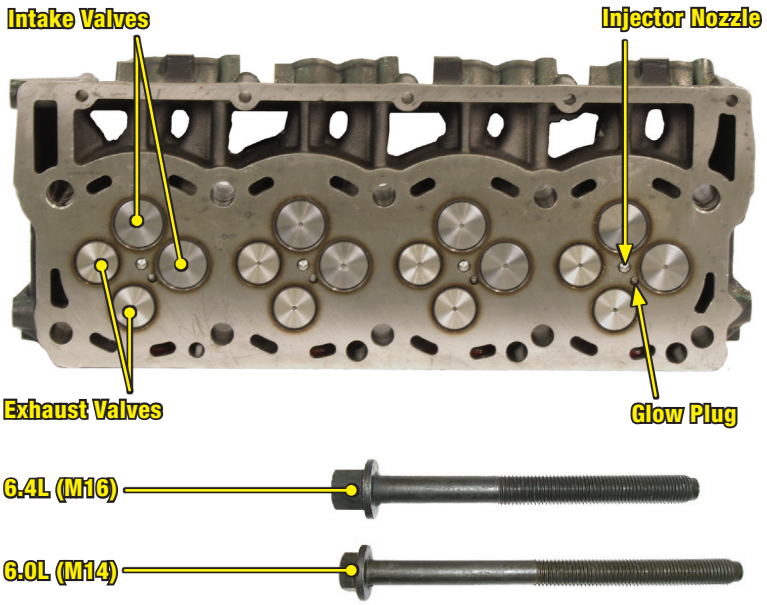
- The 6.4L Power Stroke Diesel engine uses a high pressure fuel injection pump to deliver fuel to each piezo electric fuel injector via a high pressure common fuel rail, one rail per bank.



18

Cylinder Head & Head Bolts

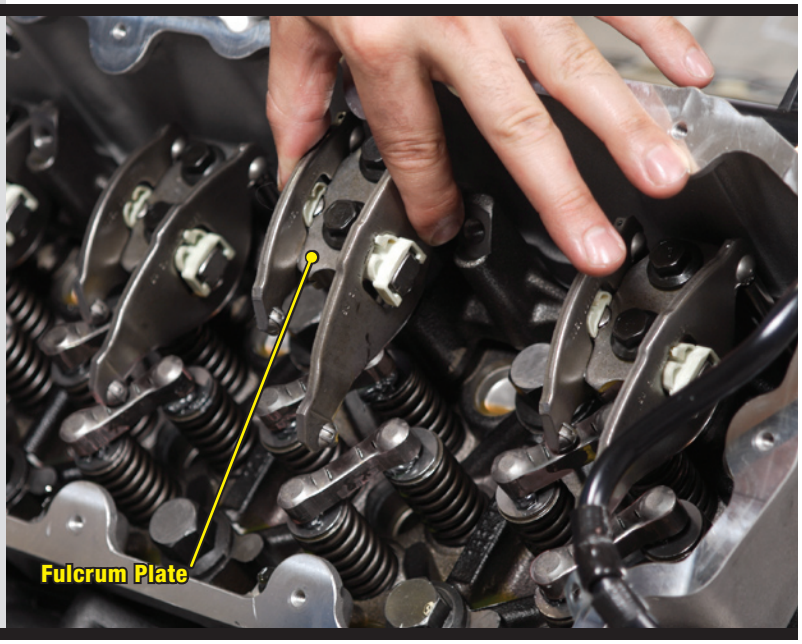
- The 6.4L Power Stroke Diesel uses a four (4) valve per cylinder head design to optimize airflow and efficiency.
- The 6.4L Power Stroke Diesel engine uses larger head bolts than the 6.0L Power Stroke Diesel engine (M16 vs M14).
- The 6.4L head bolts are also slightly shorter than the 6.0L head bolts. The 6.4L head bolts do not retain the rocker carrier like the 6.0L head bolts do.



19

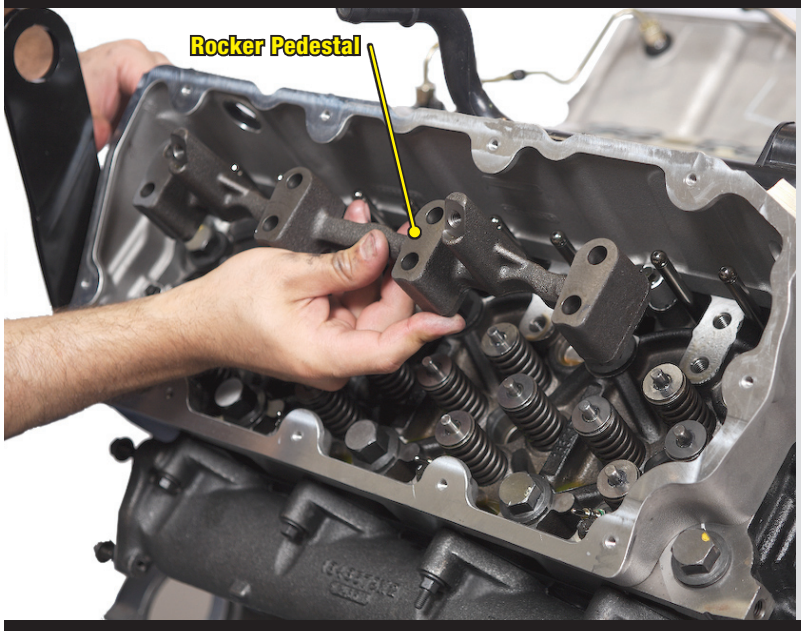
Fulcrum Plate & Rocker Arms

- The fulcrum plate, which holds the rocker arms, is bolted to the rocker pedestal.
- The two (2) bolts that secure the fulcrum plate pass through the fulcrum plate and the rocker pedestal and are then secured into the cylinder head.



20

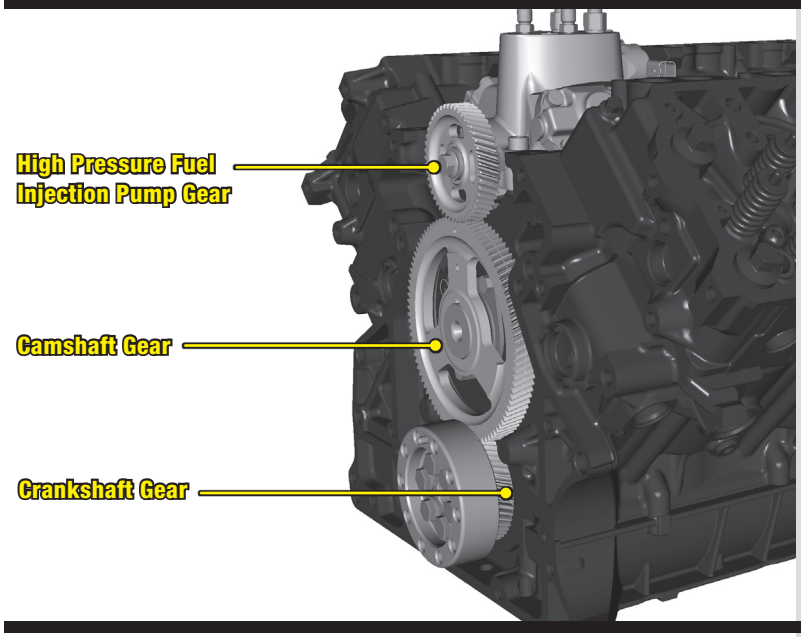
6.4L POWER STROKE® DIESEL OVERVIEW



Rocker Pedestal

- The rocker pedestal is secured independent of the cylinder head bolts, which no longer need to be removed to service the rocker arms.

21

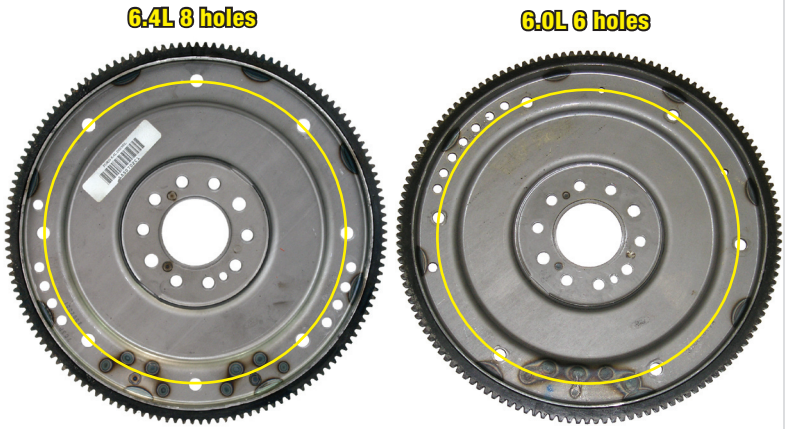


High Pressure Fuel Injection Pump & Rear Geartrain

- The geartrain for the crankshaft, camshaft, and the high pressure fuel injection pump are located in the rear of the engine under the rear cover.
- This allows for the high pressure fuel pump to be mounted inside the engine and also reduces noise.
- The high pressure fuel injection pump turns at a ratio of 1:1 with crankshaft speed.

NOTE: The helical cut gears used on the 6.4L differ from those used on the 6.0L.

22



6.4L vs 6.0L Flexplate

- The flexplate for the 6.4L automatic equipped engine uses an 8 bolt torque converter bolt pattern.
- The flexplate for the 6.0L automatic equipped engine uses a 6 bolt torque converter bolt pattern.

NOTE: Yellow circle added for bolt circle reference.

23

COOLING SYSTEM

Cooling System Features

- The coolant pump can be serviced without disconnecting radiator hoses.
- Both the glow plug sleeves and the injector sleeves are stainless steel.

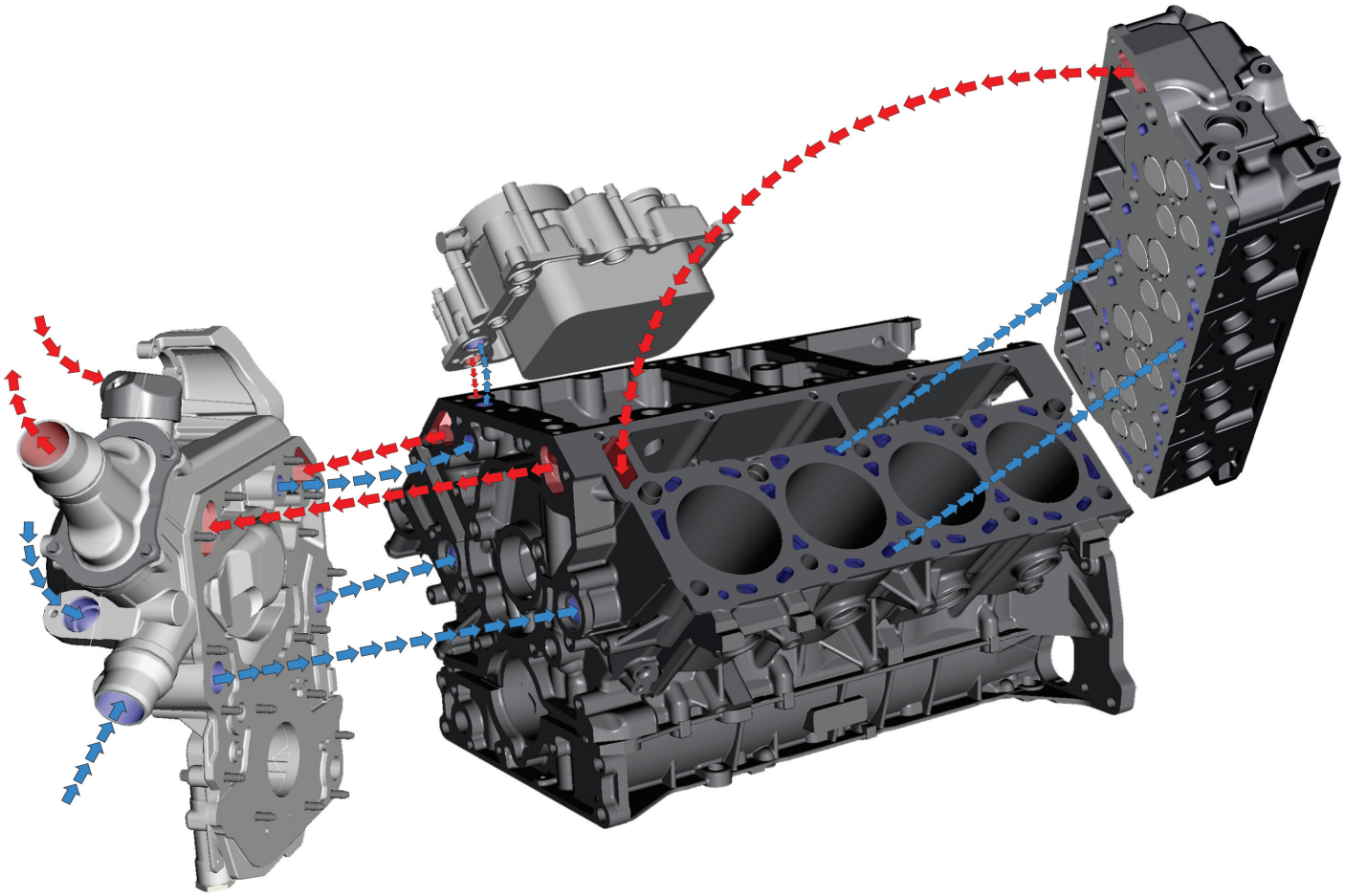
24

Cooling System Features

- Coolant Pump
- Stainless Steel Injector Sleeves
- Stainless Steel Glow Plug Sleeves

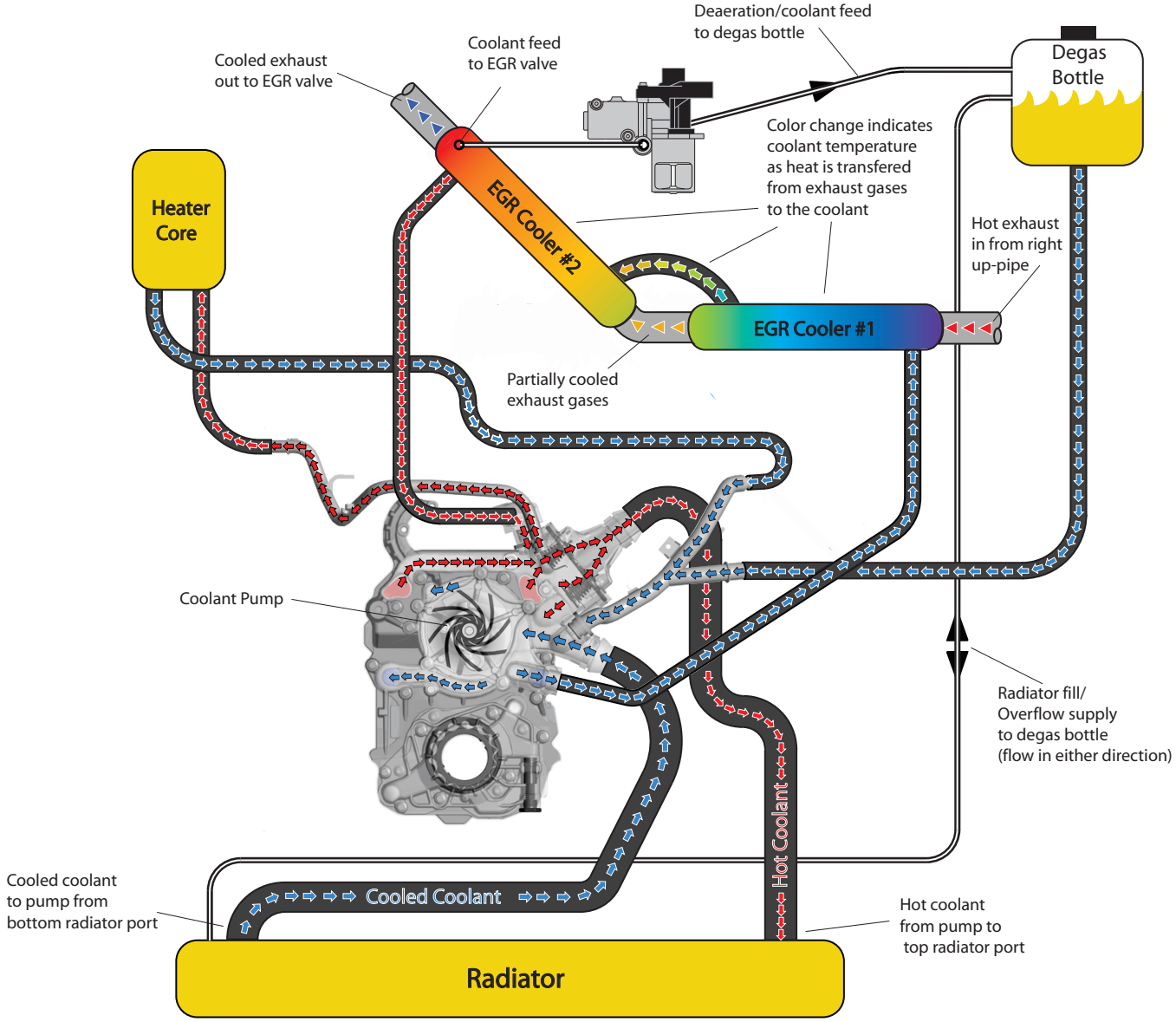
25

Internal Coolant Flow



COOLING SYSTEM

External Coolant Flow



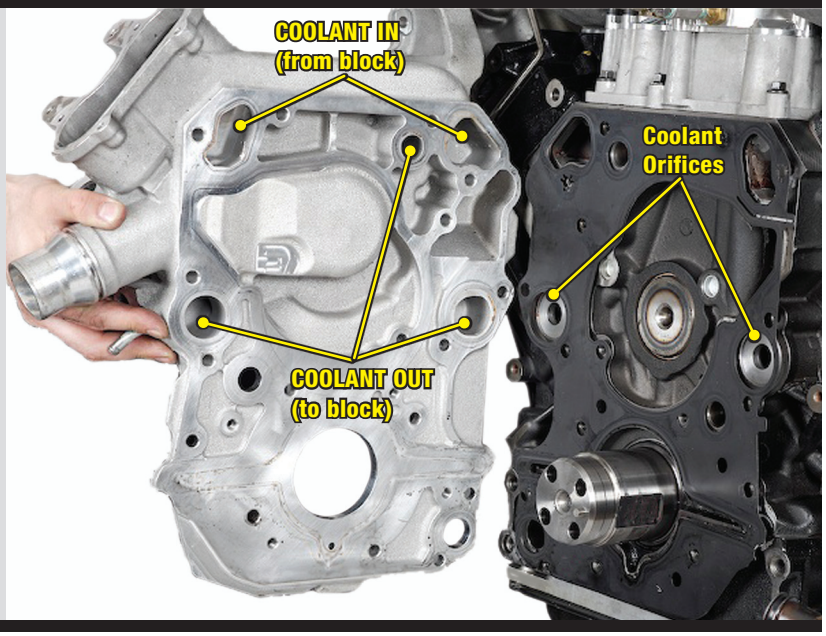
Cooling System Flow: External Flow

- Coolant is drawn into the inlet of the front cover from the bottom radiator port and then flows from the coolant pump through the front cover to the crankcase.
- Coolant is also routed from the front cover into the crankcase to a passage that feeds the oil cooler (shown on next page).
- Coolant is routed from the front cover to the EGR coolers, EGR valve, degas bottle, and the vehicle heater core.
- The horizontal EGR cooler receives coolant first, then the coolant travels to the vertical EGR cooler through a short connection hose. Hot coolant exits the vertical EGR cooler at the top and enters into the front cover.
- A port next to the hot EGR return port in the front cover routes hot coolant to the heater core for vehicle heating. The coolant then travels to a Y-pipe where it meets with degas return coolant before being sent into the front cover, just above the main coolant inlet from the radiotor.
- The EGR valve receives its coolant from a passage at the top of the vertical EGR cooler. Once the coolant exits the EGR valve it is sent to the degas bottle (this passage is the highest point in the system and is also the deaeration port).
- The port directly below the EGR valve return/deaeration port on the degas bottle is used as a radiator fill/overflow line connecting with the top of the radiator.
- A dual thermostat sytem is used to control the flow of return coolant to the radiator. If the thermostats are open, coolant flows to the radiator to be cooled. The bottom thermostat has a bypass circuit that will allow coolant to return to the pump when the thermostats are closed (speeding engine warm up).

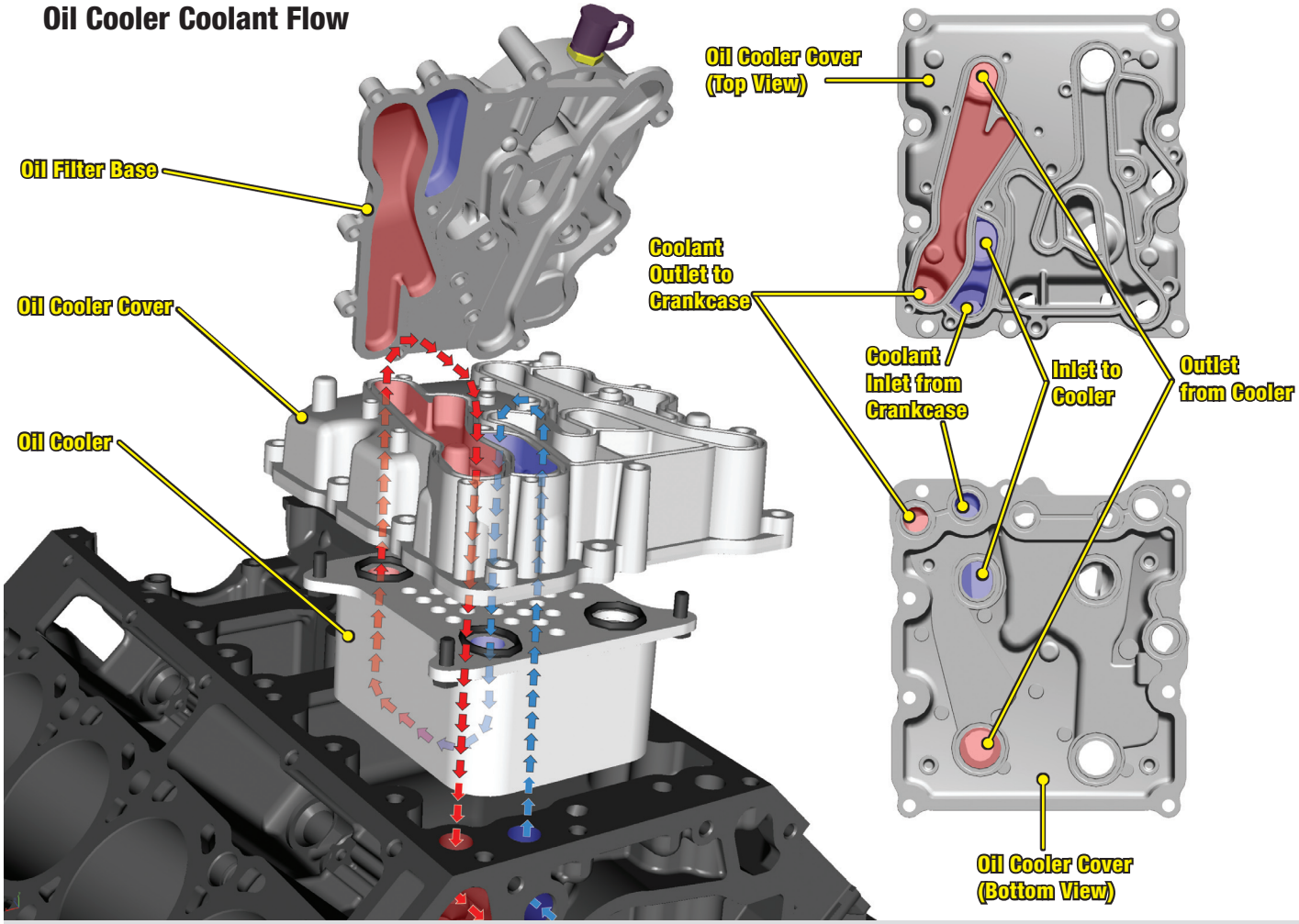
COOLING SYSTEM

Cooling System Flow: Back of Front Cover

- Coolant is sealed via a metal one piece gasket and is directed out of the front cover through three (3) passages.
- Two of the passages route coolant to the crankcase to cool the cylinder walls and cylinder heads (there are different sized orifices pressed into the crankcase in these two passages).
- The third passage routes coolant to the oil cooler via a passage in the crankcase.
- There are two passages for coolant to return from the crankcase into the front cover.



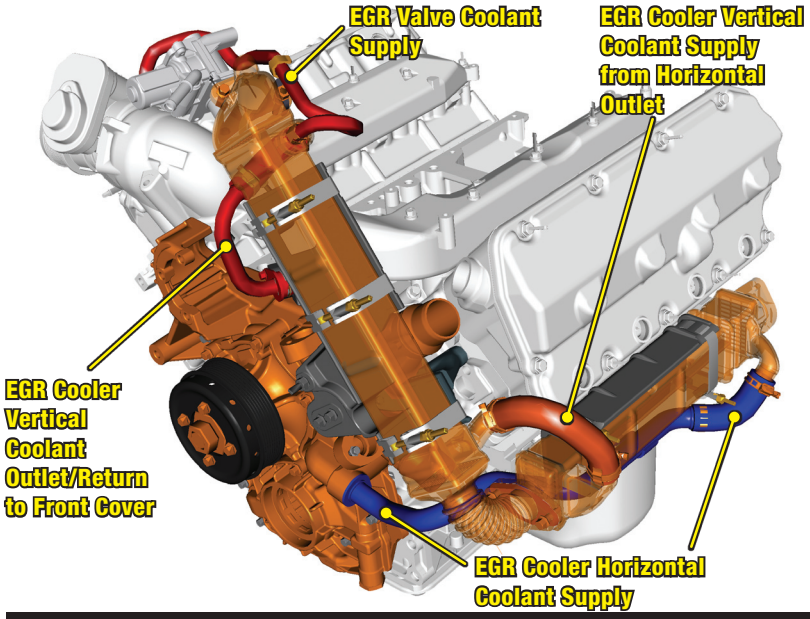
Oil Cooler Coolant Flow



Cooling System Flow: Oil Cooler

- Coolant is directed out of the crankcase and into the oil filter base at the front of the engine.
- The oil filter base routes the coolant down into the front of the oil cooler then toward the rear of the engine.
- Once the coolant has passed through the oil cooler it is routed up to the top of the oil cooler then directed towards the front through a port where it is then routed down, out of the cooler, through a port in the block.

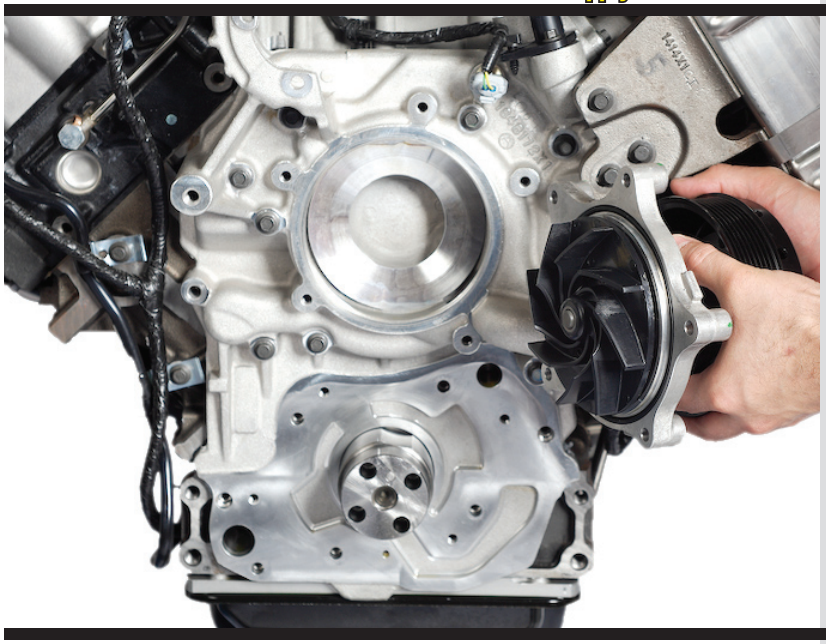
COOLING SYSTEM



Cooling System Flow: EGR Coolers

- Cooled coolant flows out of the supply port of the front cover where it is routed to the horizontal cooler at the left rear side of the engine.
- The coolant then exits the horizontal cooler and is immediately routed into the vertical cooler. The coolant then exits the vertical cooler where it is routed to the return port in the front cover.
- There is a small port at the top of the vertical cooler where coolant is allowed to flow to the EGR valve, cool the valve, then the coolant is routed to the degas bottle. This port is also used as the deaeration port.
- Coolant flows through the EGR coolers and removes heat from the exhaust before the exhaust arrives at the EGR valve.

28

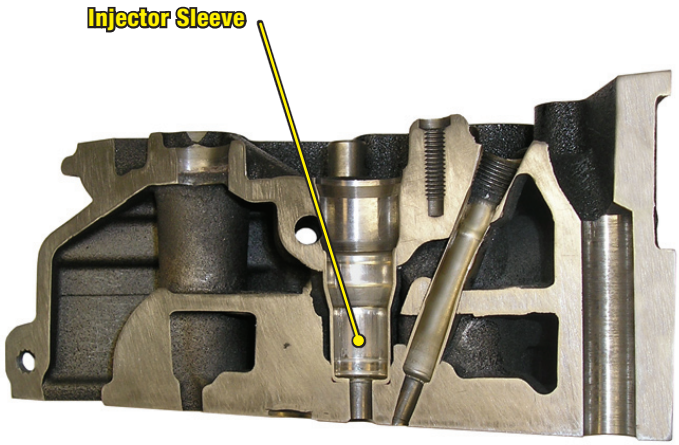


Coolant Pump & Front Cover

- The coolant pump, (hub and impeller) is mounted into the front cover which is the housing for the water pump.
- The coolant pump impeller pulls coolant from the center of the housing and pushes it outward.
- The coolant pump has a built in reservoir to catch small amounts of coolant that during normal operation of the engine may seep past the seal. This coolant will evaporate over time.

  Note: The coolant pump impeller may be damaged if dropped or hit by a hard object.

29



Injector Sleeve

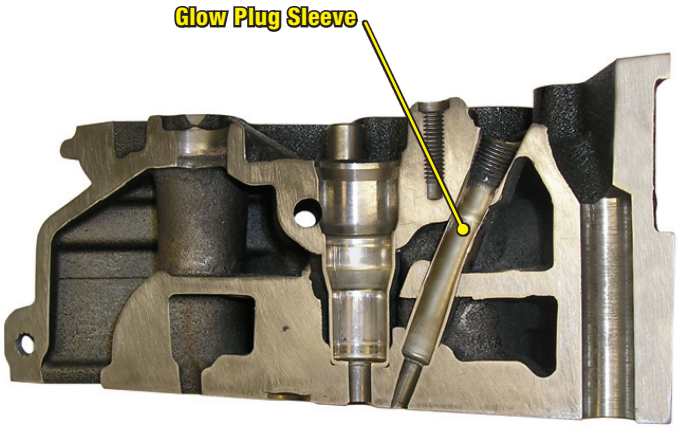
- The 6.4L Power Stroke uses stainless steel injector sleeves to seal coolant from the injector and to transfer heat from the injector to the coolant.
- The injector sleeve is replaceable.

30

COOLING SYSTEM

Glow Plug Sleeve

- Glow plug sleeves are used to keep coolant from coming in direct contact with the glow plugs and to seal coolant from the combustion chamber.
- The glow plug sleeve is replaceable. See unique service procedures or the service manual for more details.



31

Degas Bottle

- The degas bottle is located on the left side of the engine compartment and is part of the left side battery tray.
- One of the ports on the bottle is attached to the EGR valve coolant line (which is supplied from the top of the vertical EGR cooler). If this port or hose is blocked, damage could occur to the EGR coolers and/or the EGR valve.



32

LUBRICATION SYSTEM

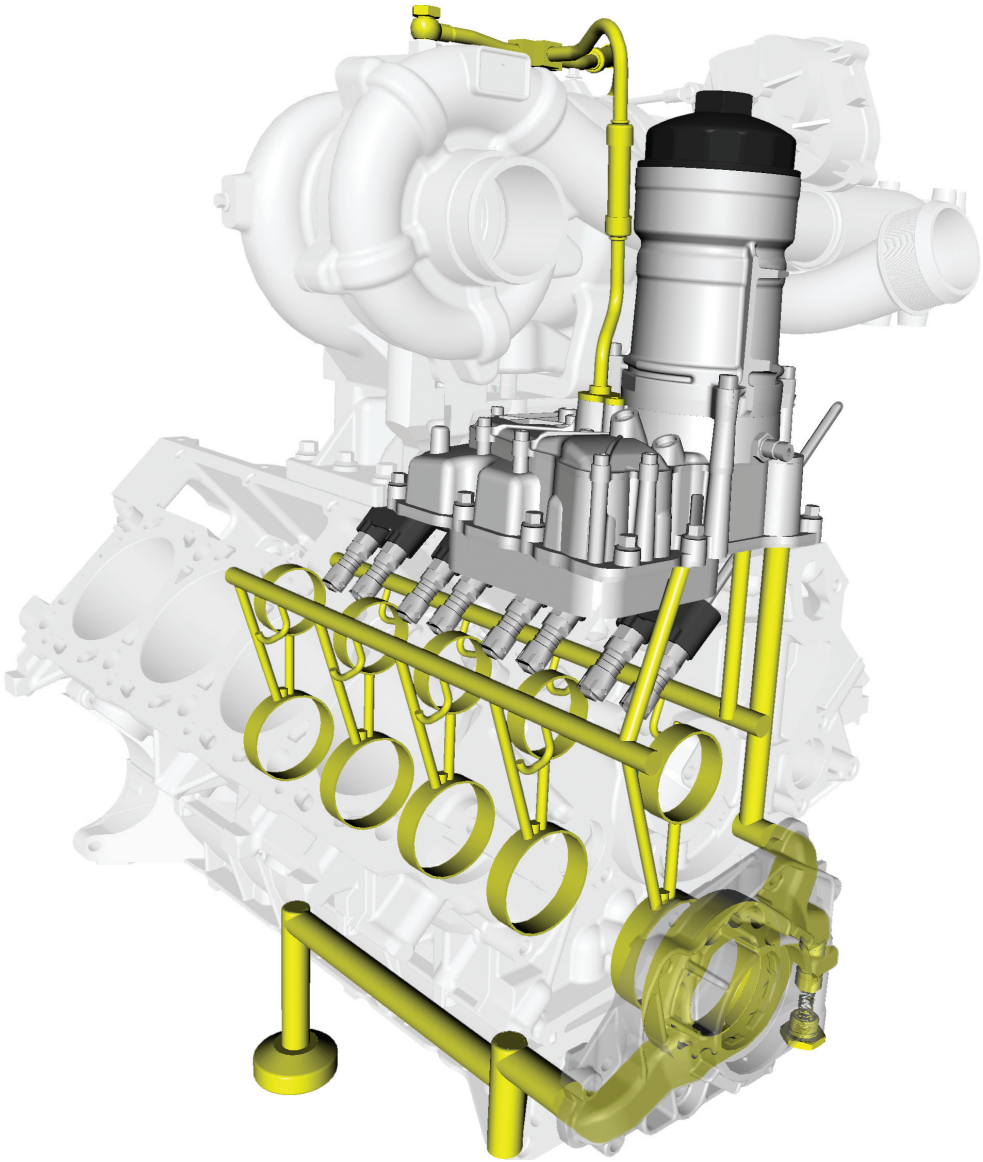
Lubrication System Features

- Integrated Oil Cooler
- No External Oil Passages in Crankcase
- Easy Access Cartridge Style Oil Filter
- External Oil Pressure Regulator

Lubrication System Features

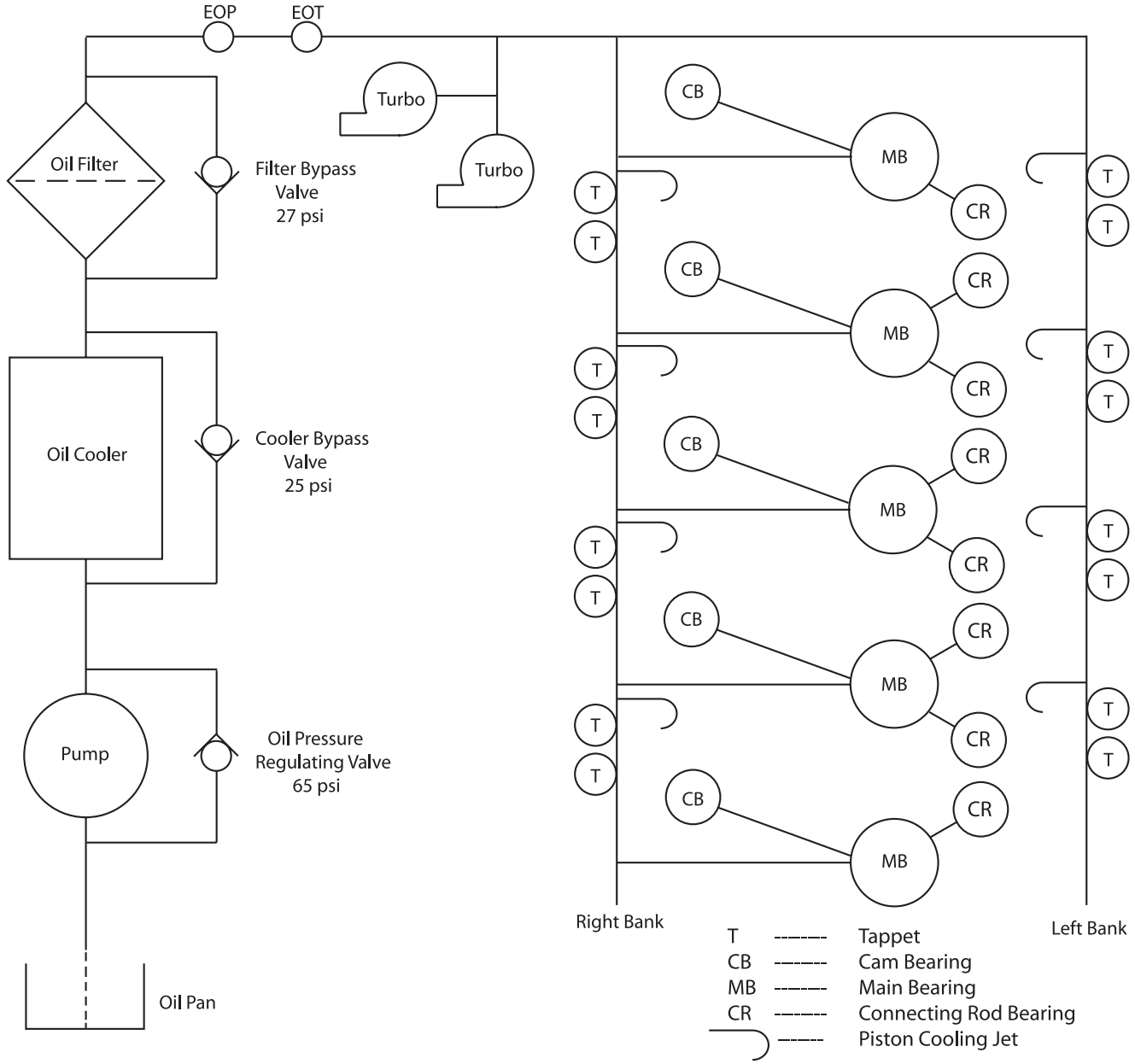
- The 6.4L Power Stroke® Diesel uses an oil cooler that is mounted in the valley of the engine under the oil filter.
- The oil filter is a cartridge style filter mounted on the top of the engine for ease of service. This system also incorporates a valve that drains the oil to the pan when the filter is removed.
- The gerotor oil pump and oil pressure regulator are both located in the front of the engine behind the vibration damper in their own removeable aluminum housing.

33



34

LUBRICATION SYSTEM

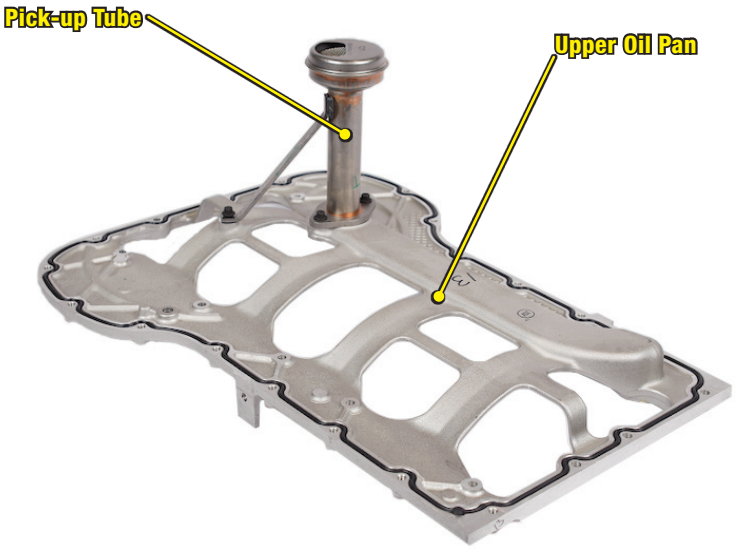


Lubrication System Oil Flow

- Oil is drawn from the oil pan through the pick-up tube. The oil is then routed through a passage cast into the upper oil pan before being routed through a passage in the block, a passage in the front cover, and finally to the oil pump inlet.
- The regulator valve utilizes a force, provided via the regulator spring, to apply a pressure equal to 65 psi. Whenever oil pressure exceeds this force, the regulator valve will move downward and allow the excess pressure to bleed off back through a passage that routes the oil back to the inlet side of the pump.
- From the oil pump, oil is directed to the oil cooler and then to the oil filter.
- From the oil filter the oil is supplied to a chamber incorporating five (5) passages. One (1) is to the turbochargers for lubrication. Two (2) are to the EOT and EOP sensors.
- The two (2) other passages are to the tappet oil supply on the right and left banks. The tappet galleries also provide oil to the piston cooling jets.
- Cross drillings off of the right bank tappet gallery supply oil to the main bearings.
- Another cross drilling vertically up from each main bearing supplies oil to the camshaft bearings.

Note: This oil supply routing is different than the 6.0L and uses different bearings which are also placed differently with respect to the oil holes.

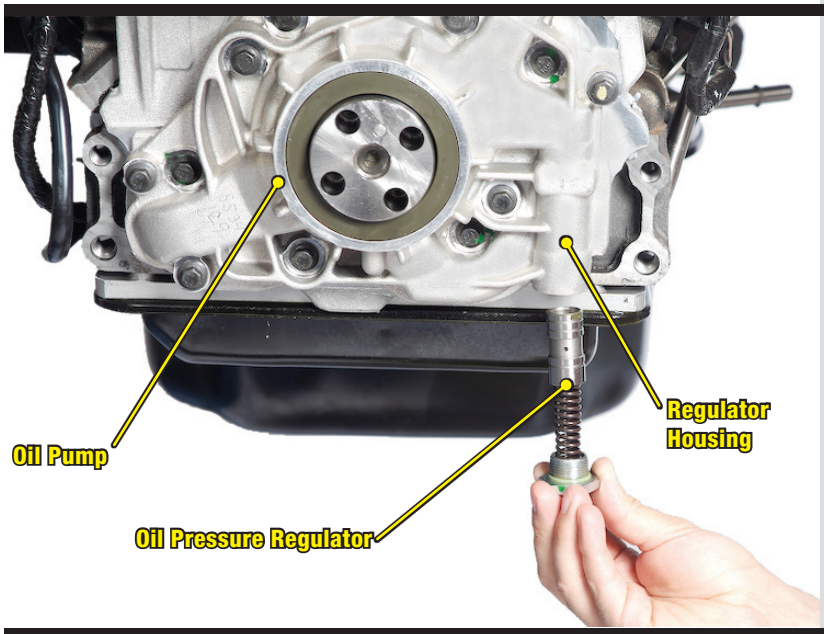
LUBRICATION SYSTEM



Pick-up Tube / Oil Aeration

- The pick-up tube supplies oil from the oil pan to the oil pump.
- The pick-up tube is sealed to the upper oil pan utilizing an o-ring. If the o-ring is damaged or missing, it could cause oil aeration.

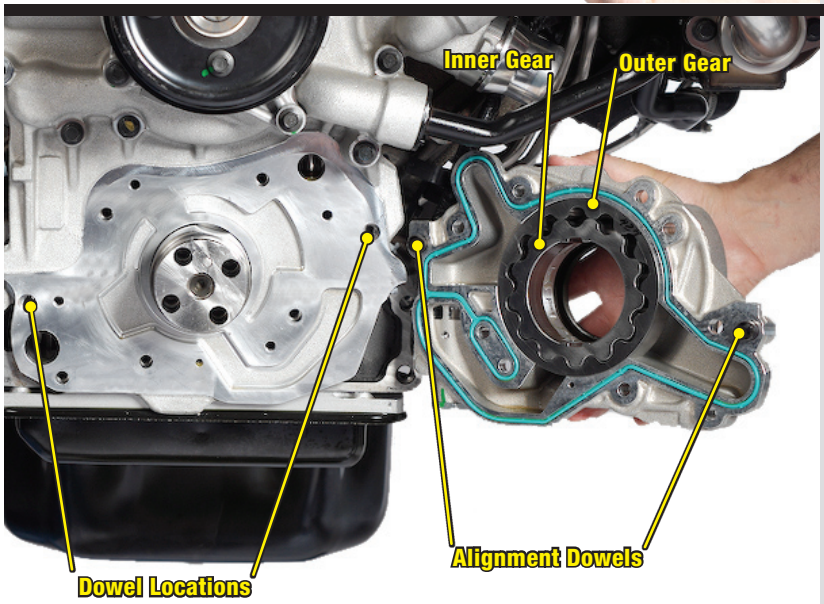
36



Oil Pressure Regulator

- The oil pressure regulator is located in the gerotor housing just to the right (when looking at the engine from the front) of the gerotor oil pump.
- The oil pressure regulator is calibrated to open at pressures above 65 psi. It should be closed below that pressure.
- The regulator valve utilizes a force, provided via the regulator spring, to apply a pressure equal to 65 psi. Whenever oil pressure exceeds this force, the regulator valve will move downward and allow the excess pressure to bleed off back through a passage that routes the oil back to the inlet side of the pump.

37

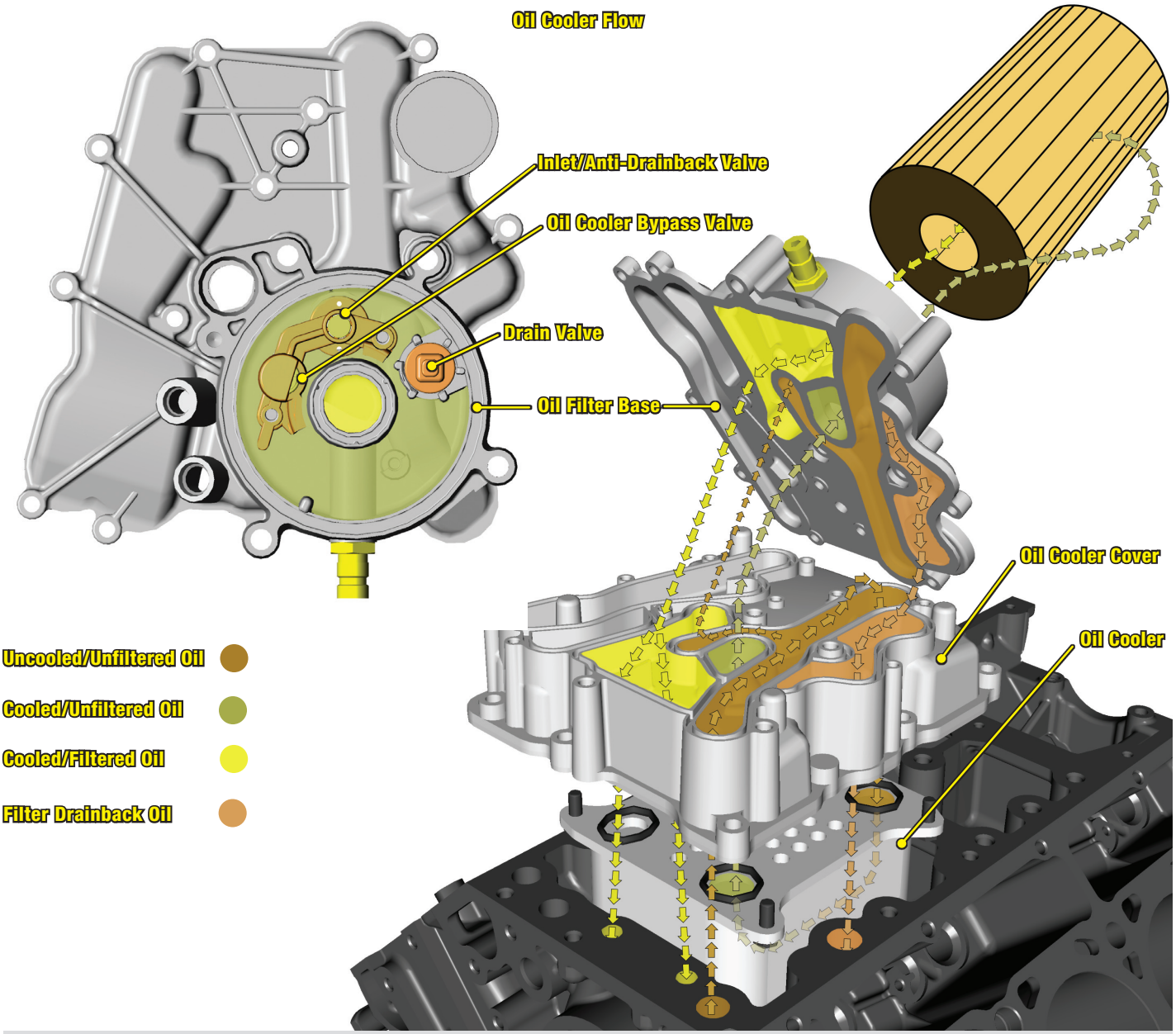


Gerotor Oil Pump

- The gerotor oil pump is driven off of the flats on the nose of the crankshaft.
- The gerotor oil pump and regulator valve are held in their own removeable housing.

38

LUBRICATION SYSTEM



Lube System Flow: Oil Cooler

- Uncooled/Unfiltered oil is directed out of the crankcase at the front left corner of the engine via a drilled passage from the oil pump.
- Uncooled/Unfiltered oil is then directed across the oil cooler cover then down into the oil cooler.
- The oil is then cooled via the oil cooler as it passes through the cooler towards the front of the engine.
- The cooled/unfiltered oil is routed up through the oil cooler cover then through the oil filter base where it enters the oil filter housing (there is a small inlet valve in the oil filter base that the oil must pass through to keep the oil from draining out of the filter housing during non-operation). At this point the oil flows through the filter (from the outside of the filter to the center) where it is cleaned.

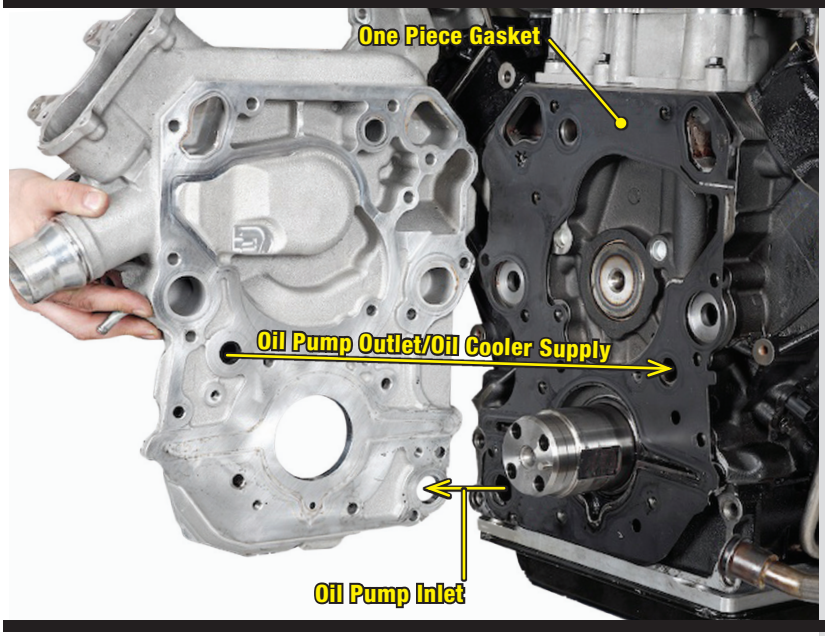
  Note: There is an oil filter bypass valve located at the top of the oil filter stand pipe (plastic tube the oil filter slides over) which will open and allow unfiltered oil to enter the system whenever a pressure differential of 27 psi is reached.

- After being cleaned via the oil filter, the oil is routed through the oil filter base and into a cavity that has ports to direct the oil to the follwing areas: left and right oil galleries, turbocharger oil supply, and the EOT & EOP sensors.

  Note: There is a drain valve inside the oil filter base which is held closed by the oil filter whenever the oil filter cap is tight. Whenever this cap is loosened, the valve is allowed to open and oil will then escape through this valve, through the oil cooler cover, and then down through a drilled passage in the crankcase to the oil pan.

  Note: There is an oil cooler bypass valve inside the oil fillter base which will open and let uncooled oil bypass the oil cooler and enter the oil filter housing whenever a pressure differential of 25 psi is reached.

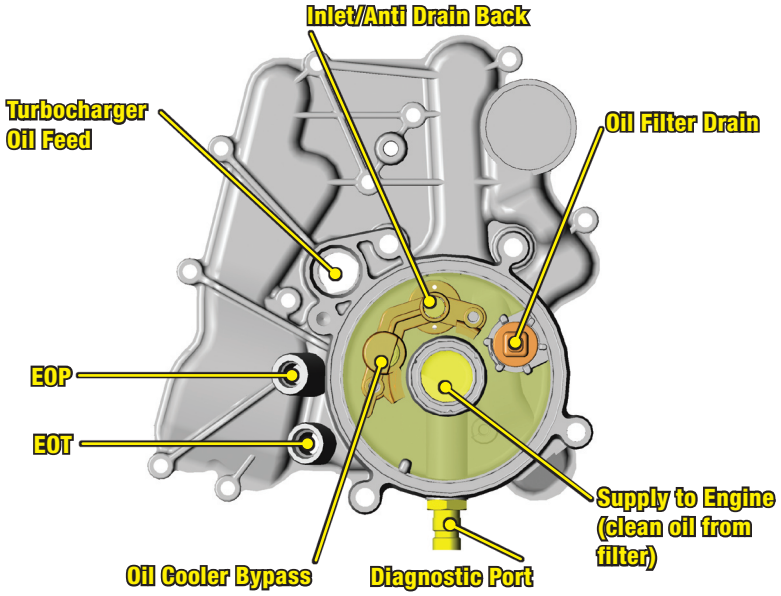
LUBRICATION SYSTEM



Front Cover

- Oil flows from the crankcase to the oil pump via a passage through the upper oil pan, front cover, and oil pump housing.
- When the oil pump is turned by the crankshaft it creates oil flow and pushes oil through two passages. One passage is to the oil cooler and the other is through the oil pressure regulator then to the oil pump inlet (this passage is only used when pressure exceeds 65 psi). When the oil reaches the numerous restrictions throughout the engine, pressure is then created (pressure is the resistance to flow).
- All of the passages from the front cover to the crankcase are sealed with a rubber coated metal, one piece gasket.

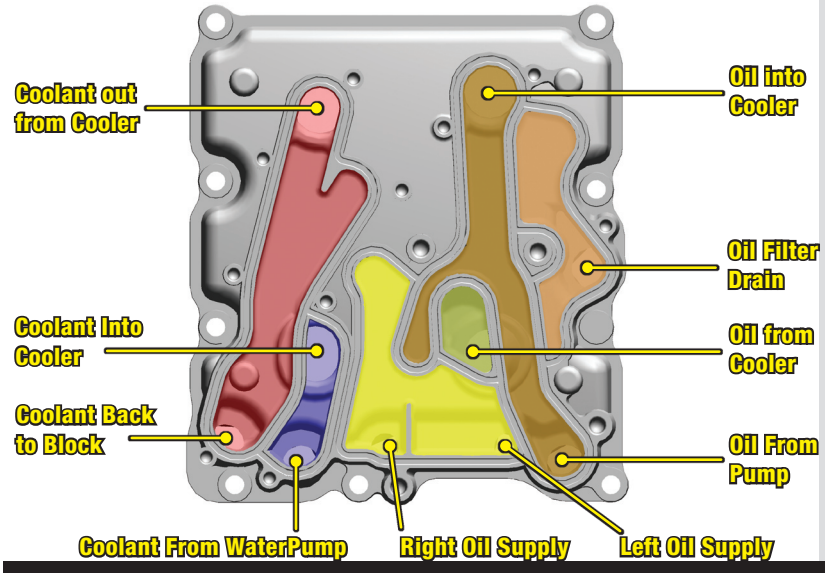
40



Oil Filter Base

- The oil filter base contains the mounting provisions for the oil filter housing and the oil filter stand pipe (which contains the oil filter bypass valve).
- Inside the oil filter housing, there are the following valves: Inlet/Anti drainback valve, oil cooler bypass valve, and the oil filter drain valve.
- The oil filter base also contains the ports for the EOT, EOP, and turbocharger oil supply. These ports are all connected with the cooled/filtered oil passage directly beneath them.

41



Oil Cooler Cover

- The oil cooler cover has passages in it to direct the flow of coolant and oil.
- Oil is routed from the front of the crankcase to the rear of the housing where it enters the oil cooler. The oil passes from the rear of the oil cooler to the front of the cooler and is cooled in the process. The oil is then sent to the oil filter through the oil filter base. Filtered oil is sent to the oil passages in the crankcase, the turbocharger supply line, and the EOT/EOP sensors.
- The coolant is directed from the front of the crankcase to the front of the oil cooler. It then passes through the oil cooler and cools the oil. As the coolant exits the front of the cooler it is directed down into the coolant stream where it re-enters the crankcase cooling system.

Note: If the oil cooler is damaged it could cause contamination of the lubrication and cooling systems.

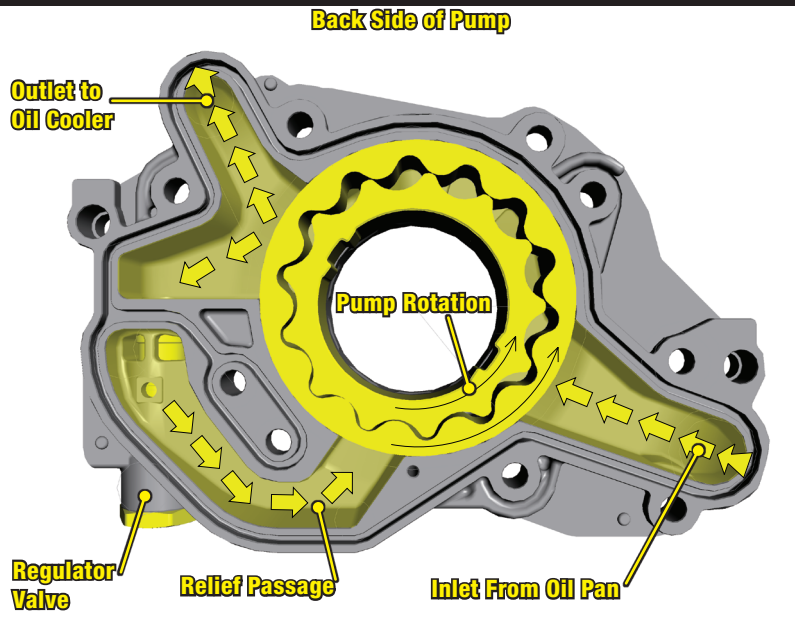
42

LUBRICATION SYSTEM

Oil Pump Flow (back side)

- The oil pump is a gerotor style pump driven off of the flats on the front of the engine's crankshaft.
- The 6.4L oil pump is held in its own removeable aluminum housing which also contains the regulator valve.
- Oil is drawn into the pump via the combination of atmospheric pressure (applied to the oil in the pan) and the low pressure area that is created between the gerotor gears on the inlet side of the pump whenever the pump is being driven by the crankshaft.
- Once this happens, the oil will flow into the pump and the pump will create a generous amount of oil flow.
- When the oil reaches various restriction throughout the engine, pressure is created.
- Pressure is limited via a pressure regulator valve located inside the pump housing. Whenever a pressure of 65 psi is reached, the regulator valve will open and allow pressurized oil to flow back through a relief passage to the inlet side of the pump, thus regulating system pressure.

43



Oil Filter

- The 6.4L Power Stroke® Diesel uses a cartridge style oil filter, located on the top of the engine.
- When the oil filter is removed, the oil filter housing drain valve is automatically opened to drain most of the oil from the housing.
- The oil filter element snaps into the oil filter lid.

Note: The oil filter lid should be removed before draining the oil from the oil pan so that the oil can drain from the filter housing into the oil pan.

44

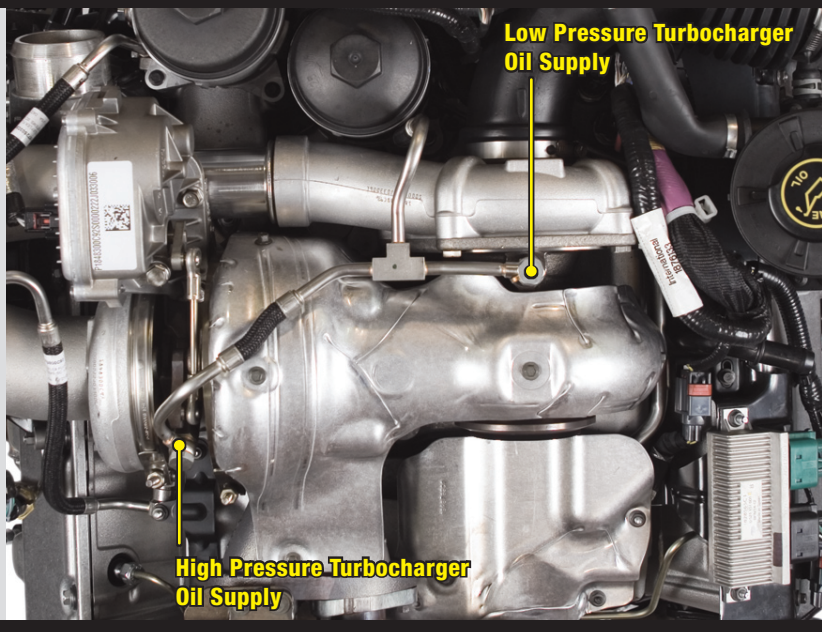


Turbocharger Oil Supply

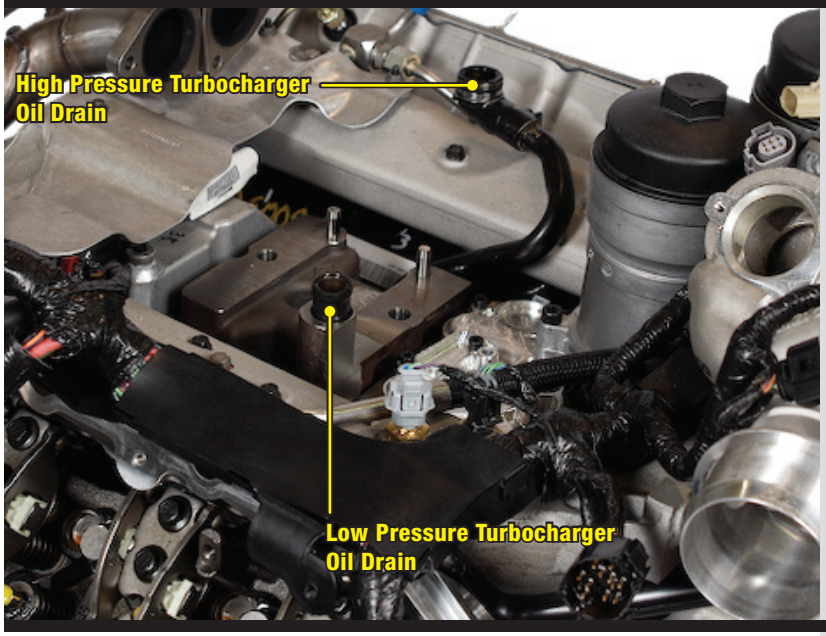
- Oil is supplied to the turbochargers from the oil filter base via a steel oil line, a steel T fitting, and two separate steel lines to each turbo (the high pressure turbocharger oil supply line has a flexible link in it).
- The oil lines are connected to each turbo via banjo fittings and washer gaskets.

Note: The washer gaskets (which are used as a gasket medium) must be replaced each time the banjo fittings are loosened.

45



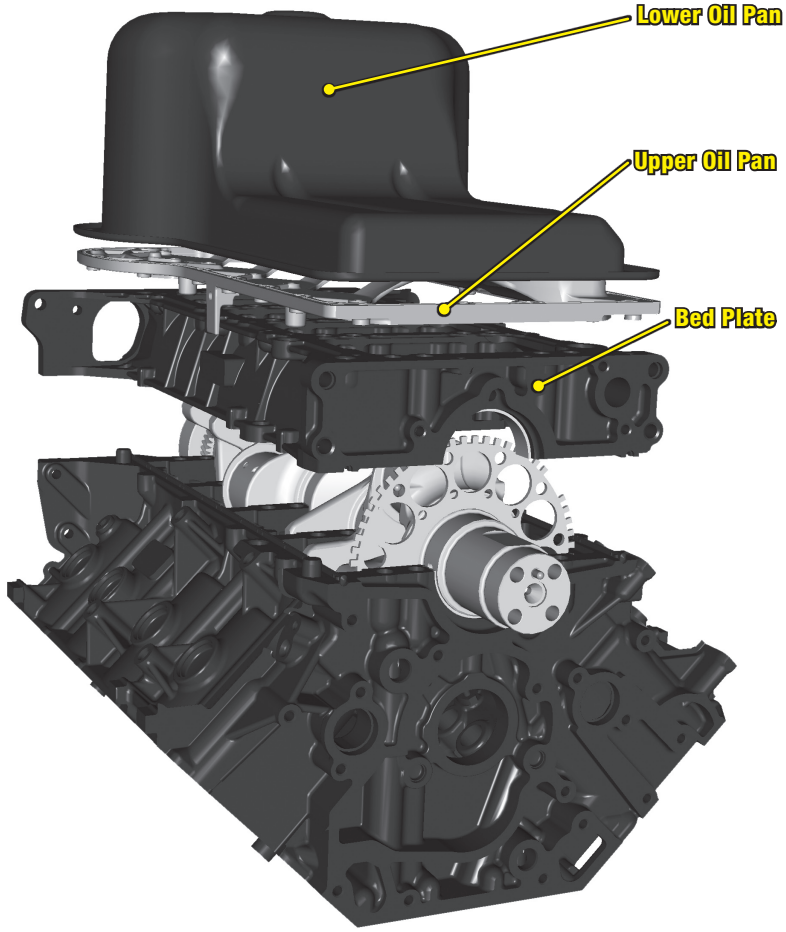
LUBRICATION SYSTEM



Turbocharger Oil Drain Tubes

- Oil is supplied to the turbochargers to lubricate and cool the bearings.
- Each turbocharger has it's own drain. The high pressure turbocharger uses a removeable tube where as the low pressure turbocharger utilizes a small extension tube off of a machined passage in the turbocharger pedestal.
- The high pressure turbocharger drain tube is sealed via two (2) O-rings, one at each end of the tube.
- The low pressure turbocharger drain extension tube is sealed via a rubber coated metal tube.

46



Oil Pan / Bed Plate

- The 6.4L Power Stroke® Diesel uses a two piece oil pan. The lower half is wider than the bottom of the engine to increase the oil capacity of the system. Due to this wider oil pan, an upper oil pan is used to adapt the lower pan to the bed plate. The upper pan also acts as an oil baffle.
- The upper pan is bolted to the bed plate. The bed plate replaces the individual main bearing caps, resulting in a more rigid bearing retaining system.

47

FUEL SUPPLY SYSTEM

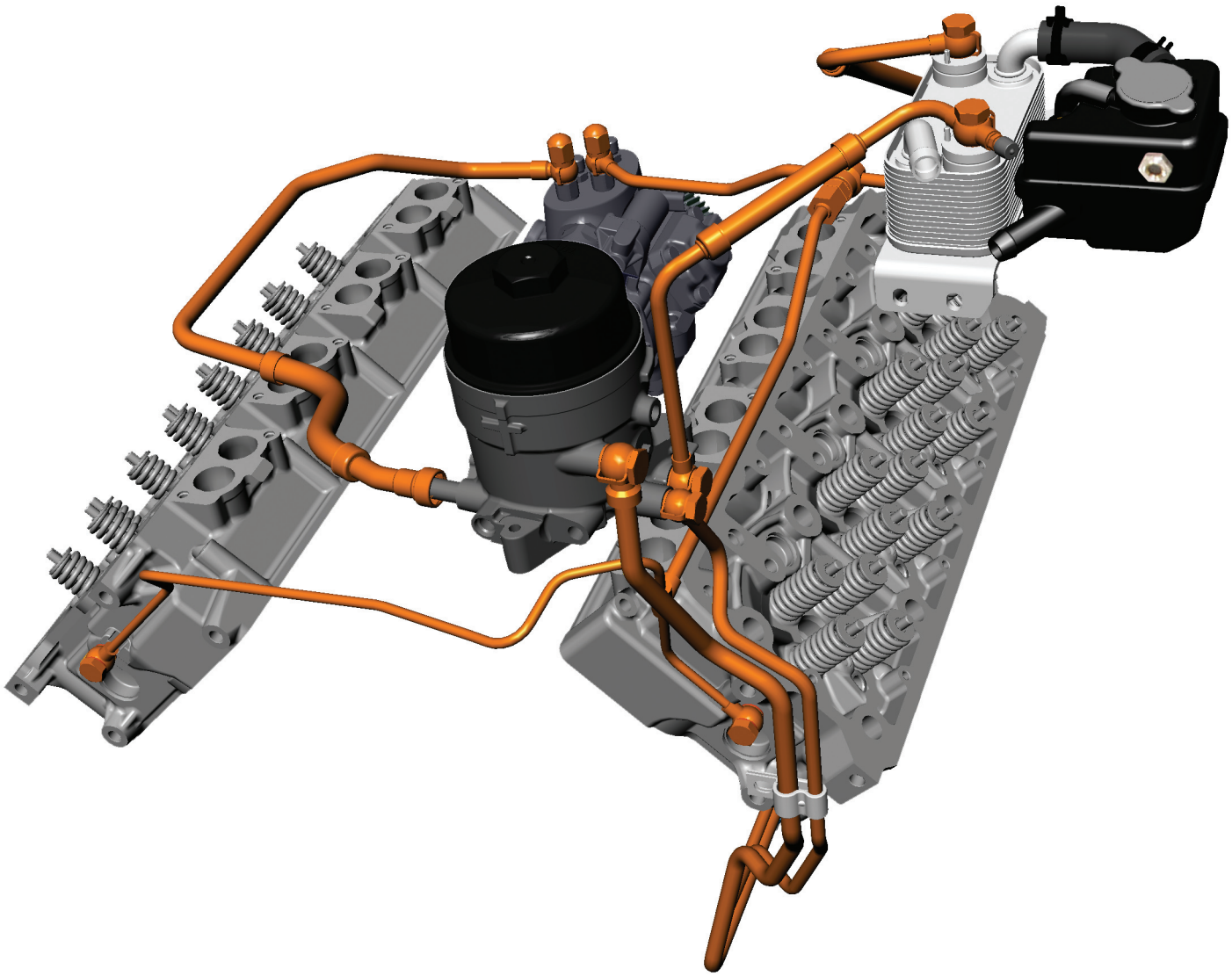
Fuel Supply System Features

- The fuel supply system uses a new Horizontal Fuel Conditioning Module (HFCM). The HFCM filters fuel, separates water, senses water, and recirculates warm fuel through the pump during cool fuel conditions.
- The 6.4L Power Stroke® Diesel also uses 2 fuel filters and a stand alone fuel cooler system.

48

Fuel Supply System Features

- **Horizontal Fuel Conditioning Module (HFCM)**
- **(1) Chassis Mounted 10 Micron Fuel Filter**
- **(1) Engine Mounted 4 Micron Fuel Filter**
- **Water Separator**
- **Fuel Cooler**

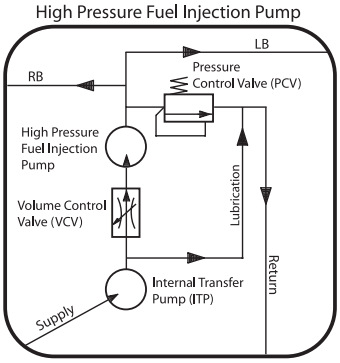


49

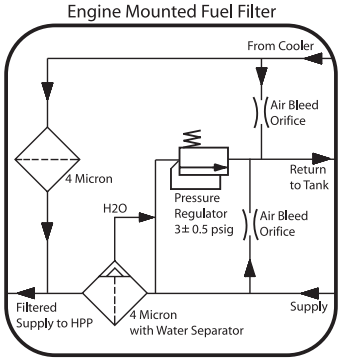
FUEL SUPPLY SYSTEM

FUEL FLOW

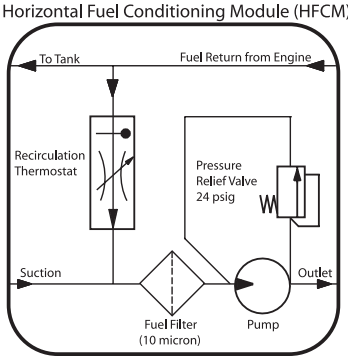
High Pressure Fuel Injection Pump

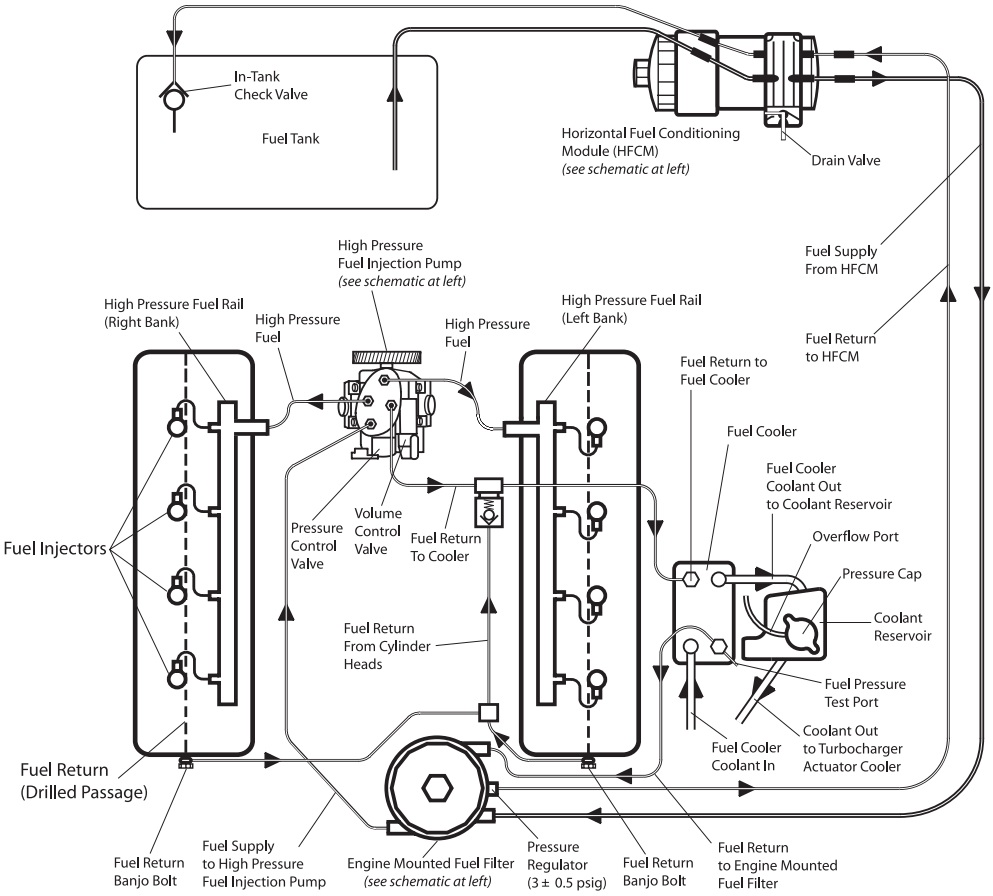


Engine Mounted Fuel Filter



Horizontal Fuel Conditioning Module (HFCM)





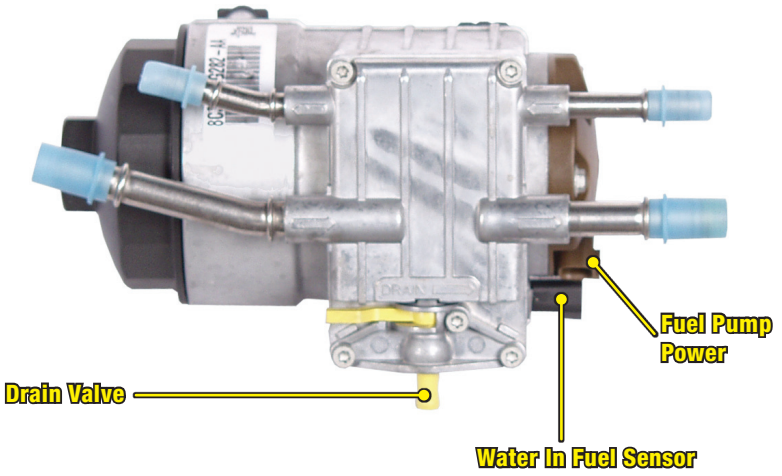
Engine Fuel Flow

- The fuel pump, located in the Horizontal Fuel Conditioning Module (HFCM), draws fuel from the fuel tank and through a 10 micron fuel filter.
- The HFCM contains the fuel pump, filter, water separator, water in fuel switch, fuel drain, and diesel thermo recirculation valve (DTRM).
- The DTRM controls the flow of fuel returned from the engine mounted filter through the HFCM. If the fuel being drawn from the fuel tank is cooler than a specified temperature then return fuel from the engine is recirculated into the inlet of the pump.
- After the fuel is conditioned by the HFCM, the clean pressurized fuel is sent to the engine mounted fuel filter assembly where particles larger than 4 micron are filtered out of the fuel.
- The engine mounted fuel filter assembly also regulates fuel pressure by releasing excess pressure via a return fuel line back to the HFCM. The engine mounted fuel filter also contains air bleed orifices to remove air and return it to the tank.
- After the fuel is filtered it is routed to the Internal Transfer Pump (ITP).
- The ITP is located inside the high pressure fuel injection pump and is used to increase the fuel pressure supplied to the high pressure fuel injection pump's three (3) internal pistons.
- After the fuel is pressurized it is routed to the high pressure fuel rails and to the fuel injectors via high pressure fuel supply tubes.
- A Pressure Control Valve (PCV) located in the outlet side of the high pressure fuel injection pump controls the fuel pressure by dumping excess fuel into the fuel return line.
- A Fuel Rail Pressure (FRP) sensor located in the right side fuel rail monitors the fuel pressure.
- Return fuel from the injectors is routed through a drilled passage from each cylinder head where it is then united with return fuel from the high pressure fuel injection pump before being sent to the fuel cooler and back to the engine mounted fuel filter.

FUEL SUPPLY SYSTEM

HFCM (Horizontal Fuel Conditioning Module)

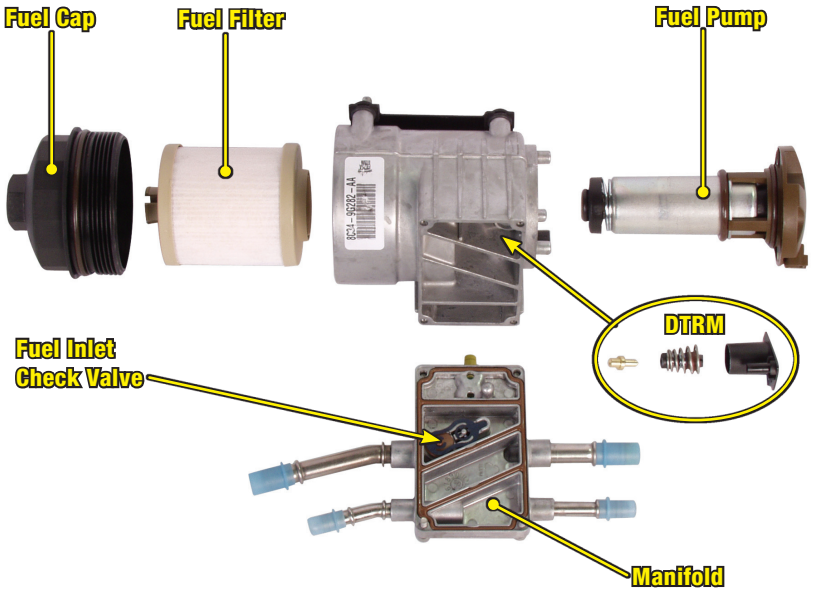
- The HFCM is mounted to the frame rail on the drivers side.
- The HFCM is a single module that performs multiple tasks. It separates water from the fuel, senses when water is present in the fuel, filters particulates from the fuel, and creates the fuel flow needed to supply fuel to the engine mounted fuel filter.
- A DTRM (Diesel Thermo Recirculation Module) is also part of the HFCM. It recirculates fuel that returns from the engine mounted fuel filter back into the fuel filter instead of back to the tank.



51

HFCM Components

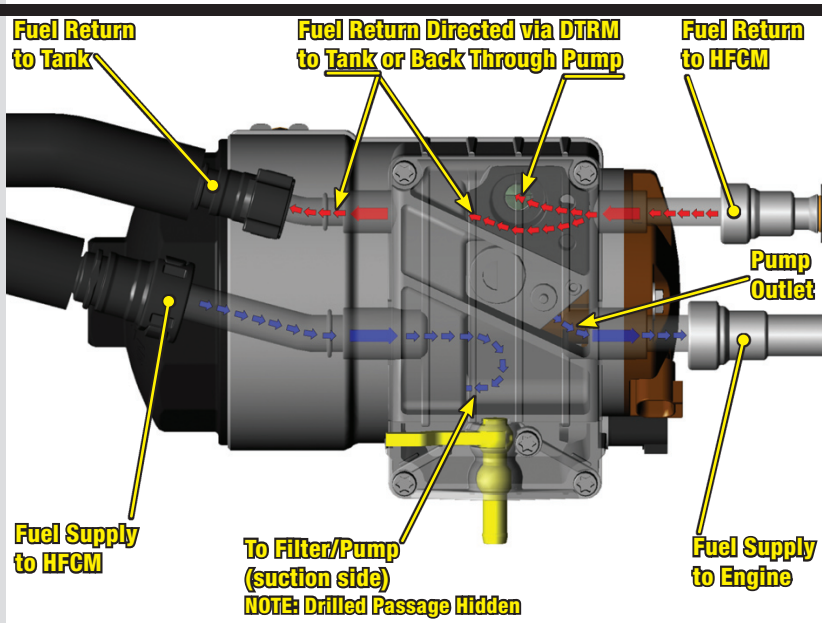
- The HFCM is composed of six (6) main components:
  - Housing
  - Fuel Filter (10 micron)
  - Fuel Cap
  - Electric Fuel Pump
  - Manifold (contains the fuel inlet check valve)
  - Diesel Thermo Recirculation Module (DTRM) is also part of the HFCM. It recirculates fuel that returns from the engine mounted fuel filter back into the fuel filter instead of back to the tank.



52

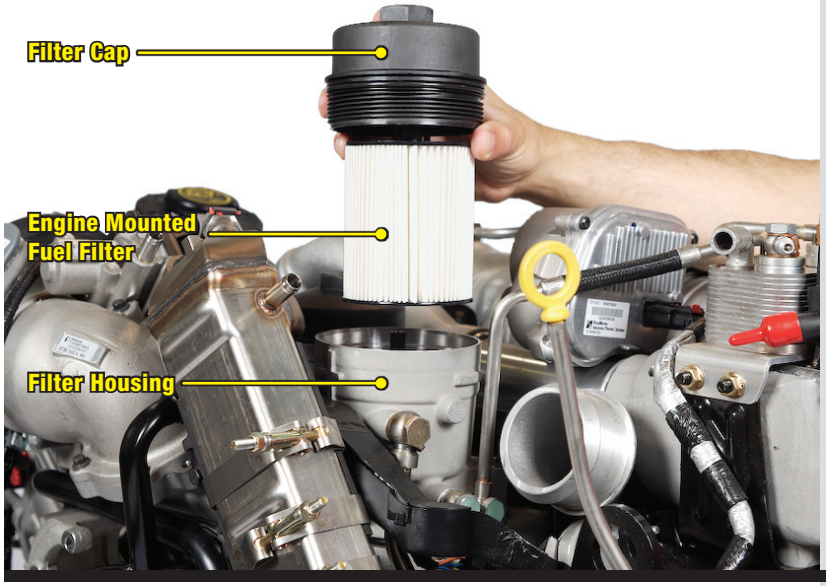
HFCM Fuel Flow

- Fuel is drawn into the HFCM from the fuel tank via a supply line.
- Fuel enters the filter housing via a one-way check valve.
- Once in the filter housing, water is separated from the fuel. If large amounts of water are found in the fuel, a sensor in the separator warns the operator of this condition by illuminating a light on the dash.
- Fuel is then drawn through the 10 micron fuel filter and into the fuel pump.
- Conditioned pressurized fuel is then supplied to the engine mounted fuel filter via a fuel supply line. The pump has an internal regulator that limits fuel pressure to 24psi.
- Fuel returning from the pressure regulator on the engine mounted fuel filter comes into the HFCM and a DTRM either allows the fuel to return to the tank or returns it to the unfiltered side of the fuel filter in the HFCM. The DTRM starts to open (recirculating fuel back into the pump) at 80°F (27°C) and is fully open at 50°F (10°C).



53

FUEL SUPPLY SYSTEM

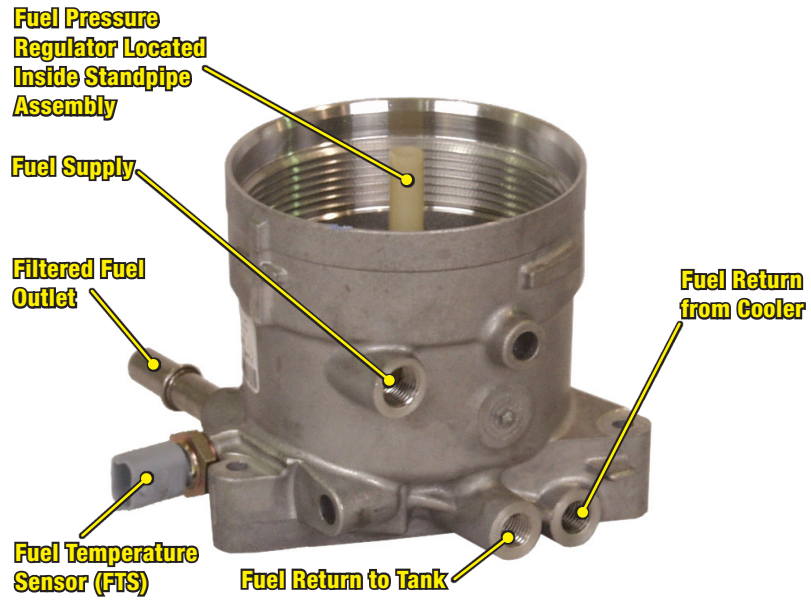


Engine Mounted Fuel Filter

- An engine mounted fuel filter is mounted to the intake manifold.
- The engine mounted fuel filter is a 4 micron cartridge style filter.
- It also incorporates a fuel pressure regulator (in the standpipe) and an air bleed. Fuel from the regulator is returned to the HFCM.

NOTE: Please exercise extreme cleanliness when servicing the fuel filter.

54

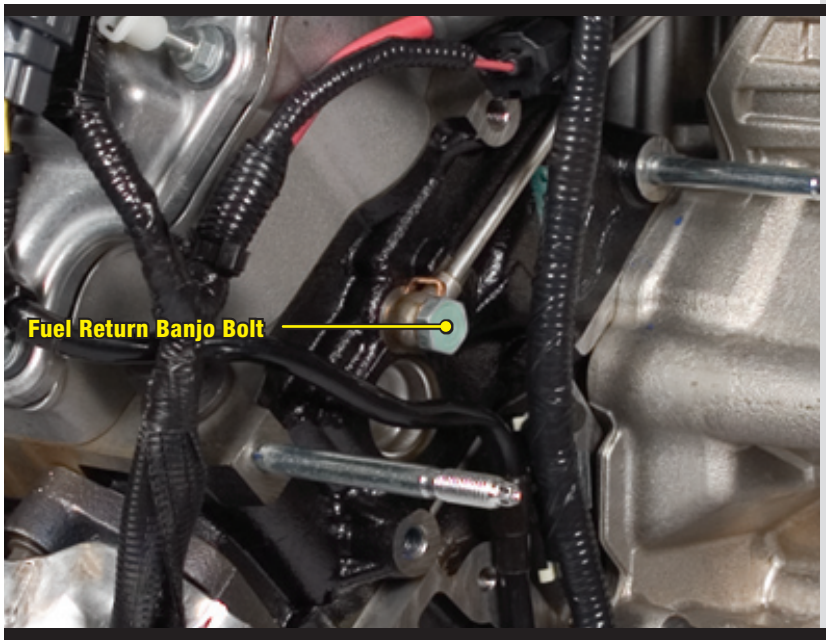


Fuel Pressure Regulator

- The fuel pressure regulator is located inside the engine mounted fuel filter housing in the standpipe.
- It regulates fuel pressure by routing unfiltered fuel from the filter housing to the HFCM via a spring loaded poppet style valve.
- The cracking pressure (pressure at which the valve begins to open) of the valve is 2psi +\- 0.5psi. Actual fuel pressure may be above or below this specification.
- The regulated pressure of the valve is 3psi+/- 0.5psi. Actual fuel pressure may be above or below this specification.

NOTE: The fuel pressure regulator is NOT serviceable separate from the housing! If the regulator needs to be replaced, then the entire housing must be replaced.

55



Fuel Return Banjo Fittings

- The fuel return lines (located on the front of each cylinder head) utilize a banjo bolt to route the return fuel back to the fuel system.

NOTE: The 6.0L Power Stroke® Diesel utilized a banjo bolt with a check valve inside. Do not interchange the 6.0L banjo bolt with the 6.4L banjo bolt.

NOTE: The 6.4L Power Stroke Diesel uses an open banjo bolt with no check valve. The check valves are no longer needed since the drilled passages in the cylinder heads are now utilized as fuel return passages.

56

This page intentionally left blank

AIR MANAGEMENT SYSTEM

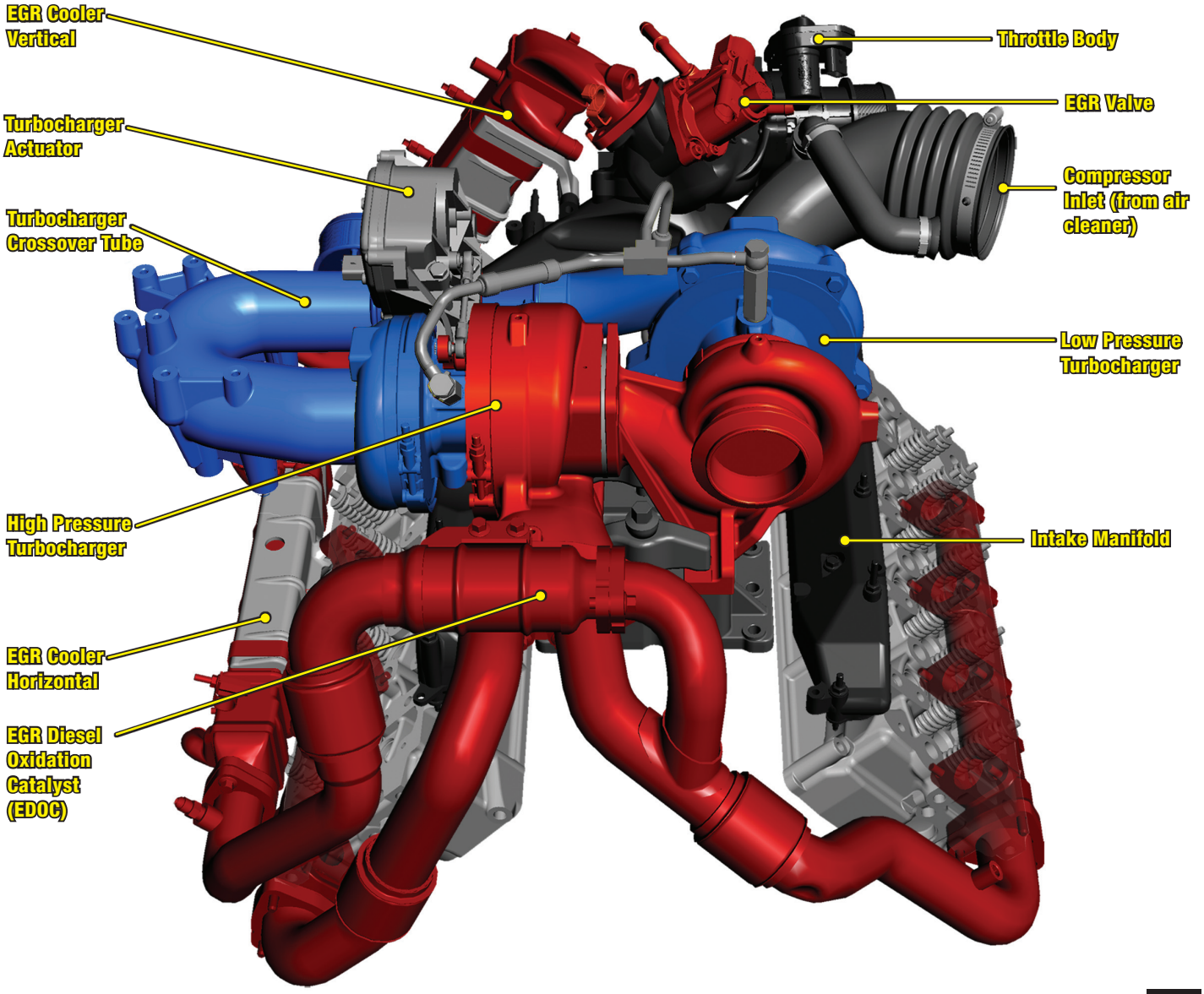
Air Management System Components

- Series Sequential Turbocharger
- Charge Air Cooler
- Intake Manifold
- Air Filter/Filter Minder
- Exhaust Gas Recirculation (EGR) System

Air Management System Features

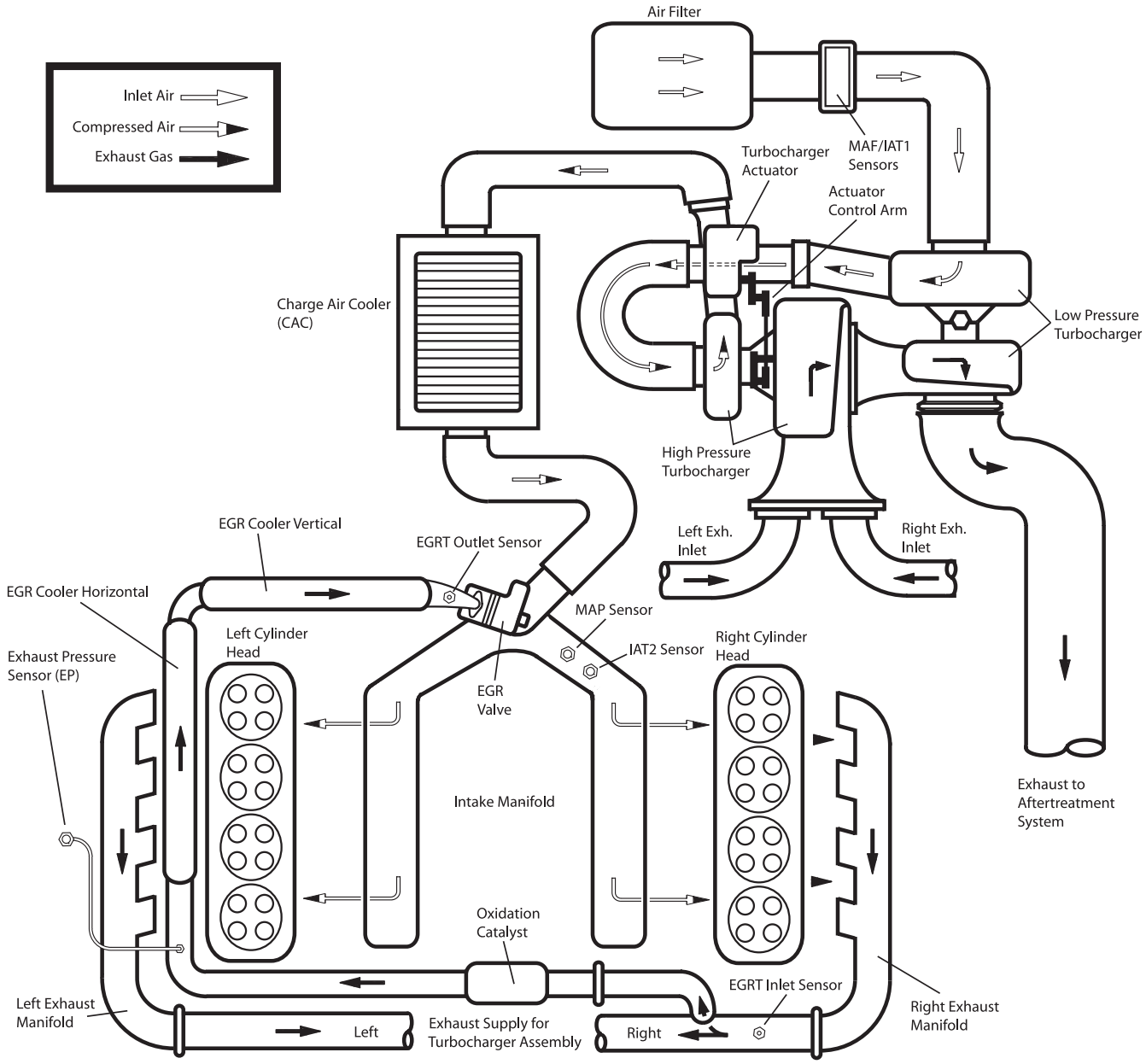
- The series sequential turbocharger is a low pressure/high pressure design working in series with a turbocharger actuator on the high pressure turbine controlling the boost pressures.
- The charge air cooler is utilized to reduce the temperature of the pressurized air therefore inducing a cooler/denser air charge into the intake manifold for maximum efficiency.
- An air filter/filter minder combination is utilzed to clean the incoming air and provide a means for monitoring the condition of the air filter via the filter minder.
- The EGR system is designed to reduce exhaust emissions.

57



58

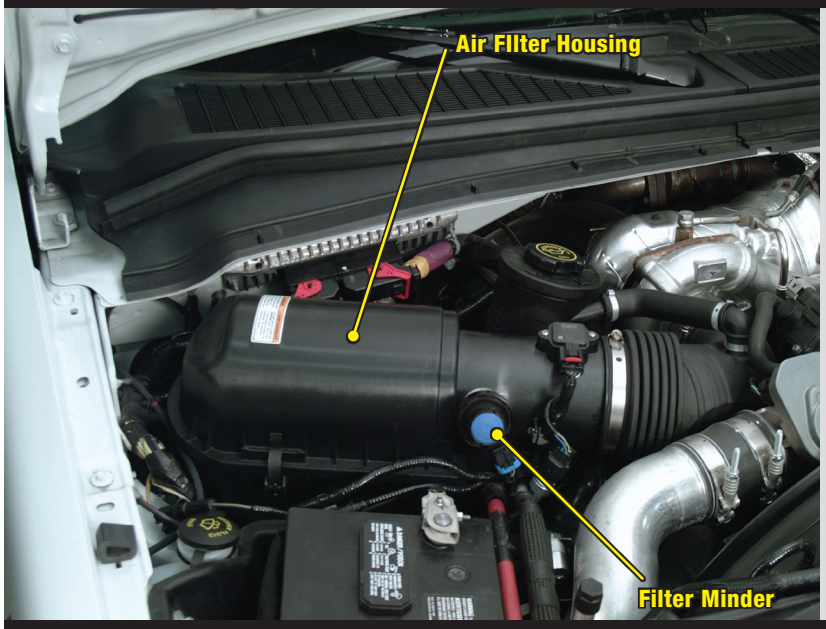
AIR MANAGEMENT SYSTEM



System Flow

- Air enters the system through the air filter where particles are removed from the air. The air filter has a filter minder on it to warn the operator of a restricted air filter.
- After the air is filtered, the mass of the air and temperature are measured by the mass air flow sensor (MAF) and the intake air temperature sensor #1 (IAT1).
- The filtered air is then directed past the crankcase ventilation system where crankcase vapors and fresh air are mixed.
- After mixing with crankcase vapors the fresh air mixture is drawn into the low pressure turbocharger compressor then the compressed air is sent to the high pressure turbocharger where it is further compressed before being sent to the charge air cooler (CAC).
- The (CAC) cools the compressed air via an air-to-air cooler, then the condensed air passes through the EGR throttle, mixes with cooled EGR gases, then enters the intake manifold.
- The intake manifold directs the cooled air to the intake ports of the cylinder heads.
- The burned air fuel mixture is pushed out of the cylinder into the exhaust manifold which collects the exhaust and routes it to the high pressure turbocharger's turbine wheel.
- The exhaust up pipe, connected to the passenger side exhaust manifold has a passage that directs exhaust to the exhaust gas recirculation (EGR) coolers and then to the EGR valve.
- The EGR valve controls the flow of exhaust into the intake system where the gases are mixed with intake air to reduce NOx (Oxides of Nitrogen) emissions and noise.
- The hot and expanding exhaust gases that are routed to the series sequential turbocharger turbines, spin the turbine wheels through flow and expansion. The spinning turbine wheels then spin the compressor wheels via common shafts.

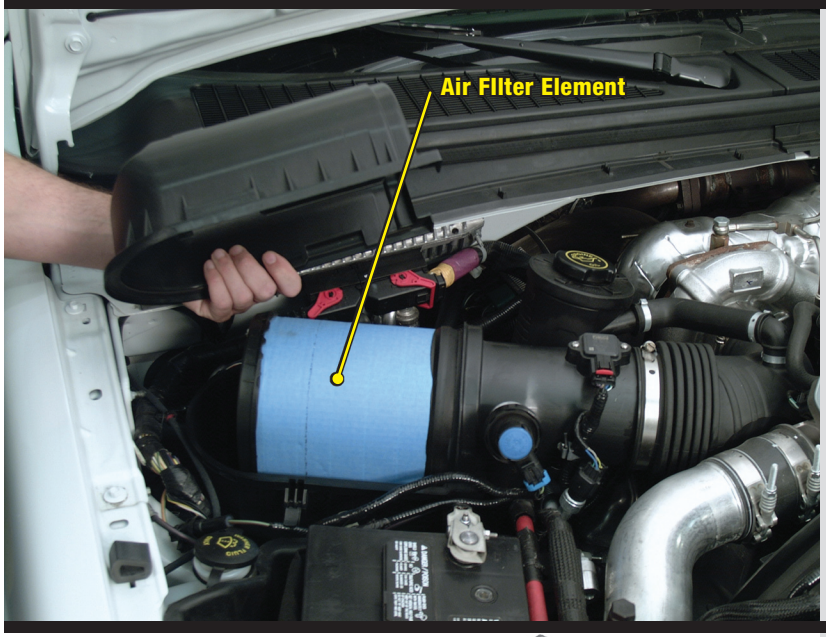
AIR MANAGEMENT SYSTEM



Air Filter Housing/ Filter Minder

- The air filter is located on the passenger side of the engine compartment between the battery and the cowl.
- A filter minder, device used to measure filter restriction, is located on the outlet side of the air filter housing just before the MAF sensor.
- Fresh air, from the passenger side fender area, is drawn into the air filter and particulates are removed from the air before going to the engine.

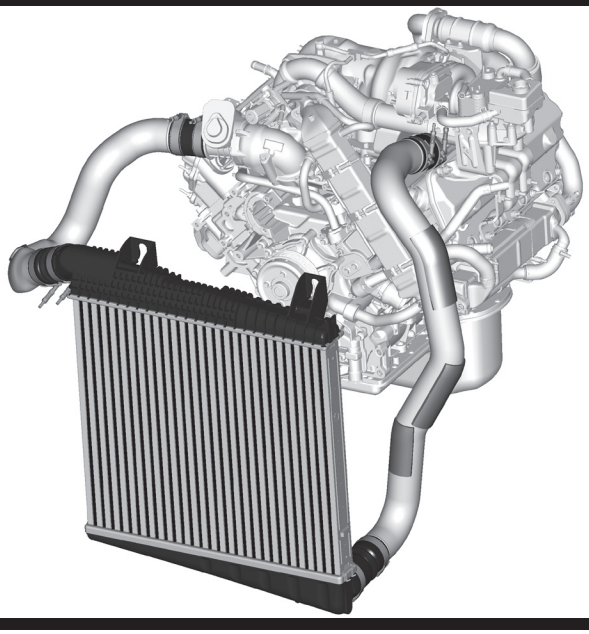
60



Air Filter Element

- The new air filter element is a replaceable cartridge separate from the housing.
- The air filter is capable of holding 750 grams of particulates before needing replacement.
- The filter element is a honeycomb design.

61



Charge Air Cooler (CAC)

- The CAC is located in the front of the radiator.
- The CAC is an air to air cooler designed to lower the temperature of the air coming out of the turbocharger outlet before entering the intake manifold.

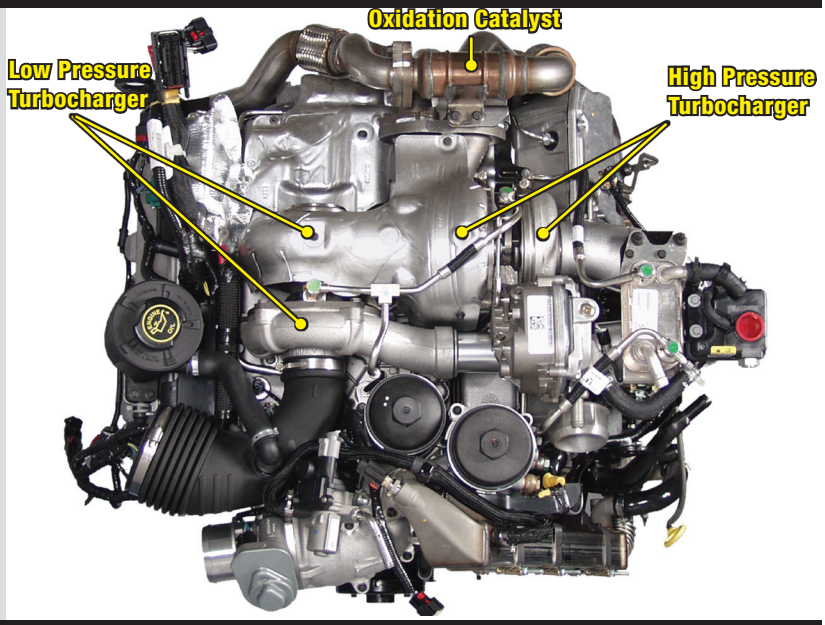
62

AIR MANAGEMENT SYSTEM

Series Sequential Turbocharger & Turbocharger Actuator

- The series sequential turbocharger for the 6.4L Power Stroke® Diesel is designed to provide boost control at low and high speeds for improved throttle response.
- The turbocharger actuator is used to control the position of the variable vanes inside the high pressure turbocharger's turbine housing.
- When the vanes of the turbocharger are closed, the engine will have a higher exhaust back pressure and create more heat which will in turn warm the engine faster in cold ambient conditions.

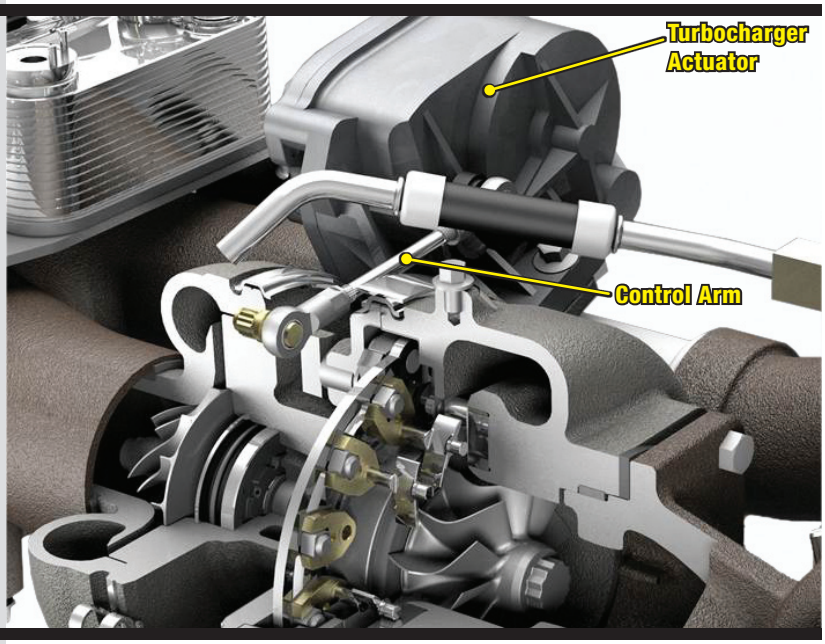
NOTE: There is an oxidation catalyst in the exhaust pipe for the EGR system that is utilized to crack hydrocarbons before they enter the EGR system.



63

Turbocharger Actuator

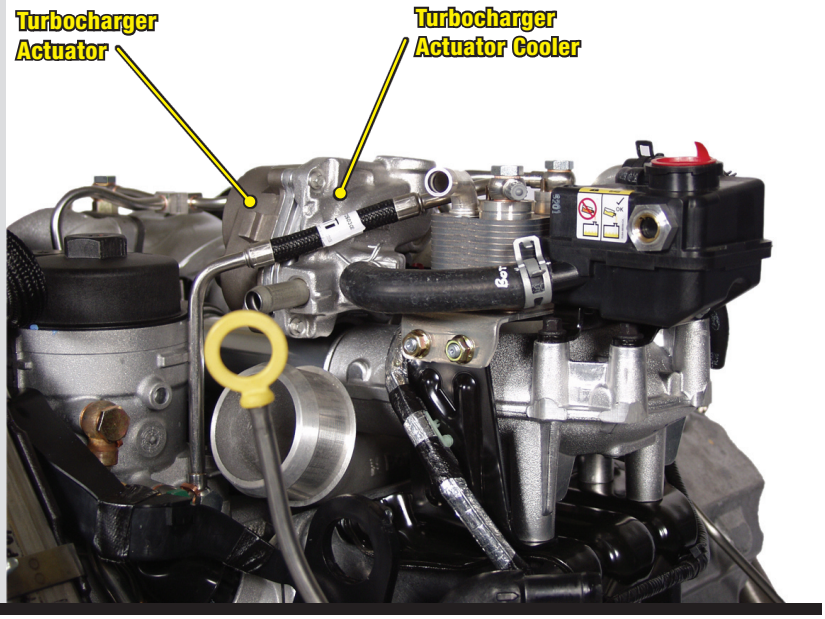
- The variable vanes inside the high pressure turbocharger's turbine housing are now controlled by the turbocharger actuator.
- The high pressure turbocharger's turbine housing contains vanes that control the effective size of the housing. These vanes are controlled by the turbocharger actuator by way of a control arm. The control arm connects the actuator to a pivot shaft which connects to the unison ring that moves the vanes.



64

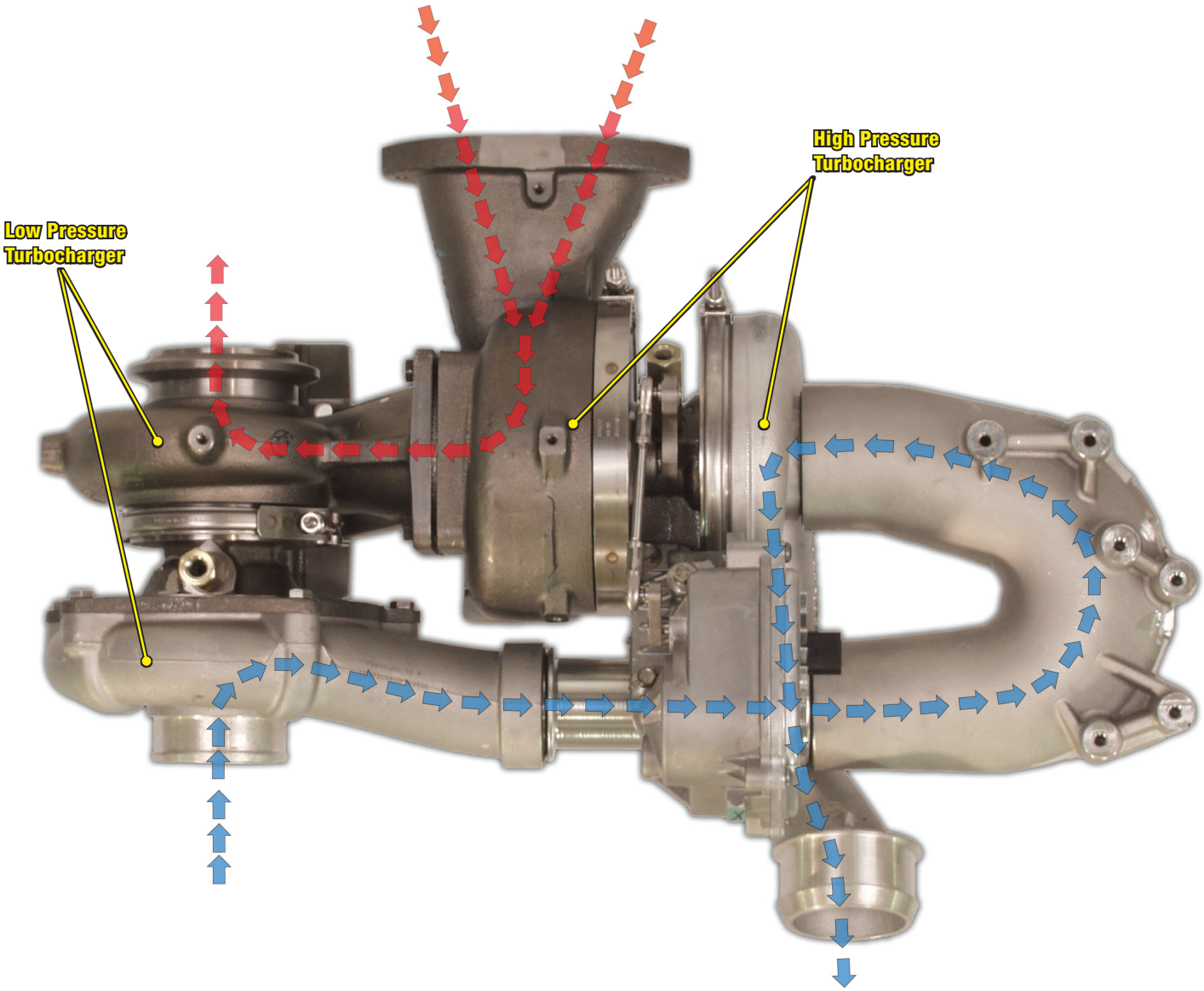
Turbocharger Actuator Cooler

- The turbocharger actuator is fitted with a cooling plate to reduce the temperature of the electronics inside the actuator housing.
- The actuator cooler uses coolant from the fuel system cooler as the heat exchange medium.



65

AIR MANAGEMENT SYSTEM



INTAKE AIRFLOW (Blue)

- Air enters the low pressure turbocharger from the air filter.
- The low pressure turbocharger compresses the air and sends the air through the extension tube and the crossover tube prior to entering the high pressure turbocharger.
- The high pressure turbocharger further compresses the air and sends the air to the charge air cooler (CAC) where the air is cooled by an air-to-air cooler prior to entering the intake manifold.

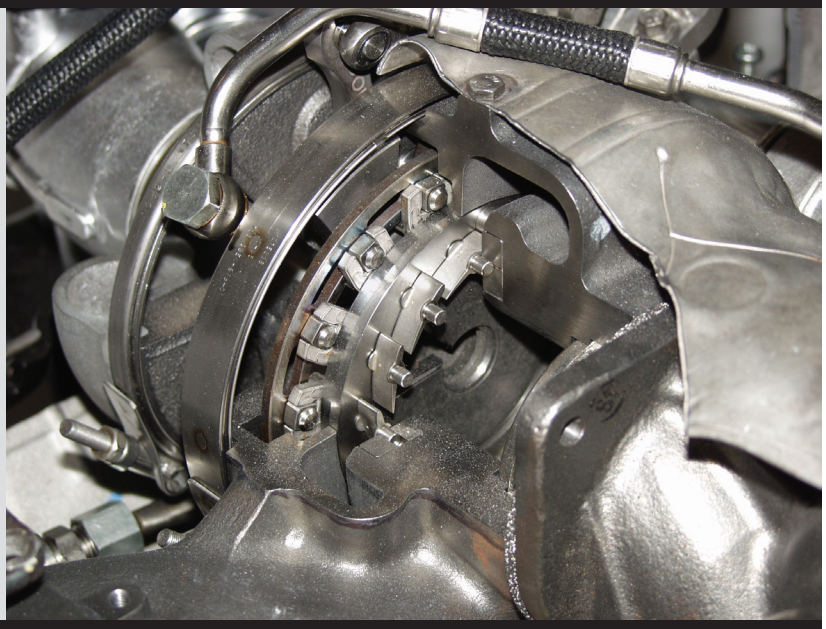
EXHAUST AIRFLOW (Red)

- Exhaust gas enters the high pressure turbocharger turbine housing after being directed through the exhaust up-pipes at the rear of the engine.
- The high pressure turbocharger turbine contains the vanes which are controlled by the turbocharger actuator. These vanes continually change the velocity of the exhaust gas in the high pressure turbocharger turbine.
- After the exhaust gas has passed through the high pressure turbocharger turbine it immediately enters the low pressure turbocharger turbine.
- Once the exhaust gas has powered the low pressure turbocharger turbine the exhaust gas exits through the housing towards the rear of the engine where it is directed to the exhaust aftertreatment system.

AIR MANAGEMENT SYSTEM

Vanes Closed

- During engine operation at low engine speeds and load, little energy is available from the exhaust to generate boost. In order to maximize the use of the energy that is available, the vanes are closed. In doing so, the exhaust gas is accelerated between the vanes and across the turbine wheel. In general, this allows the turbocharger to behave as a small turbocharger, increasing the wheel speed quickly at low speed.
- Closing the vanes also increases the back pressure in the exhaust manifold which is used to drive the exhaust gas through the EGR cooler and valve into the intake manifold.
- The closed vane position is also used for cold ambient warm up.

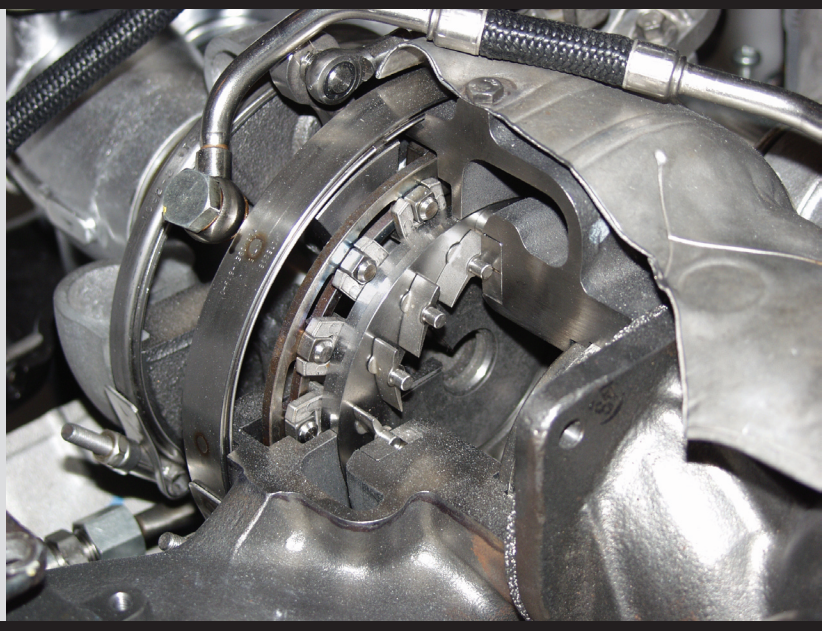


67

Vanes Partially Closed

- During Engine operation at moderate engine speeds and load, the vanes are commanded partially open.
- The vanes are set to this intermediate position to supply the correct amount of boost to the engine for optimal combustion as well as providing the necessary back pressure to drive EGR.

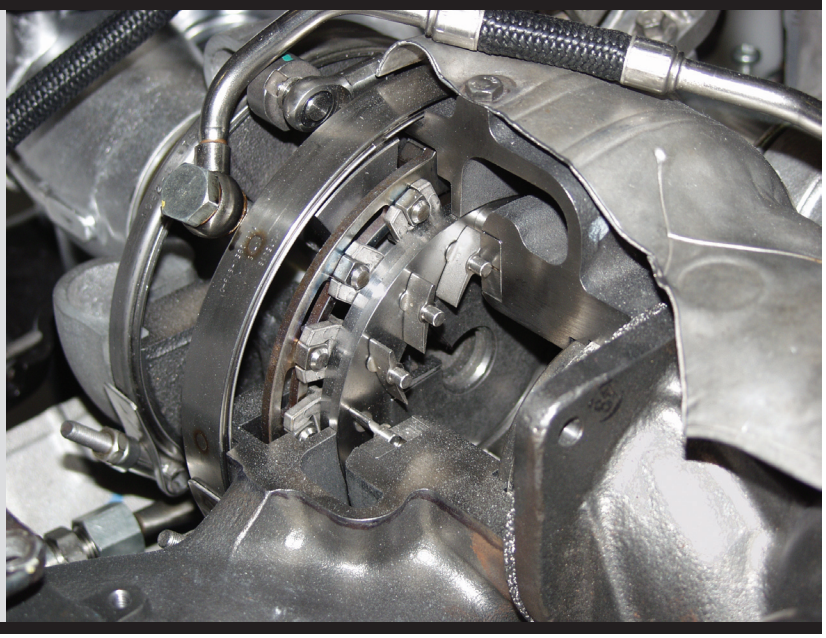
Note: There is actually an infinite number of vane positions between open and closed. The partially closed picture is for illustration purposes only.



68

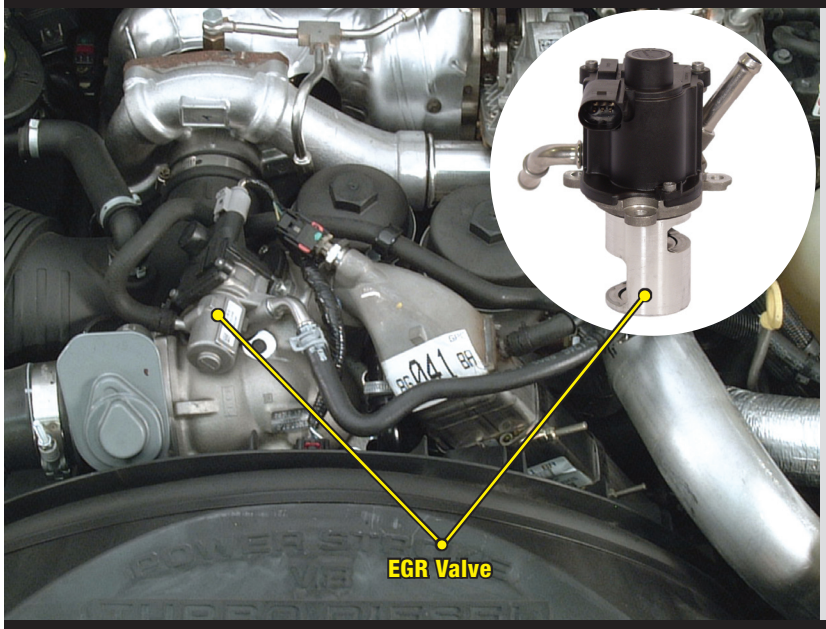
Vanes Open

- During engine operation at high engine speeds and load, there is a great deal of energy available in the exhaust.
- Excessive boost under high speed, high load conditions can negatively affect component durability, therefore the vanes are commanded open preventing turbocharger overspeed.
- Essentially, this allows the turbocharger to act as a large turbocharger with minimal restriction.



69

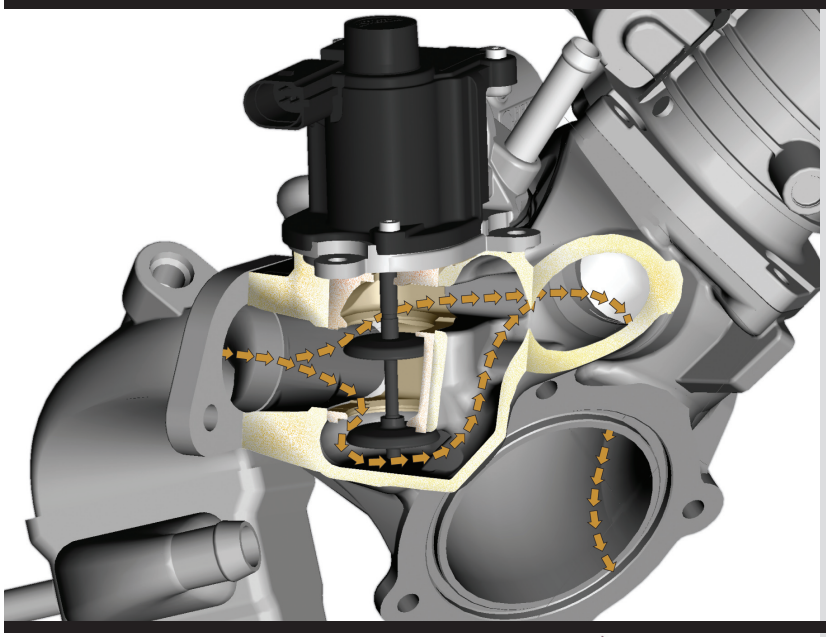
AIR MANAGEMENT SYSTEM



EGR Valve

- The ECM controlled EGR (Exhaust Gas Recirculation) valve adds cooled exhaust gases to the intake manifold to reduce NOx emissions.
- The EGR valve is opened during steady state throttle positions when exhaust back pressures are higher than intake manifold pressures (boost).

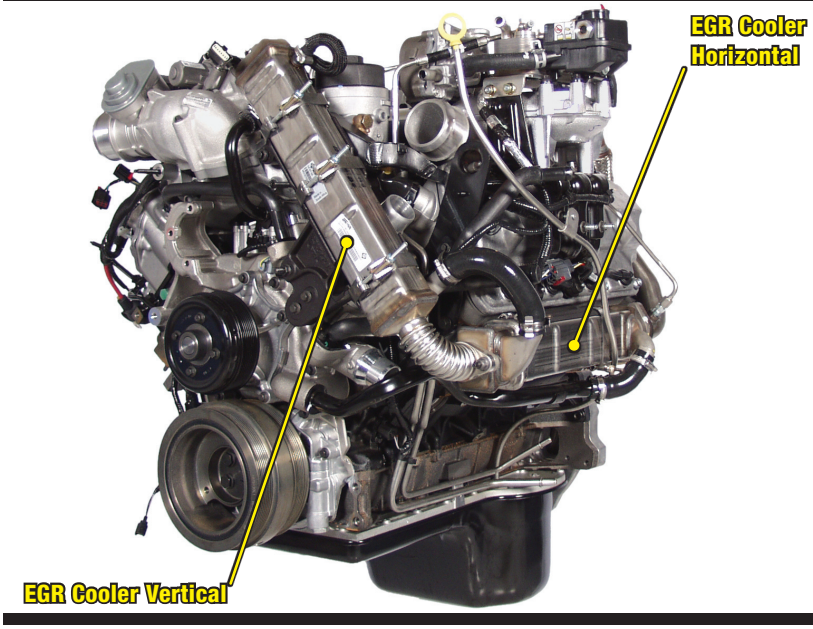
70



EGR Flow

- The EGR valve has two valves connected by a common shaft.
- Cooled exhaust gas enters the lower opening of the EGR valve after leaving the vertical EGR cooler.
- When the valve opens it allows the cooled exhaust gas to flow through two passages, one passage is through the upper opening of the EGR valve (upper valve) and the other is through a passage below the EGR valve (lower valve).
- Both passages merge together prior to being mixed with the filtered incoming air before being sent to the intake manifold.

71



Dual EGR Cooling System

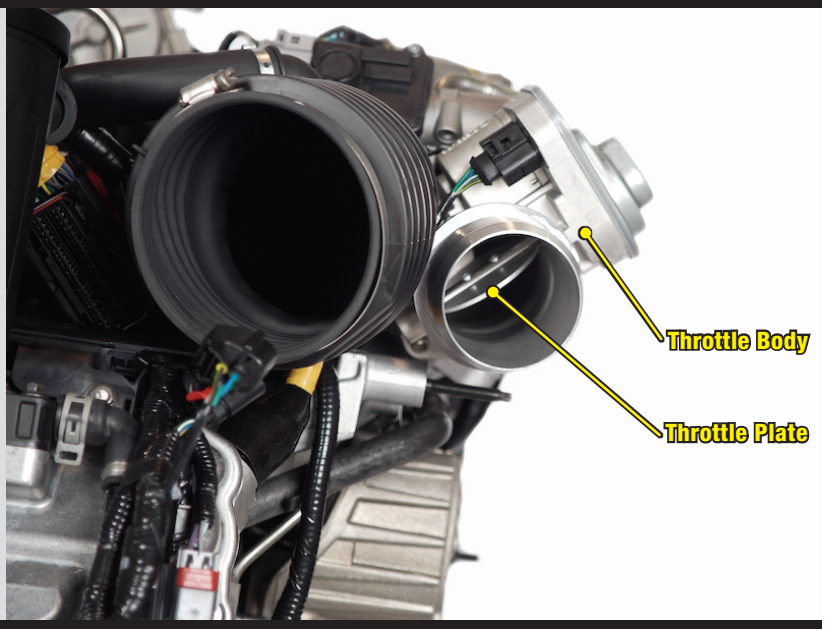
- The EGR cooling system is an air to coolant heat exchanger that is used to cool the exhaust gases before they are sent to the EGR valve.
- The exhaust is routed into the EGR coolers from the exhaust up pipes at the rear of the engine.
- The exhaust is cooled by passing through metal tubes that are surrounded by engine coolant. Depending on conditions, the temperature drop across the coolers could be as much as 850°F.
- The cooled exhaust is then routed to the EGR valve that is mounted to the inlet mixing chamber.

72

AIR MANAGEMENT SYSTEM

Throttle Body

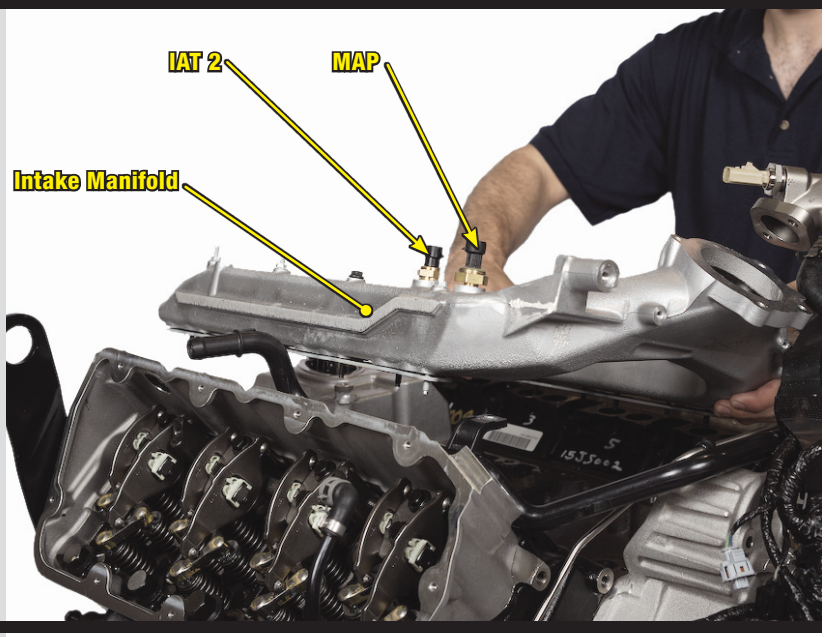
- The throttle body is used to assist with the exhaust aftertreatment system.



73

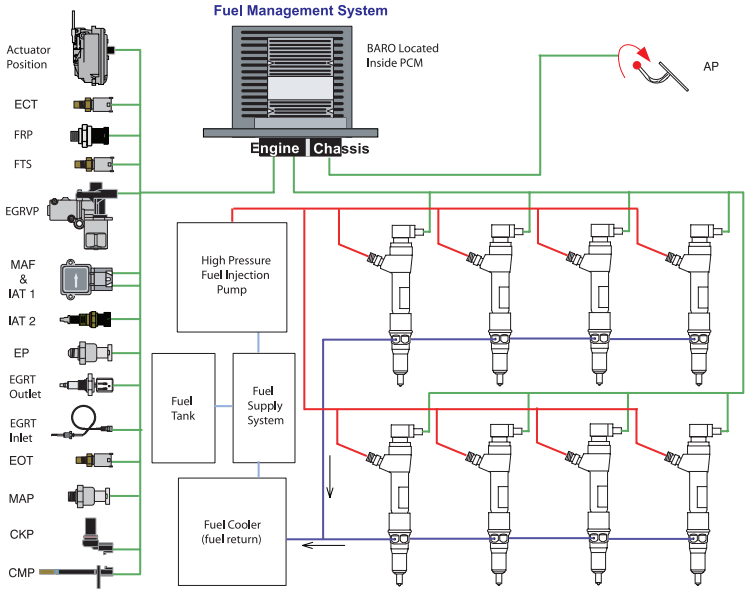
Intake Manifold

- The intake manifold on the 6.4L Power Stroke® Diesel is made of aluminum and directs the flow of air to the intake ports in the cylinder heads.
- The manifold absolute pressure sensor (MAP) and the intake air temperature 2 sensor (IAT2) are both mounted in the intake manifold.



74

FUEL MANAGEMENT SYSTEM



High Pressure Common Rail Fuel System

- The high pressure common rail fuel injection system with piezo electric fuel injectors uses pressurized fuel and electronics to actuate and control fuel injection into the cylinders.

75

Fuel Management System Major Components

- Fuel Supply System
- High Pressure Fuel Injection Pump
- High Pressure Fuel Tubes
- Sensors
- Injectors
- Electrical Components
- Actuators

High Pressure Common Rail Direct Injection Fuel System Components

- The fuel management system is comprised of several sub systems.
- Each system works together to deliver excellent power and efficiency while meeting the requirements of emissions regulations.

76

Fuel Management System Features

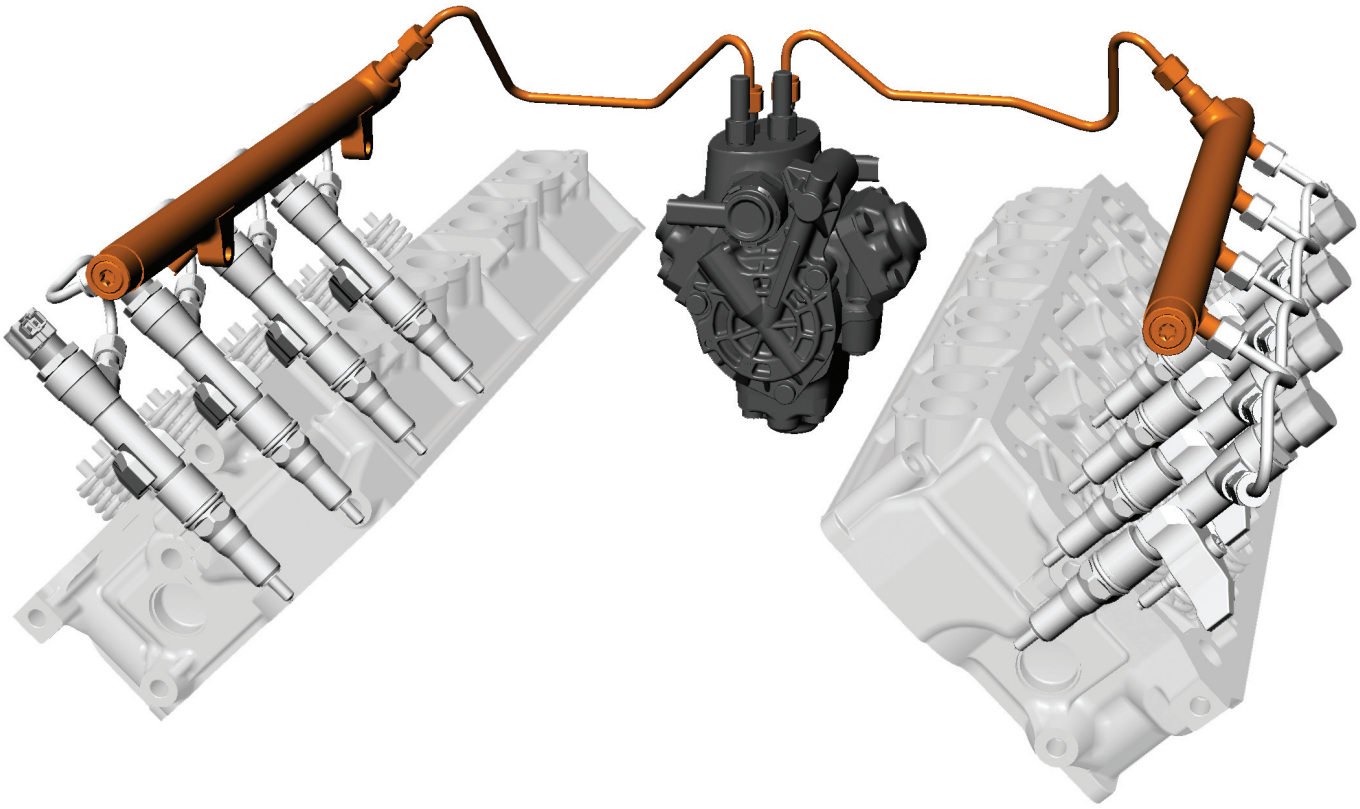
- Emissions
- Noise
- Rate Control
- Timing Control
- PCV (pressure control valve)
- VCV (volume control valve)

High Pressure Common Rail Fuel System Advantages

- Emissions and noise have been reduced through improvements in rate, timing control, and multiple injections.
- The high pressure system's pressure relief function is now controlled by the PCV (Pressure Control Valve), which is mounted to the high pressure fuel injection pump.
- The piezo fuel injectors help reduce noise while delivering optimum performance.

77

HIGH PRESSURE FUEL SYSTEM

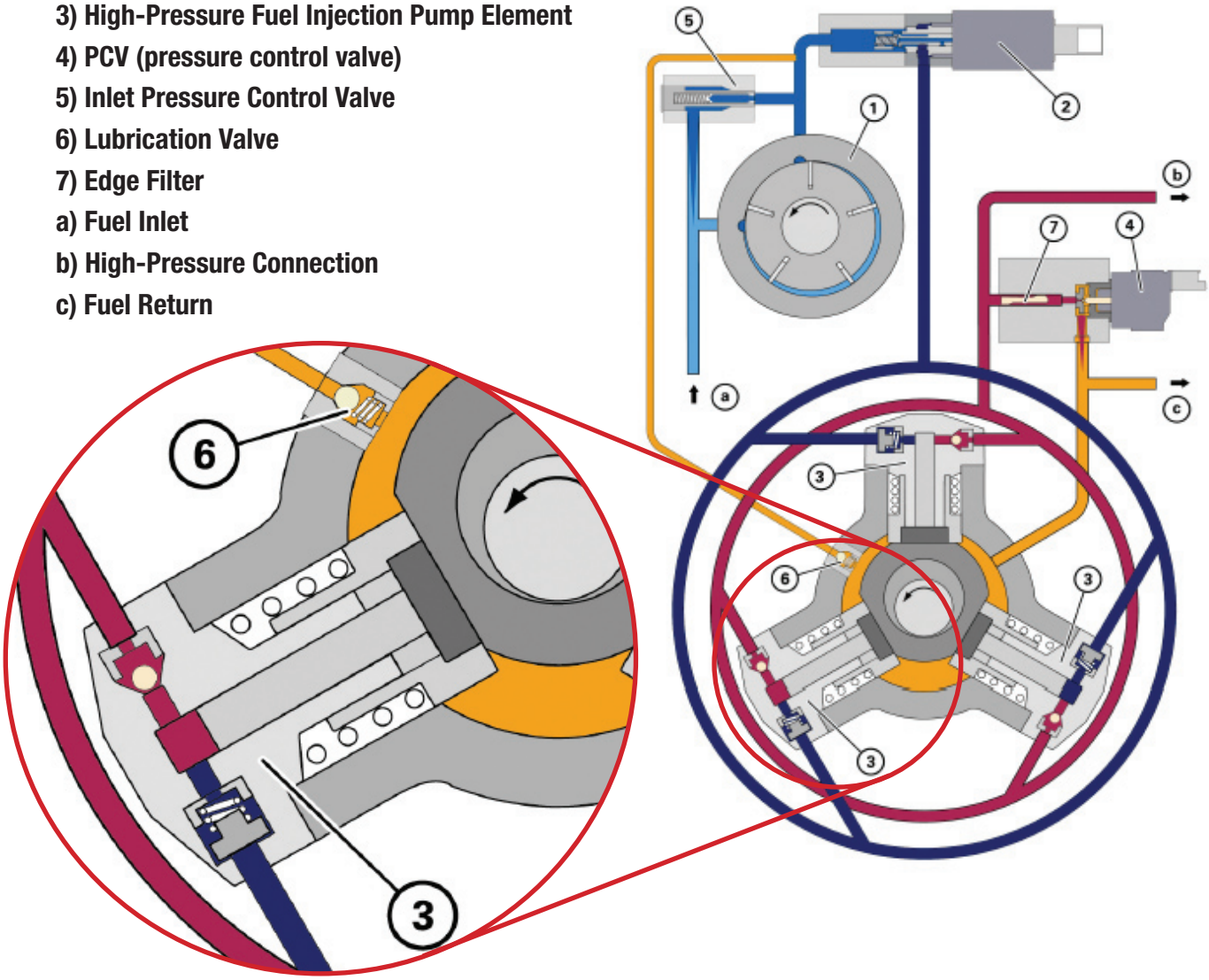


High Pressure Fuel System Flow

- Fuel is supplied to the high pressure fuel injection pump after being filtered by both the HFCM (horizontal fuel conditioning module) and the engine mounted fuel filter.
- The high pressure fuel injection pump is gear driven off of the camshaft gear at the rear of the engine.
- Once the high pressure fuel injection pump pressurizes the fuel it is routed to two (2) high pressure fuel rail supply tubes, one for each bank.
- The high pressure fuel rail supply tubes route the fuel to the high pressure fuel rail located under the valve cover.
- The high pressure fuel rail inlet protrudes through the valve cover spacer at the back of the engine and oil is sealed by a rubber seal.
- The high pressure fuel rail routes fuel to each of the four (4) fuel injectors through four (4) separate fuel injector supply tubes all located under the valve cover.

FUEL MANAGEMENT SYSTEM

1) ITP (internal transfer pump)
2) VCV (volume control valve)
3) High-Pressure Fuel Injection Pump Element
4) PCV (pressure control valve)
5) Inlet Pressure Control Valve
6) Lubrication Valve
7) Edge Filter
a) Fuel Inlet
b) High-Pressure Connection
c) Fuel Return



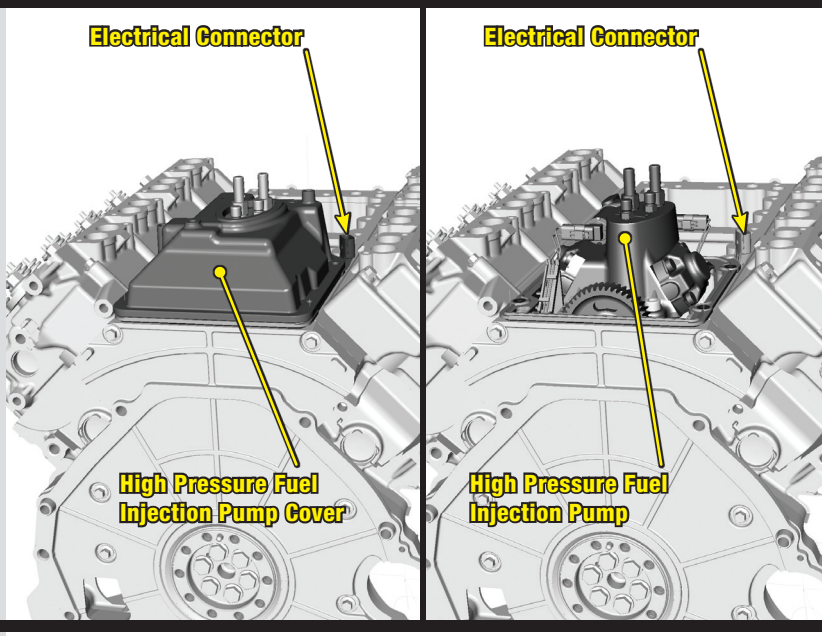
High Pressure Pump Operation

- After being filtered at the engine mounted fuel filter, fuel is directed to the high pressure fuel injection pump.
- Before fuel enters the Volume Control Valve (VCV) the pressure is stepped up by the Internal Transfer Pump (ITP). The ITP is located inside the high pressure fuel injection pump and is driven by its main shaft.
- The VCV controls how much fuel enters the three (3) main pump pistons.
- A portion of the fuel leaving the ITP is sent to a lubrication valve which allows fuel to lubricate and cool the internal mechanical components of the high pressure fuel injection pump.
- The high pressure fuel injection pump main shaft has an offset journal that actuates each of the three (3) pistons as the shaft rotates.
- The offset journal of the main shaft utilizes a free-spinning hub to make contact with the three (3) pistons.
- The pistons start their compression stroke via the offset journal and are returned to rest via spring pressure.
- The pistons receive fuel from the VCV through a one way check valve. Fuel is drawn into the cylinder while the piston is returning to rest.
- The outlet check valve ball is closed while fuel is being drawn in due to the suction (low pressure area) of the piston returning to rest and the pressure exerted by the other two pistons.
- Once the piston starts its compression stroke, the inlet check valve closes via spring and fuel pressure and the outlet check valve opens due to increasing fuel pressure forcing the check valve ball away from its seat.
- The pressure control valve (PCV) controls the pressure in the system by restricting fuel flow to the return line (pressure is the resistance to flow).

FUEL MANAGEMENT SYSTEM

High Pressure Fuel Injection Pump & Cover

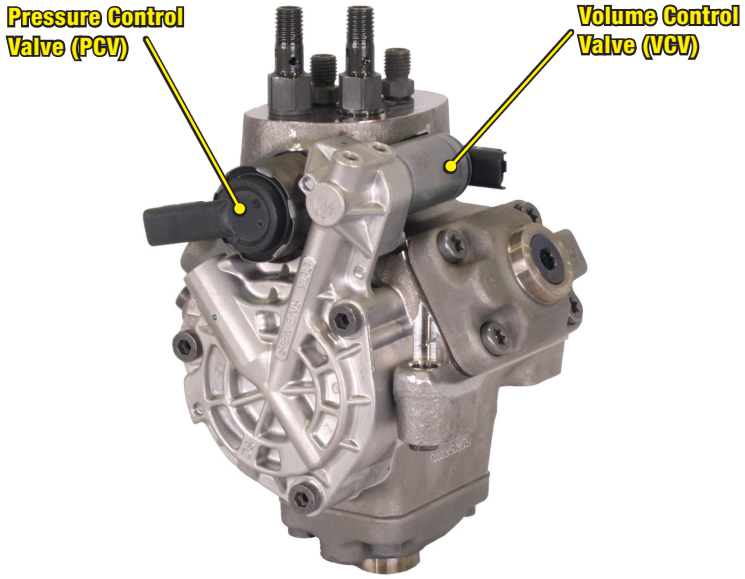
- The high pressure fuel injection pump is installed in the crankcase.
- The pump is a three (3) piston rotary style pump that is driven by the rear gear train.
- Each bank of cylinders has its own pump outlet and high pressure fuel supply tube.



80

PCV (Pressure Control Valve) VCV (Volume Control Valve)

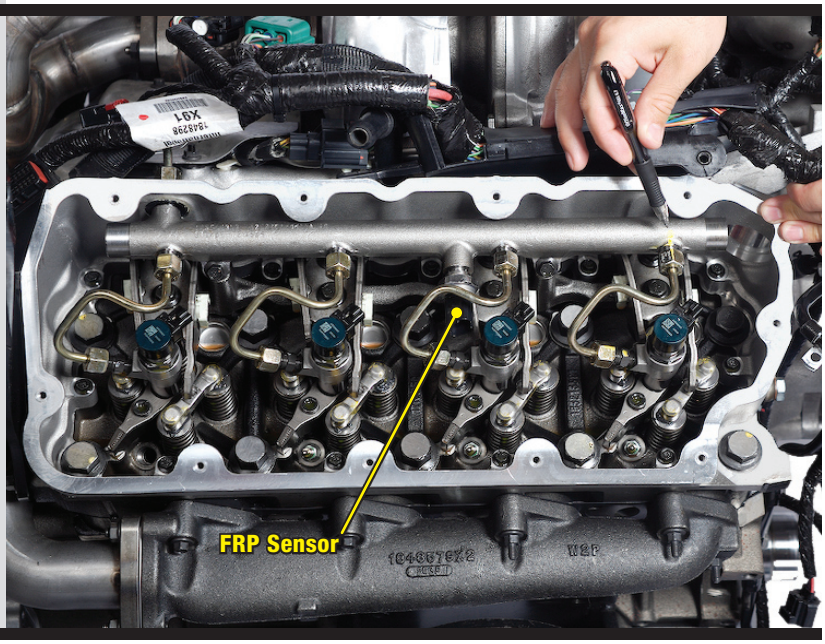
- The PCV and VCV are both installed in the high pressure fuel injection pump.
- The PCV and VCV ARE NOT SERVICEABLE.



81

High Pressure Fuel Rail & Fuel Rail Pressure Sensor (FRP)

- Fuel under extremely high pressures is delivered to the fuel injectors from the fuel rail by way of the fuel injector supply tubes.
- The FRP sensor is located on the engine's right side high pressure fuel rail.



82

FUEL MANAGEMENT SYSTEM

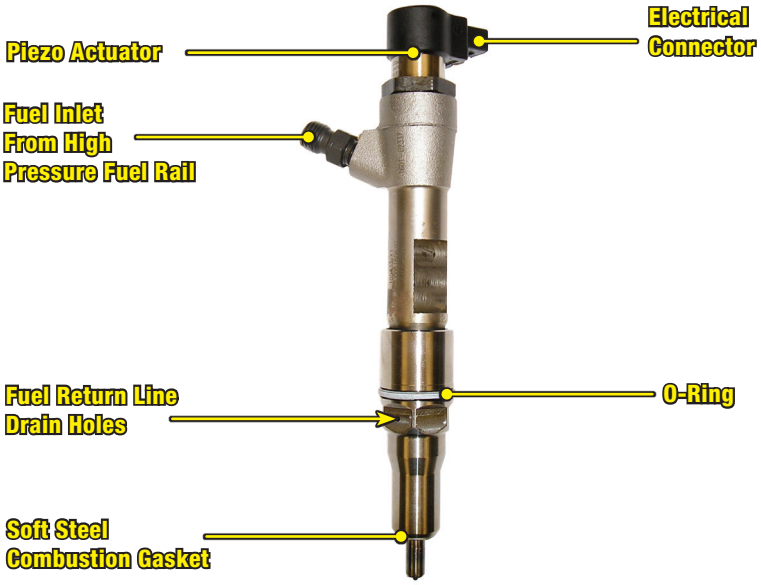
Piezo Electric Fuel Injector

- Piezo Electrically Actuated
- High Electrical Effeciency
- High Voltage Supply
- Up to 5 Injections Per Combustion Event
- Self extracting hold down clamp

Fuel Injector Features

- The injector uses a Piezo Actuator to electrically control the injections with extreme precision.
- The Piezo Actuator is turned on for approximately 0-400 µs (micro second or millionth of a second) for 2 injections.
- No special tools are needed to remove the injectors from their bore. The injector is slowly removed from its bore by removing the self-extracting hold down clamp bolt.

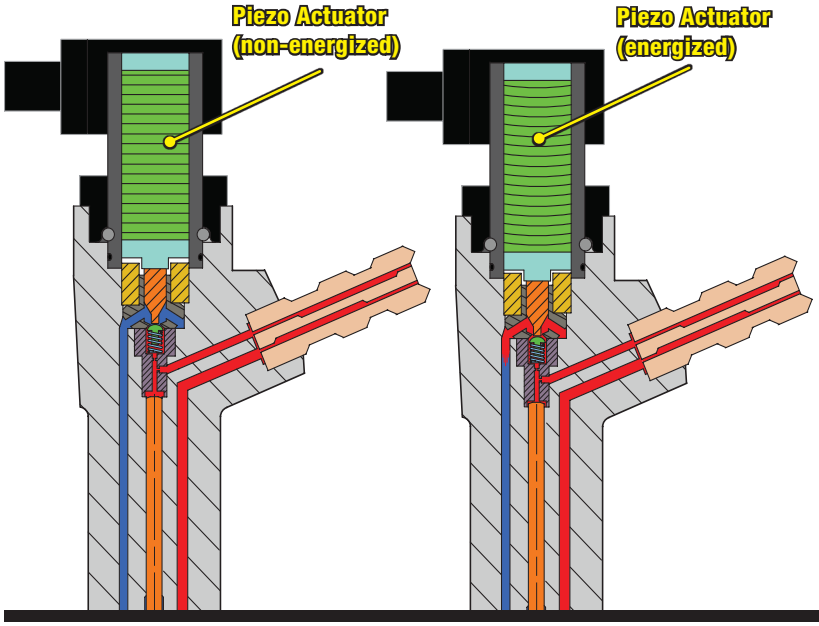
83



Injector & O-ring

- The injector has one (1) replaceable o-ring on the outside of the body, and one (1) replaceable soft steel combustion gasket on the tip of the injector.
- The injector's piezo actuator has a single two (2) pin connector that is located under the valve cover.
- The fuel charging harness has a single main connection point at the front of the valve cover spacer.

84



Piezo Actuator

- The piezo actuator is an electrically energized device that acts similar to a solenoid but is much more precise.
- A piezo actuator is a composition of piezo discs, that when electrically energized, cause the discs to deform resulting in an expansion. This expansion results in a longitudinal motion thus controlling the injector.
- When energized, the piezo actuator pushes downward against the valve piston. The piezo actuator is returned to its non energized state via the ECM switching the polarity of the electrical feed to the injector.

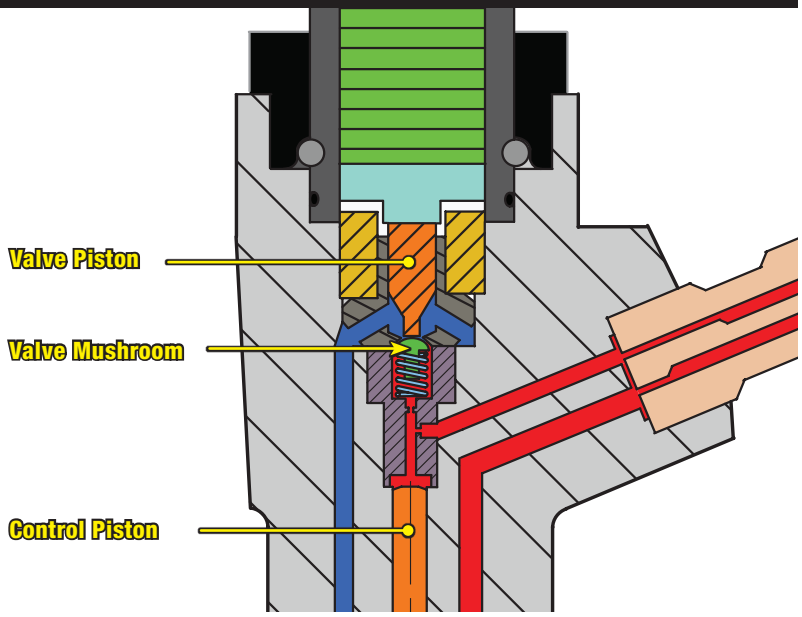
85

FUEL MANAGEMENT SYSTEM

Valve Piston

- The valve piston is utilized for one main purpose:

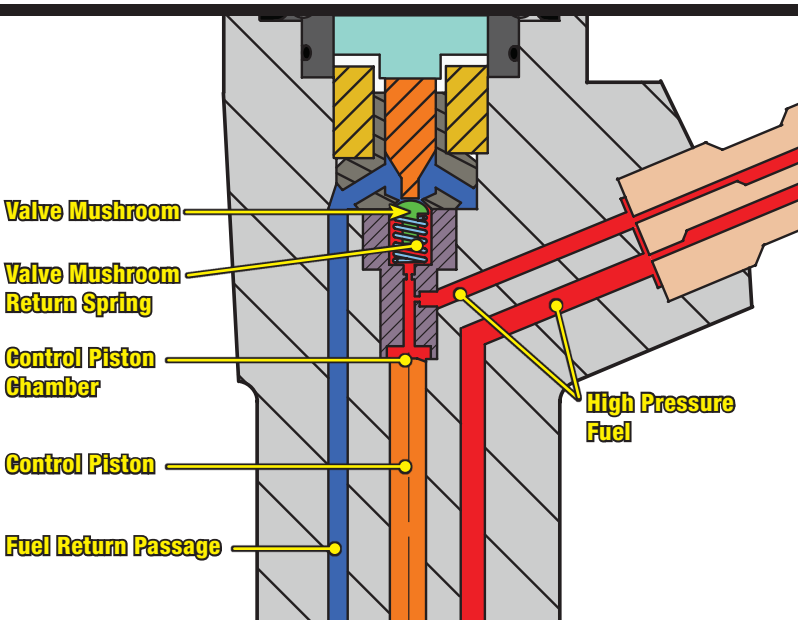
  1) It transfers the up and down movement from the Piezo Actuator to the Valve Mushroom.



86

Valve Mushroom, Return Spring, and Control Piston

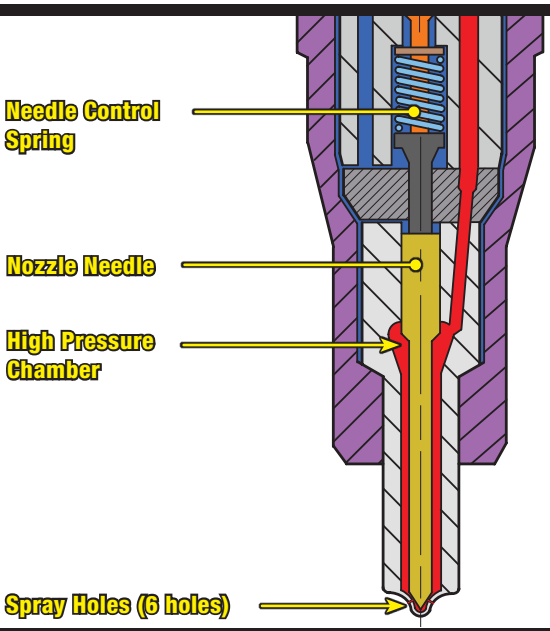
- The valve mushroom is a hydraulic check valve that allows high pressure fuel to bleed off into the fuel return passage directly above it whenever the Piezo Actuator is energized.
- The valve mushroom is held in a closed (sealed) position whenever the Piezo Actuator is not energized via high pressure fuel and spring pressure.
- The control piston utilizes its large surface area for a downward force to overcome the pressure exerted by the smaller surface area of the nozzle needle in the high pressure chamber to keep the nozzle needle in a closed position.



87

Nozzle Needle

- The nozzle needle is an inwardly opening type which lifts off its seat every time the pressure in the high pressure chamber exceeds the pressure in the control piston chamber, i.e. when the piezo is actuated.
- The needle control spring is used to hold the nozzle needle in a closed position.
- Fuel is atomized at high pressure through the nozzle tips six spray holes.



88

FUEL MANAGEMENT SYSTEM

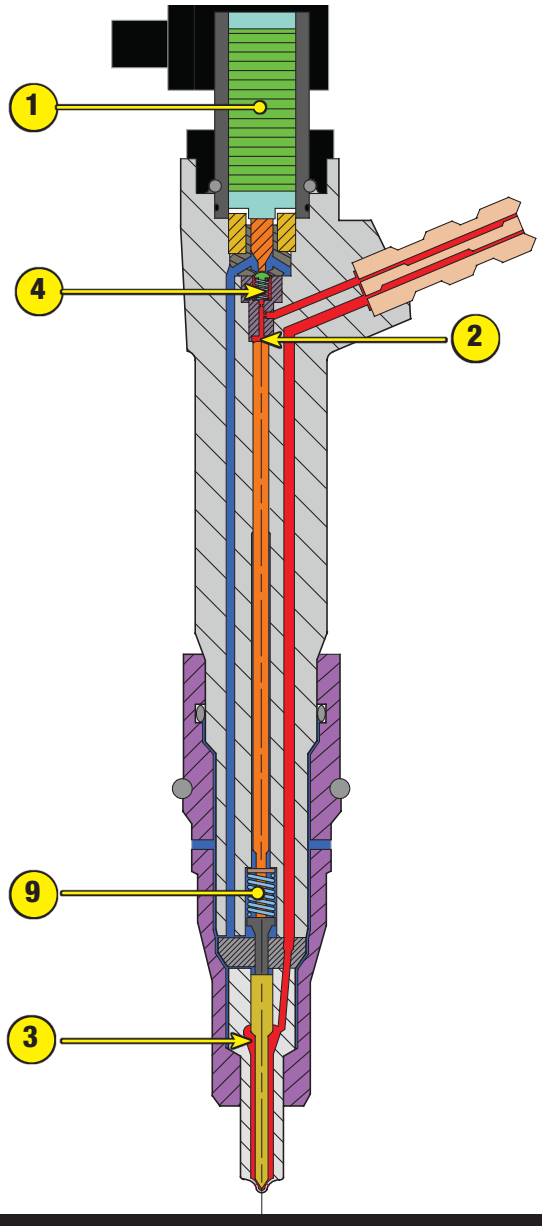
Two Stages of Injection

- Main Injection
- End of Main Injection

Stages of Injection

- The injection cycle has two (2) stages.
- Main injection.
- End of main injection.
- This injection system is capable of performing both steps of the injection cycle up to 5 times per firing cycle.

89



Pre-Main Injection

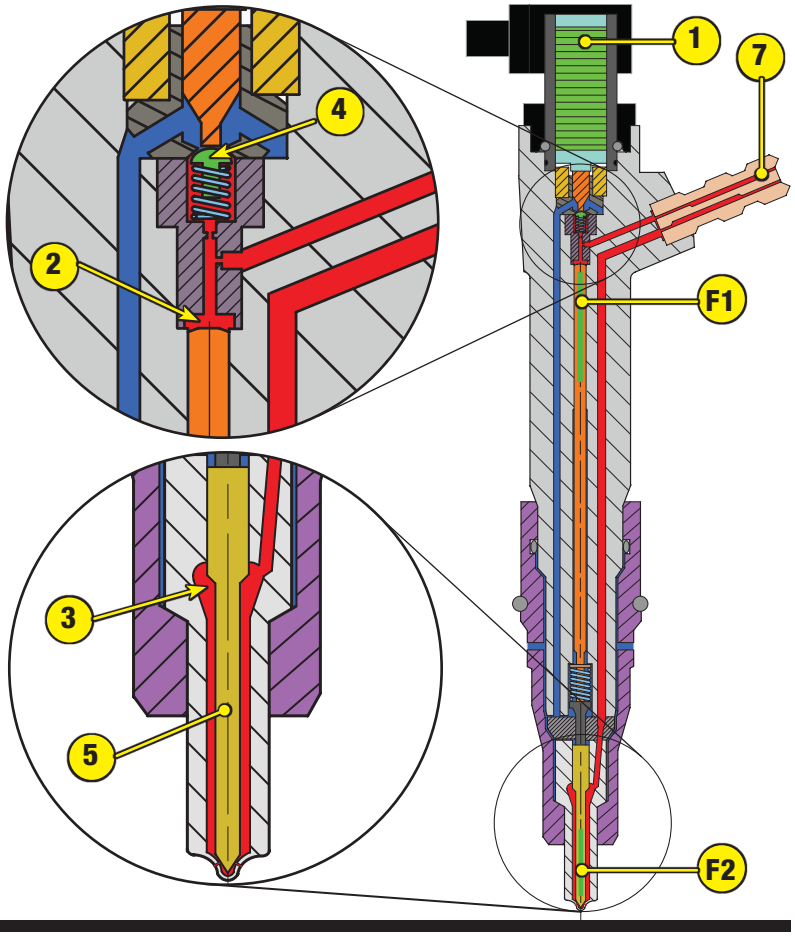
- The piezo electric fuel injector is constantly being filled with fuel via the high pressure fuel injection pump.
- High pressure fuel from the high pressure fuel injection pump enters the following areas:
  - control piston chamber (2).
  - spring side of the valve mushroom (4).
  - high pressure chamber (3).
- The needle control spring (9) holds the needle on its seat so that fuel cannot enter the combustion chamber.
- The piezo actuator (1) is in a non-energized state.

90

FUEL MANAGEMENT SYSTEM

Main Injection Step 1

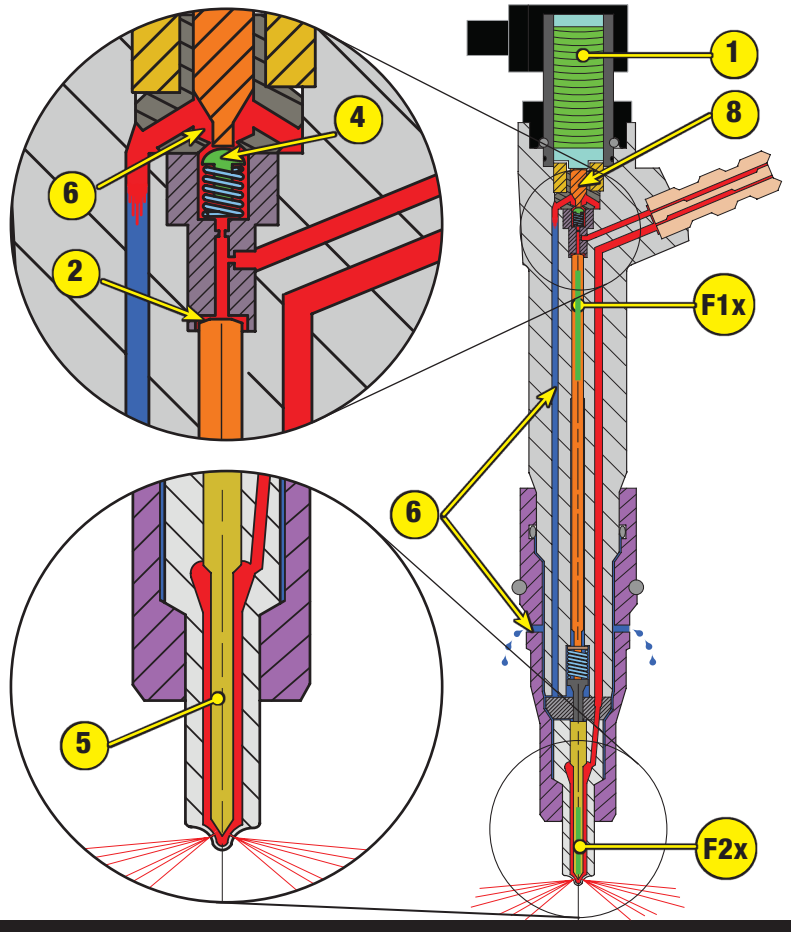
- Fuel under pressure from the rail (7) reaches the control piston chamber (2) and the high pressure chamber (3) of the nozzle needle (5).
- The bore hole to the fuel return line is closed via the valve mushroom (4), which is held closed by a spring and high pressure fuel.
- The surface area of the control piston is much larger than the surface area of the nozzle needle in the high pressure chamber.
- The force (F1) exerted by the control piston due to its larger surface area along with the force of the needle control spring overcomes the force (F2) exerted by the smaller surface area of the nozzle needle in the high pressure chamber which holds the nozzle needle closed.



98

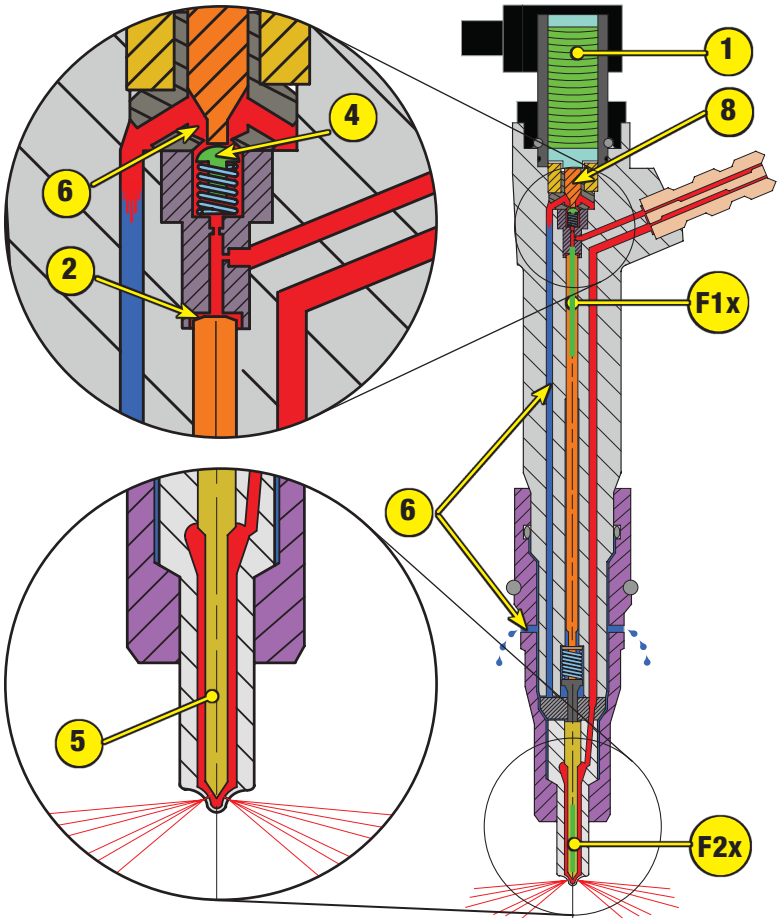
Main Injection Step 2

- When the piezo actuator (1) is commanded on, the actuator is energized (which causes the piezo discs to deform and create a downward force) and pushes the valve piston (8) downward.
- The downward force of the valve piston pushes the valve mushroom (4) and spring down which opens up a bore hole that connects the high pressure fuel to the fuel return line (6).
- When this happens it allows a small amount of high pressure fuel to enter the fuel return line (6) effectively dropping the pressure in the control piston chamber (2).
- This pressure drop is enough for the force (F2x) on the nozzle needle (5) in the high pressure chamber to overcome the force (F1x) in the control piston chamber (2).
- This allows the nozzle needle (5) to move upward uncovering the six spray holes and allowing high pressure fuel to atomize and enter the combustion chamber.



99

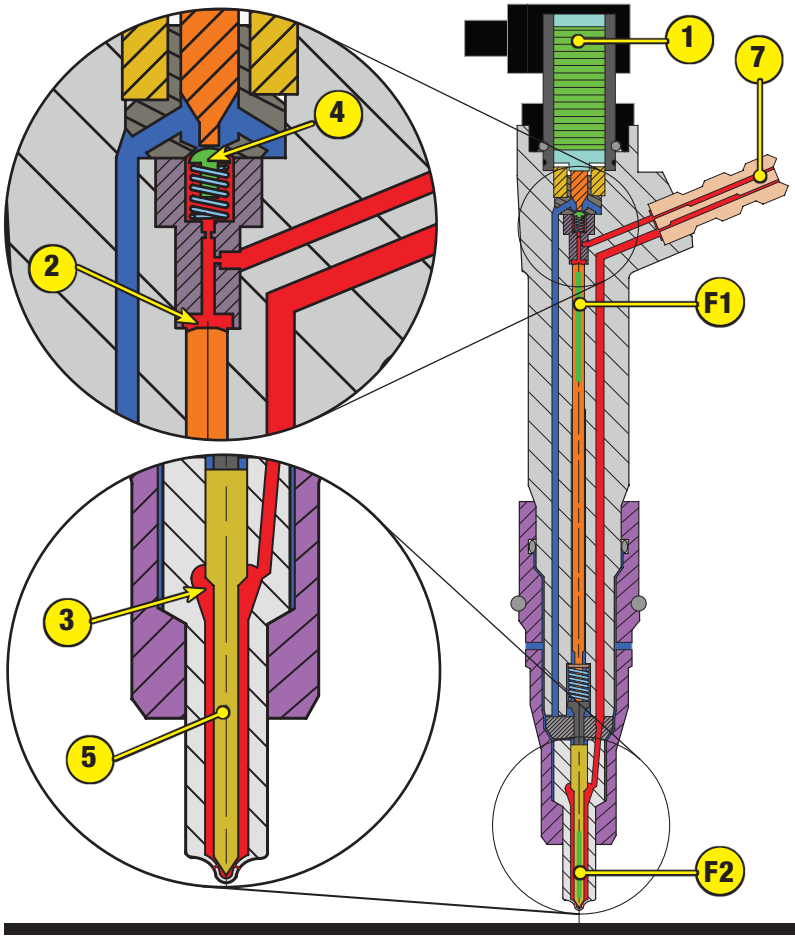
FUEL MANAGEMENT SYSTEM



End of Main Injection Step 1

- The high pressure fuel, that is allowed to escape past the valve mushroom (4) into the fuel return line (6), is routed down a drilled passage to the drain holes in the sides of the injector just below the O-ring seal towards the base of the injector.
- The fuel is then routed through the cylinder head and exits through a banjo fitting on the front side of the cylinder head before being returned to the fuel supply system.

100



End of Main Injection Step 2

- When the Engine Control Module (ECM) determines that the correct injector on time has been reached, it switches the polarity of the piezo actuator (1) which causes the piezo discs to return to a non-enerrgized state.
- Switching the polarity of the piezo actuator (1) enables the valve mushroom (4) to seat via spring pressure and completely block the bored passage that connects the high pressure fuel to the fuel return line.
- Seating the valve mushroom (4) allows the pressure to build in the control piston chamber (2) and equal that in the high pressure chamber (3).
- Once these two chambers have equalized in pressure the downward force (F1) of the control valve will overcome the upward force (F2) of the nozzle needle due to the larger surface area of the control valve.
- The control valve then moves downward effectively closing the nozzle needle (5), blocking any fuel from entering the combustion chamber.

101

This page intentionally left blank

ELECTRICAL COMPONENTS

Electrical Components

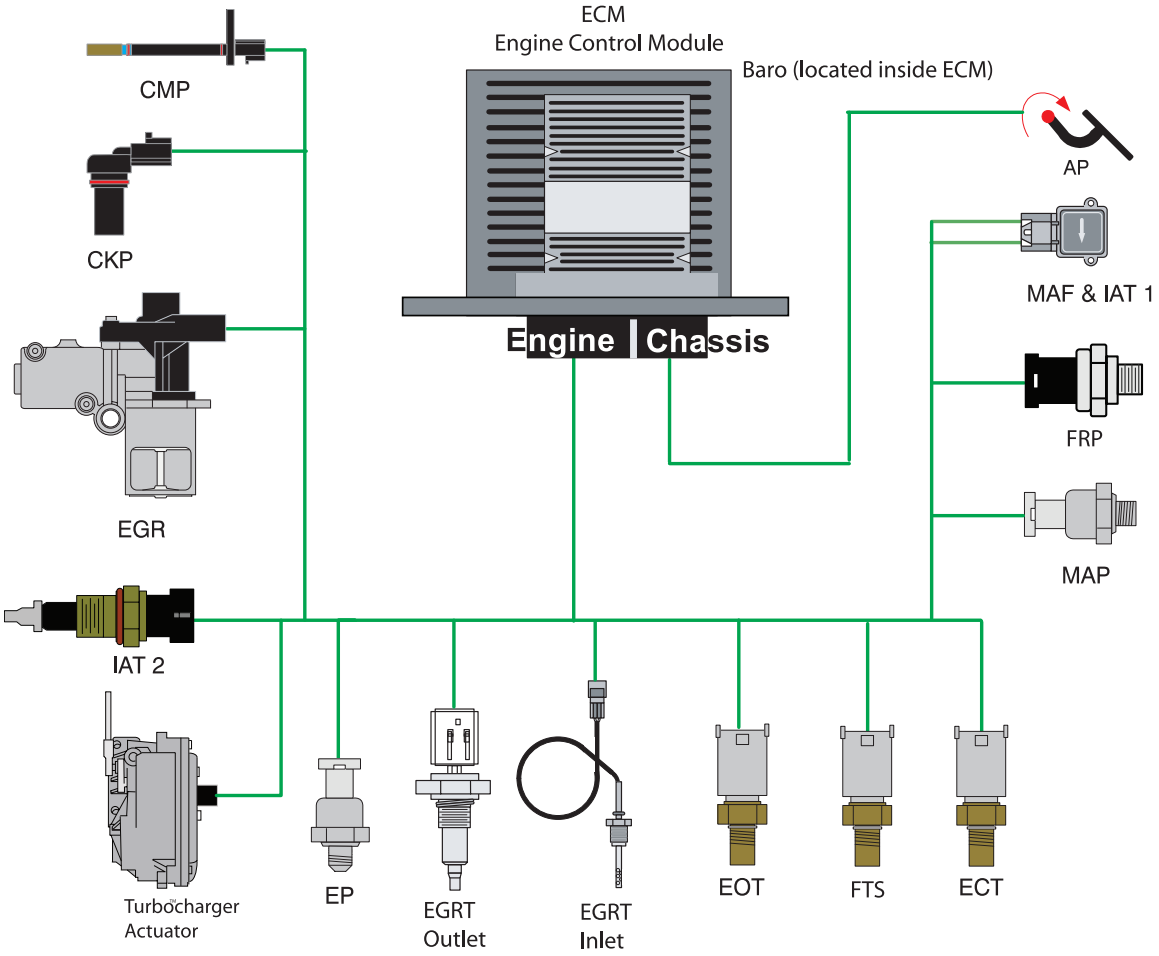
- Sensors
- Actuators
- ECM
- Glow Plug System

Components Overview

- The ECM uses information from the sensors to decide which commands to send to the actuators, and the glow plug system.

102

Sensor Overview



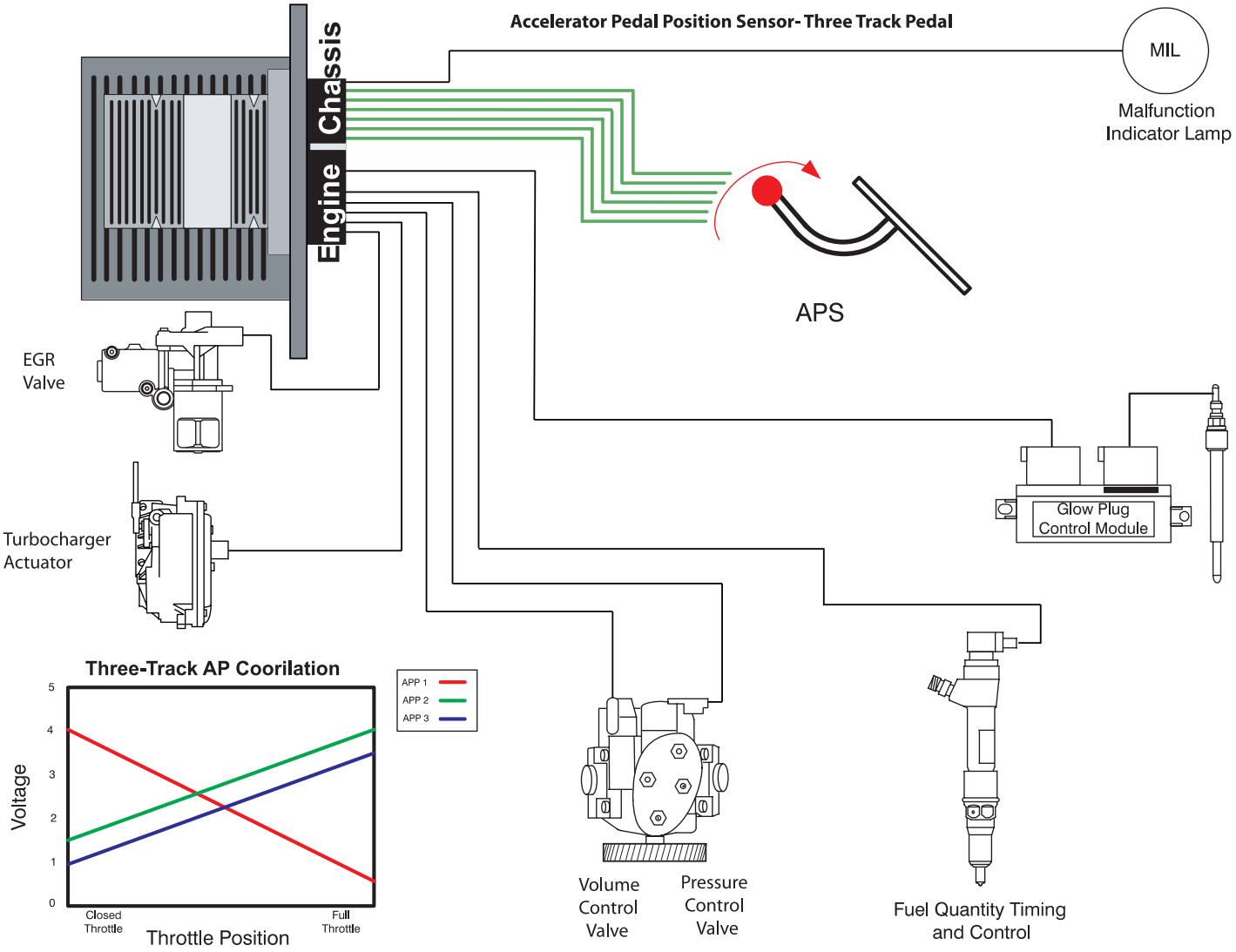
103

Sensors Overview

- The ECM sends a reference voltage (Vref) of 5.0 volts (external power) to the pressure sensors and 5.0 volts (internal power) to the temperature sensors, except for CMP and CKP which generate voltage through the collapse of a magnetic field.
- The sensor signals are conditioned by the interface circuits within the ECM. The signals are used as inputs to various control strategies.

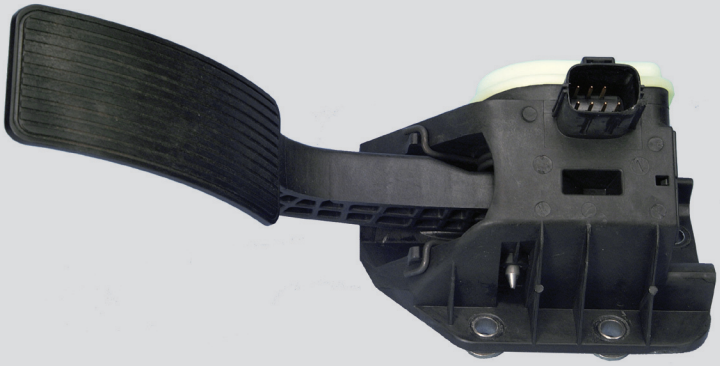
104

ELECTRICAL COMPONENTS

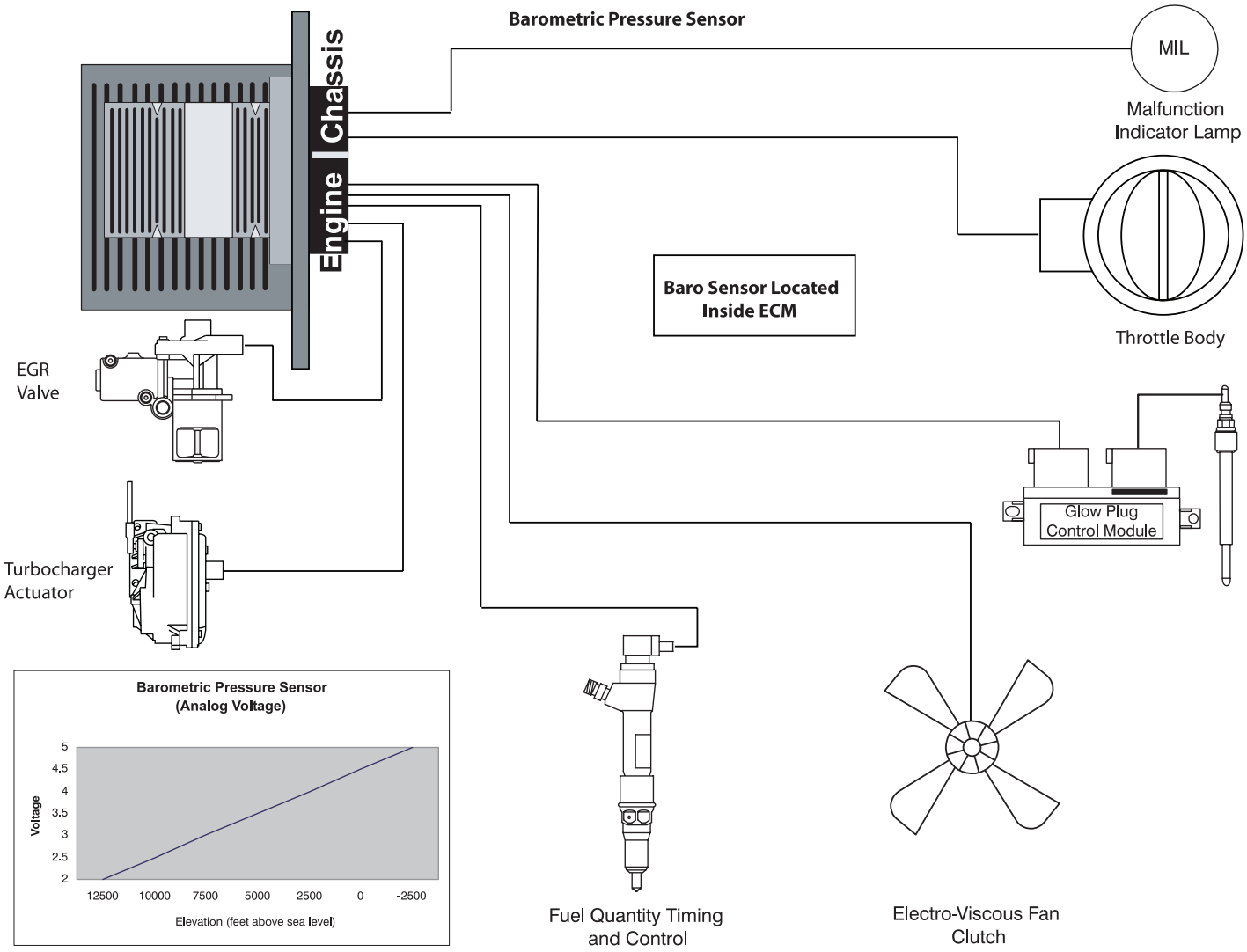


AP (Accelerator Pedal Position)

- The AP (Accelerator Pedal) is a three track pedal. The AP incorporates three potentiometers. Throughout the movement of the AP the resistance values of the three potentiometers must agree. During the movement of the AP if any of the three potentiometer readings do not agree, the check engine light will illuminate and the vehicle will continue to perform as normal. If two signals from the AP are lost the ECM will allow the engine to idle only and illuminate the check engine light.
- Having three (3) signals for comparison is an added safety feature.



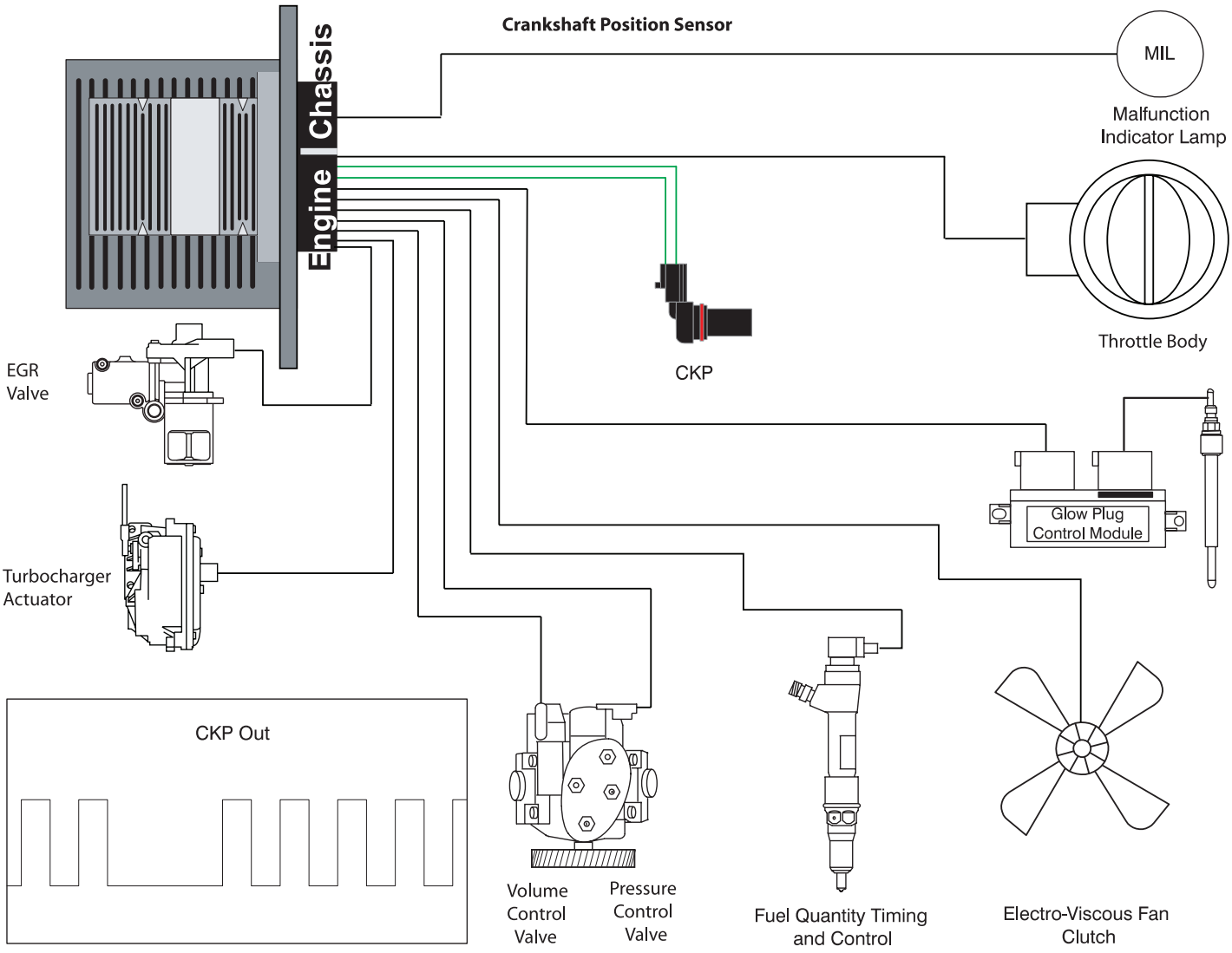
ELECTRICAL COMPONENTS



Baro (Barometric Pressure)

- The ECM supplies a 5 volt reference signal which the Baro sensor uses to produce a linear analog voltage signal that indicates pressure.
- The primary function of the Baro sensor is to provide altitude information so that the ECM can adjust timing, fuel quantity, glow plug on time, and turbocharger control.
- The Baro sensor is located inside the ECM. If the sensor fails, the ECM must be replaced.

ELECTRICAL COMPONENTS



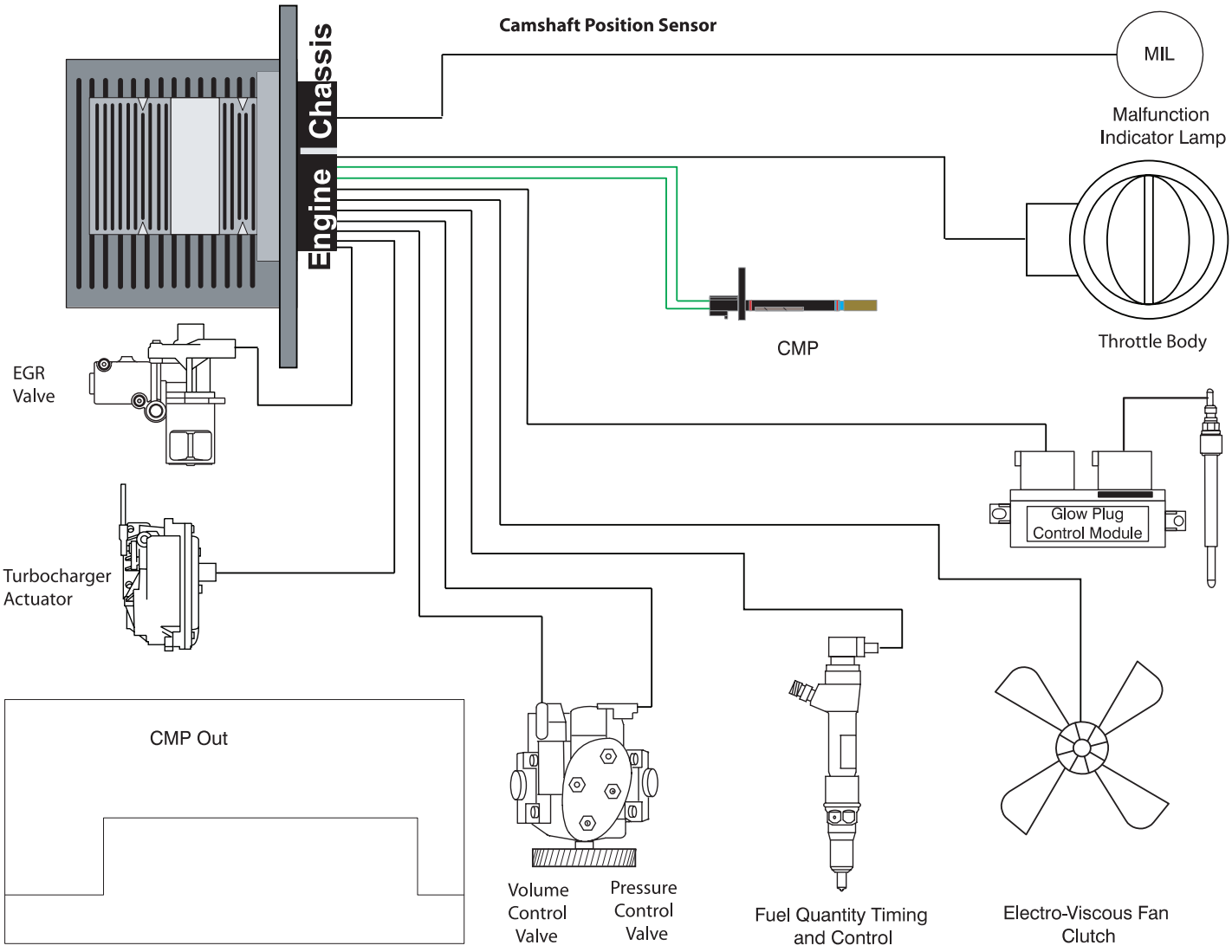
CKP (Crankshaft Position)

- The crankshaft position signal source is a magnetic pickup sensor mounted in the right front side of the engine block.
- The sensor reacts to a trigger wheel positioned on the crankshaft. The trigger wheel is a 60 minus 2 tooth steel disk with 58 evenly spaced teeth and a slot that's width is equivalent to removing 2 teeth (minus 2 slot) that is the SYNC gap.
- The sensor produces sine waves (converted to square waves via the ECM) for each tooth edge that breaks the magnetic field created by the permanent magnet that is in the end of the sensor.
- Crankshaft speed is derived from the frequency of the CKP sensor signal.
- Crankshaft position can be determined by the syncronization of the CMP peg signal to the CKP minus 2 slot signal.
- Diagnostic information on the CKP input signal is obtained by performing accuracy checks on frequency.
- The ECM needs both the CKP and CMP signal to calculate engine position. The CKP creates a signal that relates to crankshaft speed and position relative to TDC (Top Dead Center). The CMP creates a signal relative to which stroke (compression or exhaust)





ELECTRICAL COMPONENTS



CMP (Camshaft Position)

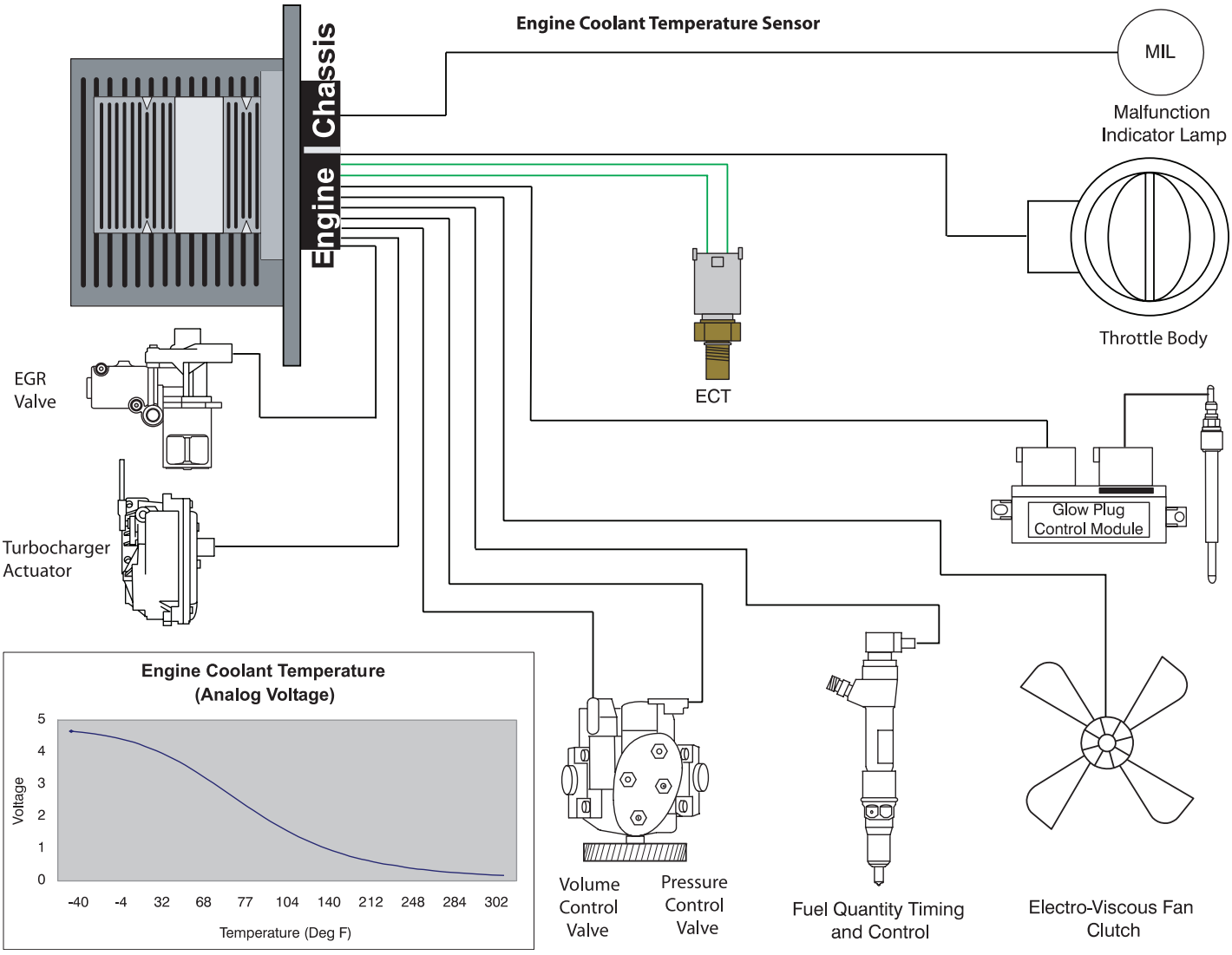
- The camshaft position signal source is a magnetic pickup sensor mounted on the left front side of the engine block.
- The sensor reacts to a peg, pressed into the camshaft at the front of the engine.
- The peg will pass the sensor once per camshaft revolution, the sensor will produce a single pulse correspondingly.
- Camshaft speed is derived from the frequency of the CMP sensor signal.
- Diagnostic information on the CMP input signal is obtained by performing accuracy checks on signal levels and frequency.
- The ECM needs both the CKP and CMP signal to calculate engine position. The CMP creates a signal that the ECM uses to indicate a particular bank.
- The CMP contains a permanent magnet which creates a magnetic field, when the magnetic field is broken by the peg on the camshaft a signal in the form of a sine wave is created (converted to a square wave by the ECM).





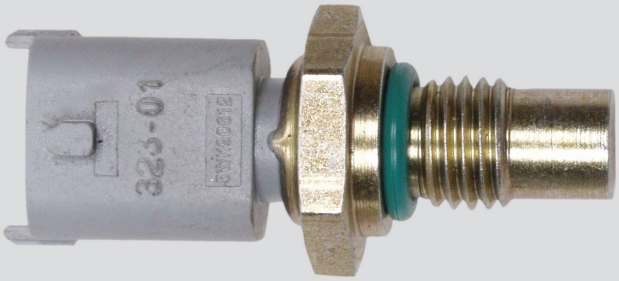
108

ELECTRICAL COMPONENTS

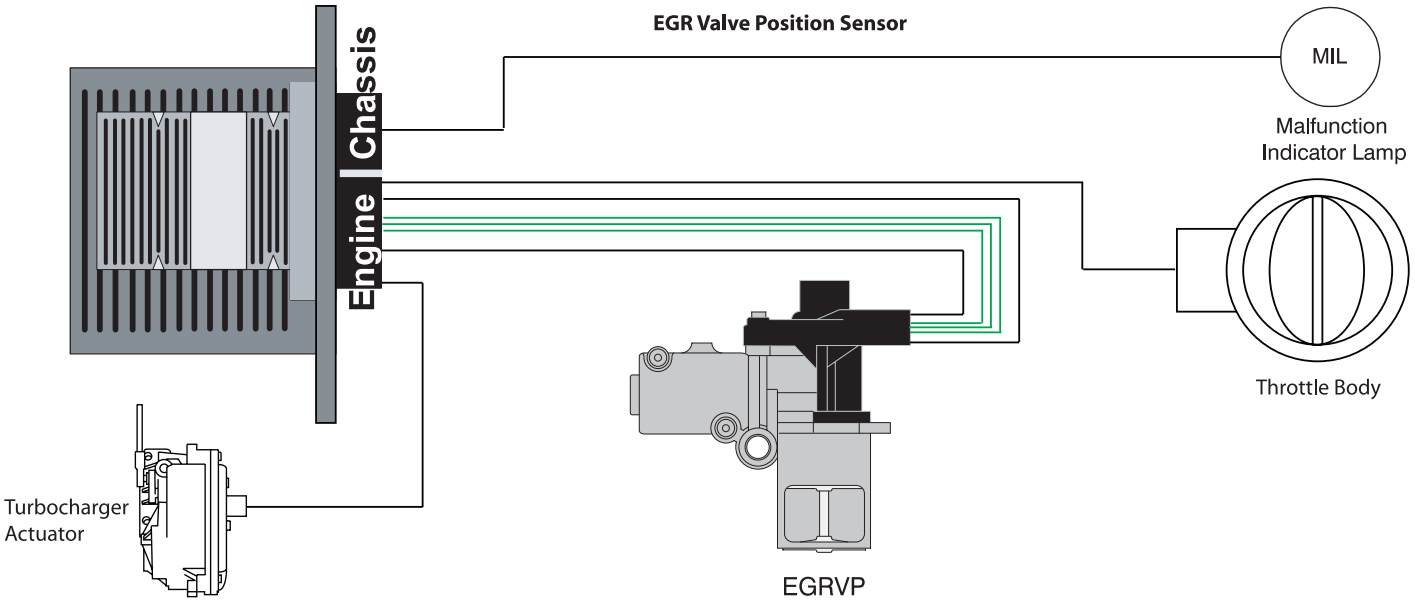


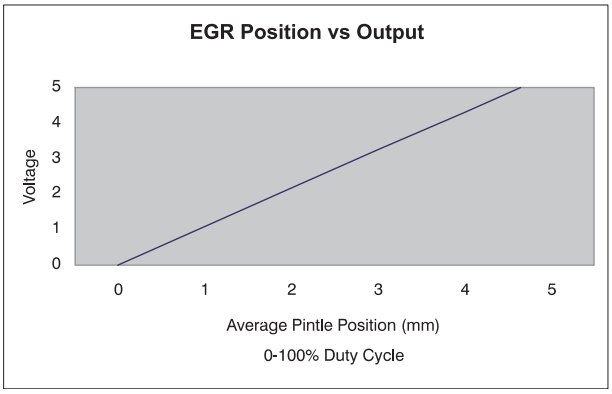
ECT (Engine Coolant Temperature)

- The ECT sensor is a two (2) wire thermistor sensor.
- The ECT sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECT sensor changes resistance when exposed to different temperatures.
- When the temperature of the coolant decreases, the resistance of the thermistor increases and the signal voltage increases.
- When the temperature of the coolant increases, the resistance of the thermistor decreases and the signal voltage decreases.



ELECTRICAL COMPONENTS





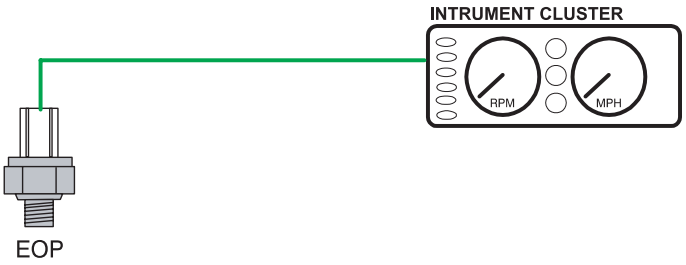
EGRVP (EGR Valve Position)

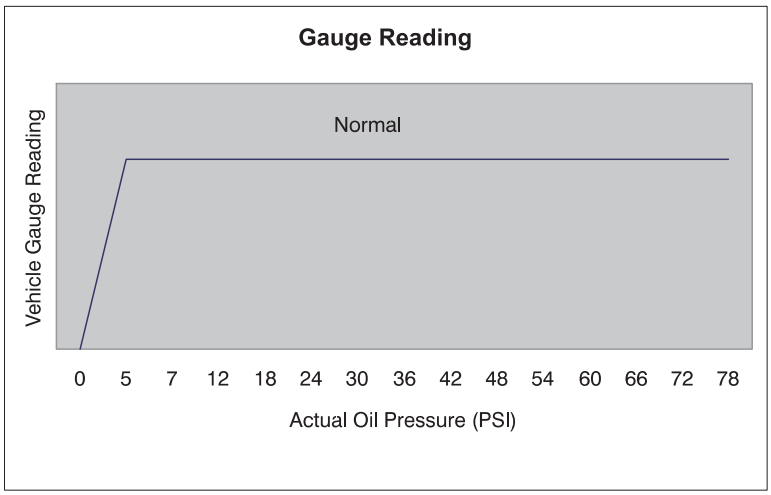
- The EGRVP sensor is a three (3) wire potentiometer type sensor.
- The ECM supplies a 5 volt reference voltage that the EGRVP uses to produce a linear analog voltage that indicates the amount of movement of the valve.
- The ECM monitors EGRVP as the engine is operating to modulate the EGR valve.
- This is a closed loop function which means that the ECM continuously monitors the EGRVP to ensure proper valve position.



ELECTRICAL COMPONENTS

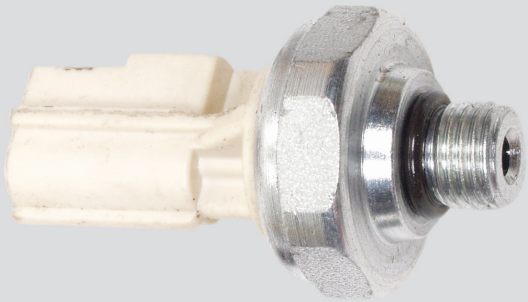
Engine Oil Pressure Switch



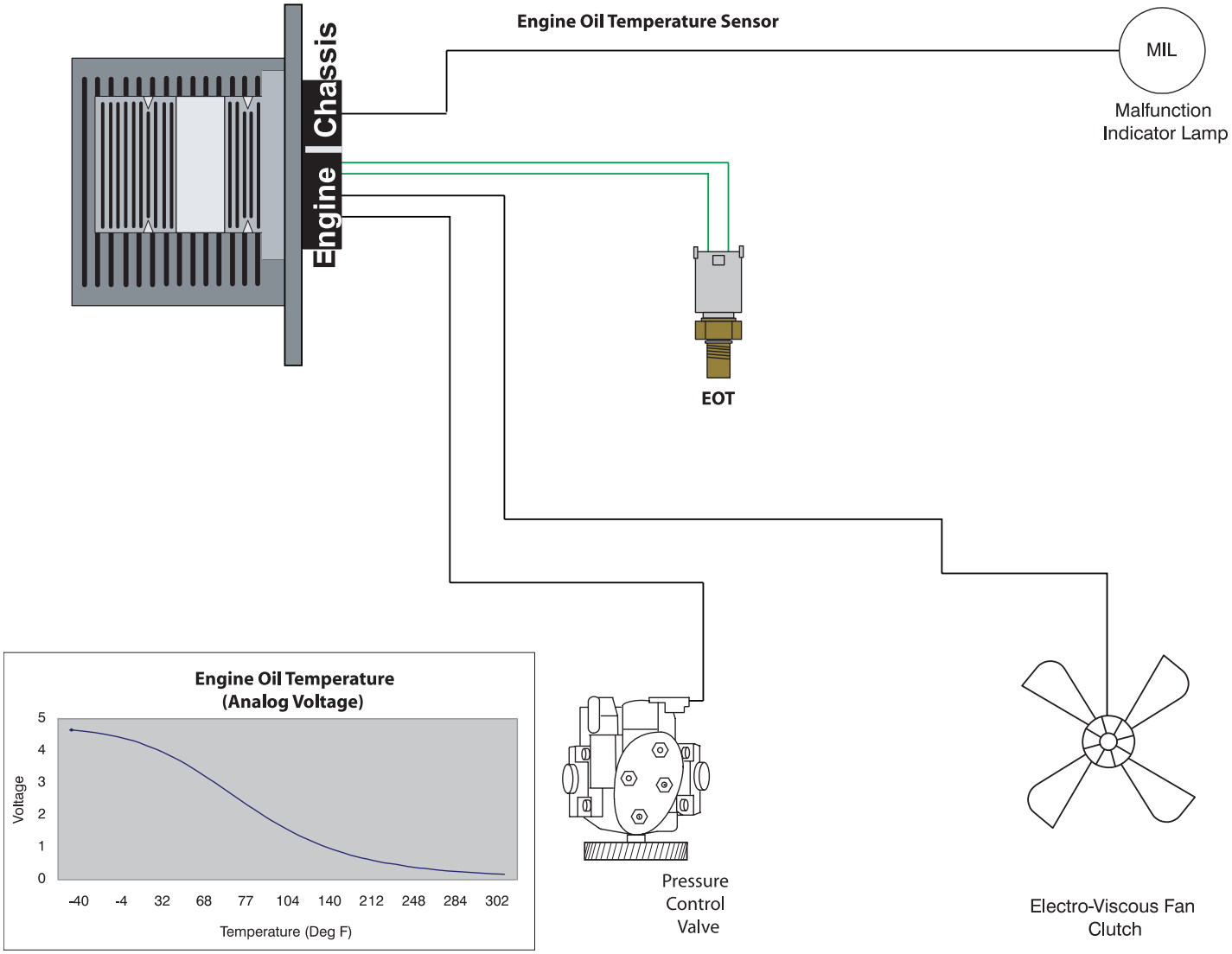


EOP (Engine Oil Pressure)

- The EOP (Engine Oil Pressure) is a switch that closes a circuit to ground after engine oil pressure reaches approximately 5-7psi.
- This switch controls the oil pressure gauge on the instrument panel. When pressure is above 7psi the gauge will read normal and if the pressure drops below 5 psi the gauge will show 0.
- The information from the switch is not sent back to the ECM in any way and is to be used as a reference only.

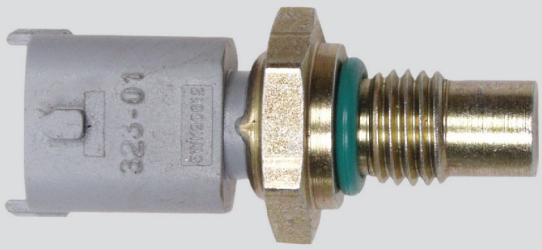


ELECTRICAL COMPONENTS

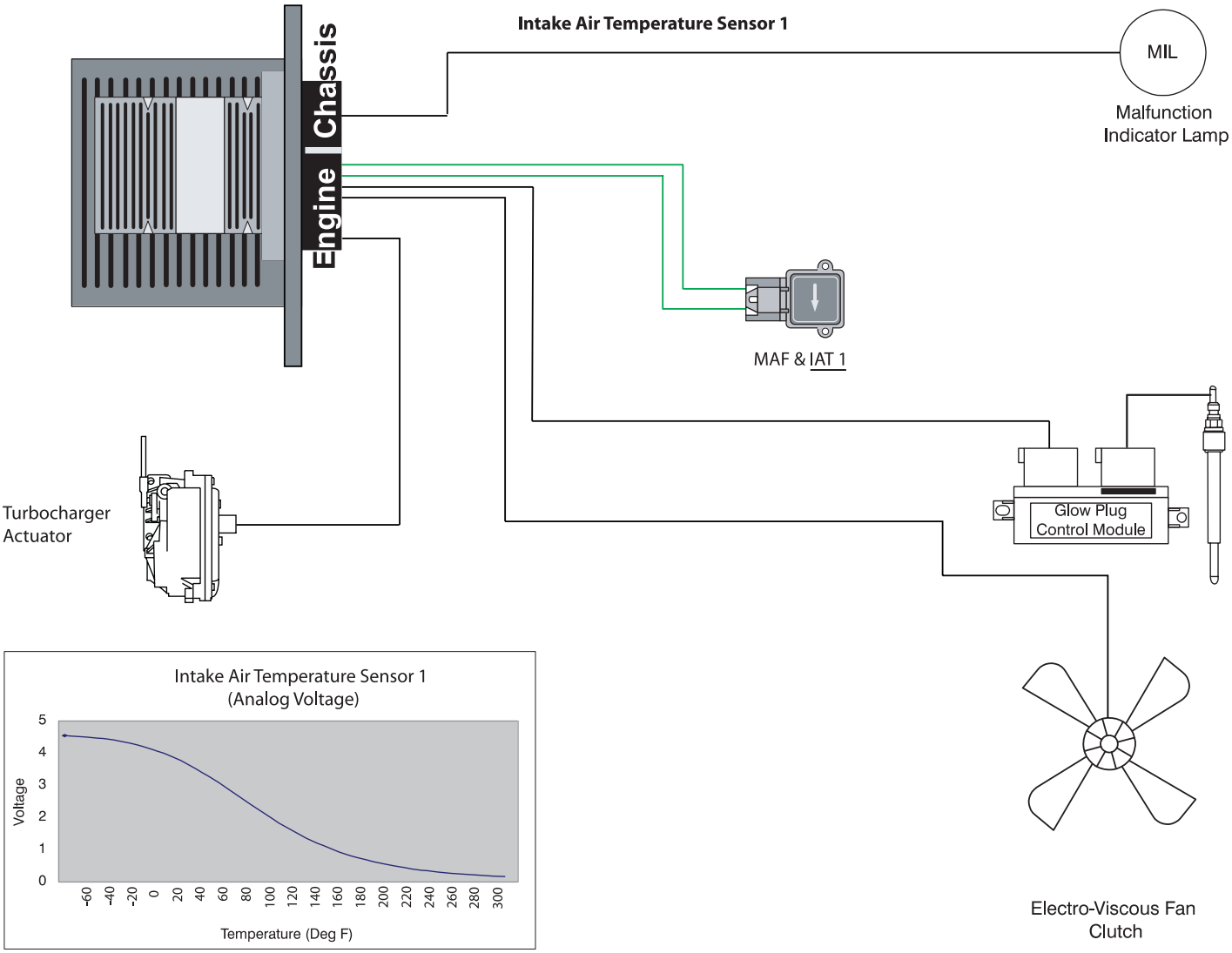


EOT (Engine Oil Temperature)

- The EOT sensor is a two (2) wire thermistor type sensor.
- The EOT sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors engine oil temperature via the EOT sensor signal to aid in controlling fuel rail pressure (FRP) and fan control.
- The EOT signal allows the ECM to compensate for oil viscosity variations due to temperature changes in the operating environment, ensuring adequate power and torque are available for all operating conditions.



ELECTRICAL COMPONENTS

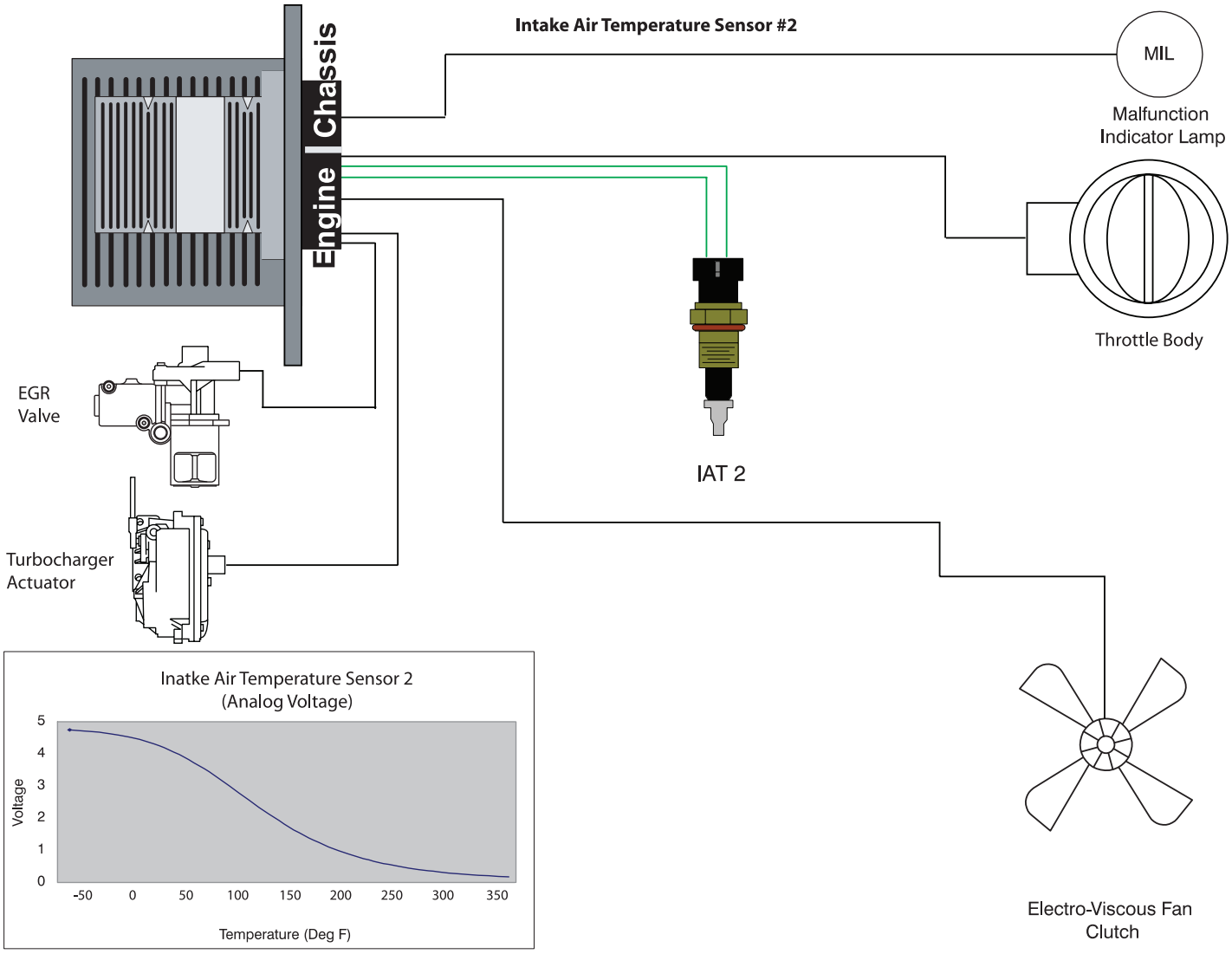


IAT1 (Intake Air Temperature #1)

- The Intake Air Temperature1 (IAT1) sensor is a two wire thermistor sensor that is located inside the Mass Air Flow (MAF) sensor.
- The IAT1 sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The IAT1 sensor's primary function is to measure intake air temperature to aid in controlling EVTG and the glow plug system.
- The MAF/IAT1 sensor is mounted in the intake air piping after the air filter.

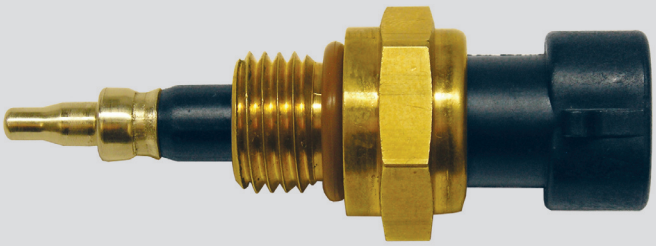


ELECTRICAL COMPONENTS

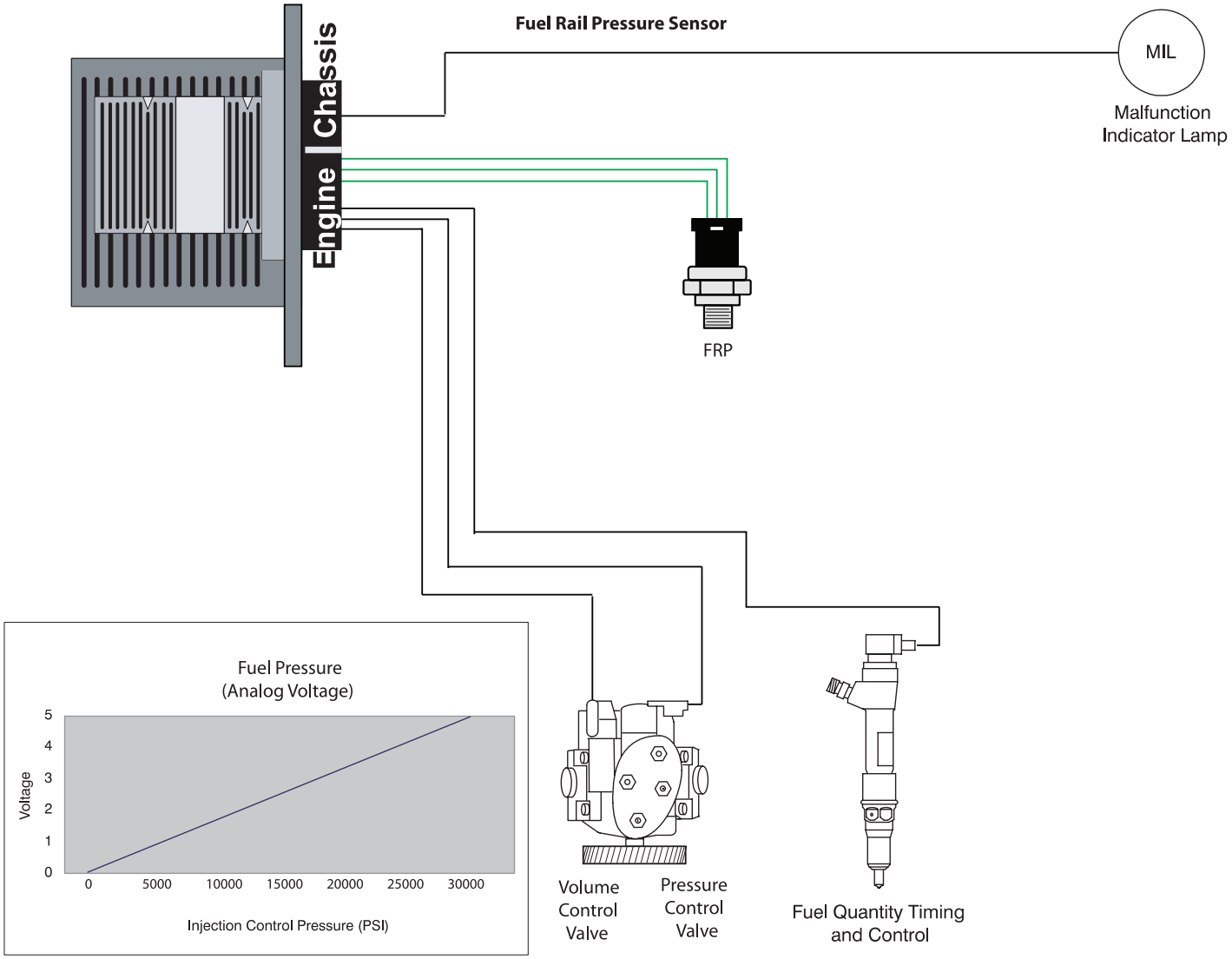


IAT2 (Intake Air Temperature #2)

- The IAT2 sensor is a two (2) wire thermistor type sensor.
- The IAT2 sensor changes resistance when exposed to different air temperature.
- The primary function of the IAT2 sensor is to provide a feedback signal to the ECM indicating manifold air temperature.
- The IAT2 sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors the IAT2 signal to control temperature by adjusting other devices.



ELECTRICAL COMPONENTS

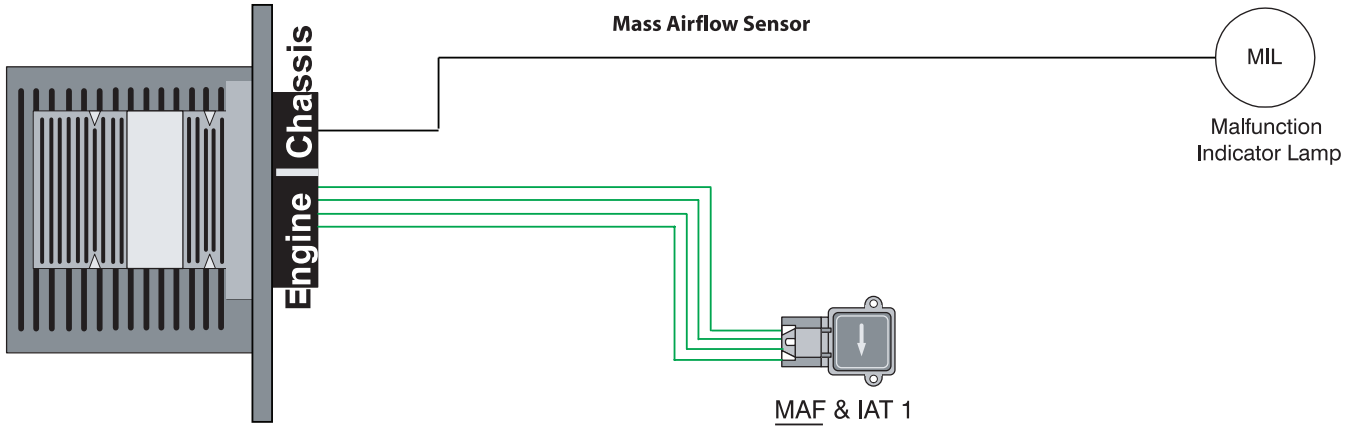


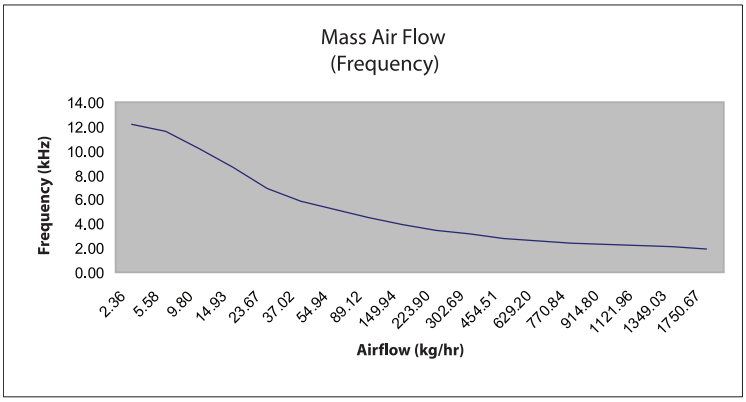
FRP (Fuel Rail Pressure)

- The FRP sensor is a (3) wire variable capacitance sensor.
- The ECM supplies a 5 volt reference signal (Vref) which the FRP sensor uses to produce a linear analog voltage that indicates pressure.
- The primary function of the FRP sensor is to provide a feedback signal to the ECM indicating the pressure of the fuel in the fuel rail.
- The ECM monitors FRP as the engine is operating to modulate the PCV. This is a closed loop function which means the ECM continuously monitors and adjusts for ideal FRP determined by conditions such as load, speed, and temperature.
- The ECM monitors the FRP signal to determine if the performance of the fuel system is satisfactory.
- During engine operation, if the ECM recognizes that the FRP signal is lower or higher than the value the PCV is trying to achieve the ECM will set a Diagnostic Trouble Code (DTC) and illuminate the amber malfunction indicator lamp on the dash.
- The FRP signal to the ECM is one of the signals used to command the correct injection timing.
- This sensor is replaceable.



ELECTRICAL COMPONENTS





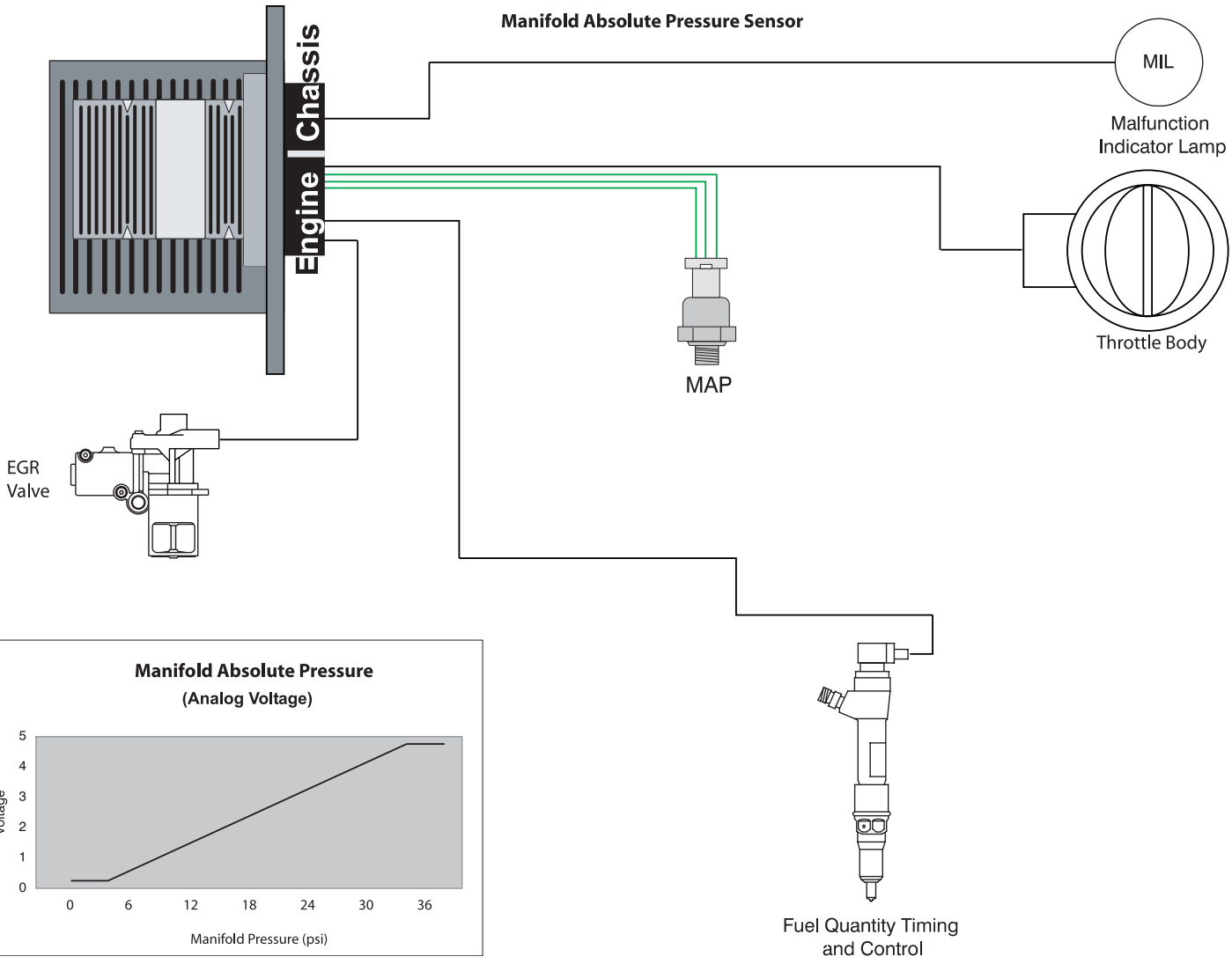
MAF (Mass Air Flow)

- The Mass Air Flow (MAF) sensor uses a hot wire sensing element to measure the amount of air entering the engine. Air passing over the hot wire causes it to cool. This hot wire is maintained at 200°C (392°F) above ambient temperature as measured by a constant cold wire.
- The current required to maintain the temperature of the hot wire is proportional to the mass air flow.
- The MAF sensor then outputs a frequency signal to the ECM proportional to the air mass.



115

ELECTRICAL COMPONENTS



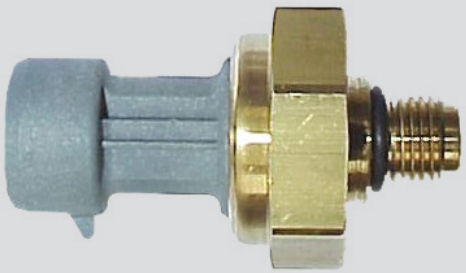
MAP (Manifold Absolute Pressure)

- The MAP sensor is a three (3) wire variable capacitance sensor.
- The ECM uses the MAP sensor signal to assist in the calculation of EGR duty cycle, Fuel Delivery, and Throttle Body Position.
- The ECM measures the MAP signal to determine intake manifold (boost) pressure.

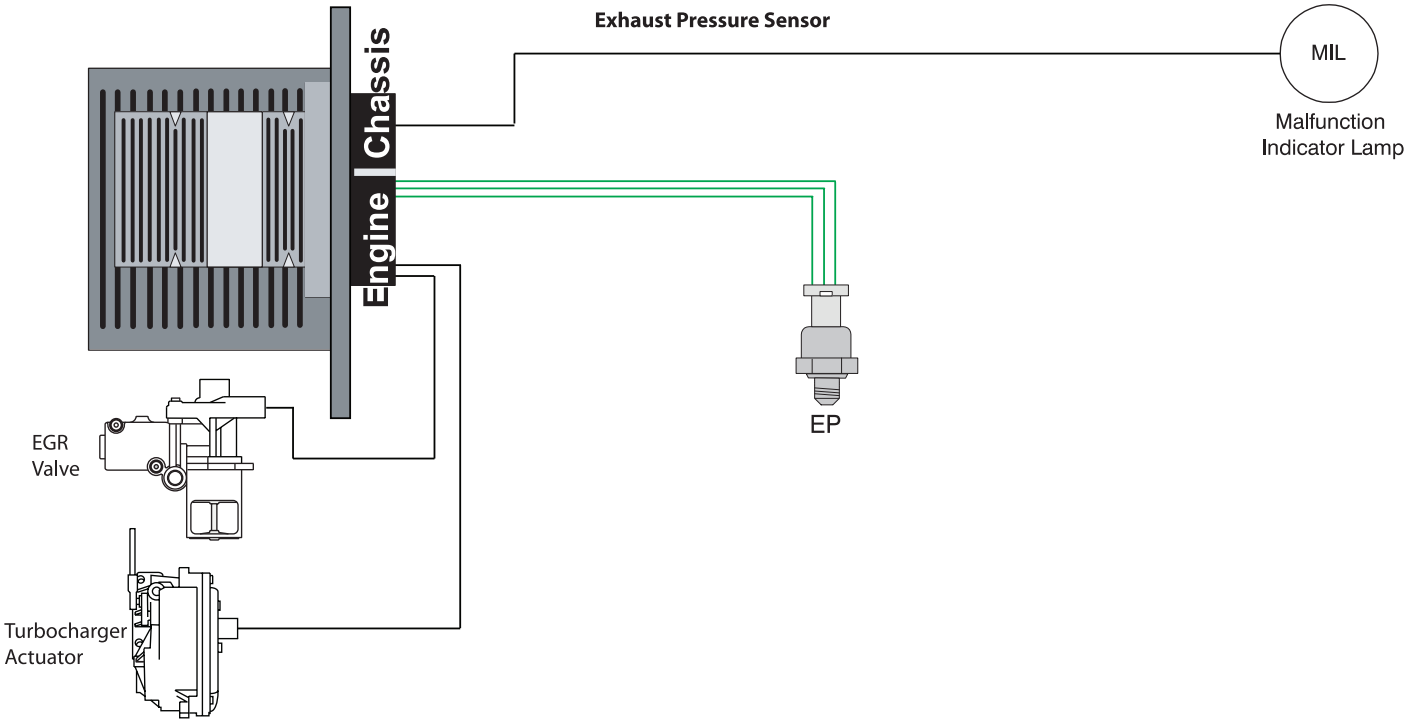
NOTE: Washing a hot engine can have negative effects on this sensor!

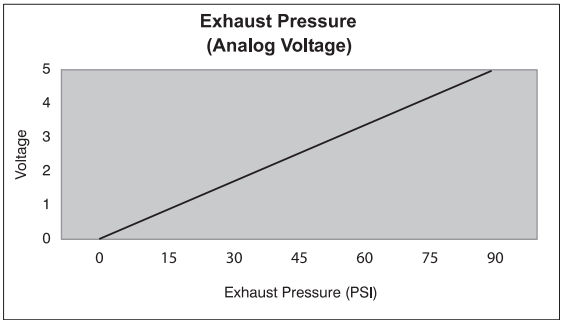
NOTE: The 6.0L engine used a remote mounted MAP sensor.

NOTE: Pay special attention to differentiating between the MAP sensor and the EP sensor, do not interchange them!



ELECTRICAL COMPONENTS





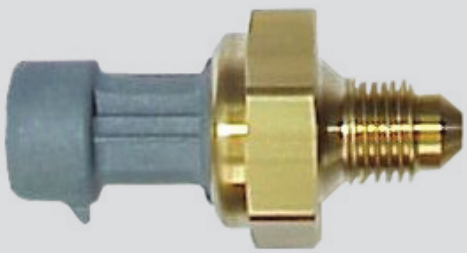
EP (Exhaust Pressure)

- The EP sensor is a three (3) wire variable capacitance sensor.
- The ECM supples a 5 volt reference signal which the EP sensor uses to produce a linear analog voltage that indicates pressure.
- The EP measures exhuast back pressure so that the ECM can control the EGR, and the high pressure turbocharger via the turbocharger actuator.

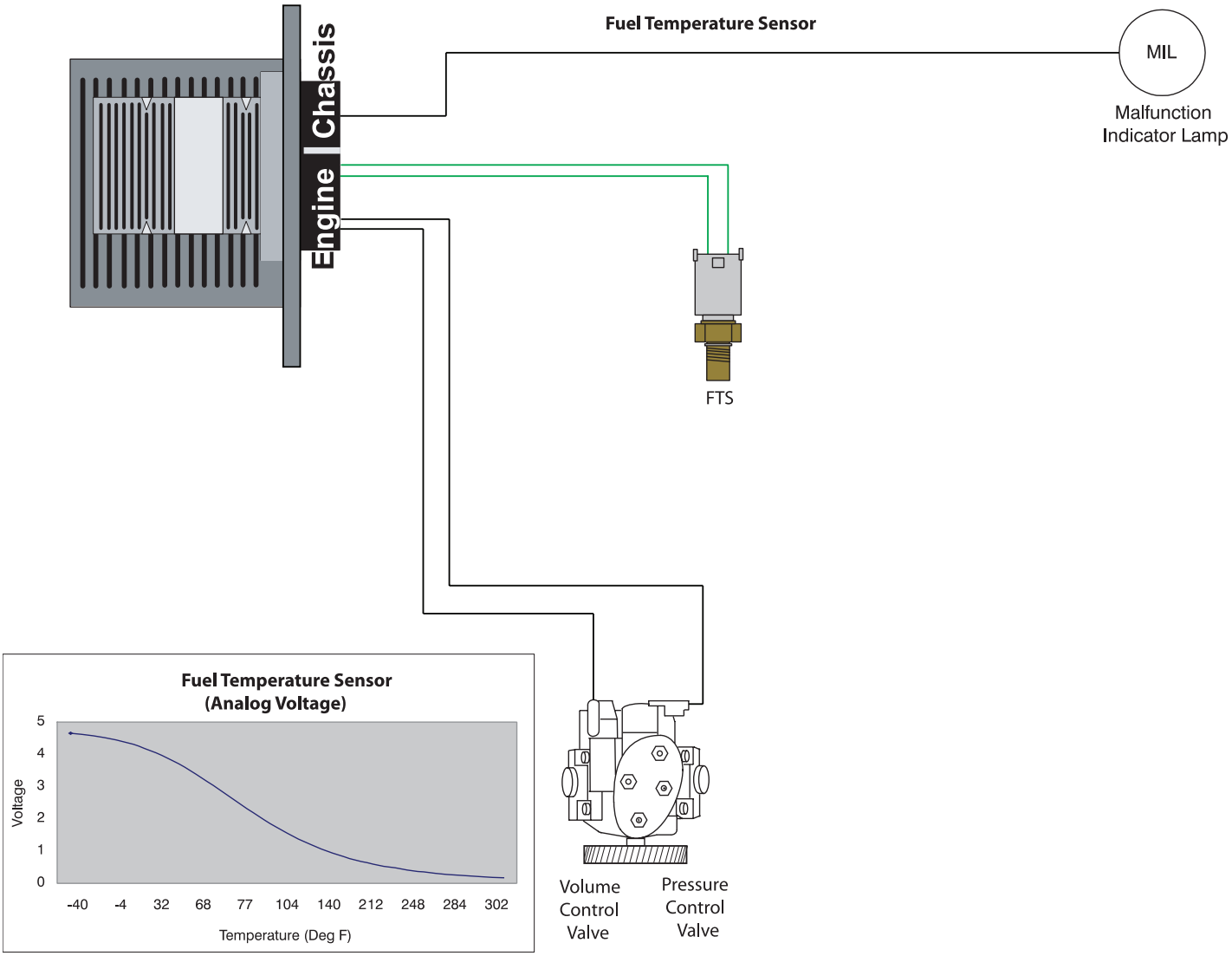
NOTE: Washing a hot engine can have negative effects on this sensor!

NOTE: This sensor is gray in color for the 6.4L and black in color for the 6.0L. Some early 6.4L engines may be equipped with black sensors. Do not interchange 6.0L EP sensors with 6.4L EP sensors, these sensors are different.

NOTE: Pay special attention to differentiating between the MAP sensor and the EP sensor, do not interchange them!

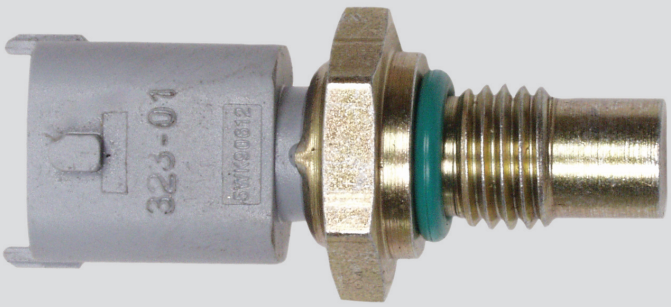


ELECTRICAL COMPONENTS

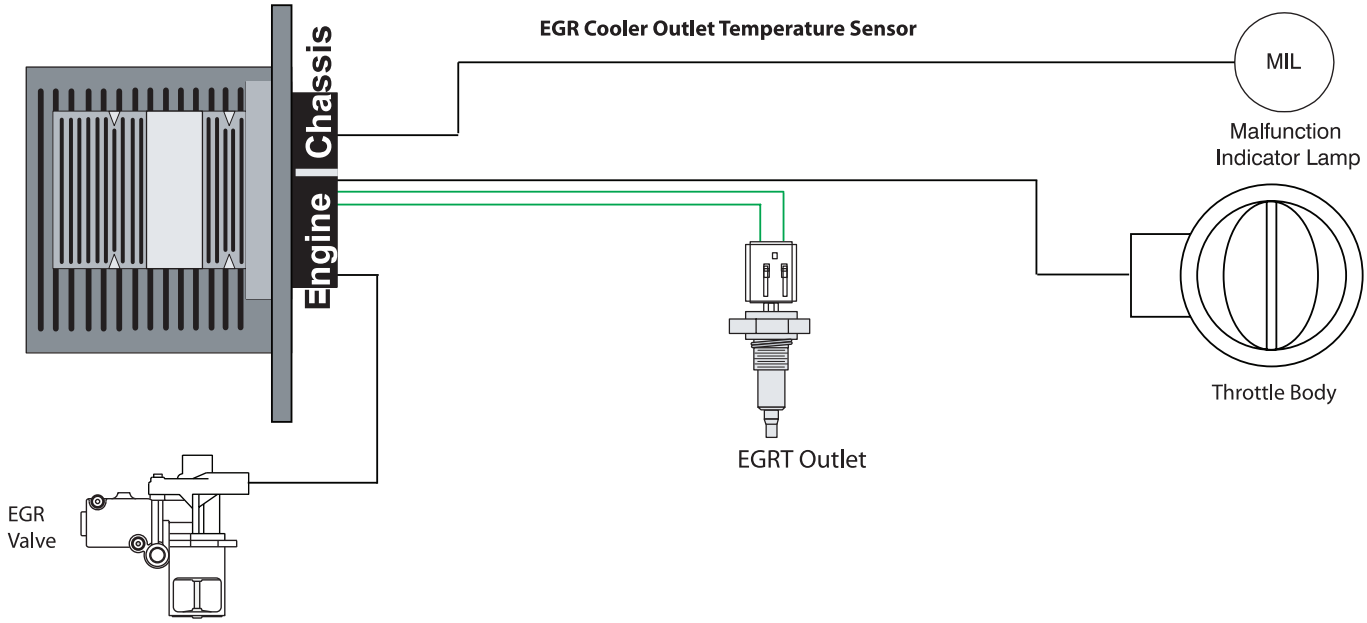


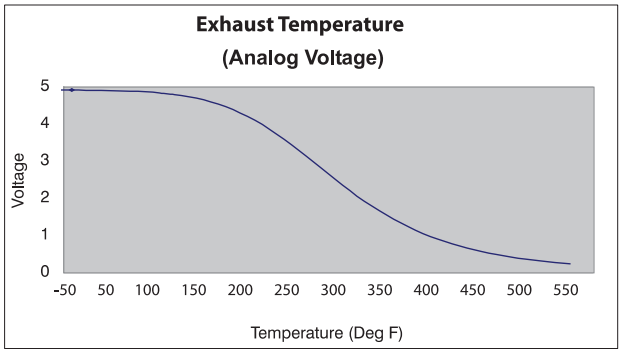
FTS (Fuel Temperature Sensor)

- The FTS sensor is a two (2) wire thermistor sensor.
- The FTS sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The FTS sensor changes resistance when exposed to different temperatures.
- When the temperature of the fuel decreases, the resistance of the thermistor increases and the signal voltage increases.
- When the temperature of the fuel increases, the resistance of the thermistor decreases and the signal voltage decreases.



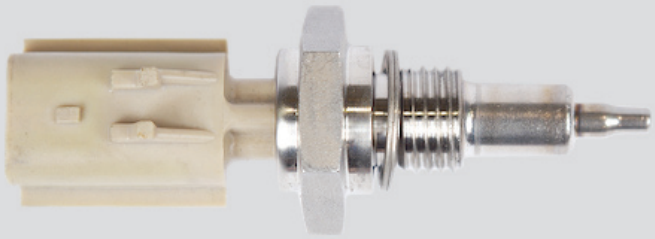
ELECTRICAL COMPONENTS





EGRT Outlet (EGR Cooler Outlet Temperature)

- The EGRT Outlet sensor is a two (2) wire thermistor type sensor.
- The EGRT outlet sensor's internal thermistor forms a voltage divider with a pullup resistor inside the ECM.
- The ECM monitors exhaust temperature from the EGRT outlet sensor signal to aid in controlling the EGR valve position and throttle position.



ELECTRICAL COMPONENTS

Control Devices

- The 6.4L Power Stroke® Diesel uses eight (8) control devices: Pressure Control Valve, Volume Control Valve, EGR Valve, Turbocharger Actuator, Glow Plug Control Module, Glow Plugs, Fuel Injectors, and the Throttle Body.

Actuators & Control Modules

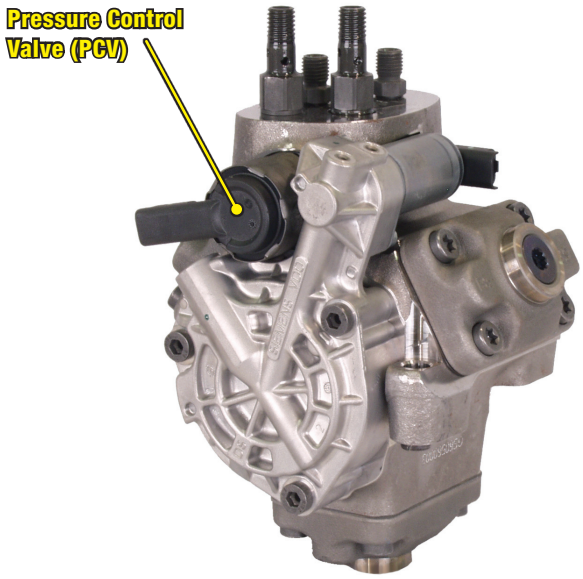
- Pressure Control Valve (PCV)
- Volume Control Valve (VCV)
- Exhaust Gas Recirculation Valve (EGR)
- Turbocharger Actuator
- Glow Plug Control Module (GPCM)
- Glow Plugs
- Piezo Electric Fuel Injectors
- Throttle Body

120

PCV (Pressure Control Valve)

- The PCV governs the fuel pressure that is delivered to the fuel injectors via the high pressure fuel rails and fuel supply tubes.
- The PCV also acts as a dampening device for the fluctuations in pressure that occur during fuel delivery through the pump and the injection process.
- The PCV is controlled by the ECM to maintain optimal fuel pressure throughout all engine operating conditions.
- The PCV is permanently mounted to the high pressure pump and is not to be removed. Removal of the PCV will result in replacement of the high pressure fuel injection pump.

NOTE: Fuel caps have been left off for visualization purposes. Always use fuel caps when servicing the high pressure fuel system!



121

VCV (Volume Control Valve)

- The VCV regulates the delivery of fuel from the internal transfer pump (ITP) to the high pressure pumping elements.
- The VCV adjusts the low pressure side of the system to match the needs of the engine thus increasing efficiency.
- The VCV is permanently mounted to the high pressure pump and is not to be removed. Removal of the VCV will result in replacement of the high pressure fuel injection pump.

NOTE: Fuel caps have been left off for visualization purposes. Always use fuel caps when servicing the high pressure fuel system!



122

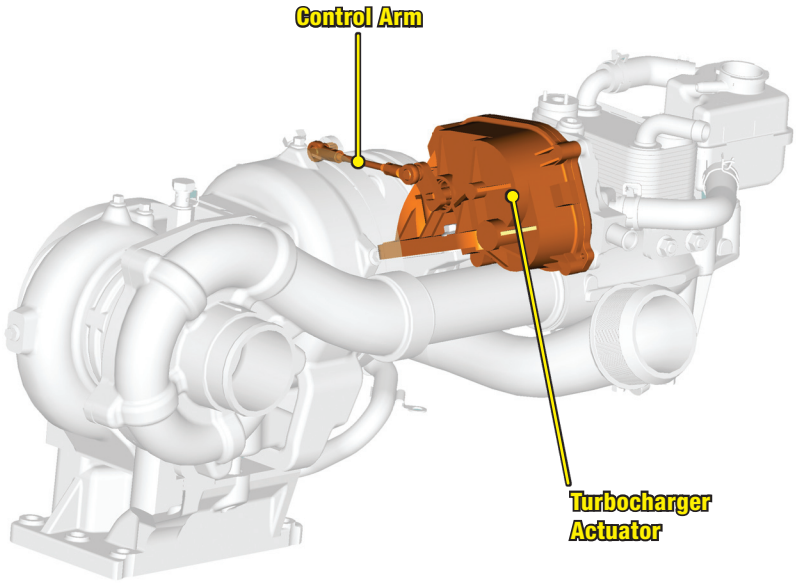
ELECTRICAL COMPONENTS



Exhaust Gas Recirculation Valve (EGR Valve)

- The EGR valve is used to mix cooled exhaust gases with intake air to lower emissions and noise.
- The EGR valve is stepper motor controlled
- The valve is powered in both the open and close directions.

123



Turbocharger Actuator

- The turbocharger actuator is an electronic motor that controls the position of the vanes inside of the high pressure turbocharger's turbine housing.
- The turbocharger actuator is mounted directly to the high pressure turbo and is connected to the vanes inside the turbine housing by a control arm.

124



Throttle Body

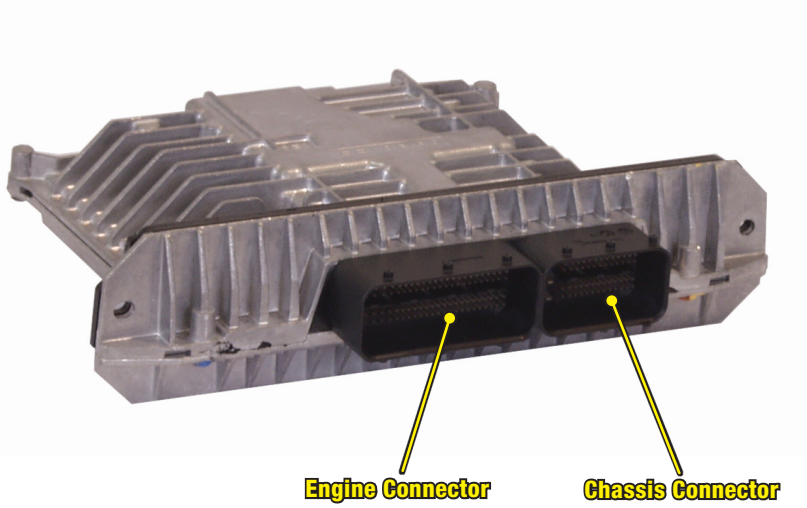
- The throttle body is operated by a stepper motor controlled by the ECM and assists with the exhaust aftertreatment system.

125

ELECTRICAL COMPONENTS

ECM (Engine Control Module)

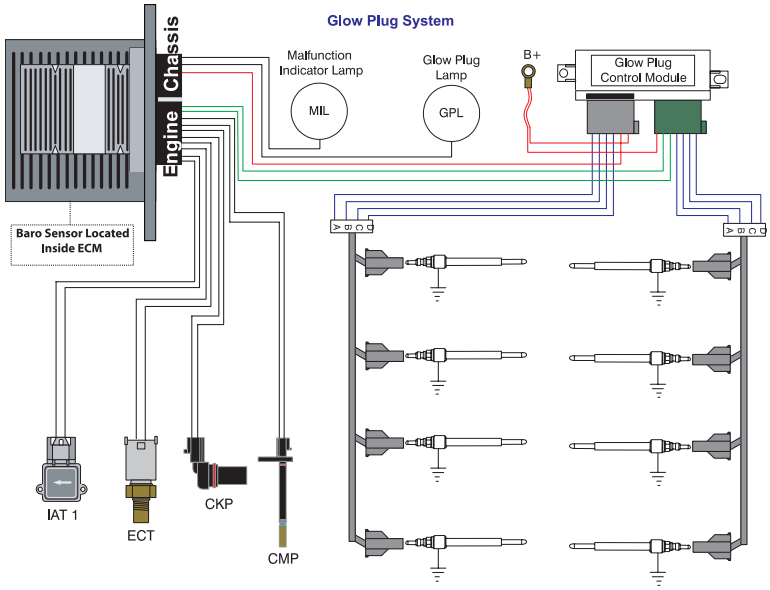
- The ECM, which is mounted behind the engine on the passenger side cowl, uses sensor inputs to control actuators and send fueling commands to the fuel inectors.
- The ECM controls the fuel and air management system on the 6.4L Power Stroke® Diesel.



126

Glow Plug System

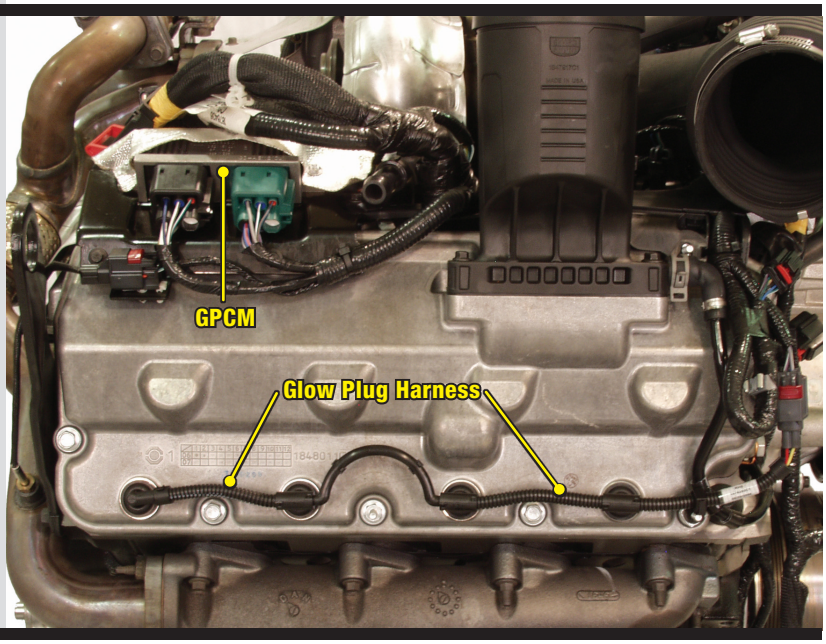
- The glow plug system is used to warm the air in the cylinders to enhance cold weather startability and reduce start up smoke.
- The glow plug system is ECM controlled, and powered by the GPCM.



127

Glow Plug Control Module(GPCM) & Glow Plug Harness

- The GPCM is a unit that controls the glow plugs in order to warm the air in the cylinders.
- The GPCM uses a glow plug enable signal to turn the glow plugs on for a time controlled by the ECM.
- The GPCM is capable of diagnosing a problem with one glow plug and then sending a diagnostic signal to the ECM.
- It also has the ability to turn off one glow plug if a short is detected in that circuit.
- Each bank of glow plugs is connected to the engine wiring harness via a glow plug harness, either left bank or right bank.
- The glow plug harness has four connectors that supply power to the glow plugs and seal oil from escaping through the glow plug access holes.



128

ELECTRICAL COMPONENTS



Glow Plug

- The glow plug is used to heat the air in the cylinder.
- The glow plug utilizes a system of sending voltage through a resistance coil to create heat.

NOTE: The 6.4L glow plug is very similar to the glow plug used on the 6.0L Power Stroke® Diesel, but they are different. The glow plugs must not be interchanged!

NOTE: The 6.4L glow plug uses a green isolator.

129



Fuel Injector

- The fuel injector is controlled by an extremely precise piezo electric actuator that can accomplish multiple injections per combustion event.

NOTE: Never unplug a fuel injector while the engine is running, serious engine damage could occur!

130

This page intentionally left blank

UNIQUE SERVICE PROCEDURES



Oil Filter: Replacement

- First loosen the oil filter cap which will open the oil filter drain and allow the oil from the filter housing to drain into the crankcase.
- Drain the oil from the oil pan.
- After all of the oil has drained from the oil pan remove the oil filter and discard it in the appropriate location.
- Install the new oil filter element and tighten the oil filter cap to the recommended torque. This will close the oil filter drain.
- Refill crankcase with the correct volume of recommended oil.

Note: The oil filter snaps into the oil filter lid.

131



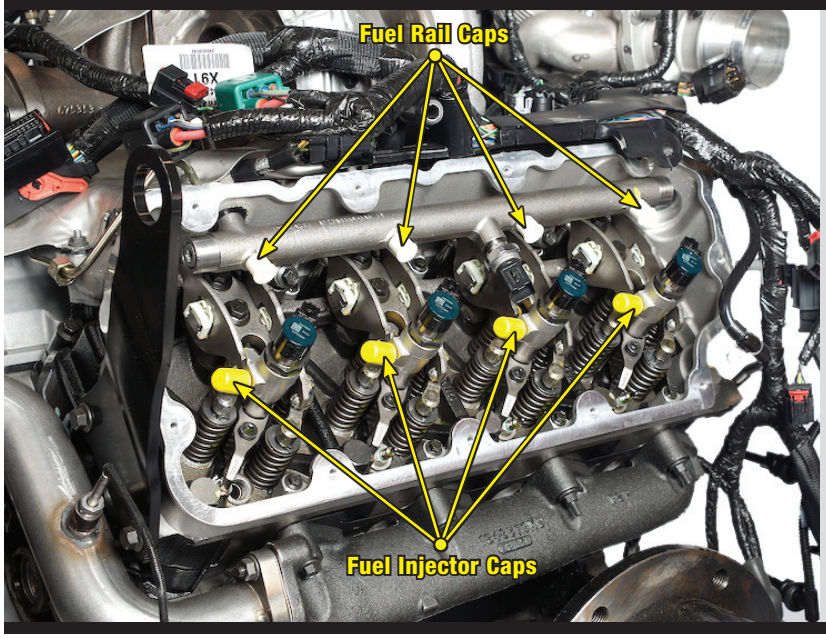
Fuel Filter: Replacement

NOTE: Use proper cleanliness practices while servicing the fuel system, do not let any dirt get into the housing!

- Clean all dirt and debris from the engine mounted fuel filter lid thoroughly. Make sure your hands and any tools involved are clean also!
- Remove the fuel filter lid and lift the filter element out of the housing and discard in the appropriate location.
- To avoid fuel spills, use a suction gun or similar device to remove the remaining fuel from the fuel filter housing.
- Install the new filter and tighten the fuel filter lid to the specified torque.

NOTE: Before starting the vehicle, turn the key to the on position for 30 seconds, then key off. Do this 6 times to ensure the fuel filter housing is full of fuel before starting the vehicle.

132



Fuel System Service Cleanliness: Fuel Injectors, Fuel Rail

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always use fuel system caps when servicing the fuel injectors or replacing fuel lines.
- Do not have the fuel system open to the elements any longer than is necessary to perform the job at hand.
- Tool # 310-158 (fuel caps)

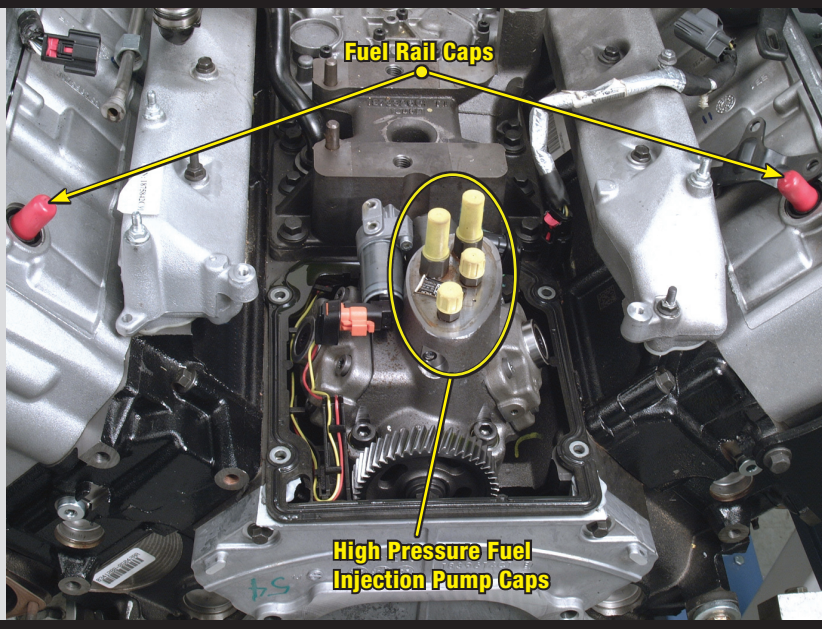
133

UNIQUE SERVICE PROCEDURES

Fuel System Service Cleanliness: High Pressure Fuel Injection Pump

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always use fuel system caps when servicing the high pressure fuel injection pump.
- Do not have the fuel system open to the elements any longer than is necessary to perform the job at hand.
- Tool # 310-158 (fuel caps)



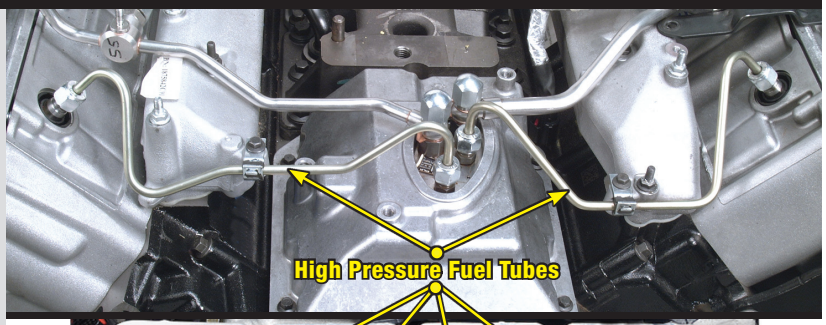
134

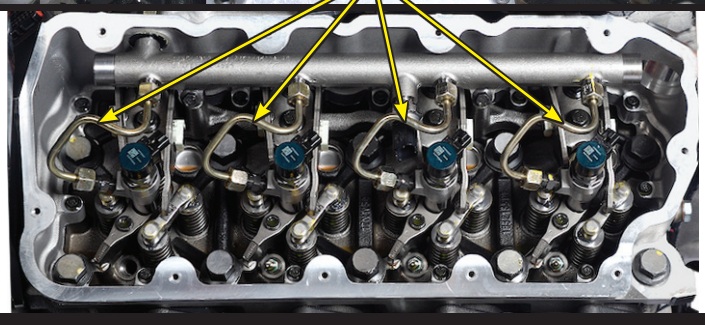
Fuel System Service: High Pressure Fuel Tubes

NOTE: Use proper cleanliness practices while servicing the fuel system!

- High pressure fuel supply tubes must always be replaced once loosened. Never re-use a high pressure tube once it has been loosened under any circumstances!

NOTE: Always use the fuel injector connector disconnect tool (tool # 310-157) whenever disconnecting the fuel injector electrical connector. Failure to use this tool can damage the connector.





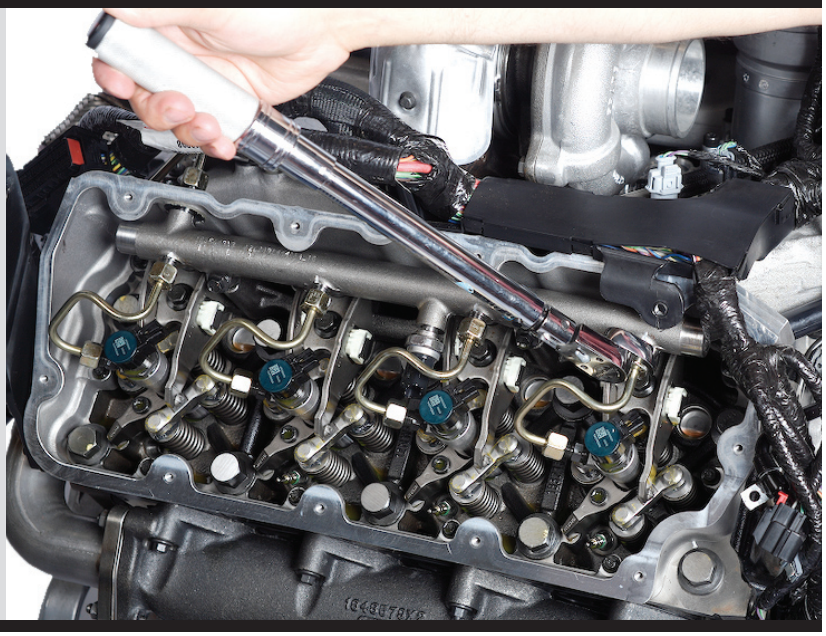
135

Fuel System Service: High Pressure Fuel Tube Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

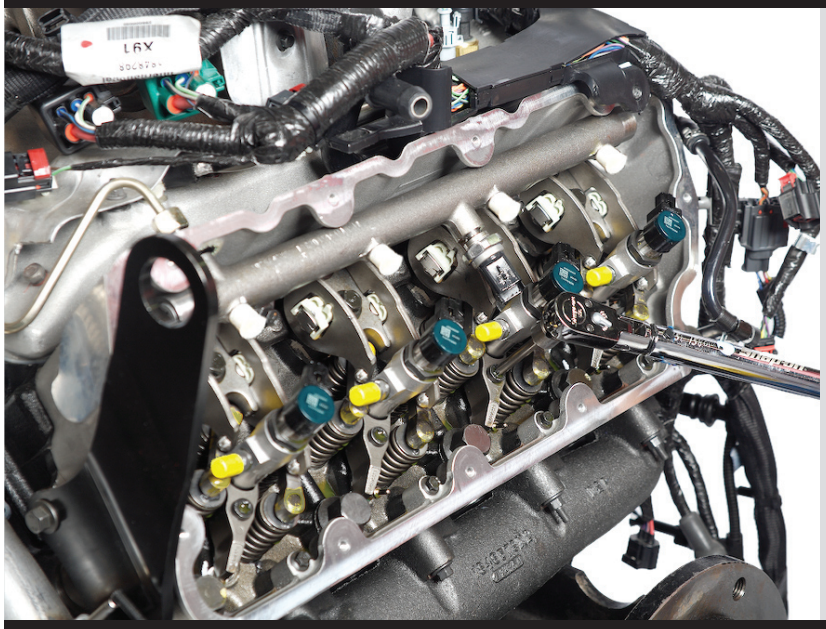
NOTE: Follow the proper service procedures while servicing the fuel system and always use the correct torque!

- Proper torque is crucial with the 6.4L Power Stroke® Diesel's high pressure fuel system.
- When replacing high pressure fuel tubes, always follow the correct procedure for installation and torque.



136

UNIQUE SERVICE PROCEDURES



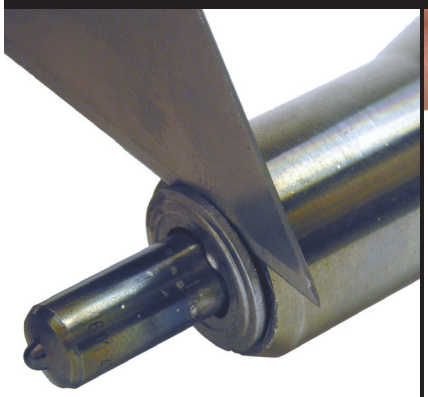
Fuel System Service: Fuel Injector Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

NOTE: Follow the proper sercive procedures while servicing the fuel system and always use the correct torque!

- Proper torque is crucial with the 6.4L Power Stroke® Diesel's high pressure fuel system.
- When replacing fuel injectors, always follow the correct procedure for installation and torque.
- Always use proper protective fuel system caps whenever a tube is removed.
- Avoid cleaning parts near fuel system components.
- Tool # 310-158 (fuel caps)

137





Fuel System Service: Removing and Installing Injector Gasket

NOTE: Use proper cleanliness practices while servicing the fuel system!

- To remove the gasket, use a razor blade to get between the gasket and injector body, then slowly work the gasket off.
- To install the new gasket, use a 9mm 12 point deep well socket and press the gasket on by hand making sure it is fully seated.
- Make sure the gasket is installed correctly. The raised portion of the gasket should be facing away from the injector body.

138



Fuel System Service: Fuel Injector Lubrication

NOTE: Use proper cleanliness practices while servicing the fuel system!

- Always replace the O-ring and the steel gasket at the tip of the injector when reinstalling an injector. New injectors come with these items already installed.
- Always lightly lubricate the new O-ring with clean engine oil prior to assembly.

139

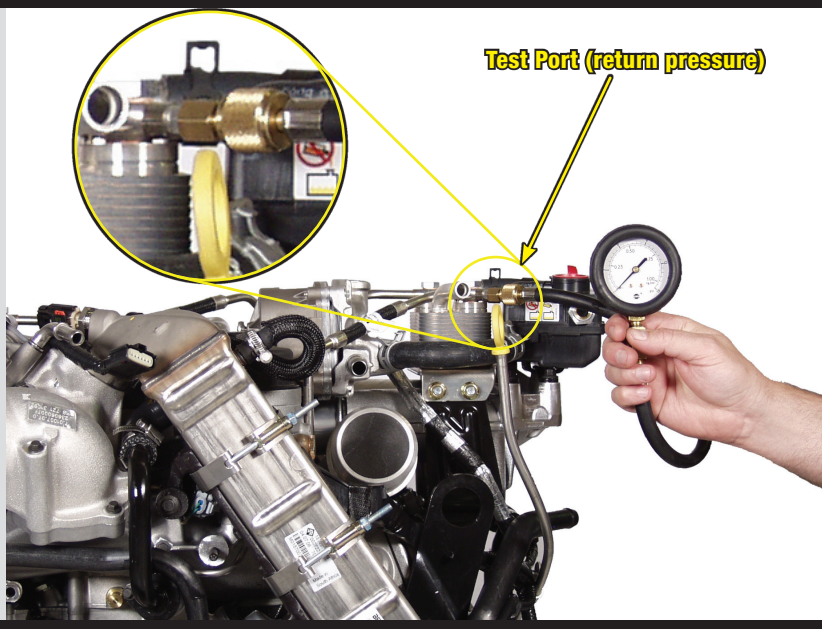
UNIQUE SERVICE PROCEDURES

Checking Fuel Pressure

NOTE: Use proper cleanliness practices while servicing the fuel system!

- There is a fuel return presure test valve (schrader) located on the front of the fuel cooler on the left side of the engine.
- Proper fuel pressure is very important. Too much or too little pressure could be detrimental.
- Follow the proper procedure for checking fuel pressure and make sure the correct specification for supply pressure is achieved.

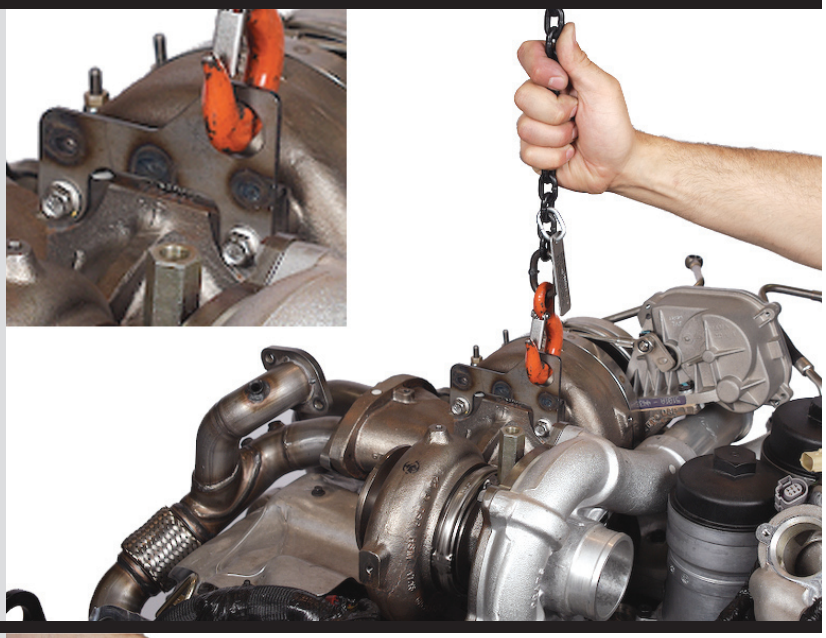
NOTE: Supply pressure needs to be checked at the horizontal fuel conditioning module (HFCM) outlet.



140

Turbocharger Lifting Bracket

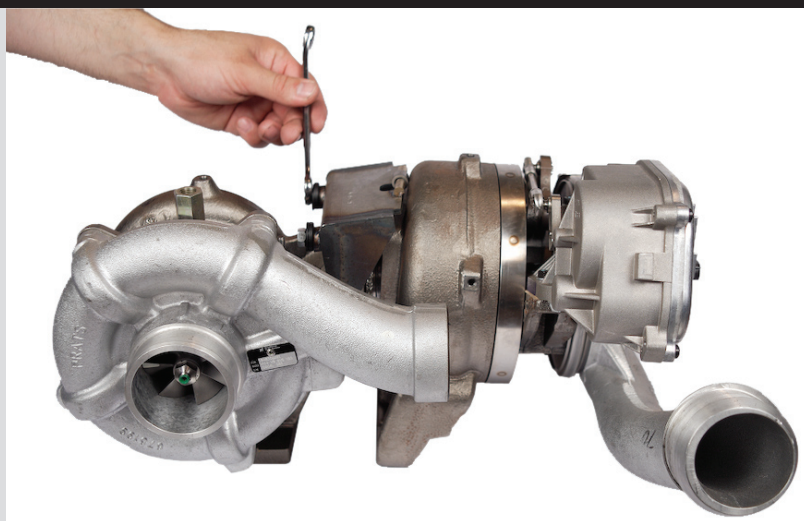
- Anytime removal or installation of the turbocharger is performed, always use the turbocharger lifting bracket to ensure proper engagement and disengagement of the turbocharger drain tubes.
- The tool is designed to balance the turbochargers and hold the two turbine housings in alignment.
- Tool # 303-1266



141

Turbocharger Assembly Tool

- The series sequential turbocharger is comprised of two turbochargers, low pressue turbocharger and high pressure turbocharger. When assembling these two turbochargers together, always use the turbocharger assembly tool shown at right.
- Tool # 303-1269
- Follow the proper assembly procedure.
- The turbocharger assembly tool is necessary to ensure that proper alignment/engagement of the two turbochargers is achieved.



142

UNIQUE SERVICE PROCEDURES



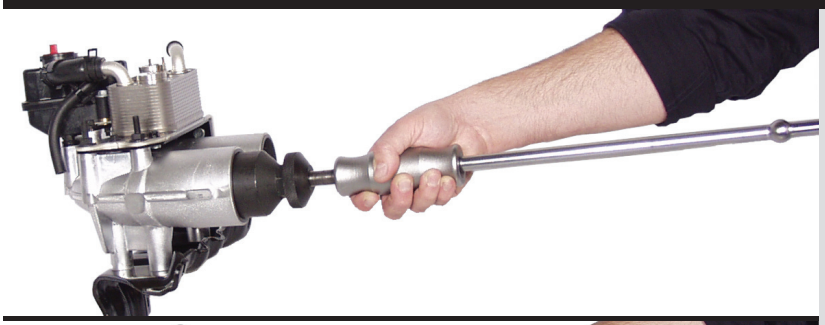


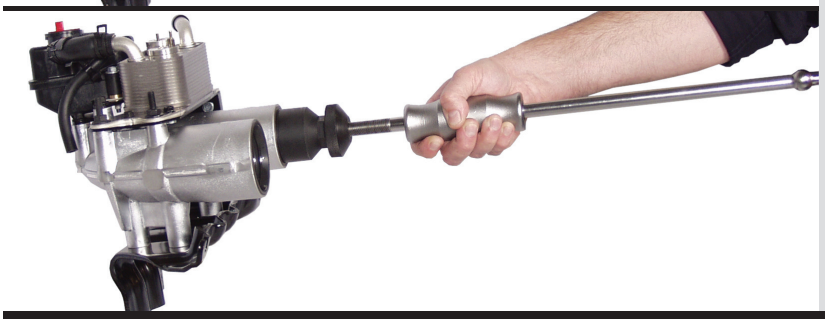
EGR Valve Removal

- Removing the EGR valve must be performed using the proper EGR valve removal tool.
- This tool is comprised of numerous pieces that must be put together around the EGR valve.
- Once the removal tool is assembled on the valve, the valve can be slowly pulled from its housing.
- Tool # 303-1267

NOTE: Pay close attention that the removal tool is installed and used correctly while removing the valve or damage can occur to the EGR valve and/or tool.

143





Crossover Tube Seal Removal

- Crossover tube seal removal requires the use of special service tools; slide hammer, seal removal tools.
- There is a different size removal tool for each opening of the crossover tube.
- Tool # 303-1264

144





Crossover Tube Seal Installation

- When installing new seals into the turbocharger crossover tube, always use the appropriate installation tools.
- The seals for each passage are two (2) different sizes. Make sure you use the correct sized seal installation tool for each sized seal.

NOTE: Make sure you have the crossover tube mounted securely to assure proper seal installation.

145

UNIQUE SERVICE PROCEDURES

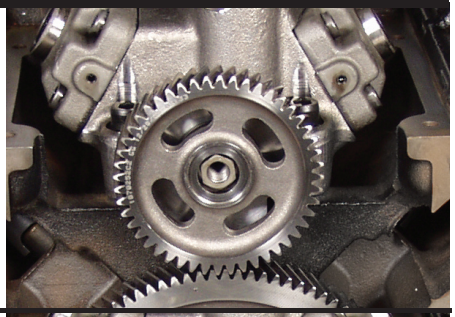
High Pressure Fuel Injection Pump: Gear Service

NOTE: Use proper cleanliness practices while servicing the fuel system!

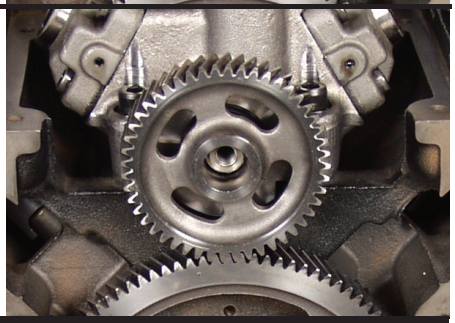
NOTE: Severe engine damage can occur if installed incorrectly!

- It is possible to tighten the gear on the high pressure fuel injection pump with the gear backwards. The gear and shaft both have a taper that needs to match.
- If you tighten the gear with it backwards the tapers will not be aligned but the bolt will start providing a means of tightening.
- Please pay special attention to insure that the gear is installed correctly with the tapers on both the gear and the high pressure fuel injection pump shaft aligned.

Correct



Incorrect



146

Cutting T-Joints: Rear Cover

- The T joint is where the bedplate gasket is bonded to the rear cover. This bond must be cut prior to removing the rear cover.
- After you loosen all of the bolts you can slide a cutting tool between the block/bedplate and the rear cover to sever the bonding compound.

NOTE: Failure to cut the T joint will stretch the bedplate gasket and result in an oil leak!



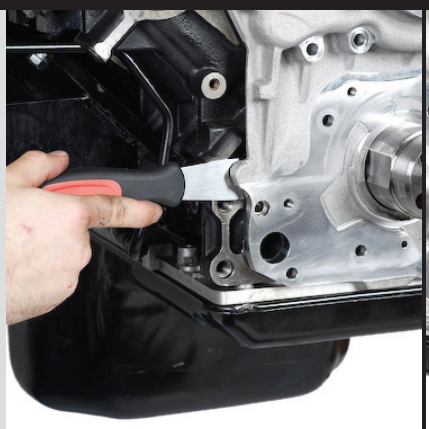


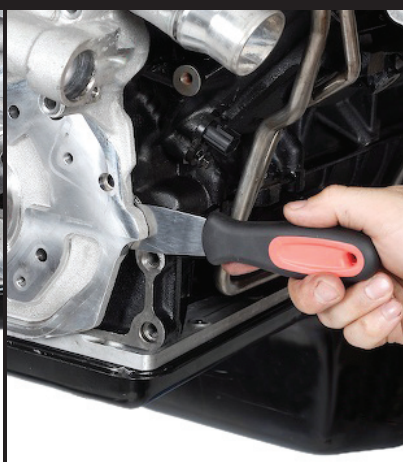
147

Cutting T-Joints: Front Cover

- The T joint is where the bedplate gasket is bonded to the front cover. This bond must be cut prior to removing the front cover.
- After you loosen all of the bolts you can slide a cutting tool between the block/bedplate and the front cover to sever the bonding compound.

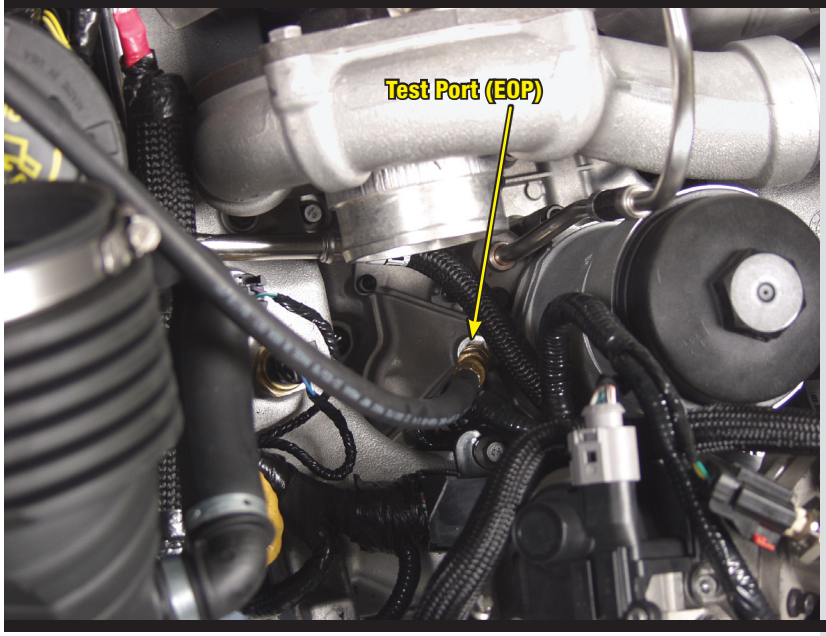
NOTE: Failure to cut the T joint will stretch the bedplate gasket and result in an oil leak!





148

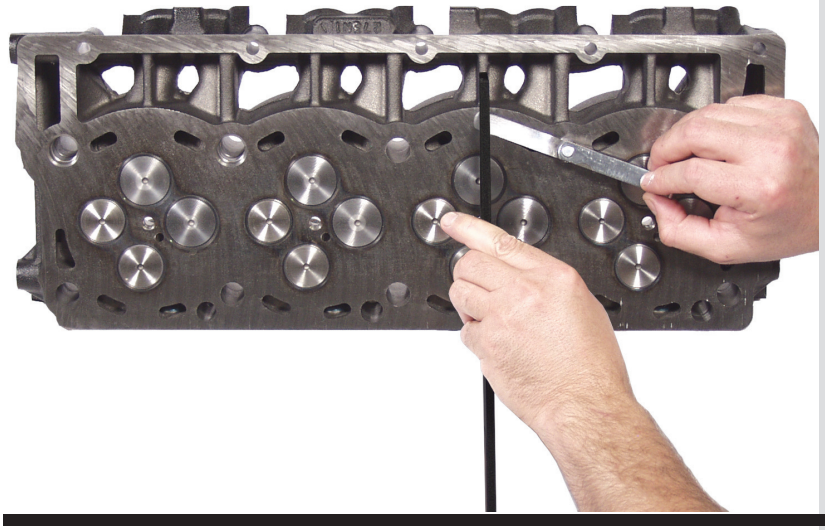
UNIQUE SERVICE PROCEDURES



Checking Oil Pressure

- Remove the engine oil pressure sensor (EOP) from the oil cooler.
- Install an adapter fitting into the port where the EOP was and install an approved oil pressure gauge.
- Follow the proper service procedures for checking oil pressure.
- The thread size for the opening is 7/16 - 20.

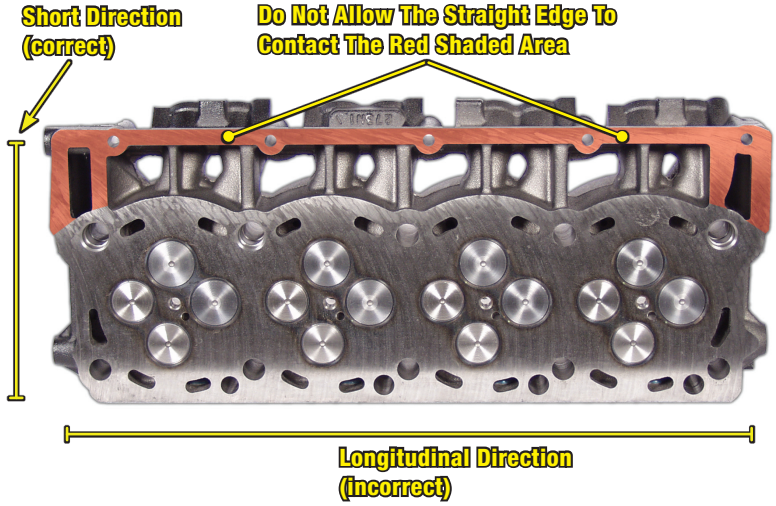
149



Checking Cylinder Head Flatness

- Checking cylinder head flatness for the 6.4L engine is carryover from the late 6.0L procedure.
- Check flatness across the short direction (perpendicular to the longitudinal) of the head.
- Use a straight edge that is calibrated by the manufacturer to be flat within 0.0002 in. per running foot length.
- Set the 0.002” feeler guage on each measurement point (refer to the service procedure graphic in the Ford workshop manual) with the straight edge perpendicular to the longitudinal and not across the area that contains the smaller head bolt holes. Set the straight edge on top of the feeler gauge.
- Use a firm steady force to properly hold the straight edge on top of the feeler gauge. Pull lightly on the feeler guage.
- The head is locally out of flat, and needs replaced if the 0.002” feeler gauge is loose and easily slides out from under the straight edge.

150



Checking Cylinder Head Flatness: Straight Edge Placement

- Never lay the straight edge across the area shaded in red.
- Do not check flatness in the longitudinal direction. Check flatness in the short (perpindicular to longitudinal) direction only.

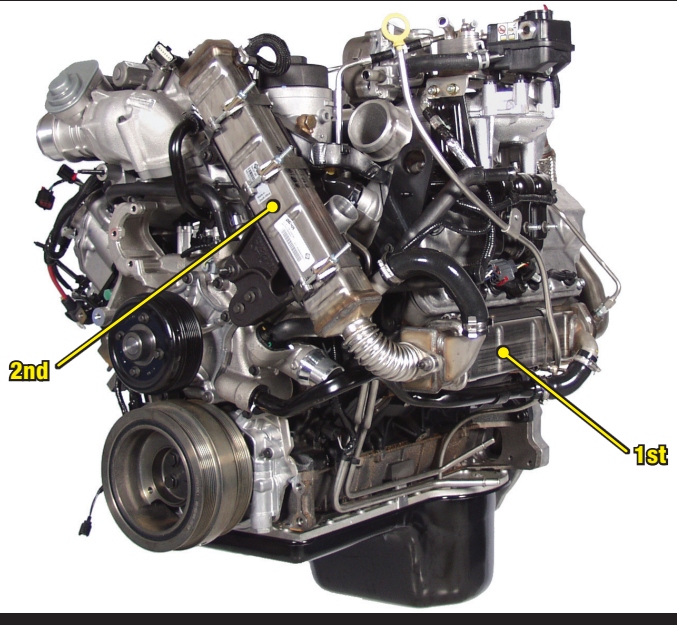
151

UNIQUE SERVICE PROCEDURES

EGR Cooler Service

- Servicing the EGR coolers must be performed in the proper order.
- The coolers must first be installed loosely in the order shown, then torqued in the proper sequence as shown in the Ford workshop manual.
- Proper assembly is crucial due to the extreme temperature changes within the EGR coolers. Temperature changes of 800 deg F are possible.

NOTE: All bolts, nuts, clamps, and cooler brackets must be replaced if the coolers are removed

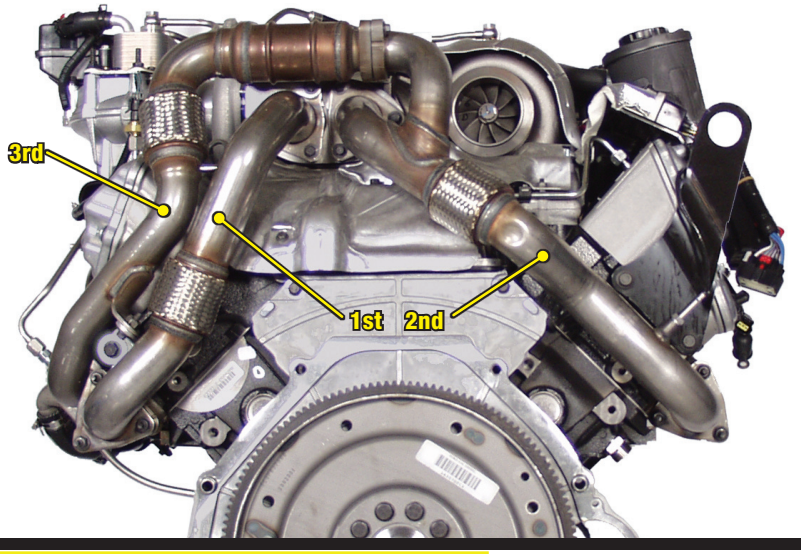


152

Exhaust Up-Pipe Service

- Assembly of the exhaust up-pipes and EGR cooler supply pipe must be performed in the proper order.
- The pipes must first be installed loosely in the order shown, then torqued in the proper sequence as shows in the Ford workshop manual.

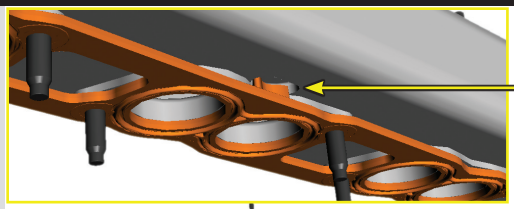
NOTE: Failure to follow the assembly steps can result in exhaust leaks.

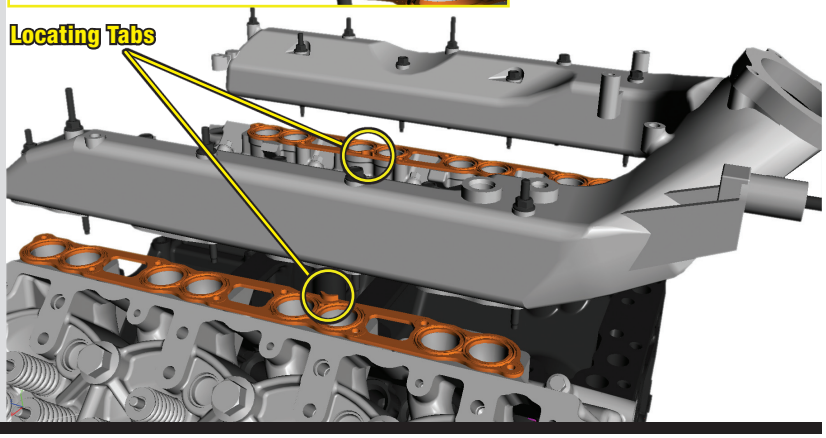


153

Intake Manifold And Gaskets

- When reinstalling the intake manifold, the locating tabs on the intake manifold gasket should face up and toward the center of the engine.





154

6.4L DIT APPENDIX

TABLE OF CONTENTS

Torque Charts..... 82-87

Wiring Diagram..... 88-89

Diagnostic Codes..... 90-101

SPECIAL TORQUE CHART (REFERENCE ONLY)

Note: All torque specs are ±10% unless stated otherwise.

COMPONENT	STANDARD	METRIC
Bedplate mounting bolts (crankcase bolts)	Figure C	Figure C
Camshaft follower guide bolt/washer	114 lbf/in	13 Nm
Camshaft position (CMP) sensor	114 lbf/in	13 Nm
Camshaft thrust plate mounting bolts	23 lbf/ft	31 Nm
Connecting rod bolt (Initial)	33 lbf/ft	45 Nm
Connecting rod bolt (Final)	50 lbf/ft	68 Nm
Coolant (block) heater	30 lbf/ft	41 Nm
Coolant pump mounting bolts	23 lbf/ft	31 Nm
Coolant pump pulley mounting bolts	23 lbf/ft	31 Nm
Crankcase breather to valve cover	114 lbf/in	13 Nm
Crankcase breather drain fitting to crankcase	18 lbf/ft	25 Nm
Crankcase breather tube clip bolt	23 lbf/ft	31 Nm
Crankcase coolant drain plug (M16)	180 lbf/in	20 Nm
Crankshaft position (CKP) sensor	114 lbf/in	13 Nm
Cylinder head bolts (only use new bolts, note 3)	Figure A	Figure A
EGR cooler inlet temperature sensor (EGRT Inlet)	32 lbf/ft	44 Nm
EGR coolant system hose clamps	31 lbf/in	3.5 Nm
EGR cooler outlet temperature sensor (EGRT Outlet)	28 lbf/ft	38 Nm
EGR DOC tube to RB up-tube bolts & nuts	23 lbf/ft	31 Nm
EGR DOC tube to EGR cooler horizontal bolts	23 lbf/ft	31 Nm
EGR cooler band clamps	Figure K	Figure K
EGR cooler vertical to EGR valve housing bolts	23 lbf/ft	31 Nm
EGR cooler vertical bracket mounting bolts	23 lbf/ft	31 Nm
EGR cooler horizontal to EGR cooler vertical flange	23 lbf/ft	31 Nm
EGR throttle body to EGR valve housing	88 lbf/in	10 Nm
EGR valve housing to intake manifold	88 lbf/in	10 Nm
EGR valve to EGR valve housing	88 lbf/in	10 Nm
Engine coolant temperature sensor (ECT)	159 lbf/in	18 Nm
Engine oil pressure switch (EOP)	124 lbf/in	14 Nm
Engine oil temperature sensor (EOT)	159 lbf/in	18 Nm
Exhaust backpressure (EP) connector to DOC tube	20 lbf/ft	27 Nm
Exhaust backpressure (EP) tube bracket nut	80 lbf/in	9 Nm
Exhaust backpressure (EP) tube nut to EP sensor	180 lbf/in	20 Nm
Exhaust backpressure (EP) tube nut to exhaust connector	180 lbf/in	20 Nm
Exhaust manifold flange studs	159 lbf/in	18 Nm
Exhaust manifold heat shield mounting bolts & nut	88 lbf/in	10 Nm
Exhaust manifold heat shield spacers to stud bolts	88 lbf/in	10 Nm
Exhaust manifold mounting bolts and stud bolts (note 4)	Figure F	Figure F
Exhaust up-tube to exhaust manifold nuts	23 lbf/ft	31 Nm
Exhaust up-tube to turbo bolts	18 lbf/ft	24 Nm
Flywheel/flexplate bolts (only use new bolts, note 3)	Figure B	Figure B
Front cover mounting bolts	23 lbf/ft	31 Nm
Fuel cooler reservoir mounting bolts	114 lbf/in	13 Nm
Fuel filter cap	20 lbf/ft	27 Nm
Fuel fitting banjo bolt with copper washer (M12)	28 lbf/ft	38 Nm
Fuel fitting banjo bolt with steel washer w/viton insert (M12)	18 lbf/ft	25 Nm
Fuel fitting banjo bolt (M14)	35 lbf/ft	47 Nm
Fuel injector hold down clamp bolts	28 lbf/ft	38 Nm
Fuel injector return tube nut to check valve	28 lbf/ft	38 Nm
Fuel return passage plug (rear of cylinder head)	20 lbf/ft	27 Nm
Fuel rail pressure sensor (FRP)	Figure L	Figure L
Fuel supply and return tube clamp to upper oil pan	23 lbf/ft	31 Nm

SPECIAL TORQUE CHART (REFERENCE ONLY)

COMPONENT	STANDARD	METRIC
Glow plug	124 lbf/in	14 Nm
Glow plug control module bolts and nuts (GPCM)	114 lbf/in	13 Nm
High pressure common rail (HPCR) mounting bolts	23 lbf/ft	31 Nm
High pressure common rail (HPCR) to fuel injector tubes	Figure G, I	Figure G, I
High pressure fuel injection pump & pump-to-rail tube installation	Figure H	Figure H
High pressure fuel injection pump cover mounting bolts	114 lbf/in	13 Nm
High pressure fuel injection pump drive gear bolt	57 lbf/ft	78 Nm
High pressure fuel injection pump mounting bolts	45 lbf/ft	62 Nm
High pressure fuel tube nuts (all)	144 lbf/in	30 Nm
Intake manifold pressure sensor (MAP)	106 lbf/in	12 Nm
Intake air temperature 2 (IAT2) sensor	124 lbf/in	14 Nm
Intake manifold bolts and stud bolts	Figure D	Figure D
Lifting eye bolts	45 lbf/ft	62 Nm
Oil cooler to crankcase mounting bolts (M8)	23 lbf/ft	31 Nm
Oil filter base to cooler cover screws (M6 thread forming)	89 lbf/in	10 Nm
Oil filter cap	18 lbf/ft	25 Nm
Oil filter housing to filter base bolts	16 lbf/ft	22 Nm
Oil filter stand pipe bolt (M5 thread forming) W/new oil cooler	61 lbf/in	7 Nm
Oil filter stand pipe bolt (M5 thread forming) reusing existing oil cooler	30 lbf/in	3 Nm
Oil pan bolt - lower pan	114 lbf/in	13 Nm
Oil pan bolt - upper pan	114 lbf/in	13 Nm
Oil pan drain plug (see note 1)	32 lbf/ft	44 Nm
Oil pickup tube bolts	114 lbf/in	13 Nm
Oil pump housing bolts	16 lbf/ft	22 Nm
Oil pressure regulator plug	26 lbf/ft	35 Nm
Piston cooling jet mounting bolts (see note 2)	114 lbf/in	13 Nm
Rocker arm assembly bolts	Figure J	Figure J
Rear cover M10 (manual only)	45 lbf/ft	62 Nm
Rear cover M8 (man & auto)	23 lbf/ft	31 Nm
Thermostat housing hold down plate bolts	114 lbf/in	13 Nm
Turbocharger actuator mounting bolt	168 lbf/in	19 Nm
Turbocharger air inlet duct clamp	44lbf/in	5 Nm
Turbocharger pedestal bolts	45 lbf/ft	62 Nm
Turbocharger to pedestal bolts	148 lbf/ft	201 Nm
Turbocharger crossover tube support mounting	79 lbf/in	9 Nm
Turbocharger heat shield bolts	96 lbf/in	11 Nm
Turbocharger oil supply banjo bolts (M12)	28 lbf/ft	38 Nm
Turbocharger oil supply standoff fittings to center housings	35 lbf/ft	47 Nm
Turbocharger oil supply tube retaining bolt to oil cooler	114 lbf/in	13 Nm
Valve cover base bolts	114 lbf/in	13 Nm
Valve cover bolts and studs	80 lbf/in	9 Nm
Vibration damper bolts (note 3) (only use new bolts)	Figure E	Figure E

STANDARD TORQUE CHART
Hex Flange Head

Thread Diameter	Torque	Torque Nm	Wrench Size (mm)
M6 x 1	114 lbf/in	13	8
M8 x 1.25	23 lbf/ft	31	10
M10 x 1.5	45 lbf/ft	62	13
M12 x 1.75	79 lbf/ft	107	15
M14 x 2	127 lbf/ft	172	
M15 x 2	159 lbf/ft	216	
M16 x 2	196 lbf/ft	266	21

Torque Chart Notes

1) Lightly coat o-ring with clean engine prior to install.

2) Apply threadlock 262 to bolt threads prior to install.

3) Do not reuse. These bolts are one time stretch to yield.

4) Do not reuse exhuast manifold bolts and studbolts.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE A: Cylinder Head Bolts

Step 1: Lightly lubricate M16 head bolt threads and washer faces with clean engine oil prior to assembly.

Step 2: Torque M16 head bolts (labeled 1-10) to 70 lb/ft (95 Nm) in numerrical sequence shown.

Step 3: Back out M16 head bolts and retorque to 115 lb/ft (156 Nm) one at a time in numerical sequence shown.

Step 4: Tighten M16 head bolts and additional 90 degrees in numerical sequence shown.

Step 5: Tighten M16 head bolts an additional 90 degrees (2nd time) in numerical sequence shown.

Step 6: Torque M8 head bolts (labeled 11-15) to 18 lb/ft (24 Nm) in numerical sequence shown.

Step 7: Torque M8 head bolts to 23 lb/ft (31 Nm) in numerical sequence shown.

Note: Head bolts may not be reused once torqued.

Note: If bolt chatter occurs during step 4, repeat step 3 and continue.

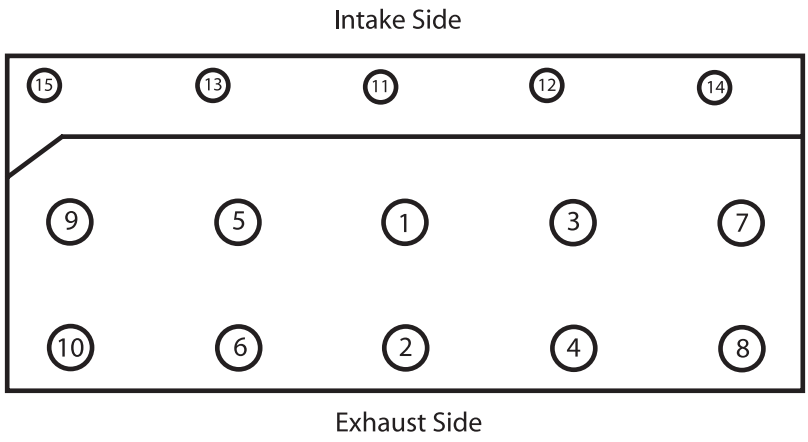


FIGURE B: Flywheel Bolts

Step 1: Torque the bolts to 44 lbf/in (5 Nm) in the numerical sequence shown.

Step 2: Torque the bolts to 69 lbf/ft (94 Nm) in the numerical sequence shown above.

Note: Flywheel bolts may not be reused once torqued.

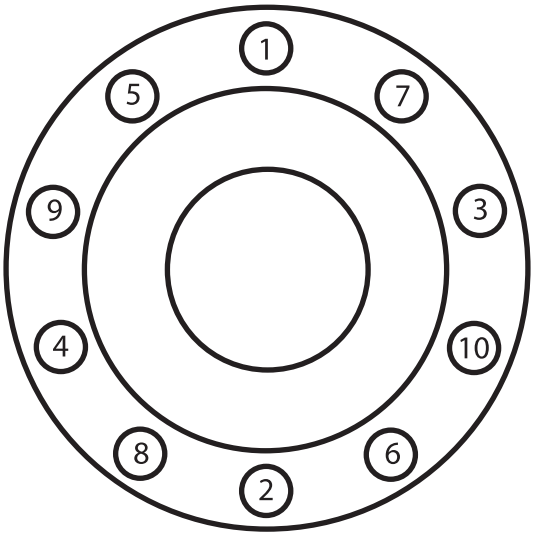
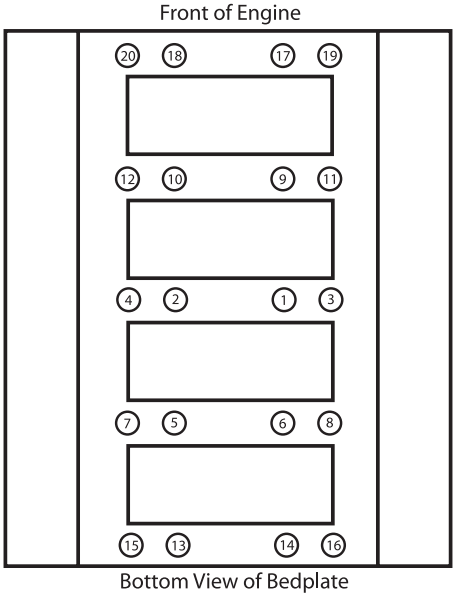


FIGURE C: Bedplate Bolts (main bearing bolts)

Step 1: Torque the bolts to 110 lbf/ft (149 Nm) in the numerical sequence shown.

Step 2: Torque the bolts to 130 lbf/ft (176 Nm) in the numerical sequence shown.

Step 3: Torque the bolts to 170 lbf/ft (231 Nm) in the numerical sequence shown.



SPECIAL TORQUE CHART (REFERENCE ONLY)

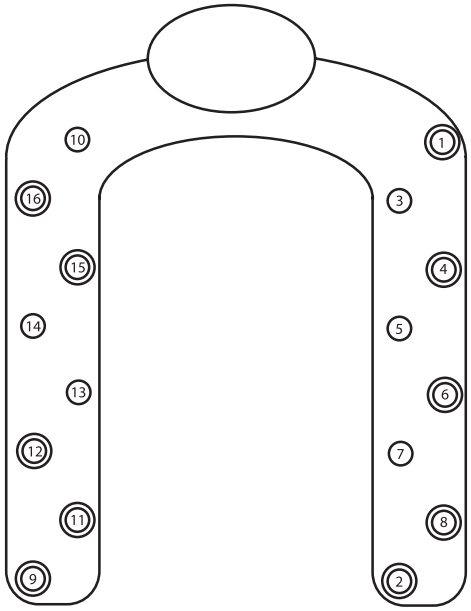


FIGURE D: Intake Manifold Bolts

Step 1: Loosely install all bolts in the numerical sequence shown.

Step 2: Torque bolts to 100 lb/in (11Nm) in the numerical sequence shown.

Note: Bolt locations with double circles represent stud bolts.

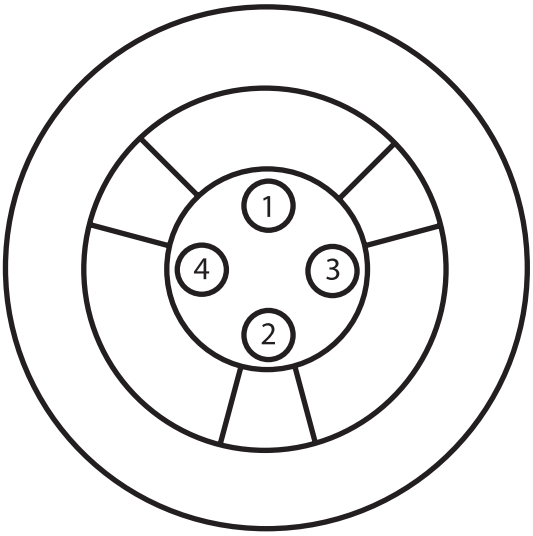


FIGURE E: Vibration Damper Bolts

Step 1: Torque each bolt to 50 lb/ft (68 Nm) in the numerical sequence shown.

Step 2: Tighten each bolt 90 degrees clockwise in the numerical sequence shown.

Note: Damper bolts may not be reused once torqued.

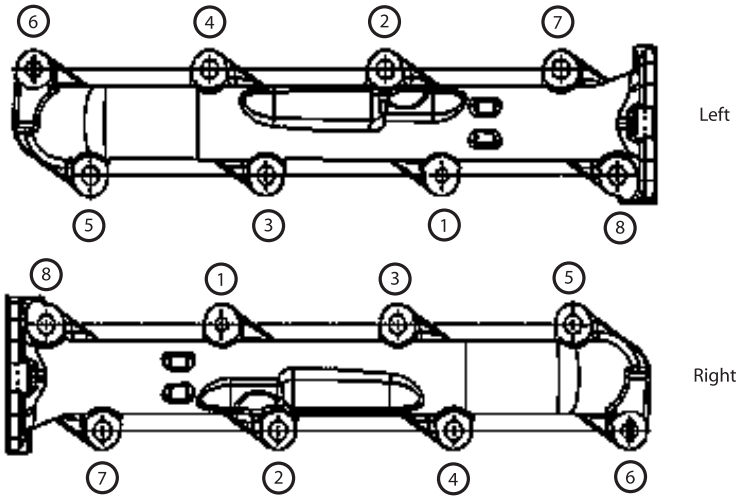


FIGURE F: Exhaust Manifold Bolts

Step 1: Torque bolts to 18 lb/ft (25Nm) in the numerical sequence shown.

Step 2: Repeat the sequence using the same torque.

Note: Exhaust manifold bolts and studbolts may not be reused once torqued.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE G: HPCR Fuel Components Assembly Procedure

Hand start and hand snug tube nuts.

Step 1: Install injectors, clamps and bolts and hand start the clamp bolts.

Step 2: Rundown the injector clamp bolts to a torque of 1.5 lb/ft (2 Nm). Injectors will seat while torquing the bolts.
Note: The injectors must be fully seated and snugged, but moveable for high pressure connector and HP tube alignment.

Step 3: Install the HP rail and hand start two rail mounting bolts.
Note: Rail must be moveable, but not loose.

Step 4: Remove the four plastic caps from the rail high pressure connectors (HPC's) and four plastic caps from the injector HPC's.

Step 5: Obtain four "rail to injector" jumper tubes from the packaging.

Step 6: Position the four (one at a time) between the rail and injectors and fully hand start and seat the tube nuts onto the mating rail and injector HPC's. Snug the rail and injector tube nuts using the inside-out step sequence (i.e. two inside nuts then two outside nuts) with a tube nut click wrench set to 1.5 lb/ft (2 Nm).

Step 7: Final torque the injector clamp bolts to 28 lb/ft (38 Nm).

Step 8: Final torque the two M8 rail bolts to 23 lb/ft (31 Nm).

Step 9: Torque the rail and injector tube nuts to 106 lb/in (12 Nm +2 / -0).

Step 10: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail and fuel injector threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees.

FIGURE H: High Pressure Pump and Pump-to-Rail HP Tubes Installation Procedure

Step 1: Install and final torque the high pressure fuel injetion pump to 45 lb/ft (61 Nm).

Step 2: Install the pump cover gasket and make electrical connections between the pump and gasket. Install the pump cover and fasten the bolts.

Step 3: Remove the four plastic caps covering the supply, return, and high pressure rail connectors.

Step 4: Obtain left and right "pump-to-rail" high pressure tubes from the packaging.

Step 5: Position the high pressure tubes between the pump and the rails and fully hand start and seat the tube nuts onto the mating pump and rails high pressure connections.
Note: Support the tubes while hand snugging the nuts to assure proper assembly of the joints.

Step 6: Snug the tube nuts to 1.5 lb/ft (2 Nm).

Step 7: Torque the pump and rail tube nuts to 106 lb/in (12 Nm +2 / -0).

Step 8: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail and the high pressure fuel injection pump threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees.

FIGURE I: Injector-Pipe-Rail Sub-Assembly Process

Step 1: Place the fuel injectors w/clamps in the head and snug the bolts.

Step 2: Place and snug the fuel rail (leave one thread loose).

Step 3: Place four fuel jumper tubes to injector/fuel rail and start 1-2 threads.

Step 4: Snug injector side tube nuts to 1.5 lb/ft (2 Nm). (Special torque sequence is used, see note below).

Step 5: Snug fuel rail side tube nuts to 1.5 lb/ft (2 Nm). (Special torque sequence is used, see note below).

Step 6: Final torque the fuel rail mounting bolts.

Step 7: Final torque the injector bolts. (Special torque sequence is used, see note below).

Step 8: Final torque the injector side tube nuts to 106 lb/in (12 Nm +2 / -0). (Special torque sequence is used, see note below).

Step 9: Final torque the fuel rail side tube nuts to 106 lb/in (12 Nm +2 / -0). (Special torque sequence is used, see note below).

Step 10: Place a visible mark with a permanent marker on the tube nut and the fuel injector threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees. (Special torque sequence is used, see note below).

Step 11: Place a visible mark with a permanent marker on the tube nut and the high pressure fuel rail threaded connection. Turn the tube nuts one flat of the nut which is equal to 60 degrees. (Special torque sequence is used, see note below).

NOTE: Torque the components in the center two cylinders first, then torque the components in the outer two cylinders last.

SPECIAL TORQUE CHART (REFERENCE ONLY)

FIGURE J: Fulcrum Plate / Rocker Arm Support Assembly

Step 1: Position crankshaft at approximate #1 & #4 cylinder TDC by observing damper dowel pin and clocking it to the 10:30 position (as viewed from the front of the engine)

Step 2: Determine which cylinder is actually in the firing position by installing pushrods, and observing #3 intake and #8 intake.

Step 3: If #3 intake pushrod shows cam lift, this is the #1 firing position. Torque only fulcrum plates #1,2,7,8 per steps 4-6.

If #8 intake pushrod shows cam lift, this is the #4 firing position. Torque only fulcrum plates #3,4,5,6 per steps 4-6.

Step 4: Partially run down both M10 bolts until they just contact the fulcrum plate.

Step 5: Fully run down and torque inboard (upper) bolt to 45 lb/ft (62 Nm).

Step 6: Fully run down and torque outboard (lower) bolt to 45 lb/ft (62 Nm).

Step 7: Rotate crankshafft 360 degrees to position it at the alternate cylinder TDC (dowel pin at 10:30 position).

Step 8: Identify remaining group of fulcrum plates per step 3, and torque per steps 4-6.

FIGURE K: EGR Cooler Mounting Clamps

Horizontal Cooler

Step 1: Pre-torque EGR clamps to 88lb/in (10 Nm).

Step 2: Loosen clamp nuts two full turns.

Step 3: Final torque to 69 lb/in (8 Nm)

Vertical Cooler

Step 1: Pre-torque EGR clamps to 75 lb/in (8.5 Nm).

Step 2: Loosen clamp nuts two full turns.

Step 3: Final torque to 57 lb/in (6.5 Nm).

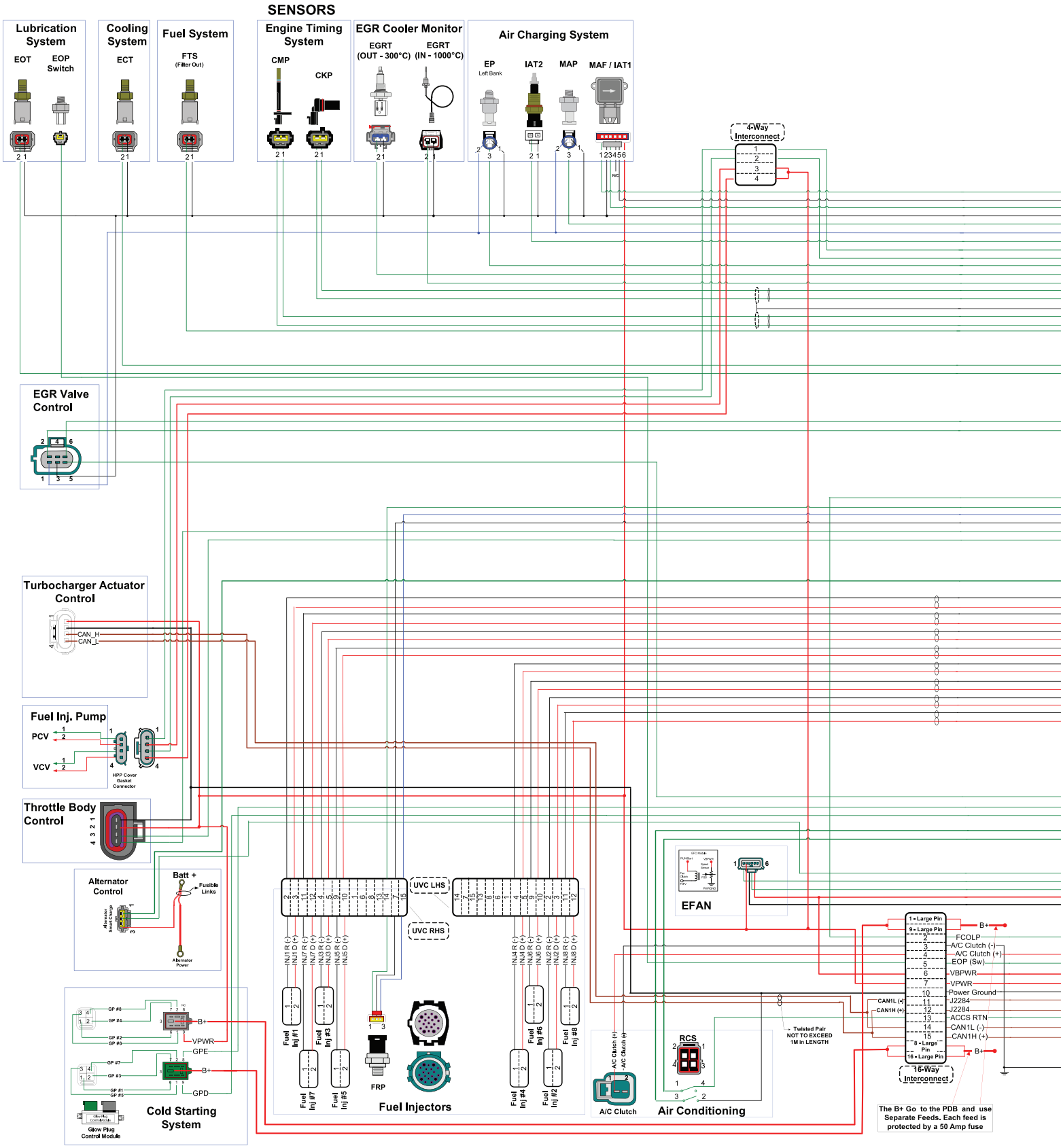
FIGURE L: Fuel Rail Pressure Sensor (FRP)

Step 1: Snug the sensor hand tight to 1.5 lb/ft (2 Nm)

Step 2: Place a visible mark with a permanent marker on the sensor and the high pressure fuel rail connection. Turn the sensor one flat of the sensor base which is equal to 60 degrees.

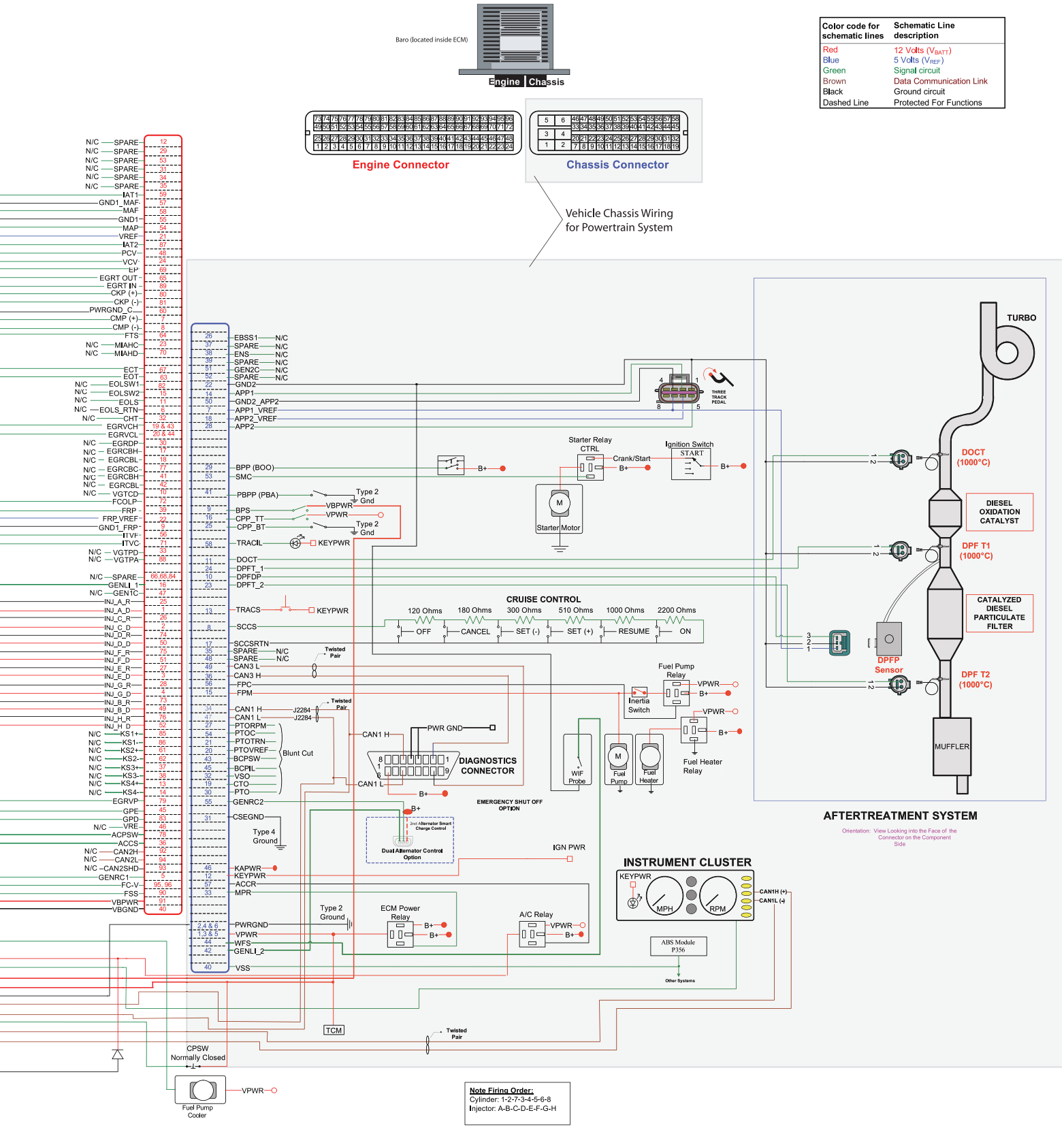
WIRING DIAGRAM (SINGLE ALT.) REFERENCE ONLY

Refer to Ford Wiring Diagrams for Wiring



WIRING DIAGRAM (SINGLE ALT.) REFERENCE ONLY

Refer to Ford Wiring Diagrams for Wiring



DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P1111	X	X	X	System Pass			PCM, connection to service tool
P000E		X	X	Fuel Volume Regulator Control Adaptive Learning at Limit	This error is set when the Pulse Width Modulated (PWM) signal for the Volume Control Valve (VCV) is either too low or too high for current operating modes.	+/- 8% error in VCV control	Low pressure fuel system, injector leakage
P0A09	X	X	X	DC/DC Converter Fault Circuit Low	The purpose is to diagnose the analog output voltage from the DCDC converter (voltage converter for injectors inside PCM). If the voltage from the converter is lower than a threshold, the fault is set.	Low: < 42 V High: >96 V	PCM
P0A10	X	X	X	DC/DC Converter Fault Circuit High	The purpose is to diagnose the analog output voltage from the DCDC converter (voltage converter for injectors inside PCM). If the voltage from the converter is higher than a threshold, the fault is set.	Low: < 42 V High: >96 V	PCM
P0001		X	X	Fuel Volume Regulator Control Circuit / Open	This error is recorded when an open circuit causes the Pulse Width Modulated (PWM) signal of the Volume Control Valve (VCV) to be abnormally high for an extended period of time.	For open load: Resistance > 500 Ohm	Wiring, VCV electrical system
P0003	X	X	X	Fuel Volume Regulator Control Circuit Low	During KOEO diagnostics, this error is set when the measured current through the system is greater than intended. During the KOER or Continuous Monitor modes, this code is a result of a short to ground, which causes the measured current in the system to be lower than expected.	Short to ground: 0 V > 3A	Wiring, VCV electrical system
P0004		X	X	Fuel Volume Regulator Control Circuit High	This error is set if there is short to ground, short to power, or an open load detected in the volume control circuit.	Short to plus: 12 V"	Wiring, VCV electrical system
P0069			X	MAP - Barometric Pressure Correlation	This error is set when the difference between Manifold Absolute Pressure (MAP) and Barometric Pressure (BP) is greater than the specified value for a predetermined period of time.	300 hPa < 2.5 sec	Wiring, MAP sensor, BP sensor (intergral part of PCM)
P006B	X		KO	MAP/EBP Correlation	This error is set when the difference between Manifold Absolute Pressure (MAP) and Exhaust Pressure (EP) is greater than the threshold for a predetermined period of time.	Engine off time > 5.0s. 300 hPa > 5.0 sec	Wiring, EP tube plugged, EP Sensor, MAP sensor, PCM
P008C			X	Fuel Cooler Pump Control Circuit / Open	This diagnostic will detect if the relay for the fuel cooling pump has an open load error.		
P008D			X	Fuel Cooler Pump Control Circuit Low	This diagnostic will detect if the relay for the fuel cooling pump has grounded.		
P008E			X	Fuel Cooler Pump Control Circuit High	This diagnostic will detect if the relay for the fuel cooling pump has shorted to positive voltage.		
P008F	X	X	X / KO	Engine Coolant Temperature / Fuel Temperature Correlation	This error is set when the difference between Engine Coolant Temperature (ECT) and Fuel Temperature (FTS) is either greater than or less than a specified value depending on current operating modes.	Engine off time > 3600 sec no block heater detected 20 deg C or -20deg < 1 sec	Wiring, ECT or TFU sensor, unknown type block heating device, PCM
P0087		X	X	Fuel Rail/System Pressure - Too Low	This error will be set if the fuel pressure in the rail is too low and the controller cannot regulate it to the setpoint.	20 % "overposition" of the PCV or VCV [% PWM] 5% deviation of the fuel rail pressure to the fuel rail pressure setpoint.	Low pressure system, wiring to VCV and PCV, FUP sensor, pump
P0088		X	X	Fuel Rail/System Pressure - Too High	This error will be set if the fuel pressure in the rail is too high and the controller cannot regulate it to the setpoint.	20 % "overposition" of the PCV [% PWM] 3% deviation of the fuel rail pressure to the fuel rail pressure setpoint	Low pressure system, wiring to VCV and PCV, FUP sensor, pump
P0090	X	X	X	Fuel Pressure Regulator Control Circuit	This error occurs if a short to power is found in the fuel pressure regulator (PCV) circuit.	For open load: Resistance > 500 Ohm	Wiring to PCV, PCV electrical system
P0091	X	X	X	Fuel Pressure Regulator Control Circuit Low	This error occurs if a short to ground or, during the KOEO self test, a current that is excessively high is found in the fuel pressure regulator (PCV) circuit.	Short to ground: 0 V > 3A	Wiring to PCV, PCV electrical system
P0092	X	X	X	Fuel Pressure Regulator Control Circuit High	This error occurs if an open circuit is found in the fuel pressure regulator (PCV) circuit.	Short to plus: 12 V	Wiring to PCV, PCV electrical system

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0096	X	X	X	Intake Air Temperature Sensor 2 Circuit Range/Performance	This error is set when the change in IAT2 is 5ºC less than specified over a predetermined period of time.	5 deg C ECT has to change from 40 deg C to 80 deg C to equal 1 drive cycle. 10 drive cycles required	Wiring, IAT2 sensor, PCM
P0097	X	X	X	Intake Air Temperature Sensor 2 Circuit Low Input	This error is set when the IAT2 sensor temperature output provides a value higher than a maximum probable temperature (lower voltage reading) for a predetermined period of time, which indicates a short to ground.	0.17v > 5sec.	Wiring, IAT2 sensor, PCM
P0098	X	X	X	Intake Air Temperature Sensor 2 Circuit High Input	This error is set when the IAT2 sensor temperature output provides a value lower than a minimum probable temperature (higher voltage reading) for a predetermined period of time, which indicates an open circuit or a short to power.	4.81v > 5sec.	Wiring, IAT2 sensor, PCM
P0101			X	Mass Air Flow A Circuit Range/Performance	This error occurs when the PCM detects a MAF sensor that is sending no signal.		Wiring, MAF assembly, PCM
P0102			X	Mass or Volume Air Flow A Circuit Low Input	This error occurs when the value of the mean period time per ms of the mass air flow sensor is less than a calibrateable value.		
P0103			X	Mass or Volume Air Flow A Circuit High Input	This error occurs when the value of the mean period time per ms of the mass air flow sensor is greater than a calibrateable value.		
P0104			X	Mass or Volume Air Flow A Circuit Intermittent/Erratic	This error occurs when the MAF senor change is too great over a predetermined period of time.		
P0106			X	Manifold Absolute Pressure/BARO Sensor Range/Performance	This diagnostic compares MAP and BP pessures at idle conditions, when they should be within a specified range. This error is set if the MAP sensor reading is above or below the thresholds for a predetermined period of time.	N > function of (ECT) Vehicle speed =0 ECT> 70 deg C 10% < EGRTP command <100% no DPF regen requested for > 10 seconds 300hPa or -300hPa >5sec	Wiring, MAP sensor, BP sensor (intergral part of PCM)
P0107			X	Manifold Absolute Pressure/ BARO Sensor Low Input	This diagnostic checks for a minimum intake manifold pressure, indicating an open circuit or a short to ground. This error occurs when the MAP signal voltage is lower than a specified value for a predetermined period of time.	0.15v > 5sec.	Wiring, MAP sensor, PCM
P0108			X	Manifold Absolute Pressure/ BARO Sensor High Input	This diagnostic checks for a maximum possible intake manifold pressure, indicating a short to power. This error sets when the MAP signal voltage is higher than a specified value for a predetermined amount of time.	4.90v > 5 sec.	Wiring, MAP sensor, PCM
P0112			X	Intake Air Temperature Sensor 1 Circuit Low Input	This error occurs if the input signal from the intake air temperature sensor falls below a minimum calibrateable threshold for a predetermined period of time.	0.15v > 5sec	
P0113			X	Intake Air Temperature Sensor 1 Circuit High Input	This error occurs if the input signal from the intake air temperature sensor rises above a maximum calibrateable threshold for a predetermined period of time.	4.6v > 5 sec	
P0114			X	Intake Air Temperature Sensor 1 Intermittent/Erratic	This error sets if the gradient of measured intake air temperature sensor outputs is outside of a threshold.		
P0117	X	X	X	Engine Coolant Temperature Sensor 1 Circuit Low Input	This error is set when the ECT sensor signal is lower than the minimum threshold for a predetermined period of time.	0.04v > 1sec.	Wiring, ECT sensor, PCM
P0118	X	X	X	Engine Coolant Temperature Sensor 1 Circuit High Input	This error sets when the ECT sensor signal is higher than a maximum threshold for a predetermined period of time.	4.67v > 1 sec.	Wiring, ECT sensor, PCM
P0128			X	Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature)	This error occurs when the ECT sensor signal indicates a coolant temperature lower than the operating temperature of the thermostat for an extended period of time.		
P0148	X	X	X	Fuel Delivery Error	This error sets when injections are detected although they are not commanded.	N/A	PCM, check injectors
P0149		X		Fuel Timing Error			PCM
P0168		X	X	Engine Fuel Temperature Too High	This error occurs when fuel temperature exceeds a predetermined temperature.		
P0181	X		X	Fuel Temperature Sensor A Circuit Range/Performance	This error occurs when the difference of the minimum and maximum fuel temperature exceeds a threshold.		
P0182	X	X	X	Fuel Temperature Sensor A Circuit Low Input	This error occurs when the FTS temperature output is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.07v > 5sec.	Wiring, MAP sensor, PCM

DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0183	X	X	X	Fuel Temperature Sensor A Circuit High Input	This error occurs when the FTS temperature output is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.	4.76v > 5 sec.	Wiring, MAP sensor, PCM
P0191	X	X	X	Fuel Rail Pressure Sensor A Circuit Range/Performance	This error occurs if the voltage signal of rail pressure sensor is not updated during a calibrated period of time.	checktime is 0.4 s maximum sensor voltage signal minus minimum voltage signal must be greater than 0.01 V	FUP sensor, HP system
P0192			X	Fuel Rail Pressure Sensor A Circuit Low Input	This error occurs if the voltage of the fuel pressure sensor falls below a calibratable threshold.	Low: < 0.20 V	Wiring to FUP sensor, FUP sensor
P0193	X			Fuel Rail Pressure Sensor A Circuit High Input	This error occurs if the voltage of the fuel pressure sensor exceeds a calibratable threshold.	High: >4.80 V	Wiring to FUP sensor, FUP sensor
P0194	X	X	X	Fuel Rail Pressure Sensor A Circuit Intermittent/Erratic	This error occurs if the rate of change of the measured fuel pressure exceeds a calibratable threshold.	max gradient: 40Mpa/10ms	Wiring to FUP sensor (especially for bad connections), FUP sensor, possibly HP system
P0196			X	Engine Oil Temperature Sensor Circuit Range/Performance	This error occurs if time required for EOT to warm up to 50º C is greater than the specified value or the EOT does not change by at least 2 degrees from the value stored in KAM, followed with the engine running off low idle.	EOT dependant 20minutes of engine running and EOT has not changed more than 5 deg C	Wiring, ECT sensor, PCM
P0197	X	X	X	Engine Oil Temperature Sensor Circuit Low Input	This error occurs if the EOT sensor output value is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.04v < 5sec.	Wiring, ECT sensor, PCM
P0198	X	X	X	Engine Oil Temperature Sensor Circuit High Input	This error occurs if the EOT sensor temperature output value is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.	4.76v < 5 sec.	Wiring, ECT sensor, PCM
P02CC		X	X	Cylinder 1 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02CD		X	X	Cylinder 1 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02CE		X	X	Cylinder 2 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02CF		X	X	Cylinder 2 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P02D0		X	X	Cylinder 3 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D1		X	X	Cylinder 3 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02D2		X	X	Cylinder 4 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02D3		X	X	Cylinder 4 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P02D4		X	X	Cylinder 5 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D5		X	X	Cylinder 5 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02D6		X	X	Cylinder 6 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02D7		X	X	Cylinder 6 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P02D8		X	X	Cylinder 7 Minimum Fuel Mass Adaptive Learning at Min Limit	This error sets if the fuel mass estimated by the adaptation feature falls outside of a calibrated threshold.		Injector
P02D9		X	X	Cylinder 7 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of the fuel pressure dependent calibration threshold.		
P02DA		X	X	Cylinder 8 Minimum Fuel Mass Adaptive Learning at Min Limit	This error occurs when the fuel mass estimated by the adaptation feature falls outside of a calibration threshold.		Injector
P02DB		X	X	Cylinder 8 Minimum Fuel Mass Adaptive Learning at Max Limit	This error occurs when the absolute fuel mass deviation of the available fuel mass estimate to the current set point falls outside of a fuel pressure dependent calibration threshold.		
P0201			X	Injector Circuit / Open - Cylinder 1	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0202			X	Injector Circuit / Open - Cylinder 2	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0203			X	Injector Circuit / Open - Cylinder 3	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0204			X	Injector Circuit / Open - Cylinder 4	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0205			X	Injector Circuit / Open - Cylinder 5	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0206			X	Injector Circuit / Open - Cylinder 6	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0207			X	Injector Circuit / Open - Cylinder 7	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0208			X	Injector Circuit / Open - Cylinder 8	This error occurs when the maximum current rise time is exceeded.		Wiring to injector, injector
P0216		X		Injector/Injection Timing Control Circuit	This error occurs if a post injection cycle is recognized without a main injection cycle.		PCM
P0219			X	Engine Overspeed Condition	This failure occurs when actual engine speed exceeds governed engine speed for a predetermined amount of time.	4000 rpm	
P0231			X	Fuel Pump Secondary Circuit Low			
P0232			X	Fuel Pump Secondary Circuit High			
P0234			X	Turbocharger/Supercharger Overboost Condition	This error occurs when the MAP sensor reading is above the threshold for a predetermined period of time.	4050hPa > 5 sec	System error, causes of overboost.
P0263		X	X	Cylinder 1 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.	Between 0.3 & 1.8	Injector, cylinder (compression)
P0266		X	X	Cylinder 2 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0269		X	X	Cylinder 3 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0272		X	X	Cylinder 4 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0275		X	X	Cylinder 5 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0278		X	X	Cylinder 6 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0281		X	X	Cylinder 7 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0284		X	X	Cylinder 8 Contribution/Balance	This error occurs when the cylinder balance controller output has exceeded its allowed minimum or maximum value.		Injector, cylinder (compression)
P0297			X	Vehicle Overspeed Condition	This error occurs when the vehicle speed exceeds the vehicle speed limiting.		
P0298			X	Engine Oil Overtemperature Condition	This error occurs when the time required for EOT to cool down to 110 deg. C is greater than the specified value.	time dependant on initial EOT temp could be >15minutes	System error, causes of EOT overtemperatue, sensor, PCM
P0300			X	Random Misfire Detected	This error occurs when cylinder deceleration is excessively large and persists long enough on more than one cylinder to set the code. Misfire monitor is calibrated to detect a complete loss of combustion in the cylinder; therefore, cylinder balance codes can be expected.		

DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0301			X	Cylinder 1 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0302			X	Cylinder 2 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0303			X	Cylinder 3 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0304			X	Cylinder 4 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0305			X	Cylinder 5 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0306			X	Cylinder 6 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0307			X	Cylinder 7 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0308			X	Cylinder 8 Misfire Detected	This error occurs if the case of a loss of combustion.		
P0336	X	X	X	Crankshaft Position Sensor A Circuit Range/Performance	This error occurs if the tooth count of the crankshaft trigger wheel reaches a threshold and the system is still not detecting sync between CKP and CMP circuits while a valid CMP sensor signal has been detected (intermittent CKP signal), when the number of missing or extra teeth exceed the threashold, or if spikes are detected in the CKP signal.	3 CAM edges <1sec	Wiring, CMP sensor, CKP sensor, PCM
P0337	X	X	X	Crankshaft Position Sensor A Circuit Low Input	This error occurs when a short or open fault in the CKP circuit is present causing the amplitude of the AC voltage to be excessive.	0.5v < 1sec	Wiring, CKP sensor, PCM
P0341	X	X	X	Camshaft Position Sensor A Circuit Range/Performance	This error occurs when either the number of CMP signals is too great to filter or the CMP signal is not properly aligned with the CKP signal.	Internal to the engine control module Once at key on < 1 sec	Wiring, CMP sensor, PCM
P0342	X	X	X	Camshaft Position Sensor A Circuit Low Input	This error occurs when the CMP signal is missing entirely.	Internal to the engine control module Once at key on < 1 sec	Wiring, CMP sensor, PCM
P0381			X	Glow Plug/Heater Indicator Circuit	The instrument cluster performs the diagnostic of the wait-to-start indicator once per driving cycle and transmits the result to the PCM. The PCM analyzes the message to check if the glow plug lamp circuit is operational.		
P040B	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit Range/Performance	This error occurs when the change in the EGR cooler inlet temperature is less than 40 deg C for a predetermined period of time.	Initial ECT < 30 deg C. ECT increase to > 80 deg C during drive cycle ECM on time > 3 seconds TEGR_IN has not changed more than 6 deg. C in 2 drive cycles	Wiring, Tegr_IN sensor, PCM
P040C	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit Low	This error occurs when the EGR cooler inlet sensor temperature output value is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.	0.07v > 5sec.	Wiring, Tegr_IN sensor, PCM
P040D	X	X	X	Exhaust Gas Recirculation Temperature Sensor A Circuit High	This error occurs when the EGR cooler inlet sensor temperature output value is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or short to power.	N > 650 rpm torque setpoint >53 N-m ECT > 60 deg C 4.65v >5sec	Wiring, Tegr_IN sensor, PCM
P0401			X	Exhaust Gas Recirculation Flow Insufficient Detected	This error is set when the estimated EGR percent is less than the minimum limit for the operating condition.	DPF regeneration not requested PTO not active Pressure ratio across EGR valve < 1 rate of change of engine speed < 0.05 rate of change of indicated torque setpoint < 0.05 600 rpm <engine speed< 800 rpm 45Nm <tqi_sp< 174Nm 12 sec to run test 2 low flow failures required to set fault (test runs 5 times per trip) 60 sec wait time between tests	EGR system error

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0402			X	Exhaust Gas Recirculation Flow Excessive Detected	This error occurs when the estimated EGR percent is greater than the maximum limit for the operating condition.	DPF regeneration not requested PTO not active Pressure ratio across EGR valve < 1 rate of change of engine speed < 0.05 rate of change of indicated torque setpoint < 0.05 600 rpm <engine speed< 800 rpm 45Nm <tqi_sp< 174Nm 12 sec to run test 2 low flow failures required to set fault (test runs 5 times per trip) 60 sec wait time between tests	EGR system error
P0403			X	Exhaust Gas Recirculation Control Circuit	This error occurs when the current through the EGR control circuit is outside of a predetermined range.	Internal to the engine control module	Wiring, EGR valve assembly, PCM
P0404			X	Exhaust Gas Recirculation Control Circuit Range/ Performance	This error is set when the deviation in EGR position is outside the threshold.	10 percent of full range error >5 sec	System error, EGR valve, PCM
P0405	X	X	X	Exhaust Gas Recirculation Sensor A Circuit Low	This error occurs when the EGR position voltage is below the specified voltage for a predetermined amount of time. This error can indicate either a short to ground or an open circuit.	0.24v <3 sec	Wiring, EGR valve assembley, PCM
P0406	X	X	X	Exhaust Gas Recirculation Sensor A Circuit High	This error occurs when the EGR position voltage is above the specified voltage, for maximum position given the current operation, for a predetermined amount of time. This error can indicate a short to power.	4.84v <3 sec	Wiring, EGR valve assembley, PCM
P041B	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit Range/Performance	This error occurs when the change in the EGR cooler outlet temperature is less than the threshold for a predetermined period of time.	Initial ECT < 30 deg C ECT increase to > 80 deg C during drive cycle ECM on time > 3 seconds TEGR_IN has not changed more than 6 deg. C in 2 drive cycles	Wiring, Tegr_OUT sensor, PCM
P041C	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit Low	This error occurs when the EGR cooler outlet sensor temperature output value is lower than a minimum probable temperature for a predetermined amount of time, indicating an open circuit or short to power.	0.15v > 5sec.	Wiring, Tegr_OUT sensor, PCM
P041D	X	X	X	Exhaust Gas Recirculation Temperature Sensor B Circuit High	This error occurs when the EGR cooler outlet sensor temperature output value is higher than a maximum probable temperature for a predetermined period of time, indicating a short to ground.	N > 650 rpm torque setpoint >53 N-m ECT > 60 deg C 4.95v > 5 sec	Wiring, Tegr_OUT sensor, PCM
P0420	REGEN			Catalyst System Efficiency Below Threshold	This error occurs if the observed exothermic reaction (a reaction that produces heat) during a regeneration event falls below a threshold for a predetermined period of time.		
P042E	X	X	X	EGR Control Stuck Open	This error occurs when the EGR set point is less than a specified threshold, the actual EGR position is greater than a specified threshold, and the EGR control limit is less than a specified limit.	EGR Position > 30 % EGR Position desired < 15% > 4 sec	System error, EGR valve, PCM
P042F	X	X	X	EGR Control Stuck Closed	This error occurs when the EGR set point is greater than a specified threshold, the actual EGR position is less than a specified threshold, and the EGR control limit is greater than a specified limit.	EGR Position < 15 % EGR Position desired > 30% > 4 sec	System error, EGR valve, PCM
P0472			X	Exhaust Pressure Sensor A Circuit Low	This error occurs when the EP signal voltage is lower than a specified value for a predetermined period of time.	0.15v < 3 sec	Wiring, EP sensor, PCM
P0473			X	Exhaust Pressure Sensor A Circuit High	This error occurs when the EP signal voltage is higher than a specified value for a predetermined amount of time.	4.90v < 3 sec	Wiring, EP sensor, PCM
P0480			X	Fan 1 Control Circuit			
P0488			X	EGR Throttle Position Control Range/Performance	This error occurs when there is an error in throttle position vs. desired position, high temperature condition and throttle not returned to open position when commanded, faulty input signal detected, or broken return spring detected.	THR_STATE is low > 3 sec	Wiring, EGRTP, PCM
P0494		X		Fan Speed Low			
P0495		X		Fan Speed High			
P0500			X	Vehicle Speed Sensor A	This error occurs when either a faulty signal or a missing signal occurs from the vehicle speed sensor circuit.		
P0503			X	Vehicle Speed Sensor A Intermittent/Erratic/High	This error occurs when an intermittent error is detected in the vehicl speed sensor circuit.		

DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0528			X	Fan Speed Sensor Circuit No Signal			
P0529			X	Fan Speed Sensor Circuit Intermittent			
P0544			1PC	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 1	This error occurs if the EGT1 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P0545			X	Exhaust Gas Temperature Sensor Circuit Low - Bank 1 Sensor 1	This error occurs when the EGT1 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P0546			X	Exhaust Gas Temperature Sensor Circuit High - Bank 1 Sensor 1	This error occurs when the EGT1 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		
P0560		X		System Voltage	This error occurs when battery voltage falls below a predetermined threshold.		
P0563			X	System Voltage High	This error occurs if the battery voltage increases above a predetermined threshold.		
P0565		X	X	Cruise Control ON Signal	This error occurs is the cruise control on switch is not pressed during the KOER or the cruise control on switch is stuck on during continuos operation.		
P0566		X	X	Cruise Control OFF Signal	This error occurs when the cruise control off switch is not depressed during the KOER self test or when the switch is stuck during continuous operation.		
P0567		X	X	Cruise Control RESUME Signal	This error occurs when the cruise control resume switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0568		X	X	Cruise Control SET Signal	This error occurs when the cruise control set switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0569		X	X	Cruise Control COAST Signal	This error occurs when the cruise control coast switch is not depressed during the KOER self test or is stuck during continuous operation.		
P0571		X		Brake Switch A Circuit	This error occurs when the brake switch is not depressed during the KOER self test.		
P0578			X	Cruise Control Multi-Function Input A Circuit Stuck	This error occurs if the voltage received by the PCM for the cruise control circuit is above the calibrated threshold.		
P0579			X	Cruise Control Multi-Function Input A Circuit Range/Performance	This error occurs when all cruise control circuit voltages are equal to zero.		
P060B	X	X	X	Internal Control Module A/D Processing Performance	This error occurs is the voltages for main controller and monitoring controller within the PCM are outside of a predetermined range.		ECU
P060C			X	Internal Control Module Monitoring Processor Performance	This error occurs if a fault occurs to the monitoring processor within the PCM.		Verify reprogramming files, reflash module, change ECU
P060D			X	Internal Control Module Accelerator Pedal Position Performance			Pedal, wiring to pedal, PCM
P0600	X			Serial Communication Link			PCM
P0602			1PC	Powertrain Control Module Program Error			VID Block program, PCM
P0603	X		1PC	Powertrain Control Module Keep Alive Memory (KAM) Error	This error occurs if a fault is detected in the keep alive memory circuit.	engine not longer running than 600 sec	PCM

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0604	X	X	X	Internal Control Module Read Only Memory (RAM) Error	This error occurs if a fault is detected in the read only memory circuit.		PCM
P0605	X	X	X	Internal Control Module Read Only Memory (ROM) Error	The checksum of the calibration ROM area is checked and compared against an expected value (calibration value) at startup.		Verify programming files, PCM
P061B	X	X	X	Internal Control Module Torque Calculation Performance	This error occurs if a fault is detected when monitoring the status of the injection of all cylinders compaired to the current engine speed.		PCM
P061C	X	X	X	Internal Control Module Engine RPM Performance	This error occurs when the engine RPM signal, derived from the CKP circuit, differs significantly from the expected engine RPM, developed by the PCM, for a predetermined amount of time		PCM, CRK sensor, CRK wiring
P062D	X	X		Fuel Injector Driver Circuit Performance Bank 1	This error occurs when the sum of the voltage signals for the main injection of all injectors on bank 1 or if the fuel injector driver circuit for bank 1 fails to initialize properly.	max = 229 V min = 93 V	Wiring to injectors, PCM
P062E	X	X		Fuel Injector Driver Circuit Performance Bank 2	This error occurs when the sum of the voltage signals for the main injection of all injectors on bank 2 or if the fuel injector driver circuit for bank 2 fails to initialize properly.	max = 229 V min = 93 V	Wiring to injectors, PCM
P0620			X	Generator Control Circuit			
P0625			X	Generator Field Terminal Circuit Low			
P0626			X	Generator Field Terminal Circuit High			
P0627			X	Fuel Pump A Control Circuit / Open	This error occurs if electrical errors from the fuel pump module result in an open circuit.		
P0628			X	Fuel Pump A Control Circuit Low	This error occurs if electrical errors from the fuel pump module result in a short to ground.		
P0629			X	Fuel Pump A Control Circuit High	This error occurs if electrical errors from the fuel pump module result in a short to power.		
P0642	X	X	X	Sensor Reference Voltage A Circuit Low	This error occurs when the sensor reference voltage falls below the minimum threshold.	Low: < 4.75V	Wiring, PCM
P0643	X	X	X	Sensor Reference Voltage A Circuit High	This error occurs when the sensor reference voltage falls above a maximum threshold.	High: >5.25 V	Wiring, PCM
P065B			X	Generator Control Circuit Range/Performance			
P0652	X	X	X	Sensor Reference Voltage B Circuit Low	This error occurs when the sensor reference voltage falls below a minimum threshold.	Low: < 4.75V	Wiring to sensors, PCM
P0653	X	X	X	Sensor Reference Voltage B Circuit High	This error occurs when the sensor reference votage is above a maximum threshold.	High: >5.25 V	Wiring to sensors, PCM
P0670	X	X	X	Glow Plug Control Module Control Circuit / Open	This error occurs if the glow plug enable circuit detects an open circuit, short to ground, or short to power.	Internal to Glow Plug Control Module (GPCM) > 5 sec	Wiring, GPCM, PCM
P0671	X	X	X	Cylinder 1 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0672	X	X	X	Cylinder 2 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0673	X	X	X	Cylinder 3 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0674	X	X	X	Cylinder 4 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0675	X	X	X	Cylinder 5 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM

DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P0676	X	X	X	Cylinder 6 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0677	X	X	X	Cylinder 7 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0678	X	X	X	Cylinder 8 Glow Plug Circuit	This error occurs if the current for an individual glowplug is either lower than the minimum current threshold or higher than the maximum current threshold.	An open is a current level less than 4 amps and a shorted current level is above 60 amps. Glow Plug on time > 8.5 sec	Wiring, Glow Plug, GPCM
P0684	X	X	X	Glow Plug Control Module to PCM Communication Circuit Range/Performance	This error occurs when the pass/fail status information signal, sent by the GPCM to the PCM, is consistantly high, consistantly low, or the period of the signal is out of range.	GP active >5 sec	Wiring, GPCM, PCM
P0691			X	Fan 1 Control Circuit Low			
P0692			X	Fan 1 Control Circuit High			
P0703		X		Brake Switch B Input Circuit	This error occurs when the brake switch is not activated during the KOER self test.		
P1000	RESET			OBD Systems Readiness Test Not Complete	This error occurs when all other DTC's have been erased from the system. This error will subside when all OBD monitors have been completed.		
P1102			X	Mass Air Flow Sensor In Range But Lower Than Expected	This error occurs when the measured value of mass air flow is lower than a threshold value for a predetermined period of time.	0%< EGR Position < 50% Engine speed >700 rpm < 2400 rpm based on a table > 30sec	Wiring, MAF assembly, PCM
P1103			X	Mass Air Flow Sensor In Range But Higher Than Expected	This error occurs when the measured value of mass air flow is higher than a threshold value for a predetermined period of time.	0%< EGR Position < 50% Engine speed >700 rpm < 2400 rpm based on a table > 30sec	Wiring, MAF assembly, PCM
P115A			X	Low Fuel Level - Forced Limited Power	This error occurs when the PCM recieves a signal indicating that the vehicle is critically low on fuel.		
P117B			X	Exhaust Gas Temperature Sensor Correlation	This error occurs when the three exhaust temperature sensor readings are not within a specified temperature range when compared to one another.		
P117F		X	X	Fuel Pressure Regulator Excessive Variation	This error occurs when any of the fuel pressure corrections either become less than a minimum threshold or more than a maximum threshold.		Low pressure fuel system, injector leakage
P1184		X		Engine Oil Temperature Sensor Out Of Self Test Range	This error occurs when the KOER self test is attempted but the engine has not reached an operating temperature of 60º C.	EOT < 60 >205deg C	NA
P120F			X	Fuel Pressure Regulator Excessive Variation	This error occurs when the difference between actual rail pressure and the PCM's calculated setpoint is large, and the actual fuel pressure crosses the setpoint too frequently.		Wiring to FUP sensor, FUP sensor, low pressure fuel system
P127A	X	X	X	Aborted KOER - Fuel Pressure Failure	This error occurs when fuel pressure does not rise sufficiently during the KOER self test.	Cannot achieve or return to 53 FUP_SP. Cannot achieve 139MPa	NA
P132A	X	X	X	Turbocharger Boost Control A Electrical	This error occurs if the turbocharger cannot perform a sweep/learn of the min/max position.		
P132B	X	X	X	Turbocharger/Supercharger Boost Control A Performance	This error occurs if a fault is detected within the turbocharger actuator.	Internal to the turbocharger control module	Wiring, SRA module,PCM
P132C	X	X	X	Turbocharger/Supercharger Boost Control A Voltage	This error occurs when the voltage to the turbocharger actuator is below the threshold for a predetermined period of time.	Internal to the turbocharger control module	Wiring, SRA module,PCM
P1335	X	X	X	EGR Position Sensor Minimum/ Maximum Stop Performance	This error occurs when voltage of the EGR valve falls below the minimum threshold.	1.3v >2.5sec	Wiring, EGR valve assembly,PCM
P1336	X	X	X	Crankshaft/Camshaft Sensor Range/Performance	This error occurs when the reference gap of the crankshaft trigger wheel is not detected at the correct position.	Internal to the engine control module	System error, electrical noise,…

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P138D	X	X	X	Turbocharger Boost Control A Temperature Too High	This error occurs when the internal operating temperature of the actuator exceeds the threshold for a predetermined period of time.	150 deg C	
P1397		X		System Voltage Out Of Self Test Range	This error occurs if the KOER self test is attempted but the vehicle battery voltage is too low.	< 9.0v prior to KOER start	NA
P1408		X		Exhaust Gas Recirculation Flow Out Of Self Test Range	This error occurs is the EGR valve position is not wihin test limits when the EGR valve is commanded open during the KOER self test.	> 1500hPa and <1500hPa (note numbers are valid only until D00 is released where these need to be in gauge pressure)	NA
P1501		X		Vehicle Speed Sensor Out Of Self Test Range	This error occurs if the KOER self test is attampted while vehicle is moving.	>5MPH (This entry condition condition is primarily used for the Manual Transmission applications that do not have a “in gear” message.)	NA
P1531		X		Invalid Test - Accelerator Pedal Movement	This error occurs when the accelerator pedal moves during the KOER self test.	>10%	NA
P1536		X		Parking Brake Switch Circuit	This error occurs if the parking brake switch is not active during the KOER self test.		
P1551	X	X		Injector Circuit Range/ Performance - Cylinder 1	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1552	X	X		Injector Circuit Range/ Performance - Cylinder 2	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1553	X	X		Injector Circuit Range/ Performance - Cylinder 3	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1554	X	X		Injector Circuit Range/ Performance - Cylinder 4	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1555	X	X		Injector Circuit Range/ Performance - Cylinder 5	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1556	X	X		Injector Circuit Range/ Performance - Cylinder 6	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1557	X	X		Injector Circuit Range/ Performance - Cylinder 7	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1558	X	X		Injector Circuit Range/ Performance - Cylinder 8	This error occurs when the minimum current rise time is outside the valid range.	max = 210 V min = 62 V	Wiring to injectors, injectors, HP system, coolant temp sensor
P1586	X	X	X	Electronic Throttle to PCM Communication Error	This error occurs when the digital feedback communication line of the EGR throttle plate is either unreadable by the PCM or missing.		
P1639		X	X	Vehicle ID Block Corrupted, Not Programmed	This error occurs when the VID block data are not programmed or programmed incorrectly.		
P1703		X		Brake Switch Out Of Self Test Range	This error occurs during the KOER self test if the break pedal switch is stuck in the closed position or the break pedal is depressed twice.		
P1725	X	X	X	Insufficient Engine Speed Increase During Self Test	This error occurs if the engine RPM drops below a minimum threshold during the KOER self test.	< 500RPM	NA
P1726		X		Insufficient Engine Speed Decrease During Self Test	This error occurs if the engine RPM increases above a maximum threshold during the KOER self test.	>1600 RPM	NA
P179A	X	X	X	CAN ECM/Turbocharger Boost Control & Actuator Circuit Malfunction	This error occurs is the CAN data communication is interrupted between the PCM and the turbocharger actuator.		
P2002	REGEN			Particulate Trap Efficiency Below Threshold	This error occurs if an expected pressure drop through the DPF is lower than the specified value following a regeneration cycle (based on the concept of normalized pressure differential).		
P2031			1PT	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 2	This error occurs if the EGT2 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P2032			X	Exhaust Gas Temperature Sensor Circuit Low Bank 1 Sensor 2	This error occurs when the EGT2 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P2033			X	Exhaust Gas Temperature Sensor Circuit High Bank 1 Sensor 2	This error occurs when the EGT2 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		

DIAGNOSTIC CODES

O - Self Test - Key On Engine Off
R - Key On Engine Running
C - Continuous Operation
REGEN - Test Follows a REGEN CYCLE
SHUT DOWN - Test Follows Key Off
KO - Test Operates at Key On
1PC - Once Per Cycle

DATA Color Code	
	MIL For Both F250/F350 and F450/F550
	MIL For Only F250/F350
	MIL For F250/F350 and Wrench for F450/F550
	Wrench for Both F250/F350 and F450/F550
	No MIL or Wrench Light

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P2080			1PC	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 1	This error occurs if the EGT1 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2081			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 1	This error occurs if the temperature in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2084			X	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 2	This error occurs if the EGT2 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		
P2085			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 2	This error occurs if an intermittent signal from the exhaust gas temperature sensor is detected.		
P2122			X	Throttle/Pedal Position Sensor/ Switch D Circuit Low Input			
P2123			X	Throttle/Pedal Position Sensor/ Switch D Circuit High Input			
P2127			X	Throttle/Pedal Position Sensor/ Switch E Circuit Low Input			
P2128			X	Throttle/Pedal Position Sensor/ Switch E Circuit High Input			
P2138			X	Throttle/Pedal Position Sensor/ Switch D / E Voltage Correlation			
P2199	X	X	X	Intake Air Temperature 1/2 Correlation	This error occurs when the difference between IAT2 and IAT1 is greater than a specified value for a predetermined period of time.	>20 deg C 8 minutes	Wiring, IAT or IAT2 sensor, PCM
P2228	X			Barometric Pressure Circuit Low Input	This error occurs when the voltage signal from the barometric pressure circuit falls below a minimum threshold.	Low: < 2.22 V	PCM
P2229	X			Barometric Pressure Circuit High Input	This error occurs when the voltage signal from the barometric pressure circuit rises above a maximum threshold.	High: >4.36 V	PCM
P2230	X			Barometric Pressure Circuit Intermittent			PCM
P2262			X	Turbocharger/Supercharger Boost Pressure Not Detected - Mechanical	This error occurs if the MAP sensor readings are below a calibrated value for a predetermined amount of time.	engine speed and torque based table >30 sec	System error, CAC hose, MAP sensor plugged,…
P2263			X	Turbocharger/Supercharger Boost System Performance	This error occurs when the difference between the gage exhaust pressur and the set point is less than the minimum threshold or greater than the maximum threshold for a predetermined period of time.	Engine speed > 550 rpm Torque set point > 50 N-m, ECT > 81 deg C IAT > -50 deg C No DPF regeneration request EP setpoint is stable Based on a table on N and TQI >5sec	System error
P2269			X	Water in Fuel Condition	This error occurs when water is detected in the HFCM.		
P2289	SHUTDOWN			Injector Control Pressure Too High - Engine Off	This error occurs if excessive fuel pressure is present after a predetermined period of time following key off.	0.4 sec after engine switch-off fuel rail pressure (FUP) must be lower than 10MPa.	FUP sensor, wiring to FUP sensor, HP fuel system
P2291		X	X	Injector Control Pressure Too Low - Engine Cranking	This error occurs when enough injection control pressure to start the vehicle cannot be achieved during cranking.		Low pressure fuel system, HP fuel system, FUP sensor and wiring to sensor, battery voltage (crank speed)
P242A			1PC	Exhaust Gas Temperature Sensor Circuit Bank 1 Sensor 3	This error occurs if the EGT3 temperature signal of the exhaust system does not rise sufficiently immediately after a cold-start following an 8-hour soak.		
P242B			1PC	Exhaust Gas Temperature Sensor Circuit Range/ Performance Bank 1 Sensor 3	This error occurs if the EGT3 temperature sensor signal in the exhaust at key on, following an 8-hour soak, is significantly different than ambient temperature.		

DIAGNOSTIC CODES

DTC	How Set			Code Description	Brief Description	Software Parameters Required to Set Code	Service Instructions / Part Replaced
	O	R	C				
P242C			X	Exhaust Gas Temperature Sensor Circuit Low Bank 1 Sensor 3	This error occurs when the EGT3 sensor temperature signal is higher (lower voltage signal) than a maximum probable temperature, indicating a short to ground.		
P242D			X	Exhaust Gas Temperature Sensor Circuit High Bank 1 Sensor 3	This error occurs when the EGT3 sensor temperature signal is lower (higher voltage signal) than a minimum probable temperature, indicating an open circuit or a short to power.		
P242E			X	Exhaust Gas Temperature Sensor Circuit Intermittent Bank 1 Sensor 3	This error occurs if an intermittent signal from the exhaust gas temperature sensor is detected.		
P242F	REGEN			Diesel Particulate Filter Restriction - Ash Accumulation	This error occurs if excessively high exhaust pressures are detected after a regen cycle.		
P244A	REGEN			Diesel Particulate Filter Differential Pressure Too Low	This error occurs if an expected pressure drop through the DPF is lower than the specified value following a regeneration cycle (based on the concept of observed pressure differential).		
P244C	X	X	X	Exhaust Temperature too low for Particulate Filter Regeneration	This error occurs if the exhaust temperature is too low to perform a regen cycle of the diesel particulate filter.		
P244D	REGEN			Exhaust Temperature too high for Particulate Filter Regeneration	This error occurs if exhaust temperatures are too high to perform a regen cycle of the diesel particulate filter.		
P2453	X		X / KO	Diesel Particulate Filter Differential Pressure Sensor Circuit Range/Performance	This error occurs if the differential pressure of the diesel particulate filter reads a constant value while the engine is running.		
P2454			X	Diesel Particulate Filter Differential Pressure Sensor Circuit Low	This error occurs if a short to ground is detected in the diesel particulate filter differential pressure sensor circuit.		
P2455			X	Diesel Particulate Filter Differential Pressure Sensor Circuit High	This error occurs if a short to power occurs in the diesel particulate filter differential pressure sensor circuit.		
P2456			X	Diesel Particulate Filter Differential Pressure Sensor Circuit Intermittent/Erratic	This error occurs if the signal from the diesel particulate filter differential pressure sensor to the PCM is unreadable.		
P2457		X	X	Exhaust Gas Recirculation Cooler System Performance	This error occurs if the EGR cooler temperature sensor reading is above a maximum threshold for a predetermined period of time.	EGR Position >= 0 600 rpm<Engine speed < 1300 rpm 50 N-m< Torque set point< 400 N-m >165 deg C >20sec	System error, TEGR_OUT sensor,…
P2458			X	Diesel Particulate Filter Regeneration Duration			
P2459			X	Diesel Particulate Filter Regeneration Frequency			
P2545		X		Torque Management Request Input Signal A Range/Performance			CAN wiring, change ECU
P2563	X	X	X	Turbocharger Boost Control Position Sensor A Circuit Range/Performance	This error occurs when the difference between the turbocharger actuator commanded duty cycle and the feed forward commanded duty cycle is less than the threshold value for the given engine speed and engine load for a predetermined period of time.	600 rpm <Engine speed< 1000 rpm Torque set point > 50 N-m ECT > 70 deg C IAT > -50 deg C No DPF regeneration request EP setpoint is stable -60 % of desired 7.5 sec	System error
P2610			X	ECM/PCM Internal Engine Off Timer Performance	This error occurs when the engine off timer does not correlate to the PCM's internal timer (compared while the engine is running), if the engine off time does not correspond with the measured ECT temperature variation between the last engine stop and the next engine start, or when the engine off timer is defective.		
U0073	X	X	X	Control Module Communication Bus A Off	This error occurs if a fault in the CAN communication is detected.		
U0101	X	X	X	Lost Communication with TCM	This error occurs is the CAN data communication is interrupted between the PCM and the TCM.		



6.4L Power Stroke® Diesel Engine

© 2007 International Truck and Engine Corporation

Printed in U.S.A. FCS-14853-MISC



6.7L POWER STROKE® DIESEL ENGINE





2011 "F" SERIES SUPER DUTY

• Engine Description • Systems Overview • Component Location •

REPAIR TECHNIQUES

Appropriate service methods and procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This manual provides general directions for performing service with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedure, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that they compromise neither their personal safety nor the vehicle integrity by their choice of methods, tools or parts.

NOTE, NOTICE, CAUTION AND WARNING

As you read through this manual, you may come across a **NOTE**, **NOTICE**, **CAUTION** or **WARNING**. Each one is there for a specific purpose. A **NOTE** calls attention to unique, additional or essential information related to the subject procedure. A **NOTICE** identifies a hazard that could damage the vehicle or property. A **CAUTION** identifies a hazard that could result in minor personal injury to yourself or others. A **WARNING** identifies a hazard that could result in severe personal injury or death to yourself or others. Some general **WARNINGS** that you should follow when you work on a vehicle are listed below.

- **ALWAYS WEAR SAFETY GLASSES FOR EYE PROTECTION.**
- **KEEP SOLVENTS AWAY FROM IGNITION SOURCES. SOLVENTS MAY BE FLAMMABLE AND COULD IGNITE OR EXPLODE IF NOT HANDLED CORRECTLY.**
- **USE SAFETY STANDS WHENEVER A PROCEDURE REQUIRES YOU TO BE UNDER THE VEHICLE.**
- **MAKE SURE THAT THE IGNITION SWITCH IS ALWAYS IN THE OFF POSITION, UNLESS OTHERWISE REQUIRED BY THE PROCEDURE.**
- **SET THE PARKING BRAKE WHEN WORKING ON THE VEHICLE. IF YOU HAVE AN AUTOMATIC TRANSMISSION, SET IN PARK UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. IF YOU HAVE A MANUAL TRANSMISSION, IT SHOULD BE IN REVERSE (ENGINE OFF) OR NEUTRAL (ENGINE ON) UNLESS INSTRUCTED OTHERWISE FOR A SPECIFIC OPERATION. PLACE WOOD BLOCKS (4" X 4" OR LARGER) OR WHEEL CHOCKS AGAINST THE FRONT AND REAR SURFACES OF THE TIRES TO HELP PREVENT THE VEHICLE FROM MOVING.**
- **OPERATE THE ENGINE ONLY IN A WELL-VENTILATED AREA TO AVOID THE DANGER OF CARBON MONOXIDE POISONING.**
- **KEEP YOURSELF AND YOUR CLOTHING AWAY FROM MOVING PARTS WHEN THE ENGINE IS RUNNING, ESPECIALLY THE DRIVE BELTS.**
- **TO PREVENT SERIOUS BURNS, AVOID CONTACT WITH HOT METAL PARTS SUCH AS THE RADIATOR, EXHAUST MANIFOLD, TAIL PIPE, THREE-WAY CATALYTIC CONVERTER AND MUFFLER.**
- **DO NOT SMOKE WHILE WORKING ON A VEHICLE.**
- **TO AVOID INJURY, ALWAYS REMOVE RINGS, WATCHES, LOOSE HANGING JEWELRY AND LOOSE CLOTHING BEFORE BEGINNING TO WORK ON A VEHICLE.**
- **WHEN IT IS NECESSARY TO WORK UNDER THE HOOD, KEEP HANDS AND OTHER OBJECTS CLEAR OF THE COOLING FAN BLADES!**

TOOLS

Commercially available hand tools and equipment are used along with Essential Special Service Tools (ESST) and Rotunda equipment. Power tools have become the acceptable industry standard and are used for disassembly only where applicable, unless specified otherwise in the Workshop Manual. The only exception to this policy is installing wheels in conjunction with the use of torque sticks, when possible.

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

Publication Ordering Information

To order additional copies of this publication go to the Motorcraft® web site at www.motorcraftservice.com.

Select "Technical Training," the "Diesel Engine Performance" category, course code "51S13T0," FCS number "FSC-21079-MISC."

All right reserved. Reproduction by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system or translation in whole or part is not permitted without written authorization from Ford Motor Company.

Copyright © 2010, Ford Motor Company

6.7L POWER STROKE® DIESEL

TABLE OF CONTENTS

6.7L POWER STROKE® DIESEL OVERVIEW 6
Engine Features 6
2011 6.7L Power Stroke® Diesel Horsepower and Torque Ratings 6
6.7L Power Stroke® Diesel Specifications 7

COMPONENT LOCATION 9

UPPER ENGINE COMPONENTS 15

LOWER ENGINE COMPONENTS 17

COOLING SYSTEM 23
Primary Cooling System 24
Powertrain Secondary Cooling System 27

LUBRICATION SYSTEM 33
Lubrication System Oil Flow 33
Lubrication System Components 34

AIR MANAGEMENT SYSTEM 37
Air Inlet Components 38
Glow Plug System 42
DualBoost Variable Geometry Turbocharger (VGT) 43
Exhaust Gas Recirculation (EGR) 46

FUEL SYSTEM 51
Fuel Supply System 52
Fuel Management System 56

ELECTRICAL COMPONENTS 63
Pressure Sensors 64
Temperature Sensors 66
Position Sensors 70
Miscellaneous Sensors 71
Outputs 72

EXHAUST SYSTEM 77
Regeneration Process 81
Selective Catalyst Reduction (SCR) System Operation 86

SPECIAL SERVICE TOOLS 87

6.7L POWER STROKE
B20 TURBO DIESEL



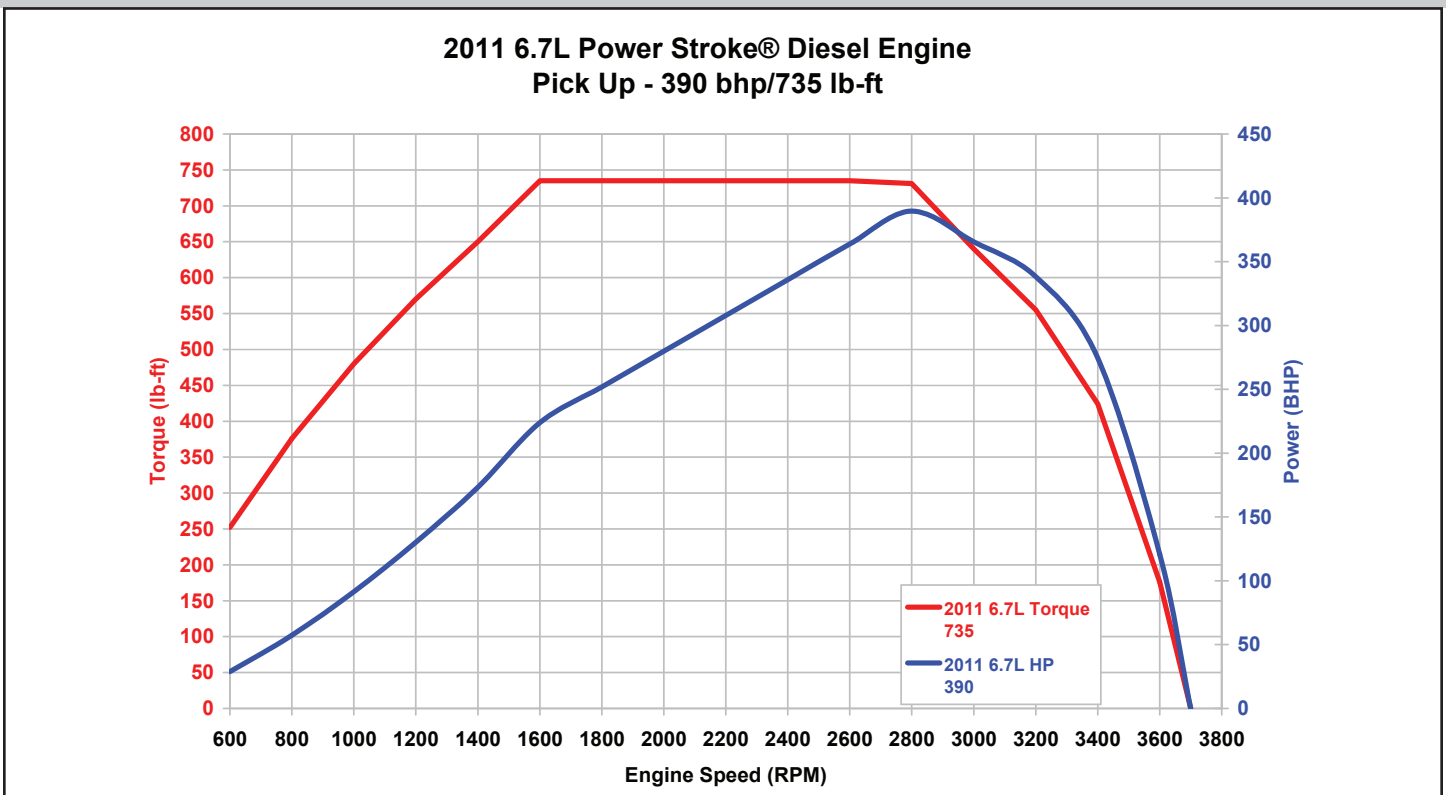
Direct Injection Turbocharged Diesel Engine

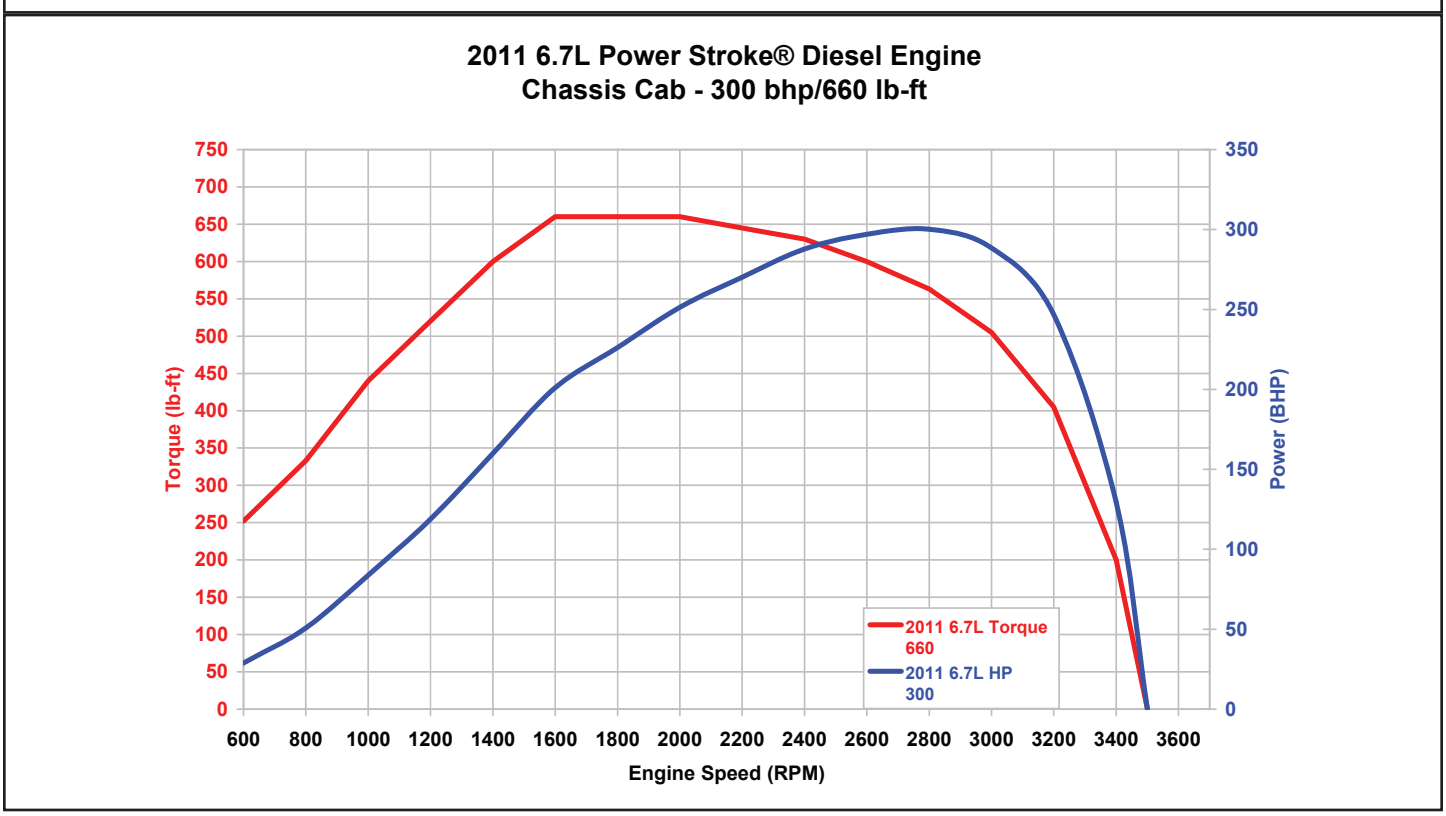
6.7L POWER STROKE® DIESEL OVERVIEW

Engine Features

- The 6.7L Power Stroke® diesel has been designed to meet the tougher emissions standards set by the government.
- The 6.7L Power Stroke® diesel has been designed to meet the customer's expectations of high horsepower and torque over a wide RPM range.
- Meeting the more stringent customer and regulatory demands are accomplished in part by a high pressure common rail fuel system, DualBoost turbocharger system, 4 valves per cylinder, and a Selective Catalyst Reduction (SCR) system.

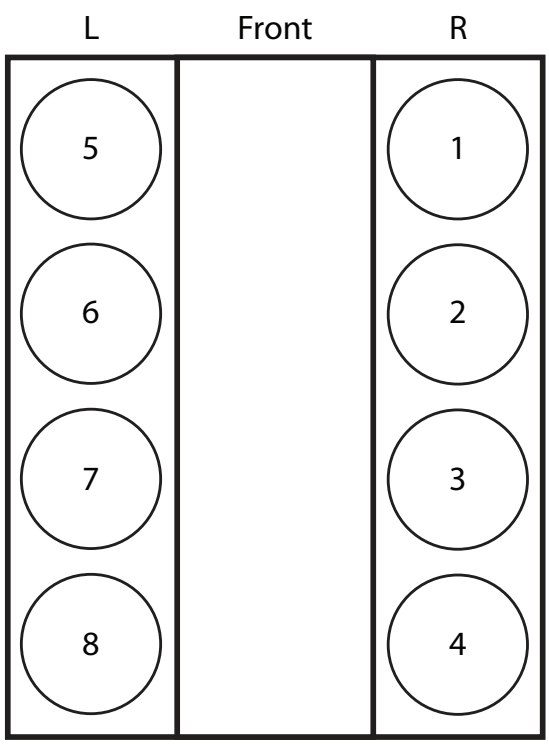
2011 6.7L Power Stroke® Diesel Horsepower and Torque Ratings





OVERVIEW

6.7L Power Stroke® Diesel Specifications		
Engine Type	Diesel, 4-Cycle	
Configuration	4 OHV/1 Cam-in-Crankcase-V8	
Displacement	6.7L (409 cu. in.)	
Bore and Stroke	99x108 mm (3.90 x 4.25 in)	
Compression Ratio	16.2:1	
Induction	DualBoost Variable Geometry Turbocharger	
	Chassis Cab	Pick Up
Rated Power @ RPM	300 hp @ 2800 rpm	390 hp @ 2,800 rpm
Peak Torque @ RPM	660 ft.-lb. @ 1600 rpm	735 ft.-lb. @ 1,600 rpm
Engine Rotation, Facing Flywheel	Counterclockwise	
Combustion System	High Pressure Common Rail Direct Injection	
Total Engine Weight (auto with oil)	499kg (1100 lbs)	
Primary Cooling System Capacity	27.8L (29.4 qts.)	
Powertrain Secondary Cooling System Capacity	11.1L (11.7 qts.)	
Lube System Capacity (including filter)	12.3L (13 qts.)	
Firing Order	1-3-7-2-6-5-4-8	

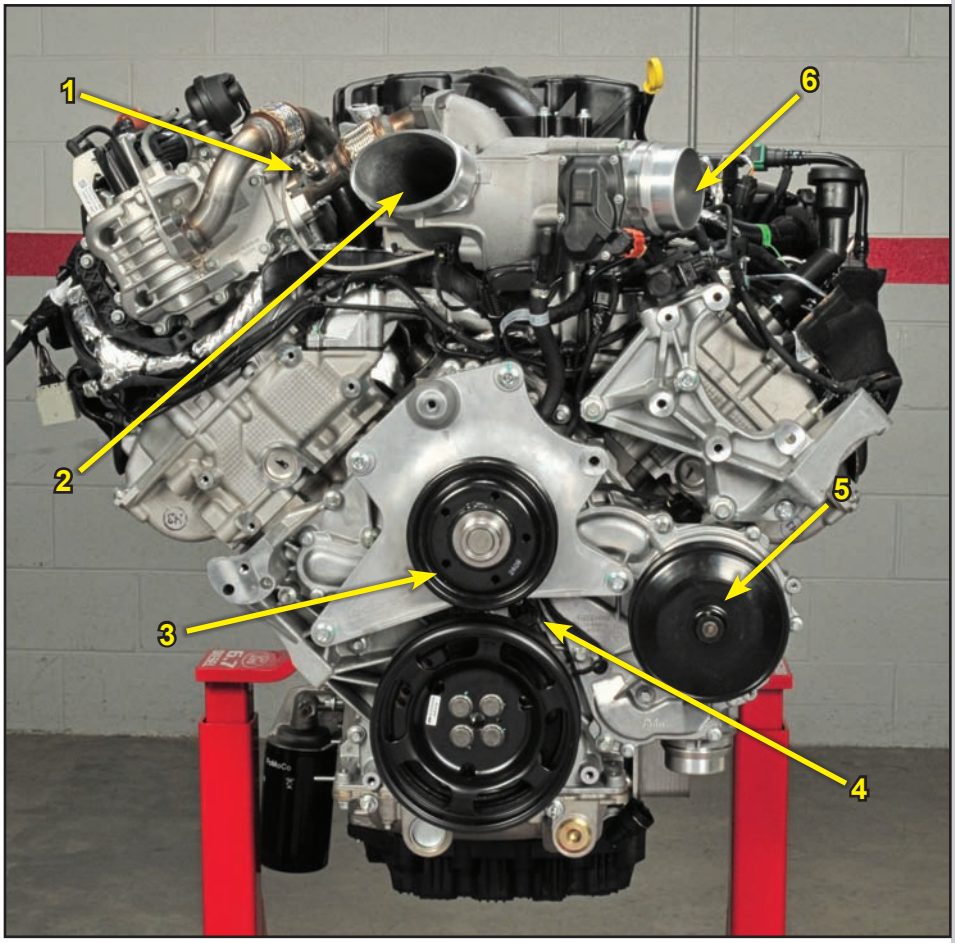


Specifications

The 6.7L Power Stroke® diesel cylinders are numbered from the front. The right side are cylinders 1, 2, 3, and 4 and the left side are cylinders 5, 6, 7, and 8.

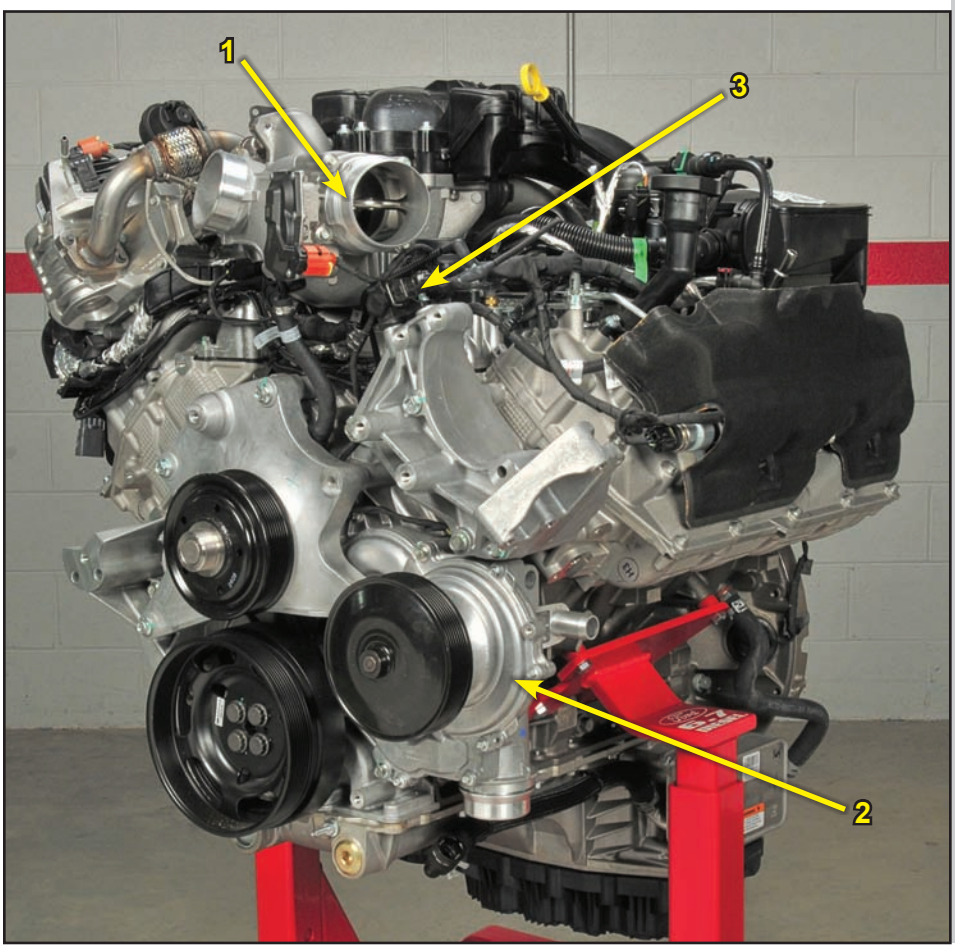
NOTES

COMPONENT LOCATION



Front of Engine

1. EGR Temperature (EGRT) sensor
2. Air inlet from air filter
3. Front Engine Accessory Drive (FEAD) idler pulley
4. Camshaft Position (CMP) sensor
5. Primary coolant pump
6. Air inlet from Charge Air Cooler (CAC)



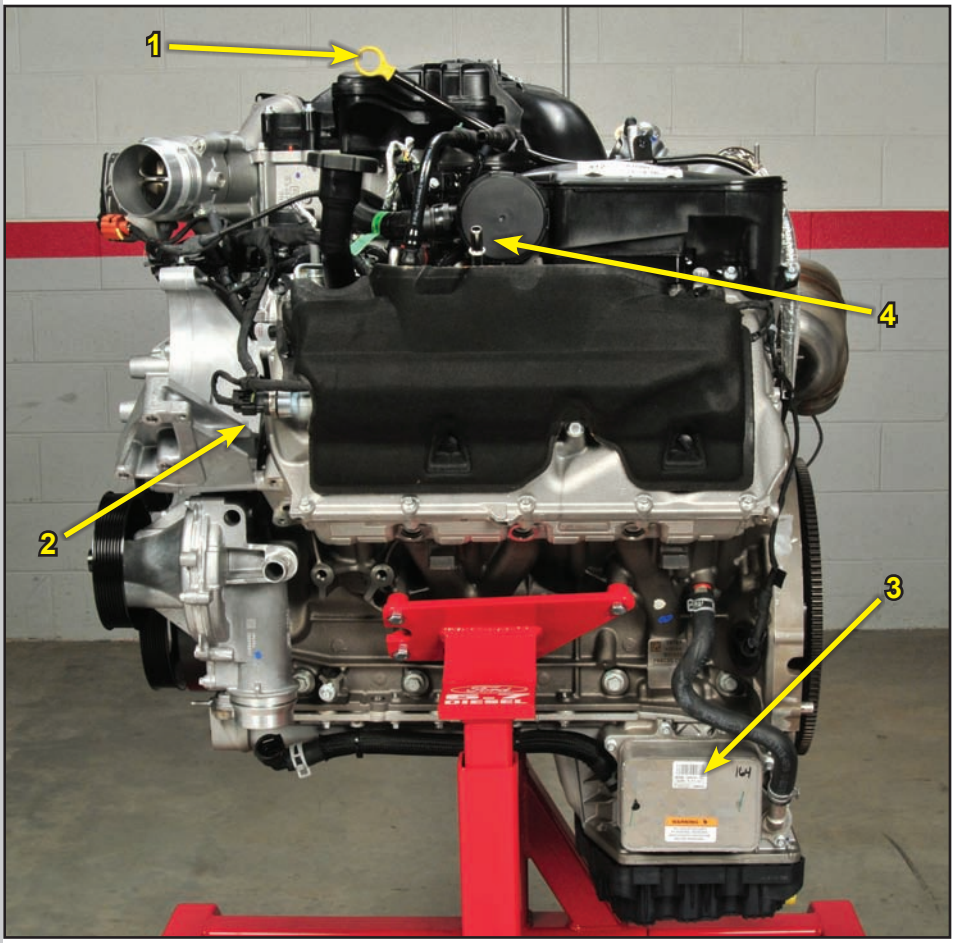
Left Front of Engine

1. Intake throttle body
2. Primary coolant pump
3. Wastegate control solenoid

COMPONENT LOCATIONS

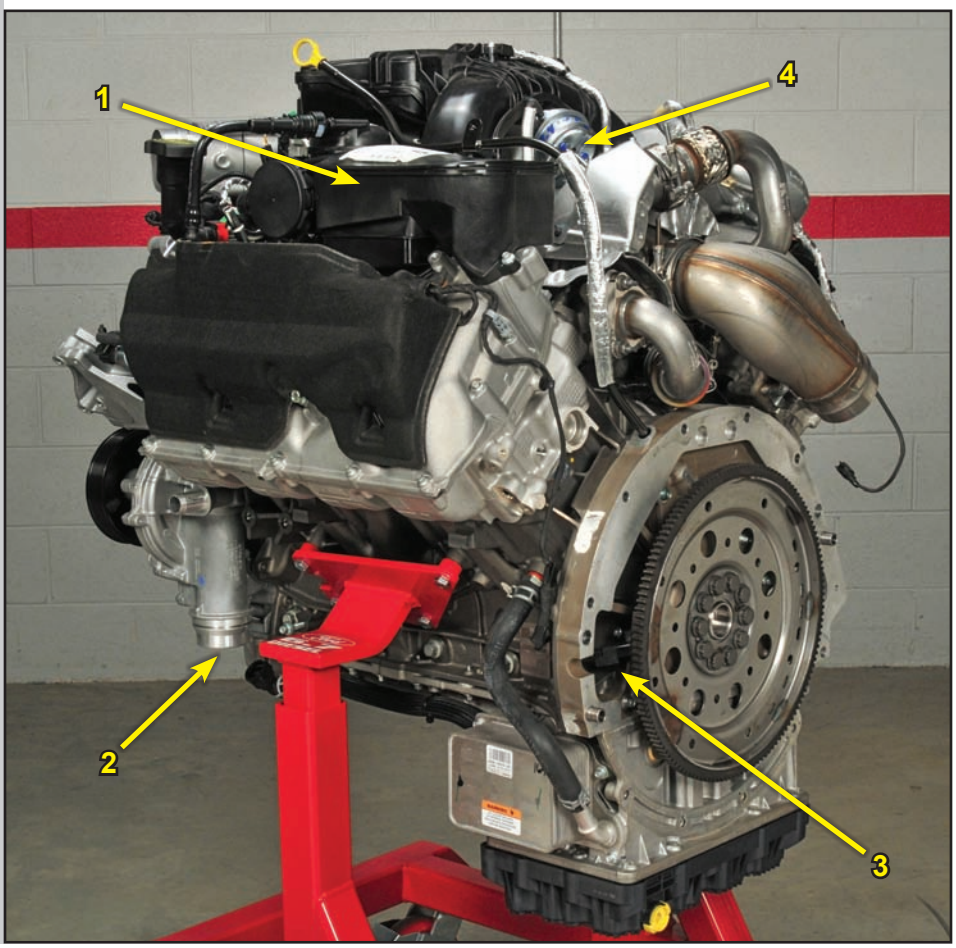
Left of Engine

1. Oil level indicator
2. Fuel Rail Pressure (FRP) sensor
3. Engine oil cooler
4. Fuel return line

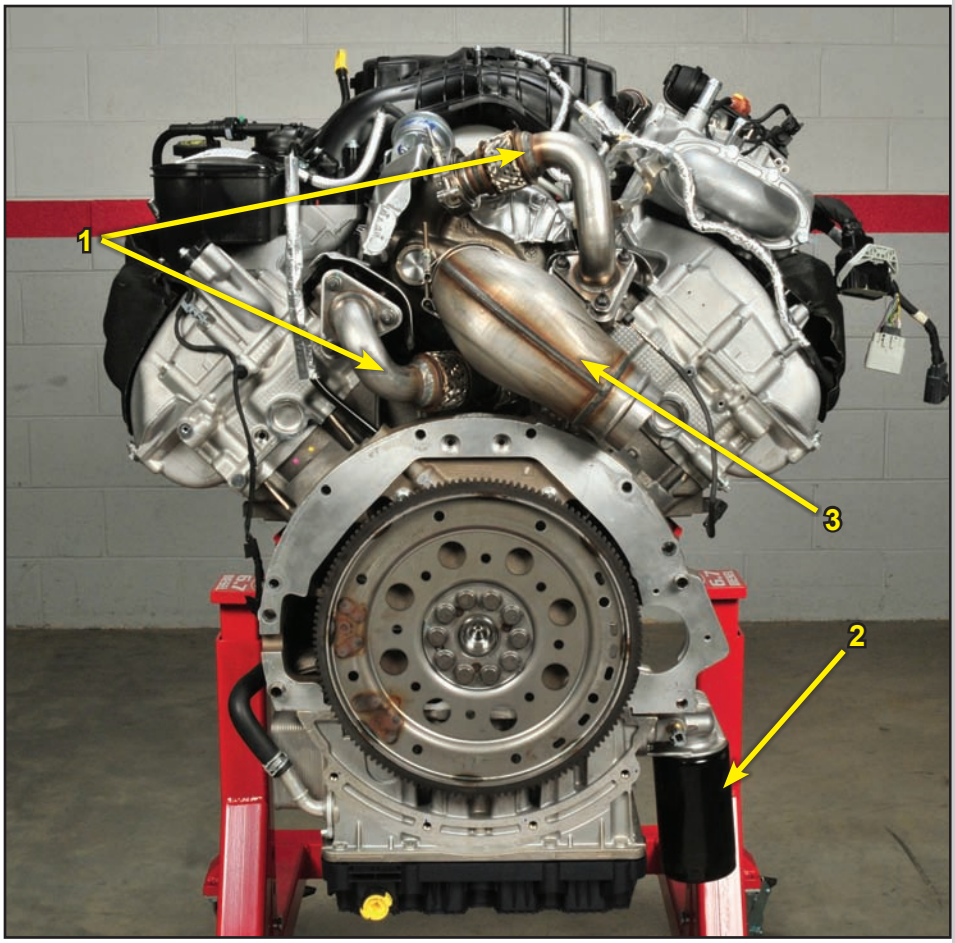


Left Rear of Engine

1. Crankcase vent oil separator
2. Primary coolant pump inlet
3. Crankshaft Position (CKP) sensor
4. Wastegate actuator



COMPONENT LOCATIONS



Rear of Engine

1. Turbocharger inlet pipes
2. Spin-on oil filter
3. Turbo outlet pipe (Cobra head)



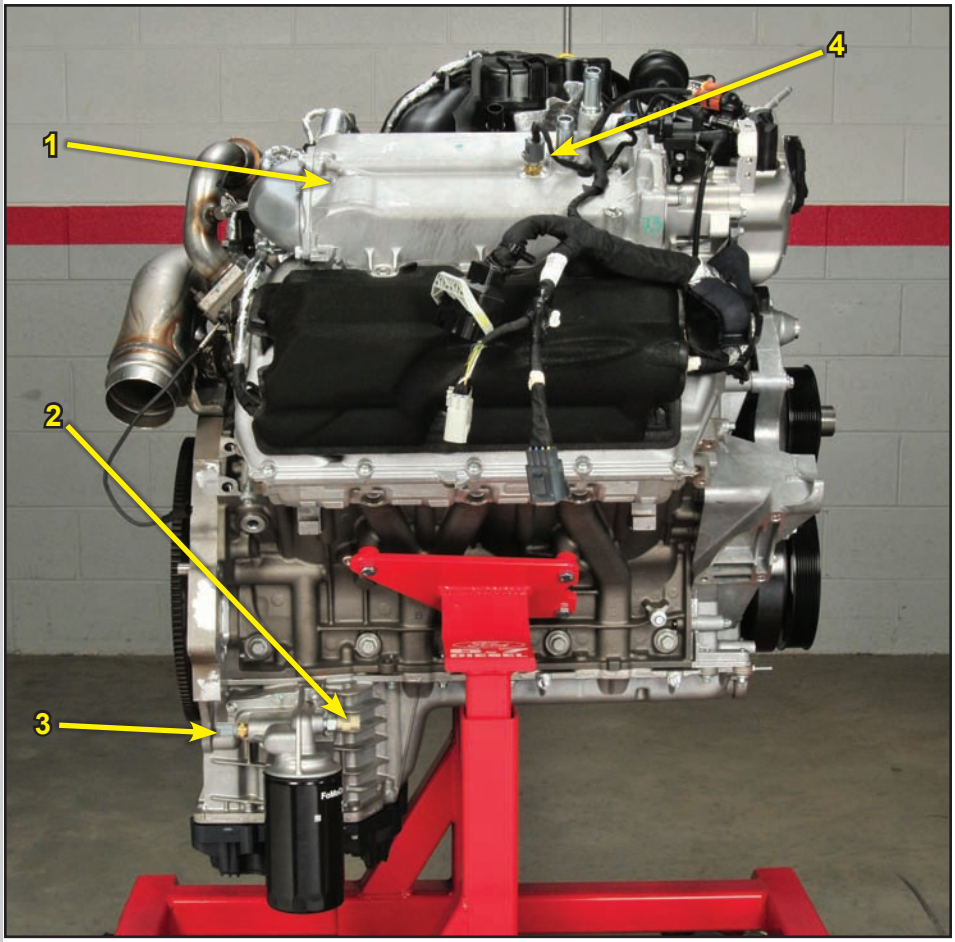
Right Rear of Engine

1. Exhaust Pressure (EP) sensor
2. Variable Geometry Turbocharger (VGT) actuator
3. Block heater

COMPONENT LOCATIONS

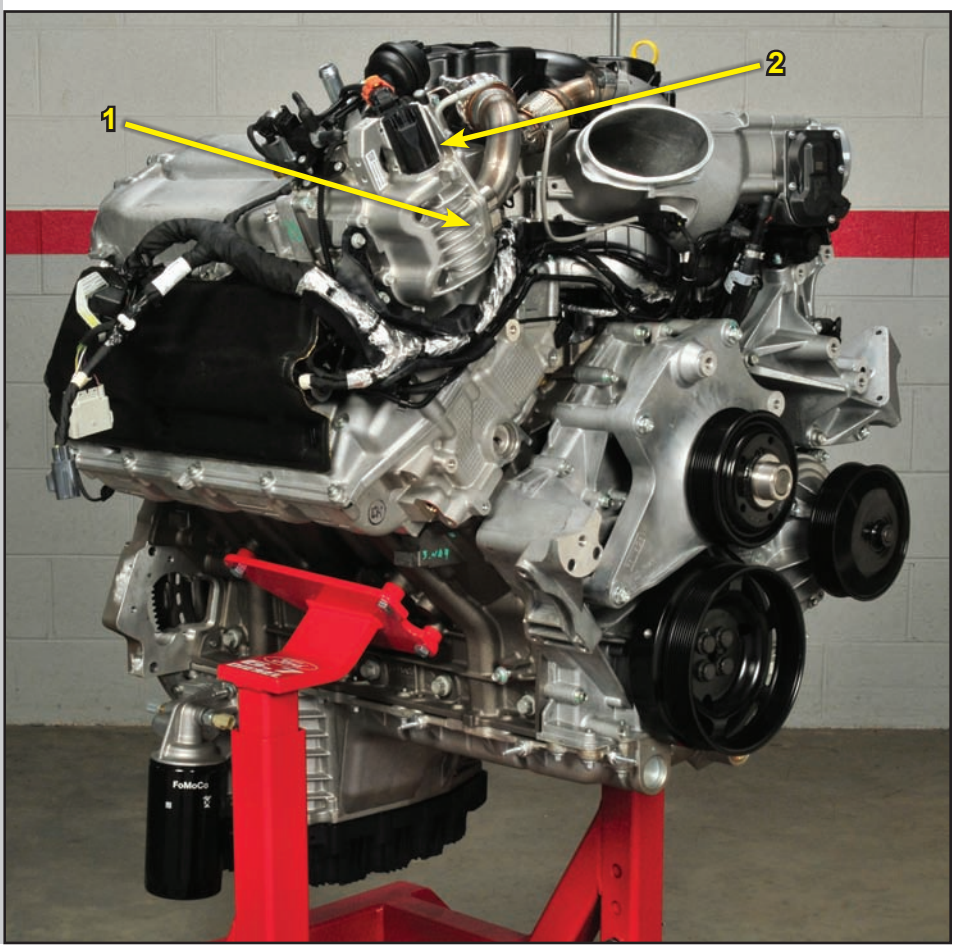
Right Side of Engine

1. Exhaust Gas Recirculation (EGR) cooler
2. Oil pressure switch
3. Engine Oil Temperature (EOT) sensor
4. Secondary Cooling System Temperature (ECT2) sensor

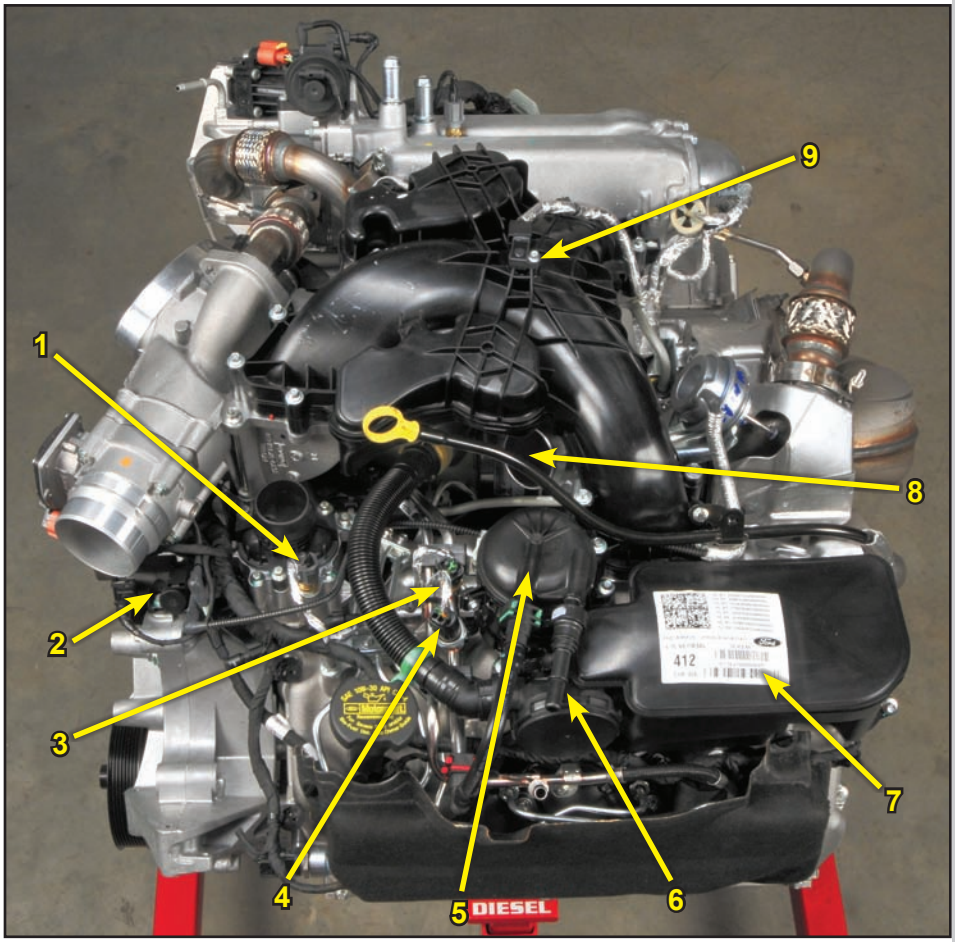


Right Front of Engine

1. EGR valve
2. EGR valve motor with position sensor

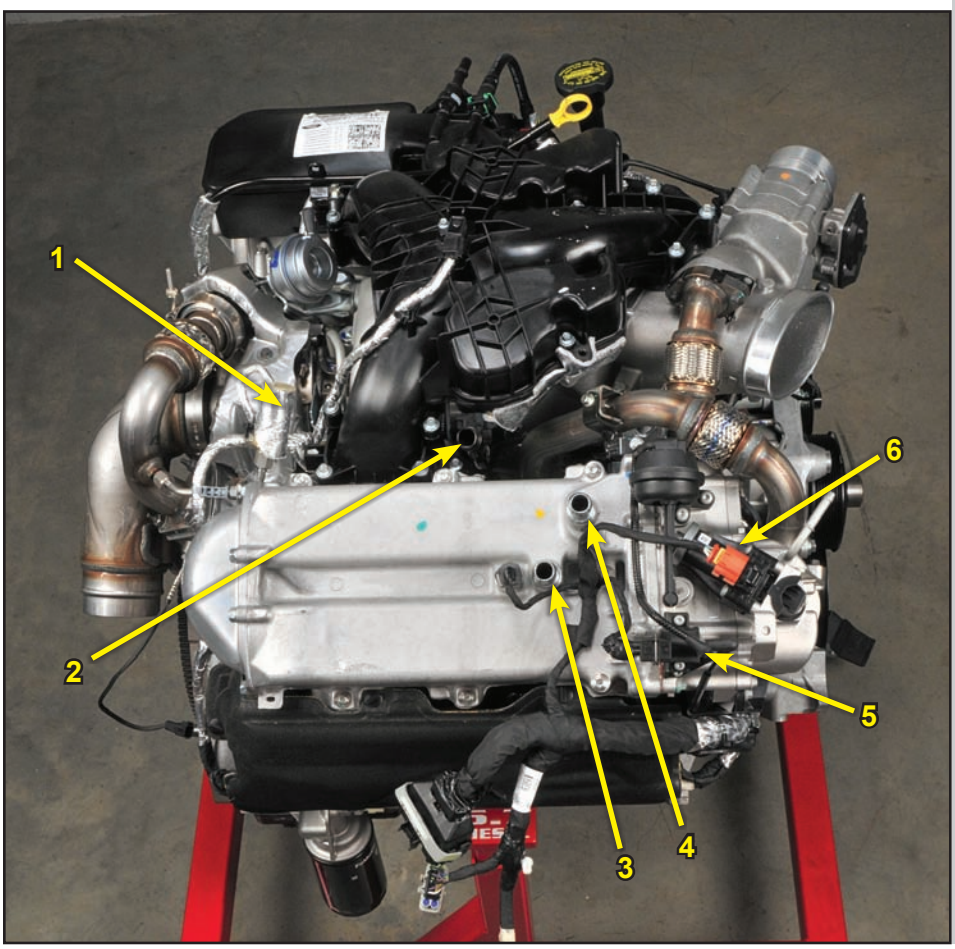


COMPONENT LOCATIONS



Left Top of Engine

1. Engine Coolant Temperature (ECT) sensor
2. Wastegate control vacuum solenoid
3. Fuel Rail Temperature (FRT) sensor
4. Fuel delivery pressure switch
5. Engine mounted fuel filter
6. Fuel supply line
7. Injector Quantity Adjustment (IQA) sticker
8. Turbocharger compressor outlet
9. Manifold Absolute Pressure (MAP) sensor

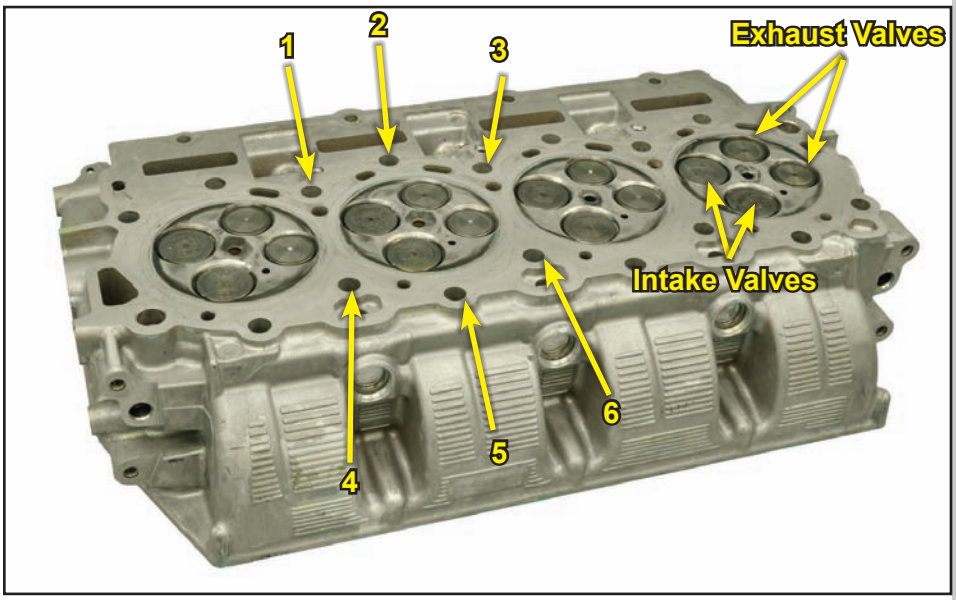


Right Top of Engine

1. Exhaust Pressure (EP) sensor
2. Heater core supply
3. EGR cooler secondary coolant inlet
4. EGR cooler secondary coolant outlet
5. EGR cooler bypass solenoid
6. EGR valve motor and position sensor

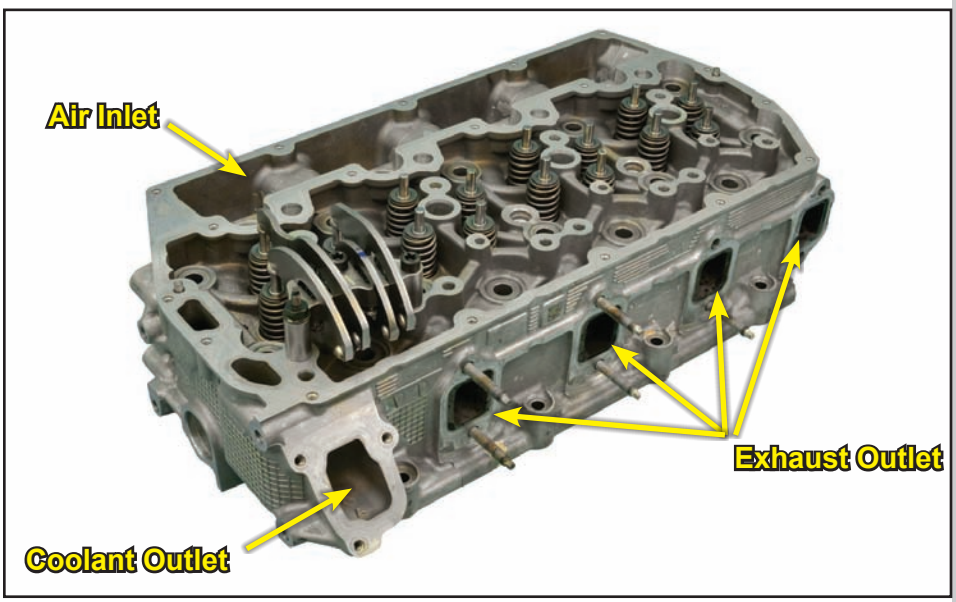
NOTES

UPPER ENGINE COMPONENTS



Bottom Cylinder Heads

Six bolts per cylinder clamp the aluminum cylinder heads to the block. Each cylinder has two exhaust and two intake valves.



Top of Cylinder Head

The air inlet is located on the out board side of the cylinder heads. The exhaust outlet is located on the inboard side of the cylinder head to reduce the loss of radiant heat.

The weight of the engine is reduced due to the configuration of the intake and exhaust ports.



Rocker Arms

Each valve has its own rocker arm and pushrod.

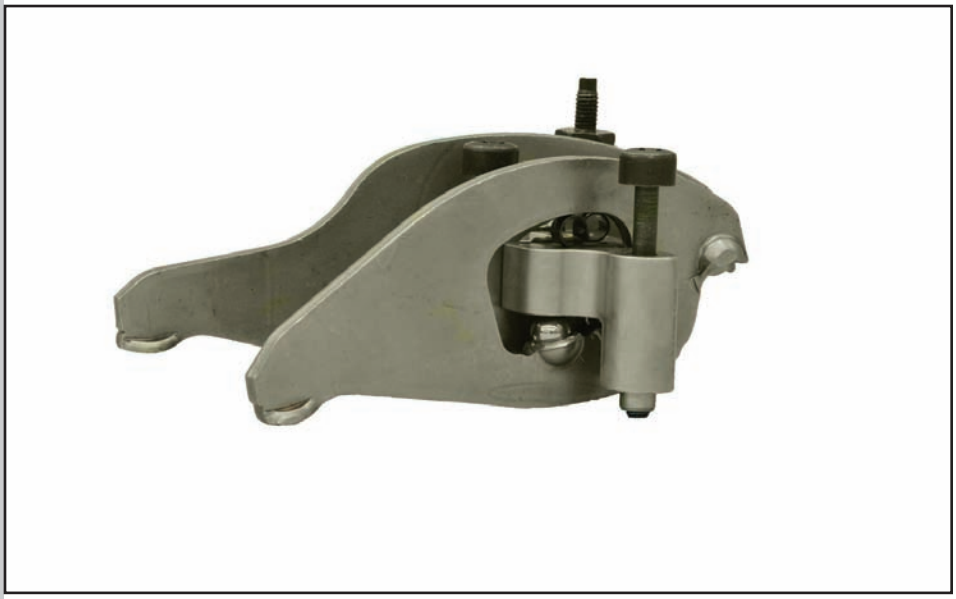
Note: The rocker arms are not attached by head bolts.

UPPER ENGINE COMPONENTS

Rocker Arms (continued)

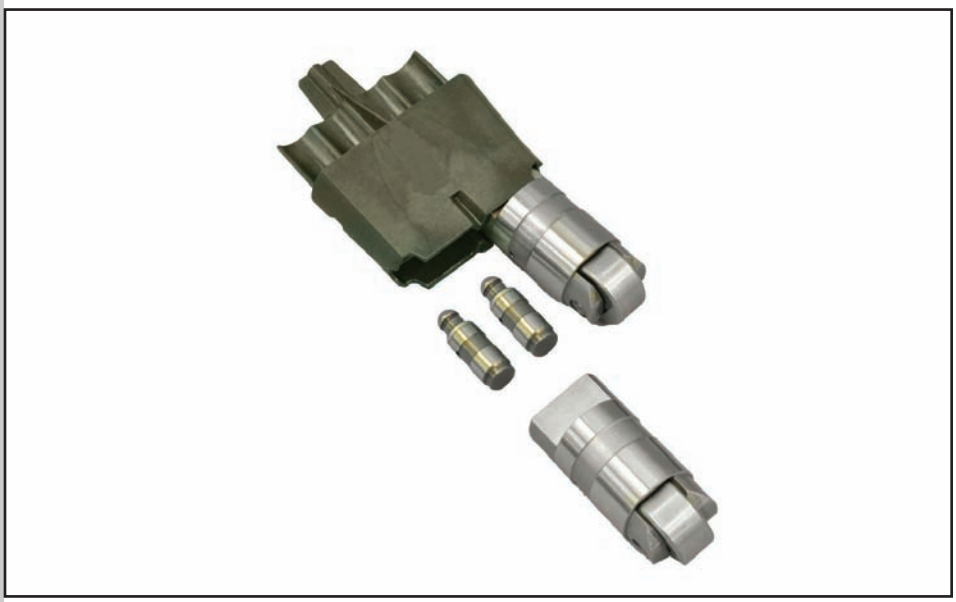
The rocker arms for each cylinder ride on their own common fulcrum. They are attached to the cylinder heads by three bolts.

Note: Individual rocker arms reduce side loading of the valves.



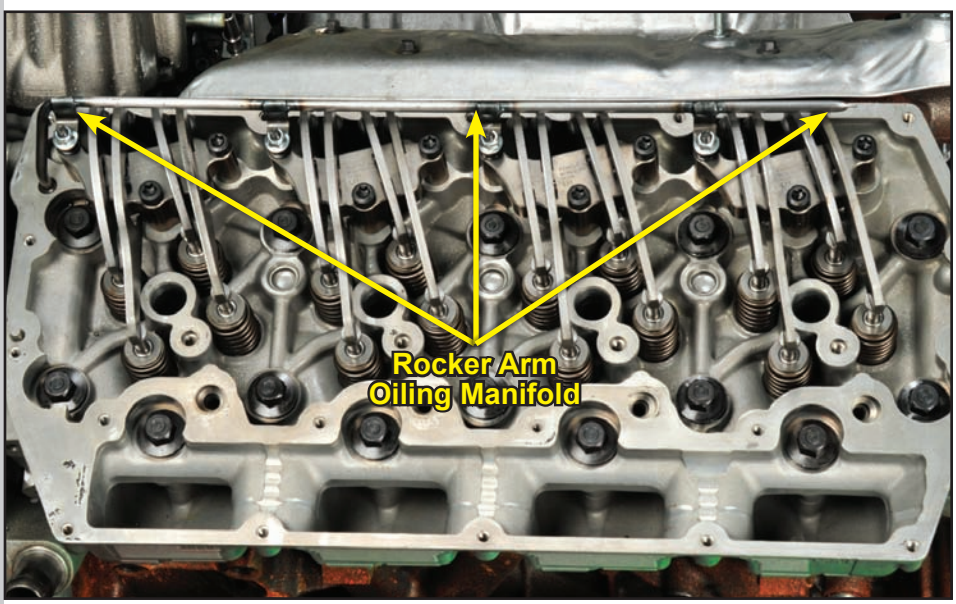
Cam Followers

- Design patented by Ford.
- Each roller lifter contains two hydraulic lash adjusters and each valve is individually actuated through its own pushrod and rocker arm.
- Simple stamped rocker arms allow efficient package, robust quality, and reliable motion.
- Eliminates the floating bridge used to open a pair of valves with a single rocker arm, improving wear performance and Noise, Vibration, and Harshness (NVH).

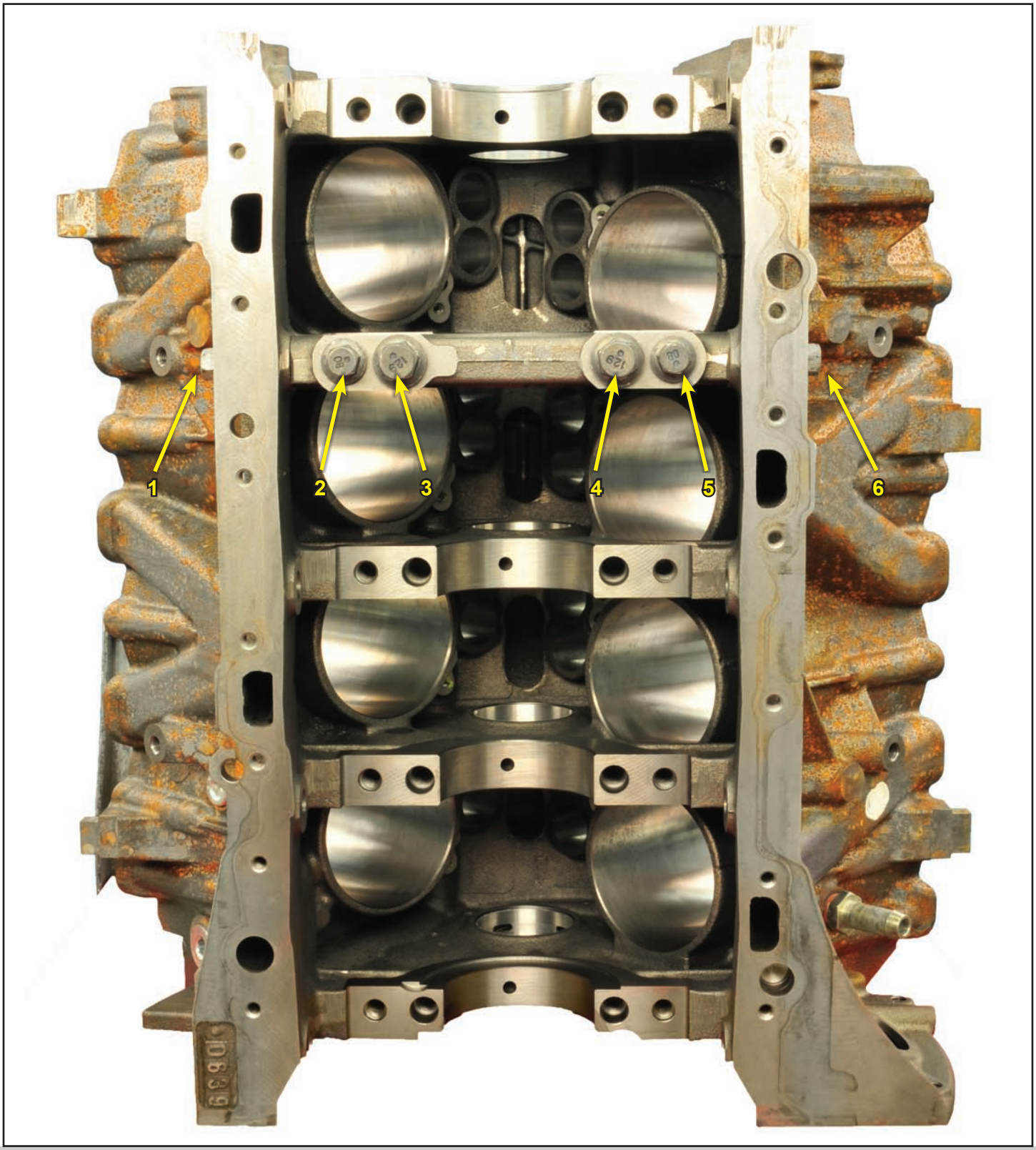


Rocker Arm Oiling Manifold

Both cylinder heads have a rocker arm oiling manifold that cools and lubricates the valves and rocker arms.



LOWER ENGINE COMPONENTS



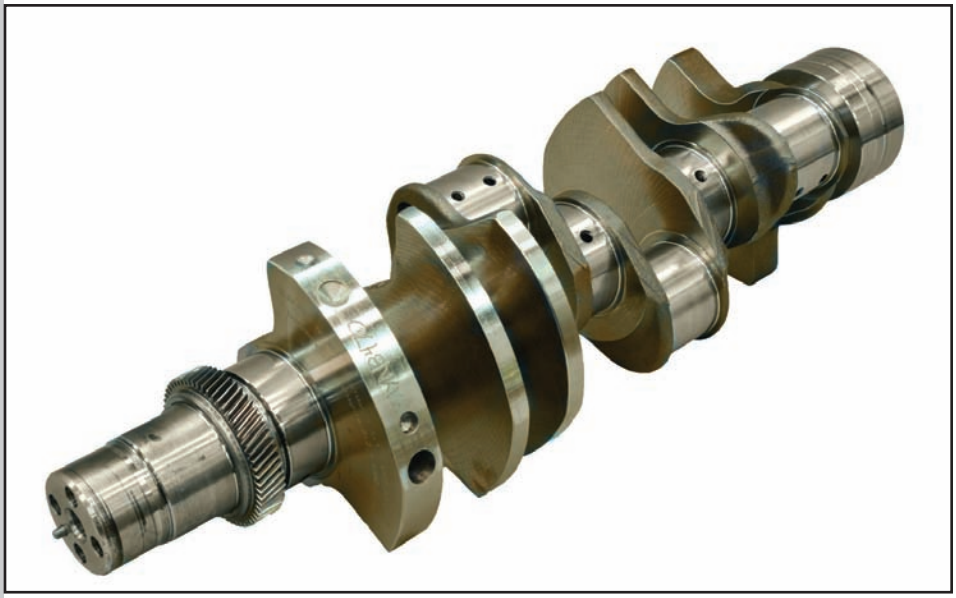
Engine Block

- The engine block is made from a Compacted Graphite Iron (CGI) enables best-in-class weight and improved NVH.
- Cam-in-block design with dry valley
- Integrated direct mount for high pressure fuel pump
- Six head bolts per cylinder and six bolts per main bearing cap

LOWER ENGINE COMPONENTS

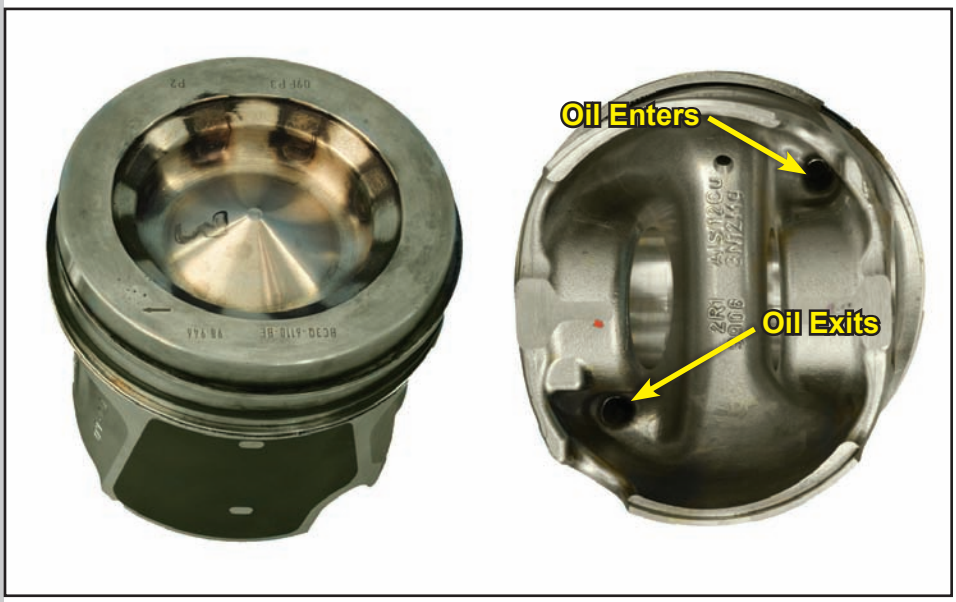
Crankshaft

- Forged microalloyed medium carbon steel
- Undercut rolled fillet radius on each journal
- Fully lightened crankshaft pins
- Two radiused counterweights
- One piece rear flange:
  - increase torque capabilities.
  - improved sealing and balance.
- Shrink fit assembled front drive gear
- Single mode torsional damper
- Direct accessory drive for improved NVH



Pistons

The pistons are oil cooled. A oil jet that bolts into the block sprays oil into a hole in the bottom of the piston. The oil flows through the top of the piston and exits from a hole in the other side of the piston.



Connecting Rods

The connecting rod is a fractured cap design.



LOWER ENGINE COMPONENTS

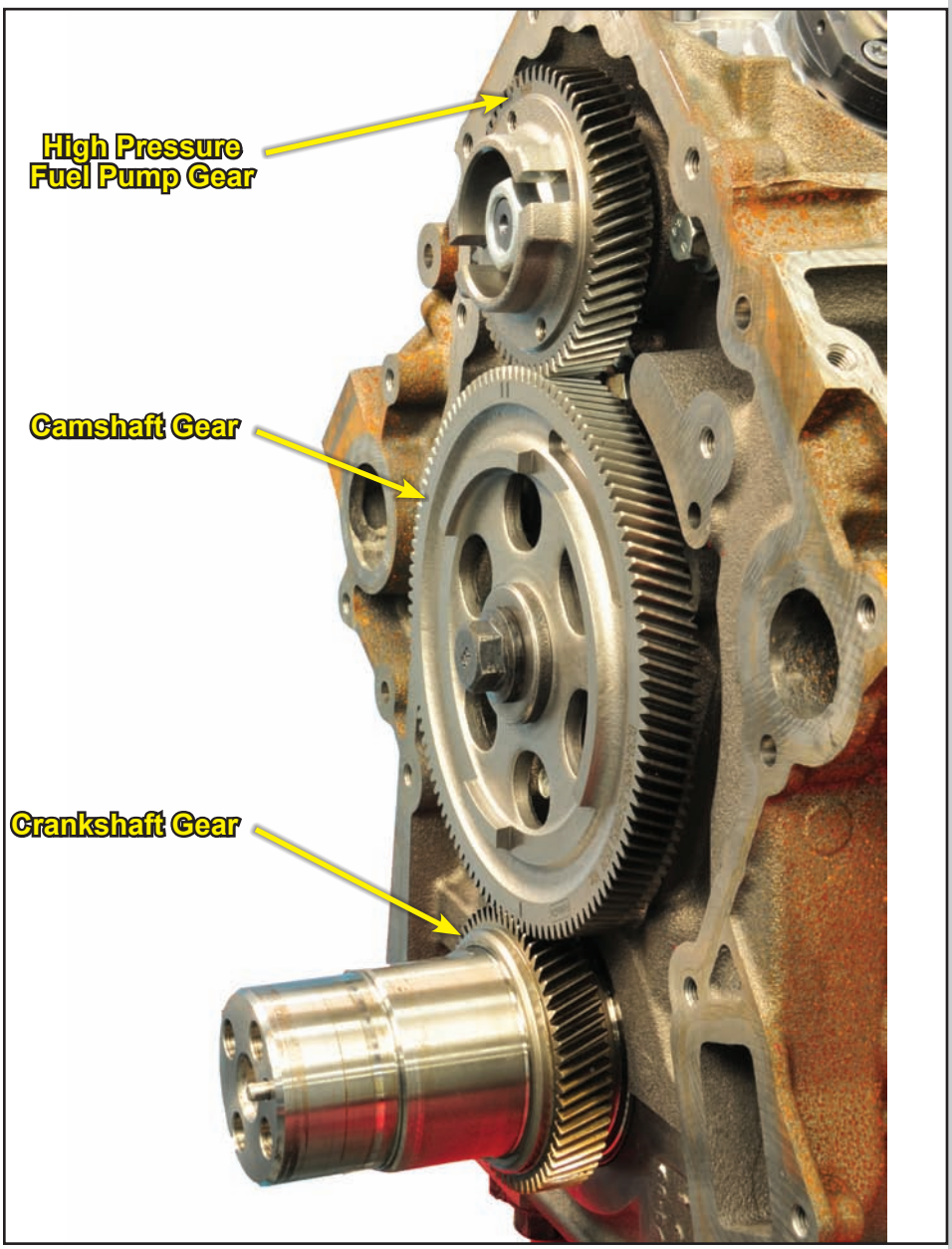


Camshaft

The camshaft is driven by the crankshaft. The camshaft has one exhaust and one intake lobe per cylinder.

The two exhaust valves are actuated by a single exhaust lobe and the two intake valves are actuated by a single intake lobe.

The camshaft bearings are lubricated by the rear cam groove. This groove receives oil from the block gallery and oil flows through the center of the camshaft to each cam bearing journal.



Gear Timing

The camshaft and high pressure fuel pump gears are driven off the crankshaft. The timing gears are accessible by removing the front cover. The camshaft, crankshaft and high pressure fuel pump all need to be timed together.

Note: The fuel pump is timed so that the fuel pump stroke happens at the same time as the injection stroke. This provides a more consistent fuel delivery.

See the Workshop Manual for the specific procedure for timing the crankshaft, camshaft and fuel pump.

LOWER ENGINE COMPONENTS

Crankshaft Main and Connecting Rod Bearings

Both the crankshaft main and connecting rod bearings are color coded and a tangless design.

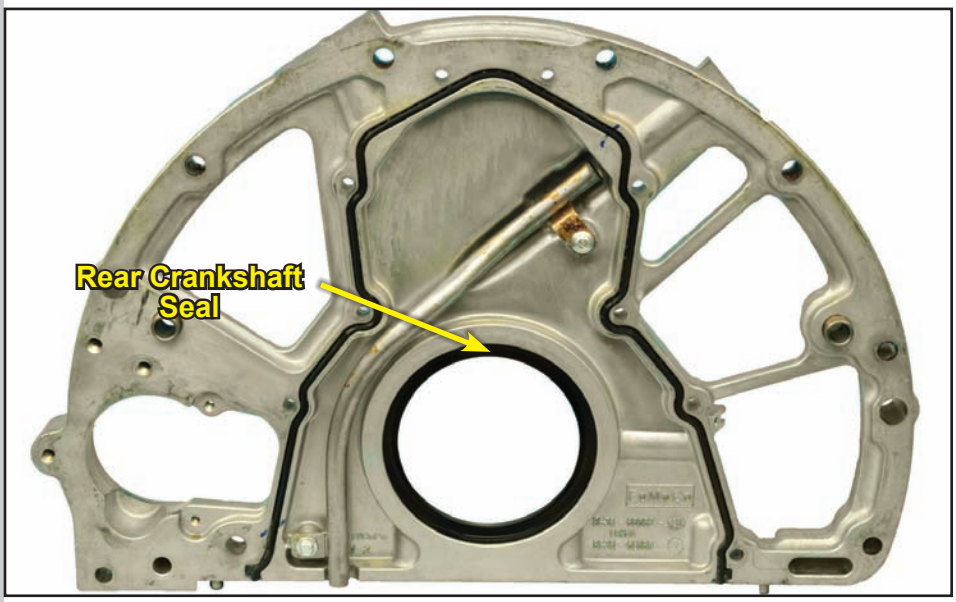
The lower half of the crankshaft main bearings are a dark gray color while the upper half is a bright metal with a lubrication groove and a slot for the oil to flow through.

The upper half of the connecting rod bearings are dark gray while the lower half is a bright metal with no grooves.



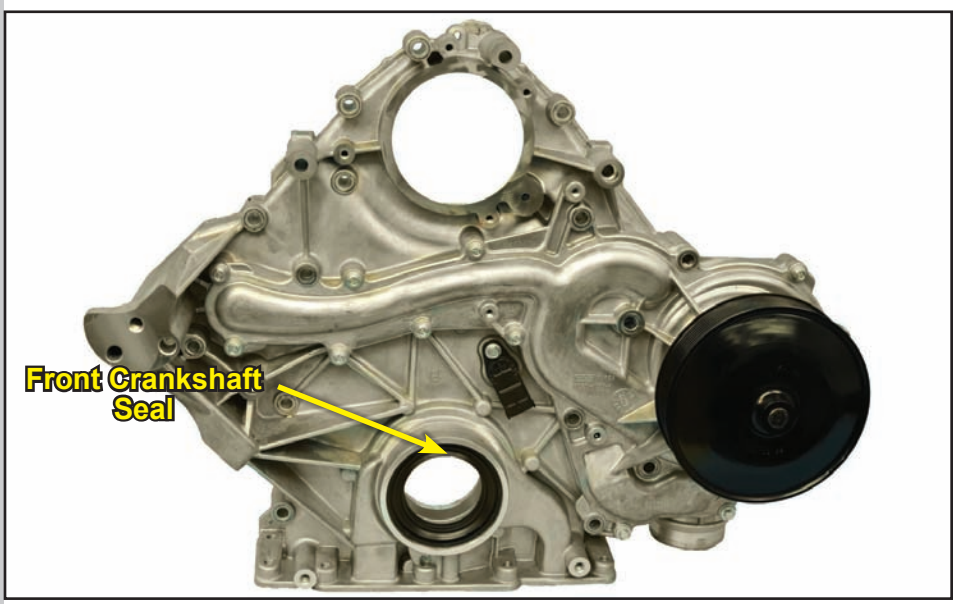
Rear Crankshaft Seal

The rear crankshaft seals have no sealing sleeves.

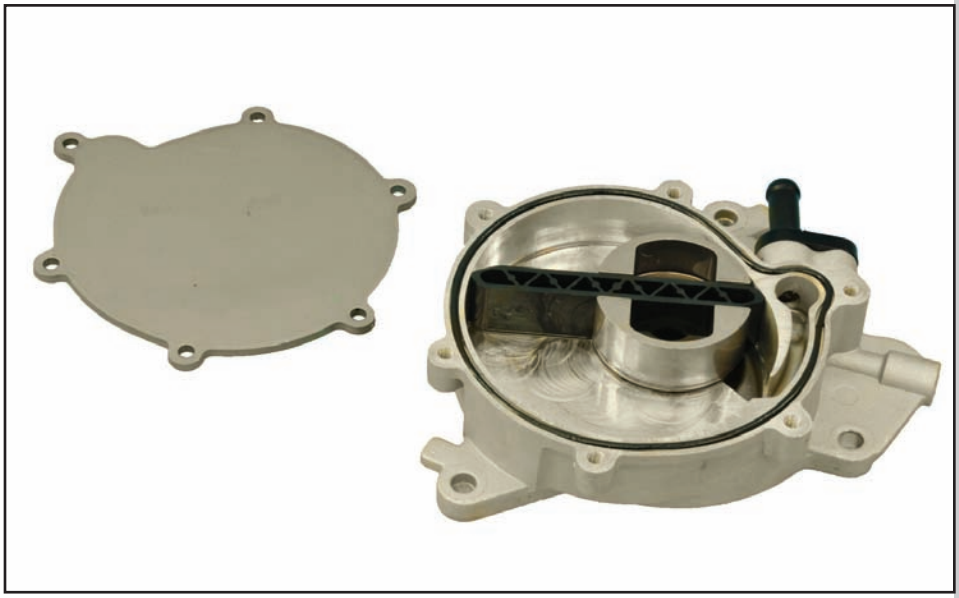


Front Crankshaft Seal

The front crankshaft seal and oil slinger are pressed on together.

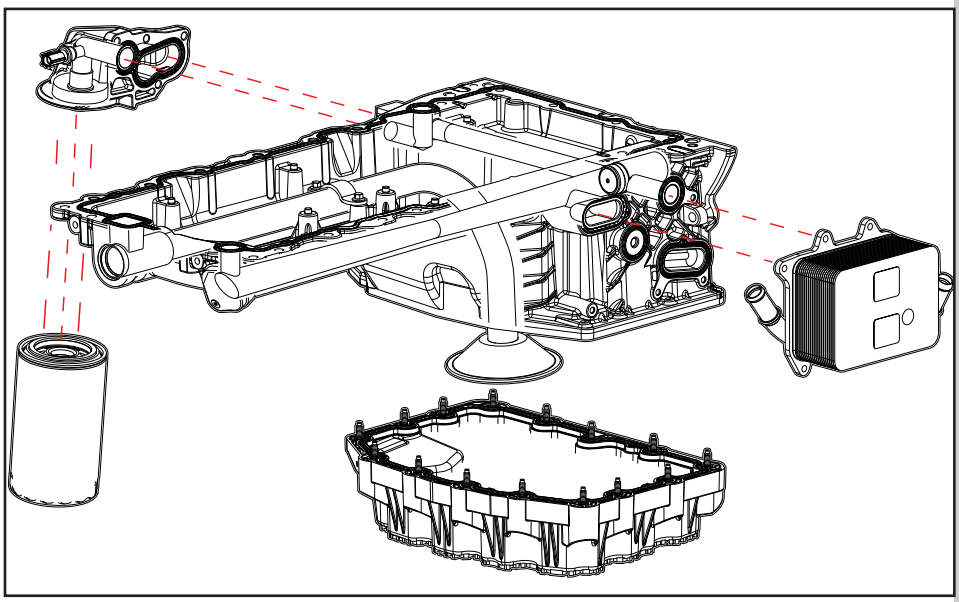


LOWER ENGINE COMPONENTS



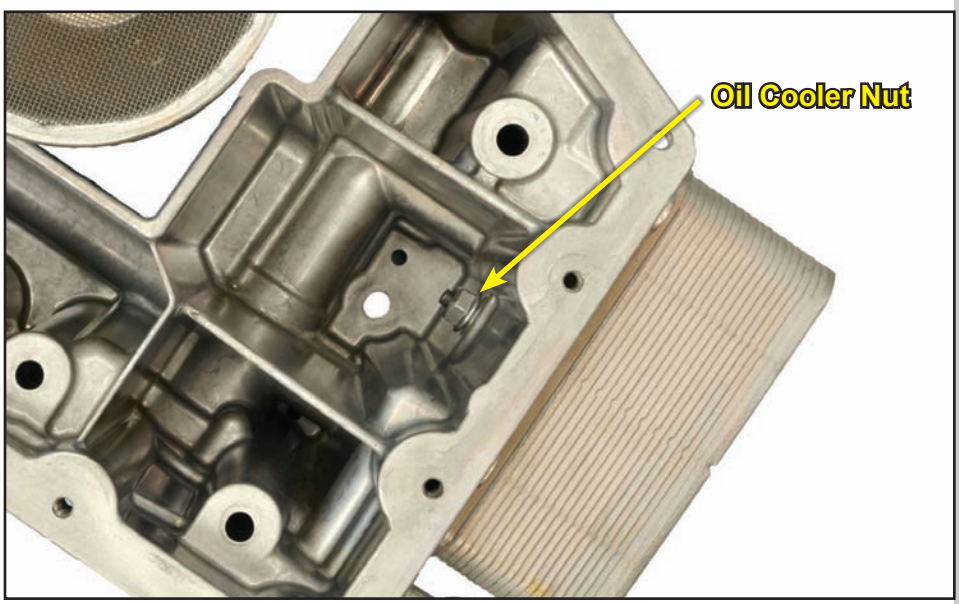
Vacuum Pump

The vacuum pump is located on the upper portion of the front cover and is driven by the high pressure fuel pump. Vacuum is used for the EGR cooler bypass system and the wastegate control system.



Oil Pan

The oil pan provides the mounting locations for the oil cooler and the oil filter adapter. The oil filter adapter is mounted to the right rear of the oil pan and contains the oil pressure switch and the Engine Oil Temperature (EOT) sensor. The oil cooler is mounted to the left rear of the oil pan. The oil cooler is a coolant-to-oil cooler.



Oil Cooler

The oil cooler is mounted, and secured with bolts to the outside left of the oil pan.

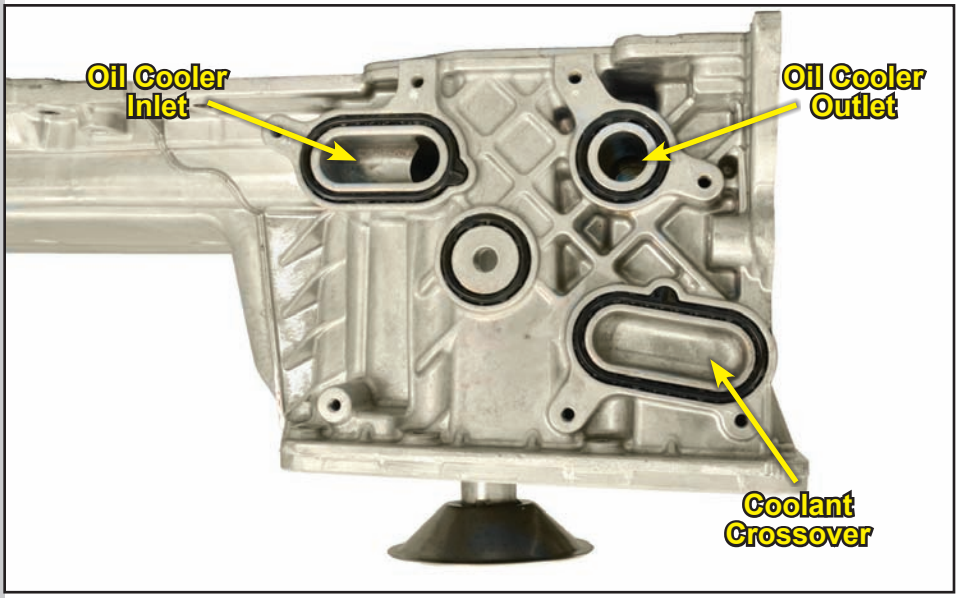
A nut on the inside of the pan secures the center ports of the cooler.

Note: Remove the lower oil pan to gain access to the oil cooler nut.

LOWER ENGINE COMPONENTS

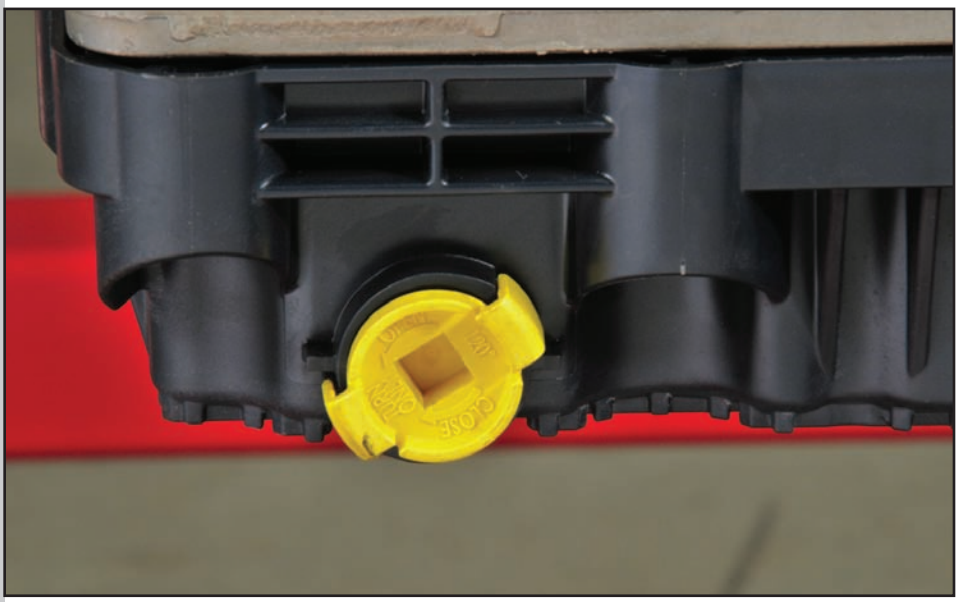
Oil Cooler Passages

The oil travels through the oil pan from the oil pump to the cooler, back into the oil pan to the oil filter, then back to the oil pan and feeds the engine.



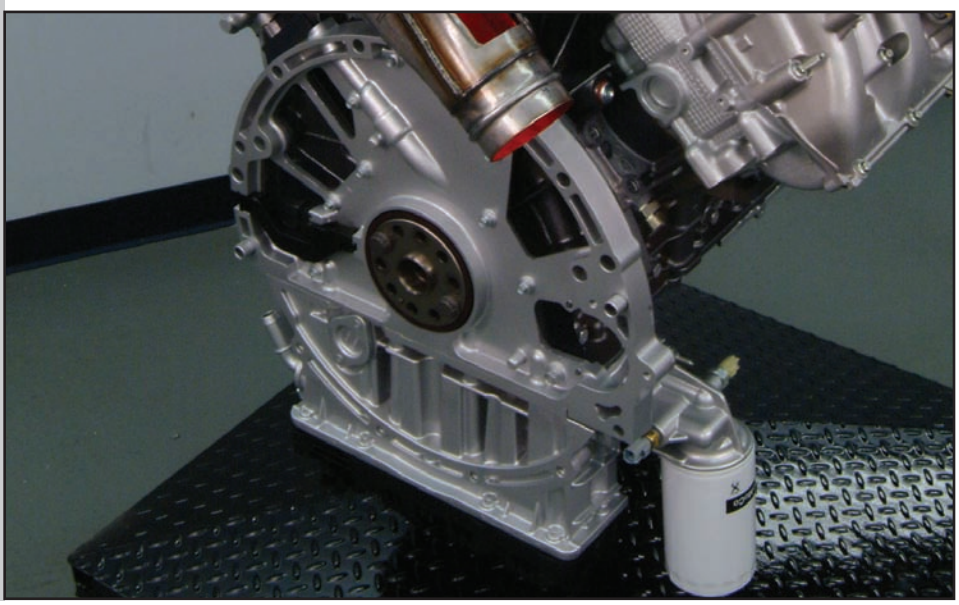
Quarter Turn Drain Plug

The oil drain plug is a quarter turn drain plug located in the left rear of the lower composite pan.



Oil Pan Structural Support

The oil pan is a structural member of the powertrain assembly and contains the lower part of the 6R140 transmission bolt circle to support the transmission.



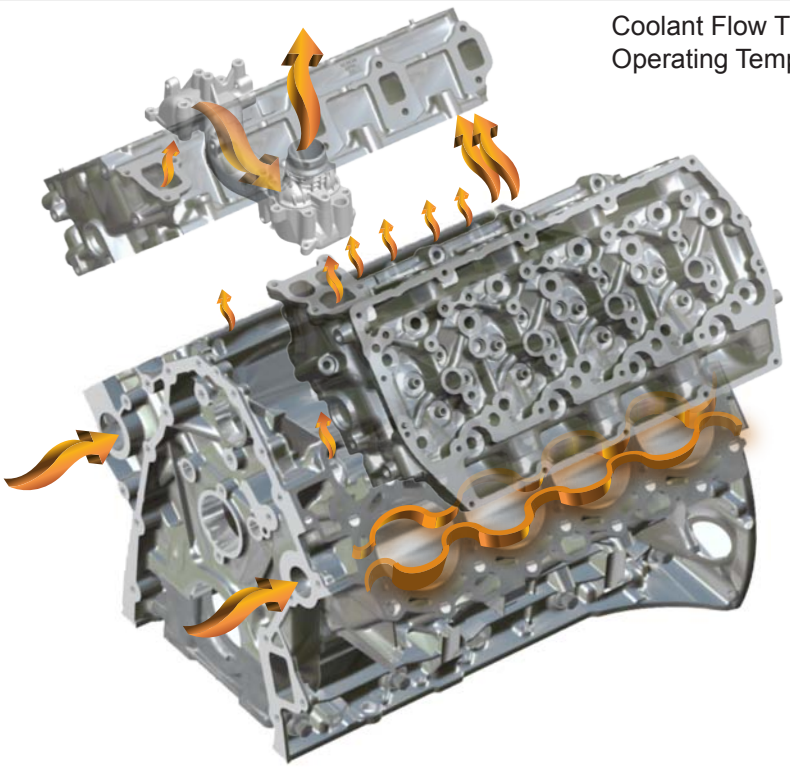
COOLING SYSTEM

The 6.7L Power Stroke® diesel engine has two separate cooling systems:

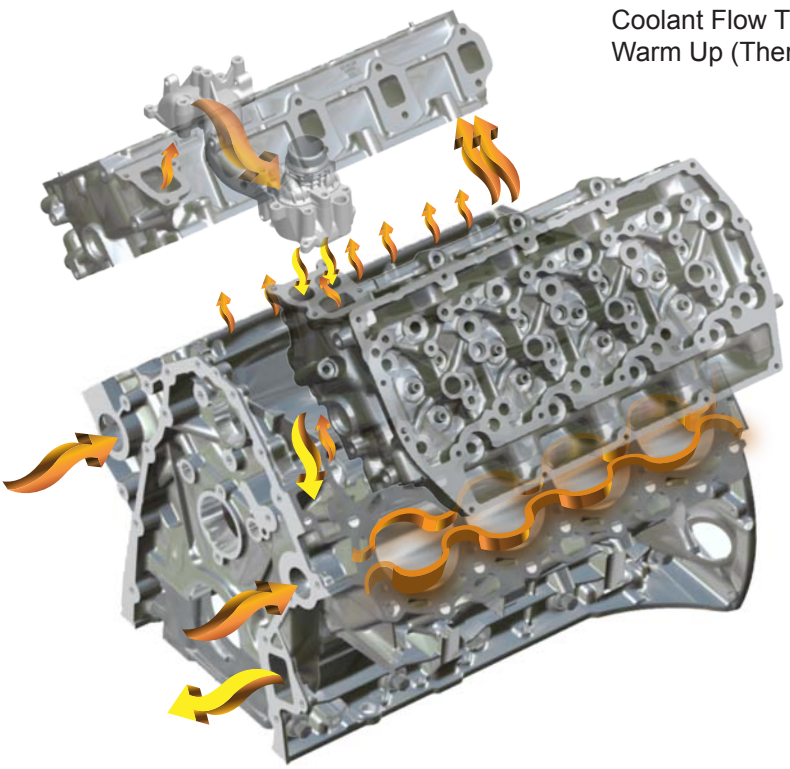
- The engine cooling system, called the primary or high temperature cooling system,
- The powertrain secondary cooling system, a low temperature system which cools the Charge Air Cooler (CAC), fuel cooler, EGR cooler and transmission oil cooler.

Both cooling systems have their own radiator, belt-driven coolant pump, thermostats and degas bottle.

Use only Motorcraft® Specialty Orange coolant mixed with 50/50 by volume distilled water in the 6.7L Power Stroke® diesel engine. Check corrosion resistance at specified intervals using Motorcraft® test strip kit. Consult the Workshop Manual for details.



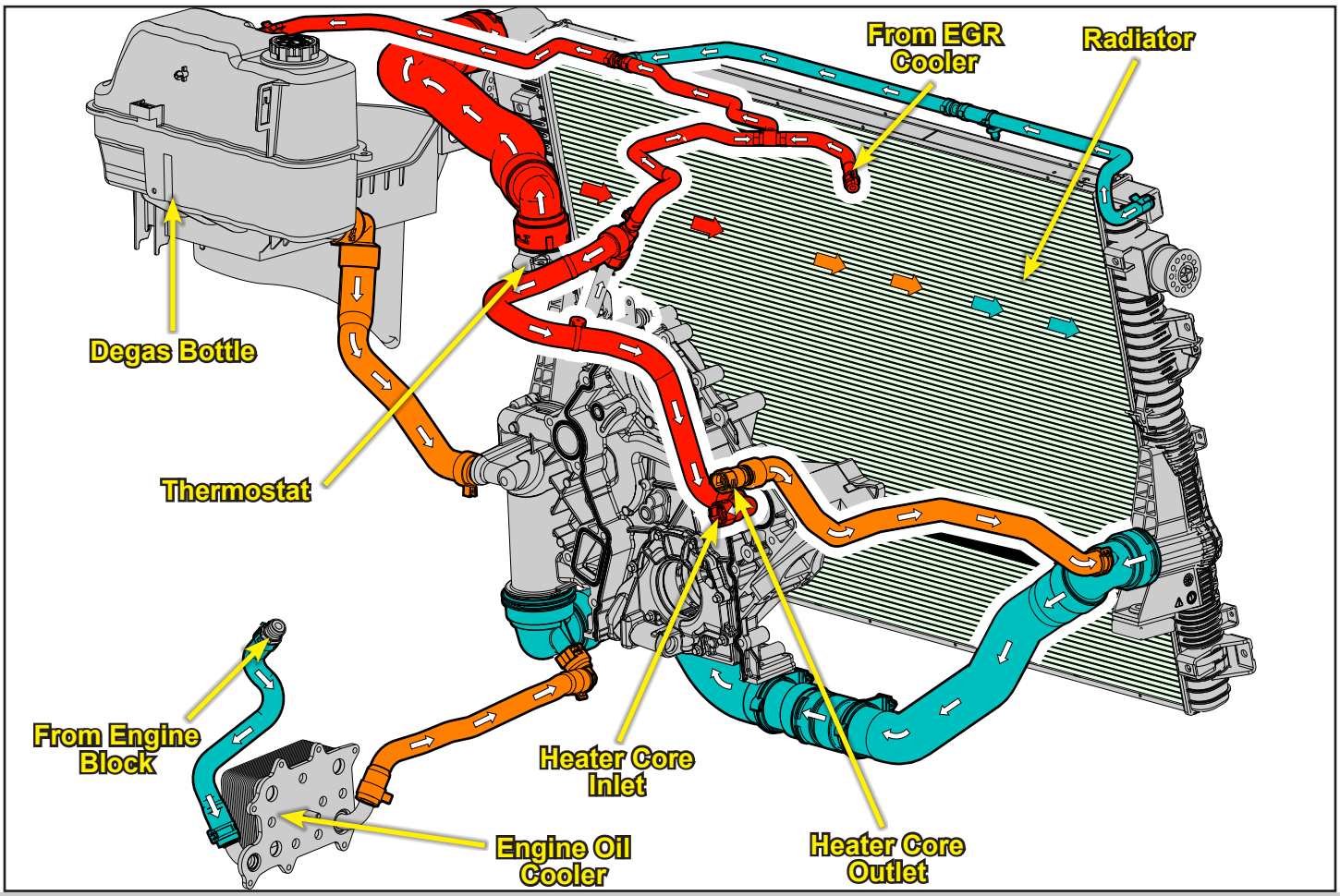
Coolant Flow Through the Block at Operating Temperature (Thermostat Open)



Coolant Flow Through the Block During Warm Up (Thermostat Closed)

COOLING SYSTEM

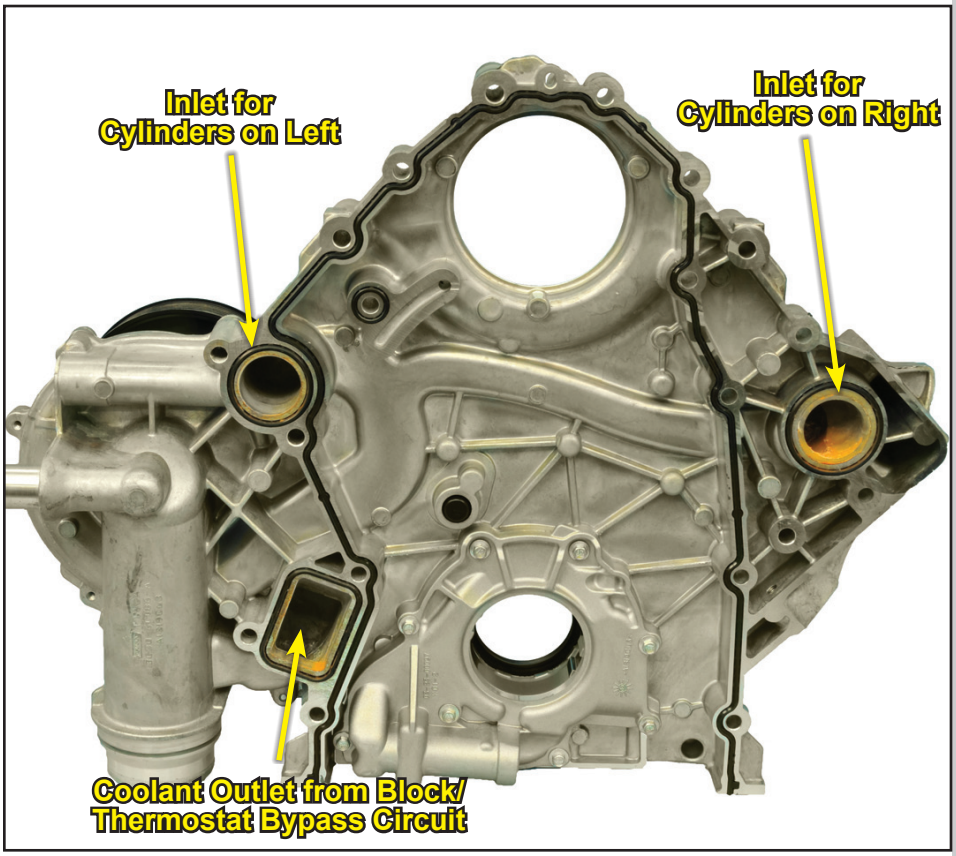
Primary Cooling System



Primary Cooling System Flow

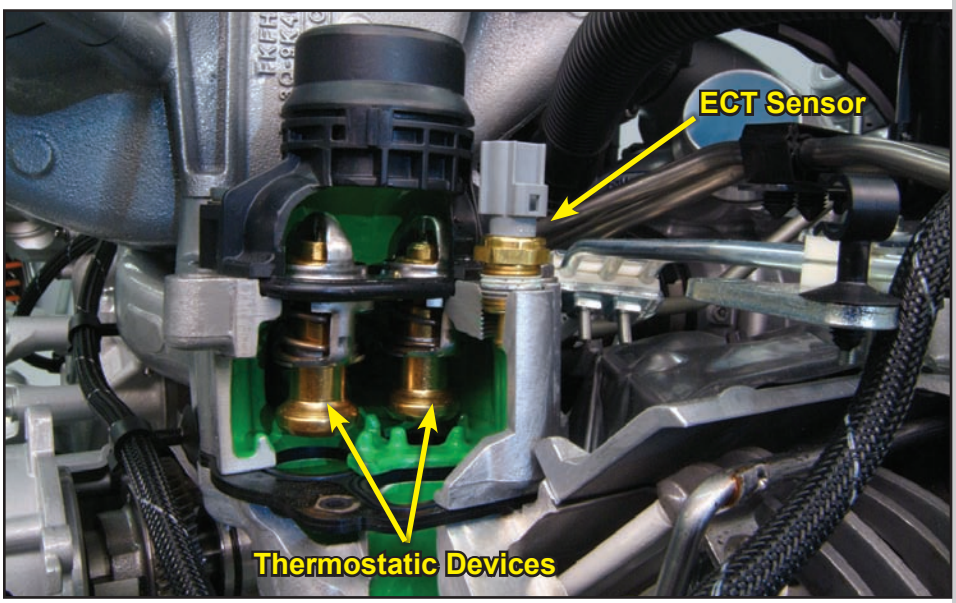
- The primary cooling system cools the following components:
  - engine block
  - cylinder heads
  - engine oil cooler
  - turbocharger
  - EGR cooler
- Coolant is drawn from the bottom radiator port into the pump inlet, located in the front cover, and flows from the coolant pump through the front cover to the crankcase.
- From the crankcase the coolant is routed to the cylinder heads, turbocharger, engine oil cooler and the heater core.
- The coolant enters the turbocharger from a passageway in the engine block. The coolant exits by a tube mounted on the left side of the turbocharger and goes into the water crossover at the front of the engine.
- Coolant is routed through the right valve cover to the EGR cooler and the EGR valve. Most of the coolant returns to the right valve cover, but there is a small passage that allows a small amount of coolant to flow to the degas bottle.
- The inlet for the heater core comes off the front water crossover. The outlet goes into the bottom radiator hose where it attaches to the radiator.
- The inlet for the engine oil cooler comes out of the left side of the engine block. The outlet goes into the bottom radiator hose where it attaches to the front cover.
- A dual thermostat system controls the flow of return coolant to the radiator. If the thermostats are open, coolant flows to the radiator to be cooled. If they are closed, the coolant circulates through a bypass passage in the left cylinder head and engine block and returns to the pump inlet.

COOLING SYSTEM



Coolant System Flow (Behind the Front Cover)

- Coolant is sealed using rubber O-ring seals.
- Coolant is directed through two passages in the front cover. One for the right bank of cylinders and one for the left bank of cylinders.
- During warm up the thermostat blocks coolant flow to the radiator and the coolant is routed back to the pump through the bypass circuit.
- At normal operating temperature, the thermostats completely open and the coolant is routed to the pump through the radiator.



Primary Thermostat

The primary thermostat is located in the coolant crossover at the front of the engine and contains two thermostatic devices in one assembly. The thermostat regulates the engine coolant temperature by controlling the flow of coolant through the primary radiator.

The two thermostatic devices do not open at the same coolant temperature. The opening temperatures are staggered with the back one opening at 90°C (194°F), and the front one opening at 94°C (201°F).

Engine Coolant Temperature (ECT) Sensor

The ECT sensor is located in the coolant crossover, above the coolant pump and next to the thermostat housing.

COOLING SYSTEM

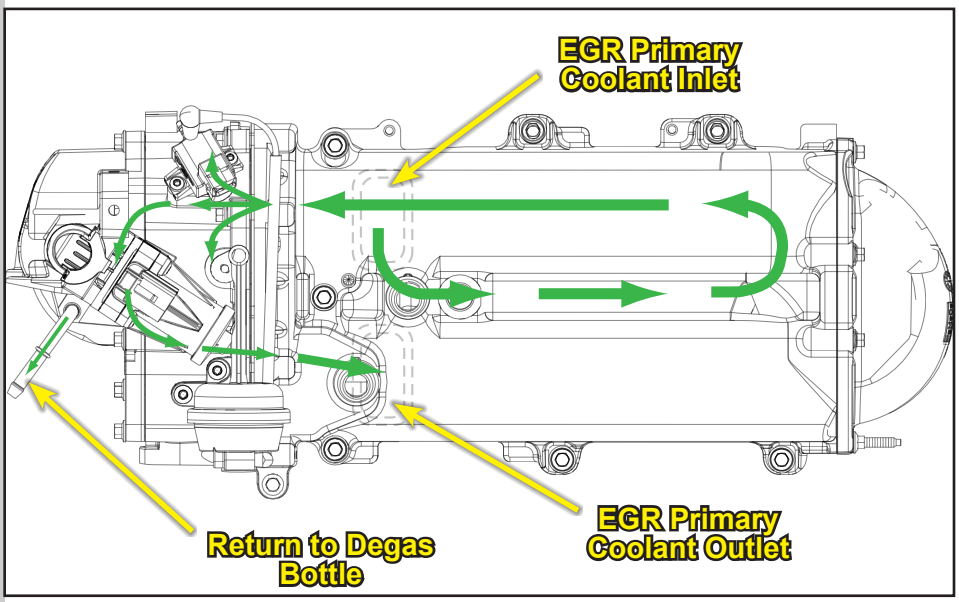
Engine Oil Cooler

The engine oil cooler is located on the left side of the engine oil pan. Coolant flows from the lower rear of the block through the heat exchanger and back to the coolant pump inlet at the lower hose connection.



EGR Cooler Primary Coolant Flow

The coolant also passes from the cylinder head into the first half of the EGR cooler and then back into the cylinder head to cool the exhaust gases before they enter the cylinder.

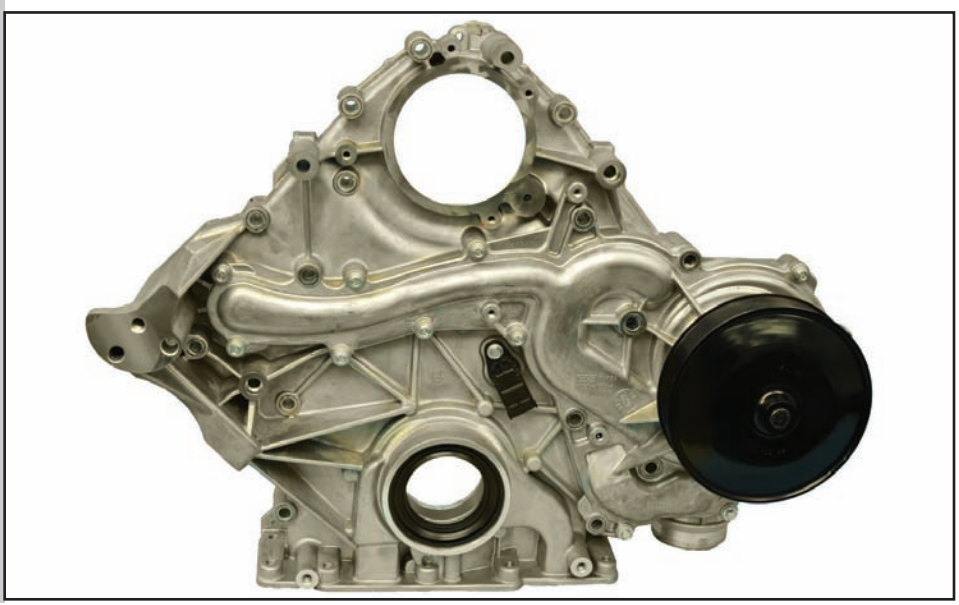


Primary Coolant Pump

The primary coolant pump is located on the left front of the engine.

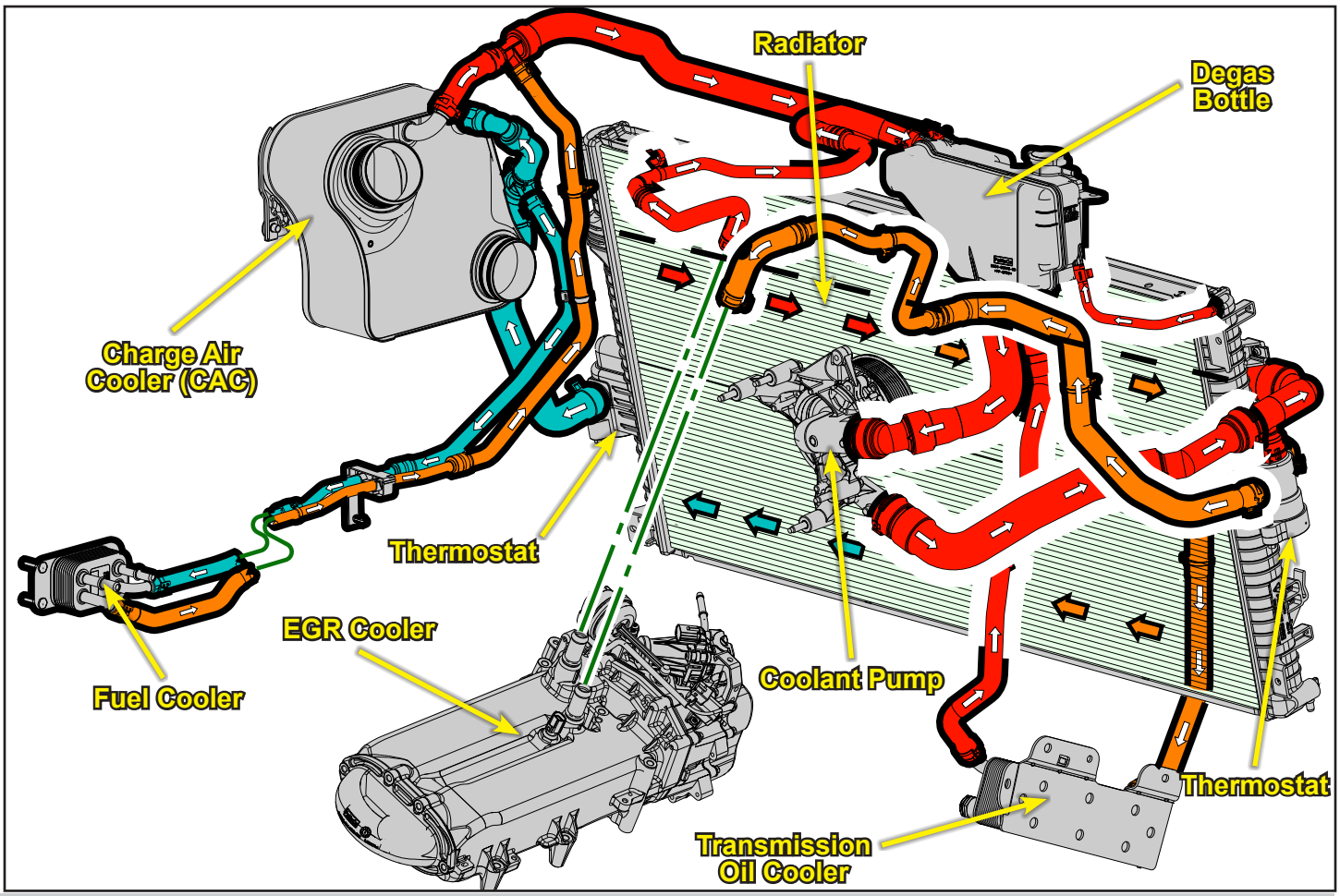
Heater Core

The heater core transfers heat from the primary cooling system to the passenger compartment. Coolant is routed into the heater core from the coolant crossover pipe at the front of the engine. Coolant passes through the heater core and is routed to the lower radiator hose.



COOLING SYSTEM

Powertrain Secondary Cooling System



Powertrain Secondary Cooling System Flow

- The powertrain secondary cooling system cools the following components:
  - Charge Air Cooler (CAC)
  - fuel cooler
  - EGR cooler
  - transmission oil cooler
- The coolant is drawn into the inlet of the coolant pump from the degas bottle. The coolant exits the pump and routed to the radiator.
- The radiator for the powertrain secondary cooling system has two stages.
- The inlet for the transmission oil cooler and the EGR cooler comes from the right side of the radiator after the first stage of cooling.
- The inlet for the CAC and the fuel cooler comes from the left side of the radiator after both stages of cooling.
- The outlet for all heat exchangers returns to the degas bottle.

COOLING SYSTEM

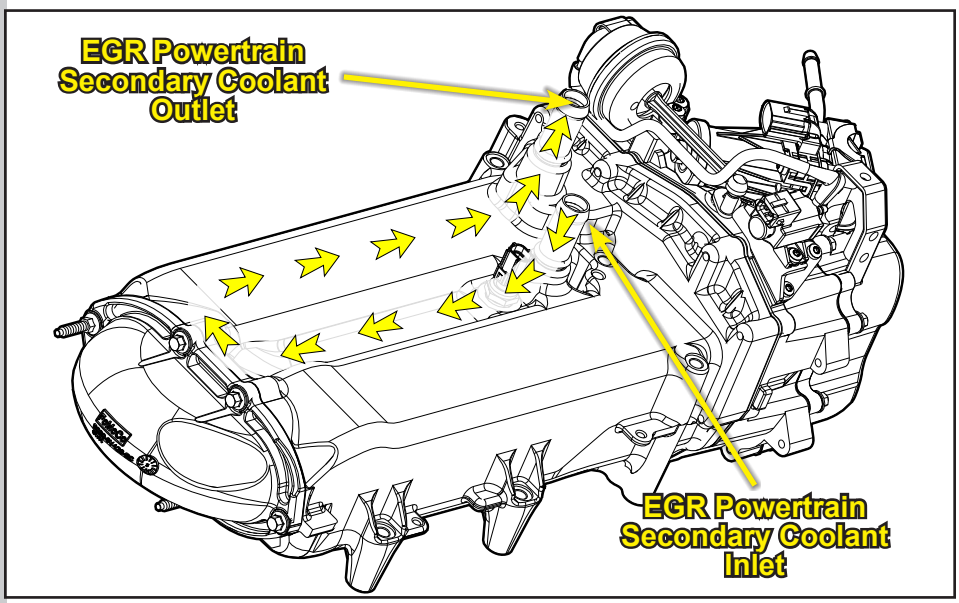
Charge Air Cooler (CAC)

The CAC is an air-to-coolant heat exchanger. This allows for more cooling capacity in a smaller under hood space.



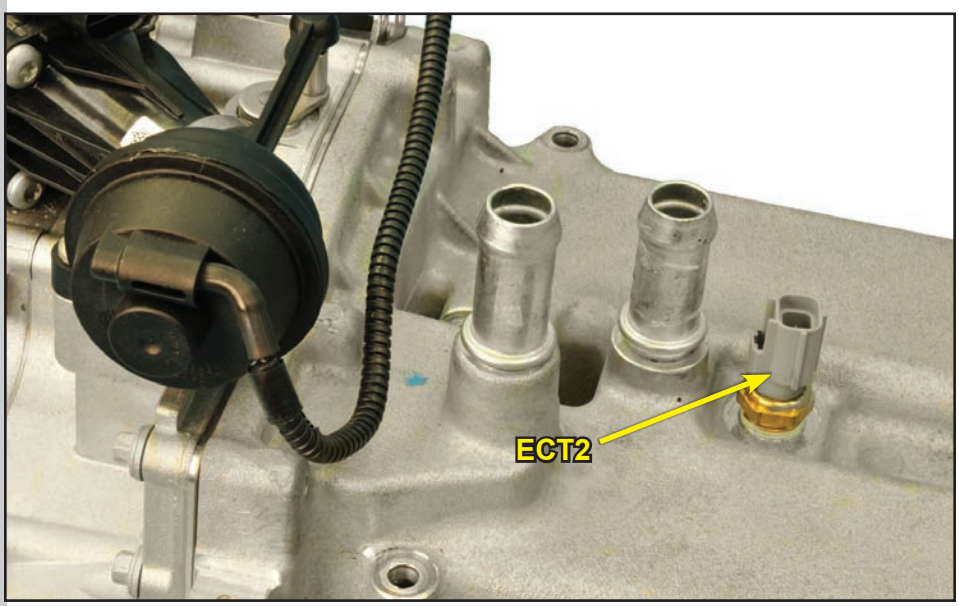
EGR Cooler Powertrain Secondary Coolant Flow

The EGR cooler is located on top of the right valve cover and cools the exhaust gas before it enters the engine. This device, like the CAC, is an air-to-coolant heat exchanger.

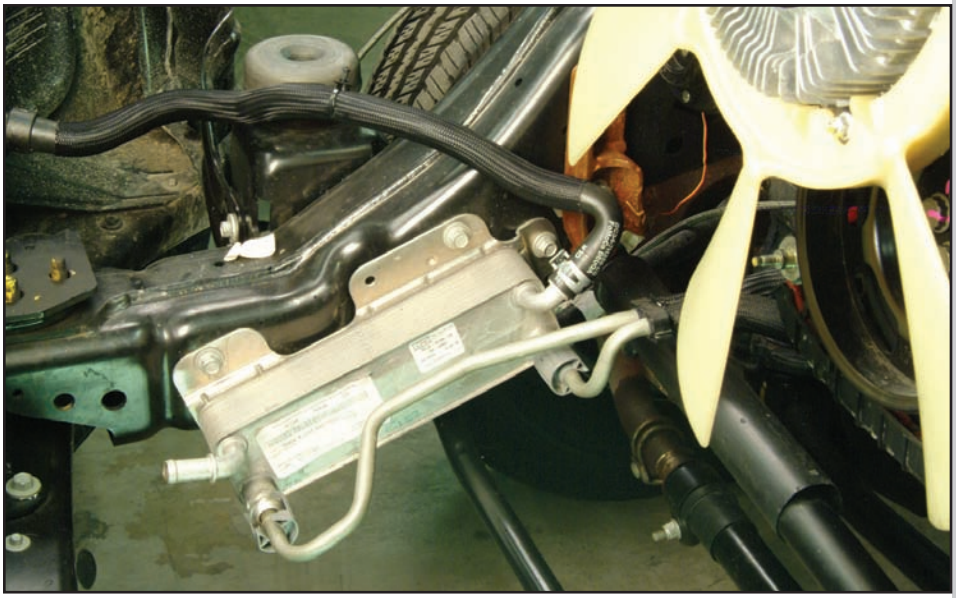


Secondary Cooling System Temperature (ECT2) Sensor

The ECT2 sensor is located in the powertrain secondary cooling system part of the EGR cooler, just after the coolant inlet.

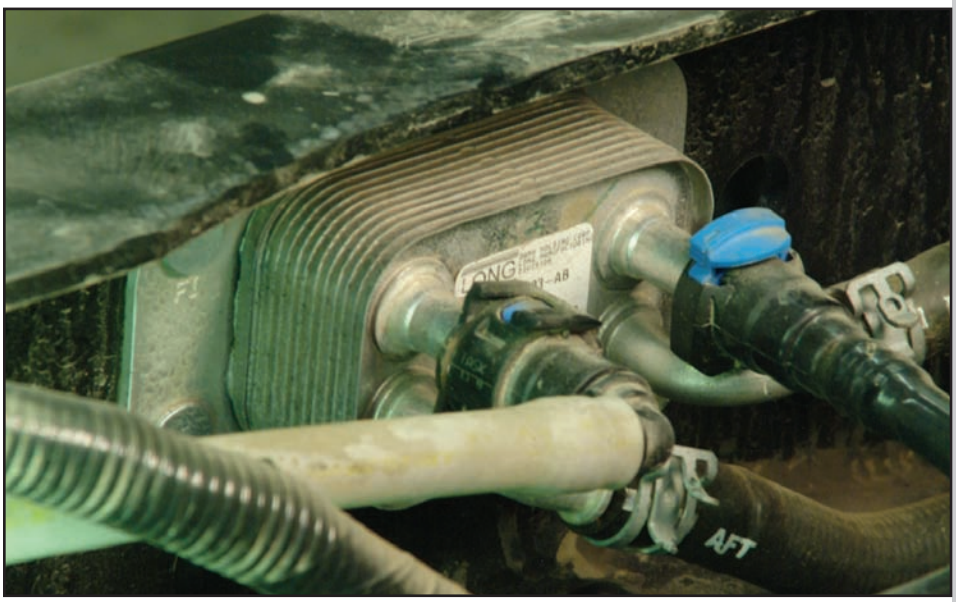


COOLING SYSTEM



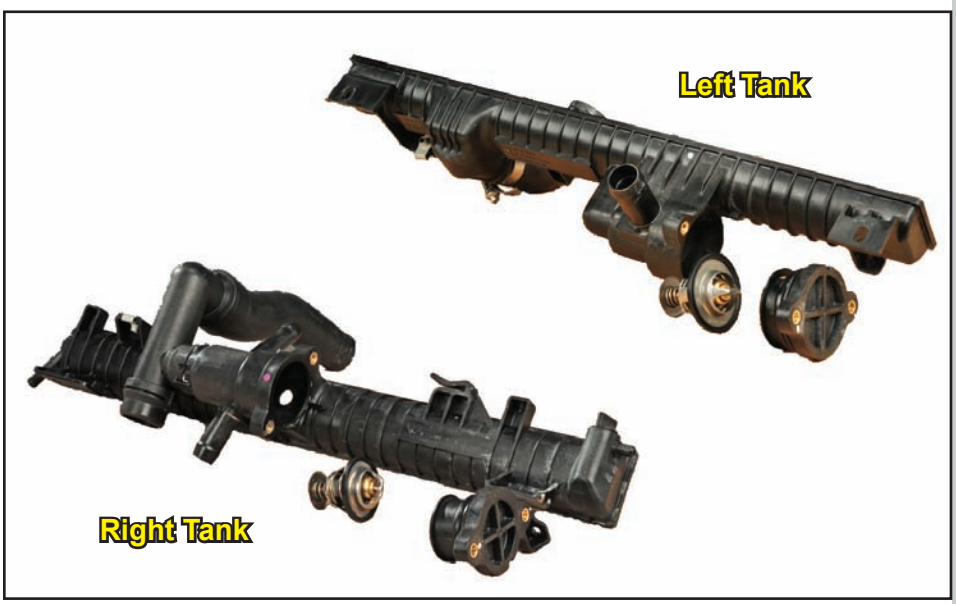
Transmission Cooler

The transmission cooler for the 6R140 transmission is located on the right front inner frame rail.



Fuel Cooler

The fuel cooler is located on the left frame rail between the engine and the Diesel Fuel Conditioning Module (DFCM). It cools the return fuel before it is sent to the DFCM.



Secondary Thermostats

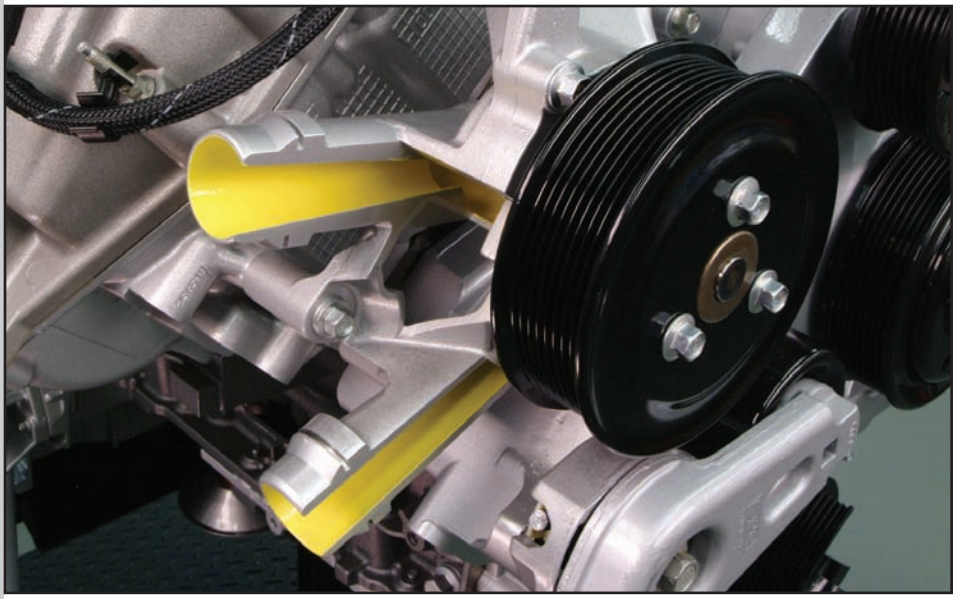
The high temperature thermostat is located on the right side of the secondary radiator, starts to open at 45°C (113°F) and regulates the upper radiator temperature to approximately 60°C (140°F).

The low temperature thermostat is located on the left side of the secondary radiator, starts to open at 20°C (68°F) and regulates the lower radiator temperature to approximately 45°C (113°F).

COOLING SYSTEM

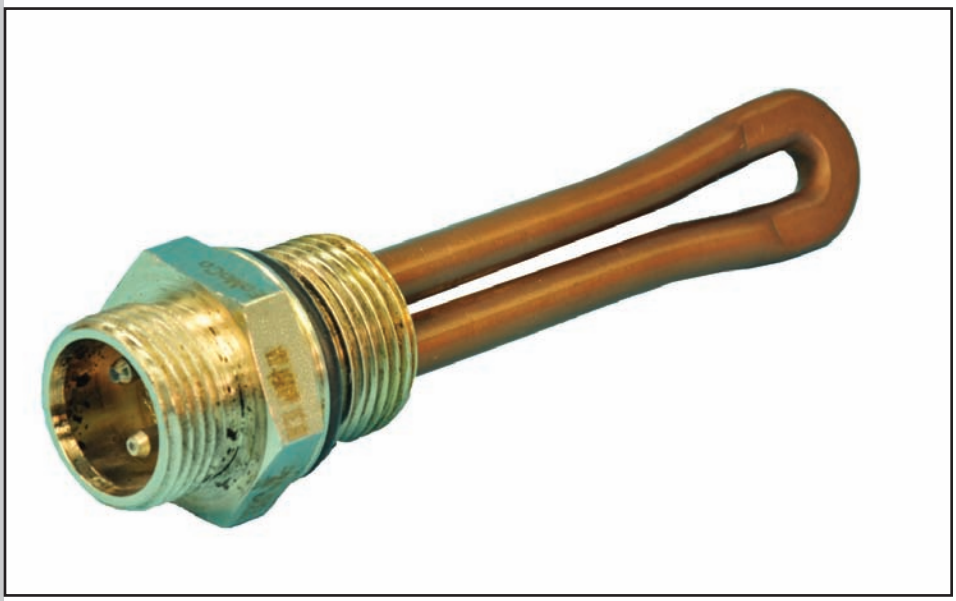
Secondary Coolant Pump

The secondary coolant pump is located on the right front of the engine.



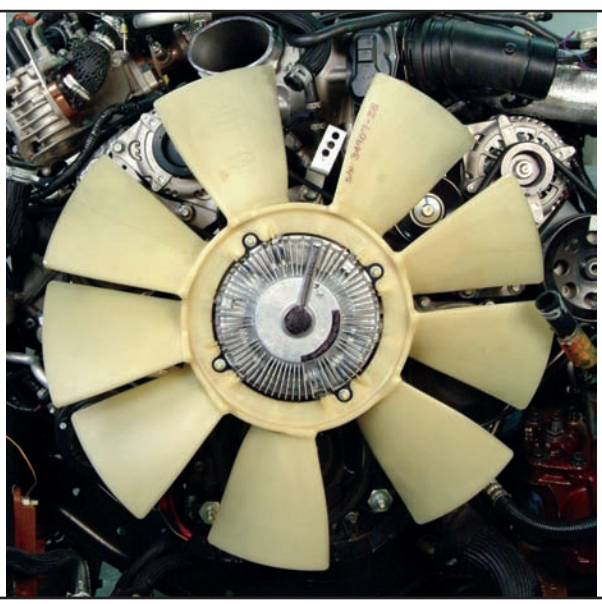
Engine Block Heater

If equipped, the engine block heater is located on the right side of the engine block. The block heater uses 110V AC to heat the engine coolant in cold weather climates. Use the engine block heater whenever ambient temperatures are at or below -23°C (-9°F).

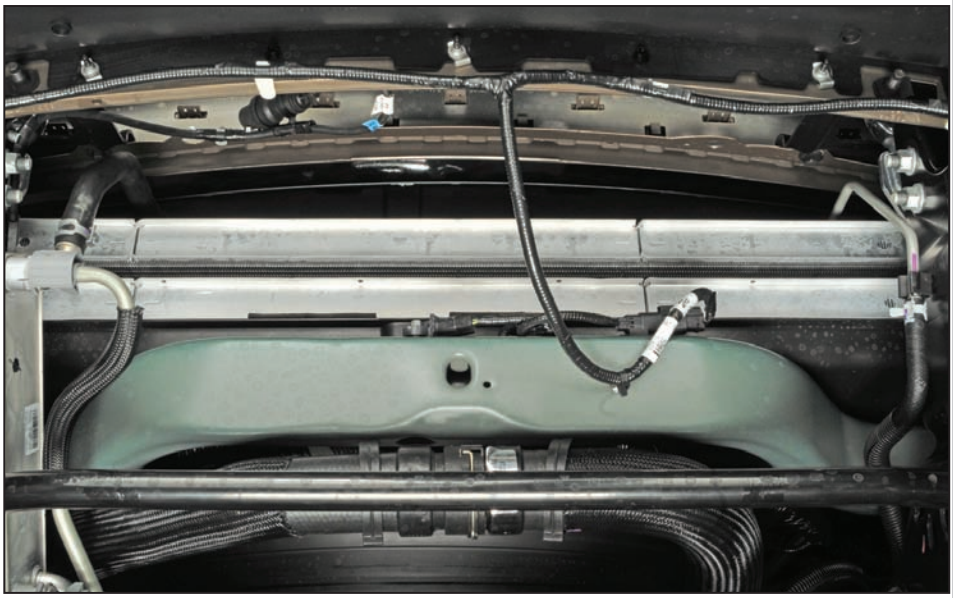


Engine Cooling Fan

The engine cooling fan is an electro-viscous design. The engine cooling fan clutch is electronically controlled by the PCM, based on input information received from various engine sensors. The PCM provides a Pulse Width Modulated (PWM) signal to the fan clutch and monitors fan speed through the Fan Speed Sensor (FSS).



COOLING SYSTEM

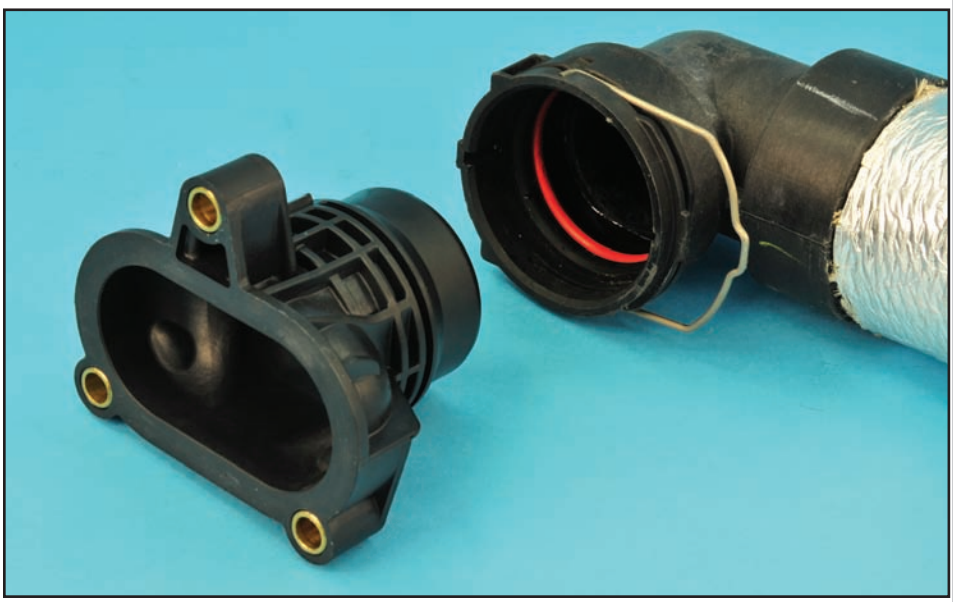


Radiators

The coolers located at the front of the grille opening include:

- primary radiator
- secondary radiator
- air conditioning condenser
- power steering cooler

The secondary radiator is located in front of the primary radiator to allow the powertrain secondary cooling system to operate at a lower temperature than the primary cooling system.

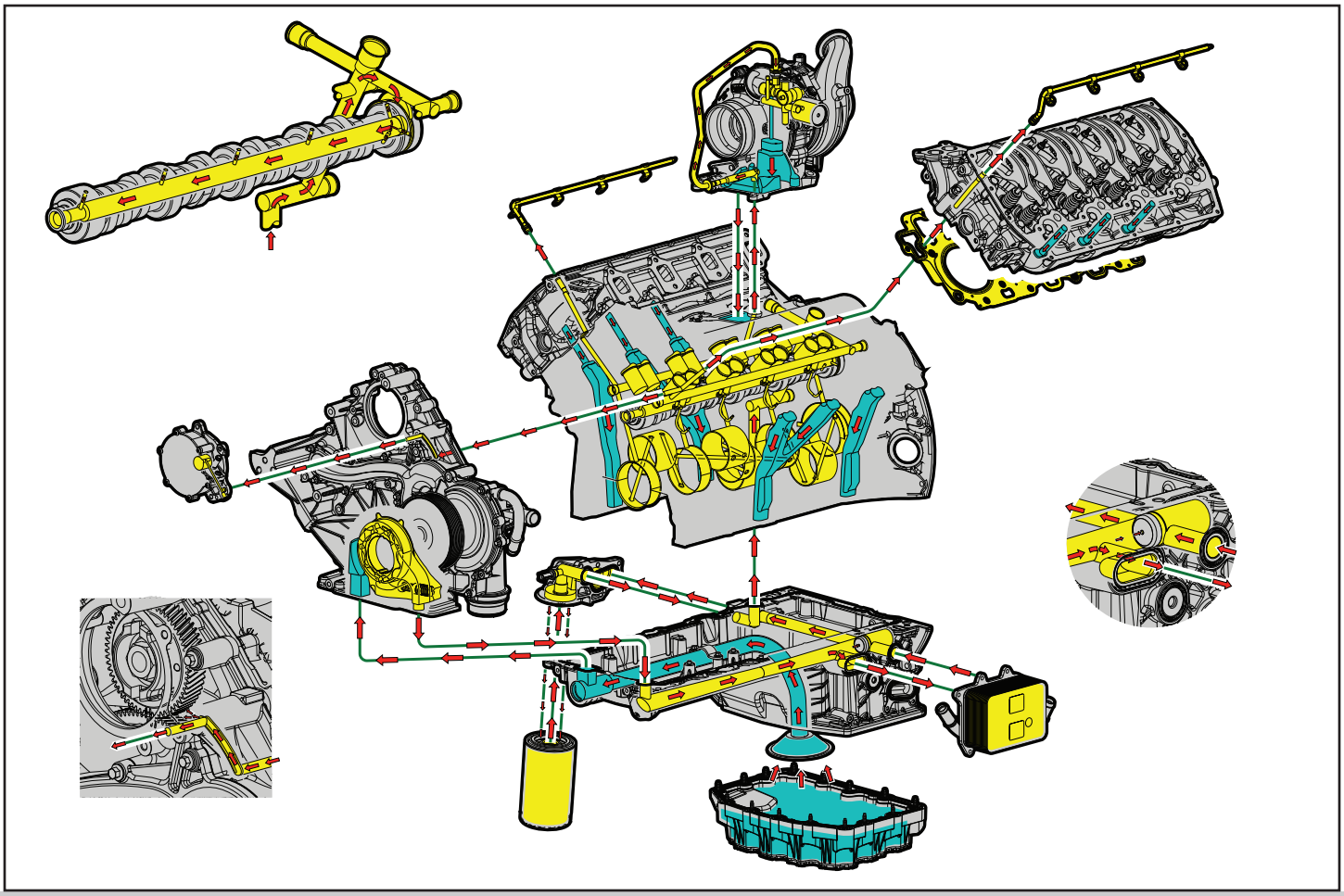


Quick-Connect Fittings

Both cooling systems use unique quick-connect fittings on the larger coolant hoses and standard style clamps on the smaller hoses.

NOTES

LUBRICATION SYSTEM



Lubrication System Oil Flow

- Oil is drawn from the oil pan through the pickup tube. It is then routed through a passage cast into the upper oil pan and then to the oil pump inlet.
- From the oil pump, oil is directed to the oil cooler and then to the oil filter.
- The main oil passage in the rear of the engine block feeds the right, left and the camshaft galleries.
- Right oil gallery feeds the:
  - rocker arm oiling manifold for the right cylinder head.
  - cam followers and hydraulic lifters on the right side.
  - piston cooling jets on the right side.
  - crankshaft main bearings,
    - a separate oil passage for each main bearing.
    - also used to lubricate the connecting rod bearings.
  - turbocharger.
- Left oil gallery feeds the:
  - rocker arm oiling manifold for the left cylinder head.
    - An oil passage connected to the gallery going up to the left cylinder head also provides engine oil to the:
      - vacuum pump.
      - meshed gears of the crankshaft, camshaft and high pressure fuel pump.
  - cam followers and hydraulic lifters on the left side.
  - piston cooling jets on the left side.
- Camshaft oil gallery feeds the camshaft bearings.

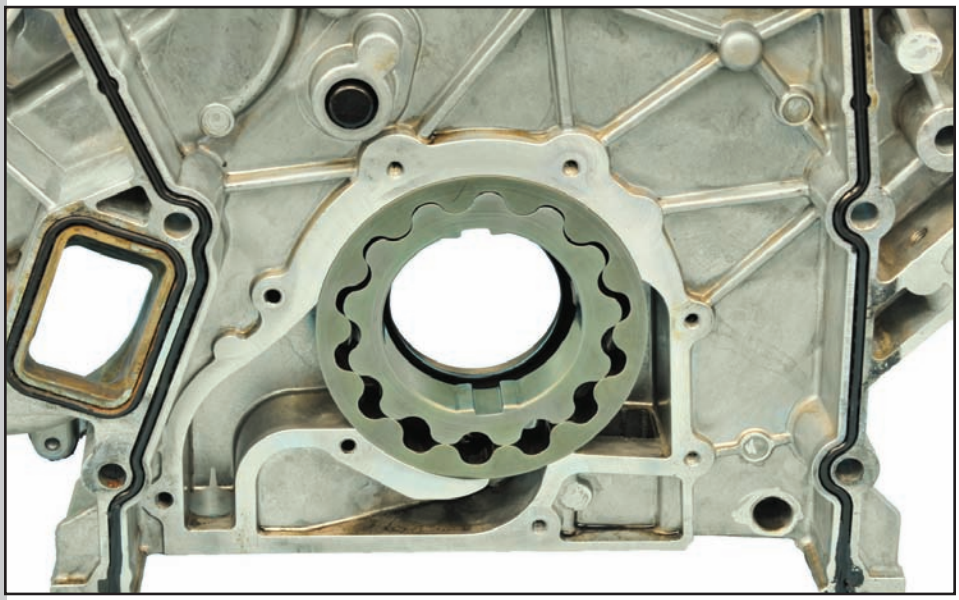
LUBRICATION SYSTEM

Lubrication System Components

Oil Pump

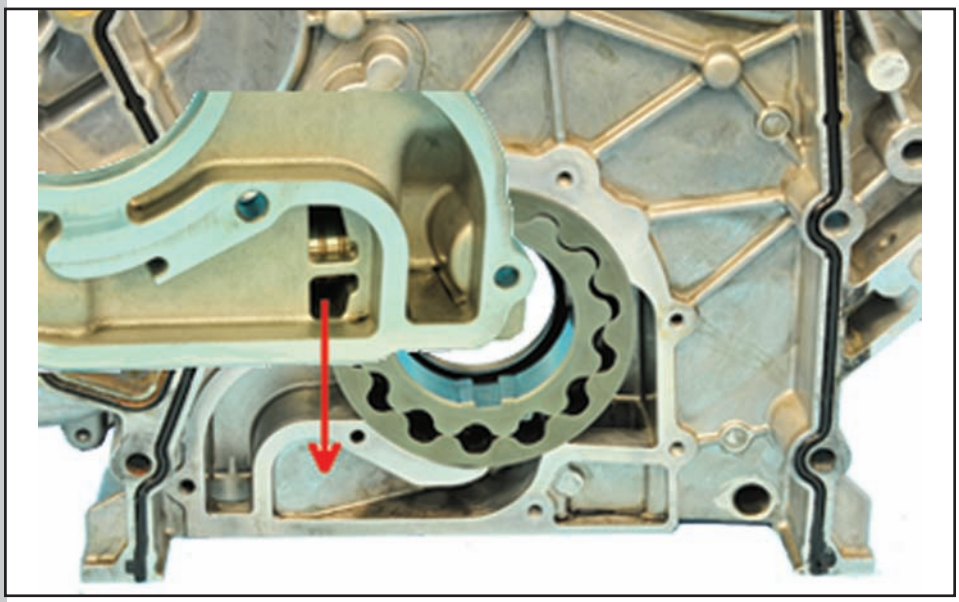
The gerotor style oil pump is mounted to the back side of the front cover.

Note: The front cover must be replaced to service the oil pump.



Oil Pressure Regulator

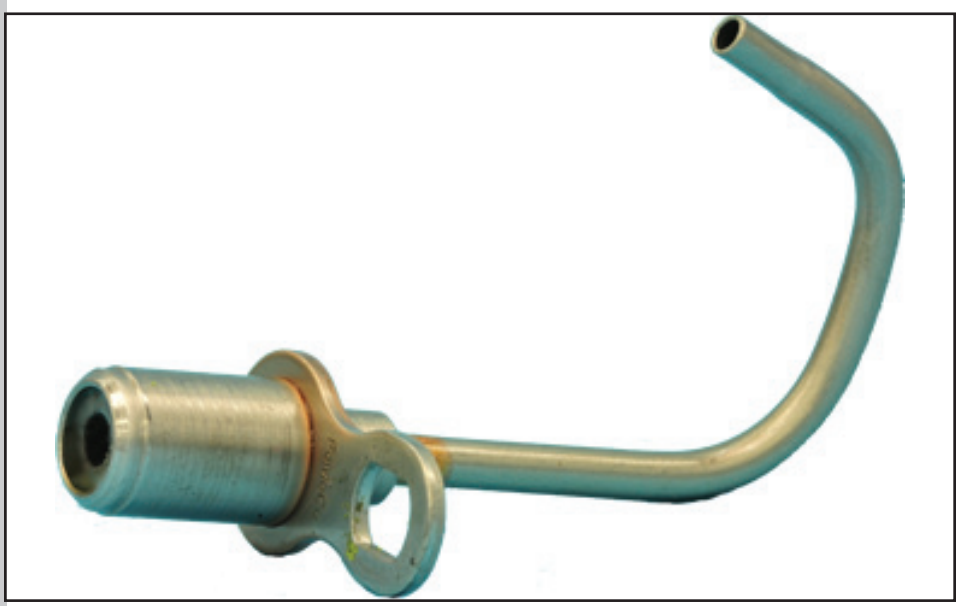
The oil pressure regulator valve is located in the oil pump cover on the back of the front cover.



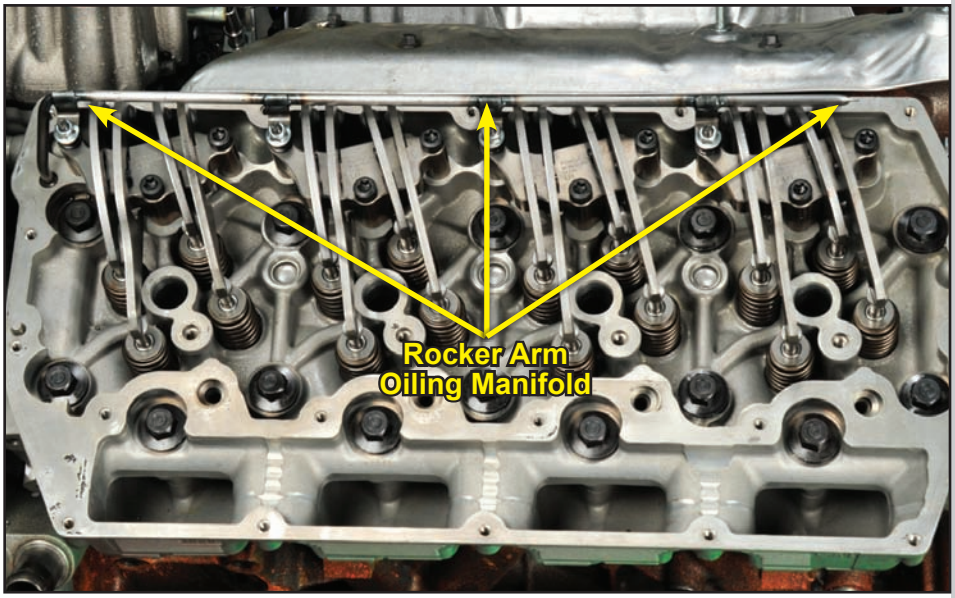
Piston Cooling Jets

The 6.7L engine incorporates piston cooling jets that spray oil into a hole in the bottom of the piston to cool the top of the piston.

The oil jets bolt into the bottom of the block and direct the oil into the piston.

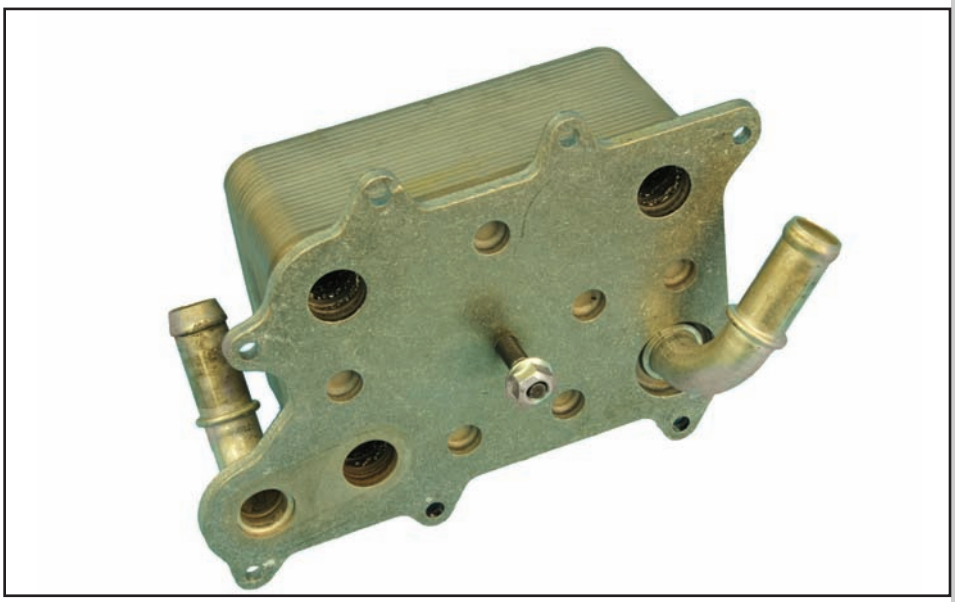


LUBRICATION SYSTEM



Cylinder Head Lubrication

There is a rocker arm oil manifold in each cylinder head that sprays oil onto the rocker arms and valve springs for cooling and lubrication.

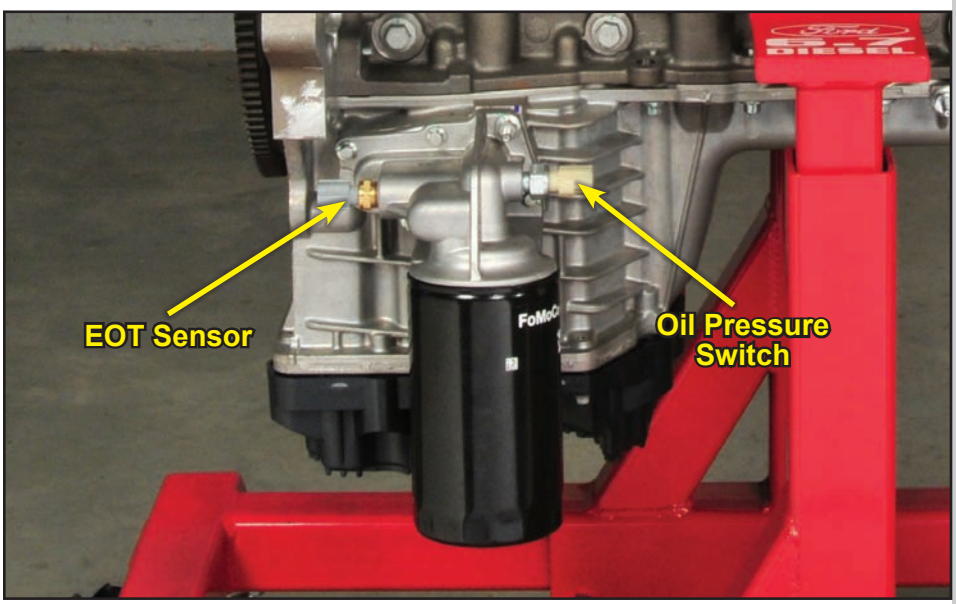


Oil Cooler

The oil cooler is mounted on the oil pan of the engine and uses engine coolant to dissipate heat from the engine oil.

The coolant and oil are separated by multiple plates that create passages in the oil cooler.

After oil has been cooled, it exits the oil cooler and travels through the oil pan to the oil filter.



Oil Filter Adapter

The oil filter is a spin-on style mounted on the right side of the oil pan.

The Engine Oil Temperature (EOT) sensor is upstream of the oil filter. The sensor features 2 pins, and has a brass or bronze sensing face.

The oil pressure switch is downstream of the oil filter. The sensor features 1 pin, and has a small diameter hole feeding the sensing unit.

NOTES

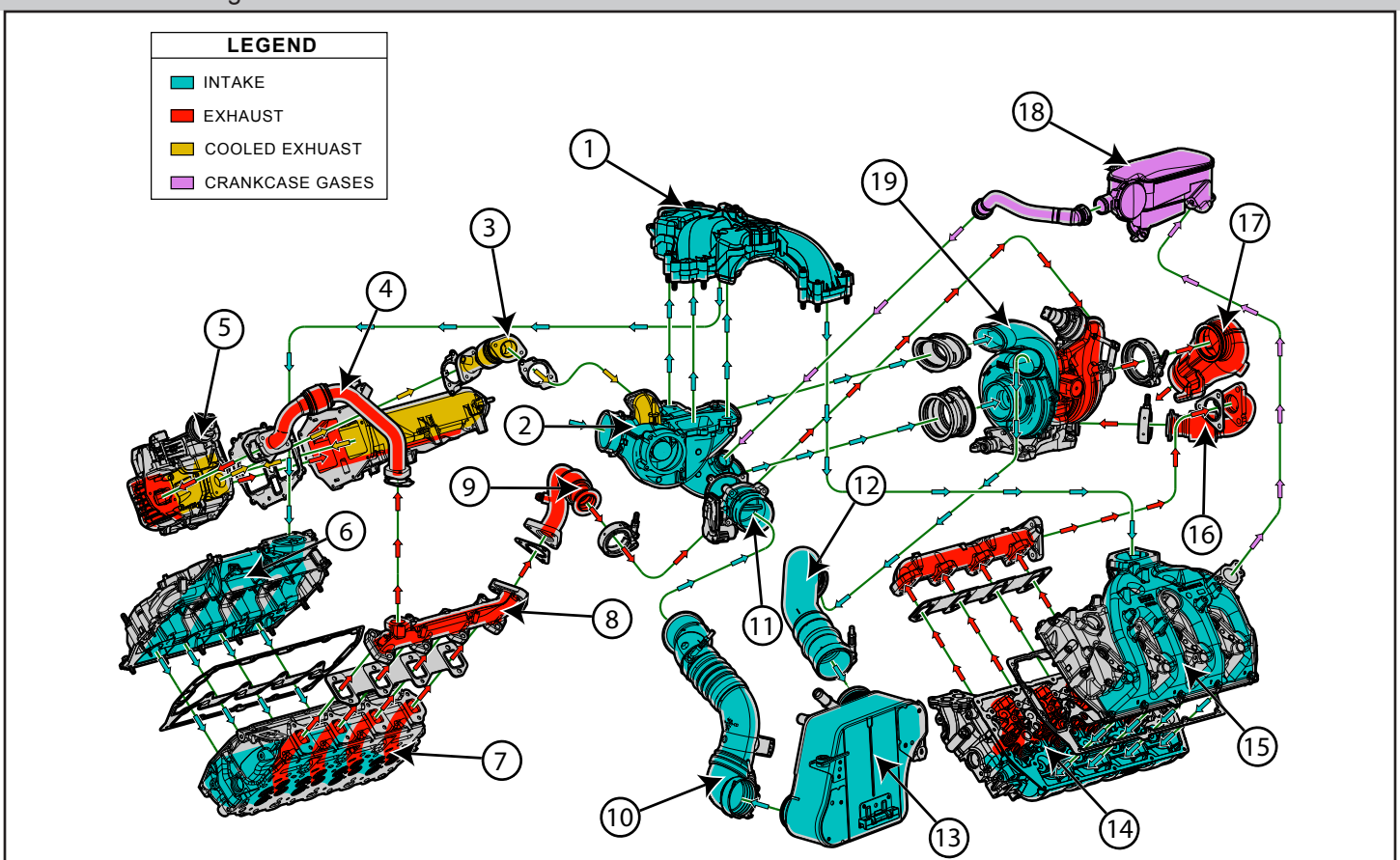
AIR MANAGEMENT SYSTEM

Intake Side

Air is drawn through the air filter, past the Mass Air Flow (MAF) and Intake Air Temperature (IAT) sensors. The MAF sensor measures the mass of the air entering the engine and IAT sensor obtains the temperature. Next, the air enters the compressor side of the turbocharger through the lower intake manifold. The air is compressed above atmospheric pressure, causing the air to heat up. The hot, pressurized air is routed through an air-to-water Charge Air Cooler (CAC) which cools the charge, increasing power capability of the engine. From the CAC the air passes the CAC temperature sensor, through the intake throttle body and into the other side of the lower intake manifold. Inside the lower intake manifold the air mixes with EGR gases (if EGR valve is open), travels to the upper intake manifold, and through the right and left side rocker covers to the intake ports of the cylinder heads.

Exhaust Side

Exhaust gases exit the exhaust ports into the inboard exhaust manifolds. Exhaust gases are directed to the dual inlet of the turbo through the right and left side up-pipe. The exhaust spins the turbine wheel inside the turbocharger. The turbine wheel spins the compressor wheel(s) through their common shaft. Some of the exhaust from the passenger side manifold is directed to the EGR valve through the EGR inlet pipe. When the EGR valve is being operated the exhaust gas has two possible paths to follow; it can either flow through or it can bypass the EGR cooler. This is done by the EGR cooler bypass valve. The exhaust gas enters the lower intake manifold and combines with the fresh air.



Number	Component	Number	Component
1	Upper intake manifold	11	Intake throttle body
2	Lower intake manifold	12	CAC inlet
3	EGR outlet tube	13	CAC
4	Exhaust manifold to EGR tube	14	Left cylinder head
5	EGR valve	15	Left valve cover
6	Right valve cover	16	Left turbo inlet pipe
7	Right cylinder head	17	Turbocharger downpipe
8	Right exhaust manifold	18	Crankcase vent oil separator
9	Right turbo inlet pipe	19	Turbocharger
10	CAC outlet		

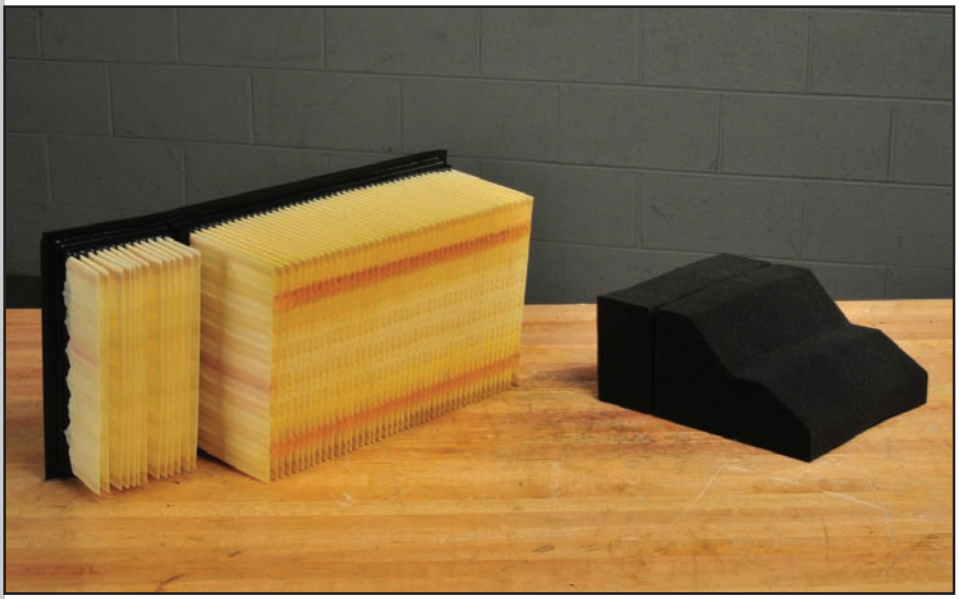
AIR MANAGEMENT SYSTEM

Air Inlet Components

Air Filter

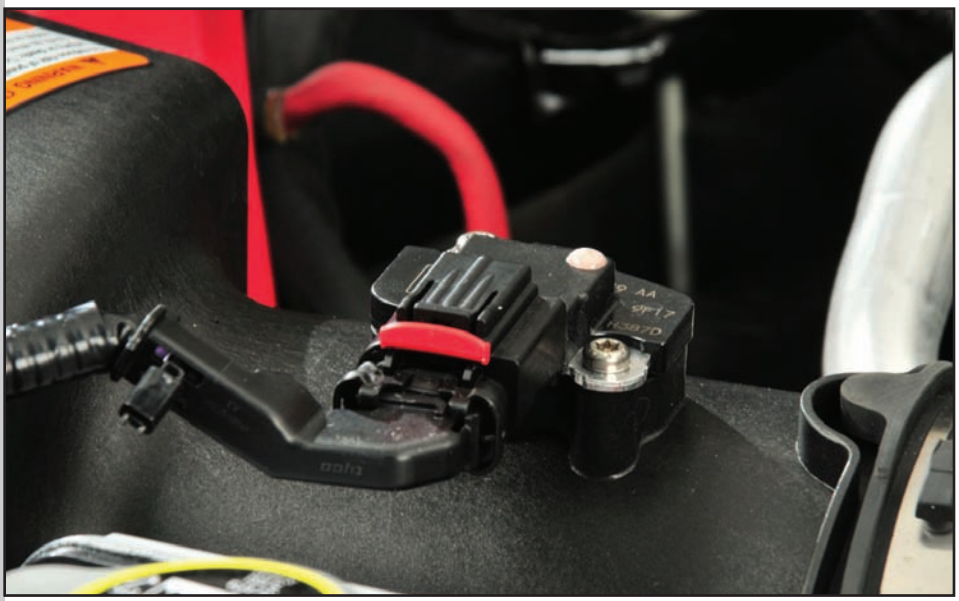
The air filter is located on the passenger side of the engine compartment in front of the battery.

The air filter housing includes a non-electrical filter minder to measure inlet restriction. When the filter element becomes contaminated beyond useful limits, the filter minder visually indicates the need for replacement.



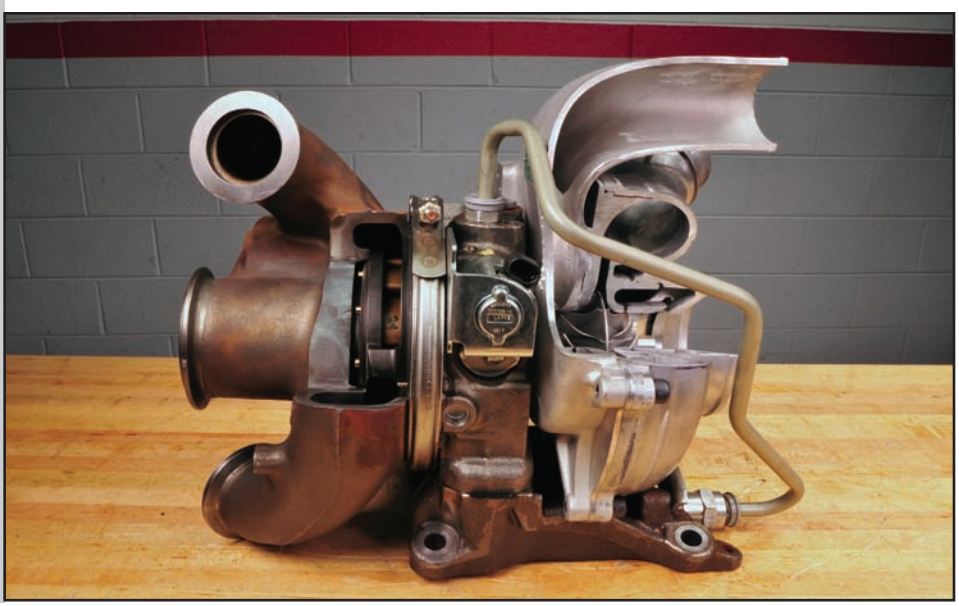
Mass Air Flow/Intake Air Temperature (MAF/IAT) Sensor

The air intake system includes MAF and IAT sensors integrated into one unit. The MAF/IAT sensor is located in the air inlet tube after the air filter.



Pickup Turbocharger (Wide Frame)

The turbocharger pickup models use a DualBoost turbocharger. This turbocharger has one exhaust turbine, two intake compressors and incorporates a wastegate. The exhaust turbine has variable vanes that change with engine oil pressure from a PCM-controlled solenoid.

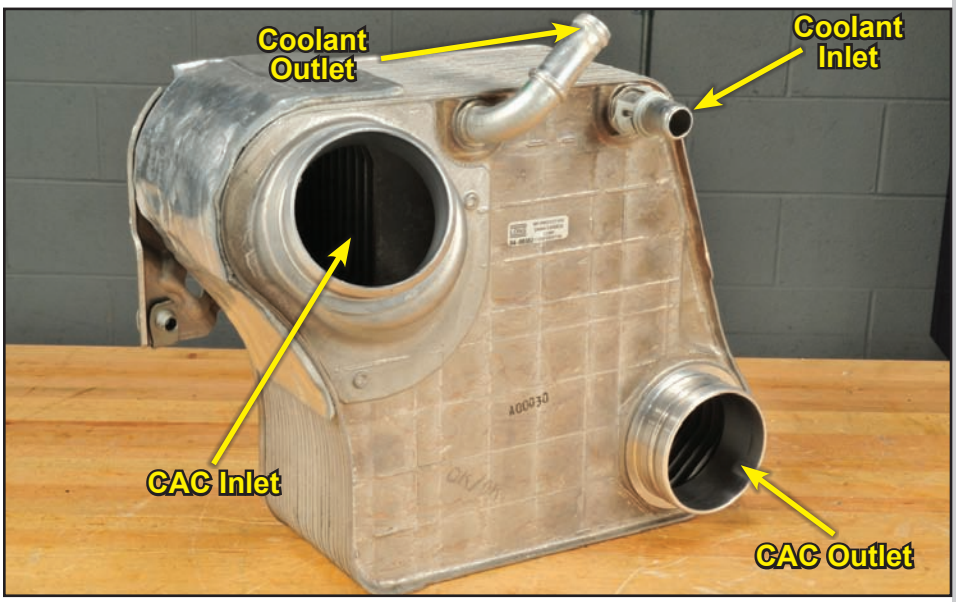


AIR MANAGEMENT SYSTEM



Chassis Cab Turbocharger (Narrow Frame)

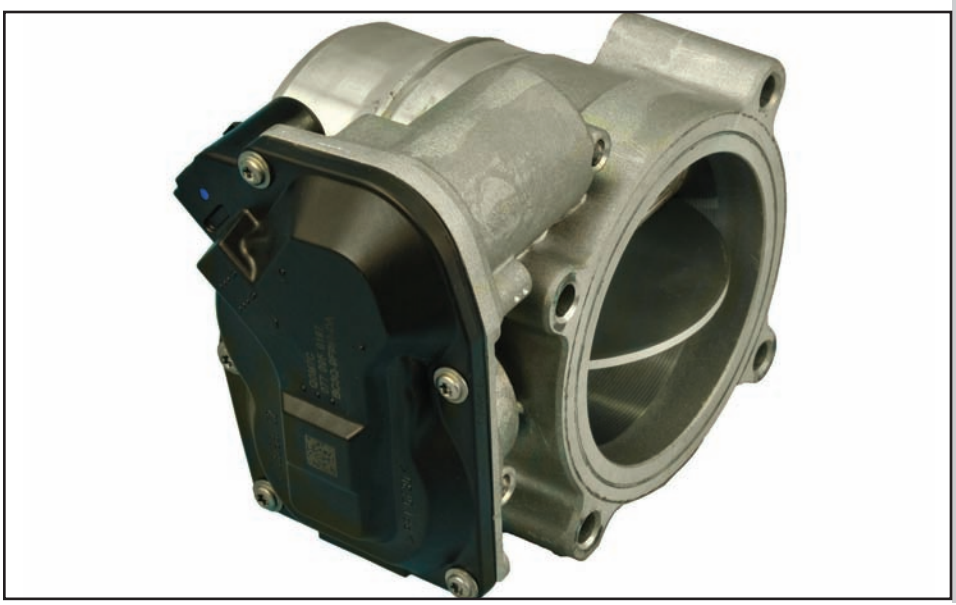
The chassis cab uses a standard Variable Geometry Turbocharger (VGT) operated with engine oil pressure that is controlled by the PCM. This turbocharger does not incorporate a wastegate.



Charge Air Cooler (CAC)

The CAC is located on the left side of the engine, on top of the fender well.

The CAC is an air-to-coolant heat exchanger used to reduce the temperature of the compressed air from the turbocharger prior to entering the combustion chambers. Cooler air is denser (improving volumetric efficiency), resulting in increased power.



Intake Throttle Body

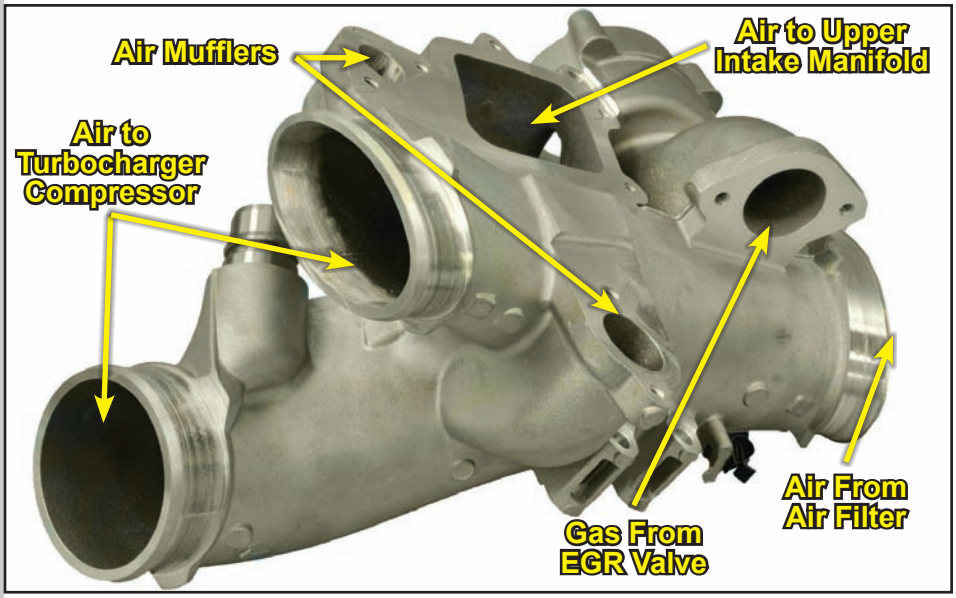
The intake throttle body is located on the top of the engine, attached to the lower intake manifold.

The intake throttle body controls air flow into the intake air system.

AIR MANAGEMENT SYSTEM

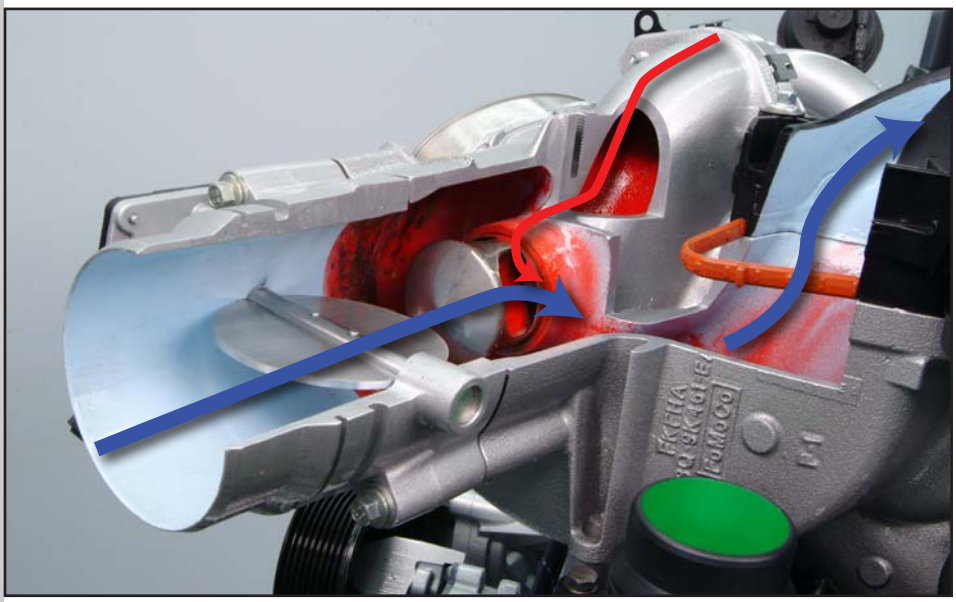
Lower Intake Manifold

The lower intake manifold is on the top of the engine and intake air passes through it twice. The first time it flows through the lower intake manifold before going to the turbocharger inlet, pulling crankcase vapors into the lower intake manifold with the air on its way to the turbocharger.



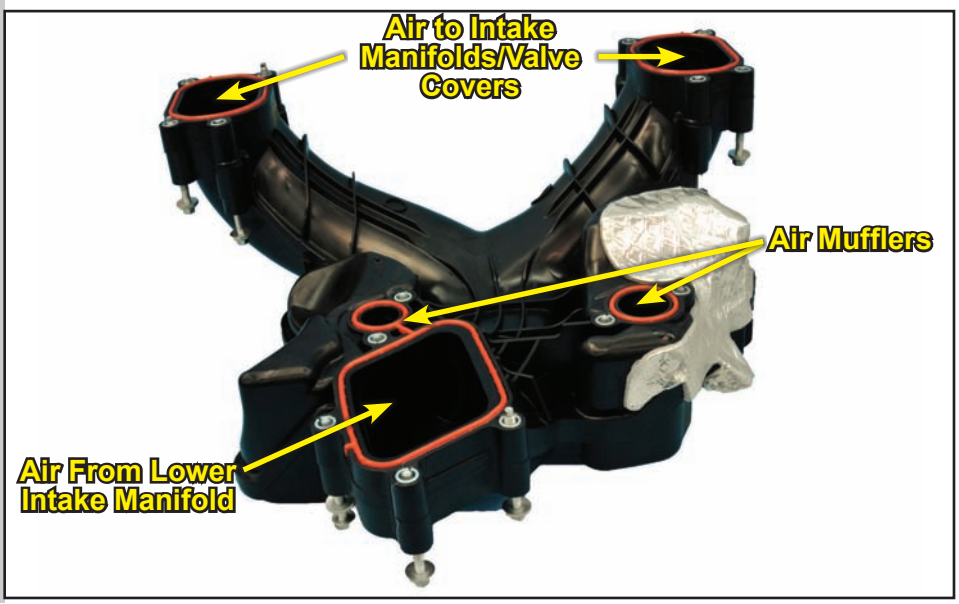
Lower Intake Air Flow after the CAC

After leaving the turbocharger outlet the air goes through the CAC and then through the intake throttle body before it is mixed with exhaust gases from the EGR valve. The blue line represents the flow of cooled intake air and the red line represents the flow of EGR gases.

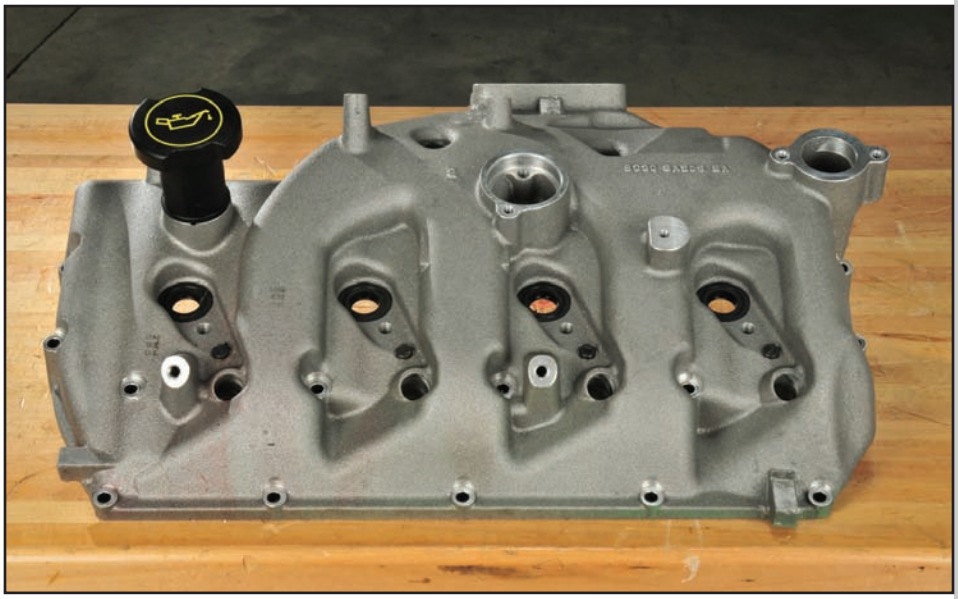


Upper Intake Manifold

The upper intake manifold directs pressurized air from the lower intake manifold to the intake manifold/valve covers. The upper intake manifold contains two intake noise mufflers to reduce intake noise.

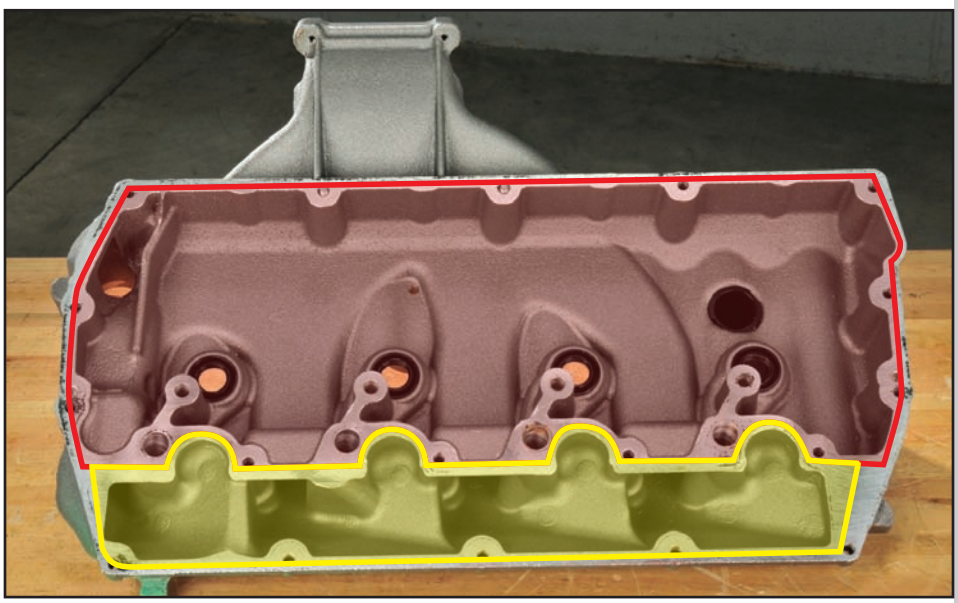


AIR MANAGEMENT SYSTEM



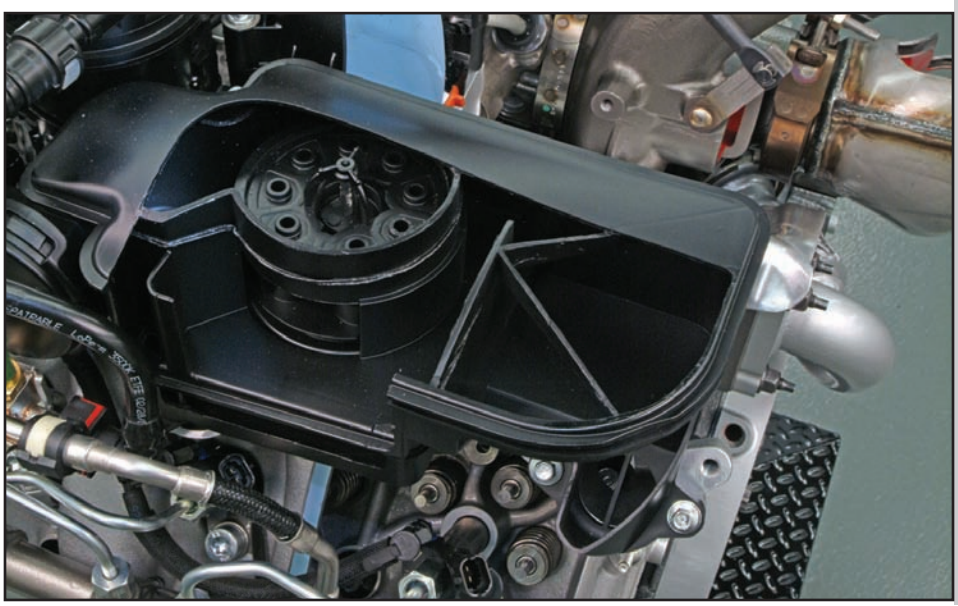
Intake Manifold/Valve Cover

The intake manifold/valve cover for each cylinder head are incorporated into one piece. The air flows from the upper intake manifold into the top of the valve cover and across to the intake ports.



Bottom of Valve Cover

In the picture you can see the intake manifold port on the bottom (indicated in yellow) and the valve cover cavity on the top (indicated in red).



Crankcase Vent Oil Separator

The crankcase vent oil separator is attached to the left valve cover.

The engine crankcase vent oil separator separates the oil from crankcase vapors and returns it to the crankcase through the valve cover. The vapors are routed into the intake ducting at the lower intake, before the turbo inlet.

AIR MANAGEMENT SYSTEM

Glow Plug System

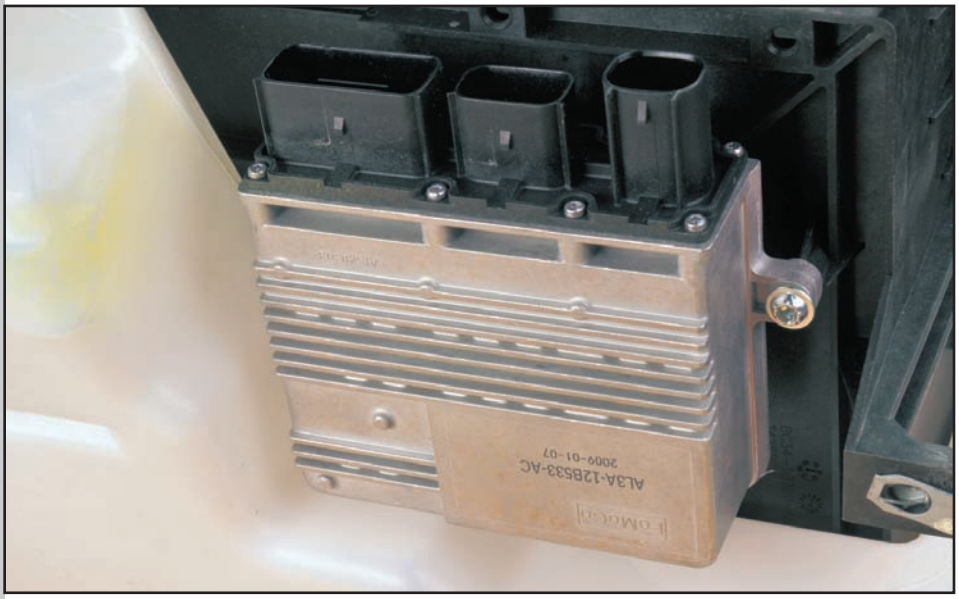
Glow Plug Control Module (GPCM)

The GPCM is located under the passenger side battery box.

The glow plug system is electronically controlled by the PCM. The PCM monitors the Ambient Air Temperature (AAT), ECT and BARO sensors to control glow plug operation.

The GPCM controls the glow plugs and the reductant system heating elements.

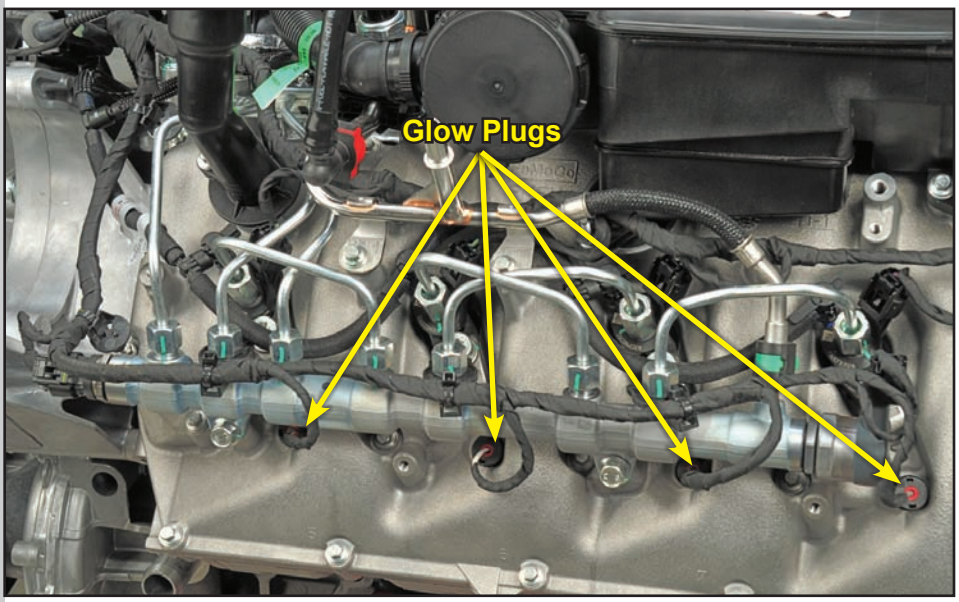
When required, the PCM supplies a signal to the GPCM which in turn supplies current to the glow plugs.



Glow Plugs

The glow plugs are mounted in the cylinder heads and are accessible through the valve cover.

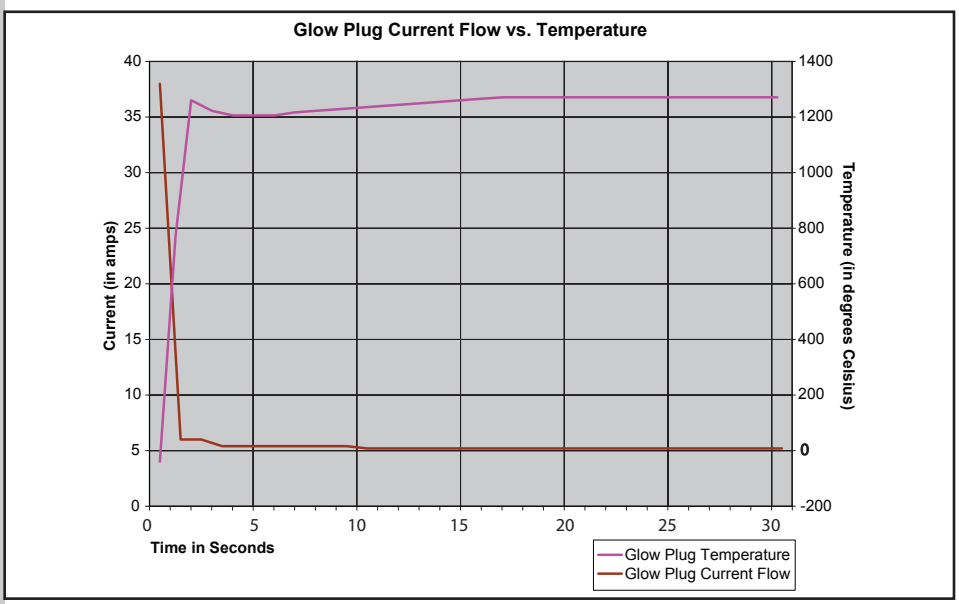
The GPCM supplies the required current to each glow plug, based on commands from the PCM. Ground is provided through the glow plug body to the cylinder head.



Glow Plug Operation

Some of the features of the ceramic glow plugs used on the 6.7L Power Stroke® diesel are:

- End of compression temperature is high enough to auto-ignite the fuel.
- The ceramic glow plugs can reach 1250°C (2282°F) in 2 seconds.
- The tip of the glow plug is closer to the rim of the piston than the injector. This causes the heat from the glow plug to contact the rim zone of the fuel spray.

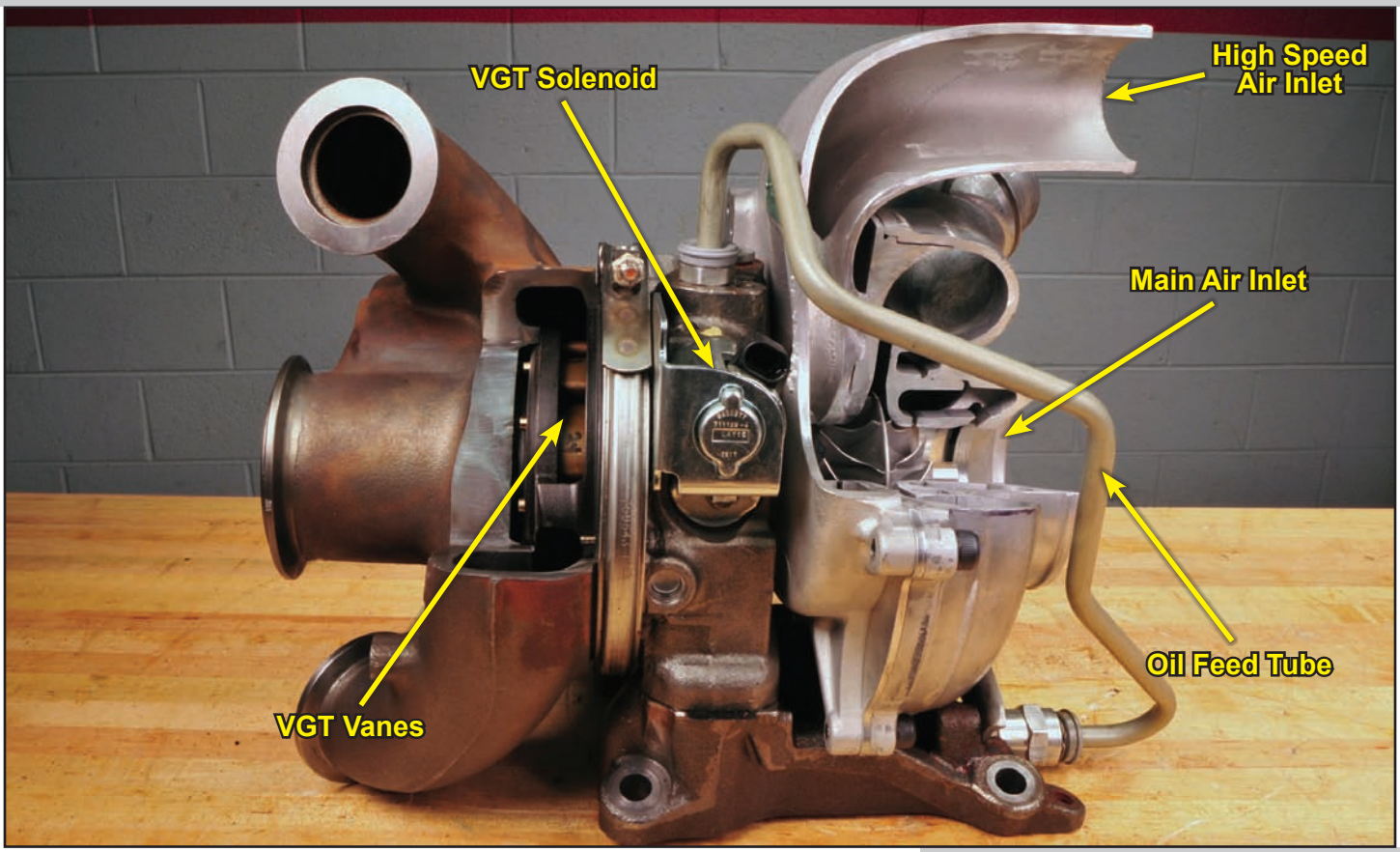


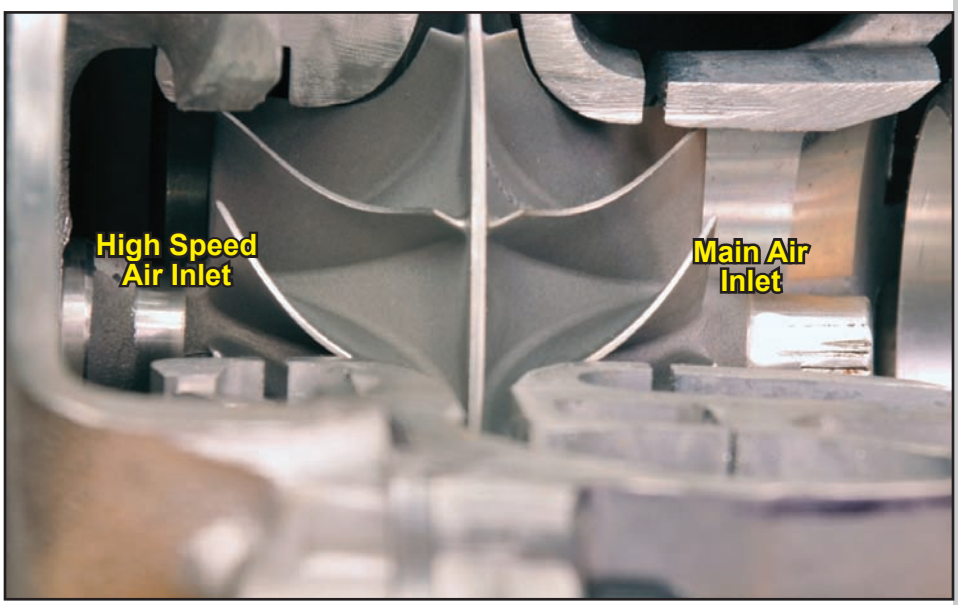
AIR MANAGEMENT SYSTEM

DualBoost Variable Geometry Turbocharger (VGT)

Turbocharger control is based off an air system model that produces a desired intake pressure to meet the power requirements requested by the operator. The PCM commands the VGT control valve by a feedback loop in the intake system to achieve the desired intake pressure to meet the driver's needs (pedal position, engine load). The air system model considers engine temperature, air temperature, EGR operation, RPM, and engine load.

The turbocharger on pickup box models have a wastegate. The PCM controls the wastegate solenoid to supply vacuum to the actuator. When intake pressure is greater than desired and the VGT has commanded the vanes to the full open position the wastegate opens allowing exhaust gases to bypass the turbine fins, reducing exhaust pressure thus reducing intake pressure.





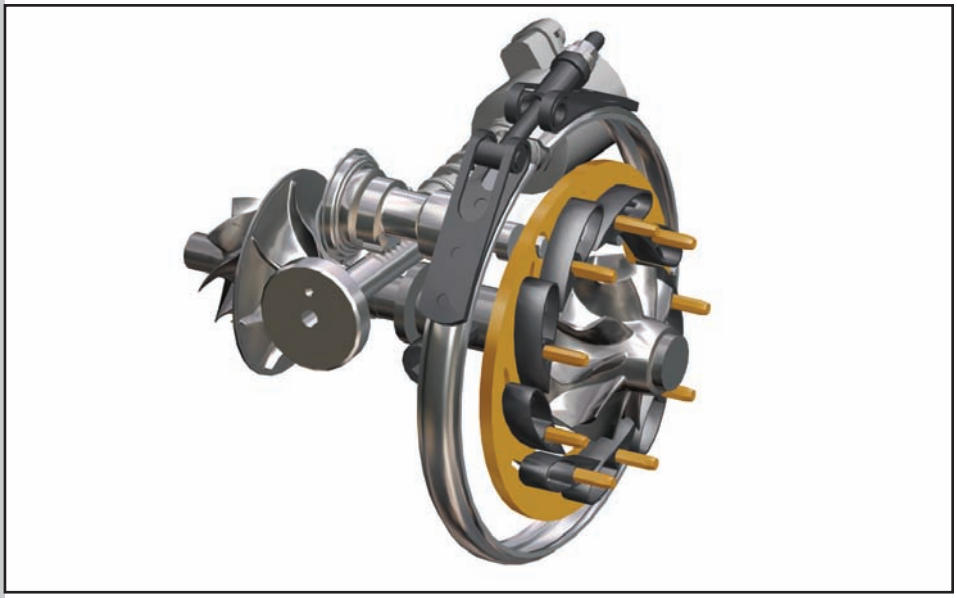
Intake Compressors

The DualBoost VGT has two intake compressors and one exhaust turbine on a common shaft.

AIR MANAGEMENT SYSTEM

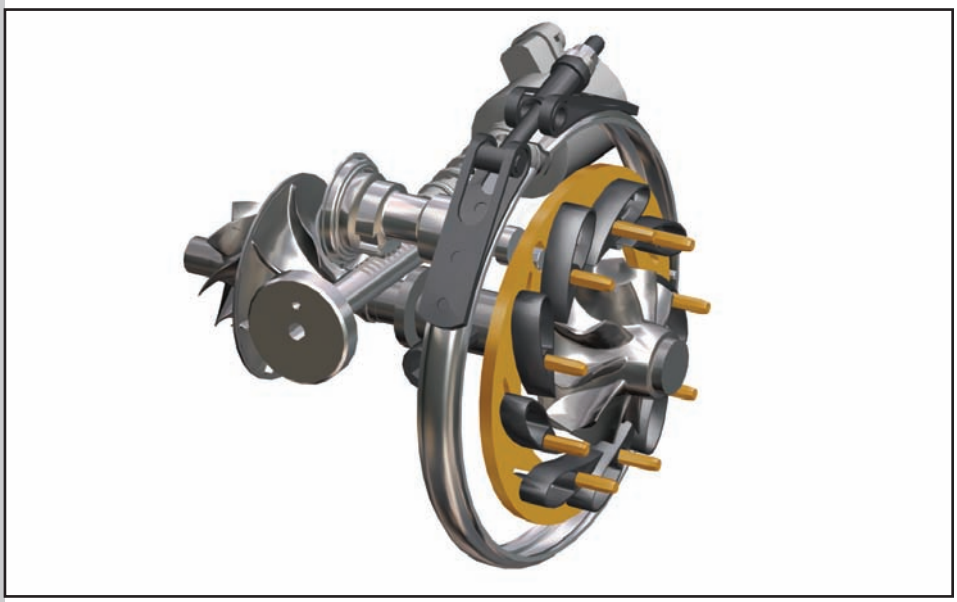
VGT Closed

When the VGT is closed it maximizes the use of the energy that is available at low speeds. Closing the VGT accelerates exhaust gas flow across the vanes of the turbine wheel. This allows the turbocharger to behave as a smaller turbocharger. Closing the vanes also increases the exhaust pressure in the exhaust manifold, which aids in pushing exhaust gas into the intake. This is also the position for cold ambient warm-up.



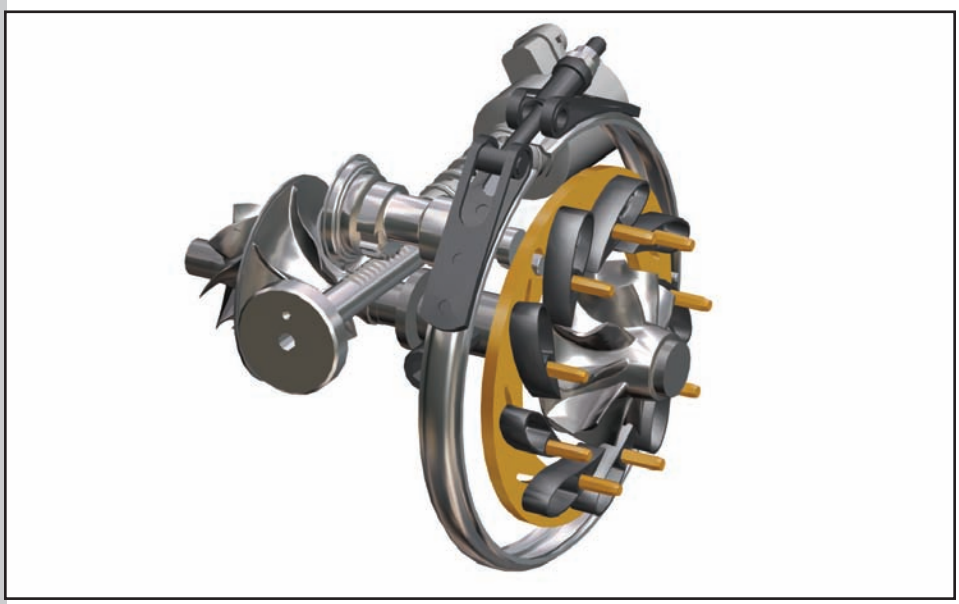
VGT Partially Open

During engine operation at moderate engine speeds and load, the vanes are commanded partially open. The vanes are set to this intermediate position to supply the correct amount of boost to the engine for optimal combustion, as well as providing the necessary exhaust pressure to assist in EGR flow.

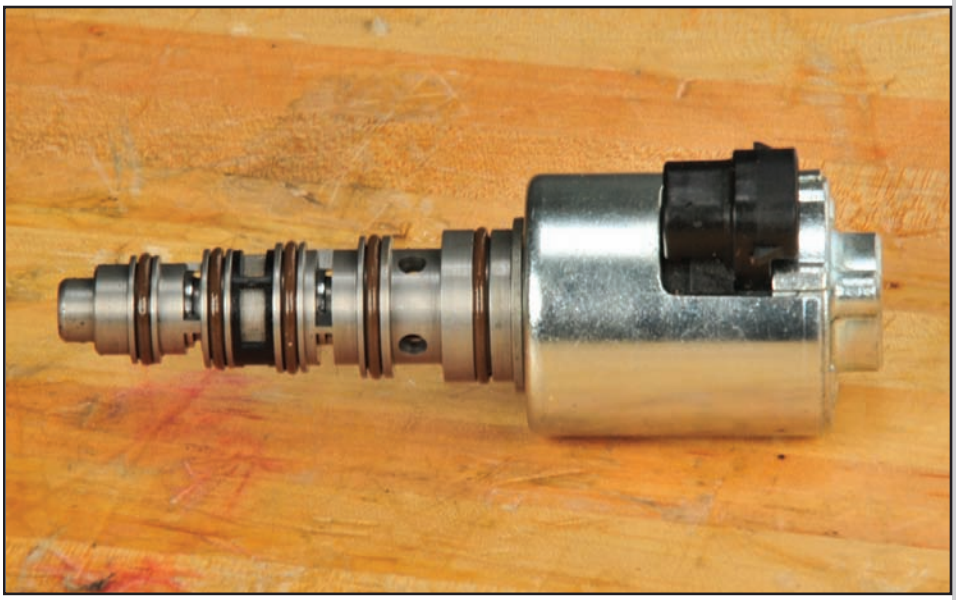


VGT Open

During engine operation at high engine speeds and load, there is a great deal of energy available in the exhaust. Excessive boost under high speed, high load conditions can negatively affect component durability. Therefore, the vanes are commanded open preventing turbocharger overspeed. Essentially, this allows the turbocharger to act as a large turbocharger.

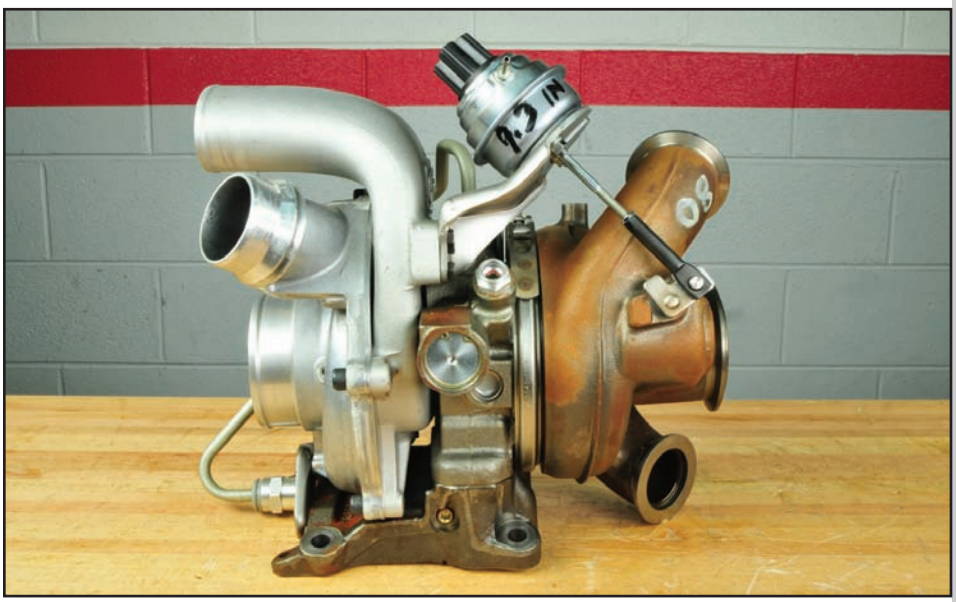


AIR MANAGEMENT SYSTEM



VGT Actuator

The 6.7L VGT actuator uses engine oil pressure on a piston to move the vanes on the exhaust turbine. The VGT actuator is commanded by the PCM, based on a desired manifold pressure. This actuator meters engine oil to either side of the piston. This design feature reacts quickly to changes in demand based on driving conditions. When one side of the piston is pressurized, the opposite side is vented.

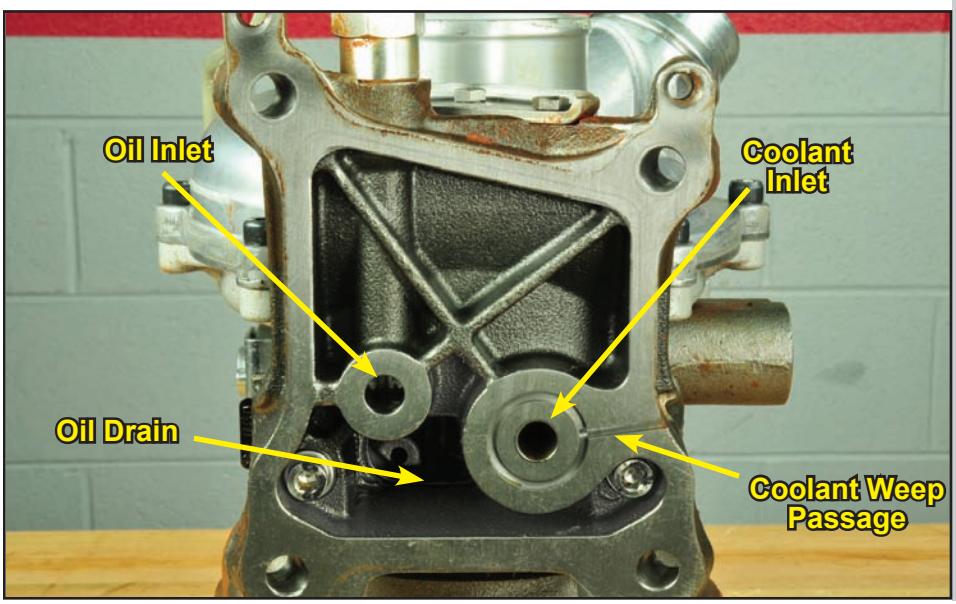


Wastegate Solenoid and Actuator

The wastegate on the DualBoost VGT is vacuum controlled through a solenoid that is controlled by the PCM. The wastegate is only used on the DualBoost turbocharger.

The wastegate opens to relieve excessive exhaust pressure at higher RPMs.

When the VGT cannot react quickly enough to reduce MAP pressure, the wastegate opens to reduce Exhaust Pressure (EP) to slow down the turbocharger.



Coolant Passages

The turbocharger is cooled using coolant from the primary cooling system. Coolant enters the turbocharger from the block on the bottom of the turbocharger and flows through and out the top of the turbocharger through a line back to the coolant crossover tube.

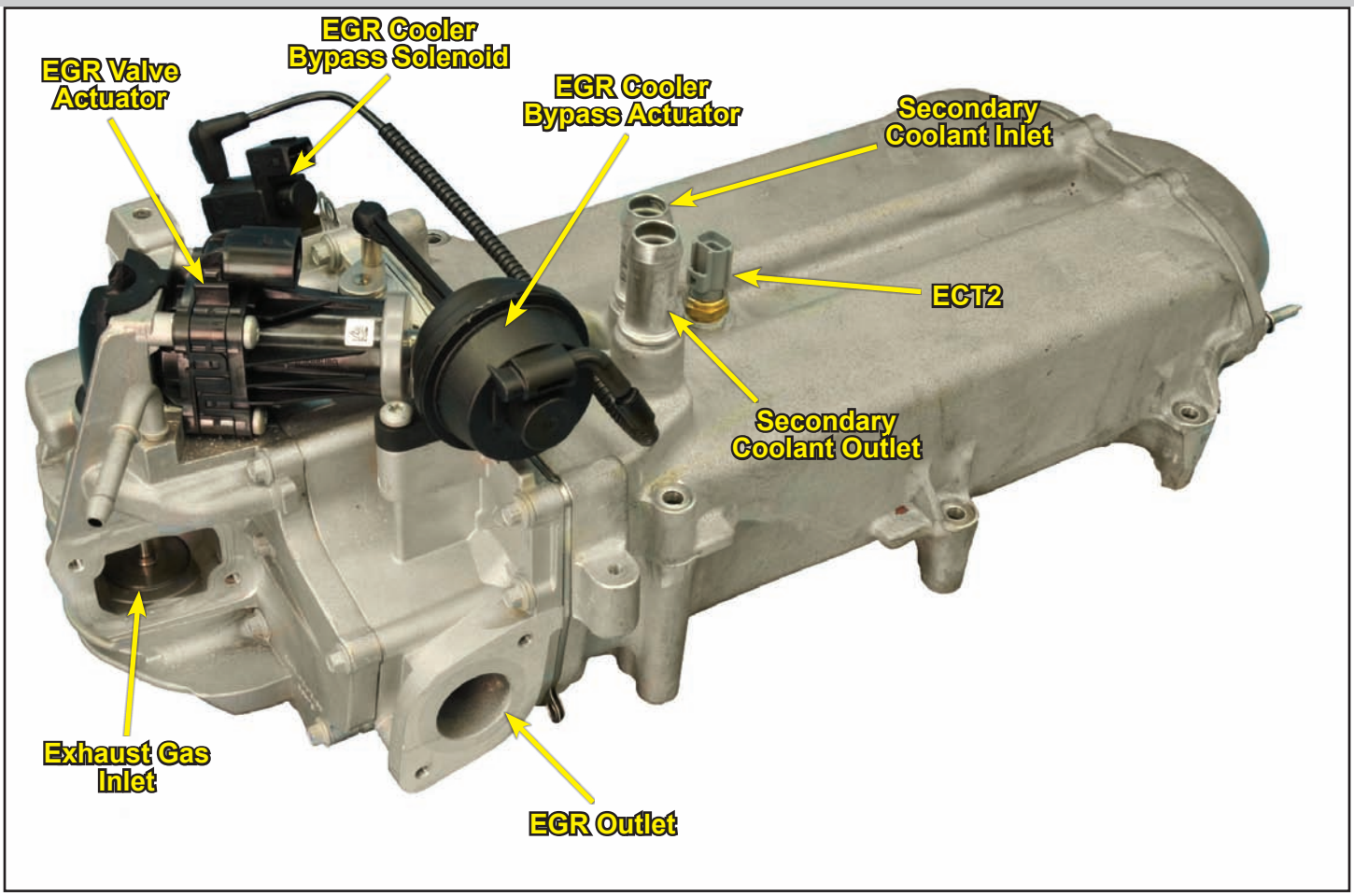
AIR MANAGEMENT SYSTEM

Exhaust Gas Recirculation (EGR)

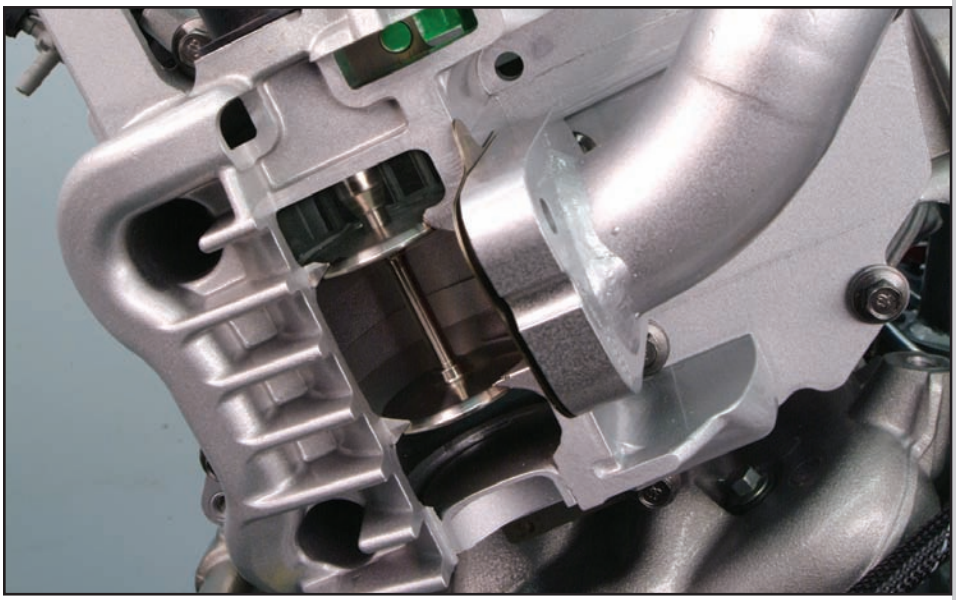
The EGR system allows cooled (inert) exhaust gases to re-enter the combustion chamber, which lowers combustion temperatures and Oxides of Nitrogen (NO_x) emissions.

EGR system control is based off an air system model to estimate the percentage of exhaust gas in the cylinder. The PCM looks at engine temperature, intake pressure, Exhaust Pressure (EP), RPM, and engine load to determine the EGR flow rate. The PCM uses the ratio of MAP and EP to estimate a desired EGR valve position. The desired position is compared to the actual position and the duty cycle is adjusted to meet that desired position for the required EGR flow rate. If the rate is not achieved with EGR valve position, the intake throttle valve closes to a desired position, reducing intake manifold pressure. Reducing the intake manifold pressure increases the pressure ratio allowing more exhaust to fill the intake manifold at a given EGR valve position. As more exhaust gas is introduced into the intake manifold the amount of air measured by the Mass Air Flow (MAF) sensor is decreased.

The 6.7L has a hot side EGR valve due to it being before the EGR cooler. Once past the EGR valve, the exhaust gas is either directed through or bypasses the EGR cooler. This is done by the PCM controlling the EGR cooler bypass solenoid which turns vacuum on or off to the actuator on the bypass door. The EGR Temperature (EGRT) sensor measures the temperature of the exhaust gas leaving the system for cooler effectiveness and bypass control.

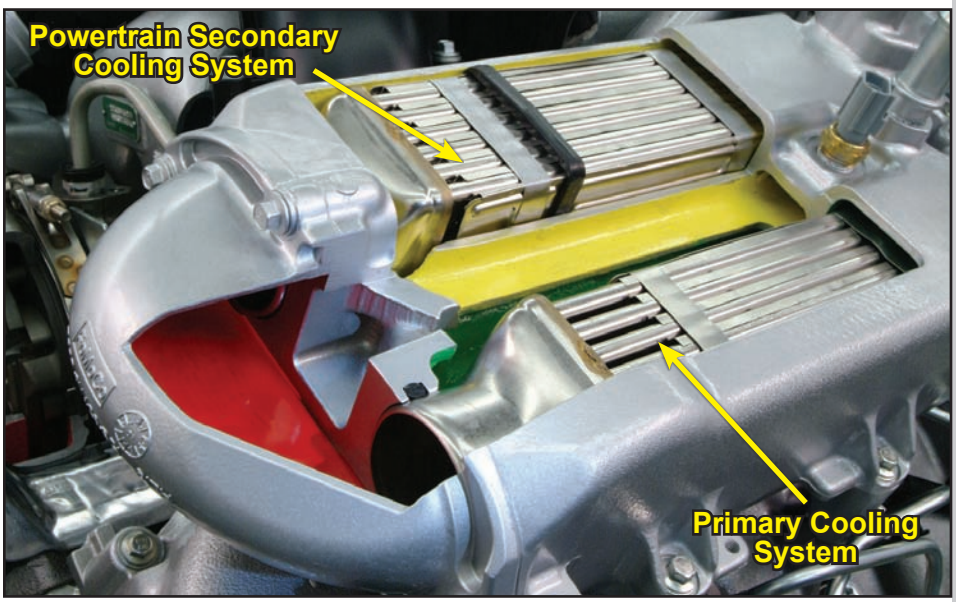


AIR MANAGEMENT SYSTEM



EGR Valve

The EGR valve receives a duty cycle signal from the PCM and sends a variable voltage signal from the Exhaust Gas Recirculation Valve Position (EGRVP) sensor back to the PCM to indicate actual position. Internally, it has two valves connected by a common shaft. Exhaust gases are routed from the right exhaust manifold to the center of the valve. When the valve is opened, exhaust gases flow out the top and bottom poppet valves. Wide frame pickup box vehicles use aluminum EGR valve bodies, while narrow frame chassis cab vehicles use iron EGR valve bodies due to higher EGR flow rates required for narrow frame emissions.

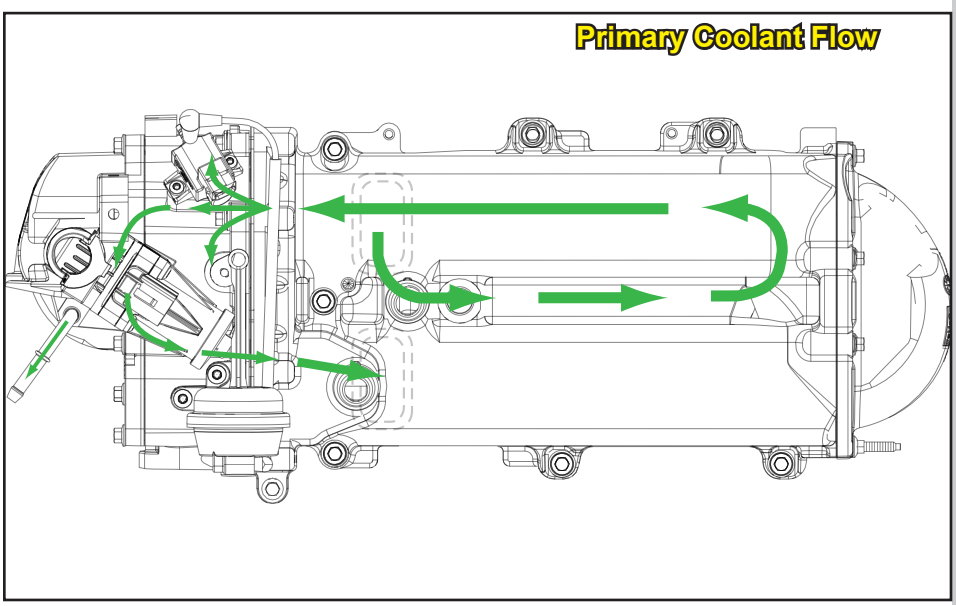


EGR Cooler

The EGR system uses an EGR cooler after the EGR valve. This keeps the EGR valve cleaner than previous engines.

The EGR cooler is located on the right valve cover, for easier service.

The cooler EGR temperature reduces NO_x emissions.



EGR Primary Coolant Flow

The first part of the EGR cooler is cooled by the primary cooling system.

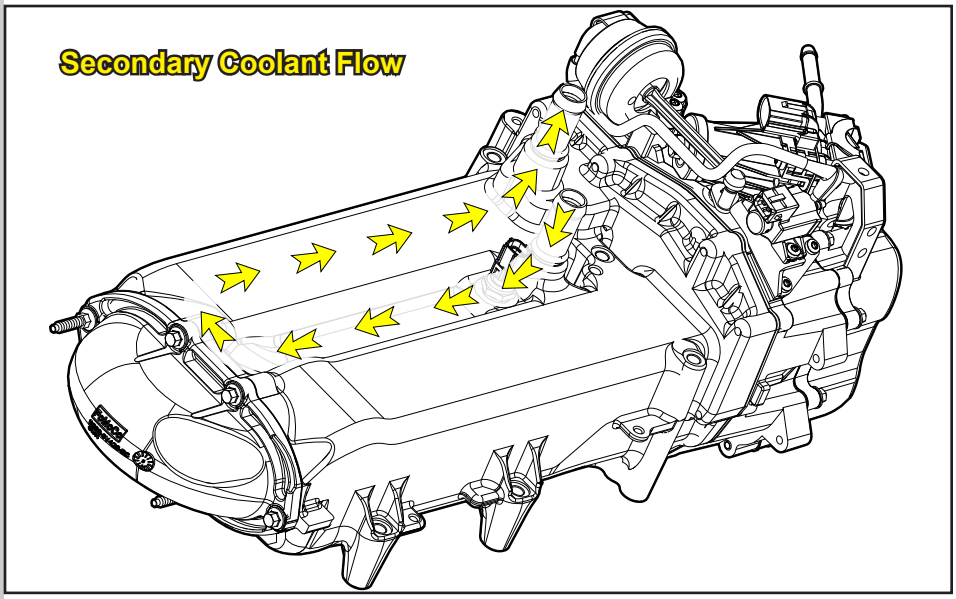
An internal air-to-coolant heat exchanger absorbs heat from the exhaust gases and dissipates heat to the atmosphere through the primary radiators.

AIR MANAGEMENT SYSTEM

EGR Powertrain Secondary Coolant Flow

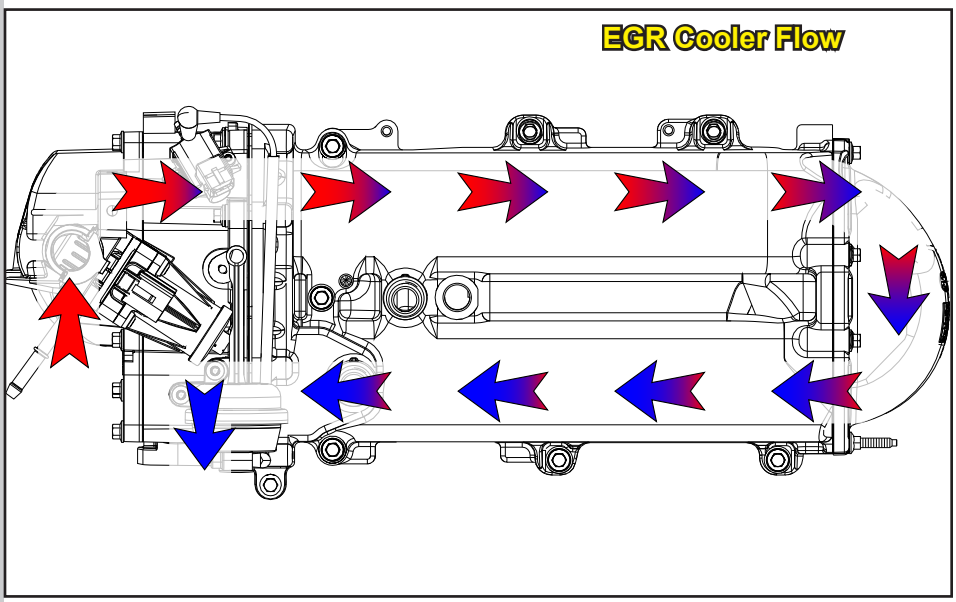
The second part of the EGR cooler is cooled by the powertrain secondary cooling system.

An internal air-to-coolant heat exchanger absorbs heat from the exhaust gases and dissipates heat to the atmosphere through the powertrain secondary radiators.



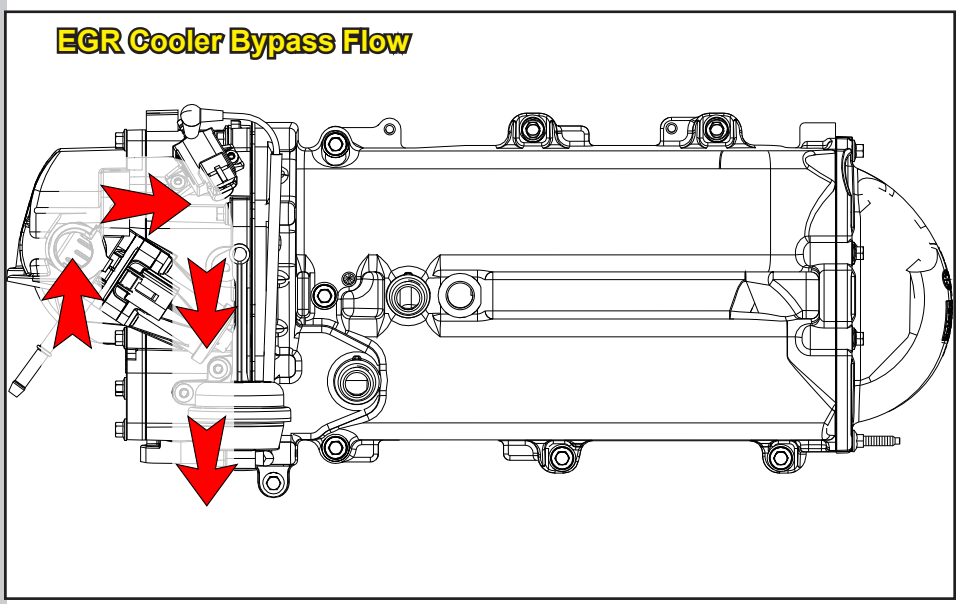
EGR Flow

The exhaust gas enters through the EGR valve and then goes through the EGR bypass valve. As the exhaust gas enters the EGR cooler, it is first cooled by the primary cooling system. It flows through the secondary EGR cooler where it is cooled further before exiting the EGR cooler and entering the intake air system.

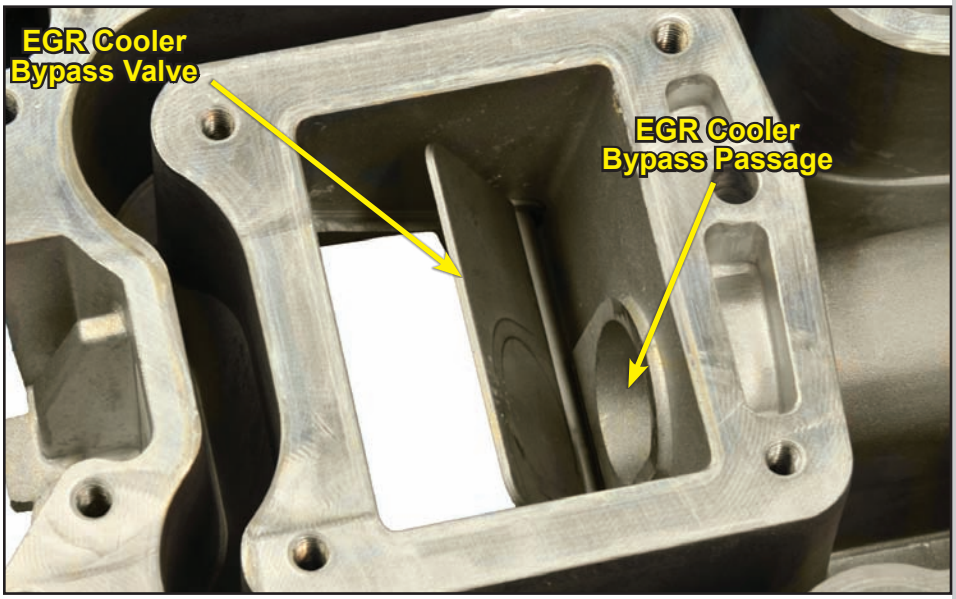


EGR Cooler Bypass Flow

During some operating conditions the EGR cooler is bypassed.



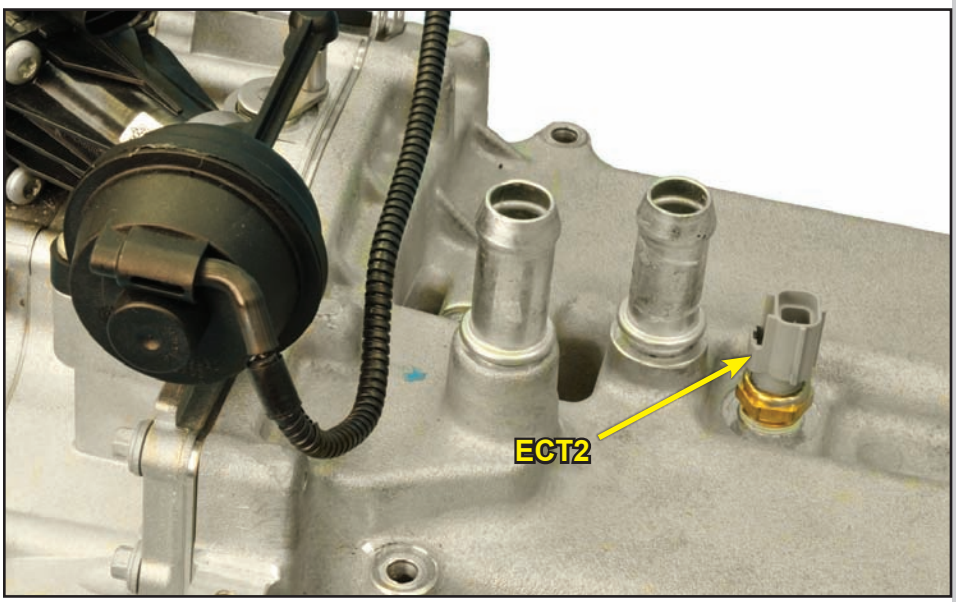
AIR MANAGEMENT SYSTEM



EGR Cooler Bypass Valve

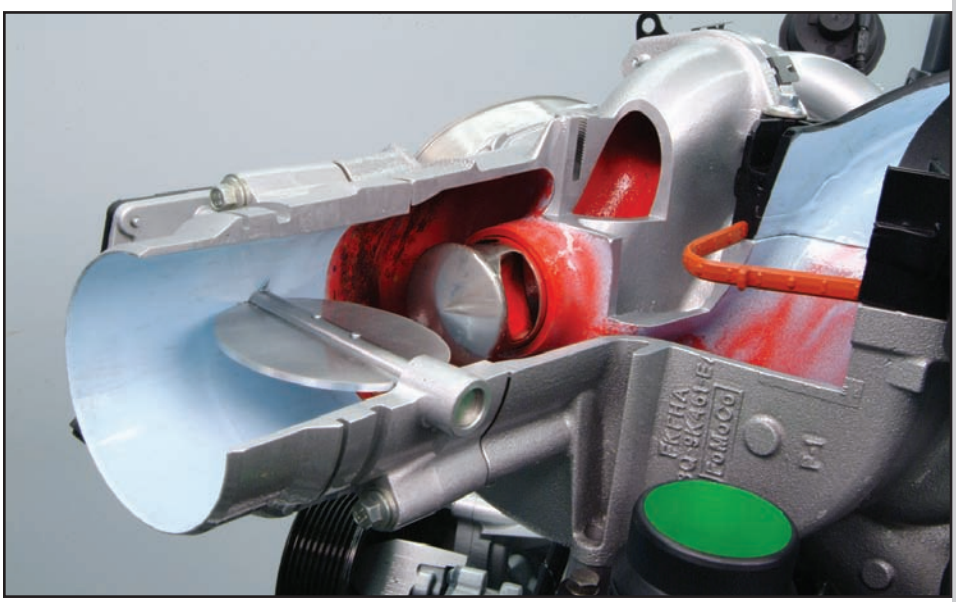
The EGR cooler bypass valve alters the flow of EGR gases to bypass the cooler at low engine speeds and during periods of low EGR flow. The vacuum controlled valve is solenoid controlled by the PCM.

If the PCM determines that it does not need to cool the exhaust gas,it commands the EGR solenoid to close the bypass valve and route the exhaust gas directly to the intake air system.



Secondary Cooling System Temperature (ECT2) Sensor

The ECT2 sensor monitors secondary cooling system temperature, which affects EGR cooler temperature and performance.



Intake Throttle Body

The intake throttle body is mounted on the lower intake manifold.

The intake throttle body promotes flow of EGR gases to the intake manifold by creating a differential between exhaust pressure and intake pressure.

NOTES

FUEL SYSTEM

At key on, the fuel pump within the Diesel Fuel Conditioning Module (DFCM) is turned on and the low pressure fuel system is pressurized. If the engine is not started, the pump runs for up to 30 seconds. The PCM obtains information from the Ambient Air Temperature (AAT), Engine Coolant Temperature (ECT) , Engine Oil Temperature (EOT), and Fuel Rail Temperature (FRT) sensors for fuel delivery calculations. The Volume Control Valve (VCV) and Pressure Control Valve (PCV) are open.

During engine cranking the PCM identifies Top Dead Center (TDC) within approximately 120 degrees of crankshaft rotation. The pressure control valve closes, allowing fuel pressure in the rail to achieve the calibrated value. This allows the engine to start very quickly.

Once the Fuel Rail Pressure (FRP) sensor detects the required fuel pressure, the PCM begins fuel injection operation to meet the desired idle RPM based upon the temperature sensors and engine load. During this initial start-up mode, the high pressure fuel system is run in PCV mode for a calibrated amount of time. The VCV is set to a specified point while the PCV is duty cycled to meet the desired fuel rail pressure.

The high pressure fuel system operates in PCV mode until a calibrated fuel temperature and time is achieved.

In VCV mode the fuel volume entering the high pressure fuel pump is adjusted by the VCV to meet the required fuel rail pressure while still being trimmed by the PCV. VCV mode is a more efficient operating mode because only the amount of fuel required for combustion is being compressed by the pump and sent to the fuel rails.

During acceleration, the VCV and PCV are commanded to meet the driver's demand (accelerator pedal input/engine load). The PCM's commands to the VCV and PCV are based upon: FRT, ECT, EOT, AAT, engine load, and regeneration state.

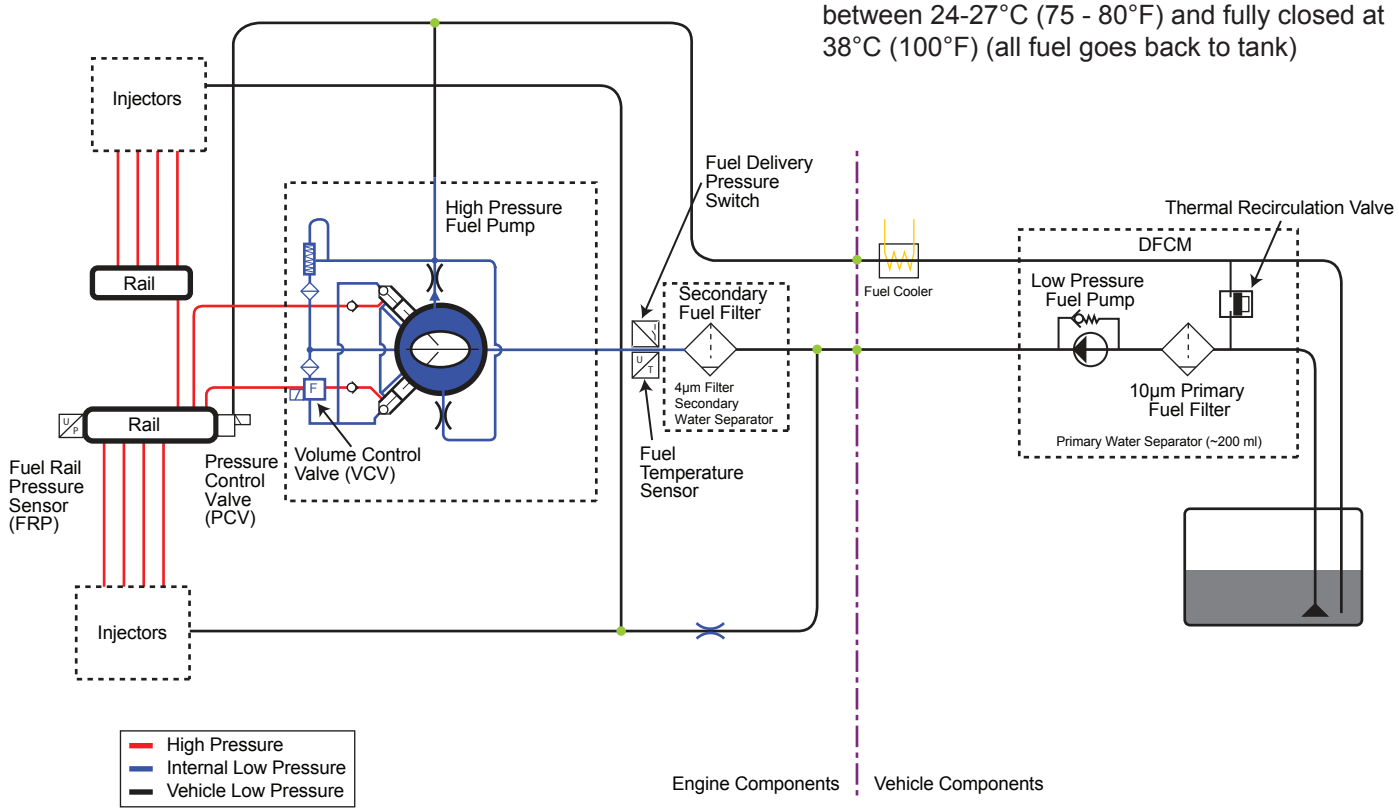
On deceleration, the VCV is closed and the PCV is opening to maximum position to reduce fuel pressure. When RPM is approaching the desired idle speed, the VCV begins opening to prepare for injector usage.

During regeneration, the left side injectors perform post injection. The right side injectors do not provide fuel for regeneration because right side cylinders supply exhaust gas to the EGR valve and EGR cooler.

Under certain conditions, like battery disconnect and fuel system reset, the fuel system operates in Adaptive PCV (APCV) mode on the first start. In the APVC mode, the PCM is learning the duty cycle needed for the PCV to achieve the desired fuel pressure.

High pressure fuel system operating mode:

- runs in PCV mode at start up until a calibrated time and temperature have been met.
- thermal recirculation valve is fully open up to between 24-27°C (75 - 80°F) and fully closed at 38°C (100°F) (all fuel goes back to tank)



FUEL SYSTEM

Fuel Supply System

- The DFCM includes the following components:
  - low pressure fuel pump
  - 10 micron primary fuel filter
  - thermal recirculation valve
  - water fuel separator (~200ml)
  - Water in Fuel (WIF) sensor
  - water drain valve (manual operation)
- After the fuel is conditioned by the DFCM, the clean pressurized fuel is sent to the engine mounted secondary fuel filter assembly where particles larger than 4 micron are filtered out of the fuel. After the fuel is filtered, it is routed to the high pressure fuel pump.

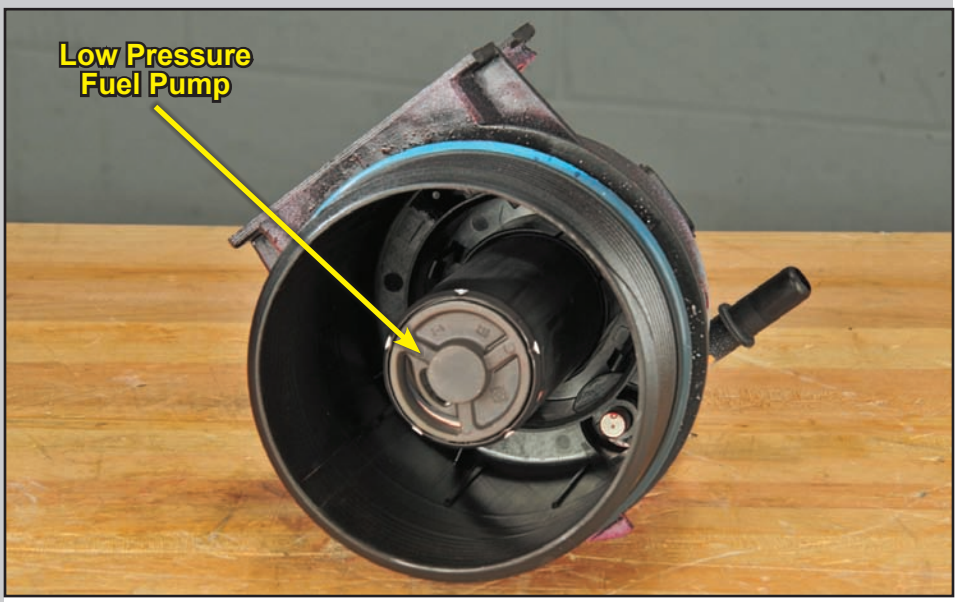
Low Pressure Fuel Pump

The low pressure fuel pump is located inside the DFCM assembly.

The low pressure fuel pump draws fuel from the fuel tank through the 10 micron primary fuel filter and pushes it to the engine mounted secondary fuel filter. The fuel pump pressure relief valve is integral to the fuel pump and is not serviceable separately. The fuel pump pressure regulator limits fuel pressure to 827 kPa (120 psi).

The low pressure fuel pump supplies approximately 3 times the maximum amount of fuel required for combustion. The excess fuel lubricates and cools the high pressure fuel pump.

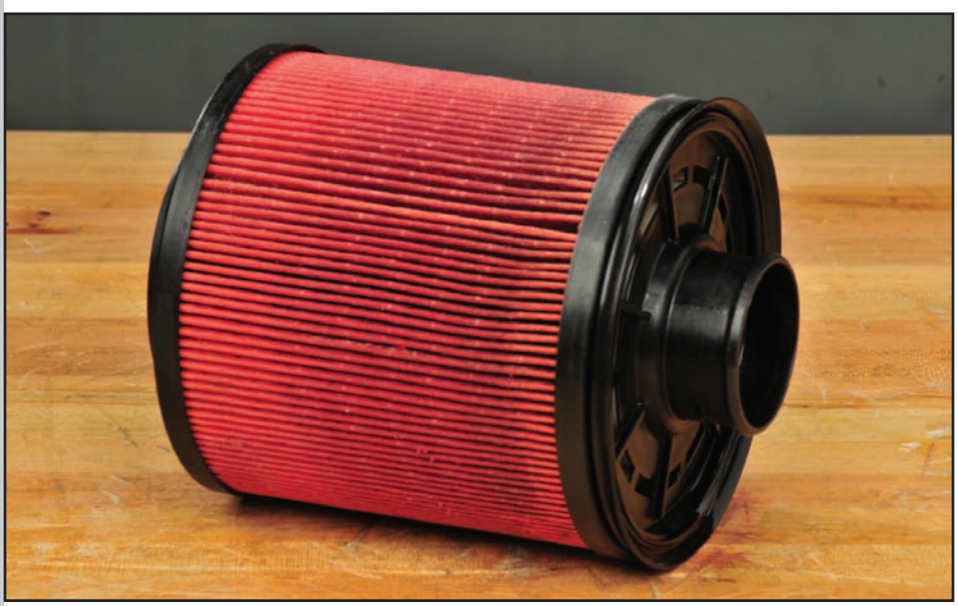
The IDS has a “FPL_CMD#” PID to command the low pressure fuel pump on and off.



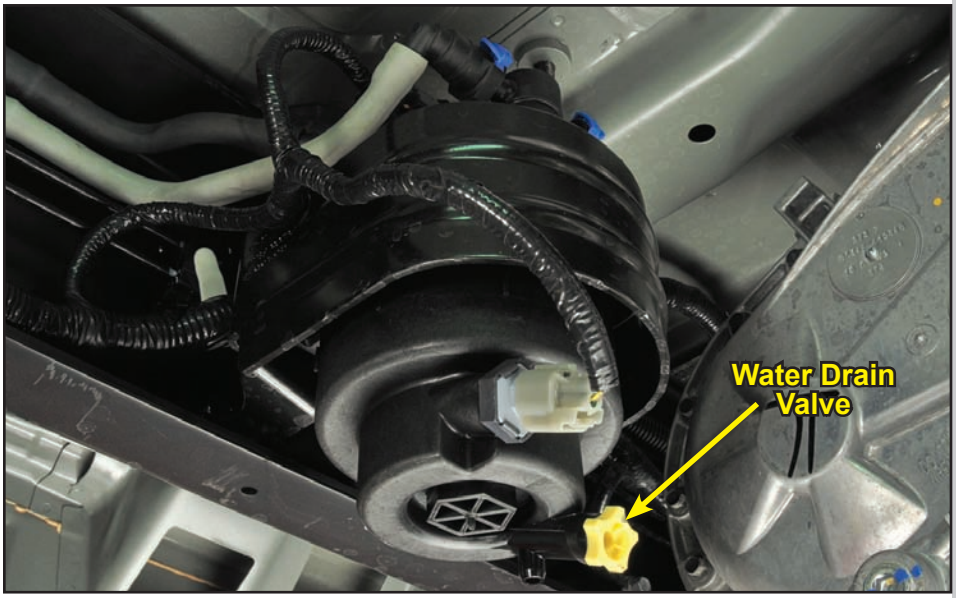
Primary Fuel Filter

The primary fuel filter is located in the DFCM.

The primary fuel filter removes particulates larger than 10 microns from the fuel. The DFCM has a recessed nut on the bottom to remove the fuel filter. The service interval of the fuel filter varies with usage; always consult the Owner’s Literature or Workshop Manual for service intervals.



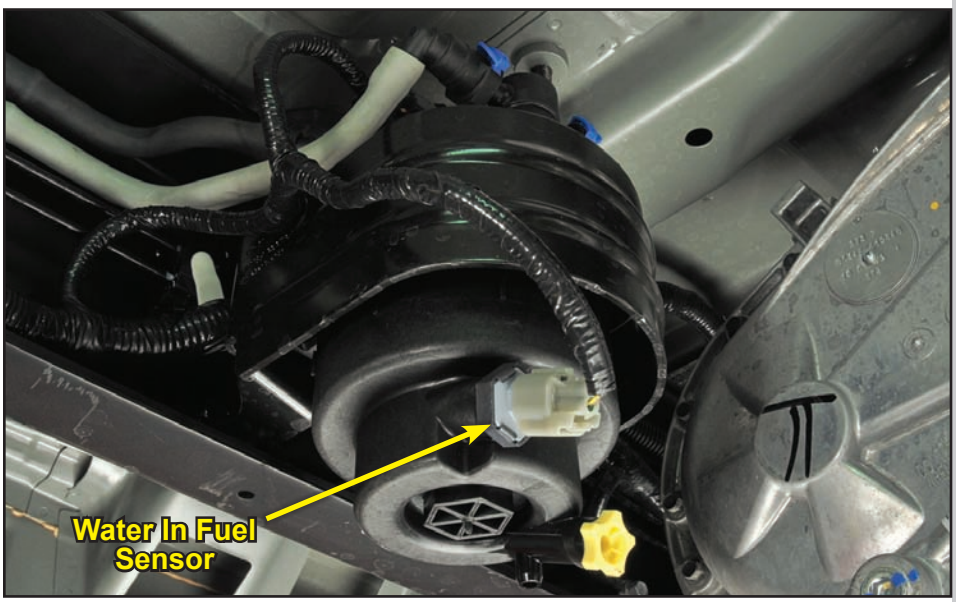
FUEL SYSTEM



Water Drain Valve

The water drain valve is located on the bottom of the DFCM.

To drain water that has accumulated in the DFCM, turn the water drain valve to the open position.



Water In Fuel (WIF) Sensor

The DFCM also includes a WIF sensor that indicates when the reservoir in the water separator is full and needs to be drained. When this occurs, an indicator lamp illuminates and a message appears in the message center.



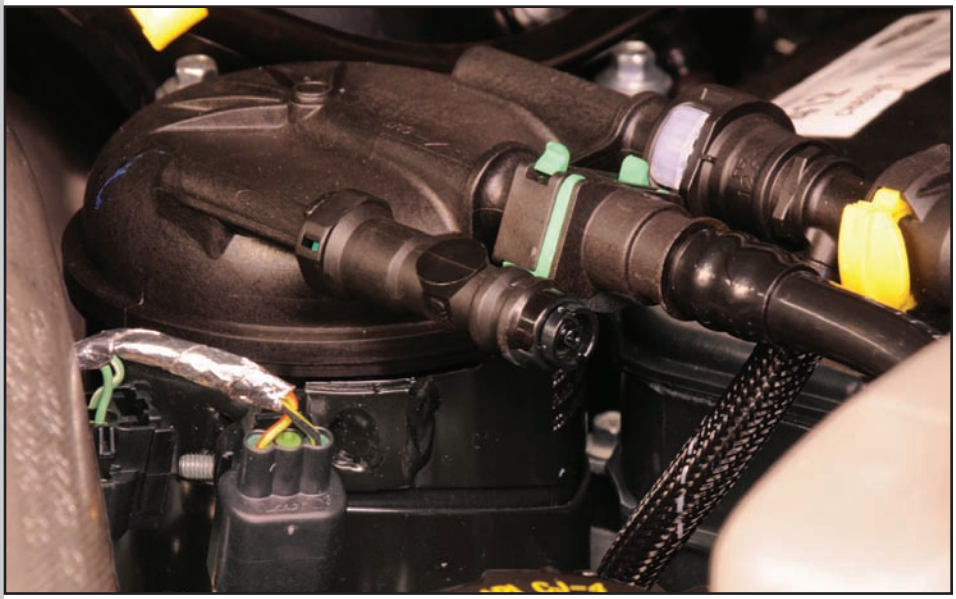
Secondary Fuel Filter Assembly

To provide additional fuel filtering, an engine mounted secondary fuel filter is located on the top of the left valve cover. The secondary fuel filter is a 4 micron cartridge style filter and is replaced as a complete unit.

FUEL SYSTEM

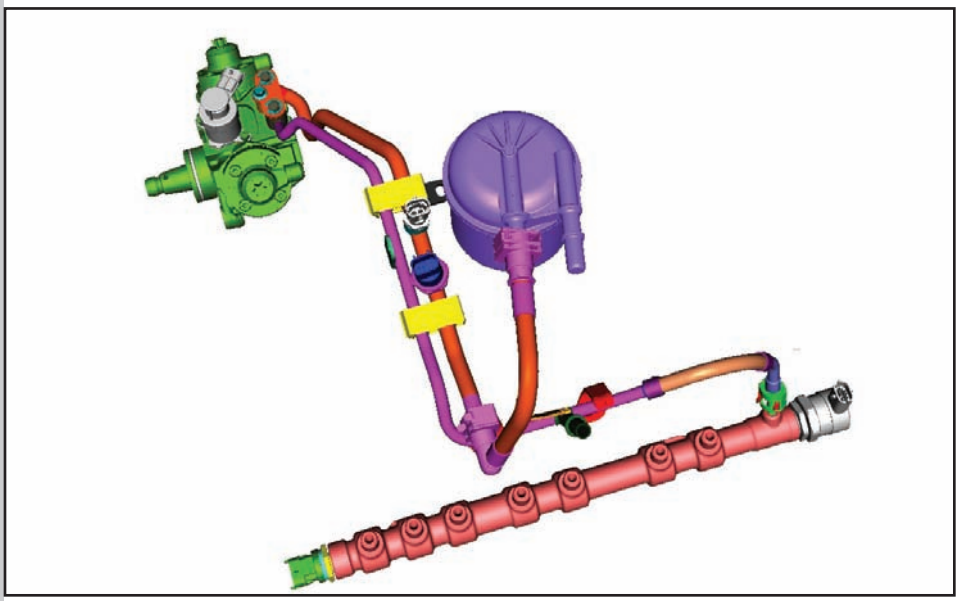
Secondary Fuel Filter Assembly from the Factory

The secondary fuel filter that is installed at the factory has three ports. The third port is used during the assembly process. The service part only has two ports: the inlet from the DFCM and the outlet to the VCV inlet which is mounted on the high pressure fuel pump.



Low Pressure Fuel Supply to High Pressure Fuel Pump

The fuel supply system uses a Fuel Rail Temperature (FRT) sensor to calculate fuel delivery and a fuel delivery pressure switch to help protect the high pressure fuel system.



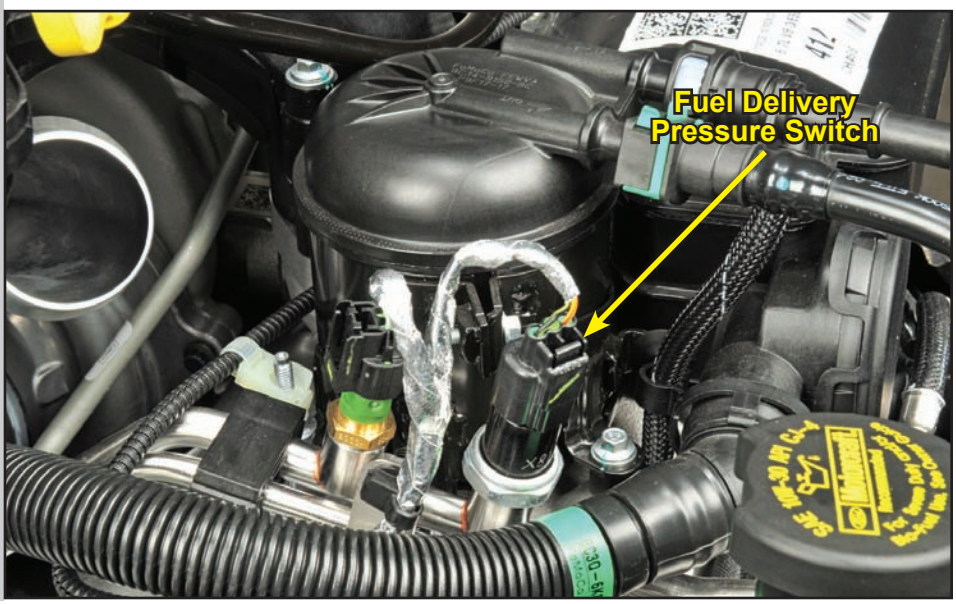
Fuel Delivery Pressure Switch

The fuel delivery pressure switch is mounted in the fuel line that runs between the secondary fuel filter and the high pressure fuel pump.

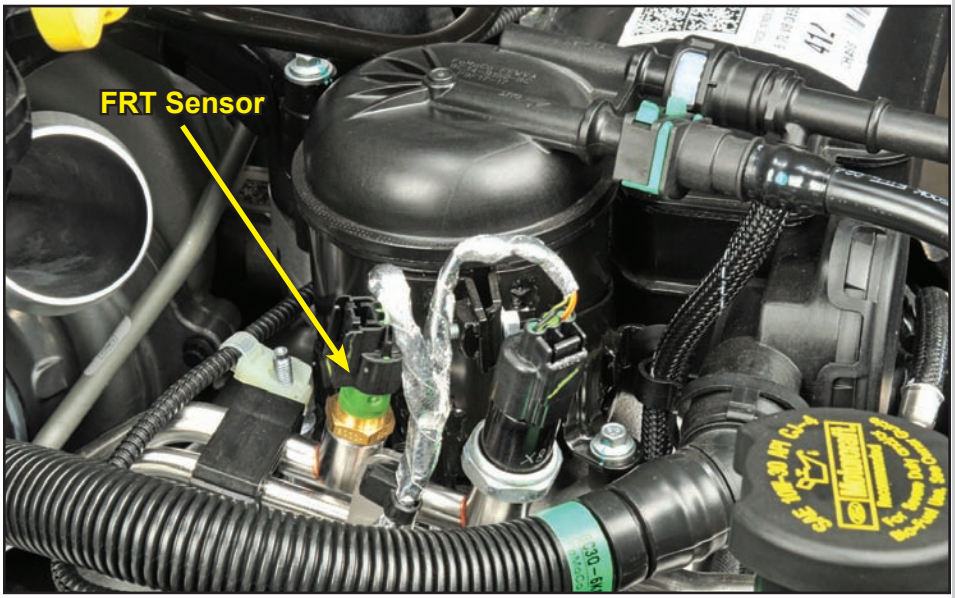
The fuel delivery pressure switch has a 331-400 kPa (48-58 psi) gauge setpoint for detection of a low pressure fuel supply. The PCM de-rates the engine's power by 30% if the switch is triggered.

The fuel delivery pressure switch protects the high pressure fuel system from damage due to low fuel pressure supply.

LOW FUEL PRESSURE displays in the message center to advise the customer of a low fuel pressure concern.



FUEL SYSTEM

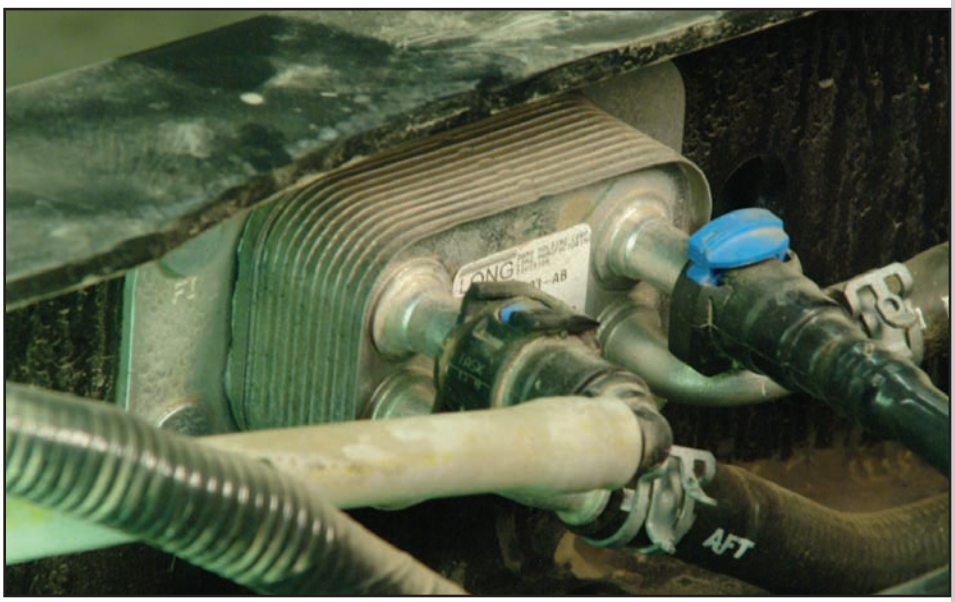


Fuel Rail Temperature (FRT) Sensor

The FRT sensor is mounted in the fuel line that runs between the secondary fuel filter and the high pressure fuel pump. It is green in color.

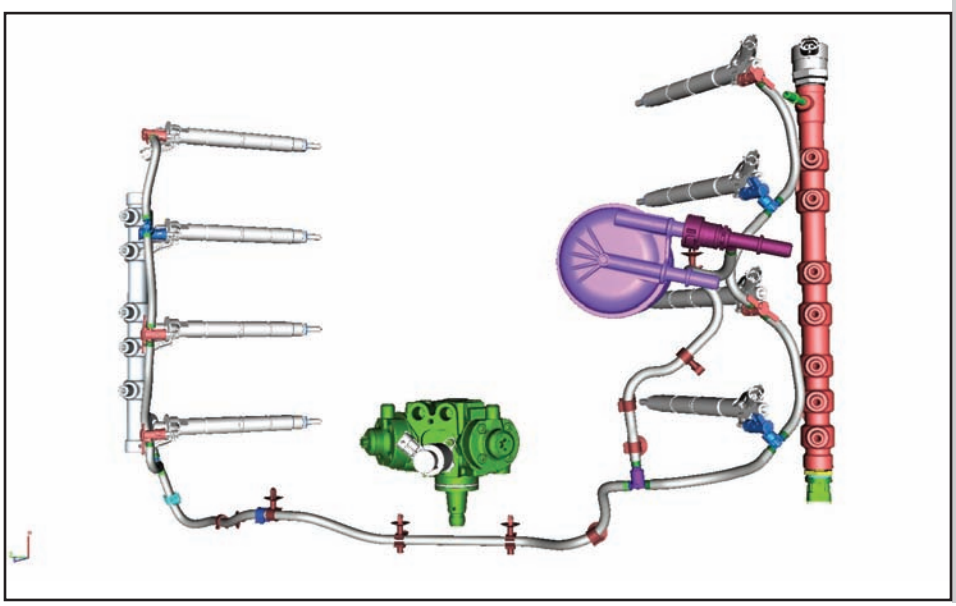
The PCM monitors the temperature of the fuel using the FRT sensor before the fuel enters the high pressure fuel pump.

Fuel temperature effects fuel viscosity. The PCM uses this information for more precise fueling no matter what the fuel temperature.



Fuel Cooler

A fuel cooler is located on the left frame rail forward of the DFCM. The black fuel line returns fuel from the engine to the cooler. The gray fuel line returns fuel from the cooler to the DFCM. Depending on the temperature of the fuel from the injectors, the fuel cooler can be used to cool or heat the fuel going back to the DFCM. The powertrain secondary cooling system provides the coolant for the fuel cooler.



Injector Low Pressure Connectors

The injector low pressure connectors have a dual purpose. First, it is a low pressure back feed to keep fuel pressure inside the hydraulic coupler. Without fuel pressure in the hydraulic coupler, the injector will not deliver fuel. Second, it is a return. The fuel that passes through the injector during the injection process exits the injector through the low pressure connectors and is returned through an orifice to the inlet of the secondary fuel filter.

FUEL SYSTEM

Biodiesel

The 6.7L Power Stroke® diesel engine may be operated on diesel fuels containing up to 20% biodiesel, also known as B20.

To help achieve acceptable engine performance and durability when using biodiesel in your vehicle:

- be alert to fuel gelling/waxing.
- flush the fuel system with regular diesel fuel if the vehicle is going to be in storage for more than a month
- only use biodiesel fuel of good quality that complies with industry standards.
- do not use raw oils, fats or waste cooking greases.

Use of fuels containing more than 20% biodiesel can damage the engine and fuel system components, resulting in a non-warranty condition.

Fuel Management System

The Volume Control Valve (VCV) controls how much fuel enters the two high pressure pump pistons. The fuel flow to the high pressure fuel pump is restricted as required by the PCM. Under varying conditions the fuel system is in PCV or VCV mode.

Two high pressure fuel lines from the high pressure fuel pump transport the fuel to the diverter volume area of the left (driver's side) fuel rail. From the diverter volume area, fuel goes through an orifice to supply the left fuel rail and through a high pressure fuel line over to the right fuel rail.

Excess fuel from the high pressure fuel pump is routed back to the DFCM/fuel tank. The left fuel rail supplies fuel to the 4 injectors in the left cylinder head via high pressure fuel lines and it supplies fuel to the right side fuel rail via another high pressure fuel line.

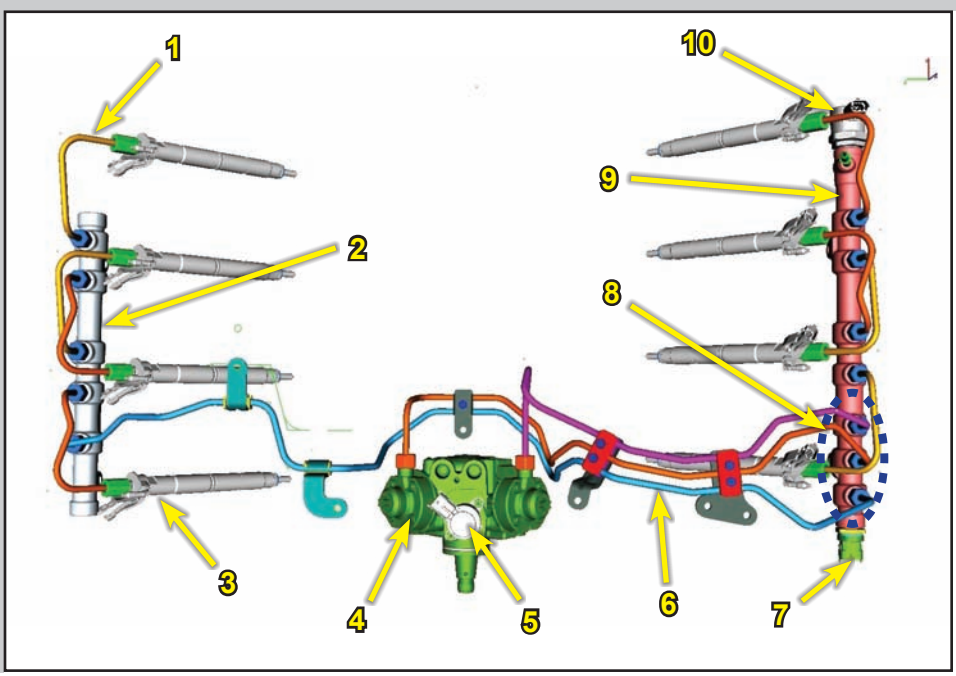
The left side fuel rail contains the Pressure Control Valve (PCV) mounted in the rear of the fuel rail and the Fuel Rail Pressure (FRP) sensor in the front of the fuel rail The PCV regulates the pressure in the fuel rails under specific operating conditions. When operating in PCV mode, fuel released by the PCV is returned to the DFCM/fuel tank.

The high pressure fuel pump is capable of producing up to 199,948 kPa (29,000 psi) to the fuel injectors.

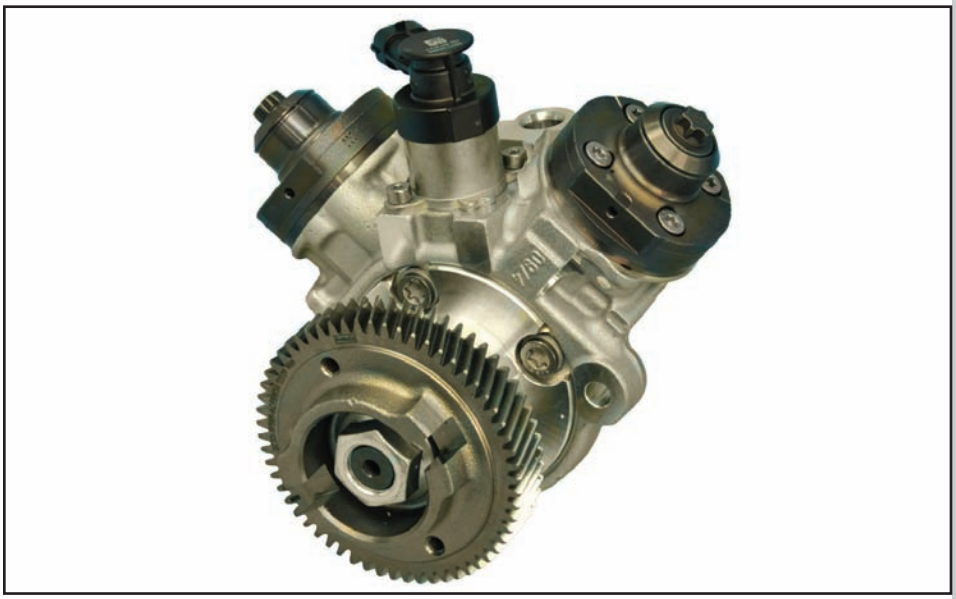
Each fuel rail has 4 individual high pressure fuel lines to supply fuel to the injectors. Injector return fuel is directed back to the low pressure line supplying the secondary fuel filter. The injector return line assembly contains a single throttle (orifice) to generate back flow for proper injector operation. Fuel being directed back to the DFCM/fuel tank goes through the fuel cooler first then to the DFCM.

Fuel Management Components

1. High pressure fuel line
2. Right high pressure fuel rail
3. Fuel injector
4. High pressure fuel pump
5. Volume Control Valve (VCV)
6. High pressure fuel transfer line from the left fuel rail to the right fuel rail
7. Fuel Rail Pressure (FRP) sensor
8. Diverter volume area
9. Left high pressure fuel rail
10. Pressure Control Valve (PCV)



FUEL SYSTEM

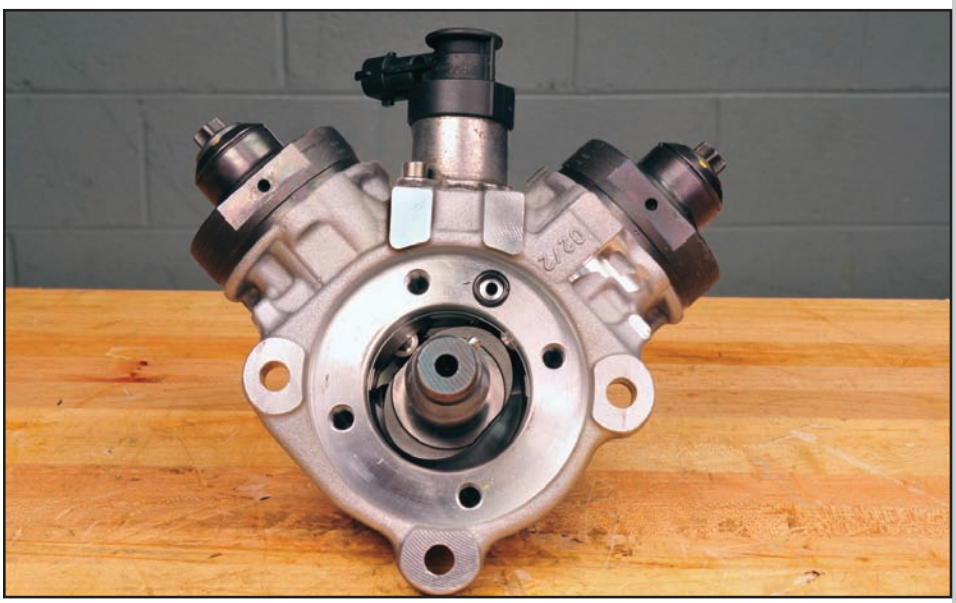


High Pressure Fuel Pump

The high pressure fuel pump is mounted in the front valley of the engine and is gear driven by the camshaft.

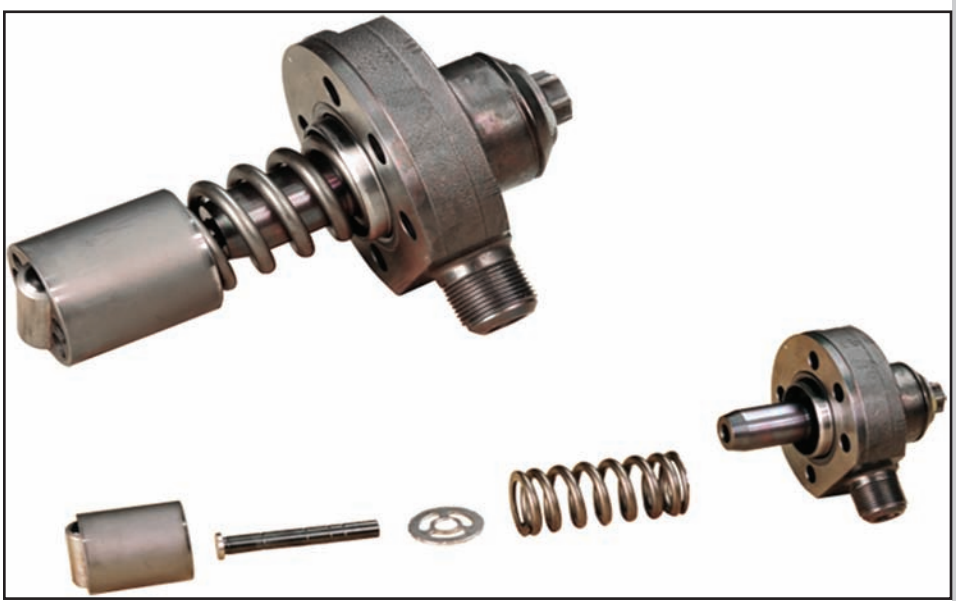
The high pressure fuel pump is timed to the crankshaft and camshaft to optimize the effects of the high pressure fuel pulses.

The high pressure fuel pump is lubricated by diesel fuel.



High Pressure Fuel Pump Operation

The high pressure fuel pump is a 2-cylinder design. The main shaft has two actuating lobes that are offset 180 degrees from each other. Each pump piston is actuated twice per crankshaft revolution.



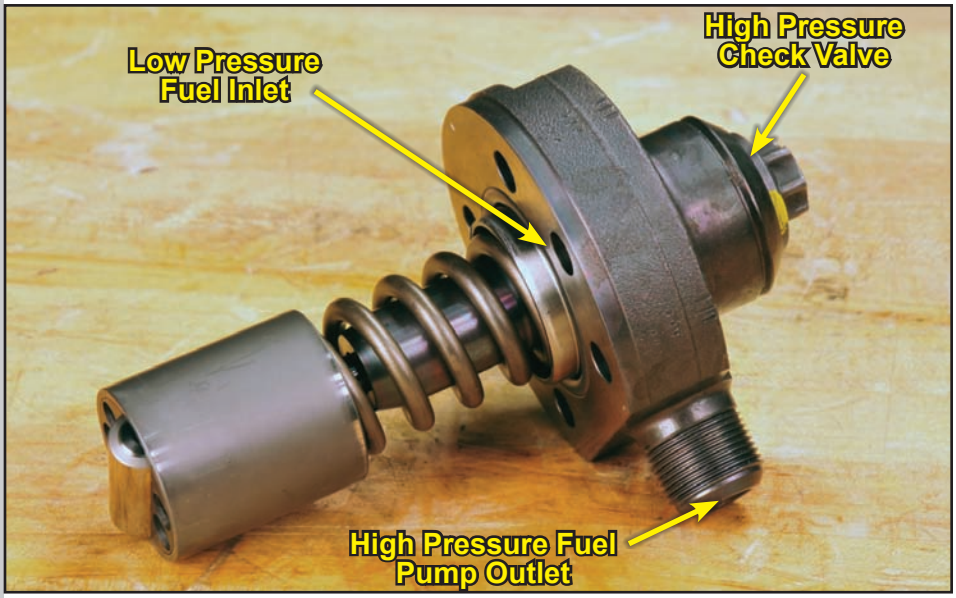
Piston Assemblies

The pistons are actuated via the actuating lobes and are returned to rest via spring pressure. The pistons receive fuel from the one-way check valve. Fuel is drawn into the cylinder while the piston is returning to rest. The fuel flow to the cylinders of the pump are metered by the VCV.

FUEL SYSTEM

Piston Assembly Check Valves

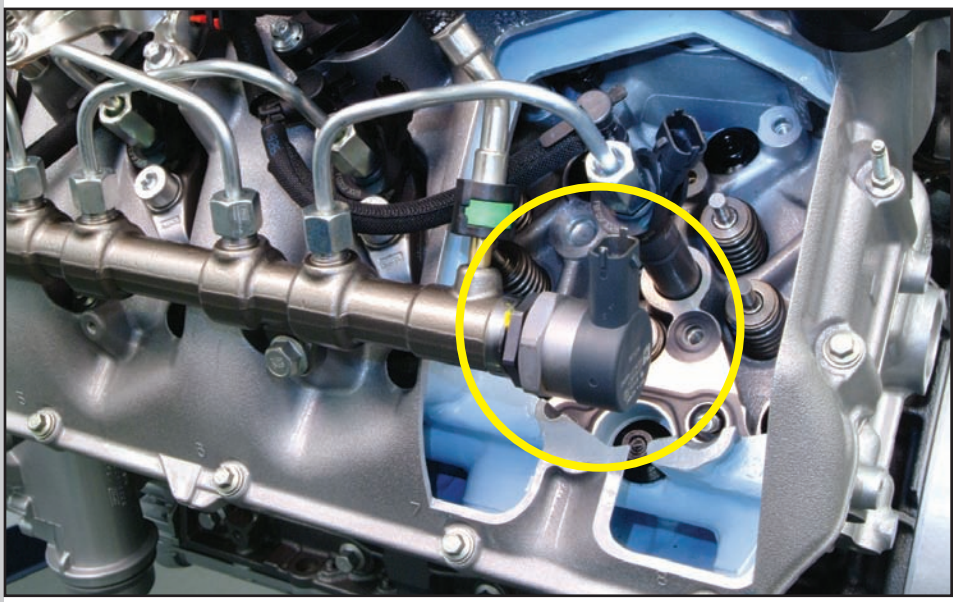
The outlet check valve closes while fuel is being drawn in due to a pressure difference on the two sides of the check valve. Once the piston starts its compression stroke, the inlet check valve closes via the spring and fuel pressure and the outlet check valve opens due to increasing fuel pressure, forcing the check valve off its seat.



Pressure Control Valve (PCV)

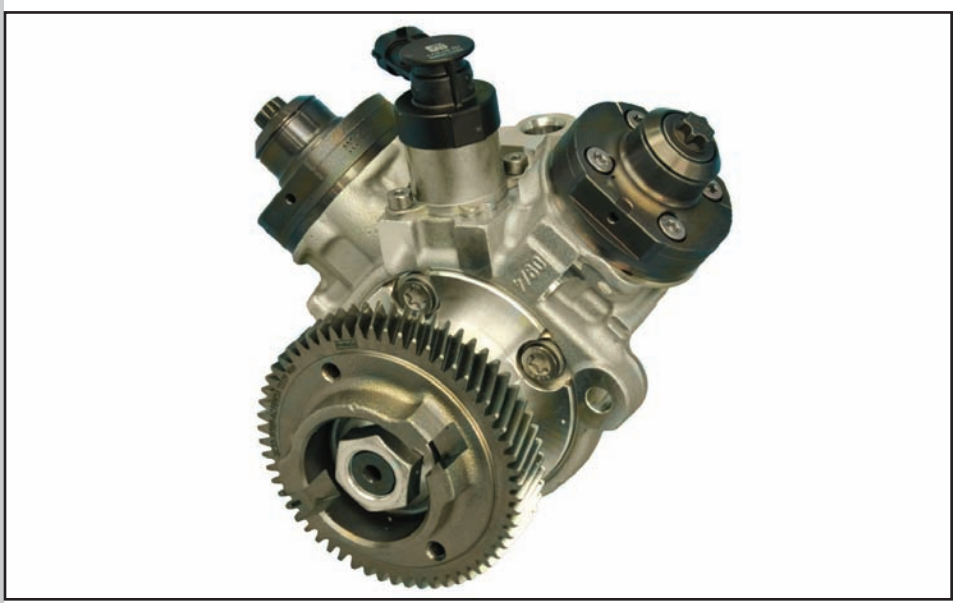
The PCV is threaded into the rear of the left fuel rail. The PCV is a two wire normally open Pulse Width Modulated (PWM) solenoid. The PCM relay supplies system voltage to one wire of the solenoid. The PCM pulse width modulates the ground to control the PCV until the desired fuel pressure is reached.

The PCV regulates the pressure in the fuel rails under specific operating conditions. The PCV controls the fuel pressure using information from the FRP sensor.

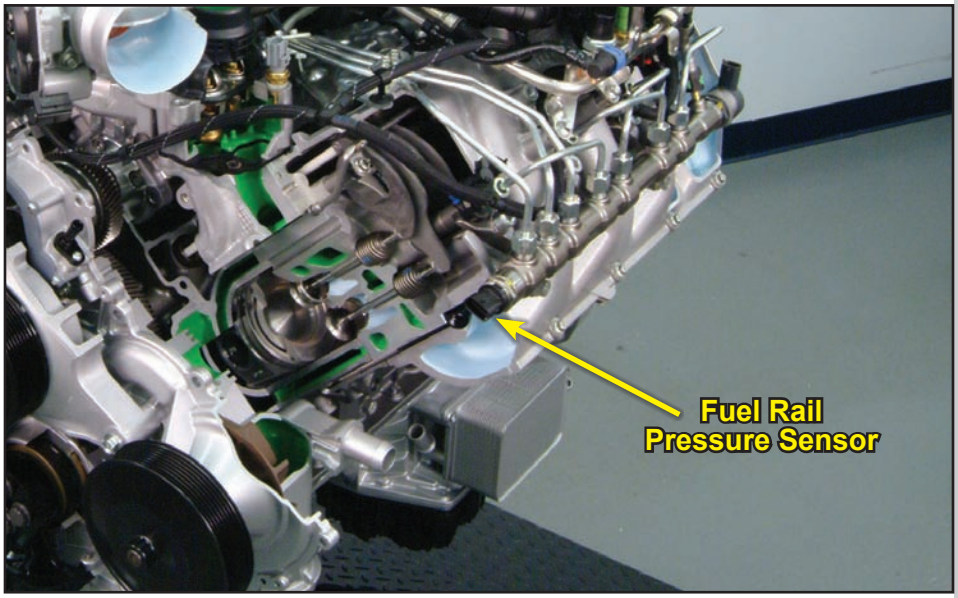


Volume Control Valve (VCV)

The fuel VCV is mounted on the top of the high pressure fuel pump. The VCV is pulse width modulated by the PCM to control the amount of fuel that enters the high pressure fuel pump. Together with the PCV, the VCV regulates the fuel rail pressure. As the engine is switched off the VCV shuts off the fuel supply to the high pressure fuel pump.

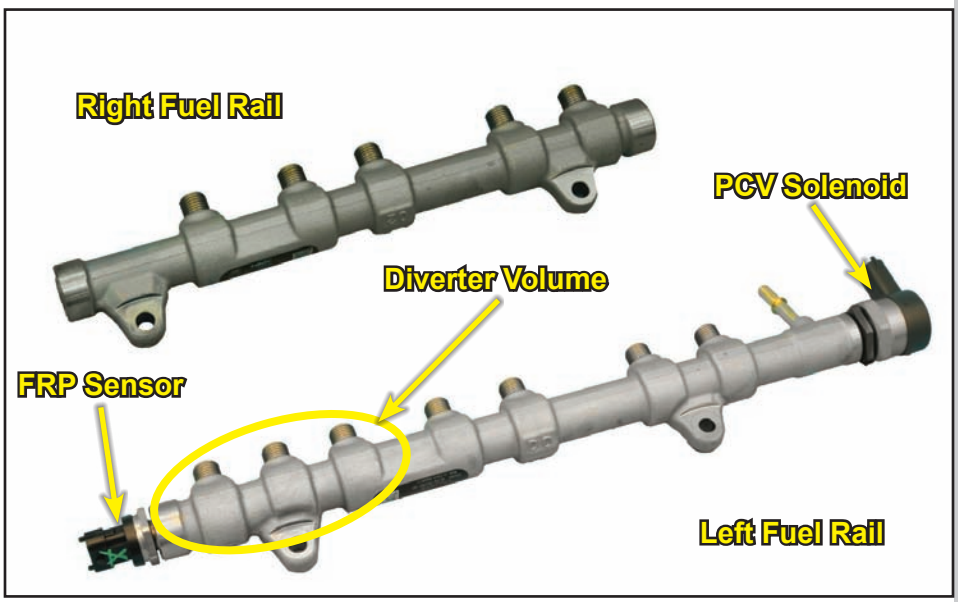


FUEL SYSTEM



Fuel Rail Pressure (FRP) Sensor

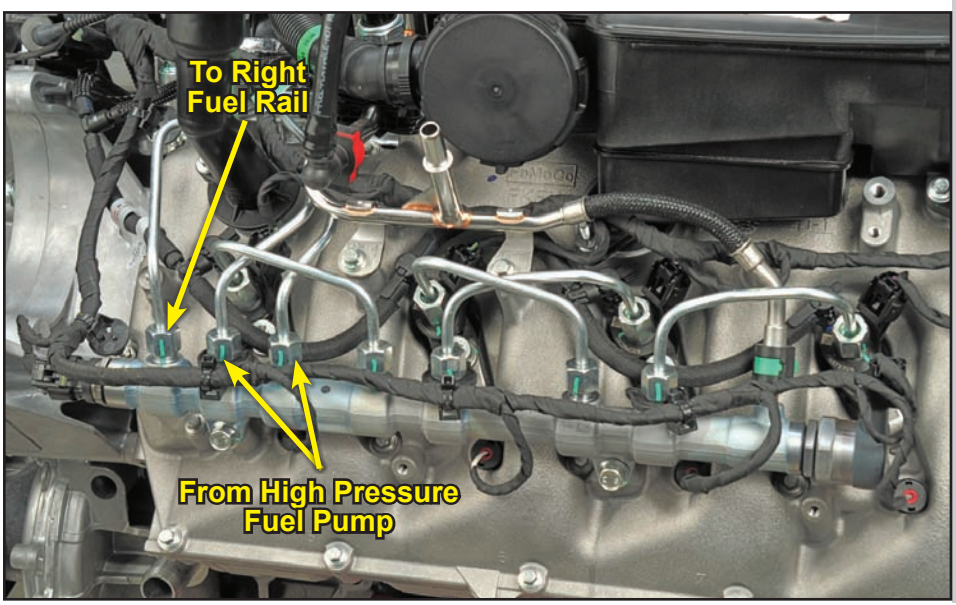
The FRP sensor is threaded into the front of the left fuel rail. The FRP sensor is a three-wire variable capacitance sensor. The PCM supplies a 5 volt reference signal which the FRP sensor uses to produce a linear analog voltage that indicates pressure. The FRP sensor actively monitors fuel rail pressure to provide a feedback signal to the PCM.



Fuel Rails

The fuel rails on the 6.7L Power Stroke® diesel engine are on the outside of the valve covers. The left fuel rail has the FRP sensor and the PCV solenoid. The right fuel rail does not have any sensors or solenoids.

The left fuel rail is longer due to a diverter volume.



High Pressure Fuel Lines

The high pressure fuel lines run between the:

- high pressure fuel pump and left fuel rail.
- right and left fuel rails.
- fuel rails and the fuel injectors on the outside of the valve covers.

FUEL SYSTEM

Piezo Fuel Injectors

There are eight fuel injectors; four mounted on each cylinder head. They are serviced without removing the valve covers. The Injector Quantity Adjustment (IQA) must be programmed into the PCM when a new injector is installed.

The injector is a 19 mm piezo-actuated injector with an 8 hole nozzle.

Each fuel injector is retained with a single clamp and bolt through the rocker cover to the cylinder head.

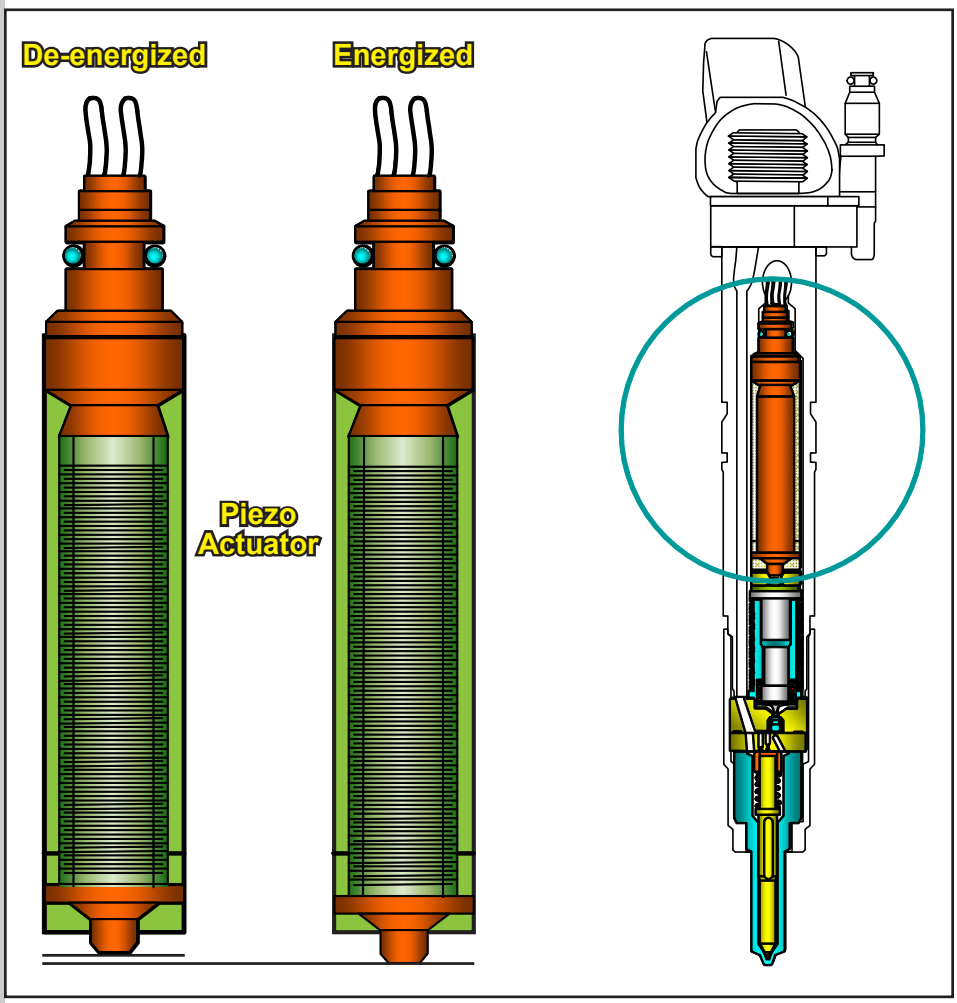
A stepped copper gasket is used to better distribute the sealing load between the cylinder head and injector. This allows heat to transfer from the injector nozzle to the cylinder head. The step is installed towards the cylinder head.



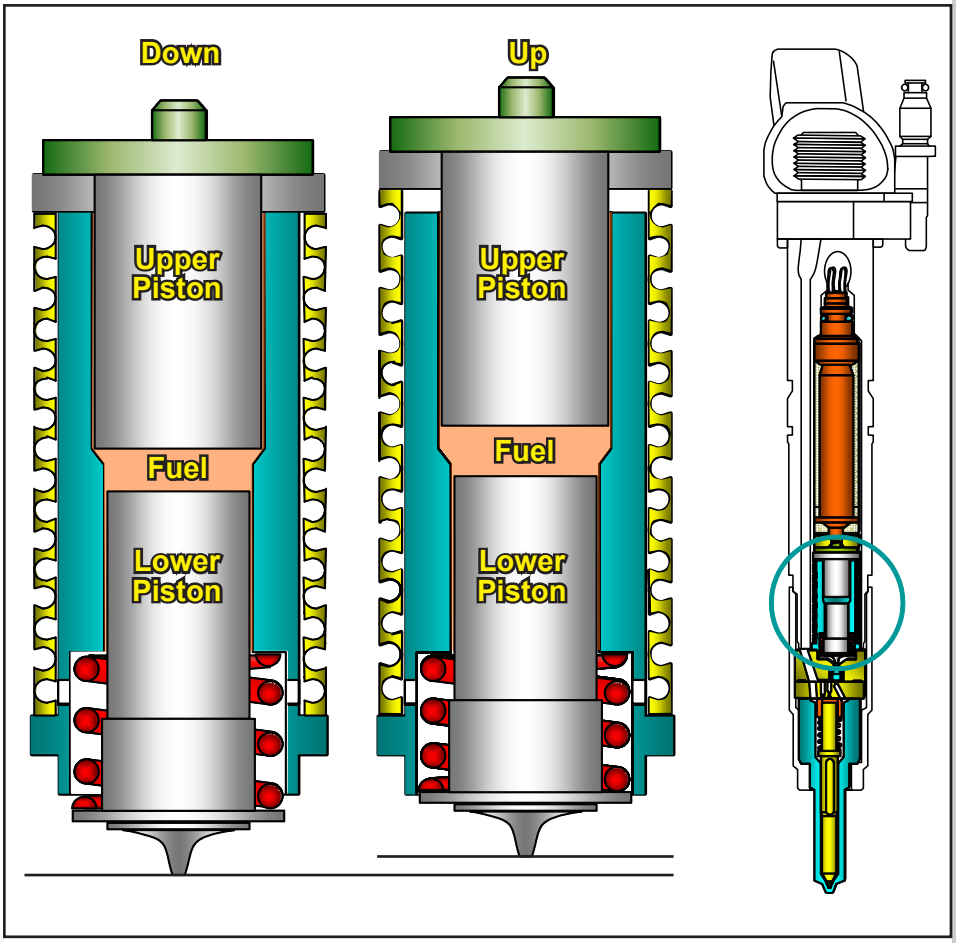
Fuel Injector Piezo Actuator

The piezo actuator is a stack of piezo crystals. When current is applied to the crystals, the crystals expand. When the PCM supplied current is removed from the piezo crystals, they contract. When the crystals contract, they create voltage (current flow reverses).

The PCM supplies current to the piezo stack and when the injector is de-energized the current is removed from the piezo stack and stored by the PCM to actuate the injector in a companion cylinder.



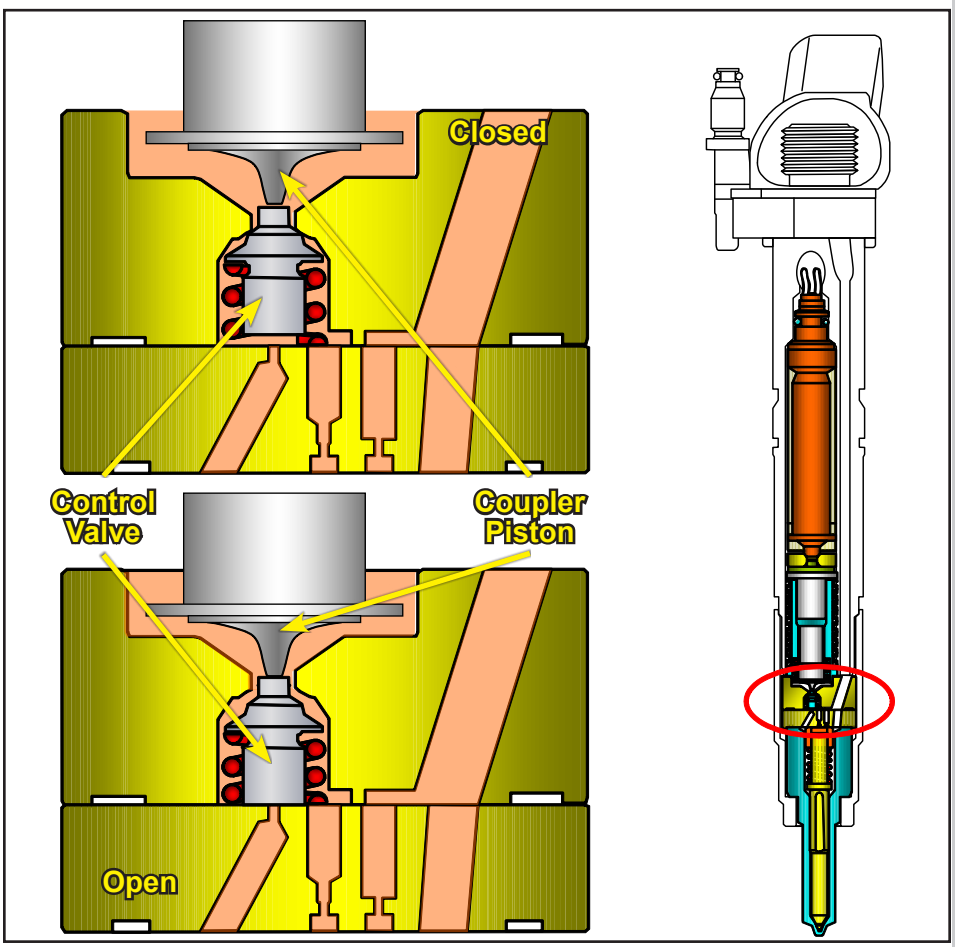
FUEL SYSTEM



Hydraulic Coupler

The piezo stack is linked to the control valve of the fuel injector via a fuel-filled hydraulic coupler. The upper piston of the coupler is a larger diameter than the lower piston. This difference in diameter causes an increase in the linear movement of the lower piston (more travel).

Note: If the hydraulic coupler is not full of fuel, the lower piston will **not** move and fuel will **not** be injected into the combustion chamber. The hydraulic coupler is supplied with fuel by the low pressure fuel pump when the key is turned on and from return fuel when the engine is running.



Control Valve

The lower hydraulic coupler piston moves the control valve down to relieve high pressure from the top of the nozzle needle (the control chamber).

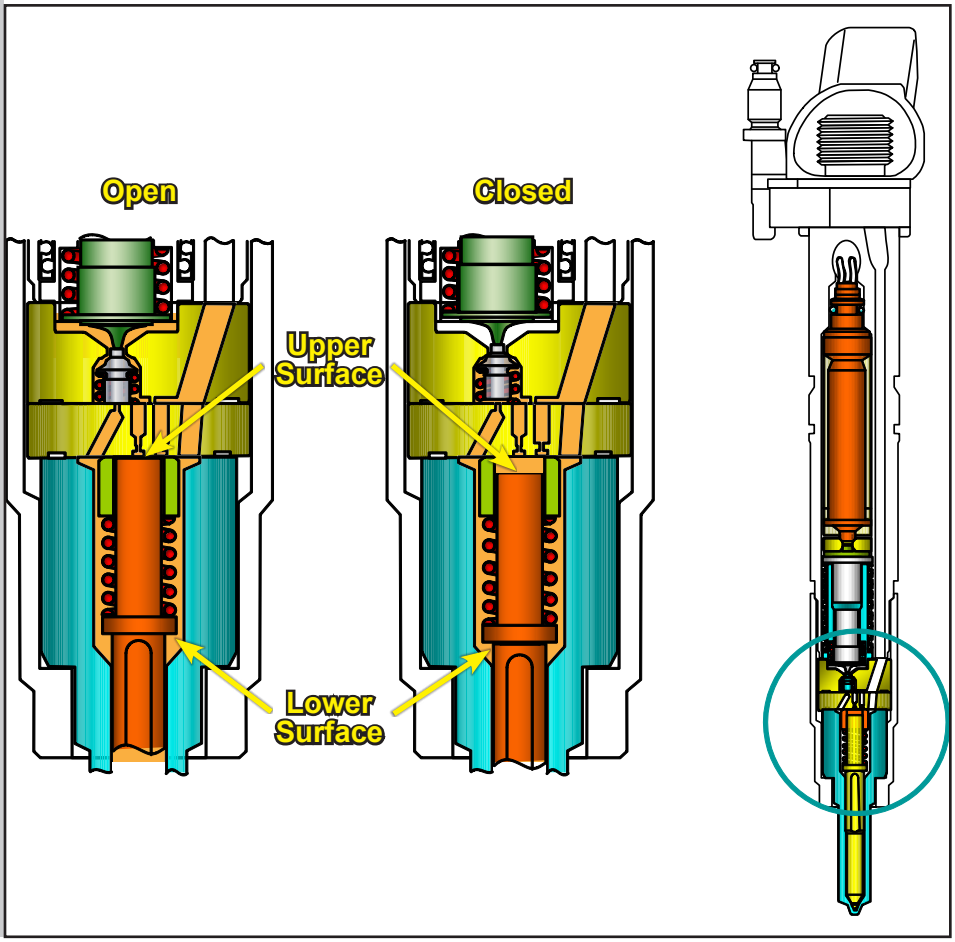
When the control valve is pushed fully down, it seals off an orifice in the intermediate plate, stopping that fuel flow path of high pressure fuel to the top of the nozzle needle. Fuel is allowed to flow past the control valve, also removing pressure from the top of the nozzle needle.

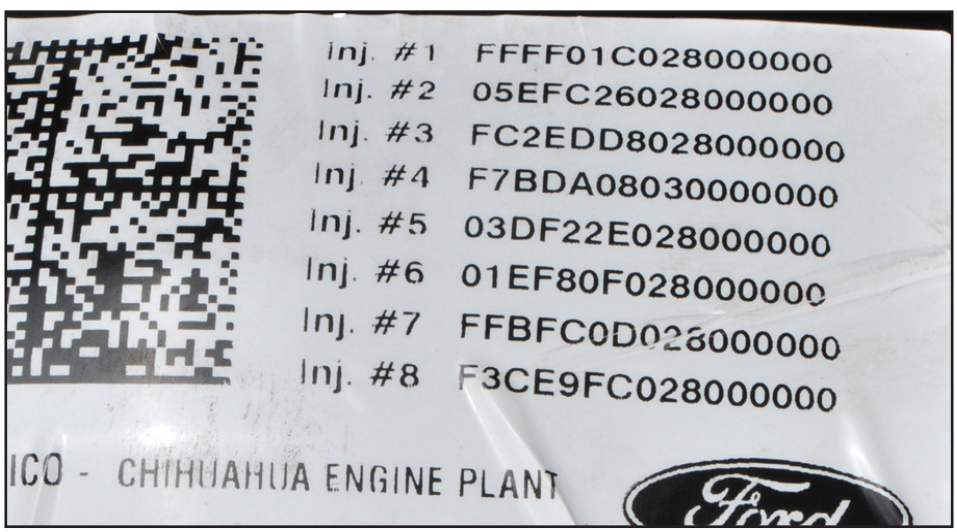
FUEL SYSTEM

Injector Nozzle Needle

When the high pressure is relieved from the top of the nozzle needle, high pressure on the lower surfaces force the needle up and allows fuel to be sprayed into the combustion chamber.

When the control valve is released, spring pressure and high pressure fuel moves the needle back up against the seat in the control valve housing, sealing the nozzle control chamber. High pressure fuel is again applied to the top of the nozzle needle, pushing the needle down to stop fuel flow into the combustion chamber.





Injector Quantity Adjustment (IQA) Code

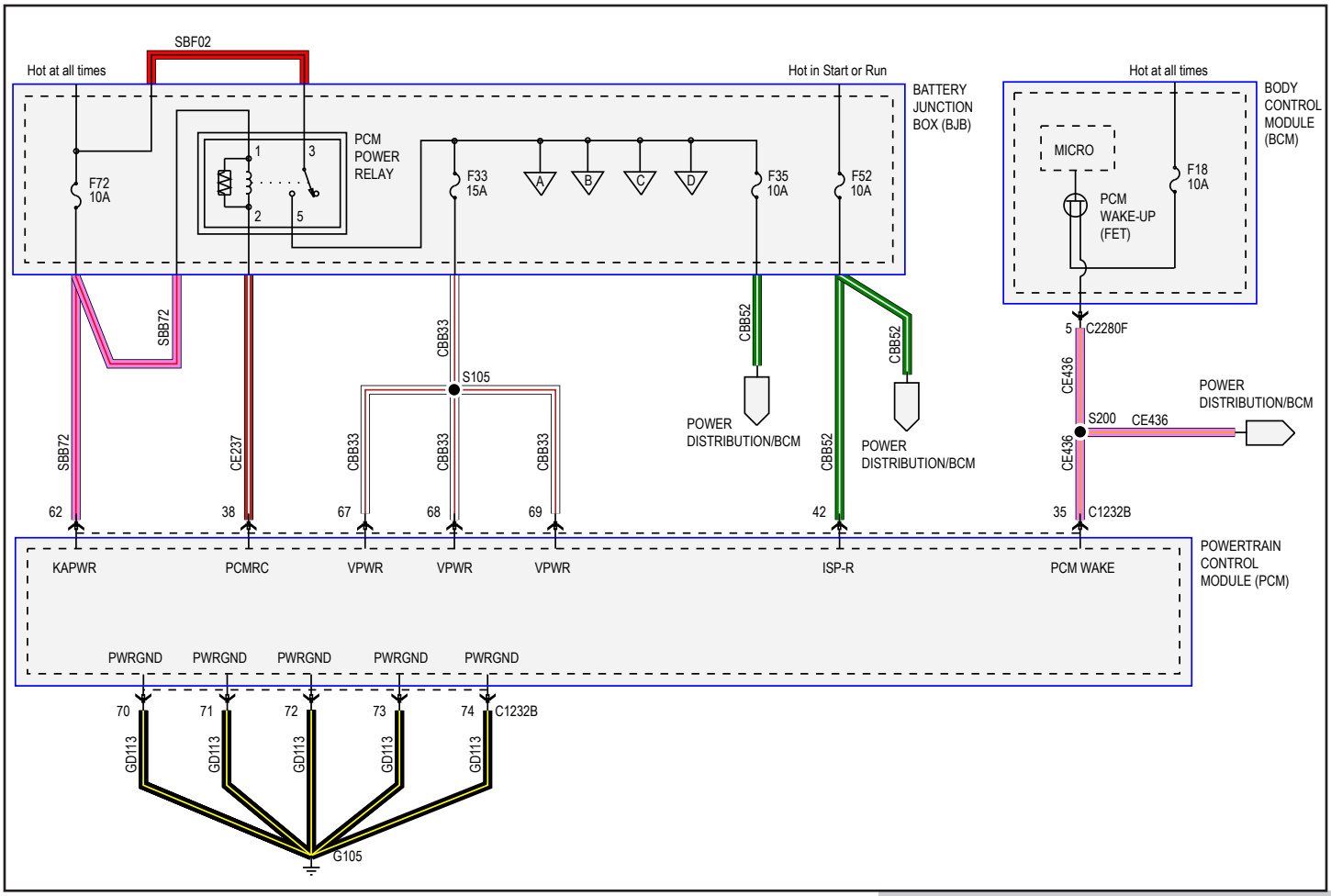
Each injector has a unique 10 digit code representing the flow characteristic of that injector. The IQA code is located on each injector head and is also printed on a factory label located on the engine. The factory installed label indicates the IQA data for all of the original injectors installed at the factory. In addition, there are individual injector IQA labels provided with each service replacement injector. Refer to both the factory label and the individual service labels to obtain the latest IQA data. If the labels are missing or damaged retrieve the IQA data from each injector head.

When an injector is replaced, program the IQA code for the injector using the IDS. The IDS automatically clears the keep alive memory values associated with the old injector when the new injector IQA code is entered.

Affix the new injector IQA sticker next to the old sticker.

Note: If an injector is being swapped to a different cylinder the IQA number must be programmed.

ELECTRICAL COMPONENTS





Powertrain Control Module (PCM)

The PCM is located on the top right side of the bulkhead.

The PCM receives battery power from the PCM power relay through the chassis connector. Ground is provided through the chassis connector and also includes a case ground.

ELECTRICAL COMPONENTS

Pressure Sensors

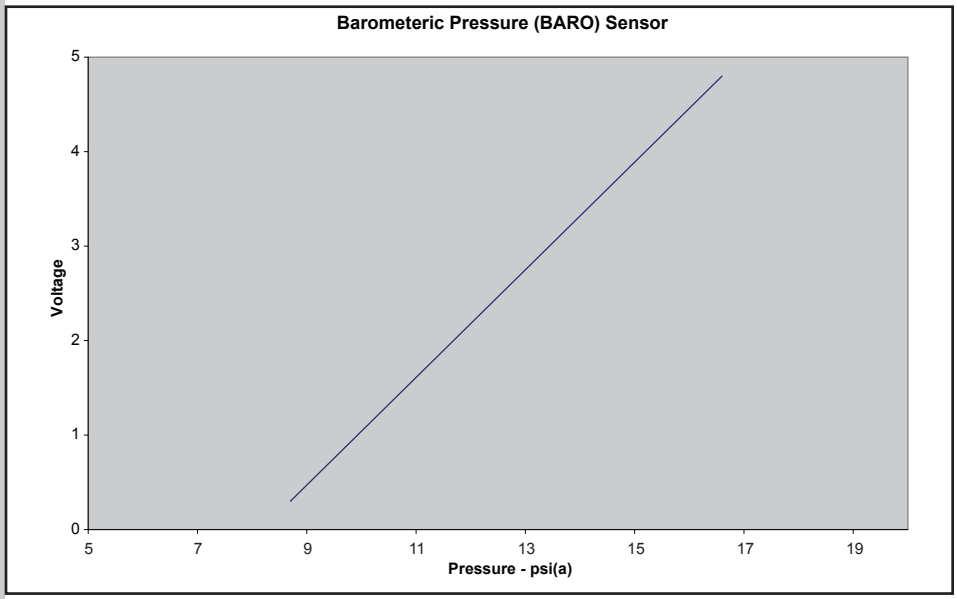
Barometric Pressure (BARO)

The BARO sensor is internal to the PCM.

The PCM supplies a 5 volt reference signal (VREF) which the BARO sensor uses to produce a linear analog voltage that indicates pressure.

The PCM uses the BARO sensor to determine atmospheric pressure for fuel control, timing, and turbocharger control.

IDS: BARO (volts) and BARO (pressure)

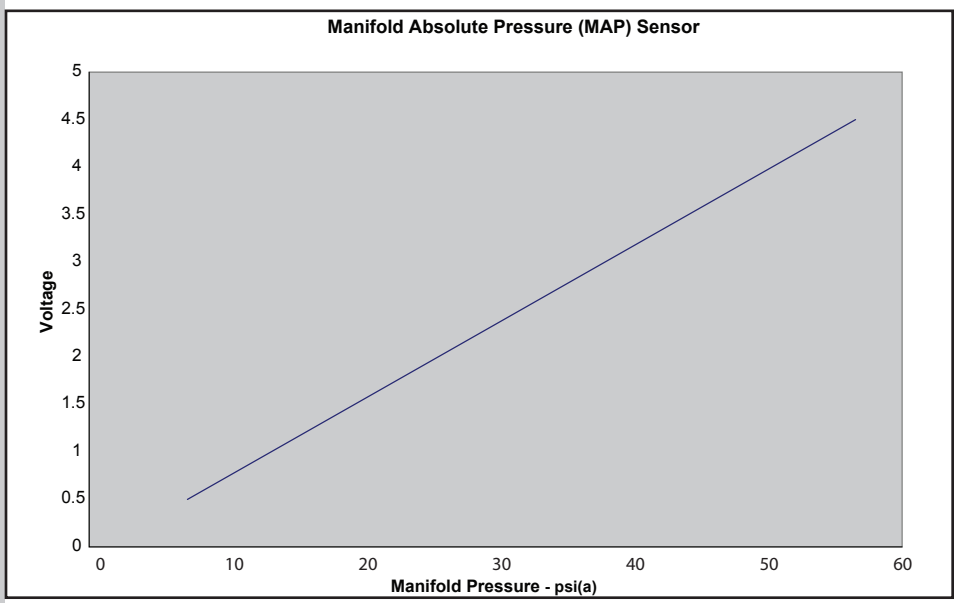


Manifold Absolute Pressure (MAP)

The MAP sensor is a 3-wire variable capacitance sensor. The PCM supplies a 5 volt reference (VREF) signal which the MAP sensor uses to produce a linear analog voltage that indicates pressure.

The MAP sensor is used for turbocharger, EGR, and regeneration control.

IDS: MAP (volts) and MAP_A (pressure)

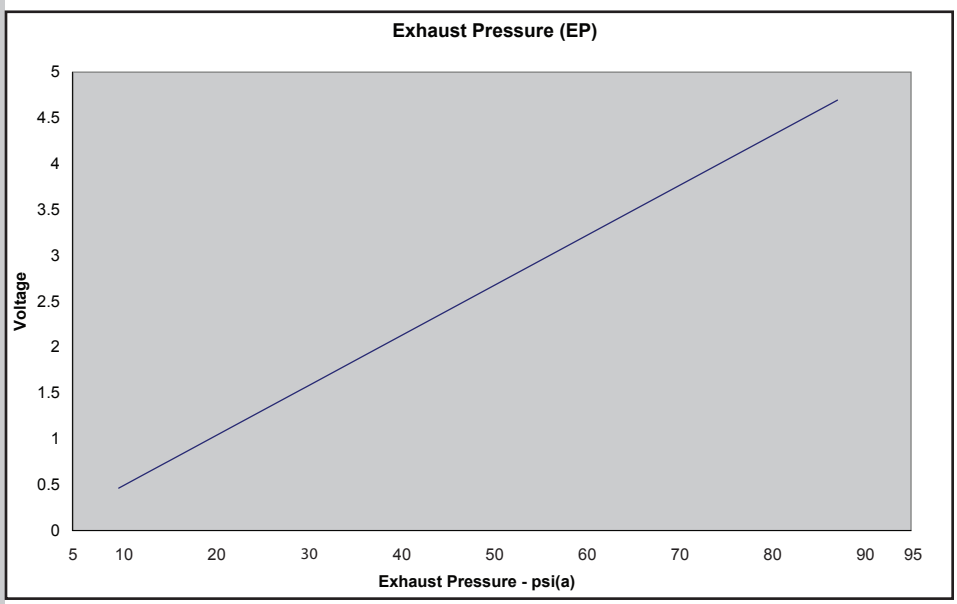


Exhaust Pressure (EP)

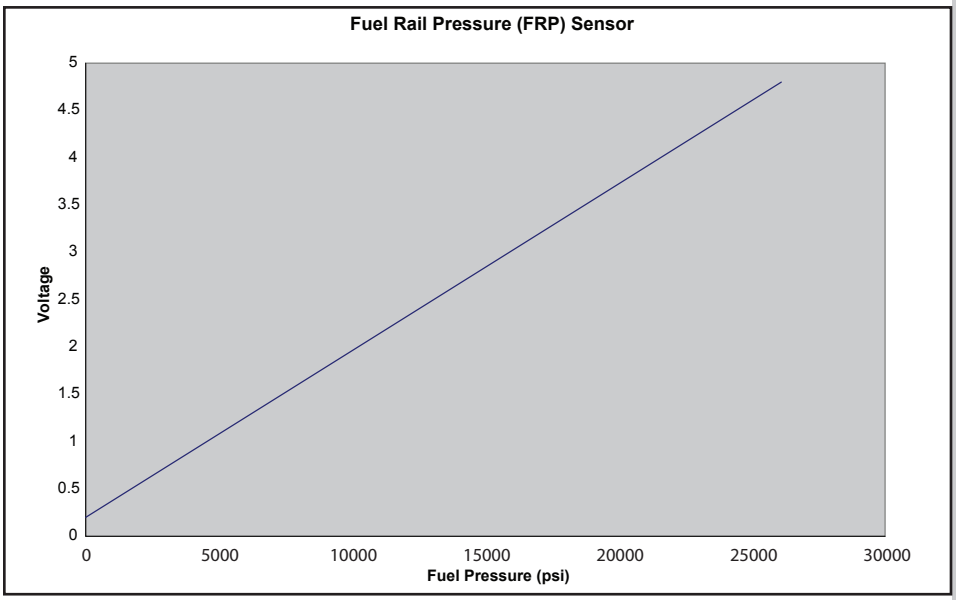
The EP sensor is a 3-wire variable capacitance sensor. The PCM supplies a 5 volt reference (VREF) signal which the EP sensor uses to produce a linear analog voltage that indicates pressure.

The PCM monitors the EP sensor as an input for EGR operation for the delta pressure calculation.

IDS: EP (pressure) and EP_V (volts)



ELECTRICAL COMPONENTS

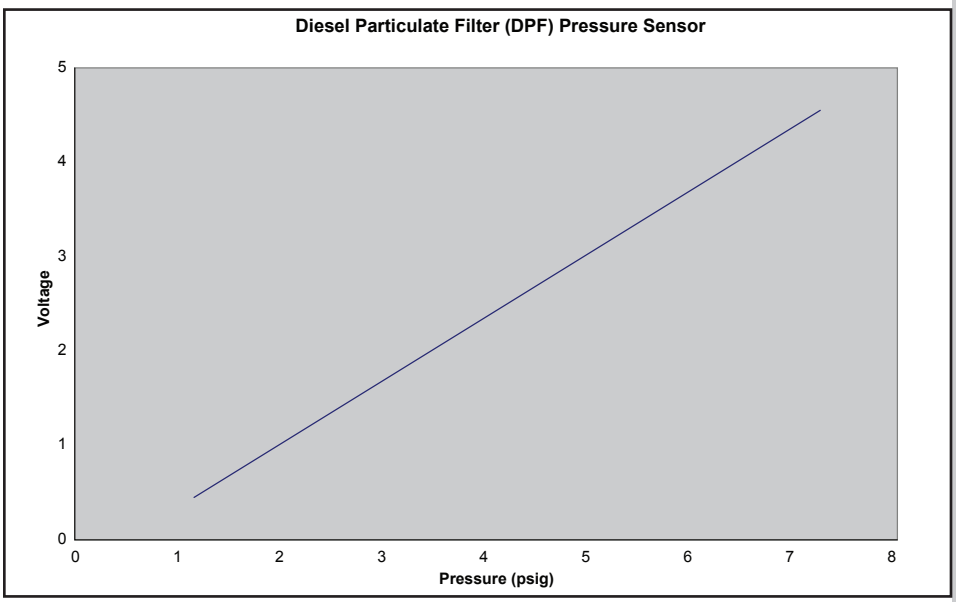


Fuel Rail Pressure (FRP)

The FRP sensor is a 3-wire variable capacitance sensor. The FRP sensor produces a linear analog voltage that indicates pressure of the high pressure fuel system.

The PCM monitors fuel rail pressure as the engine is operating to control fuel pressure. This is a closed loop function which means the PCM continuously monitors and adjusts for ideal fuel rail pressure determined by conditions such as load, speed and temperature.

IDS: FRP (volts) and FRP_A (pressure)



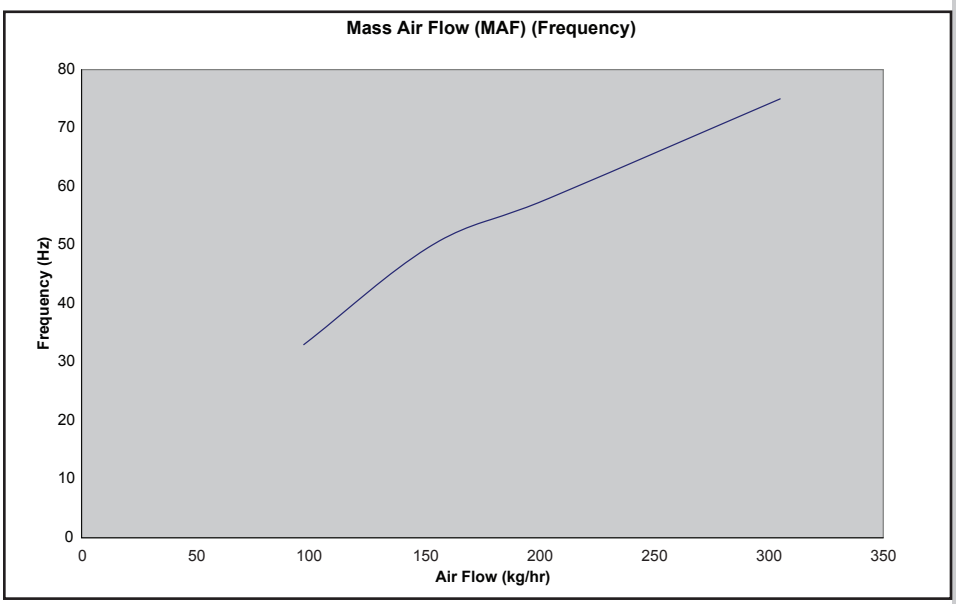
Diesel Particulate Filter (DPF) Pressure

The DPF pressure sensor is a 3-wire variable capacitance sensor. The PCM supplies a 5 volt reference (VREF) signal which the DPF pressure sensor uses to produce a linear analog voltage that indicates pressure.

The DPF pressure sensor measures the exhaust pressure upstream of the diesel particulate filter.

Used as part of the diesel particulate filter load calculation for active regeneration.

IDS: DPF (pressure) and DPF_V (volts)



Mass Air Flow (MAF)

The MAF sensor uses a hot wire sensing element to measure the air flow rate entering the engine. The hot wire is maintained at a constant temperature. The temperature of the hot wire changes with varying air flow. The current required to keep the constant temperature is measured and converted to a frequency which is converted by the PCM to an air flow value.

PCM uses the MAF sensor to measure the air flow into the engine. MAF sensor input is used for EGR, fuel system, and regeneration control.

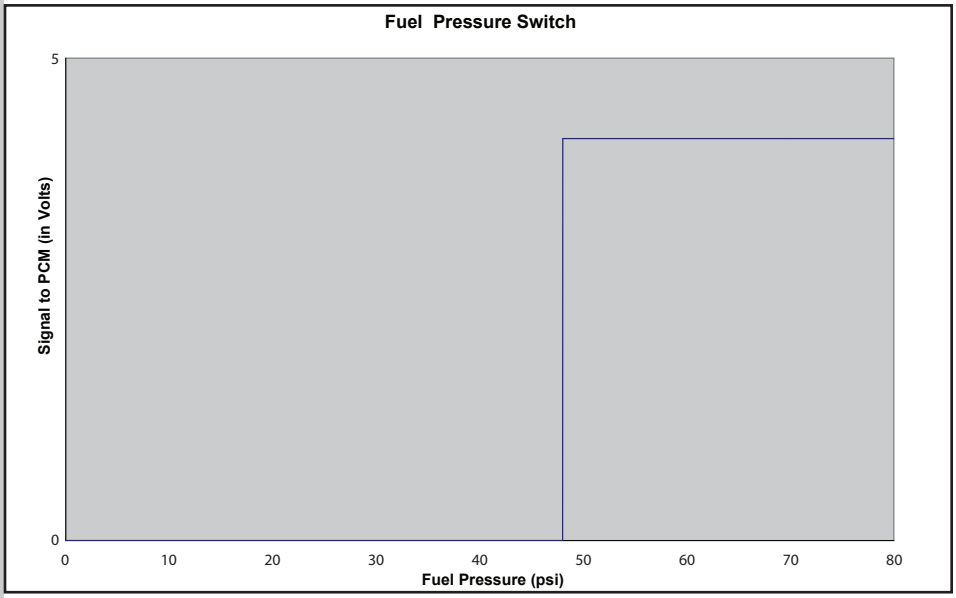
IDS: MAF_A (flow) and MAF_HZ (frequency)

ELECTRICAL COMPONENTS

Fuel Delivery Pressure Switch

The fuel delivery pressure switch provides input to the PCM when a low fuel pressure condition exists. The PCM notifies the customer via an Instrument Panel Cluster (IPC) warning and an engine derate occurs.

IDS: LP_FUEL_SW (low/not low)

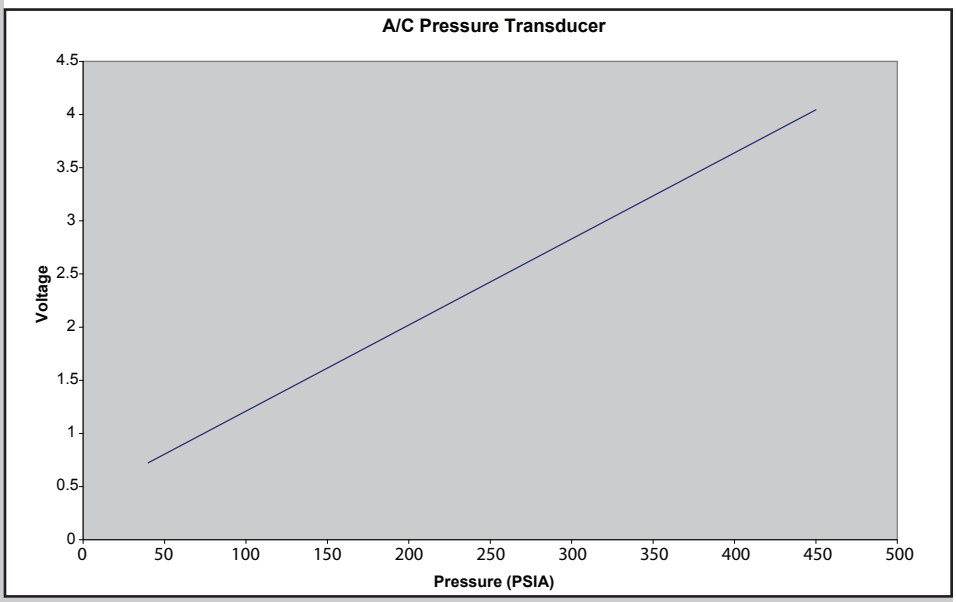


A/C Pressure Transducer

The A/C pressure transducer is a 3 wire sensor. The PCM applies 5 volts to the A/C pressure transducer. The PCM provides the ground for the A/C pressure transducer. The output signal from the A/C pressure transducer changes depending on the pressure of the refrigerant.

The A/C pressure transducer sends the voltage signal to the PCM to indicate the A/C pressure.

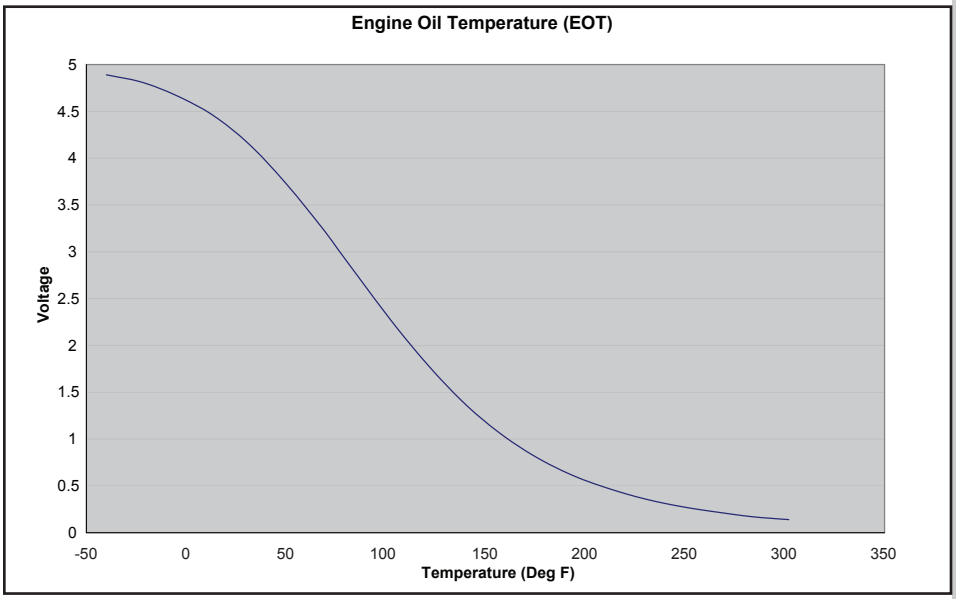
IDS: ACP_V



Temperature Sensors

Temperature sensors are thermistor devices in which resistance changes with temperature. The electrical resistance of a thermistor decreases as the temperature increases, and resistance increases as the temperature decreases. The varying resistance affects the voltage drop across the sensor terminals and provides electrical signals to the PCM corresponding to temperature. Unless specified otherwise, all temperature sensors operate this way.

ELECTRICAL COMPONENTS

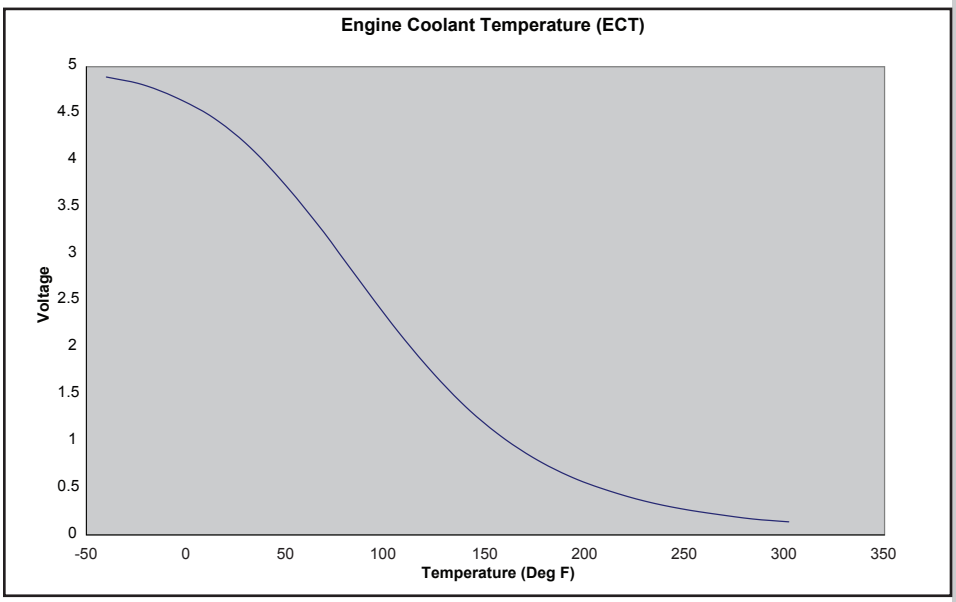


Engine Oil Temperature (EOT)

The EOT sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the EOT sensor circuit. The sensor changes the internal resistance as engine oil temperature changes. The EOT sensor is an input for the cooling fan operation, VGT command, and engine control as well as diagnostics.

The EOT sensor signal allows the PCM to compensate for oil viscosity variations due to temperature changes in the operating environment.

IDS: EOT (volts) and EOT (temperature)

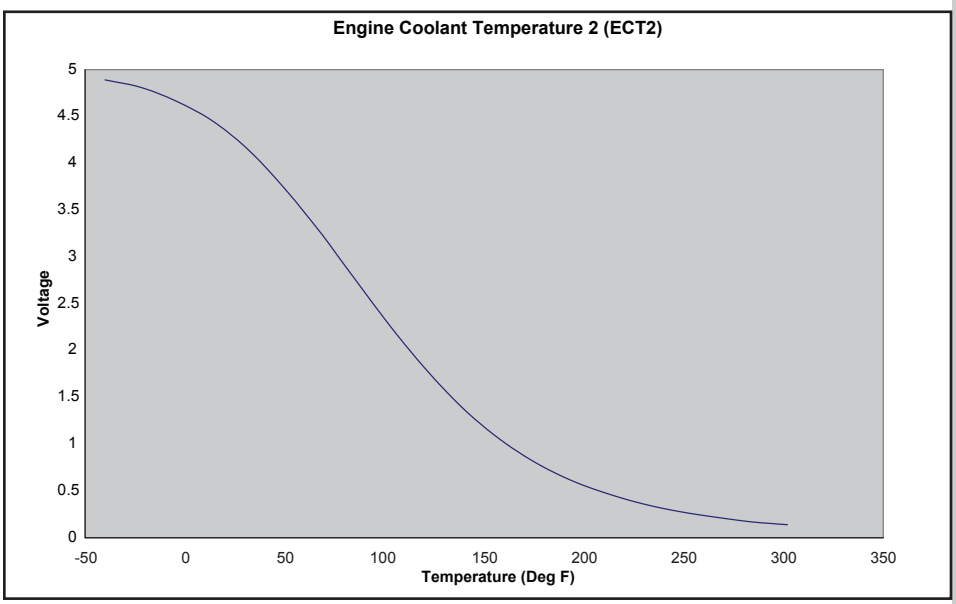


Engine Coolant Temperature (ECT)

The ECT sensor is a 2 -wire thermistor-type sensor. The PCM applies 5 volts to the ECT sensor circuit. The sensor changes the internal resistance as the coolant temperature changes. The PCM uses the ECT sensor for engine temperature protection, input for EGR function, fuel control, and engine fan operation.

The ECT sensor measures temperature of the primary cooling system.

IDS: ECT (temperature) and ECT_V (volts)



Secondary Cooling System Temperature (ECT2)

The ECT2 sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the ECT2 sensor circuit. The sensor changes the internal resistance as the coolant temperature changes.

The PCM uses the ECT2 sensor to monitor EGR cooler effectiveness by measuring the amount of heat being absorbed by the coolant.

The ECT2 sensor measures coolant temperature in the powertrain secondary cooling system.

IDS: ECT2 (temperature) and ECT2_V (volts)

ELECTRICAL COMPONENTS

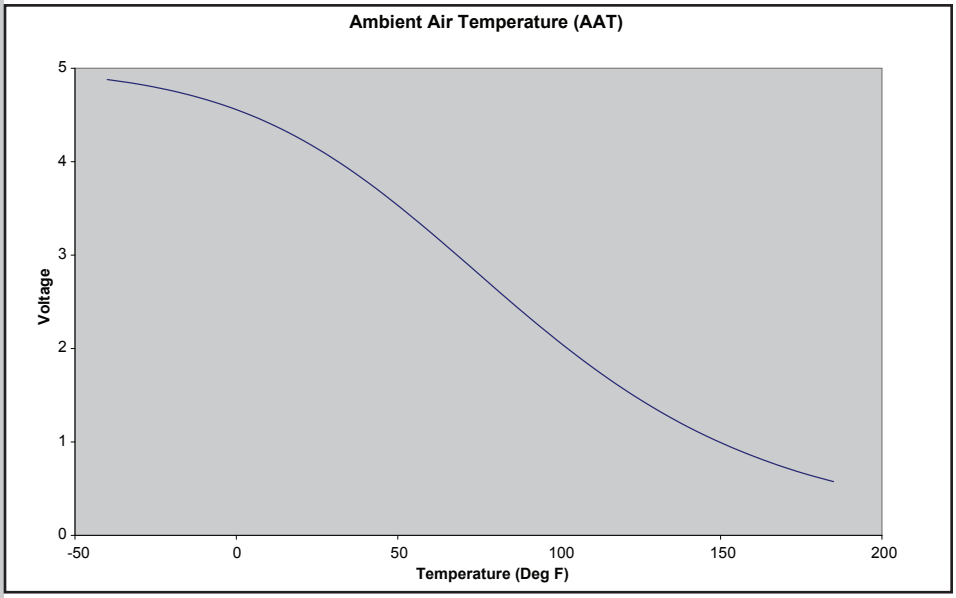
Ambient Air Temperature (AAT)

The AAT sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the AAT sensor circuit. The sensor changes the internal resistance as the ambient air temperature changes.

The AAT sensor is used as an input for engine control, particularly engine coolant fan operation, glow plug system control and diagnostics.

The AAT sensor is located in the passenger's mirror.

IDS: AAT (temperature) and AAT_V (volts)

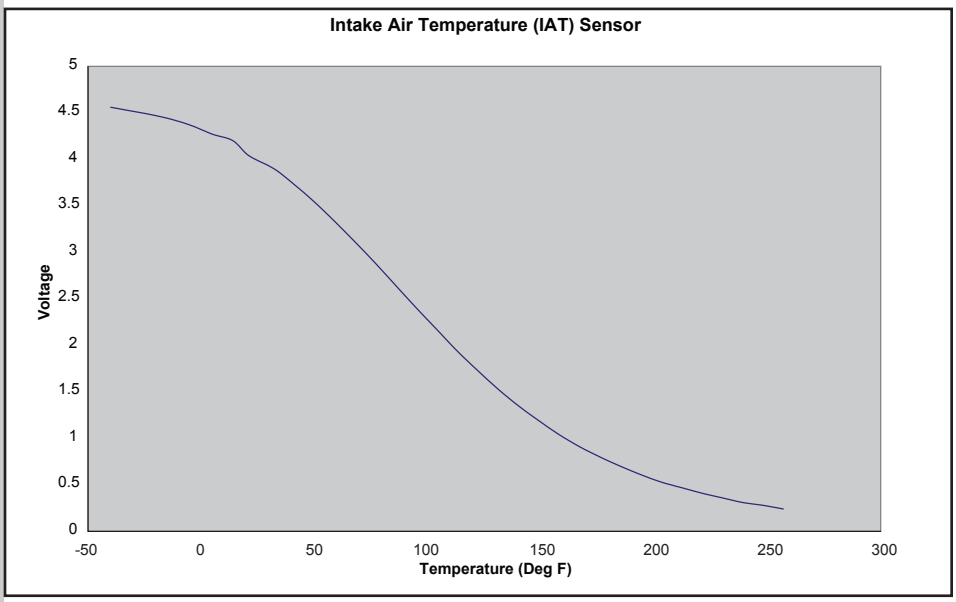


Intake Air Temperature (IAT)

The IAT sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the IAT sensor circuit. The sensor changes the internal resistance as the intake air temperature changes.

The intake air temperature is used for MAF sensor correction and as an input for engine control, particularly engine coolant fan operation and diagnostics.

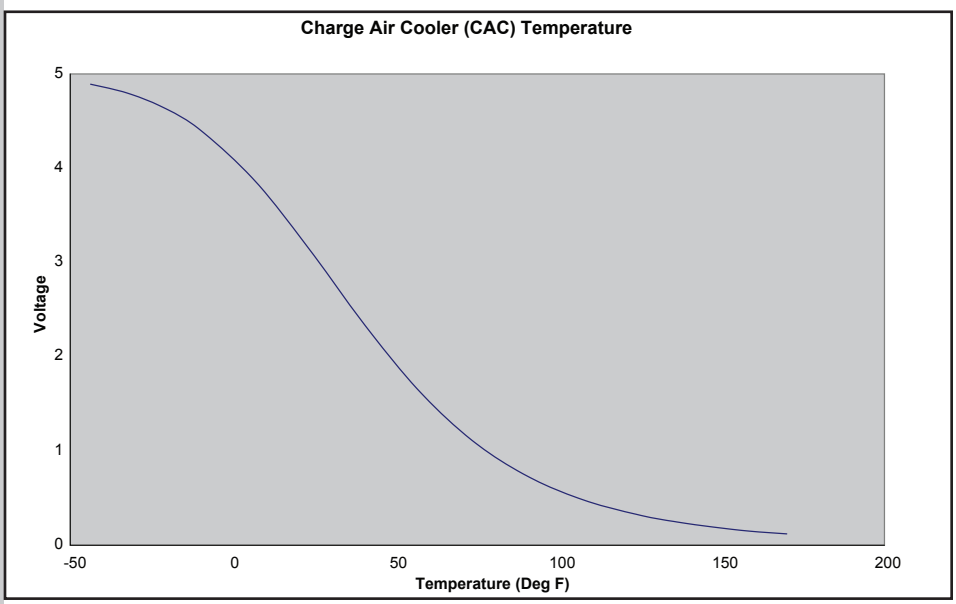
IDS: IAT (temperature) and IAT_V (volts)



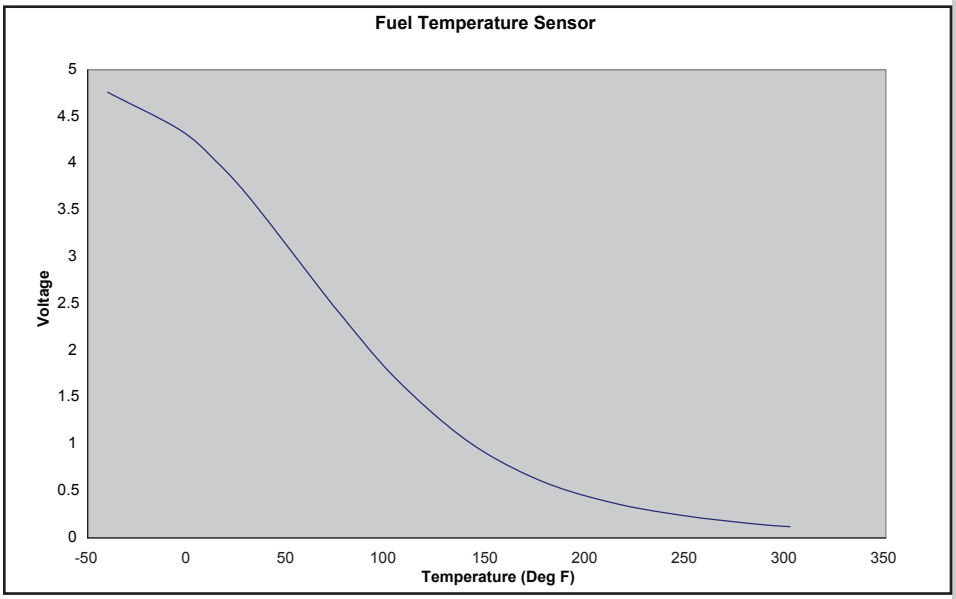
Charge Air Cooler (CAC) Temperature

The CAC temperature sensor is a 2-wire thermistor-type sensor. The PCM applies 5 volts to the CAC temperature sensor circuit. The sensor changes the internal resistance as the air temperature changes. The PCM uses the CAC temperature sensor as an input in determining turbocharger vane and EGR position, as well as fuel and regeneration control.

IDS: CAC_T (temperature) and CAC_V (volts)



ELECTRICAL COMPONENTS

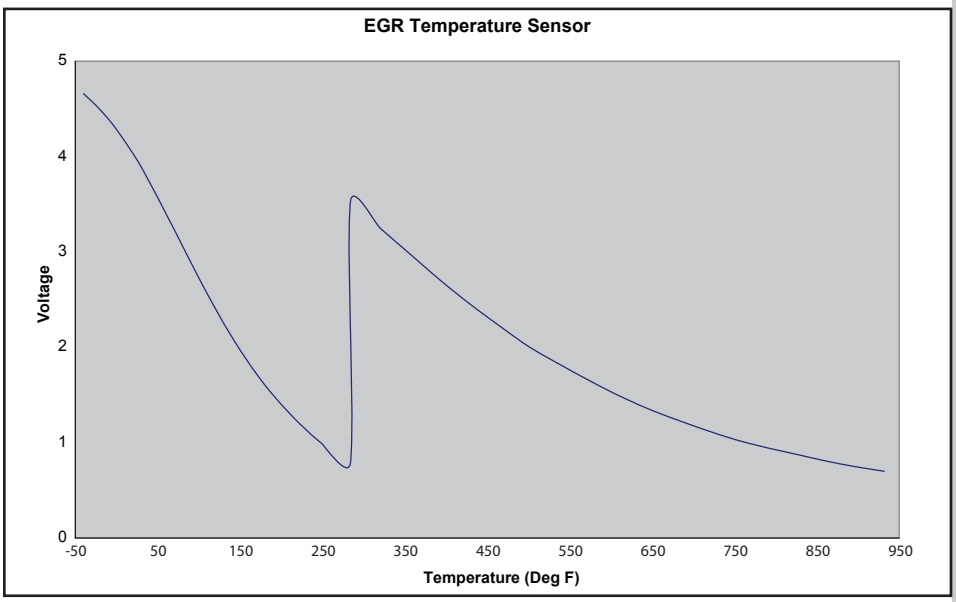


Fuel Rail Temperature (FRT)

The FRT is a 2-wire thermistor-type sensor. The PCM supplies 5 volts to the FRT sensor circuit. The sensor's internal resistance changes as the fuel temperature changes.

The PCM uses the fuel temperature for fuel delivery correction and to determine the fuel pressure control mode (PCV or VCV mode).

IDS: FRT (volts) and FRT_A (temperature)



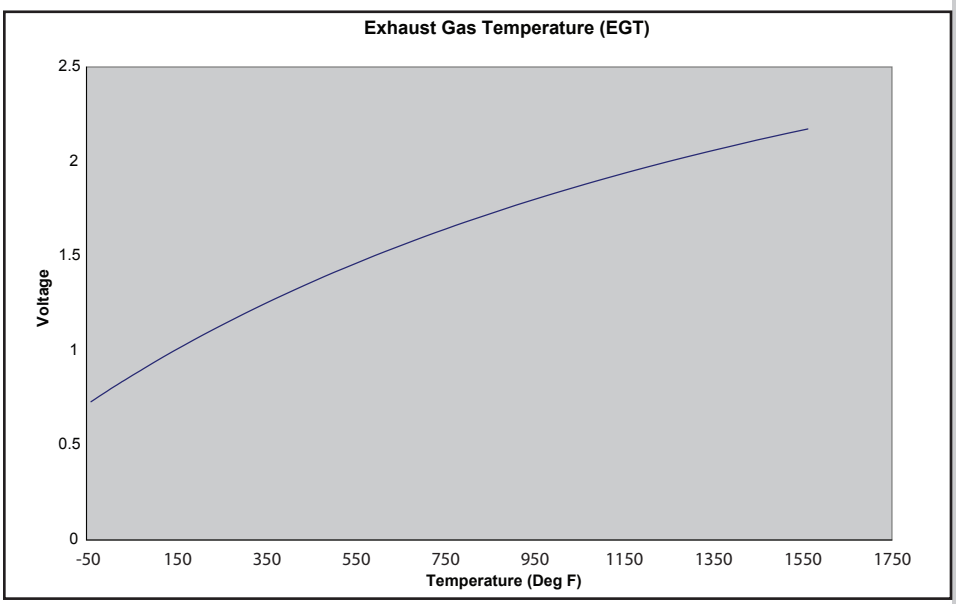
EGR Temperature (EGRT)

The EGRT sensor is a 2-wire thermistor-type sensor. The PCM supplies 5 volts to the EGRT sensor circuit. The sensor changes the internal resistance as the temperature changes.

This sensor has a two step pull-up resistor. Notice the two temperature curves with voltage.

The PCM uses the EGRT sensor as an input in determining EGR cooler bypass actuator function, cooler effectiveness, turbocharger, EGR, fuel and regeneration control.

IDS: EGRT11 (temperature) and EGRT11_V (volts)



Exhaust Gas Temperature (EGT)

The EGT sensors are Resistance Temperature Detector (RTD) type sensors. The electrical resistance of the sensor increases as the temperature increases, and resistance decreases as the temperature decreases.

There are four EGT sensors used as part of the regeneration reductant injection strategy.

IDS: EGT11 (temperature) and EGT11_V (volts), EGT12 (temperature) and EGT12_V (volts), EGT13 (temperature) and EGT13_V (volts), EGT14 (temperature) and EGT14_V (volts)

ELECTRICAL COMPONENTS

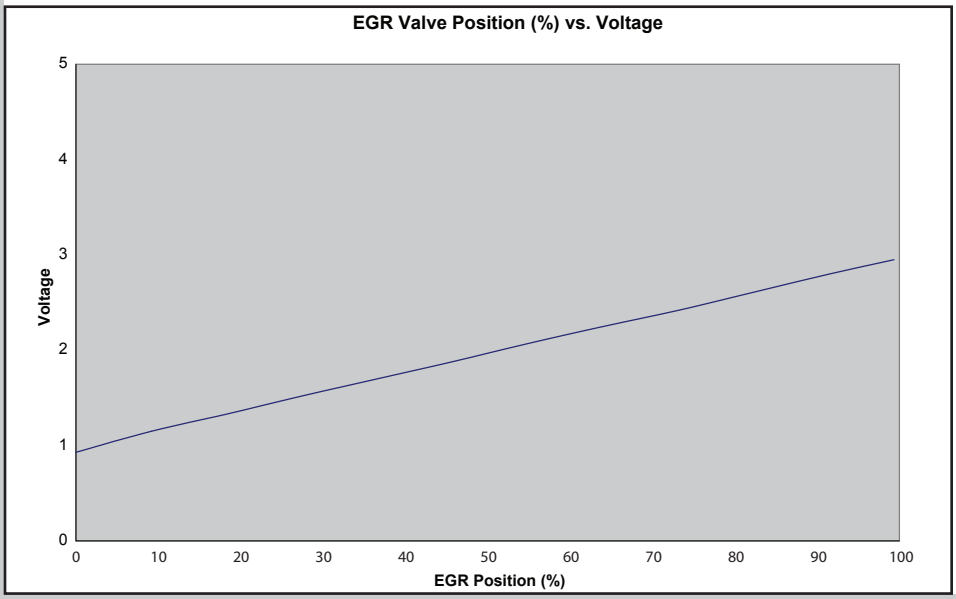
Position Sensors

Exhaust Gas Recirculation Valve Position (EGRVP)

The EGRVP sensor is a 3-wire non-contacting position sensor based upon the magneto-resistive effect (that is, a non-contacting Hall-effect). The PCM supplies a 5 volt reference (VREF) signal which the EGR position sensor uses to produce a linear analog voltage indicating EGRVP.

The PCM uses the EGRVP sensor to determine EGRVP and compares it to the calculated desired position.

IDS: EGRVP (volts) and EGR_A_ACT (%)



Crankshaft Position (CKP)

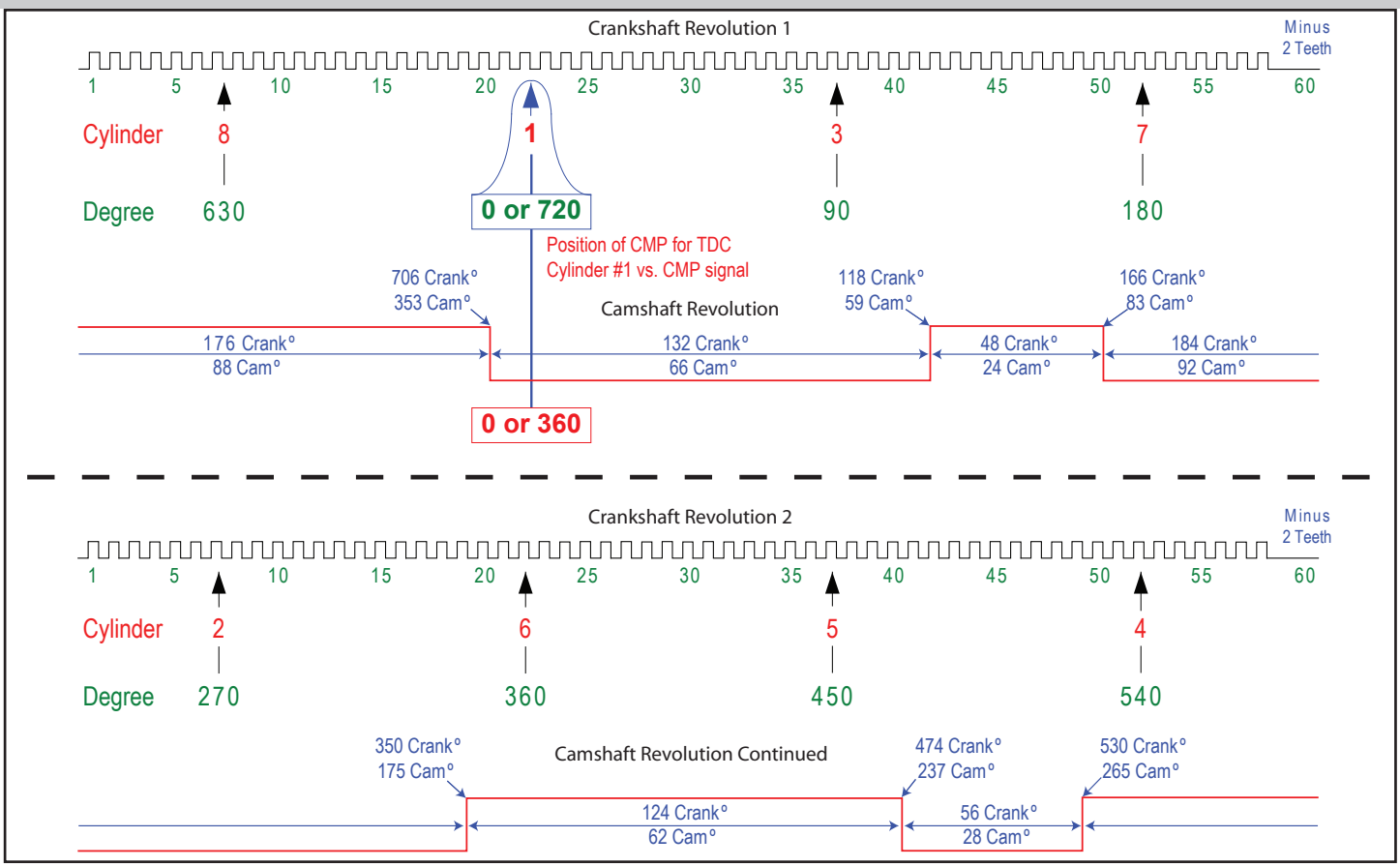
The CKP sensor is a Hall-effect sensor. The PCM filters the information from the sensor which indicates the tooth edges of the magnetic trigger wheel. There are 2 teeth removed to allow the PCM to determine the crankshaft and piston position.

The PCM uses the CKP sensor for engine speed and crankshaft position calculation.

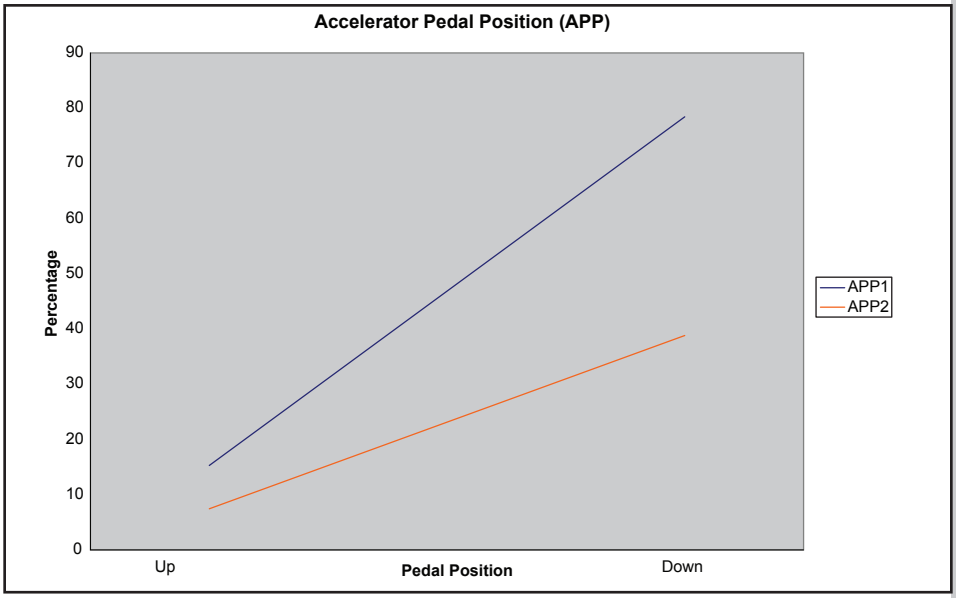
Camshaft Position (CMP)

The CMP sensor is a Hall-effect sensor. The PCM filters the information from the sensor which indicates the 6 targets on the target wheel.

The PCM uses CMP sensor for diagnostics, cylinder position and as a backup for the CKP sensor in the event of failure.



ELECTRICAL COMPONENTS



Accelerator Pedal Position (APP)

The APP is a 2-track position pedal. The pedal has 2 potentiometers providing pedal position to the PCM. This is a safety feature.

IDS: APP1 (volts) and APP1 [APP_D] (%)

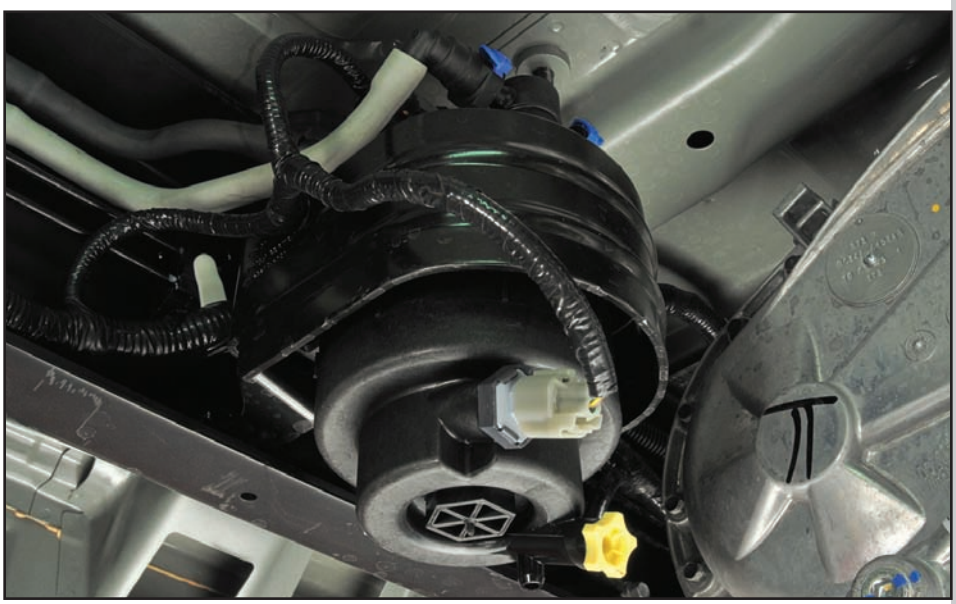
IDS: APP2 (volts) and APP2 [APP_E] (%)



Miscellaneous Sensors

NO_x

The NO_x sensor is mounted next to the EGT14 sensor. The NO_x sensor monitors the amount of NO_x out of the tailpipe. The PCM uses the information to adjust how much reductant is being injected into the exhaust as well as an input for fuel trim. The information from the NO_x sensor can also indicate the effectiveness of the Selective Catalyst Reduction (SCR) system.



Water In Fuel (WIF)

The WIF sensor monitors the water level within the DFCM to determine if the water reservoir requires draining.

The PCM notifies the customer through the Instrument Panel Cluster (IPC) when the water needs to be drained from the DFCM to protect the high pressure fuel system.

IDS: WIF (yes/no)

ELECTRICAL COMPONENTS

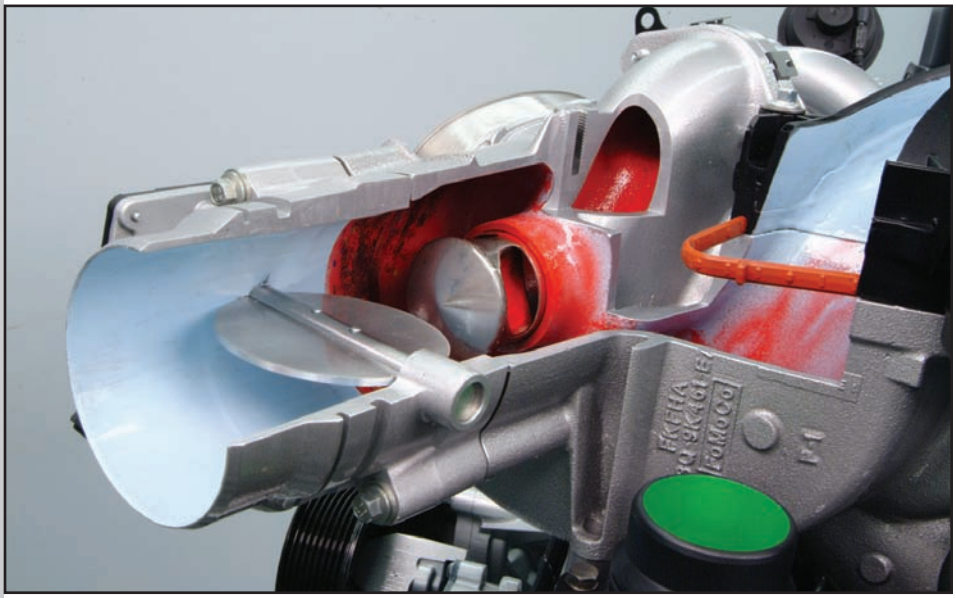
Outputs

Intake Throttle Body

The intake throttle body has an electric DC motor to move the throttle plate. The intake throttle body is controlled by the PCM. The valve is powered in both the open and closed positions.

The intake throttle body helps create the delta pressure difference between intake and exhaust for EGR flow, regeneration and shutdown noise.

IDS: EGRTP_CMD# (%)



EGR Valve

The EGR valve is an electric DC motor controlled by the PCM. The valve is powered in both the open and closed positions.

The EGR valve is opened to allow exhaust gases to mix with the intake air for NO_x emissions purposes.

IDS: EGR_A_CMD# (%)

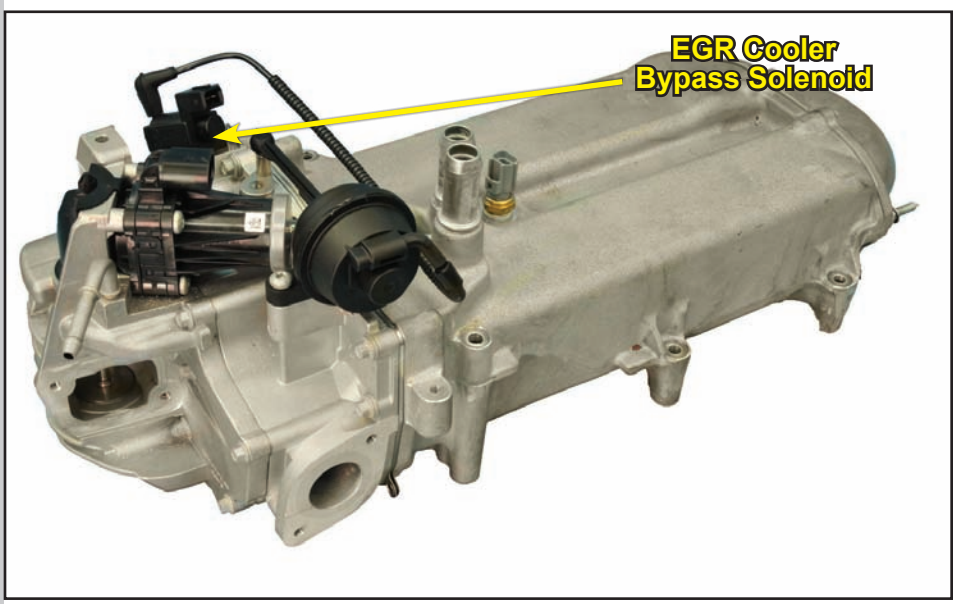


EGR Cooler Bypass Solenoid

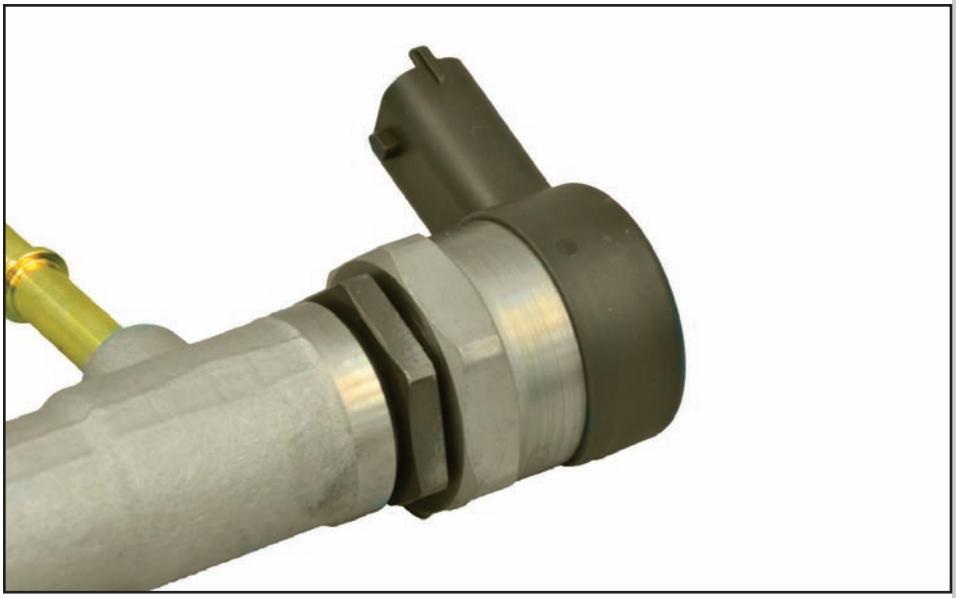
A duty cycle is applied to the solenoid from the PCM to turn vacuum to the actuator on or off. This change causes the EGR cooler bypass door to move.

The EGR cooler bypass solenoid changes the state of the EGR cooler bypass door to either allow exhaust gases to bypass the EGR cooler or direct the gases through the EGR cooler.

IDS: EGRCBV# (%)



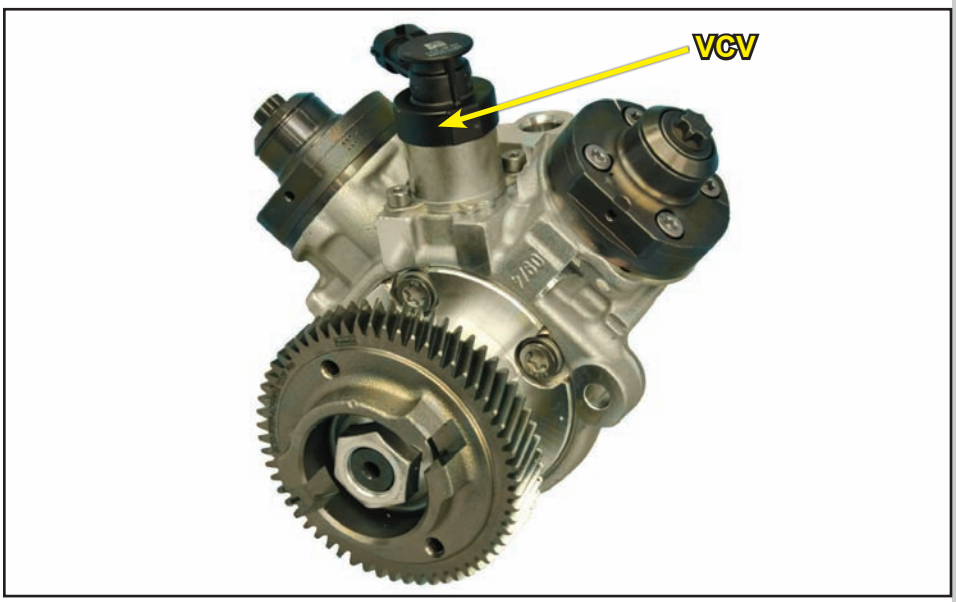
ELECTRICAL COMPONENTS



Pressure Control Valve (PCV)

The PCV is threaded into the rear of the left fuel rail. The PCM controls the fuel rail pressure by modulating the PCV which regulates the fuel rail pressure.

The PCM regulates fuel rail pressure by controlling the on/off time of the PCV solenoid. A high duty cycle indicates a high fuel rail pressure is being commanded. A low duty cycle indicates a low fuel rail pressure is being commanded.



Volume Control Valve (VCV)

The fuel VCV is mounted on the high pressure fuel pump. The PCM controls the volume of low pressure fuel that enters the inlet one-way check valve and two main pump pistons by activating the fuel VCV.

The PCM regulates fuel volume by controlling the on/off time of the fuel VCV solenoid. A high duty cycle indicates less volume is being commanded. A low duty cycle indicates a high fuel volume is being commanded.



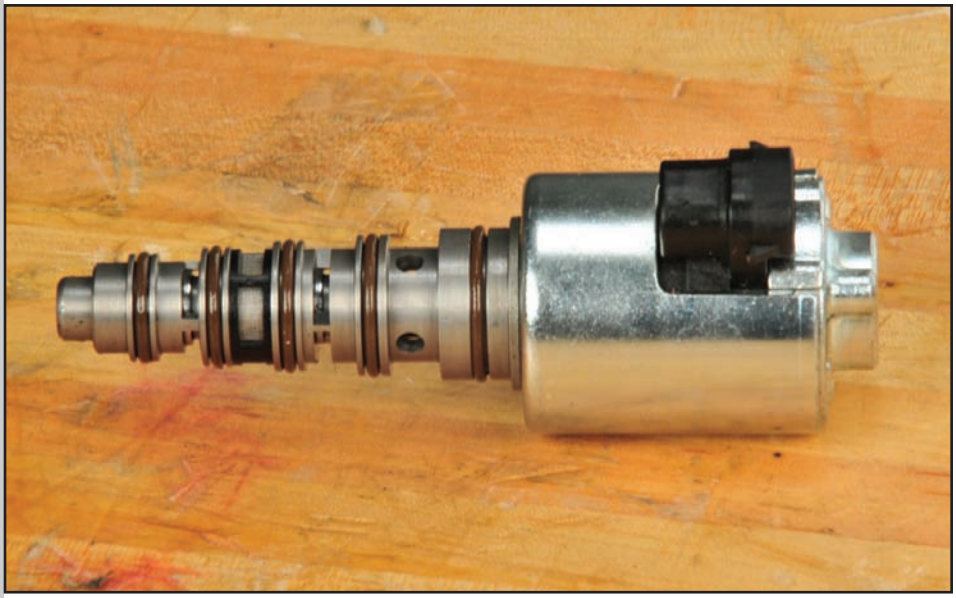
Fuel Injectors

The fuel injectors are connected to the high pressure fuel rail and deliver a calibrated amount of fuel directly into the combustion chamber. The PCM controls on and off time of the fuel injectors. The piezo actuator device allows extreme precision during the injection cycle. The piezo actuator is commanded on by the PCM during the main injection stage for approximately 0-400 micro seconds.

ELECTRICAL COMPONENTS

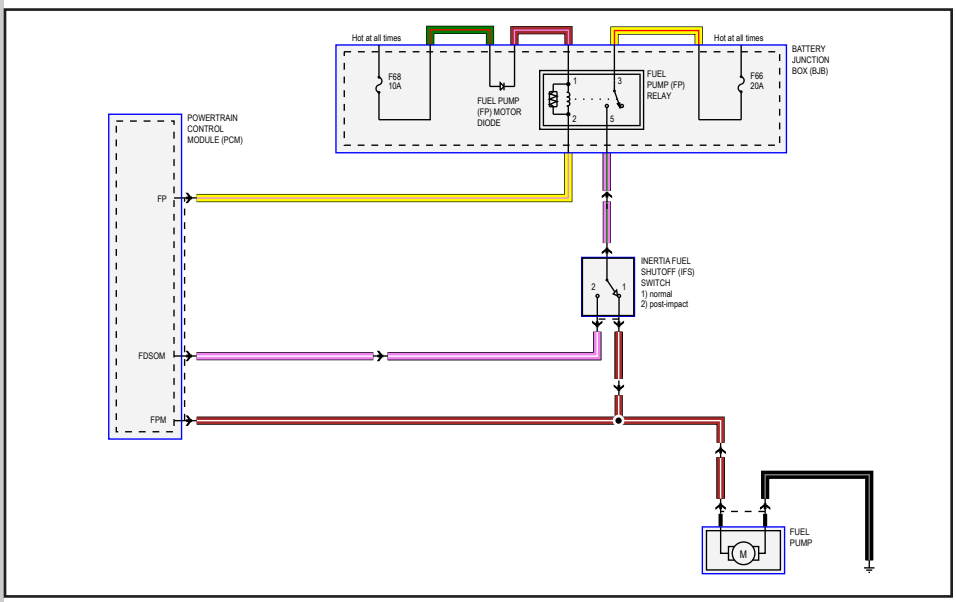
Variable Geometry Turbocharger (VGT) Actuator

The VGT actuator is mounted on the top of the turbocharger. The VGT actuator is commanded by the PCM based on engine speed and load. The magnetic field generated by this signal moves a shaft in the control valve. A cam follower at the end of the valve assembly provides feedback to the valve, allowing it to reach a neutral position during times the vanes are not commanded to move.



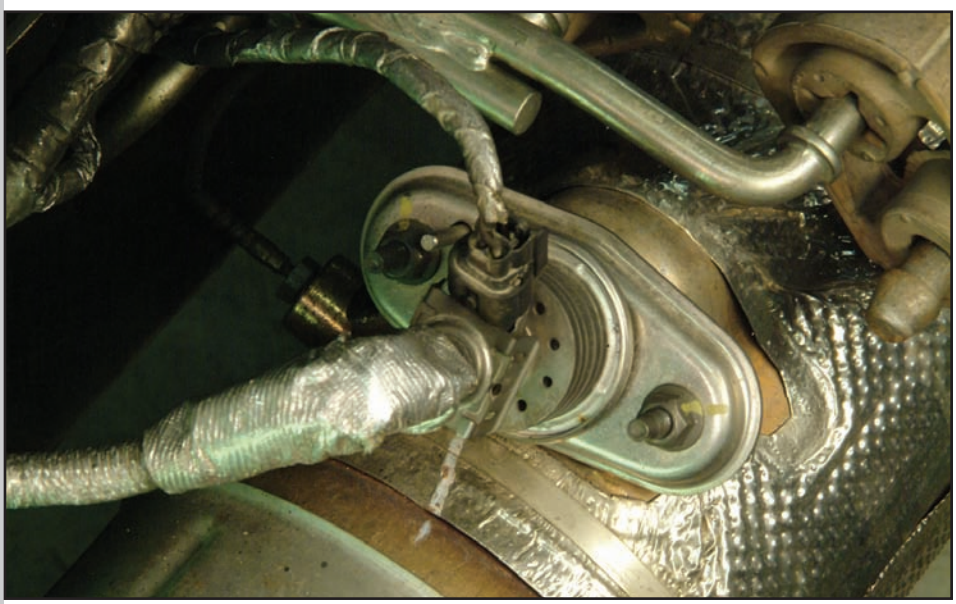
Fuel Pump Relay

The fuel pump relay is located in the Battery Junction Box (BJB). The PCM controls when the relay is on and off.

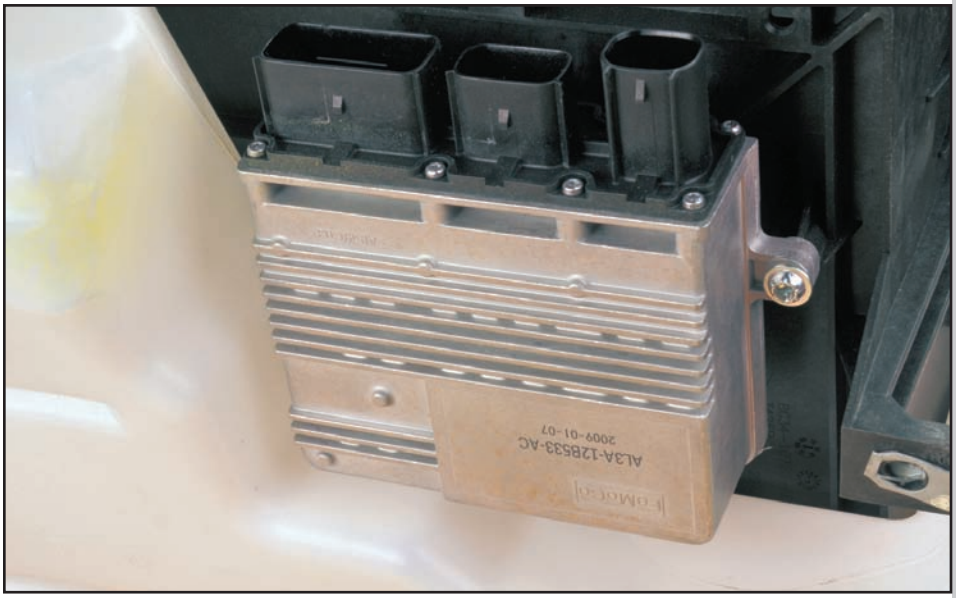


Reductant Dosing Module

The reductant dosing module is mounted next to EGT12 sensor on wide frame or pickup chassis. For narrow frame or chassis cab vehicles the reductant dosing module is located next to EGT13. The reductant dosing module is the part that injects the Diesel Exhaust Fluid (DEF) into the exhaust system.



ELECTRICAL COMPONENTS



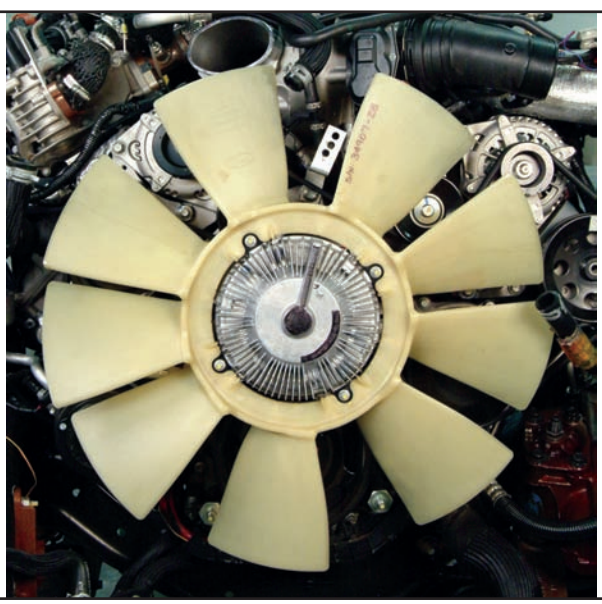
Glow Plug Control Module (GPCM)

The GPCM is mounted under the right side battery box. The PCM commands the GPCM to power the individual glow plugs, which the GPCM does by providing battery voltage. The GPCM is also responsible for powering the heaters used in the reductant system.



Transmission Control Module (TCM)

The TCM is mounted under the vehicle, on the driver side outside the frame rail. The TCM controls the operation of the transmission.



Cooling Fan

The cooling fan is mounted on the front of the engine and is controlled by the PCM.

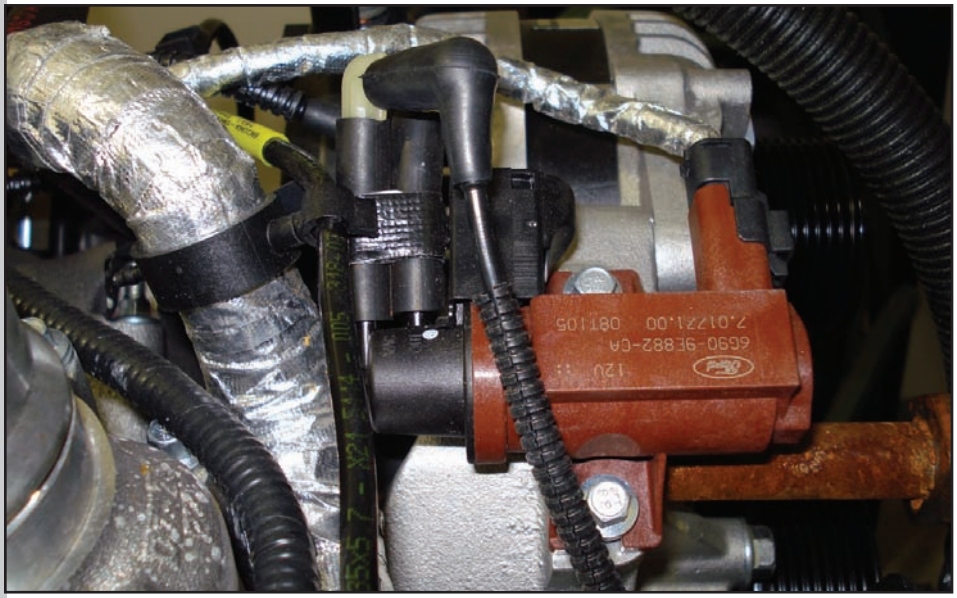
ELECTRICAL COMPONENTS

Wastegate Control Solenoid

The PCM provides a duty cycle to the solenoid which changes the vacuum flow to the actuator causing the wastegate to open and allow exhaust gases to bypass the turbine.

The wastegate helps maintain the required intake manifold pressure. It is used when intake manifold pressure needs to be decreased quickly. When the wastegate is opened, exhaust back pressure is decreased, reducing the turbocharger turbine speed.

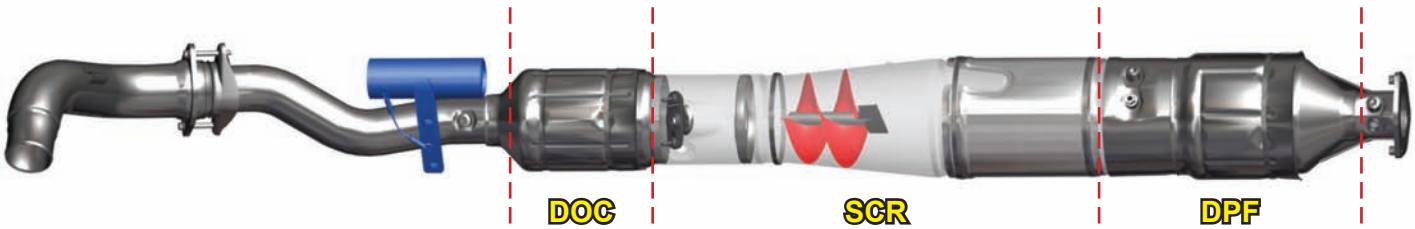
IDS: TURBO_WGATE# (%)



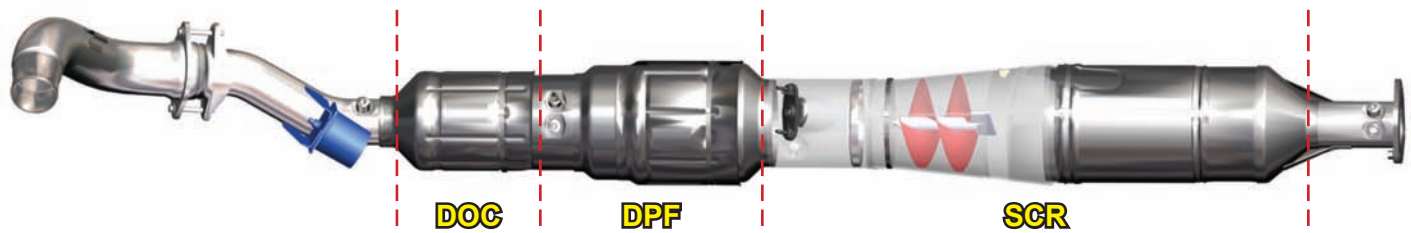
EXHAUST SYSTEM

Exhaust gases exit the exhaust ports into the inboard exhaust manifolds and are directed to the dual turbine inlets of the turbocharger through the right and left side up-pipes. The hot exhaust gas and heat spins the turbine wheel inside the turbocharger. The turbine wheel spins the compressor wheel(s) via their common shaft. Some of the exhaust from the right side exhaust manifold is directed to the EGR valve through the EGR inlet pipe. When the EGR valve is operating, exhaust gas flow goes through the valve and is either routed through or bypasses the EGR cooler. The exhaust gas bypasses the cooler through the EGR cooler bypass valve. The exhaust gas enters the lower intake manifold and combines with the fresh air.

Pickup/Wide Frame Exhaust



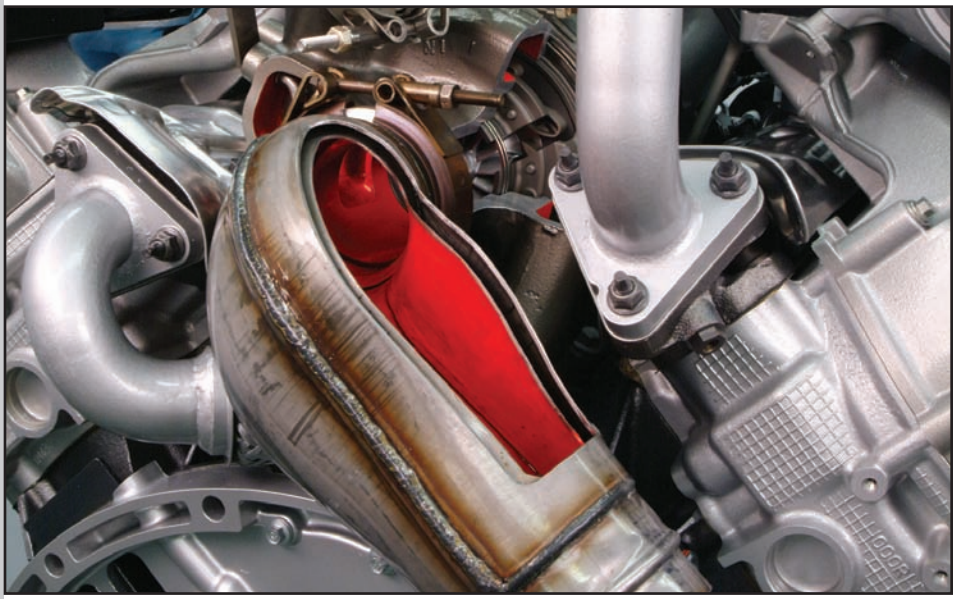
Chassis Cab/Narrow Frame Exhaust



EXHAUST SYSTEM

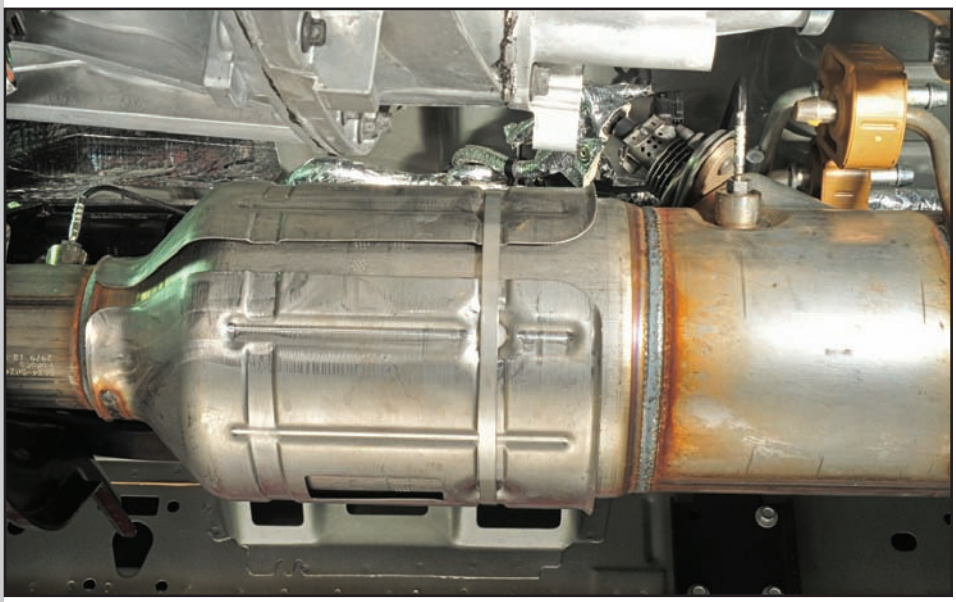
Turbocharger Down Pipe

The turbocharger down pipe is double-walled to help retain heat for the aftertreatment system. It connects to the turbocharger with a V-band clamp connector.



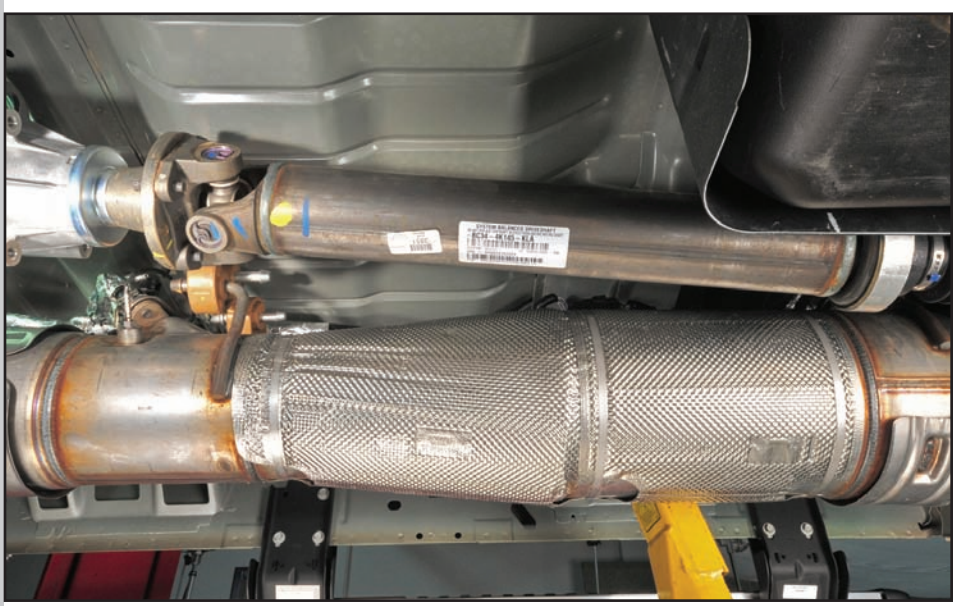
Diesel Oxidation Catalyst (DOC)

The DOC is a ceramic catalytic converter which oxidizes hydrocarbons in the exhaust and generates heat for the SCR and DPF to function properly.

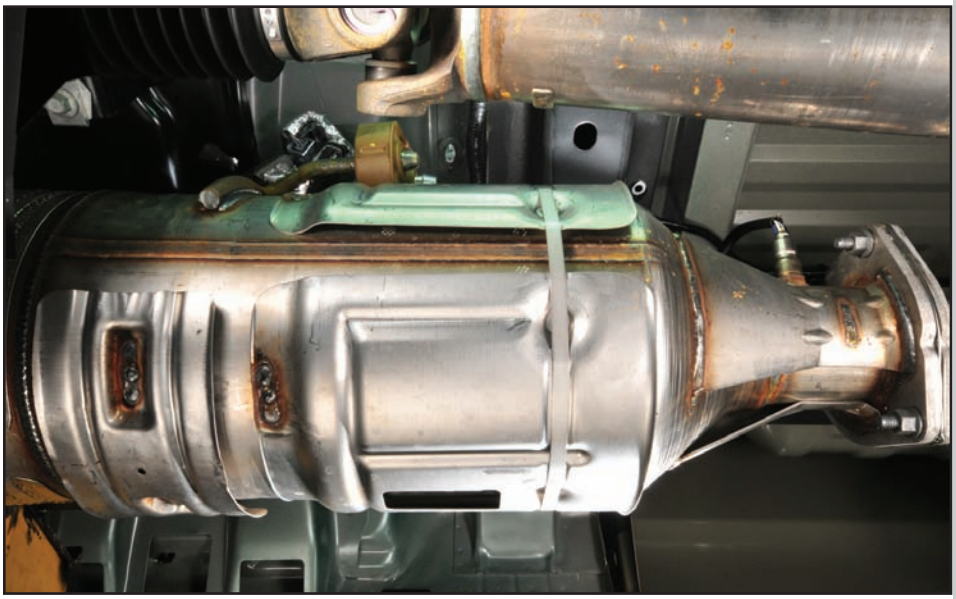


Selective Catalyst Reduction (SCR)

The SCR reduces NO_x in the exhaust. To do this the SCR system injects Diesel Exhaust Fluid (DEF) into the exhaust stream as it passes through a ceramic catalyst coated with copper and iron.

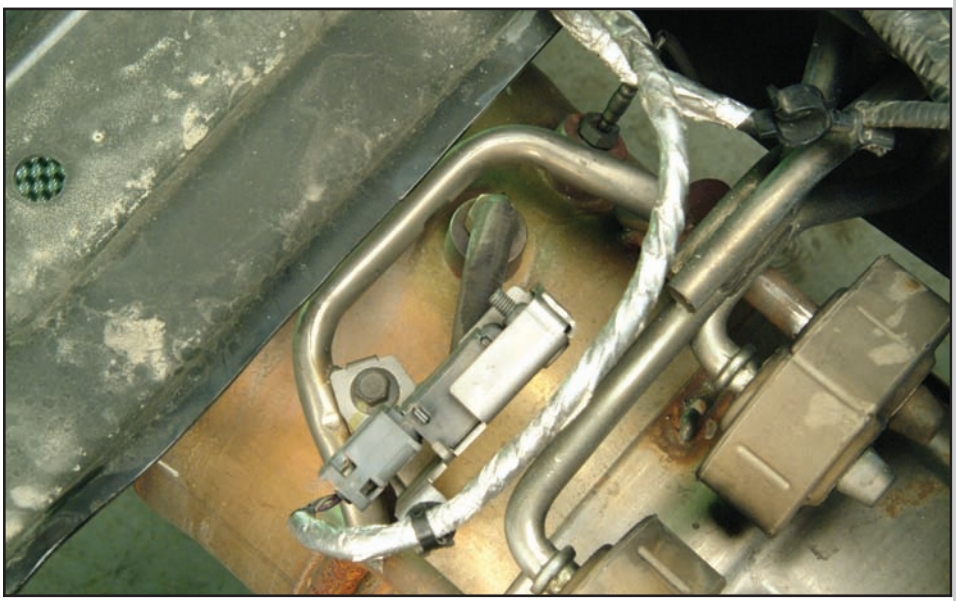


EXHAUST SYSTEM



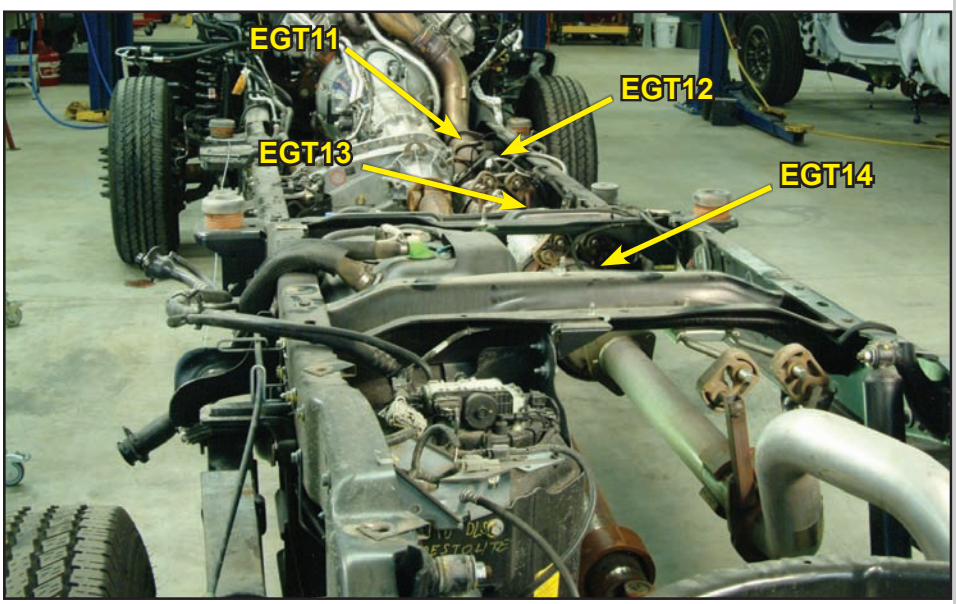
Diesel Particulate Filter (DPF)

The DPF is a highly engineered silicon carbide wall-flow catalyst that traps particulates, reducing the amount of black smoke emitted from the tailpipe. The three modes of DPF regeneration are active, passive and manual.



DPF Pressure Sensor

The DPF pressure sensor is an input to the PCM and measures the pressure before the DPF. The DPF pressure sensor is a differential-type sensor that is referenced to atmospheric pressure. The DPF pressure sensor is used by the PCM to monitor the amount of exhaust pressure produced by the DPF. An active regeneration is performed when the reading reaches a specified point.



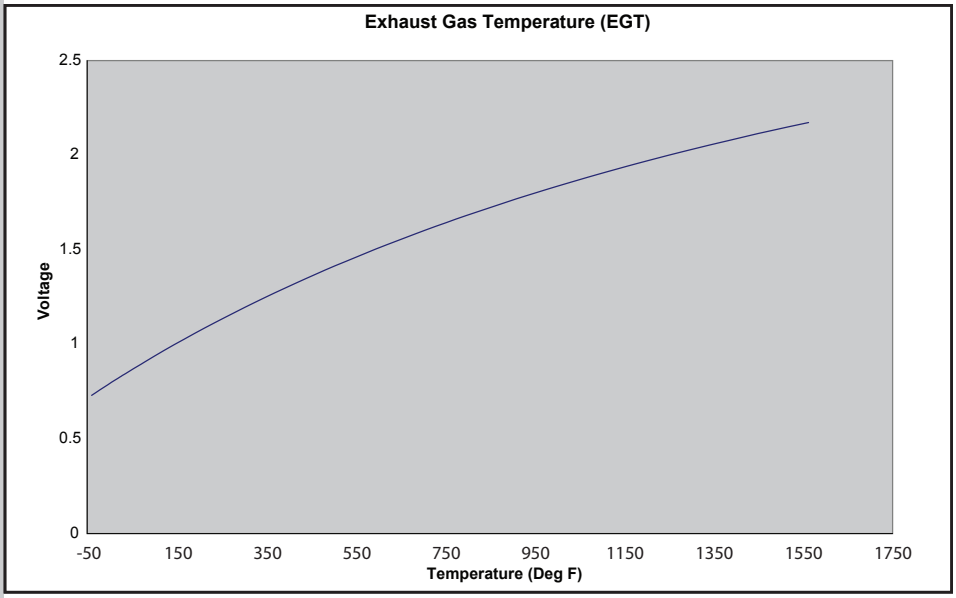
Exhaust Gas Temperature (EGT) Sensors

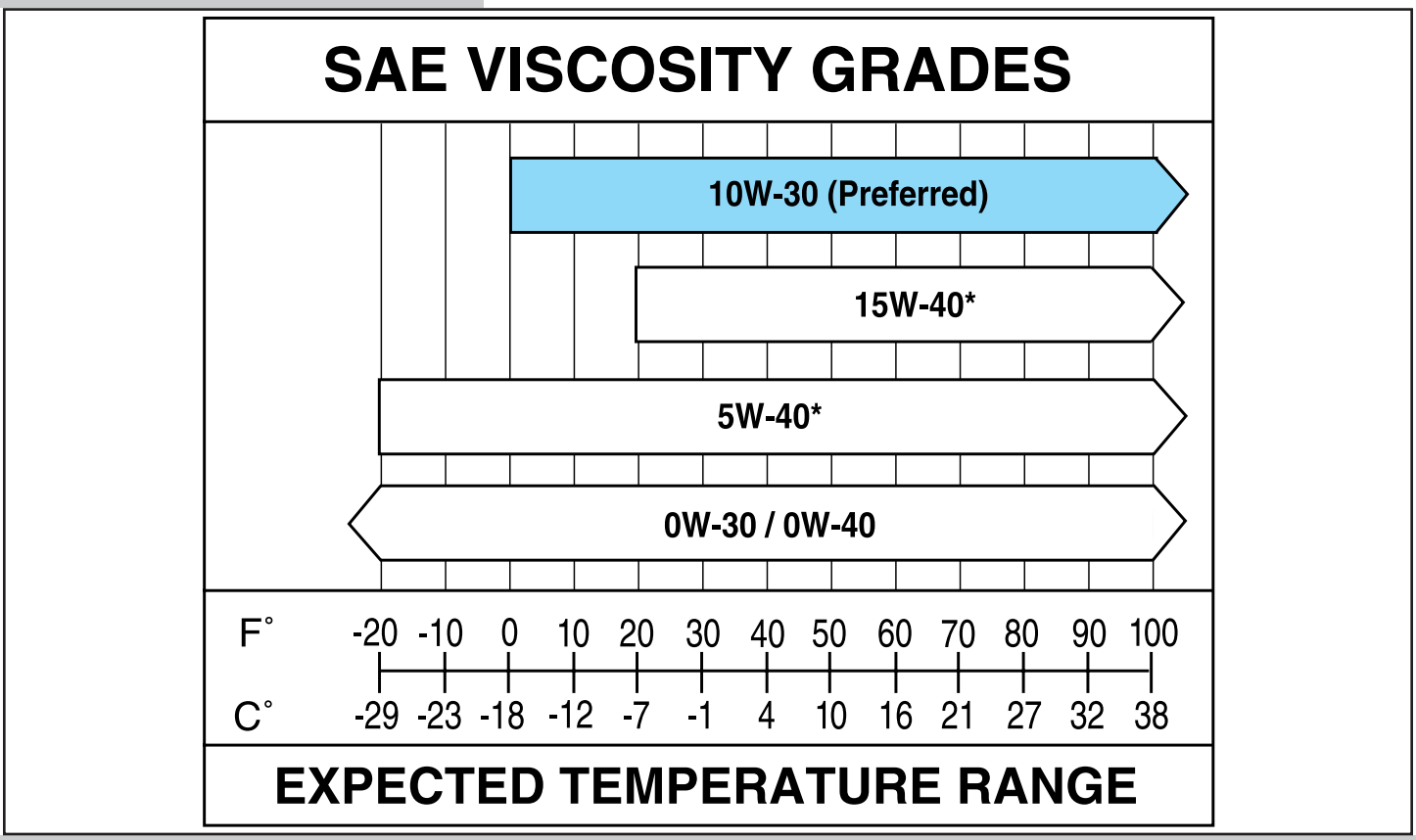
The EGT sensors are Resistance Temperature Detector (RTD) type sensors. The EGT sensors are inputs to the PCM. They measure the temperature of the exhaust gas passing through the exhaust system at four different points.

EXHAUST SYSTEM

EGT Sensor Operation

The electrical resistance of the sensor increases as the temperature increases, and resistance decreases as the temperature decreases. The varying resistance changes the voltage drop across the sensor terminals and provides electrical signals to the PCM corresponding to temperature. The PCM uses the input from four EGT sensors to monitor the exhaust gas temperature.





Recommended Motor Oil

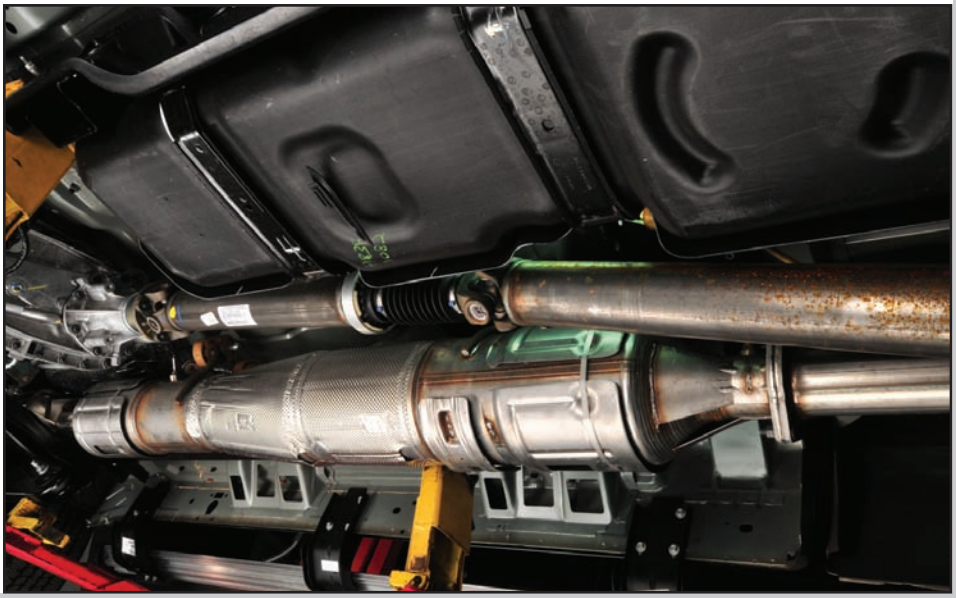
For normal or severe service, use Motorcraft® oil or equivalent conforming to Ford specifications or American Petroleum Institute (API) service categories CJ-4 or CJ-4/SM. It is important to use these oils because they are compatible with the emission control equipment of your vehicle to meet the more stringent emission standards. CJ-4 oil is low in sulfated ash, and has qualities that maintain the life of the DPF and DOC.

The use of correct oil viscosities for diesel engines is important for satisfactory operation. Determine which oil viscosity best suits the temperature range you expect to encounter for the next service interval from the following SAE viscosity grade chart.

*For severe duty use and/or when using biodiesel (grades B5-B20), SAE 5W-40 or SAE 15W-40 API CJ-4 is recommended.

The service interval for the engine oil depends on the vehicle operating conditions. Always consult the maintenance schedule for the proper maintenance interval for the operating conditions.

EXHAUST SYSTEM



The following can be negatively affected by not using the recommended API rated engine oil are:

- increased particulate matter in the aftertreatment system may cause more ash build up in the DPF
- more frequent DPF regenerations
- reduction of DPF service life
- engine oil system

Regeneration Process

As soot gathers in the aftertreatment system, the exhaust begins to become restricted. Regeneration is the process in which soot is burned off from the inside of the DPF. Regeneration can be commanded by the PCM or the scan tool.

The PCM starts regeneration of the DPF if the soot load exceeds a calibrated value. The PCM determines the load condition of the DPF, based on the exhaust gas pressure upstream of the DPF. The DPF pressure sensor provides the pressure input to the PCM.

This soot can be cleaned by passive, active, or manual regeneration. Manual regeneration is performed using the IDS.

Passive Regeneration

Passive regeneration takes place when exhaust temperatures exceed 300°C (572°F). This process does not affect engine performance and is transparent to the driver.

Active Regeneration

Active regeneration occurs when exhaust temperatures are insufficient to achieve passive regeneration and the DPF pressure sensor is indicating the need for regeneration.

The PCM automatically activates the left bank fuel injectors during the exhaust stroke to raise exhaust temperature to begin regeneration while the vehicle is in motion.

Engine performance is not affected by active regeneration, however the engine or exhaust tone may change.

Manual Regeneration

The IDS can be used to perform a manual regeneration of the DPF in the shop and set the ash value under stationary conditions to clean and calibrate the system. The Malfunction Indicator Lamp (MIL) may illuminate when service or maintenance of the DPF is necessary.

CAUTION: The manual regeneration of the DPF produces high temperatures in the exhaust system. Due to high exhaust gas temperatures, always follow the Workshop Manual Cautions, Warnings, and procedures when performing a manual DPF regeneration.

Frequency of Regeneration

The mileage between regenerations varies significantly, depending on vehicle usage.

Post Regeneration

After regeneration, the PCM reads the pressure at the DPF pressure sensor and compares it with a calibrated value. From this comparison, the PCM determines the ash quantity inside the DPF.

Non-Burnable Ash

Over time a slight amount of non-burnable ash builds up in the DPF which is not removed during the regeneration process. Ash comes from the fuel, oils and other materials that remain after the DPF regeneration process. The DPF may need to be removed for ash cleaning and replaced with a new or remanufactured part.

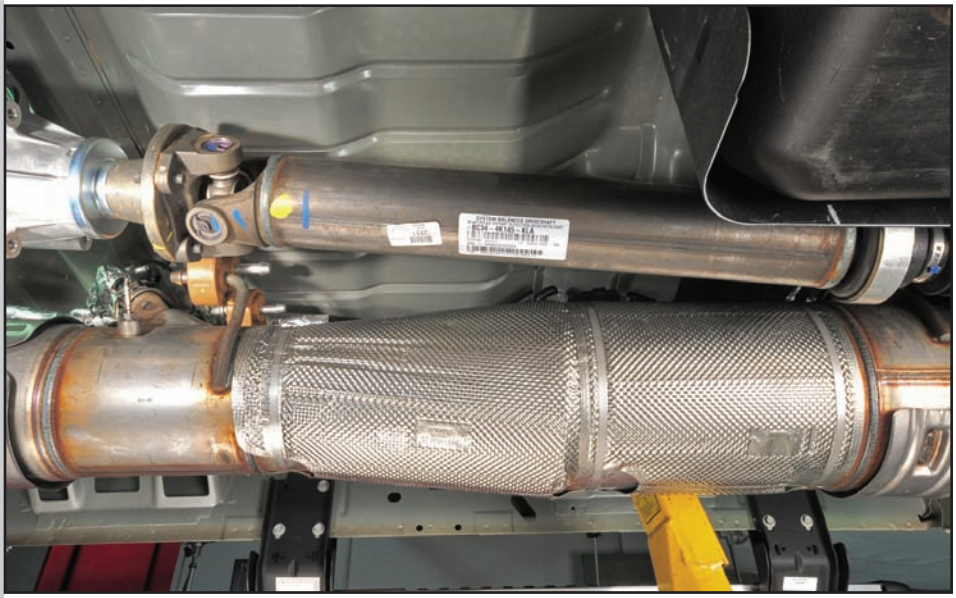
Handle the DPF with care. Dropping the DPF may cause internal damage.

EXHAUST SYSTEM

Selective Catalyst Reduction (SCR)

The SCR system components include the following:

- reductant or Diesel Exhaust Fluid (DEF)
- reductant tank
- reductant dosing module
- reductant pump and heater assembly
- reductant pressure line heater assembly
- reductant tank heater and sensor assembly
- reductant purge valve
- reductant pressure sensor
- NO_x sensor and module
- exhaust mixing system



Reductant or Diesel Exhaust Fluid (DEF)

Reductant, also known as Diesel Exhaust Fluid (DEF) is 32.5% urea/water solution. When injected into the exhaust, there is a chemical reaction that converts NO_x into N_2 and H_2O. The freezing point of reductant is -11°C (12°F).

Reductant is very caustic; take care not to spill onto connectors, wiring harnesses or the vehicle's paint.

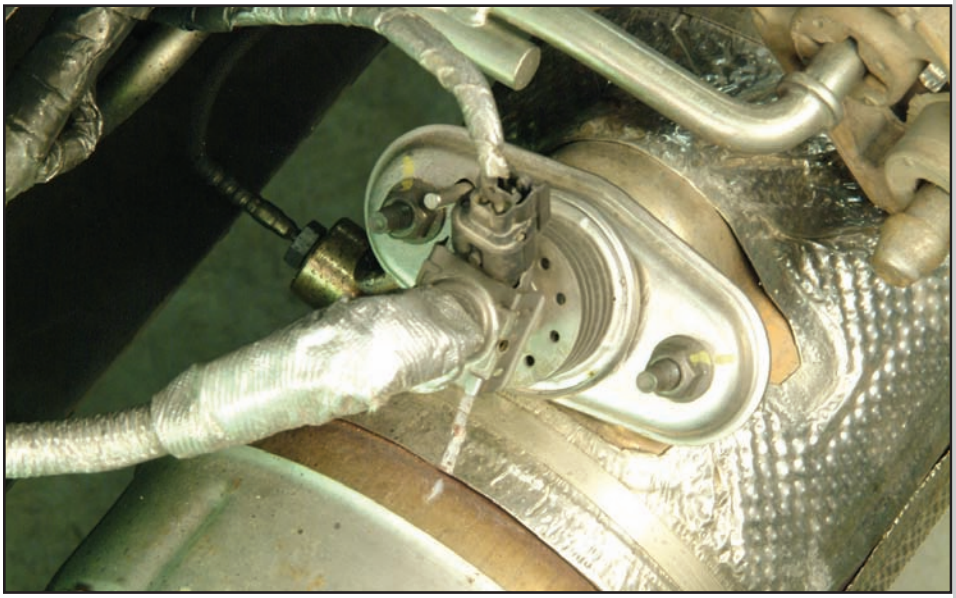


Reductant Tank

The reductant tank stores the reductant or DEF. Under normal use it needs to be refilled at the same interval as the oil change.

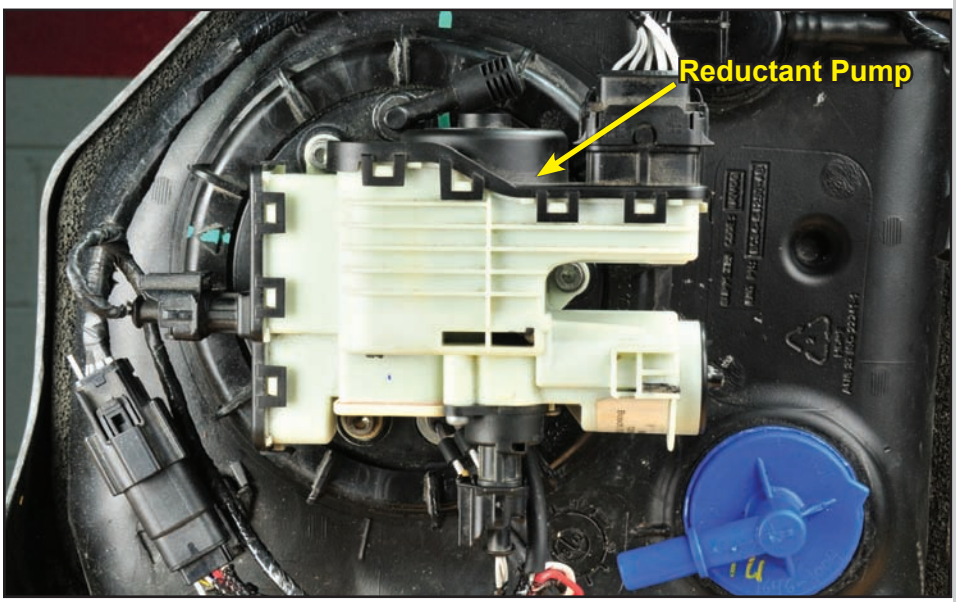


EXHAUST SYSTEM



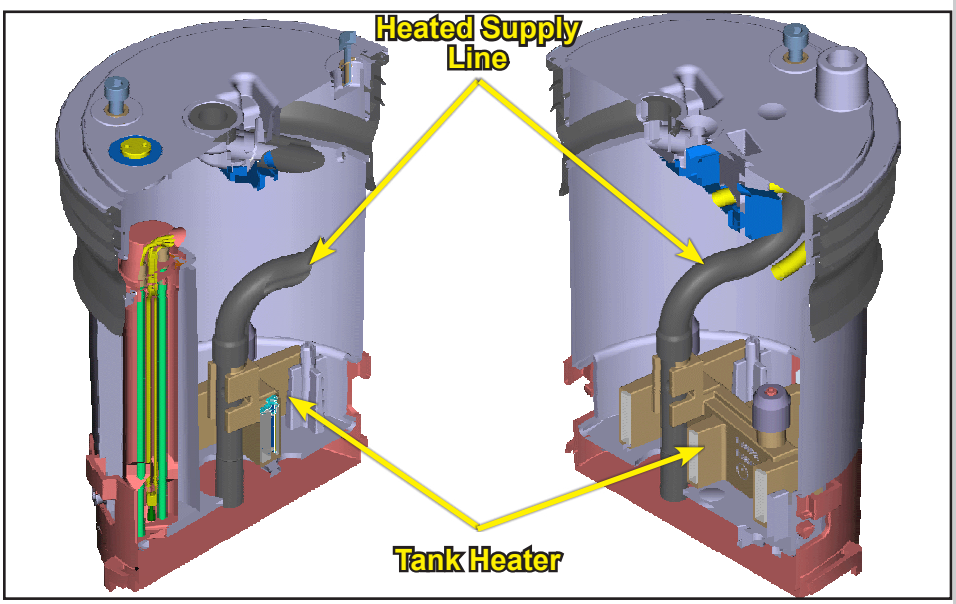
Reductant Dosing Module

The reductant dosing module is controlled by the PCM. The reductant dosing module injects reductant into the exhaust system to reduce NO_x coming out of the tailpipe. The injector is made to resist the corrosive properties of the reductant.



Reductant Pump

The reductant pump supplies reductant to the dosing module. One unique function of the pump is that when the ignition is turned off, the pump pulls all the reductant out of the lines. This prevents damage to the lines if the reductant was to freeze.



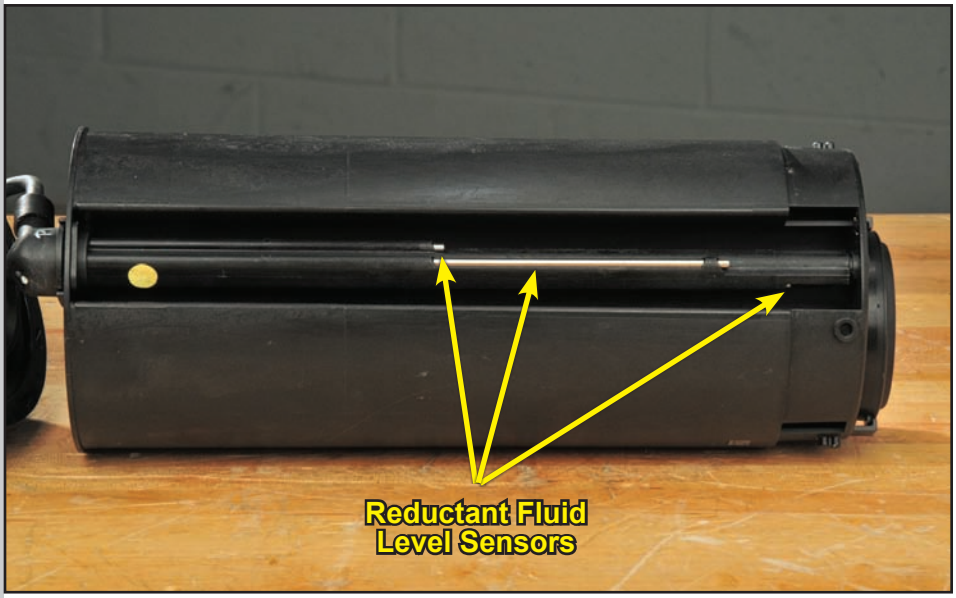
Reductant Heaters

Below a specified temperature the PCM commands the Glow Plug Control Module (GPCM) to activate the heaters in the reductant system. The reductant system has heaters in the tank, pump, and lines. The heaters in the tank thaw the DEF if it is frozen and allow it to flow to the pump without freezing. The heaters in the pump and lines allow the DEF to flow to the injector without freezing.

EXHAUST SYSTEM

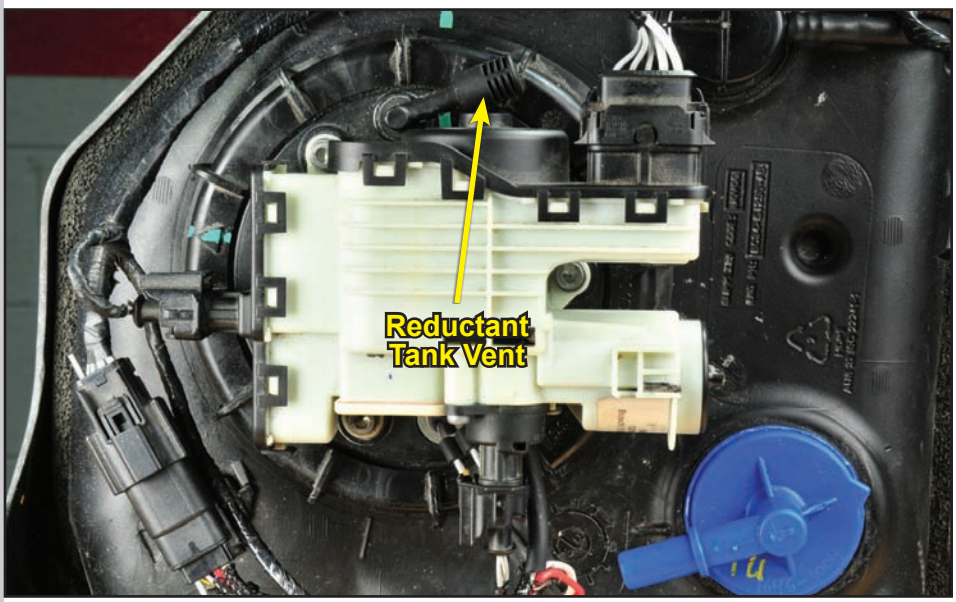
Reductant Fluid Level Sensors

The reductant fluid level sensor operates by using four electrodes (one not visible in the picture) that are mounted on the sensor at different levels. The reductant solution closes the electric circuit between electrodes for each level interface. The signal is then converted before being sent to the PCM.



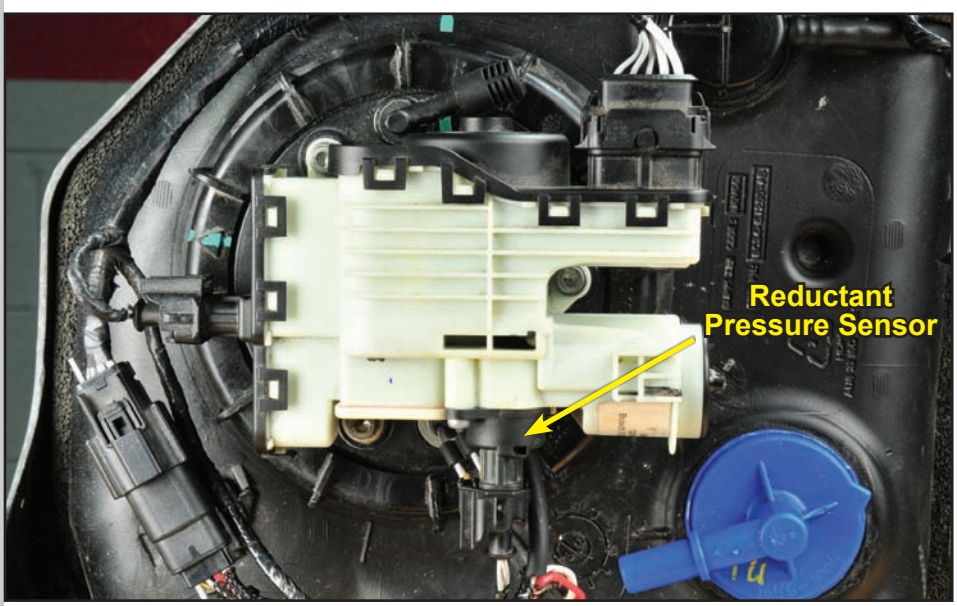
Reductant Tank Vent

The reductant tank vent allows the fluid tank pressure to equalize with atmospheric pressure. Pressure differences are caused by temperature and reductant usage.



Reductant Pressure Sensor

The PCM monitors the reductant pressure sensor to calculate how much reductant to inject into the exhaust. The reductant pressure sensor also shuts the pump off when the lines are being drained after the ignition is shut off.

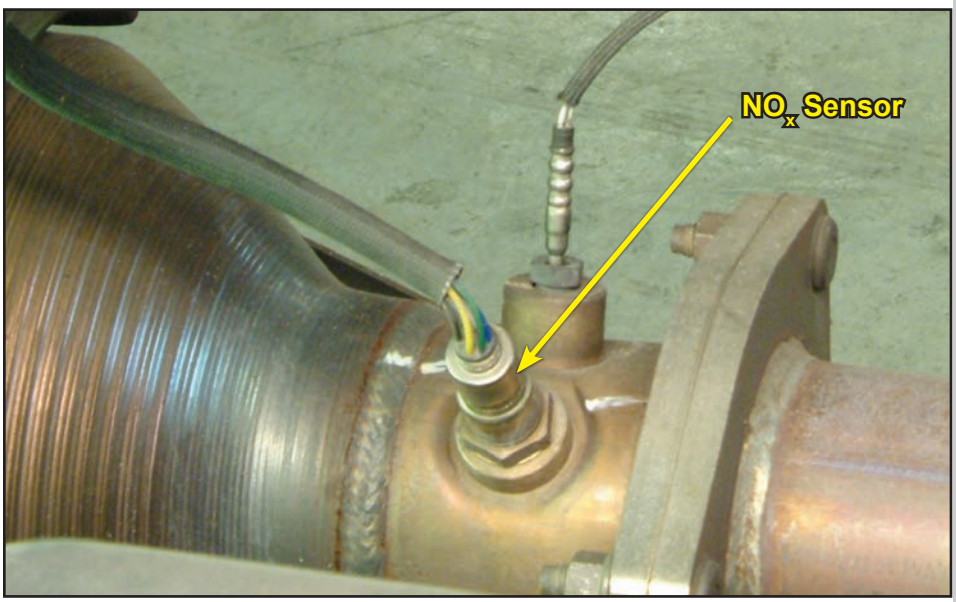


EXHAUST SYSTEM



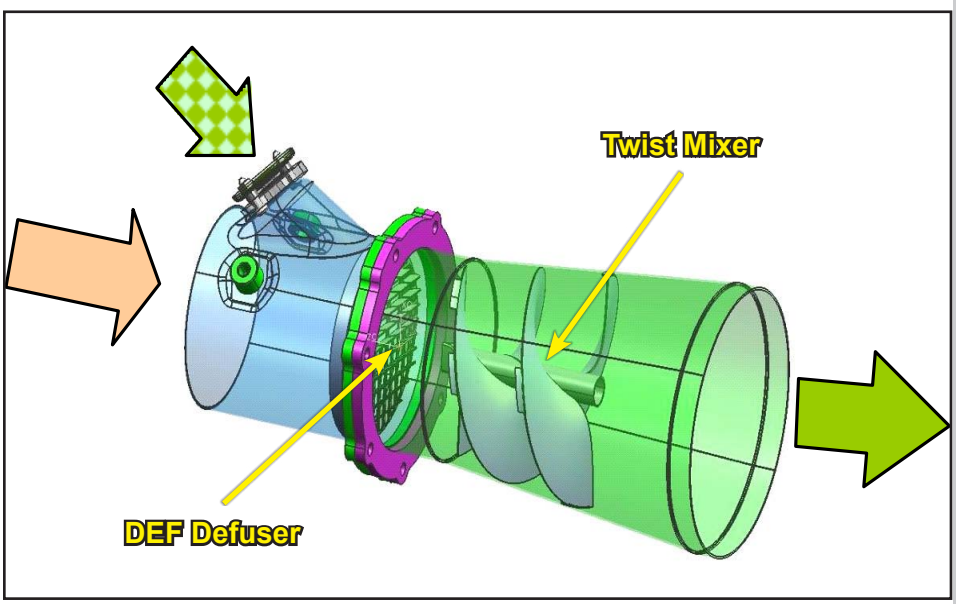
NO_x Sensor Module

The NO_x sensor module is mounted to the vehicle frame under the body. It controls the NO_x sensor mounted in the diesel aftertreatment exhaust system downstream of the SCR and DPF. It communicates to the PCM via the CAN2 to report NO_x and O_2 concentrations as well as sensor and controller errors.



NO_x Sensor

The NO_x sensor is used primarily to sense O_2 and NO_x concentrations in diesel exhaust gas. The sensor is mounted in a vehicle's exhaust pipe, perpendicular to exhaust gas flow. The sensor is mounted downstream of the SCR and DPF. The sensor interfaces with the NO_x sensor module that controls the sensor and heater circuits.



Reductant Exhaust Mixer

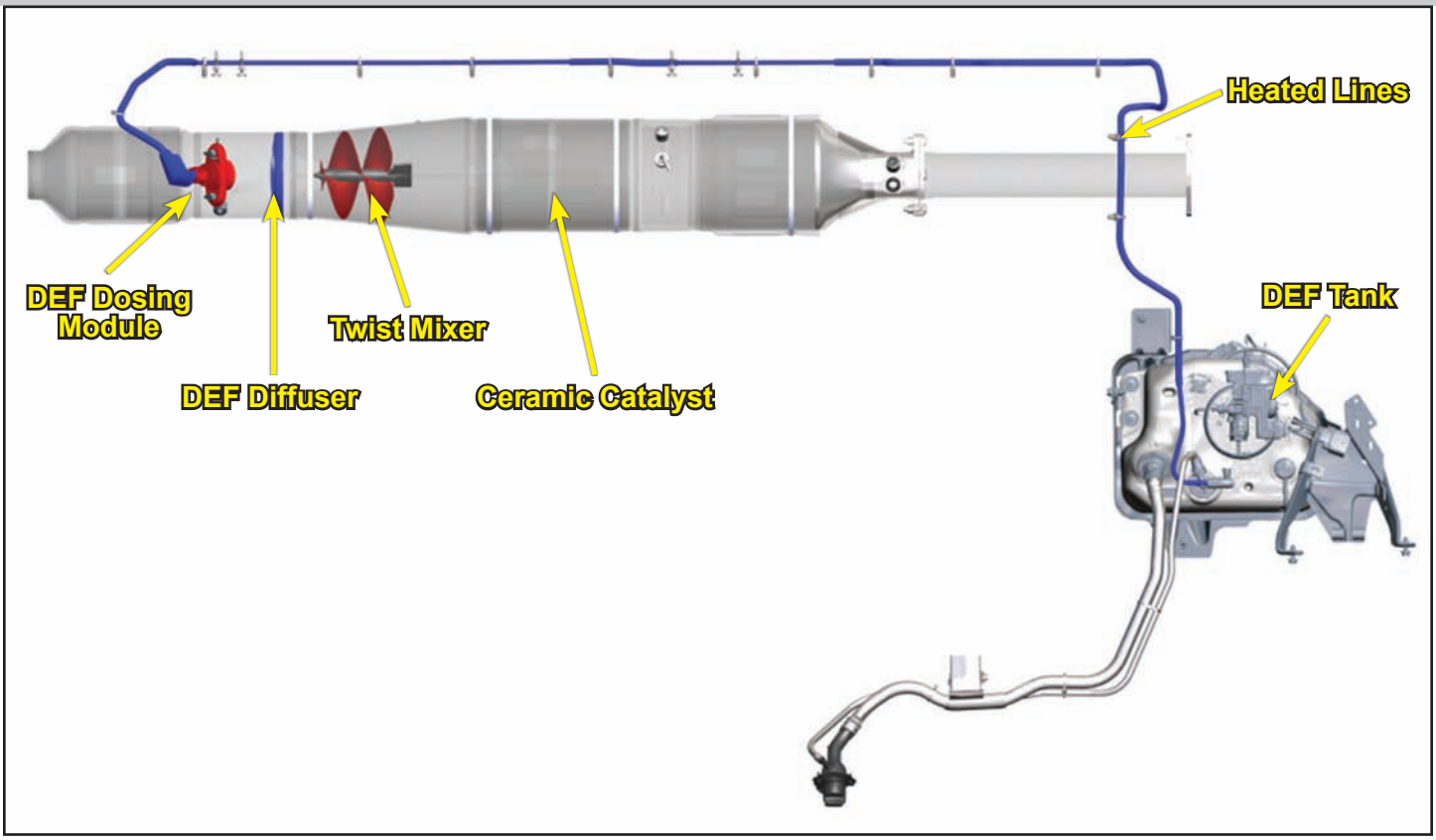
There is an exhaust mixing system in the exhaust stream to mix the reductant with the exhaust gas. The mixer is made up of an atomizer and a twist mixer. The atomizer breaks up and vaporizes the reductant droplets. The twist mixer evenly distributes the reductant in the exhaust gases for maximum efficiency.

EXHAUST SYSTEM

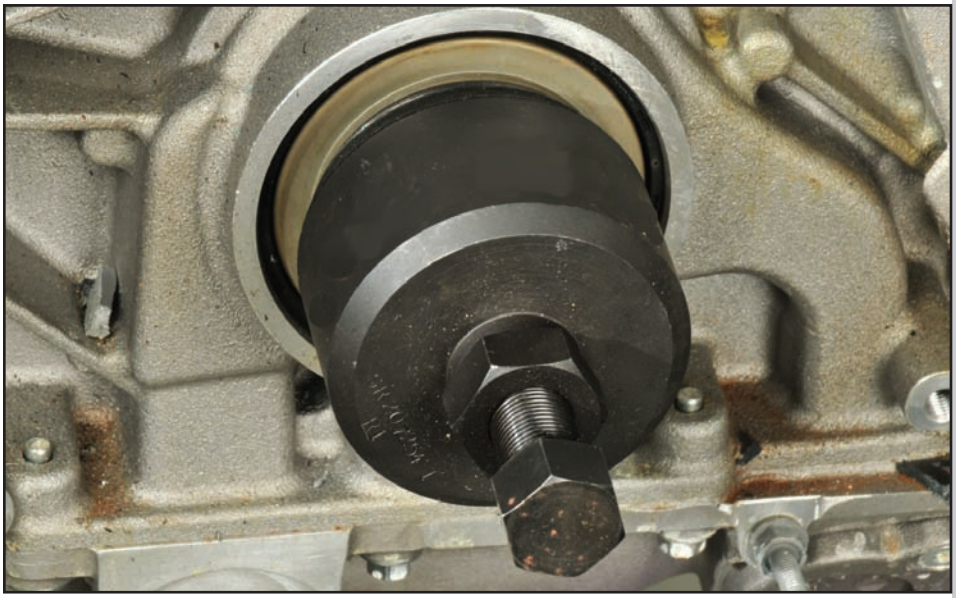
Selective Catalyst Reduction (SCR) System Operation

The SCR system reduces Oxides of Nitrogen (NO_x) present in the exhaust stream to nitrogen (N_2) and water (H_2O). The SCR contains a ceramic catalyst washcoated with copper and iron on a zeolite substrate. At the inlet of the SCR catalyst is a port for the reductant dosing module, followed by a grate diffuser and a twist mixer. When Diesel Exhaust Fluid (DEF) is introduced into the system, it finely atomizes in the grate diffuser and mixes evenly with exhaust gases in the twist mixer. During this time, the heat of the exhaust gases causes the urea to split into carbon dioxide (CO_2) and ammonia (NH_3). As the ammonia and NO_x pass through the ceramic SCR catalyst, a reduction reaction takes place and the ammonia and NO_x are converted to N_2 and H_2O.

The engine is able to run leaner and more efficiently because of the efficiency of the SCR system in eliminating the high NO_x levels produced under lean conditions.

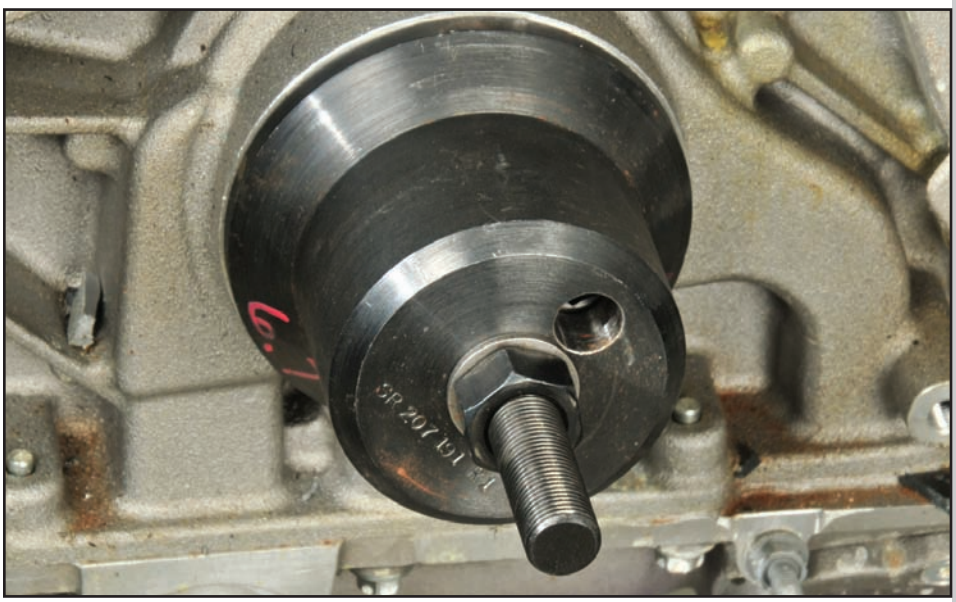


SPECIAL SERVICE TOOLS



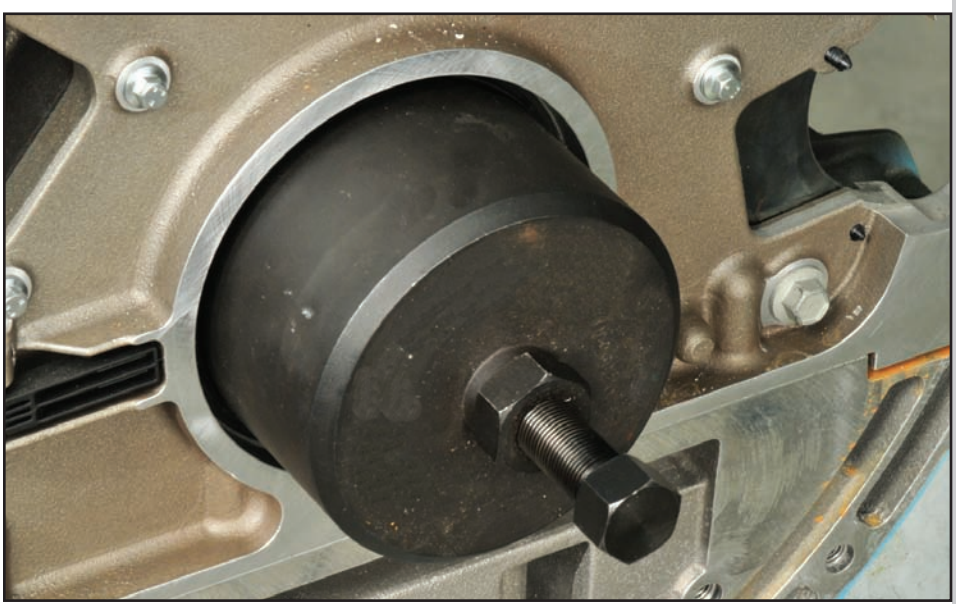
Front Crank Seal Remover

The Front Crank Seal Remover, 303-1510, is used to remove the front crankshaft seal.



Front Crank Seal Installer

The Front Crank Seal Installer, 303-1509, is used to install the front crankshaft seal.



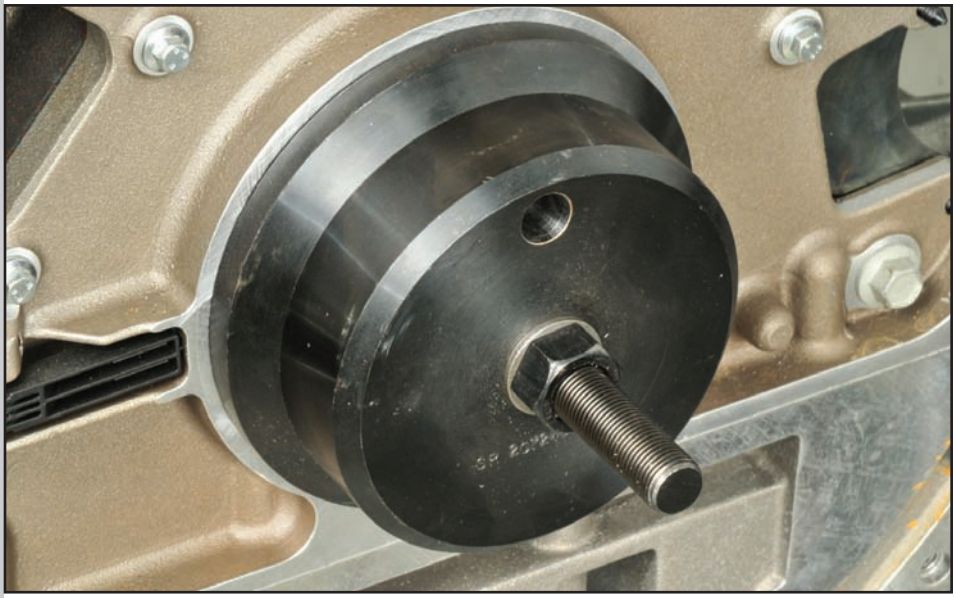
Rear Crank Seal Remover

The Rear Crank Seal Remover, 303-1513, is used to remove the rear crankshaft seal.

SPECIAL SERVICE TOOLS

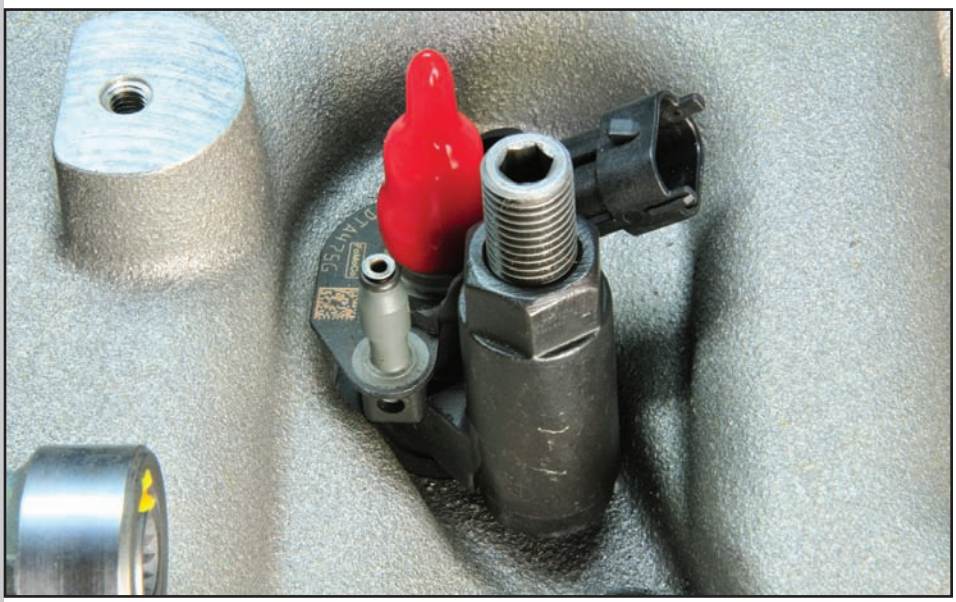
Rear Crank Seal Installer

The Rear Crank Seal Installer, 303-1514, is used to install the rear crankshaft seal.



Fuel Injector Removal Tool

The Fuel Injector Remover, 310-230, is used to remove the fuel injectors from the 6.7L diesel engine.



Engine Removal Bracket

The Engine Removal Bracket, 303-1518, is used to remove and install the 6.7L diesel engine.



SPECIAL SERVICE TOOLS



EGR Pressure Tester

The EGR Pressure Tester, 303-1511, is used to check for EGR cooler leaks.

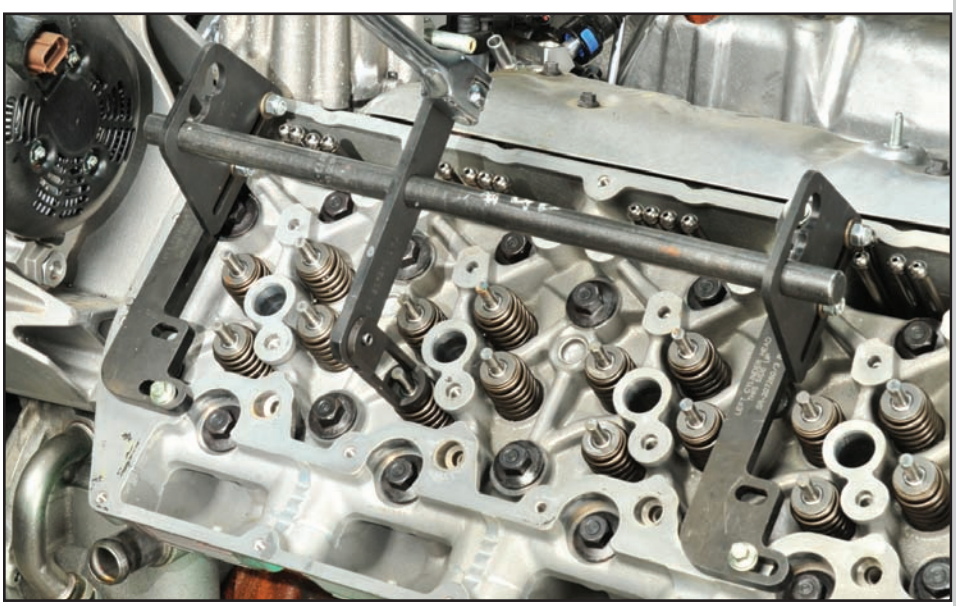
EGR Cooler Primary Coolant Passage Tester shown.



EGR Pressure Tester

The EGR Pressure Tester, 303-1511, is used to check for EGR cooler leaks.

EGR Cooler Secondary Coolant Passage Tester shown.



Valve Spring Compressor

The Valve Spring Compressor, 303-1516, is used to compress the valve springs to remove the valve keepers.

SPECIAL SERVICE TOOLS

Compression Adapter Tester

The Compression Adapter Tester, 303-1515, is used to connect a compression tester to the 6.7L diesel engine.



Camshaft Removal and Installation Adapter

The Camshaft Removal and Installation Adapter, 303-1517, is used to remove and install the camshaft.





Printed in the U.S.A.

FCS-21079-MISC

EA11-003

FORD

1-20-2012

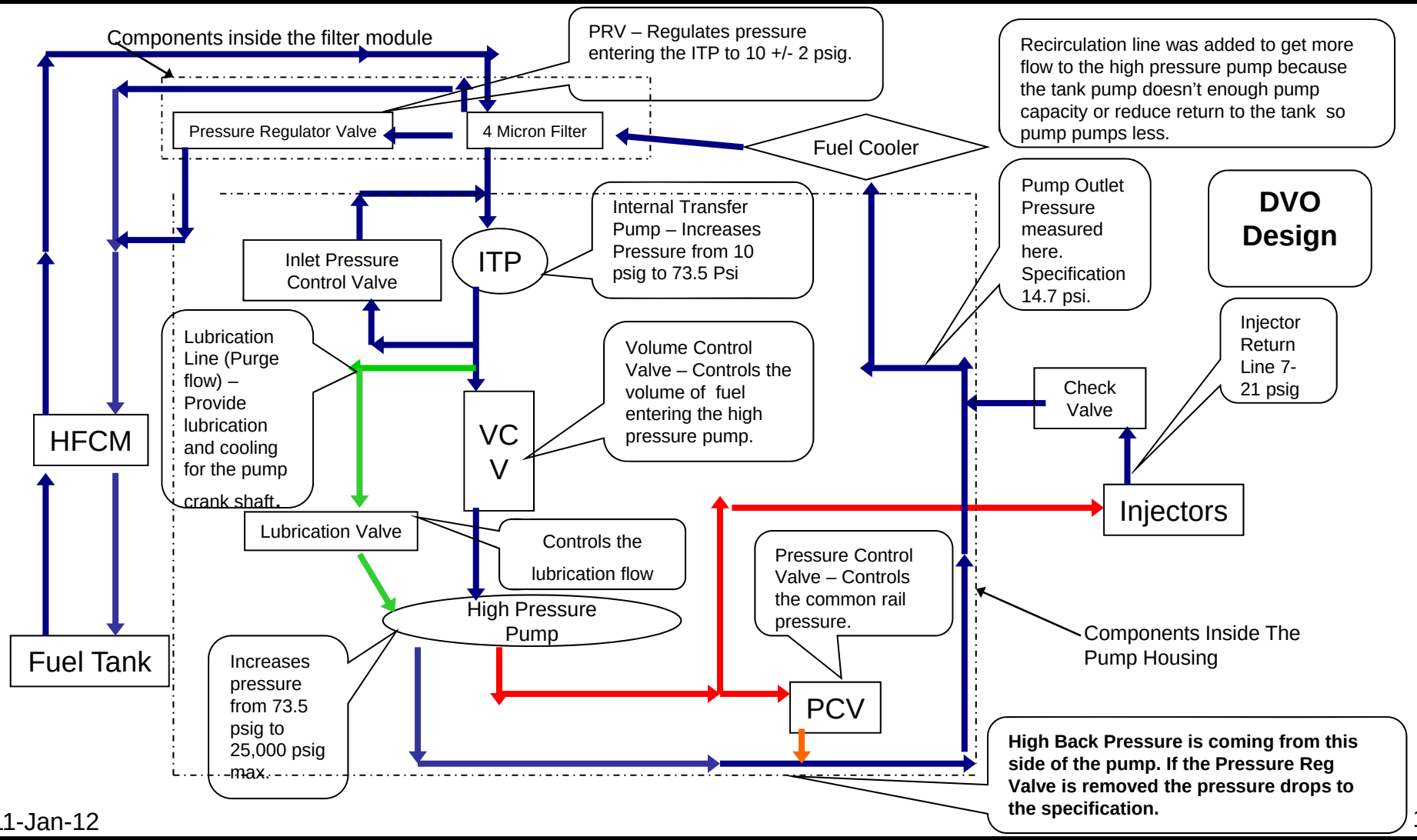
Appendix K2

6-PANEL

D M A I C R

MEASURE

VRT: SV Diesel Systems	VFG: SV P DS CR FD	CCC: International
Fuel injection system: K16_01 (ITEC V8)		Part: Common Rail Pump



11-Jan-12

Fuel Cooling Schematic
6.4L Diesel Engine

Max Fuel Outlet Temperature 70 C

Fuel Liquid to Liquid Heat Exchanger

Fuel Air to Liquid Heat Exchanger

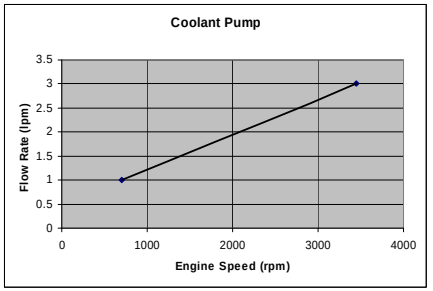
High Pressure Common Rail Fuel Outlet

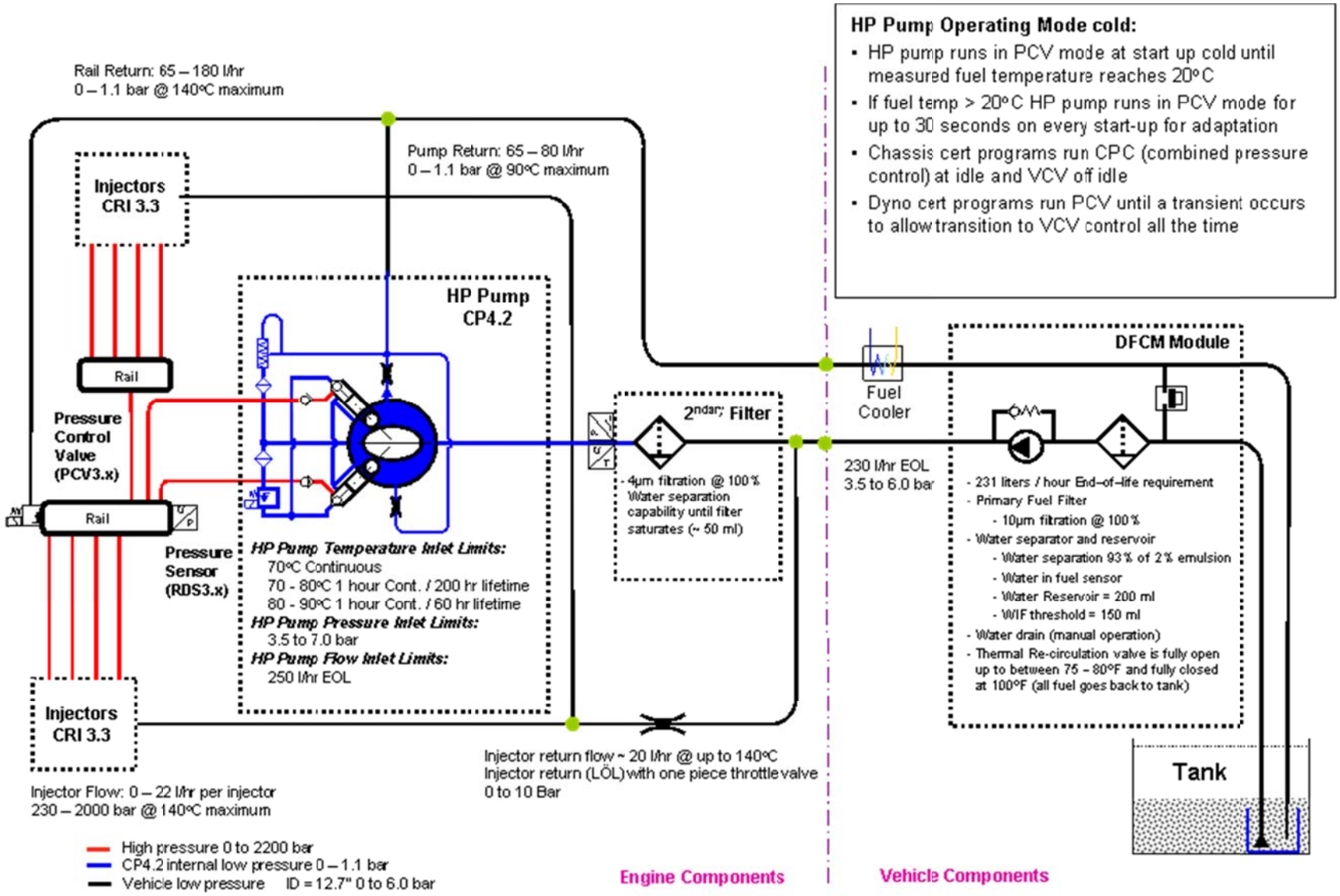
Common Rail Fuel System	700 RPM IDLE	1000 RPM FULL LOAD	2000 RPM FULL LOAD	3450 RPM FULL LOAD
Inlet Temperature Degrees C	70	70	70	70
Outlet Temperature Degrees C	75	102	113	116
Delta Temperature	5	32	43	46
Flow Rate lpm	1.04	1.63	2.26	2.8
Heat Rejection kW	0.15	1.48	2.76	3.65

Degas Bottle

Engine Coolant Pump

Coolant Pump	700 RPM	1000 RPM	2000 RPM	3450 RPM
Flow Rate lpm	1	1.25	2	3
Max Temp C	105	105	105	105





6.7L Diesel fuel system

EA11-003

FORD

1-20-2012

Appendix M1

2009 MY OBD System Operation Summary for 6.4L Diesel Engine

Table of Contents

Introduction – OBD-I, OBD-II and EMD....3
OBD-I Systems....3
OBD-II Systems....3
EMD Systems....3
General Description 6.4 DIT V8....4
System Schematic 6.4 DIT V8....5
Misfire Monitor....6
System Overview....6
Misfire Algorithm Processing....6
Exhaust Gas Recirculation Monitor....9
EGR System and Comprehensive Component Monitors:....9
EGR Flow Tests:....9
EGR Valve Monitors....13
EGR Cooler Efficiency Monitor....14
Fuel System Monitor....17
Fuel Rail Pressure Monitors:....18
Catalyst and Aftertreatment Monitors (DOC and DPF)....25
Aftertreatment System Overview....25
DOC Functional Monitor....25
DOC Aftertreatment Sensor Monitors....26
DPF Functional Monitors....28
DPF Aftertreatment Sensor Monitors....30
Boost Pressure Monitor....32
Thermostat Monitor....33

Glow Plug Monitor 34
Comprehensive Component Monitor - Engine 36
Engine Inputs (Analog) 36
Engine Inputs (Digital) 49
Engine Outputs 53
Comprehensive Component Monitor - Transmission 54
General 54
Transmission Inputs 54
Transmission Outputs 59
5R110W (RWD) Transmission 65
Transmission Inputs 65
Transmission Outputs 65
Transmission Control Module (TCM) Function 66

Introduction – OBD-I, OBD-II and EMD

OBD-I Systems

OBD-I vehicles use that same PCM, J1850/CAN serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD-II vehicle. The only difference is a different PCM calibration. Starting in the 2006 MY, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD-II and OBD-I systems will no longer be utilized in vehicles up to 14,000 lbs GVWR.

OBD-II Systems

California OBD-II applies to all California and "California State" gasoline engine vehicles up to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) starting in the 1996 MY and all diesel engine vehicles up to 14,000 lbs. GVWR starting in the 1997 MY.

"California States" are ones that have adopted California emission regulations, starting in the 1998 MY. At this time, Massachusetts, New York, Vermont and Maine have adopted California's regulations. These States receive California-certified vehicles for passenger cars and light trucks, and medium-duty vehicles, up to 14,000 lbs. GVWR."

Federal OBD-II applies to all gasoline engine vehicles up to 8,500 lbs. GVWR starting in the 1996 MY and all diesel engine vehicles up to 8,500 lbs. GVWR starting in the 1997 MY.

Starting in the 2004 MY, Federal vehicle over 8,500 lbs. are required to phase in OBD-II. Starting in 2004 MY, gasoline-fueled Medium Duty Passenger Vehicles (MDPVs) are required to have OBD-II. By the 2006 MY, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD-II.

OBD-II system implementation and operation is described in the remainder of this document.

EMD Systems

Engine Manufacturer Diagnostics (EMD) applies to all 2007 MY and beyond California gasoline-fueled and diesel fueled on-road heavy duty engines used in vehicles over 14,000 lbs Gross Vehicle Weight Rating (GVWR). EMD systems are required to functionally monitor the fuel delivery system, exhaust gas recirculation system, particulate matter trap, as well as emission related ECM input inputs for circuit continuity and rationality, and emission-related outputs for circuit continuity and functionality. EMD requirements are very similar to current OBD-I system requirements. As such, OBD-I system philosophy will be employed, the only change being the addition of some comprehensive component monitor (CCM) rationality and functionality checks.

EMD vehicles use the same PCM, CAN serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD-II vehicle. The only difference is a different PCM calibration.

The following list indicates what monitors and functions have been altered from OBD-II for EMD calibrations:

Monitor / Feature	Calibration
Misfire Monitor	Same as OBD-II but does not set the MIL.
EGR Cooler Monitor	Same as OBD-II but does not set the MIL.
Glow Plug Monitor	Same as OBD-II but does not set the MIL.
DOC Monitor	Same as OBD-II but does not set the MIL.
Comprehensive Component Monitor	All circuit checks for components supporting other EMD monitors, as well as those for some of the other components, are the same as OBD-II.
Communication Protocol and DLC	Utilizes CAN communication, same as OBD-II, all generic and enhanced scan tool modes work the same as OBD-II but reflect the EMD calibration that contains fewer supported monitors. "OBD Supported" PID indicates EMD.
MIL Control	Same as OBD-II

General Description 6.4 DIT V8

The 6.4L is a V8 engine designed to meet customer expectations of high horsepower and torque with exceptional fuel economy and low NVH. It must do this while meeting the tough emissions standards set by the EPA and CARB.

Some of the technologies employed to meet these diverse criteria include a two stage Variable Geometry Turbocharger (VGT) with Electronic Variable Response Turbocharger (EVRT) control of the high pressure stage, common rail fuel injection system, four valves per cylinder, electronically controlled, cooled EGR, a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF).

The system schematic on the next page shows the path of the air as it is compressed by the turbocharger, cooled by the air-to-air intercooler, and mixed with the cooled EGR gases. The state of this compressed and heated air is sensed by the MAT (manifold air temperature) and MAP (manifold absolute pressure) sensors just before it enters the cylinders. The exhaust gas pressure is measured by the exhaust backpressure gauge (EP) sensor before it exits through the turbocharger. The exhaust after treatment system consists of a DOC, a DPF and a muffler.

The high pressure stage EVRT is electronically controlled and actuated to achieve a desired backpressure. This backpressure is used to control manifold boost pressure, EGR rates and after treatment regeneration.

An electronic, proportional valve controls EGR rates with an integral position sensor (EGRP). Flows are determined by valve position and the amount that backpressure exceeds boost pressure. An EGR throttle (EGRTP) is used for regeneration control as well as to optimize the boost pressure vs. backpressure levels.

Fuel injection pressure is measured by the high-pressure fuel rail sensor (FRP). Injection pressure is controlled by the high pressure pump and two regulating valves, a Pressure Control Valve (PCV), and a Volume Control Valve (VCV).

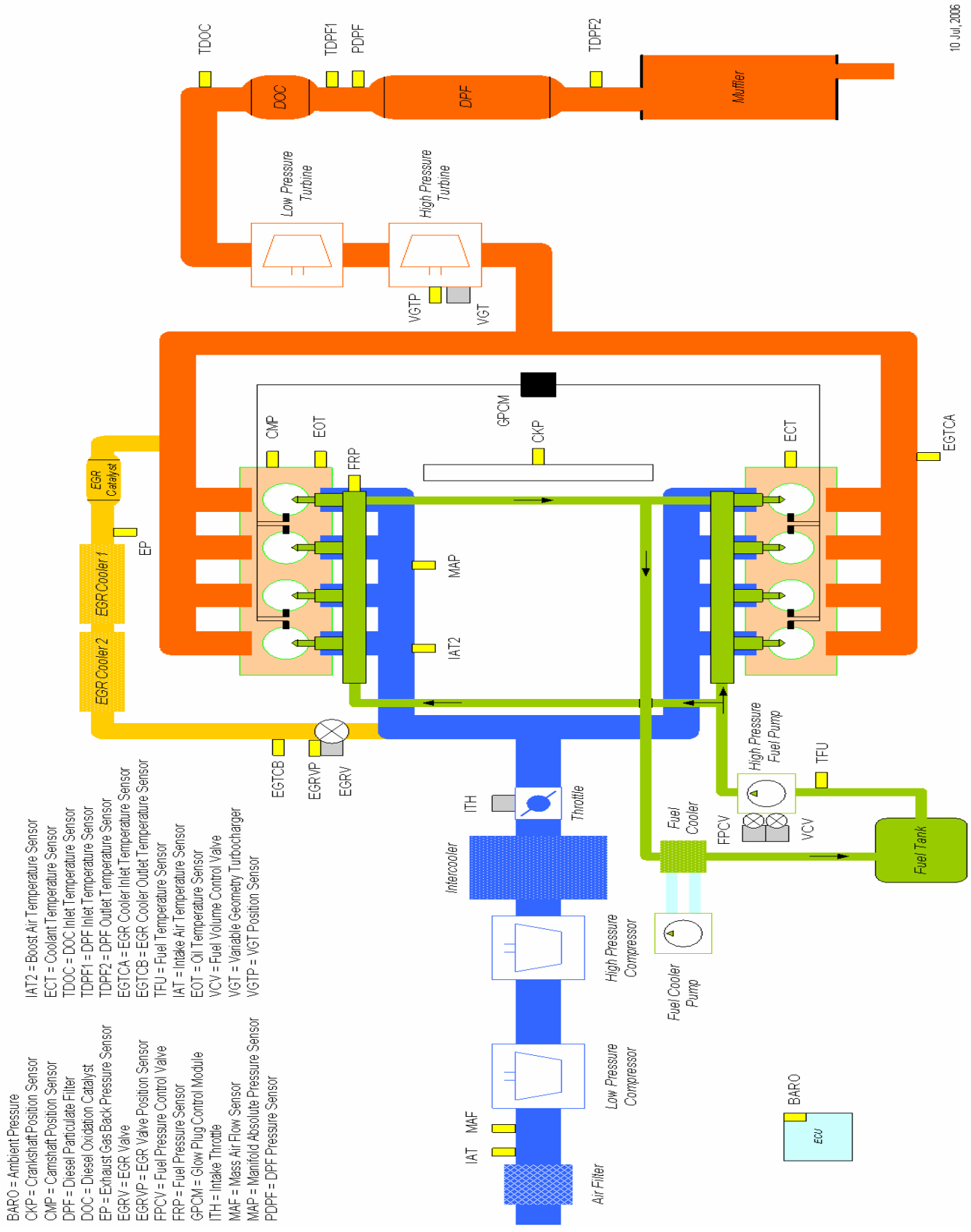
Engine speed (N) and crankshaft position are determined by the crankshaft position sensor (CKP) which senses a 60 minus 2 tooth target wheel. Camshaft position is determined by the camshaft position sensor (CMP), which senses a peg located on the camshaft.

Atmospheric pressure is determined by the Barometric pressure sensor (BP, formerly BARO).

During engine operation, the Powertrain Control Module (PCM) calculates engine speed from the crankshaft position sensor. The PCM controls engine operation by controlling the piezo injector opening and closing times as well as the pressure at which the fuel is injected, thereby controlling fuel quantity and timing. Simultaneously, airflow is modulated by controlling the turbocharger vane position.

Fuel quantity is controlled by injector “on time” (pulse width) and the fuel rail pressure. Desired engine speed is determined from the position of the accelerator pedal.

System Schematic 6.4 DIT V8



Misfire Monitor

System Overview

The 6.4L Diesel engine utilizes a variable reluctance sensor (CKP) that processes the edges of a 60-2 tooth stamped target wheel mounted on the crankshaft. The software gets an edge every 3 degrees and these edges are used for fuel injection timing, fuel quantity control, and the calculation of engine speed. The 6.4L utilizes a second variable reluctance sensor (CMP) that processes a peg mounted on the camshaft for cylinder identification. The CMP signal and the window of 2 missing teeth on the crankshaft target wheel indicate proper camshaft to crankshaft position for correct cylinder timing. The CKP and CMP signals are hardware buffered.

A cylinder balancing strategy is used to detect cylinders that are contributing either too much or too little torque relative to the other cylinders. The crankshaft rotation is divided into 8 segments, with each segment corresponding to a cylinder. The average time of the previous 8 segments is continually updated and used with the current and previous engine speeds to calculate a speed gradient value. The speed gradient is integrated and corrected so that there is no fueling bias, and the corrections are applied to the desired fuel mass for the main injection events. As engine speed increases, the time between each segment decreases. To insure accurate calculations, the cylinder balancing algorithm is only active below a calibratible engine speed limit.

Misfire Algorithm Processing

The Misfire Monitor uses both the instantaneous and the integrated speed gradient values. These values are filtered and compared to thresholds to determine if a misfire condition exists. The threshold levels depend upon whether the vehicle is in drive or park/neutral.

The misfire algorithm is active only when the cylinder balancing algorithm is active. In addition, other engine operating parameters are monitored to ensure misfire operates in a region that yields accurate misfire results. The table below outlines the entry conditions required for executing the misfire monitor algorithm.

Misfire Monitor Operation:	
DTCs	P0300 – Random Misfire Detected P0301 – Cylinder 1 Misfire Detected P0302 – Cylinder 2 Misfire Detected P0303 – Cylinder 3 Misfire Detected P0304 – Cylinder 4 Misfire Detected P0305 – Cylinder 5 Misfire Detected P0306 – Cylinder 6 Misfire Detected P0307 – Cylinder 7 Misfire Detected P0308 – Cylinder 8 Misfire Detected
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Exhaust Gas Recirculation Position (EGRP), Exhaust Pressure (EP), Intake Air Temperature (IAT), Engine Coolant Temperature (ECT), Fuel Temperature, Engine Oil Temperature (EOT), Vehicle Speed (VSS), Fuel Rail Pressure (FRP), Crankshaft Position Sensor (CKP)
Monitoring Duration	1 minute

Typical Misfire Monitor Entry Conditions:		
No Exhaust Gas Recirculation (EGR) valve actuator errors		
No EGR position sensor minimum stop performance errors		
No EGR flow monitor errors		
No EGR valve position plausibility errors		
No exhaust pressure control errors		
No fuel pressure control valve (PCV) controller errors		
No low fuel pressure at engine start errors		
No fuel volume control valve (VCV) adaptation error		
No piezo power stage errors		
No battery voltage errors		
No brake switch errors		
Entry condition	Minimum	Maximum
Engine Speed (Low Idle)	500rpm	950 rpm
Engine Coolant Temperature (ECT)	> -40 deg C	< 120 deg C
Fuel Temperature	> -50 deg C	
Engine Oil Temperature (EOT)	> -20 deg C	
Vehicle Speed (VSS)	>= 0 km/hr	<= 10 km/hr
Intake Air Temperature (IAT)	> -40 deg C	< 100 deg C
Intake Manifold Pressure (MAP)	< 1200 hPa	
Battery Voltage (IVPWR)	> 9.0 V	
Total fuel mass	>= 5.0 mg/stroke	<= 35.0 mg/stroke

Typical Misfire Monitor Malfunction Thresholds:

P0300:

Transmission in park/neutral:

Filtered instantaneous cylinder balancing speed difference > 0.75 AUTO or 0.35 MANUAL

AND Filtered integrated cylinder balancing speed difference > 1.50

Transmission in gear:

Filtered instantaneous cylinder balancing speed difference > 1.50 AUTO or n/a MANUAL

AND Filtered integrated cylinder balancing speed difference > 1.50

Every engine cycle, a counter is incremented by 2 if the above conditions are met for ANY cylinder, or decremented by 1 if they are not. If the counter exceeds **4000**, a fault is set.

P0301 - P0308:

Transmission in park/neutral:

Filtered instantaneous cylinder balancing speed difference > 0.75 AUTO or 0.35 MANUAL)

AND Filtered integrated cylinder balancing speed difference > 1.50

Transmission in gear:

Filtered instantaneous cylinder balancing speed difference > 1.50 AUTO or n/a MANUAL

AND Filtered integrated cylinder balancing speed difference > 1.50

Every engine cycle for EACH cylinder, a counter is incremented by 2 if the above conditions are met, or decremented by 1 if they are not met. If the counter exceeds **600**, a fault is set.

Exhaust Gas Recirculation Monitor

EGR System and Comprehensive Component Monitors:

The Delta Pressure Exhaust Gas Recirculation (EGR) System is a closed loop EGR Valve Position control system. It utilizes an exhaust manifold pressure sensor, an intake manifold pressure sensor and a speed density estimate of total mass flow and derives a desired EGR Valve position based on a desired EGR flow percentage.

The EGR Monitor is a series of electrical tests and functional tests that monitor various aspects of EGR system operation.

EGR Flow Tests:

An intrusive test is used to detect low EGR flow rates (P0401) and high EGR flow rates (P0402). The EGR valve is closed and engine volumetric efficiency is estimated using intake air flow (MAF), manifold pressure (MAP), manifold temperature (IAT2). Airflow through the engine is then calculated using the estimated volumetric efficiency, MAP and engine rpm. At this point, the EGR valve is commanded to open and the change in MAF is observed. The EGR flow rate can now be determined by looking at the difference between the speed density engine flow rate and MAF flow rate. EGR flow rate is divided by the engine flow rate to estimate EGR fraction, i.e. % EGR.

Exhaust Gas Recirculation (EGR) Low Flow Monitor Operation:	
DTCs	P0401 - Exhaust Gas Recirculation Flow Insufficient Detected
Monitor execution	Multiple times per driving cycle
Monitor Sequence	None
Sensors OK	MAP (P0106, P0107, P0108, P0069,P006B), MAF (P0100, P0101, P0102, P0103, P0104, P1102, P1103), IAT2 (~~P0096~~, P0097, P0098, P2199), Exhaust Gas Recirculation Position Sensor (EGRP) (P0405, P0406, P0404, P1335, P042E, P042F), CKP (P0337, P0336, P1336) EGRTA (P041B), EVRT (P2263)
Monitoring Duration	The test will run 5 times per trip. Two of the 5 test runs must indicate low flow failures to set the fault. It takes 12 seconds to run each test, which consists of 5 steps to estimate EGR flow rate. The time breakdown for each step is as follows, and there a slight lag between steps that account for another second: Open EGR valve and wait for a settling time: 4 sec Estimate flow rate with open EGR valve: 2 sec Close EGR valve and wait for a settling time: 4 sec Estimate volumetric efficiency: 1 sec Delay before EGR monitor can run again: 60 sec

Typical Exhaust Gas Recirculation (EGR) Monitor Low Flow Entry Conditions:		
Entry condition	Minimum	Maximum
DPF regeneration not requested		
Pressure ratio (MAP) / exhaust pressure (EP) across the EGR valve		< 0.99
Rate of change of engine speed (N)		< 0.05 rpm/s
Rate of change of indicated torque setpoint (TQI_SP)		< 0.05 Nm/s
Engine speed (N)	600 rpm	800 rpm
Indicated torque setpoint (TQI_SP)	45 Nm	174 Nm
ECT	**>20 deg C**	
IAT	**>15 deg C**	**<125 deg C**
PTO not active		

Typical EGR Monitor Low Flow Malfunction Thresholds:
Delivered EGR is -28 %.(less) than expected for the operating conditions. EGR rates are specified as a function of engine speed (N) and indicated torque setpoint..

Exhaust Gas Recirculation (EGR) High Flow Monitor Operation:	
DTCs	P0402 – Exhaust Gas Recirculation Flow Excessive Detected
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	**MAP (P0106, P0107, P0108, P0069,P006B),** MAF (P0100, P0101, P0102, P0103, P0104, P1102, P1103), **IAT2 (P0097, P0098, P2199),** Exhaust Gas Recirculation Position Sensor (EGRP) (P0405, P0406, P0404, P1335, P042E, P042F), **CKP (P0337, P0336, P1336) EGRTA (P041B), EVRT (P2263) ~~BAP (P2228, P2229, P2230, P0069, P0106), ECT (P0117, P118)~~**
Monitoring Duration	Continuous

Typical Exhaust Gas Recirculation (EGR) High Flow Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
DPF regeneration not requested		
Pressure ratio (MAP) / exhaust pressure (EP) across the EGR valve		**< 0.99**
Rate of change of engine speed (N)		**< 0.05 rpm/s**
Rate of change of indicated torque setpoint (TQI_SP)		**< 0.05 Nm/s**
Engine speed (N)	**600 ~~TBD~~** rpm	800 **~~TBD~~** rpm
Indicated torque setpoint (TQI_SP)	45 **~~TBD~~** Nm	174 **~~TBD~~** Nm
ECT **~~above minimum threshold~~**	**>20 deg ~~TBD~~** C	**~~TBD C~~**
IAT	**>15 deg C**	**<125 deg C**
PTO not active		
~~Minimum high resolution engine speed gradient)~~	**~~TBD rpm/sec~~**	**~~N/A~~**
~~Intrusive EGR monitor not active~~		

Typical EGR High Flow Monitor Malfunction Thresholds:
If the difference between the expected and measured mass air flow is greater than the error threshold of TBD Kg/H, determination is made that EGR high-flow condition exists.

Exhaust Gas Recirculation Position Sensor (EGRP):	
DTCs	P0405 - Exhaust Gas Recirculation Sensor A Circuit Low P0406 - Exhaust Gas Recirculation Sensor A Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	3 sec.

Typical Exhaust Gas Recirculation Position Sensor Entry Conditions:
No reference voltage errors (P2505, P2507, P2508)

Typical Exhaust Gas Recirculation Position Sensor Check Malfunction Thresholds:
Voltage < 0.24 volts or voltage > 4.50 volts

Exhaust Gas Recirculation Valve Actuator (EGRAM) Monitor Operation:	
DTCs	P0403 – Exhaust Gas Recirculation Control Circuit
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	1 sec.

Typical Exhaust Gas Recirculation Valve Actuator Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Battery voltage	7 V	
Ignition voltage	7 V	

Typical Exhaust Gas Recirculation Valve Actuator Monitor Malfunction Thresholds:
Actuator smart driver status indicates open/short

EGR Valve Monitors

The EGR functional monitor checks if the closed-loop EGR valve position deviation is within a specified limit (P0404), whether the EGR valve stuck closed (P042F) or whether the EGR valve is stuck open (P042E). There is also a check to see if the voltage adaptation at the bottom limit stays within the expected tolerance.

Exhaust Gas Recirculation (EGR) Valve:	
DTCs	P0404 – Exhaust Gas Recirculation Control Circuit Range/ Performance P042E – EGR Control Stuck Open P042F – EGR Control Stuck Closed P1335 – EGR Position Sensor Minimum Stop Performance
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	P0404, P042E, P042F – EGR (P042E, P042F), EGRP (P0405, P0406, P1335) P1335 – None
Typical Monitoring Duration	P0404 – 5 sec. P042E – 4 sec. P042F – 4 sec. P1335 – 2.5 sec.

Typical Exhaust Gas Recirculation (EGR) Valve Entry Conditions:		
Entry condition	Minimum	Maximum
Engine run time	4 sec.	
EGR monitor not active		

Typical Exhaust Gas Recirculation (EGR) Valve Thresholds:
P0404 – absolute value of the error between the commanded EGR Valve Position (EGRVP) and actual EGRVP is > 10%
P042E – Commanded EGR Valve Position (EGRVP) is < 15% AND actual EGRVP is > 30%
P042F – Commanded EGR Valve Position (EGRVP) is > 30% AND actual EGRVP is < 15%
P1335 – Actual EGRVP closed position sensor voltage < 0.4 volts or > 1.5 Volts

EGR Cooler Efficiency Monitor

The EGR cooler is monitored to determine if the EGR cooler efficiency is low. The EGR cooler monitor utilizes an EGR cooler outlet temperature sensor to determine whether or not the EGR gases are being cooled effectively by the EGR cooler. If the temperature indicated by the EGR cooler outlet temperature sensor is above a maximum limit for a long enough period of time, the P2457 fault is set.

The EGR cooler outlet temperature sensor is monitored for circuit high, circuit low, intermittents and rationality.

Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor:	
DTCs	P2457 – Exhaust Gas Recirculation Cooler System Performance
Monitor execution	Continuous
Monitor Sequence	None
Sensors/Actuators OK	EGRP (P0405, P0406), TEGR_OUT (P041B, P041C, P041D), EGR (P0401,), EGR Valve (P0404, P042E, P042F, P1335)
Monitoring Duration	20 sec.

Typical Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Time with EGR Valve Position (EGRVP) >= 0	10 seconds	
Engine speed (N)	600 rpm	1300 rpm
Indicated torque setpoint (TQI_SP)	50 Nm	400 Nm
No DPF regeneration requested		
Engine off time	2 hours	

Typical Exhaust Gas Recirculation (EGR) Cooler Efficiency Monitor Thresholds:

EGR Cooler Outlet Temperature (TEGR_OUT) > 165 deg C, multiplied by the following function of ECT:

ECT (degrees C):	50	60	70
Multiplier:	1.0	1.1	1.2

EGR Cooler Outlet Temperature (TEGR_OUT) Sensor Circuit Check:	
DTCs	P041C - Exhaust Gas Recirculation Temperature Sensor "B" Circuit Low P041D - Exhaust Gas Recirculation Temperature Sensor "B" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	5 sec.

Typical EGR Cooler Outlet Temperature Sensor Circuit Check Entry Conditions:		
Entry condition for P041C, P041D	Minimum	Maximum
Entry condition for P041C – none		
Entry condition for P041D:		
Engine Speed (N)	650 rpm	
Engine indicated torque setpoint (TQI_SP)	53 Nm	
Engine Coolant Temperature	**78** ~~**80**~~ deg C	

Typical EGR Cooler Outlet Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.15 volts or voltage > 4.95 volts

EGR Cooler Inlet Temperature (TEGR_IN) Sensor Circuit Check:	
DTCs	P040C - Exhaust Gas Recirculation Temperature Sensor "A" Circuit Low P040D - Exhaust Gas Recirculation Temperature Sensor "A" Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	5 sec.

Typical EGR Cooler Inlet Temperature Sensor Circuit Check Entry Conditions:		
	Minimum	Maximum
Entry condition for P040C – none		
Entry condition for P040D:		
Engine Speed (N)	650 rpm	
Engine indicated torque setpoint (TQI_SP)	53 Nm	
Engine Coolant Temperature	60 deg C	

Typical EGR Cooler Inlet Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.07 volts or voltage > 4.65 volts

EGR Cooler Outlet Temperature (TEGR_OUT) Rationality Check:	
DTCs	P041B - Exhaust Gas Recirculation Temperature Sensor "B" Circuit Range/Performance
Monitor Execution	Continuous
Monitor Sequence	None.
Sensors OK	TEGR_OUT (P041C, P041D), ECT (P0117, P0118)
Typical Monitoring Duration	2 drive cycles

EGR Cooler Outlet Temperature Rationality Check Entry Conditions:		
Entry condition	Minimum	Maximum
Initial Engine Coolant Temperature (ECT)		30 deg C
Engine Coolant Temperature (ECT) increase	**78** ~~**80**~~ deg C	
ECM on	3 seconds	

Typical EGR Cooler Outlet Temperature Rationality Check Malfunction Thresholds:
Increase in EGR Cooler Outlet Temperature (TEGR_OUT) is < 6 deg C

Fuel System Monitor

The fuel rail pressure is controlled either with the Pressure Control Valve or with the Volume Control Valve, depending upon whether the engine operating condition demands low fuel flow, or high fuel flow, respectively. Feedback is provided by the Fuel Rail Pressure Sensor (FRP). Fuel system monitors include those for the FRP, PCV, VCV, and for fuel pressure control.

Fuel Rail Pressure (FRP) Sensor Circuit Check:	
DTCs	P0192 - Fuel Rail Pressure Sensor A Circuit Low Input P0193 - Fuel Rail Pressure Sensor A Circuit High Input P0194 - Fuel Rail Pressure Sensor A Circuit Intermittent/Erratic
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	P0191 – VCV (P0642, P0643)
Typical Monitoring Duration	P0192, P0193 - 0.5 sec P0194 - 0.1 sec

Typical Fuel Rail Pressure Sensor Circuit Check Entry Conditions:
None

Typical Fuel Rail Pressure Sensor Circuit Check Malfunction Thresholds:
P0192, P0193 - Voltage < 0.2 **(-4570 psi or -315 bar)** volts or voltage > 4.8 volts **(28,065 psi or 1935 bar)**
P0194 - Absolute value of rate of change of pressure greater than 40 MPa / 10 ms

The fuel delivery monitor (P0148) detects if there is an injection commanded when there is no torque request from the driver.

Fuel Delivery Monitor Operation:	
DTCs	P0148 – Fuel Delivery Error
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	P0201 to P0208, P062D, P062E, P1551 to P1558
Typical Monitoring Duration	3 seconds

Typical Fuel Delivery Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Pedal Position	= 0	
Engine Speed	1600 rpm	

Typical Fuel Delivery Monitor Malfunction Thresholds:
Any of the commands to the injectors (as detected on the injection command line from the ECU) meet criteria for a 'commanded injection'

Fuel Rail Pressure Monitors:

The fuel rail pressure is controlled either with the Pressure Control Valve or with the Volume Control Valve, depending upon whether the engine operating condition demands low fuel flow, or high fuel flow, respectively. The high and low Fuel Rail Pressure Monitors detect when there is an excessive deviation from the desired fuel pressure when the controller has reached a control limit.

Fuel Rail Pressure (FRP) Monitor Operation:	
DTCs	P0088 - Fuel Rail/System Pressure - Too High P0087 - Fuel Rail/System Pressure - Too Low
Monitor Execution	P0088 - Continuous P0087 - Continuous
Monitor Sequence	None
Sensors OK	P0088 - FRP (P0191, P0192, P0193, P0194,P2289), PCV, P0090 P0091 P0092), VCV (P0001 P0002 P0003, P0642, P0643) P0087- PCV (P0090 P0091 P0092), VCV, (P0001, P0002, P0003, P0642, P0643), FRP (P0191, P0192, P0193, P0194, P2289)
Typical Monitoring Duration	P0088 - 5sec P0087 - 5sec

Typical Fuel Rail Pressure Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0088, P0087 -		
Engine running		
Rate of change of FRP setpoint	-180 MPa/s, 5sec	120 MPa/s, 5sec

Typical Fuel Rail Pressure Monitor Malfunction Thresholds:
P0088: If the relative error in Fuel Rail Pressure (FRP) (absolute value of error divided by FRP setpoint) is greater than or equal to 3% AND (the Pressure Control Valve is operating closed-loop AND the controller has reached its minimum output OR the Volume Control Valve is operating closed-loop AND the controller has reached its minimum output) AND these conditions are fulfilled for more than 0.2 seconds the fault is set. P0087: If the relative error in Fuel Rail Pressure (FRP) (absolute value of error divided by FRP setpoint) is greater than or equal to 5% AND (the Pressure Control Valve is operating closed-loop AND the controller has reached its maximum output OR the Volume Control Valve is operating closed-loop AND the controller has reached its maximum output) AND these conditions are fulfilled for more than 0.2 seconds the fault is set.

Fuel Rail Pressure (FRP) Functional Check Operation:	
DTCs	P0191 - Fuel Rail Pressure Sensor A Circuit Range/Performance
Monitor Execution	P0191 - Continuous
Monitor Sequence	None
Sensors OK	P0191 – VCV (P0642, P0643)
Typical Monitoring Duration	P0191 – 1sec

Typical Fuel Rail Pressure Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
Engine running in part load		
FRP	10 MPa	
Injections enabled		

Typical Fuel Rail Pressure Functional Malfunction Thresholds:
P0191 – Minimum and maximum Fuel Rail Pressure (FRP) sensor voltages over 0.4 seconds are found. The fault is set if the difference between the maximum and the minimum voltages is less than 0.01 V.

Fuel Rail Pressure (FRP) Functional Check Operation:	
DTCs	P2289 - Injector Control Pressure Too High – Engine Off
Monitor Execution	P2289 - Continuous
Monitor Sequence	None
Sensors OK	P2289 - VCV (P0642, P0643), FRP (P0192, P0193)
Typical Monitoring Duration	P2289 - 0.4 sec

Typical Fuel Rail Pressure Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
Engine has just been switched off and key is in off-position		
Time after engine switch-off and key-off	0.4 sec	

Typical Fuel Rail Pressure Functional Malfunction Thresholds:
Fuel Rail Pressure (FRP) is greater than 10 MPa.

Volume Control Valve (VCV) Monitor Operation:	
DTCs	P0001 - Fuel Volume Regulator Control Circuit / Open P0003 - Fuel Volume Regulator Control Circuit Low P0004 - Fuel Volume Regulator Control Circuit High
Monitor Execution	P0001 - Continuous P0003 (test 1) - Continuous P0003 (test 2) - Continuous P0004 - Continuous
Monitor Sequence	None
Sensors OK	Serial Communication (P0600)
Typical Monitoring Duration	P0001 – 0.5sec. P0003 (test 1) - 0.5sec. P0003 (test 2) - 0.5sec. P0004 - 0.5sec.

Typical Volume Control Valve Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Battery Voltage	7 V	
Engine is running		
P0003 (test 2) – Key- on		

Typical Volume Control Valve Monitor Malfunction Thresholds:
P0001 - The period of the fuel pressure control valve (VCV) command signal is greater than or equal to 400 microseconds OR circuit resistance is greater than 500 Ohm
P0003 (test 1) - The period of the fuel pressure control valve (VPCV) command signal is greater than or equal to 250 microseconds OR measured circuit voltage = 0 V.
P0003 (test 2) – Valve current (VCV) is greater than 3 A.
P0004 - The period of the fuel pressure control valve (VCV) command signal is greater than or equal to 50 microseconds OR circuit voltage = 12 V.

Fuel Pressure Control Valve (PCV) Monitor Operation:	
DTCs	P0090 - Fuel Pressure Regulator Control Circuit P0091 - Fuel Pressure Regulator Control Circuit Low P0092 - Fuel Pressure Regulator Control Circuit High
Monitor Execution	P0090 - Continuous P0091 (test 1) - Continuous P0091 (test 2) - Continuous P0092 (test 1) - Continuous
Monitor Sequence	None
Sensors OK	Serial Communication (P0600)
Typical Monitoring Duration	P0090 – 0.5sec. P0091 (test 1) - 0.5sec. P0091 (test 2) - 0.5sec. P0092 (test 1) - 0.5sec.

Typical Fuel Pressure Control Valve Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0090,P0091(test 1), P0092 (test 1):		
Battery Voltage	7 V	
Engine is running		
P0091 (test 2):		
Engine is running		

Typical Fuel Pressure Control Valve Monitor Malfunction Thresholds:
P0090 - The period of the fuel pressure control valve (PCV) command signal is greater than or equal to 400 microseconds OR circuit resistance is greater than 500 Ohm P0091 (test 1) - The period of the fuel pressure control valve (PCV) command signal is greater than or equal to 250 microseconds OR measured circuit voltage = 0 V. P0091 (test 2) – Valve current (PCV) is greater than 3 A. P0092 - The period of the fuel pressure control valve (PCV) command signal is greater than or equal to 50 microseconds OR circuit voltage = 12 V.

Fuel Injector Driver Circuits Monitor Operation:	
DTCs	P062D - Fuel Injector Driver Circuit Performance Bank 1 P062E - Fuel Injector Driver Circuit Performance Bank 2
Monitor Execution	P062D (test 1 & 4), P062E (test 1 & 4) – Once per drive cycle P062D (test 2 & 3), P062E (test 2 & 3) – Continuous
Monitor Sequence	None
Sensors OK	PPS (P062E, P062D)
Typical Monitoring Duration	P062D (test 1) – 1sec. P062D (test 2) – 5sec. P062D (test 3) – 5sec. P062D (test 4) –1 sec. P062E (test 1) – 1 sec. P062E (test 2) – 5sec. P062E (test 3) – 5sec. P062E (test 4) – 1 sec.

Typical Fuel Injector Driver Circuits Entry Conditions:		
Entry condition	Minimum	Maximum
P062D (test 1 & 4), P062E (test 1 & 4):		
Key-on		
P062D (test 2), P062E (test 2):		
Engine is cranking or running		
P062D (test 3), P062E (test 3):		
Engine is cranking or running		
Battery Voltage	7 V	

Typical Fuel Injector Driver Circuits Malfunction Thresholds:
P062D (test 1), P062E (test 1) – Fuel injector driver circuit indicates initialization error
P062D (test 2), P062E (test 2) – Fuel injector driver circuit indicates plausibility error
P062D (test 3), P062E (test 3) – (Main 1 injection event sum voltage greater than 229 V OR Main 1 injection event sum voltage less than 93 V) OR (Main 2 injection event present AND (Main 2 injection event sum voltage greater than 229 V OR Main 2 injection event sum voltage less than 93 V)) OR (Post 1 injection event present AND (Post 1 injection event sum voltage greater than 229 V OR Post 1 injection event sum voltage less than 93 V)) OR (Post 2 injection event present AND (Post 2 injection event sum voltage greater than 229 V OR Post 2 injection event sum voltage less than 93 V))
P062D (test 4), P062E (test 4) – Fuel injector driver circuit indicates initialization voltage error.

Injection Circuits Monitor Operation:	
DTCs	P0201 - Injector Circuit / Open - Cylinder 1 P0202 - Injector Circuit / Open - Cylinder 2 P0203 - Injector Circuit / Open - Cylinder 3 P0204 - Injector Circuit / Open - Cylinder 4 P0205 - Injector Circuit / Open - Cylinder 5 P0206 - Injector Circuit / Open - Cylinder 6 P0207 - Injector Circuit / Open - Cylinder 7 P0208 - Injector Circuit / Open - Cylinder 8 P1551 - Injector Circuit Range/Performance - Cylinder 1 P1552 - Injector Circuit Range/Performance - Cylinder 2 P1553 - Injector Circuit Range/Performance - Cylinder 3 P1554 - Injector Circuit Range/Performance - Cylinder 4 P1555 - Injector Circuit Range/Performance - Cylinder 5 P1556 - Injector Circuit Range/Performance - Cylinder 6 P1557 - Injector Circuit Range/Performance - Cylinder 7 P1558 - Injector Circuit Range/Performance - Cylinder 8
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	PPS (P062E, P062D)
Typical Monitoring Duration	P0201 – P208 (test 1) – 3 seconds. P0201 – P208 (test 2) – 1 second. P1551 – P1558 – 3 seconds.

Typical Injection Circuits Entry Conditions:		
Entry condition	Minimum	Maximum
Engine running or cranking		
Battery Voltage	7 V	
Injections are active on specified injector		

Typical Injection Circuits Malfunction Thresholds:
P0201 – P0208 (test 1) – (The MAIN1, MAIN2, POST1, or POST2 injection event is present AND (The injector charge during the specified injection event is greater than 1320 µAs) OR (The injector charge during the specified injection event is less than 76 µAs)) P0201 – P0208 (test 2) – The injection event is present AND (the charging time for any injection is less than 0.0144 ms OR the discharging time for any injection is less than 0.0144 ms OR the charging time for any injection is greater than 3.0 ms OR the discharging time for any injection is greater than 3.0 ms) P1551 – P1558 – Current error reported by fuel injector driver circuit OR Injector capacity for Main 1 injection greater than 32 µF OR Injector capacity for Main 1 injection less than 0.0 µF OR (Main 1 injection present AND (Main 1 injection voltage greater than 210 V OR Main 1 injection voltage less than 62 V)) OR (Main 2 injection present AND (Main 2 injection voltage greater than 210 V OR Main 2 injection voltage less than 62 V)) OR (Post 1 injection present AND (Post 1 injection voltage greater than 210 V OR Post 1 injection voltage less than 62 V)) OR (Post 2 injection present AND (Post 2 injection voltage greater than 210 V OR Post 2 injection voltage less than 62 V))

The injector/injection timing control circuit monitor (P0216) detects if the commanded post injection is erroneously producing torque.

Injector/Injection Timing Circuit Monitor Operation:	
DTCs	P0216 – Injector/Injection Timing Circuit Error
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	P0201 to P0208, P062D, P062E, P1551 to P1558
Typical Monitoring Duration	0.44 seconds

Typical Injector/Injection Timing Circuit Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Pedal Position	= 0	
Engine Speed	1600 rpm	

Typical Injector/Injection Timing Circuit Monitor Malfunction Thresholds:
Start of post injection is before 20 deg ATDC or other injections beside post injection are detected.

Catalyst and Aftertreatment Monitors (DOC and DPF)

Aftertreatment System Overview

The 6.4L Diesel engine utilizes a Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) for aftertreatment emission control. The DOC and DPF work in harmony to reduce tailpipe emissions of HC, CO, NOx and Diesel Particulates. Diesel particulates are captured and reduced periodically by performing the necessary aftertreatment regeneration cycle.

Comprehensive tests are performed on the analog pressure and temperature sensors. Circuit continuity checks are performed continuously. Rationality checks are performed on the temperature sensors after an 8-hour soak by comparing the sensor readings to ambient, and also observing temperature rise behavior immediately after start. Rationality checks are performed on the pressure sensor at every key-on. The pressure sensor is also checked for a stuck sensor reading during continuous operation.

DOC Functional Monitor

The DOC is monitored during the regeneration events to ensure that a sufficient exothermic temperature increase is achieved to support a thorough and efficient reduction of soot to ash. The exotherm is defined as the DOC outlet temperature (EGT12) minus the DOC inlet temperature (EGT11). No other preconditioning is required.

After a short time delay after the start of regeneration (to ensure that the DOC has achieved light-off), the monitor will continuously monitor the exotherm. It will compare the measured exotherm against a maximum expected value. If the exotherm drops below a certain fraction of the expected value, a filtering routine will begin. A fault will be indicated if the net accumulated time below the threshold during the regeneration event exceeds a certain limit.

DOC Aftertreatment Monitor:	
DTCs	P0420 – Diesel Catalyst System Efficiency Below Threshold
Monitor execution	Once Per Trip in which an active DPF regeneration occurs
Monitor Sequence	None
Sensors OK	EGT11, EGT12
Monitoring Duration	4 minutes

Typical DOC Aftertreatment Entry Conditions:		
Entry condition	Minimum	Maximum
Monitor is activated during aftertreatment regeneration events		
Engine speed	600	3000
Torque setpoint	100 Nm	900 Nm
Engine coolant temperature during aftertreatment regeneration events	-40 deg C	

Typical DOC Aftertreatment Malfunction Thresholds:
Output of Fault Filtering exceeds a value correlating to approximately two minutes. Fault filtering is a counter that counts up when the exotherm is below 25% of the maximum expected value and counts down when the exotherm is above that value. (Minimum value of this filter is 0.) The maximum expected exotherm is a function of post-injection quantity, and is between 120 and 180C.

DOC Aftertreatment Sensor Monitors

The temperature sensors associated with the DOC – EGT11, EGT12, and EGT13 – are monitored for circuit failure, range/performance, and functionality.

Functionality is checked by measuring the sensor output at key-on. This measurement is compared to the output of an ambient temperature model.

Range/Performance is checked by measuring the output of the sensor at key on and comparing this with the output of the sensor after the engine has run a certain amount of time.

DOC Aftertreatment Sensor Monitors	
DTCs	P0545 – EGT11 Sensor Circuit Low P0546 – EGT11 Sensor Circuit High P2080 – EGT11 Sensor Circuit Range/Performance P0544 – EGT11 Sensor Circuit Functional P2032 – EGT12 Sensor Circuit Low P2033 – EGT12 Sensor Circuit High P2084 – EGT12 Sensor Circuit Range/Performance P2031 – EGT12 Sensor Circuit Functional P242C – EGT13 Sensor Circuit Low P242D – EGT13 Sensor Circuit High P242B – EGT13 Sensor Circuit Range/Performance P242A – EGT13 Sensor Circuit Functional
Monitor execution	P0545, P0546, P2032, P2033, P242C, P242D: Continuous. P2080, P0544, P2084, P2031, P242B, P242A: Once per trip
Monitor Sequence	None
Sensors OK	Engine Off Timer, IAT (P0112, P0113)
Monitoring Duration	P0545, P0546, P2032, P2033, P242C, P242D -5 seconds P2080, P2084, P242B - 5 minutes of engine running P0544, P2031, P242A - 10 minutes of driving

Typical Aftertreatment Sensor Entry Conditions:		
Entry condition	Minimum	Maximum
P0545, P0546, P2032, P2033, P242C, P242D:		
None		
P2080, P0544, P2084, P2031, P242B, P242A		
Engine soak	8 hours	
Engine speed (for ambient model update)	25 mph	
Difference between ambient model mature value and ambient model at start		25 deg C

Typical Aftertreatment Sensor Malfunction Thresholds:

Exhaust Gas Temperature Bank 1 Sensor 1/2/3 Circuit Low/High Test:
P0545, P2032, P242C,
Voltage < 0.20 volts **(-200 deg C)**

P0546, P2033, P242D
Voltage > 4.75 volts in initial release, updated to 2.5 volts **(1400 deg C)** by running change

Temperature Sensor Range/Performance Test: (sensor comparisons to ambient model after full soak)
P2080, P2084, P242B

| ambient - actual sensor reading at key-on | > 40 deg C

("ambient" is determined from the ambient temperature model, which updates after 5 minutes of vehicle driving.)

Temperature Sensor Circuit Functional Test: (sensor dynamic response test after start)

P0544: | actual reading 10 minutes of engine running – reading at key-on | > 40 deg C for EGT1
P2031: | actual reading 10 minutes of engine running – reading at key-on | > 30 deg C for EGT2
P242A: | actual reading 10 minutes of engine running – reading at key-on | > 15 deg C for EGT3
(This test also completes after the ambient model updates.)

DPF Functional Monitors

The DPF is monitored to ensure no leaks have developed in the substrate. Preconditioning is required for DPF monitoring such that the distance traveled is greater than 5000 km, which allows the DPF to cycle through several regeneration events before the monitor becomes active.

An efficiency monitor compares the restriction of the DPF to restriction values that are a function of engine volumetric flow. A differential pressure monitor compares the measured differential pressure across the DPF to threshold values that are a function of engine volumetric flow. Both of the monitors use a filtering routine that consist of a counter that counts up when the measured value is below the threshold and counts up when it above the threshold. When a certain count is reached the fault is stored.

DPF Aftertreatment Monitor:	
DTCs	P2002 – Diesel Particulate Trap Efficiency Below Threshold P244A – Diesel Particulate Filter Differential Pressure Too Low P200E – Catalyst System Over Temperature
Monitor execution	Continuous while meeting entry conditions
Monitor Sequence	None
Sensors OK	EGT, DPFP, CKP, ECT (P0117, P0118), INJ(P0201-P0208)
Monitoring Duration	3 minutes for P2002, 5 minutes for P244A. 5 seconds for P200E.

Typical DPF Aftertreatment Entry Conditions:		
Entry condition	Minimum	Maximum
P200E - none		
P2002, P244A:		
Distance preconditioning	5000 km	
At least one active regeneration has been performed		
Exhaust volumetric flow	400 m3/hour	2400 m3/hour
Not a regeneration event		
Time after completion of an active regeneration	200 seconds	
Intake air temperature	-20 degrees C	
Coolant temperature	50 degrees C	

Typical DPF Aftertreatment Malfunction Thresholds:
For P2002 and P244A, a fault is stored when the filtering results in an accumulated count correlating to approximately two minutes. A counter counts up when the threshold is exceeded (restriction or differential pressure lower than the threshold), and counts down (to a minimum of 0) when the threshold is not exceeded. DPF Efficiency Test: (P2002) Normalized measured restriction (based primarily on pressure measurement) is below restriction threshold, which is a function of engine exhaust volumetric flow. (2 trip MIL) DPF Differential Pressure Test: (P244A) Measured differential pressure is less than a threshold that is a function of engine exhaust volumetric flow. (2 trip MIL) Catalyst Over Temperature Test: (P200E) The DTC sets and the engine FMEM actions will activate if EGT2 exceeds 830 deg C OR if EGT3 exceeds 950 deg C. The MIL lights immediately upon fault detection. (Immediate MIL)

DPF Aftertreatment Monitor:	
DTC	P2463 – Diesel Particulate Trap Overloaded
Monitor execution	Continuous while meeting entry conditions
Monitor Sequence	None
Sensors OK	None
Monitoring Duration	300 seconds

Typical DPF Aftertreatment Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Speed	625 rpm	

Typical DPF Aftertreatment Malfunction Thresholds:
Calculated normalized restriction > 7.0 (Immediate MIL)

DPF Aftertreatment Sensor Monitors

The DPF pressure sensor (DPFP) is monitored for circuit continuity and for range/performance. Range/performance comprised two tests. One measures the sensor output at key-on, and identifies a fault if the output is not near zero. The other measures the sensor output while the engine is running and verifies that the output changes appropriately.

DPF Sensor Monitors	
DTCs	P2452 – DPFP Sensor Rationality
Monitor execution	Continuous when entry conditions met
Monitor Sequence	None
Sensors OK	None
Monitoring Duration	Test 1: > 10 seconds Test 2: < 25 seconds

Typical DPF Sensor Entry Conditions:		
Entry condition	Minimum	Maximum
Test 1 – Idle:		
Engine Speed	625 rpm	
Exhaust Flow		175 cubic meters/hr
Dist. since regen	50 km	
IAT ~~TIA~~	0 deg C	
ECT ~~TCO~~	0 deg C	
Test 2 – Part Load:		
Engine Speed	1200 rpm	
Exhaust Flow	400	2800 cubic meters/hr
Dist. since regen	50 km	
IAT ~~TIA~~	0 deg C	
ECT ~~TCO~~	50 deg C	

Typical DPF Sensor Malfunction Thresholds:
Test 1: 1.5 < DPFP < 38.5 Test 2: Function of exhaust flow.

DPF Sensor Monitors	
DTCs	P2454 – DPFP Sensor Circuit Low P2455 – DPFP Sensor Circuit High P2453 – DPFP Sensor Circuit Range/Performance
Monitor execution	P2454, P2455, P2453 (Test 2): Continuous P2453 (Test 1): Once per trip at key-on
Monitor Sequence	None
Sensors OK	Engine Off Timer, IAT (P0112, P0113)
Monitoring Duration	P2453: 5 minutes P2454, p2455: 15 seconds

Typical DPF Sensor Entry Conditions:		
Entry condition	Minimum	Maximum
P2453:		
(Test 1) Engine State	Key on	
P2454, P2455: None		

Typical DPF Sensor Malfunction Thresholds:

P2454 – DPFP Sensor Circuit Low

Voltage < 0.10 volts **(-6.8 kPa)**

P2455 – DPFP Sensor Circuit High

Voltage > 4.90 volts **(86.8 kPa)**

P2453 – DPFP Sensor Circuit Range/Performance :

Test 1 - Key-on Pressure Sensor Rationality Test : pressure > 25 hPa

Test 2 - Continuous Pressure Sensor Rationality Test: absolute value of change in voltage < 0.01 volts

Boost Pressure Monitor

Electronic Variable Response Turbocharger (EVRT) Check Operation:	
DTCs	P132B - Turbocharger/Supercharger Boost Control A Performance P2563 - Turbocharger Boost Control Position Sensor A Circuit Range/Performance
Monitor Execution	P132B - Continuous P2563 - Continuous
Monitor Sequence	None
Sensors OK	P132B - Not applicable – data obtained over CAN P2563 – EP (P0472, P0473), ECT (P0117, P0118), IAT (P0112, P0113)
Typical Monitoring Duration	P132B – 1 sec. P2563 – 2.5 sec.

Typical Electronic Variable Response Turbocharger (EVRT) P2563 Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine running		
No DPF regeneration requested		
Exhaust Pressure (EP) setpoint absolute value of rate of change of stable for 5 sec.		20.07 hPa / sec
Engine Speed (N)	600 rpm	1000 rpm
Indicated torque setpoint	50 N.m	
Engine Coolant Temperature	70 deg C	
Intake Air Temperature	-50 deg C	

Typical Electronic Variable Response Turbocharger (EVRT) Check Malfunction thresholds:
P132B - Actuator performs tests and sends status via a CAN message.
P2563 (test 1) - The difference between the VGT actuator commanded position and the feedforward VGT actuator commanded position is less than -60% for at least 7.5 seconds OR
P2563 (test 2) - The difference between the VGT actuator commanded position and the feedforward VGT actuator commanded position is greater than +70% for at least 7.5 seconds

Thermostat Monitor

The Thermostat Monitor checks that the thermostat is operating properly by estimating Engine Coolant Temperature (ECT) based on engine fueling, engine speed, vehicle speed, and the ambient temperature Once that estimation reaches the thermostat start-to-open temperature, if the actual measured ECT has not reached a minimum warm-up temperature and the driver has not spent too much time in part fuel cut off (over 99.6%), too low load (over 80%), too high vehicle speed (over 99.6%), or too low vehicle speed (over 70%) - then the thermostat is determined to be stuck open. The monitor can also be exited due to a condition where the difference in Intake Air temperature when the engine coolant model reaches 86 deg C and the Intake Air temperature at start is less than -15 deg C. This protects against model inaccuracy in a condition such as a vehicle parked in a heated garage overnight driving out into much colder ambient temperatures.

Thermostat Monitor:			
DTCs	P0128 – Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature)		
Monitor Execution	Once per driving cycle		
Monitor Sequence	None		
Sensors OK	Engine Coolant Temperature (ECT), Intake Air Temperature (IAT), Vehicle Speed (VS)		
Typical Monitoring Duration	Nominal time it takes for engine to warm up to Thermostat Start To Open Temperature – see approximate times below. (Note: Unified Drive Cycle is 23.9 minutes long)		
	Ambient Temperature	Drive Cycle	Completion Time
	-7 deg C	Unified Drive Cycle + 55mph cruise	42 min
	21 deg C	Unified Drive Cycle	23 min
	38 deg C	Unified Drive Cycle	21 min

Typical Thermostat Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Estimated engine coolant temperature	87 deg C	
Engine coolant at start	-7 deg C	58 deg C
Intake Air Temperature at start	-7 deg C	
The difference of Intake Air Temperature when the model reaches 87degC and Intake Air Temperature at engine startup		-15 deg C
ratio of time that the vehicle speed is above, 100km/hr, to the total monitoring time		99.6%
ratio of time that the engine fueling is below 17 mg/str to the total monitoring time		60%
ratio of time that the engine receives no fuel to the total monitoring time		99.6%
Ratio of time that the vehicle speed is below 30km/hr to the total monitoring time		60%

Typical Thermostat Monitor Malfunction Thresholds:
Measured Engine Coolant Temperature < 78 deg C

Glow Plug Monitor

Glow Plug Control, Comprehensive Component Monitors, and Wait to Start Indicator

The California glow plug system is composed of solid state Glow Plug Control Module (GPCM), glow plugs, glow plug light, and the associated wiring harness. The glow plug on time is controlled by the Powertrain Control Module (PCM) and is a function of oil temperature, barometric pressure and battery voltage. The PCM enables the GPCM that drives the individual glow plugs. Glow plug on time normally varies between 1 and 120 seconds. In addition to PCM control, the GPCM internally limits the glow plug operation to 180 seconds regardless of PCM commanded on time. The power to the glow plugs is provided through the GPCM solid-state drivers directly from the vehicle battery. The GPCM monitors and detects individual glow plug functionality and the control and communication links to the PCM. The failures detected by the GPCM are passed to the PCM using a serial communication signal on the glow plug diagnostic line.

Glow Plug Module Control Circuit Check:	
DTCs	P0670 – Glow Plug Module Control Circuit
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	5 sec.

Typical Glow Plug Module Control Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Glow plugs disabled		

Typical Glow Plug Module Control Circuit Check Malfunction Thresholds:
Actuator driver status indicates open **(<3 Amps)** /short **(>65 Amps)**

Glow Plug Module Diagnostic Communication Circuit Operation:	
DTCs	P0684 – Glow Plug Control Module to PCM Communication Circuit Range/Performance
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	10 sec.

Typical Glow Plug Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Glow Plug Monitor Malfunction Thresholds:
The Glow Plug Control Module (GPCM) passes Glow Plug status information across the Glow Plug Diagnostic Line. If the diagnostic line is constant high or constant low, or the period of the signal is out of range, the P0684 fault is set.

Glow Plug Monitor Operation:	
DTCs	P0671 – Cylinder 1 Glow Plug Circuit P0672 – Cylinder 2 Glow Plug Circuit P0673 – Cylinder 3 Glow Plug Circuit P0674 – Cylinder 4 Glow Plug Circuit P0675 – Cylinder 5 Glow Plug Circuit P0676 – Cylinder 6 Glow Plug Circuit P0677 – Cylinder 7 Glow Plug Circuit P0678 – Cylinder 8 Glow Plug Circuit
Monitor Execution	Continuous (every 100 ms)
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	8.5 sec.

Typical Glow Plug Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Battery Voltage	7 Volts	18 Volts
Glow plug on time	8.5 sec	

Typical Glow Plug Monitor Malfunction Thresholds:
An open circuit is a current level < 4 Amps, a short circuit is a current level > 60 Amps.

Glow Plug Wait to Start Light Operation:	
DTCs	P0381 – Glow Plug/ Heater Indicator Circuit
Monitor execution	Continuous (20ms)
Monitor Sequence	None
Sensors OK	No CAN error from the Instrumental Panel, no vehicle CAN errors
Typical Monitoring Duration	5 seconds

Glow Plug Light Wait to Start Light Entry Conditions:		
Entry condition	Minimum	Maximum
Glow plugs enabled		

Glow Plug Light Wait to Start Light Malfunction Thresholds:
Smart driver status from Instrument Panel. A CAN message is sent from the Instrument Panel to the ECM indicating Wait to Start Light status.

Comprehensive Component Monitor - Engine

Engine Inputs (Analog)

Barometric Pressure (BP) Sensor Circuit Check:	
DTCs	P2228 - Barometric Pressure Circuit Low Input P2229 - Barometric Pressure Circuit High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P2228, P2229 - 5 sec.

Typical Barometric Pressure Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key-on		

Typical Barometric Pressure Sensor Circuit Check Malfunction Thresholds:
P2228 - Voltage less than 2.22 V **(599 hPa)**
P2229 - Voltage greater than 4.36 V **(1074 hPa)**

Barometric Pressure Sensor Intermittency Monitor (P2230) checks for a rate of change of indicated pressure that would not be possible.

Barometric Pressure Sensor Intermittency Monitor Operation:	
DTCs	P2230 – Barometric Pressure Sensor Intermittent
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	0.3 sec

Typical Barometric Pressure Sensor Intermittency Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Barometric Pressure Sensor Intermittency Monitor Malfunction Thresholds:
Absolute value of rate of change is greater than 25 kPa/100 milliseconds.

Manifold Absolute Pressure (MAP) Sensor Circuit Check:	
DTCs	P0107 - Manifold Absolute Pressure/BARO Sensor Low Input P0108 - Manifold Absolute Pressure/BARO Sensor High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0107, P0108 - 5 sec.

Typical Manifold Absolute Pressure Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Manifold Absolute Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.15 volts or voltage > 4.90 volts

Manifold Absolute Pressure Functional Check Operation:	
DTCs	P2262 - Turbo/ Super Charger Boost Pressure Not Detected – Mechanical P2263 - Turbo/ Super Charger Boost System Performance
Monitor Execution	P2262 - Continuous P2263 - Continuous
Monitor Sequence	None
Sensors OK	P2262 – P2228, P2229, P0107, P0108 P2263 – EP (P0472, P0473), ECT (P0117, P0118), IAT (P0112, P0113), CKP (P0336, P0337, P1336)
Typical Monitoring Duration	P2262 - 5 sec. P2263 (test 1) - 15 sec. P2263 (test 2) – 15 sec.

Typical Manifold Absolute Pressure Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
P2262		
EGR valve position		1%
Engine Speed (N) – Range (1)	600 rpm	800 rpm
Engine Speed (N) – Range (2)	2200 rpm	3600 rpm
~~Coolant Temperature (ECT)~~	~~80 deg C~~	
Torque setpoint	50 Nm	
P2263		
Engine speed (N)	550 rpm	
Indicated torque setpoint (TQI_SP)	50 Nm	
Coolant Temperature (ECT)	78 ~~81~~ deg C	
Intake Air Temperature (IAT)	-50 deg C	
Diesel Particulate Filter (DPF) is not regenerating		
Absolute value of rate of change of Exhaust Pressure (EP)		20.07 hPa / sec for 5 seconds

Typical Manifold Absolute Pressure Functional Malfunction Thresholds:
P2262 – If the Manifold Absolute Pressure (MAP) is less than -10 kPa in speed range (1) or less than 5.0 kPa in speed range (2) for 30 seconds the fault is set.
P2263 (test 1) – The difference between the gage Exhaust Gas Pressure (EP) and the exhaust gas pressure setpoint is less than a calibratable value determined as a function of engine speed and indicated torque setpoint (IP_EGBP_CTL_MIN_DIAG) for 15 seconds.
P2263 (test 2) - The difference between the gage Exhaust Gas Pressure (EP) and the exhaust gas pressure setpoint is greater than a calibratable value determined as a function of engine speed and indicated torque setpoint (IP_EGBP_CTL_MAX_DIAG) for 15 seconds.

Manifold Absolute Pressure (MAP) / Barometric Pressure (BP) Rationality Check:	
DTCs	P0069 - MAP/BARO Correlation P0106 - Manifold Absolute Pressure/BARO Sensor Range/Performance
Monitor Execution	P0069 – Continuous P0106 - Continuous
Monitor Sequence	None
Sensors OK	P0069 - BARO (P2228, P2229), MAP (P0107, P0108) P0106 - MAP (P0107, P0108)
Typical Monitoring Duration	P0069 - 3 sec. P0106 - 5 sec.

Typical MAP / BP Rationality Check Entry Conditions:		
Entry condition	Minimum	Maximum
P0069 - MAP / BARO Correlation:		
Key-on		
ECU on time	0 sec	
Battery voltage (IVPWR)	10.96 V	17.96 V
P0106 - MAP / BARO Sensor Range/Performance:		
Idle speed control is requested		
Engine Speed (N)		750 rpm
Indicated torque setpoint		100 N.m
Vehicle is not moving		
Engine Coolant Temperature (ECT)	69 deg C	
Intake throttle command output	10%	100%
DPF regeneration not requested	10 sec	

Typical MAP / BP Rationality Check Malfunction Thresholds:
P0069 - The difference between MAP and BARO is greater than 300 hPa .
P0106 - The difference between BARO and MAP is greater than 300 hPa.

Manifold Absolute Pressure (MAP) / Exhaust Pressure (EP) Rationality Check:	
DTCs	P006B - MAP/EP Correlation
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	MAP (P0107, P0108), EP (P0472, P0473), ECT (P0117, P0118), IAT (P0112, P0113), ~~**BP (P2228, P2229)**~~
Typical Monitoring Duration	5 sec.

Typical MAP / EP Rationality Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key-on	5 seconds	
Engine off	5 seconds	
Engine Coolant Temperature (ECT)	-40 deg C	
Intake Air Temperature (IAT)	-40 deg C	

Typical MAP / EP Rationality Check Malfunction Thresholds:
The absolute value of the difference between Manifold Absolute Pressure (MAP) and Exhaust Gas Back Pressure (EP) is greater than 300 hPa

Exhaust Pressure (EP) Sensor Circuit Check:	
DTCs	P0472 - Exhaust Pressure Sensor Low Input P0473 - Exhaust Pressure Sensor High Input
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0472, P0473 - 3 sec.

Typical Exhaust Pressure Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Exhaust Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.15 volts **(235 hPa)** or voltage > 4.90 volts **(6260 hPa)**

Engine Coolant Temperature (ECT) Sensor Circuit Check:	
DTCs	P0117 - Engine Coolant Temperature Sensor Circuit Low Input P0118 - Engine Coolant Temperature Sensor Circuit High Input
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	ECT (P0117,P0118) TFU (P0182, P0183)
Typical Monitoring Duration	P0117, P0118 - 1 sec.

Typical Engine Coolant Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
P0117, P0118 – ECU powered on	5 sec	

Typical Engine Coolant Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.04 **(170 deg C)** volts or voltage > 4.76 volts **(-49 deg C)**

Engine Oil Temperature (EOT) Sensor Circuit Check:	
DTCs	P0197 - Engine Oil Temperature Sensor Circuit Low Input P0198 - Engine Oil Temperature Sensor Circuit High Input
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0197, P0198 - 5 sec.

Typical Engine Oil Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Engine Oil Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.04 **(170 deg C)** volts or voltage > 4.76 volts **(-49 deg C)**

Engine Oil Temperature (EOT) Functional Check Operation:	
DTCs	P0196 - Engine Oil Temperature Sensor Circuit Range/ Performance P0298 - Engine Oil Overtemperature Condition
Monitor Execution	P0196 - Continuous P0298 - Continuous
Monitor Sequence	None
Sensors OK	P0196 – EOT (P0197, P0198) P0298 - EOT (P0197, P0198), IAT (P0112, P0113)
Typical Monitoring Duration	P0196 – After 1200 seconds of no change. P0298 – EOT dependent.

Typical Engine Oil Temperature Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
P0196 – Engine off for 36,000 seconds		
P0298 - None		

Typical Engine Oil Temperature Functional Thresholds:
P0196 – Engine Oil Temperature (EOT) is sampled when the engine starts to run. Fault sets if the difference between Engine Oil Temperature (EOT) and sampled temperature is less than 5 deg C. P0298 - Fault sets if Engine Oil Temperature (EOT) exceeds 110 deg C for a given period of time (EOT- and Intake Air Temperature 1 (IAT) - dependent).

Intake Air Temperature (IAT) Sensor Circuit Check:	
DTCs	P0112 - Intake Air Temperature Sensor 1 Circuit Low Input P0113 - Intake Air Temperature Sensor 1 Circuit High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	5 sec.

Typical Intake Air Temperature Entry Conditions:		
Entry condition	Minimum	Maximum
Engine has been started.		

Typical Intake Air Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.15 volts **(137 deg C)** or voltage > 4.60 volts **(-50 deg C)**

Intake Air Temperature 2 (IAT2) Sensor Circuit Check:	
DTCs	P0097 - Intake Air Temperature Sensor 2 Circuit Low Input P0098 - Intake Air Temperature Sensor 2 Circuit High Input
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0097, P0098 - 5 sec.

Typical Intake Air Temperature 2 Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Typical Intake Air Temperature 2 Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.17 volts **(163 deg C)** or voltage > 4.81 volts **(-50 deg C)**

Intake Air Temperature 1/2 Rationality Check #2	
DTCs	P2199 – Intake Air Temperature 1/2 Correlation
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	IAT (P0112, P0113), IAT2 (P0097, P0098), EOT (P0197, P0198), ECT (P0117, P0118), EGRP (P0405, P0406)
Typical Monitoring Duration	40 seconds

Typical Intake Air Temperature 1/2 Rationality Check #2 Entry Conditions:		
Entry condition	Minimum	Maximum
Exhaust Gas Recirculation Valve Position (EGRP)	~~**8% (0.08)**~~	**8% (0.08)**
Engine speed (N)	600 rpm	800 rpm
Indicated torque setpoint (TQI_SP)	53 Nm	184 Nm
Time After Engine Start (T_AST)	N/A	155 Sec
Engine Off Time (T_ES)	10 hours	N/A

Typical Intake Air Temperature 1/2 Rationality Check #2 Thresholds:
Upon satisfying the entry conditions, if the difference between IAT1 and IAT2 is greater than 20 C.

Keep Alive Memory Monitor (KAM) Operation:	
DTC	P0603 – Powertrain Control Module Keep Alive Memory (KAM) Error
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	50 sec.

Typical KAM Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Key- on		

Typical KAM Monitor Malfunction Thresholds:
Internal hardware status indicates non-volatile memory error such as VID-Block not or falsely programmed checksum of non-volatile-memory incorrect.

Sensor Supply Voltage Check:	
DTCs	P0642 - Sensor Reference Voltage A Circuit Low P0643 - Sensor Reference Voltage A Circuit High P0652 - Sensor Reference Voltage B Circuit Low P0653 - Sensor Reference Voltage B Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0642, P0643 - 0.5 sec P0652, P0653 - 0.5 sec

Typical Sensor Supply Voltage Check Entry Conditions:
Key-on

Typical Sensor Supply Voltage Check Malfunction Thresholds:
P0642 – Sensor supply voltage 1 less than 4.75 V.
P0643 – Sensor supply voltage 1 greater than 5.25 V.
P0652 – Sensor supply voltage 2 less than 4.75 V.
P0653 – Sensor supply voltage 2 greater than 5.25 V.

DC/DC Converter Voltage Check:	
DTCs	P0A09 - DC/DC Converter Fault Circuit Low P0A10 - DC/DC Converter Fault Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0A09 - 2 sec. P0A10 - 2 sec.

Typical DC/DC Converter Voltage Check Entry Conditions:
Key-on

Typical DC/DC Converter Voltage Check Malfunction Thresholds:
P0A09 – DC/DC converter voltage less than 42 V. P0A10 – DC/DC converter voltage greater than 96 V.

Engine-Off Timer Check:	
DTCs	P2610 - ECM/PCM Internal Engine Off Timer Performance
Monitor Execution	Tests 1 – Continuous Tests 2 – Once per driving cycle
Monitor Sequence	None
Sensors OK	Test 1 – Not applicable Test 2 – ECT (P0117, P0118)
Typical Monitoring Duration	Test 1 – 30 s Test 2 – On transition from engine “stopped” to "running" state

Typical Engine-Off Timer Plausibility Check Entry Conditions:		
Entry Conditions	Minimum	Maximum
ECT at previous key off (Test 2, long soak portion only)	78 Deg C	
Engine-off time (Test 2, long soak portion only)	28800 sec	
Engine-off time (Test 2, short soak portion only)		60 sec

Typical Engine Off Timer Thresholds:

Test 1:

Loss of communication between the engine-off timer micro and ECM

OR

The absolute delta difference between the engine-off timer and ECM's internal task rate time is greater than 5 sec

Test 2:

(The engine-off timer is greater than 288000 seconds AND the ECT at engine off is greater than 78 DegC AND the absolute value of the difference between the ECT at engine start and the ECT at engine off is less than 5 DegC)

OR

(The engine-off timer is less than 60 seconds AND the absolute value of the difference between the ECT at engine start and the ECT at engine off is greater than 5 DegC)

High Speed CAN Communication Check:	
DTCs	U0073 – Control Module Communication Bus A Off U0101 - Lost Communication with TCM P179A - CAN ECM/Turbocharger Boost Control A Actuator Circuit Malfunction
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	U0073 – 300 ms U0101 – 200 ms P179A – 5 sec

Typical High Speed CAN Communication Check Entry Conditions:		
Entry Conditions	Minimum	Maximum
Time delay to enable CAN diagnostic of Bus-Off after ignition key-on		300 ms
Time delay to enable CAN diagnostic after ignition key-on		2000 ms
Battery threshold for CAN diagnostic	9.0 volts	
Engine RPM threshold for diagnostic	0	

Typical High Speed CAN Communication Check Malfunction Thresholds:
U0073 – CAN communication hardware bus-off for 300 ms
U0101 – Lost of CAN communication between ECM and TCM for 200 ms (automatic vehicle only)
P179A – Lost of CAN communication between ECM and VGT for 5 sec

Vehicle ID Block Check:	
DTCs	P1639 – Vehicle ID Block Corrupted, Not Programmed
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	100 ms

Typical Vehicle ID Block Check Entry Conditions:		
Entry condition	Minimum	Maximum
On key-up or after VID block reprogramming		

Typical Vehicle ID Block Check Malfunction Thresholds:
Set on any of the following conditions:
VID block is not configured
VIN ID is not correct or configured
Tire size is not configured
Axle ratio is not configured
Primary Alternator is not configured
Secondary Alternator is not configured
Engine Only Traction Control is not configured
Vehicle Speed Source is not configured
Wheel Base is not configured
Snow Plow is not configured

The P0600 Serial Communication Link Diagnostic is a hardware diagnostic on a microcontroller for the SPI Bus. The outputs of the microcontroller are checked for open load, short to ground, and short to battery conditions.

Serial Communication Link:	
DTC	P0600 – Serial Communication Link
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	<1 sec

Serial Communication Link:		
Entry condition	Minimum	Maximum
None		

Serial Communication Link:
The outputs of the microcontroller are checked for open load, short to ground, and short to battery conditions.

Engine Inputs (Digital)

On the 6.4L application the Mass Air Flow (MAF) Sensor produces a frequency output. The diagnosis of the MAF sensor looks at the period of the MAF sensor signal and increments a counter based on the error found. For example, if the period of the MAF sensor is less than a minimum period an Out or Range Low Period Counter is incremented. There are 5 counters total, No Signal, Out of Range High, Out of Range Low, Gradient too High, Signal OK. To diagnose a failure the ratio of that counter to all 5 counters must be greater than a ratio threshold. For example, for the out of range low failure, the ratio of the Out of Range Low Period Counter to 5 counters is taken and compared to a ratio threshold and if it is higher than that ratio threshold P0102 is set.

Mass Air Flow (MAF) Sensor Circuit Check:	
DTCs	P0101 – Mass or Volume Air Flow Circuit A P0102 – Mass or Volume Air Flow Circuit A Low Input P0103 – Mass or Volume Air Flow Circuit A High Input P0104 – Mass or Volume Air Flow Circuit A Intermittent/Erratic
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0101 – 200 ms. P0102 – 200 ms. P0103 – 200 ms. P0104 - 500 ms.

Typical Mass Air Flow Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Battery voltage and ignition voltage	11 V	

Typical Mass Air Flow Sensor Circuit Check Malfunction Thresholds:
P0101 – The No Signal Period counter is incremented when the period of the MAF sensor is 0µs. The ratio of No Signal Period Counter to 5 counters must be greater than 60%.
P0102 – The Out or Range Low Period Counter is incremented when the period of the MAF sensor is lower than 63µs. The ratio of Out of Range Low Period Counter to 5 counters must be greater than 60%.
P0103 – The Out or Range High Period Counter is incremented when the period of the MAF sensor is higher than 580µs. The ratio of Out of Range High Period Counter to 5 counters must be greater than 60%.
P0104 – The Gradient Too High counter is incremented when the gradient exceeds 50 µs/ms. The ratio of the Gradient Too High counter to 5 counters must be greater than 10%.

Mass Air Flow Sensor Functional Check Operation:	
DTCs	P1102 – Mass Air Flow Sensor In Range But Lower Than Expected P1103 – Mass Air Flow Sensor In Range But Higher Than Expected
Monitor Execution	Continuous
Monitor Sequence	None.
Sensors OK	MAF (P0101, P0102, P0103), EGRP (P0405, P0406, P0404, P0042E, P042F, P1335) BP (P2228, P2229)
Typical Monitoring Duration	P1102 - 15 sec. P1103 - 15 sec.

Typical Mass Air Flow Sensor Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
DPF regeneration not requested		
PTO not active		
EGR flow monitor not active		
EGRP setpoint	0%	45%
Engine Speed (N)	680 rpm	2700 rpm
Indicated Torque Setpoint (TQI_SP)	70 N-m	
Barometric Pressure	800hPa	

Typical Mass Air Flow Sensor Functional Check Malfunction Thresholds:
P1102 – If the Mass Air Flow (MAF) is less than a value specified as a function of Engine Speed (N) and indicated torque setpoint (IP_MAF_KGH_MAF_TOT_MIN_DIAG). P1103 - If the Mass Air Flow (MAF) is greater than a value specified as a function of Engine Speed (N) and indicated torque setpoint (IP_MAF_KGH_MAF_TOT_MAX_DIAG).

Camshaft Position Sensor (CMP) Check Operation:	
DTCs	P0341 - Camshaft Position Sensor A Circuit Range/ Performance
Monitor Execution	P0341 - Continuous
Monitor Sequence	None.
Sensors OK	Not applicable
Typical Monitoring Duration	P0341 – Internal to the engine control module.

Typical Camshaft Position Sensor Malfunction Entry Conditions:		
Entry condition	Minimum	Maximum
Key-on		

Typical Camshaft Position Sensor Malfunction Thresholds:
P0341 – If it cannot be determined which Camshaft Position Sensor (CMP) signal edge has been detected, a counter is incremented. If the counter is greater than 3, the fault is set.

Crankshaft Position Sensor (CKP) Monitor Operation:	
DTCs	P0336 - Crankshaft Position Sensor A Circuit Range/ Performance P0337 - Crankshaft Position Sensor A Circuit Low Input
Monitor Execution	P0336 (tests 1 & 2) - Continuous P0336 (test 3) – Continuous P0337 – Continuous
Monitor Sequence	None
Sensors OK	CKP (P0336, P0337)
Typical Monitoring Duration	P0336 (test 1) – 1 sec. P0336 (test 2) – 1 sec. P0336 (test 3) – 1 sec. . P0337 – 1 sec.

Crankshaft Position Sensor Malfunction Entry Conditions:		
Entry condition	Minimum	Maximum
P0336 - None		
P0337 - None		

Crankshaft Position Sensor Malfunction Thresholds:
P0336 – Incorrect number of crankshaft teeth detected OR
Tooth period out of the CKP acceptance window established as the nominal tooth period +/- 37.5% OR
Number of detected camshaft edges is greater than 3
P0337 – The crankshaft sensor voltage is sampled 50 times, and the minimum and maximum voltages determined over the sample period. The fault is set if the minimum sample voltage is less than 1.99 OR
The maximum sample voltage is greater than 3.29 OR
The difference between the maximum and minimum sampled voltage is greater than 0.5 Volts..

Crankshaft Position Sensor (CKP)/Camshaft Position Sensor (CMP) Performance Monitor Operation:	
DTCs	P1336 - Crankshaft/Camshaft Sensor Range/Performance
Monitor Execution	P1336 - Continuous
Monitor Sequence	None
Sensors OK	CMP (P0341)
Typical Monitoring Duration	P1336 (test 1) - 1 sec. P1336 (test 2) - 1 sec.

Crankshaft Position Sensor/Camshaft Position Sensor Performance Malfunction Entry Conditions:		
Entry condition	Minimum	Maximum
None		

Crankshaft Position Sensor/Camshaft Position Sensor Performance Malfunction Thresholds:
P1336 (test 1) - Detected edge position < -24 deg crank OR Detected edge position > 24 deg crank
P1336 (test 2) - Detected number of missing teeth is greater than 2 OR Detected number of additional teeth is greater than 2 OR Detected number of missing teeth is greater than 2 + 2 (accounting for reference gap)

Engine Outputs

ABS Vehicle Speed Diagnostic Operation:	
DTCs	P215A – Vehicle Speed / ABS Wheel Speed Correlation
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	10.0 seconds

ABS Vehicle Speed Diagnostic Entry Conditions:
No ABS VSS error detected (U0121).
No vehicle CAN bus error detected (U0073).

ABS Vehicle Speed Diagnostic Malfunction Thresholds:
If the vehicle speed signal being sent over CAN to the ECU by the ABS module is equal to FFFF(hex) then a fault is detected.

Output Shaft Speed Sensor Functional Check Operation:	
DTCs	P215B – Vehicle Speed / Output Shaft Speed Correlation
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Monitoring Duration	10.0 seconds

Typical OSS functional check entry conditions:		
Entry condition	Minimum	Maximum
No transmission (TCM) VSS error detected (U0101).		
No vehicle CAN bus error detected (U0073).		

Typical OSS functional check malfunction thresholds:
If the vehicle speed signal being sent over CAN to the ECU by the Transmission module is equal to 7FFF (hex) then a fault is set.

Comprehensive Component Monitor - Transmission

General

The MIL is illuminated for all emissions related electrical component malfunctions. For malfunctions attributable to a mechanical component (such as a clutch, gear, band, valve, etc.), some transmissions are capable of not commanding the mechanically failed component and providing the remaining maximum functionality (functionality is reassessed on each power up)- in such case a non-MIL Diagnostic Trouble Code (DTC) will be stored and, if so equipped, a Transmission Control Indicator Light (TCIL) will flash.

5R110W does not have the ability to isolate a shift solenoid fault from the rest of the mechanical/hydraulic system – all detected ratio errors result in MIL illumination except those attributed to the Over Drive and Simpson On-Way Clutches (which cause Neutral condition failures which cannot be caused by an electrical component).

Transmission Inputs

Transmission Range Sensor Check Operation:	
DTCs	P0706 (Out of range signal frequency for PWM Sensor) P0707, P0708 (Low /High duty cycle for PWM Sensor)
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical TRS check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Faults can be detected independent of lever position	none

Typical TRS malfunction thresholds:
For Pulse Width Modulated (PWM) sensor: Frequency > 160 Hz or < 100 Hz, Duty Cycle > 90% or < 10% If an error is present for 5 seconds a fault code will be stored

On some applications vehicle speed is calculated in the PCM by using the transmission output shaft speed sensor signal and applying a conversion factor for axle ratio and tire programmed into the Vehicle ID block. A Vehicle Speed Output pin on the PCM provides the rest of the vehicle with the standard 8,000 pulses/mile signal.

On all other applications vehicle speed is provided by the Anti-lock Brake System (ABS) or a vehicle speed sensor. In either case the vehicle speed input is tested as a "VSS", using fault code P0500.

Note: If the Vehicle ID block has not been programmed or has been programmed with an out-of-range (uncertified) tire/axle ratio, a P1639 DTC will be stored and the MIL will be illuminated immediately.

Output Shaft Speed Sensor Functional Check Operation:	
DTCs	P0720
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical OSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	800 rpm	
Intermediate shaft rpm	800 rpm	
Vehicle speed (if available)	10 mph	

Typical OSS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and OSS < 100 to 200 rpm for 5 seconds

Intermediate Shaft Speed Sensor Functional Check Operation:	
DTCs	P0791
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical ISS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	800 rpm	
Output shaft rpm	500 rpm	
Vehicle speed (if available)	10 mph	

Typical ISS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and ISS < 250 rpm for 5 seconds

Turbine Shaft Speed Sensor Functional Check Operation:	
DTCs	P0715
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical TSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Intermediate shaft rpm OR	800 rpm	
Output shaft rpm	500 rpm	
Vehicle speed (if available)	10 mph	
Torque converter lock-up (some applications)	N/A	

Typical TSS functional check malfunction thresholds:
vehicle is inferred to be moving with positive driving torque and TSS < 200 rpm for 5 seconds

Vehicle Speed Sensor Functional Check Operation:	
DTCs	P0500
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	30 seconds

Typical VSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Any forward range	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	800 rpm	
Intermediate shaft rpm	800 rpm	
Output shaft rpm	500 rpm	

Typical VSS functional check malfunction thresholds:
Vehicle is inferred to be moving with positive driving torque and OSS < 100 to 200 rpm for 5 seconds

NOTE: on stand alone systems (engine controlled by an ECM, transmission by a TCM) the VSS input (usually provided by the ABS system) is diagnosed by the Engine Control Module.

Transmission Fluid Temperature Sensor Functional Check Operation:	
DTCs (all MIL)	P0712, P0713 (open/short) P0711 (range/performance)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	(ECT substituted if TFT has malfunction if not in cold mode or conditions to exit cold mode have been met, see note below)
Monitoring Duration	5 seconds for electrical, 500 seconds for functional check

Typical TFT functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Engine Coolant Temp (hot or cold, not midrange)	> 100 ^{o}F	< 20 ^{o}F
Time in run mode	500 sec	
Time in gear, vehicle moving, positive torque	150 sec	
Time with engine off (soak time)	420 min	
Vehicle Speed	15 mph	

Typical TFT malfunction thresholds:

Electrical check: TFT voltage <0.05 or > 4.6 volts for 5 seconds

TFT functional check (TFT stuck at high temperature or stuck at low temperature): < 6 ^{o}F rise or fall in TFT after startup

NOTES: 5R110W has a feature called "Cold Mode". If TFT is below 0 deg F, the transmission will limit operation to 1st, 2nd, 3rd, and 4th gears (5th and 6th gears are disabled). Cold mode remains in effect until TFT rises above 0 deg F or vehicle operation (based on shift times or heat generated by driving) indicates that TFT should not be in the cold mode range, at which point normal operation is enabled.

Direct clutch apply times cold have forced the addition of this cold mode because the direct clutch takes an unacceptable amount of time to apply below –10 deg F).

TFT failure management – if TFT is failed at start up, the transmission will be placed in cold mode and remain there until TFT is no longer failed and above 0 deg F or the vehicle operating conditions listed above trigger an exit from cold mode. Once out of cold mode, a TFT failure will not trigger cold mode (transmission will only go into cold mode once per power-up).

TFT In-Range tests will continue to run until a fault is set or the transmission temperature enters normal operating range where all transmission OBD test are running.

Transmission Outputs

The 5R110W shift solenoids are functionally tested by monitoring ratio and shift events for proper execution. Clutch system fault codes (since the solenoid cannot be isolated from the rest of the system using ratio alone) are set if the clutch is in the incorrect state for 3 commanded cycles of the clutch.

NOTE: For the Intermediate Clutch, Direct Clutch, and Over Drive Clutch, once the 1st "bad" event is detected, a special test mode is triggered that will cycle a suspected clutch on/off and retest – the clutch system test modes described below typically complete within 30 seconds drive time (vehicle speed > 5mph) after the 1st event.

For the Coast Clutch and Low Reverse Clutch, the test must wait until the customer goes to closed pedal so the diagnostics can test for engine braking. Once the customer tips out, the tests quickly complete; but test mode duration depends on how long until the customer tips out.

Shift Solenoid Check Operation:	
DTCs	SS A - P0750 (SSA open circuit,) P0973 (SSA short to ground) P0974 (SSA short to power) SS B - P0755 (SSB open circuit) P0976 (SSB short to ground) P0977 (SSB short to power) SS C - P0760 (SSC open circuit) P0979 (SSC short to ground) P0980 (SSC short to power) SS D - P0765 (SSD open circuit) P0982 (SSD short to ground) P0983 (SSD short to power) SS E - P0770 (SSE open circuit) P0985 (SSE short to ground) P0986 (SSE short to power)
Monitor execution	electrical - continuous, functional - during off-to-on solenoid transitions
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds

Typical Shift Solenoid electrical check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	18.0 Volts

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Turbine, intermediate, and output shaft speed	200 rpm	
Gear	In a forward range (for CC and LRC off faults a manual gear must be selected)	
Monitor execution	Both shifting and non-shifting	

Coast Clutch System (functional test of SSA):	
DTCs	P2700 Coast Clutch Failed On or Off P0751 Coast Clutch Failed Off P0752 Coast Clutch Failed On
Monitor execution	CC failed off – detected in 1M, 3M, or 5M CC failed on – detected during 1-2 or 5-6 shifts, then tested in 1A, 3A, or 5A
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	TSS, ISS
Monitoring Duration	3 bad events

Over Drive Clutch System (functional test of SSB):	
DTCs	P2701 Overdrive Clutch Failed On or Off P0756 Overdrive Clutch Failed Off P0757 Overdrive Clutch Failed On
Monitor execution	ODC failed off – detected in 2nd or 6th gear or during 1-2 or 5-6 shifts ODC failed on – detected in 1st, 3rd, or 5th gear or during shifts into 1M, 3M, or 5M
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	TSS, ISS
Monitoring Duration	3 bad events

Intermediate Clutch System (functional test of SSC):	
DTCs	P2702 Intermediate Clutch Failed On or Off P0761 Intermediate Clutch Failed Off P0762 Intermediate Clutch Failed On
Monitor execution	IC failed off – detected in 3rd gear or during shifts into 3rd gear. IC failed on – detected in 1st or 2nd gear or during shifts into 5th or 6th
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Direct Clutch System (functional test of SSD):	
DTCs	P2703 Direct Clutch Failed On or Off P0766 Direct Clutch Failed Off P0767 Direct Clutch Failed On
Monitor execution	DC failed off – detected in 5th or 6th gear or during shifts into 5th or 6th gear. DC failed on – detected in 1st or 2nd gear or during shifts into 3rd gear.
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Low/Reverse Clutch System (functional test of SSE):	
DTCs	P2704 Low Reverse Clutch Failed On or Off P0771 Low Reverse Clutch Failed Off P0772 Low Reverse Clutch Failed On
Monitor execution	LRC failed off – detected in 1M or 2M. LRC failed on – detected during upshifts from 1st or 2nd to any higher gear, tested in 1st or 2nd after a bad shift event.
Monitor Sequence	Tested in the steady state gear listed above, then after each bad event the clutch is cycled and tested again
Sensors OK	ISS, OSS
Monitoring Duration	3 bad events

Torque Converter Clutch Check Operation:	
DTCs	P0740 TCC solenoid open circuit P0742 TCC solenoid short to ground P0744 TCC solenoid short to power P0741 TCC mechanical functional
Monitor execution	electrical - continuous, mechanical - during lockup
Monitor Sequence	none
Sensors OK	TSS
Monitoring Duration	3 lock-up events

Typical Torque Converter Clutch electrical check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	18.0 Volts

Typical Torque Converter Clutch mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Throttle Position	steady	
Engine Torque	positive drive torque	
Transmission Fluid Temp	None (test runs any time TCC applied)	275 ^{o}F
Commanded TCC current (0 rpm slip)	None (tested whenever the TCC is commanded on)	None
Not shifting		

Typical TCC malfunction thresholds:
Electrical check: Output driver feedback circuit does not match commanded driver state for 5 seconds (> 1.0 volt if commanded on, < 2.0 volts if commanded off.) Mechanical check: Slip across torque converter > 100 rpm or (on some applications) speed ratio < 0.93

The Electronic Pressure Control solenoid controls line pressure. If EPC fails low, all gears will be failed (loss of all movement). If EPC fails high, engagements will be harsh; but all gears available (no impact on steady state ratio). Therefore, EPC is not functionally monitored on it's own; but is tested as each clutch system is tested (since loss of line pressure will cause result in detection of clutch faults if pressure is lower than required to keep the currently applied clutches from slipping).

Electronic Pressure Control Check Operation:	
DTCs	P0960 – open circuit P0962 – short to ground P0963 – short to power
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	Electrical: 5 seconds

Typical Electronic Pressure Control mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	18.0 Volts

Typical EPC malfunction thresholds:
Electrical check: Current feedback circuit is less than commanded current for > 5 seconds

5R110W has a single high side switch that provides power to all 7 Variable Force Solenoids (5 shift solenoids, TCC, and EPC). The high side switch has circuit diagnostics, and if failed open a fault code will be stored.

High Side Switch:	
DTCs	P0657 Actuator Supply Voltage A Circuit / Open
Monitor execution	Continuous
Monitor Sequence	none
Monitoring Duration	Electrical: 5 seconds
CAN Communication:	
DTCs	U0100 Loss of communication with the ECM over CAN link
Monitor execution	Continuous
Monitor Sequence	none
Monitoring Duration	5 Seconds

Typical CAN Communication entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	18.0 Volts
Engine running	> 500 rpm	
Module initialization time delay from startup	7 seconds	

Typical CAN Communication thresholds:
Loss of CAN communication between TCM and ECM > 30 seconds

Transmission Control Module Function:	
DTCs	KAM - P0603 (Internal Control Module KAM Error) P1633 (KAM Voltage to Low) RAM - P0604 (Internal Control Module RAM Error) ROM - P0605 (Internal Control Module ROM Error) CPU - P0607 (Control Module Performance)
Monitor execution	continuous
Monitor Sequence	None
Monitoring Duration	< 5 seconds > 20 seconds for KAM low voltage test

Typical TCM Function entry conditions:		
Entry Conditions	Minimum	Maximum
Battery Voltage	11.0 Volts	18.0 Volts

5R110W (RWD) Transmission

Transmission Inputs

Transmission Range Sensor

The Non-contacting Pulse Width Modulated Transmission Range Sensor (TRS) provides a duty cycle signal for each position. This signal is transmitted at a frequency of 125 Hz. The PCM decodes the duty cycle to determine the driver-selected gear position (Park, Rev, Neutral, OD, 3, 2, 1). This input device is checked for out of range frequency, low duty cycle and high duty cycle input signals. (P0706, P0707, P0708)

Speed Sensors

The Turbine Shaft Speed (TSS) sensor, Intermediate Shaft Speed (ISS) sensor and Output Shaft Speed (OSS) sensor, if equipped, are hall effect inputs that are checked for rationality. The vehicle speed signal is provided from the ABS system to the PCM. If the engine rpm is above the torque converter stall speed and engine load is high, it can be inferred that the vehicle must be moving. If there is insufficient output from the VSS sensor, a malfunction is indicated (P0500). If there is insufficient output from the TSS sensor, a malfunction is indicated (P0715). If there is insufficient output from the ISS sensor, a malfunction is indicated (P0791). If there is insufficient output from the OSS sensor, a malfunction is indicated (P0720).

Transmission Fluid Temperature

The transmission fluid temperature sensor is checked for circuit continuity (P0712, P0173) and for being stuck (P0711)

Transmission Outputs

Shift Solenoids

The Shift Solenoid (SSA, SSB, SSC, SSD, and SSE) output circuits are checked for opens and shorts by the PCM by monitoring the status of a feedback circuit from the output driver. SSA (P0750, P0973, P0974), SSB (P0755, P0976, P0977), SSC (P0760, p0979, P0980), SSD (P0765, P0982, P0983), SSE (P0770, P0985, P0986) each have fault codes for open circuit, short to ground, and short to power malfunctions.

The shift solenoids will be tested for function as part of the clutch system the solenoid controls. This is determined by vehicle inputs such as gear command and gear ratio. Clutch system malfunction codes:

Coast Clutch (controlled by SSA)	P2700 Transmission Friction Element A apply time range/performance.
	P0751 Shift Solenoid A Performance or Stuck Off
	P0752 Shift Solenoid A Stuck On
Over Drive Clutch (SSB)	P2701 Transmission Friction Element B apply time range/performance.
	P0756 Shift Solenoid B Performance or Stuck Off
	P0757 Shift Solenoid B Stuck On
Intermediate Clutch (SSC)	P2702 Transmission Friction Element C apply time range/performance.
	P0751 Shift Solenoid C Performance or Stuck Off
	P0752 Shift Solenoid C Stuck On

Direct Clutch (SSD)	P2703 Transmission Friction Element D apply time range/performance.
	P0766 Shift Solenoid D Performance or Stuck Off
	P0767 Shift Solenoid D Stuck On
Low/Reverse Clutch (SSE)	P2704 Transmission Friction Element E apply time range/performance.
	P0771 Shift Solenoid E Performance or Stuck Off
	P0772 Shift Solenoid E Stuck On

Gears are enabled/disabled based on clutch faults. Example: if the OD clutch is failed off, all gears requiring the ODC to be on are disabled (2^{nd}, 4^{th}, and 6^{th} gear). If the OD clutch is failed on, only gears with the ODC on are commanded (only 2^{nd}, 4^{th}, or 6^{th} gear will be commanded, 1^{st}, 3^{rd}, and 5^{th} will be disabled).

Torque Converter Clutch

The Torque Converter Clutch (TCC) Solenoid for 5R110W is a Variable Force Solenoid (VFS) that is tested electrically by a PCM output driver that has the capability to detect and distinguish opens (P0740), shorts to ground (P0742), and shorts to power (P0744).

The TCC solenoid is checked functionally by evaluating torque converter slip under steady state conditions when the torque converter is fully applied. If the slip exceeds the malfunction thresholds when the TCC is commanded on, a TCC malfunction is indicated (P0741).

Electronic Pressure Control

The EPC solenoid is a variable force solenoid that controls line pressure in the transmission. The EPC solenoid has a feedback circuit in the PCM that monitors EPC current. If a EPC short to ground is detected (minimum pressure) a high side switch will be opened, causing all solenoids to lose power. This will result in Park, Reverse, Neutral, and 5M (direct drive with engine braking) as the only forward gear. For Open or short to power faults (maximum line pressure) no gears are disabled; but engine idle is raised (to prevent line pressure instability since at low rpm the pump can't meet the maximum pressure demand caused by these faults).

High Side Switch

The high side switch provides power to all 7 solenoids. During certain failure modes the high side switch is opened, providing Park, Reverse, Neutral, and 5M.

CAN Communication Error

TCM CAN communication with the ECM is monitored. If the TCM is unable to communicate with the ECM a U0100 fault code will be stored and the TCM high side electrical drivers will be commanded off, resulting in the transmission allowing only park, reverse, neutral and 5M.

Transmission Control Module (TCM) Function

The 5R110W TCM (Transmission Control Module) is tested for KAM errors - P0603 (Internal Control Module KAM Error) and P1633 (KAM Voltage to Low), RAM errors - P0604 (Internal Control Module RAM Error), ROM errors - P0605 (Internal Control Module ROM Error), and CPU function - P0607 (Control Module Performance).

KAM is tested for both KAM memory location integrity and for voltage supply. RAM is tested for read/write errors using time based and accumulated counters. ROM is tested using a checksum computation routine and comparing the resulting value with a checksum value generated from the calibration release tools. There are several checks for CPU function such as watchdog, machine check and other hardware and software failures. These CPU tests use time based and accumulated counters.

2012 MY OBD System Operation

Summary for 6.7L Diesel Engines

Table of Contents

Introduction – OBD-II and EMD 4
OBD-II Systems 4
EMD Systems 4
General Description 6.7L Diesel Engine 7
System Schematic 6.7L Chassis Certified 8
NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITOR 12
Diesel Oxidation Catalyst Efficiency Monitor 12
Diesel Oxidation Catalyst DPF Regeneration Assistance Monitor 13
Diesel Oxidation Catalyst SCR Assistance Monitor 13
OXIDES OF NITROGREN (NOx) CONVERTING CATALYST MONITORING 13
Selective Catalyst Reduction Catalyst Efficiency Monitor 13
Selective Catalyst Reduction Feedback Control Monitors 14
Selective Catalyst Reduction Tank Level 16
MISFIRE MONITOR 17
Misfire System Overview 17
Misfire Algorithm Processing 17
FUEL SYSTEM MONITOR 19
Fuel System Overview 19
Fuel Rail Pressure Sensor Circuit Check 19
Fuel Rail Pressure Sensor Range Check: 20
Injector Code Missing/Invalid: 25
Fuel system pressure control: 25
Fuel Rail Pressure Monitors: 25
Injection Timing / Injection quantity 26
Zero Fuel Calibration: 26
Feedback control: 28
EXHAUST GAS SENSOR MONITOR 32
Air-Fuel Ratio Sensors: Tailpipe NOx and O2 Sensor Control Module 32

EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITOR 37
EGR Rate System Monitor 37
EGR Cooler / EGR Cooler Bypass Monitor 38
EGR System Slow Response 41
EGR Closed-loop Control Limits Monitor 41
Mass Airflow Closed-loop Control Limits Monitor 42
BOOST PRESSURE CONTROL SYSTEM MONITORING 44
Intrusive Turbo Position and Response Monitoring 44
Intrusive Wastegate Monitoring 46
Functional Overboost Monitoring 47
Functional Underboost Monitoring 47
Threshold Underboost Monitoring 48
Charge Air Cooler Monitoring 50
PARTICULATE MATTER (PM) FILTER MONITORING 51
DPF Filter Efficiency and Missing Substrate Monitors 51
DPF Frequent Regeneration Monitor 52
DPF Incomplete Regeneration Monitor 53
DPF Feedback Control Monitors 54
DPF Restriction Monitor 55
ENGINE COOLING SYSTEM MONITORING 56
Thermostat Monitor 56
Primary Coolant Temp Dynamic Monitoring 59
Secondary Coolant Temp Dynamic Monitoring 60
COLD START EMISSION REDUCTION STRATEGY MONITORING 61
Cold Start Emission Reduction System Monitor 61
Cold Start Emission Reduction Component Monitor 62
Engine Sensors 65
Air Temperature Rationality Test 65
Barometric Pressure and Manifold Absolute Pressure 74
Turbine Upstream Pressure Sensor Plausibility Checks 76
Upstream Turbine Pressure Sensor Signal Range Check 77
EGR Valve Position Sensor 78
Throttle Position Sensor 78
EGR Downstream Temperature Sensor Dynamic Plausibility Check 79
Engine Coolant & Engine Oil Correlation 80
Cam and Crank Sensor: 84
Mass Air Meter 86
MAF Rationality Check 87
DEF Pressure Sensor 90

Reductant Pressure Sensor Signal Range Check....91
Reductant Pressure Plausibility Check before Start-up....91
DEF Pressure Build-up Check at Start-up....92
DEF System Pressure Control....93
Reductant Tank Level Sensor....94
Reductant Tank Level Sensor Circuit Checks....95
Reductant Tank Level Sensor Plausibility Check....96
Reductant Tank Temperature Sensor....96
Exhaust Gas Temperature Sensor Rationality Test....98
Diesel Particulate Filter Pressure Sensor Rationality Test....101
Diesel Particulate Filter Pressure Offset Test....102
Engine Outputs....103
EGR Valve Actuator Signal Range Check....103
EGR Valve Actuator Jammed Detection....104
Throttle Valve Actuator Signal Range Check....105
Throttle Valve Actuator Jammed Detection....106
ECB Valve Actuator Signal Range Check....107
Urea System Pressure Control....107
Reductant Pump Motor....109
Reductant Dosing Valve (Injector)....112
Reverting Valve....115
Urea Heaters....117
Lack of Communication Codes:....124
Glow Plugs....126
Turbocharger Actuator Signal Range Check....131
Wastegate Vacuum Solenoid Signal Range Check....131
Miscellaneous ECU Errors:....132
Comprehensive Component Monitor - Transmission....132
Transmission Inputs....132
Transmission Outputs....135
6R140 (RWD) Transmission with external PCM or TCM....141
On Board Diagnostic Executive....144
Exponentially Weighted Moving Average....145
I/M Readiness Code....146
Serial Data Link MIL Illumination....146
Calculated Load Value....147
I/M Readiness....147
In-Use Monitor Performance Ratio....148
Mode$06 Results....149

Introduction – OBD-II and EMD

OBD-II Systems

California OBD-II applies to all California and "Green State" gasoline engine vehicles up to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) starting in the 1996 MY and all diesel engine vehicles up to 14,000 lbs. GVWR starting in the 1997 MY.

"Green States" are states that have adopted California emission regulations, starting in the 1998 MY. Green States receive California vehicles for all light duty passenger cars and trucks. Green States are Massachusetts, New York, Vermont for 2000, Maine for 2001, Rhode Island, Connecticut, Pennsylvania for 2008, New Jersey, Washington, Oregon for 2009, Maryland, New Mexico for 2011, Arizona for 2012, and Florida for 2013.

Federal OBD-II applies to all gasoline engine vehicles up to 8,500 lbs. GVWR starting in the 1996 MY and all diesel engine vehicles up to 8,500 lbs. GVWR starting in the 1997 MY.

Starting in the 2004 MY, Federal vehicle over 8,500 lbs. are required to phase in OBD-II. Starting in 2004 MY, gasoline-fueled Medium Duty Passenger Vehicles (MDPVs) are required to have OBD-II. By the 2006 MY, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD-II.

OBD-II system implementation and operation is described in the remainder of this document.

EMD Systems

:

Engine Manufacturer Diagnostics (EMD) – Heavyduty vehicles (>14,000) certified to EMD under title 13, CCR section 1971 (e.g., 2007-2009 model year diesel and gasoline engines)

Engine Manufacturer Diagnostics (EMD) applies to all 2007 MY and beyond California gasoline-fueled and diesel fueled on-road heavy duty engines used in vehicles over 14,000 lbs Gross Vehicle Weight Rating (GVWR). EMD systems are required to functionally monitor the fuel delivery system, exhaust gas recirculation system, particulate matter trap, as well as emission related ECM input inputs for circuit continuity and rationality, and emission-related outputs for circuit continuity and functionality. For gasoline engines, which have no PM trap, EMD requirements are very similar to current OBD-I system requirements. As such, OBD-I system philosophy will be employed, the only change being the addition of some comprehensive component monitor (CCM) rationality and functionality checks.

Engine Manufacturer Diagnostics Enhanced (EMD+) - Heavy-duty engines (>14,000) certified to EMD+ under title 13, CCR section 1971.1 (e.g., 2010-2012 model year diesel and gasoline engines not certified to HD OBD, 2013-2019 model year alternate fuel engines)

Starting in the 2010 MY, EMD was updated to require functional monitoring of the NOx aftertreatment system on gasoline engines. This requirement is commonly known as EMD+.

EMD+ vehicles use that same PCM, CAN serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD-II vehicle. The only difference is the possible removal of the fuel tank pressure sensor, canister vent solenoid, and a different PCM calibration.

The following list indicates what monitors and functions have been altered from OBD-II for EMD calibrations:

Monitor / Feature	Calibration
NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITOR	
Diesel Oxidation Catalyst Efficiency Monitor	Same as OBD-II but does not set the MIL.
Diesel Oxidation Catalyst DPF Regeneration Assistance Monitor	Same as OBD-II.
Diesel Oxidation Catalyst SCR Assistance Monitor	Same as OBD-II
OXIDES OF NITROGREN (NOx) CONVERTING CATALYST MONITORING	
Selective Catalyst Reduction Catalyst Efficiency Monitor	Same as OBD-II.
Selective Catalyst Reduction Feedback Control Monitors	Same as OBD-II.
Selective Catalyst Reduction Tank Level	Same as OBD-II.
Misfire Monitor	Same as OBD-II but does not set the MIL.
FUEL SYSTEM MONITOR	
Fuel Rail Pressure Sensor Circuit Check	Same as OBD-II
Fuel Rail Pressure Sensor Range Check:	Same as OBD-II
Injector Code Missing/Invalid:	Same as OBD-II
Fuel system pressure control:	Same as OBD-II
Fuel Rail Pressure Monitors:	Same as OBD-II
Injection Timing / Injection quantity Zero Fuel Calibration:	Same as OBD-II
Feedback control:	Disabled
EXHAUST GAS SENSOR MONITOR Air-Fuel Ratio Sensors: Tailpipe NOx and O2 Sensor Control Module	Same as OBD-II
EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITOR	
EGR Rate System Monitor	Increased threshold from OBD-II
EGR Cooler / EGR Cooler Bypass Monitor	Same as OBD-II but does not set MIL.
EGR System Slow Response	Disabled
EGR Closed-loop Control Limits Monitor	Disabled
Mass Airflow Closed-loop Control Limits Monitor	Disabled

BOOST PRESSURE CONTROL SYSTEM MONITORING	
Intrusive Turbo Position and Response Monitoring	Same as OBD-II
Intrusive Wastegate Monitoring	Same as OBD-II
Functional Overboost Monitoring	Same as OBD-II
Functional Underboost Monitoring	Same as OBD-II
Threshold Underboost Monitoring	Same as OBD-II but with Increased Thresholds.
Charge Air Cooler Monitoring	Same as OBD-II
PARTICULATE MATTER (PM) FILTER MONITORING	
DPF Filter Efficiency and Missing Substrate Monitors	Same as OBD-II
DPF Frequent Regeneration Monitor	Disabled
DPF Incomplete Regeneration Monitor	Disabled
DPF Feedback Control Monitors	Disabled
DPF Restriction Monitor	Same as OBD-II
Crank Case Ventilation	Same as OBD-II but does not set the MIL.
Cold Start Emission Red Monitor	Same as OBD-II, However, since the dynamometer certified P473 vehicles do no utilize a cold start strategy it is disabled.
Comprehensive Component Monitor	All circuit checks for components supporting other EMD monitors, as well as those for some of the other components, are the same as OBD-II.
Glow Plug Resistance Monitor	Same as OBD-II but does not set the MIL.
Idle Fuel Monitor	Disabled
Idle Torque Monitor	Disabled
Communication Protocol and DLC	Utilizes CAN communication, same as OBD-II, all generic and enhanced scan tool modes work the same as OBD-II but reflect the EMD calibration that contains fewer supported monitors. "OBD Supported" PID indicates EMD.
MIL Control	Same as OBD-II

EMD system implementation and operation is a subset of OBD-II and is described in the remainder of this document.

General Description 6.7L Diesel Engine

The 6.7L is a V8 engine designed to meet customer expectations of high horsepower and torque with exceptional fuel economy and low NVH. It must do this while meeting the tough emissions standards set by the EPA and CARB.

Some of the technologies employed to meet these diverse criteria include a Variable Geometry Turbocharger (VGT), common rail fuel injection system, electronically controlled, cooled EGR, a diesel oxidation catalyst (DOC) , Selective Catalytic Reduction catalyst (SCR), Diesel Exhaust Fluid (DEF) injection system, and a diesel particulate filter (DPF).

The system schematic on the next page shows the path of the air as it is compressed by the turbocharger, cooled by the air-to-coolant intercooler, and mixed with the cooled EGR gases. The state of this compressed and heated air is sensed by the manifold absolute pressure (MAP) sensor just before it enters the cylinders and the two temperature sensors that represent Charge Air Cooler Outlet temperature (CACT1) and EGR Cooler outlet temperature (EGRCOT). The exhaust gas pressure is measured by the exhaust backpressure (EP) sensor before it exits through the turbocharger. The exhaust after treatment system consists of a DOC, a SCR, a DPF and a muffler.

An electronic, proportional valve controls EGR rates with an integral position sensor (EGRP). Flows are determined by valve position and the amount that backpressure exceeds boost pressure. An EGR throttle (EGRTP) is used for regeneration control as well as to optimize the boost pressure vs. backpressure levels.

Fuel injection pressure is measured by the high-pressure fuel rail sensor (FRP). Injection pressure is controlled by the high pressure pump and two regulating valves, a Pressure Control Valve (PCV), and a Fuel Metering Unit (MeUn), formerly known as Volume Control Valve (VCV).

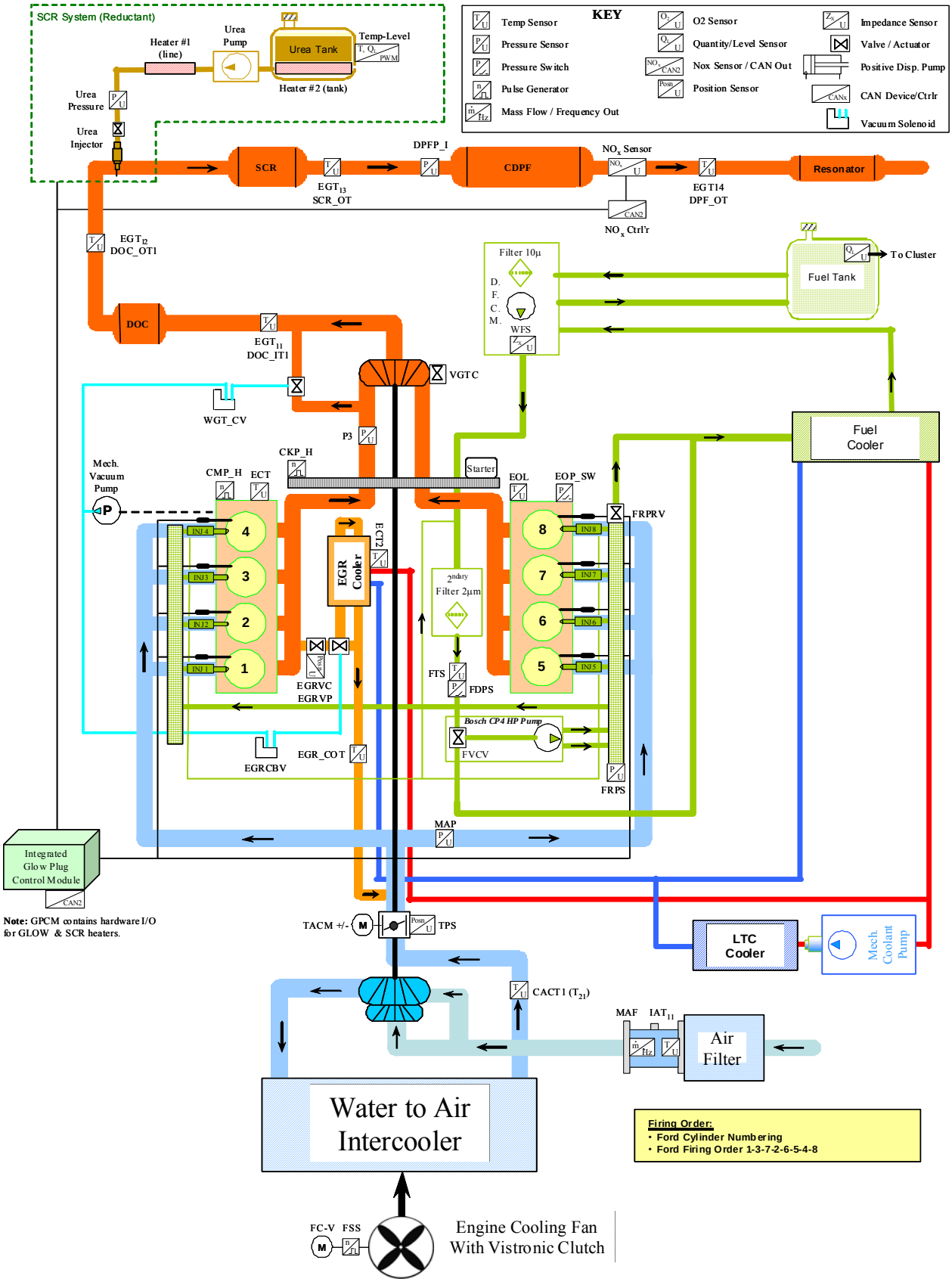
Engine speed (N) and crankshaft position are determined by the crankshaft position sensor (CKP) which senses a 60 minus 2 tooth target wheel. Camshaft position is determined by the camshaft position sensor (CMP), which senses the profile of a multiple lobed camshaft.

Atmospheric pressure is determined by the Barometric Pressure sensor (BARO) mounted internally in the Engine Control Module (ECM).

During engine operation, the ECM calculates engine speed from the crankshaft position sensor. The ECM controls engine operation by controlling the piezo injector opening and closing times as well as the pressure at which the fuel is injected, thereby controlling fuel quantity and timing. Simultaneously, airflow is modulated by controlling the turbocharger vane position.

Fuel quantity is controlled by injector “on time” (pulse width) and the fuel rail pressure. Desired engine speed is determined from the position of the accelerator pedal.

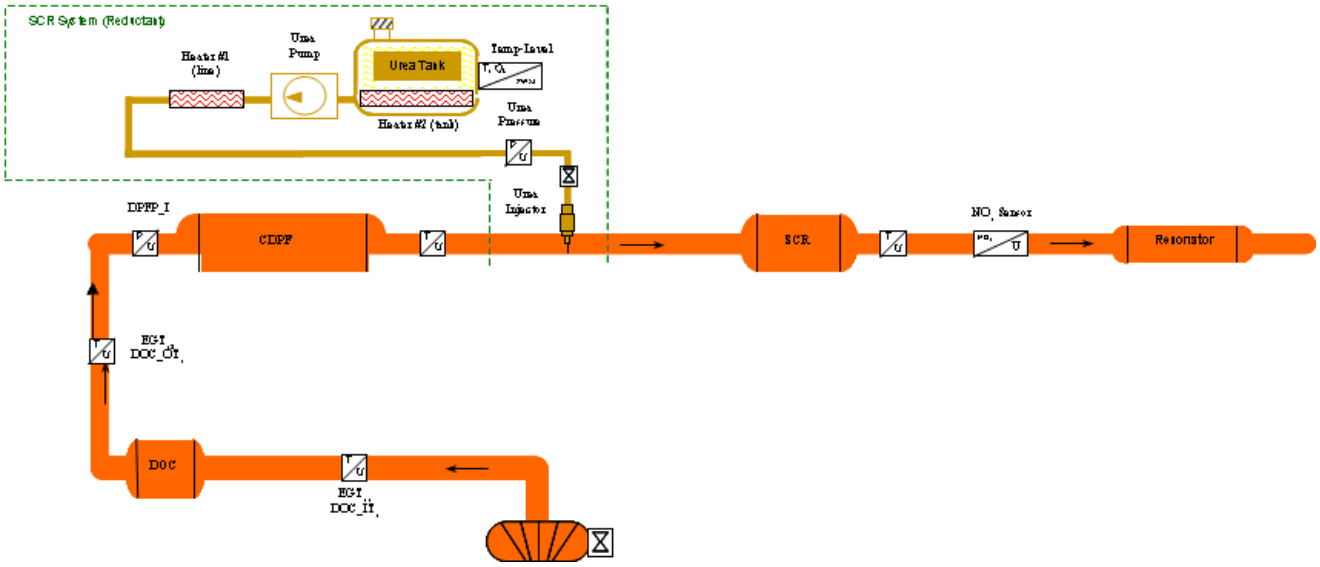
System Schematic 6.7L Chassis Certified



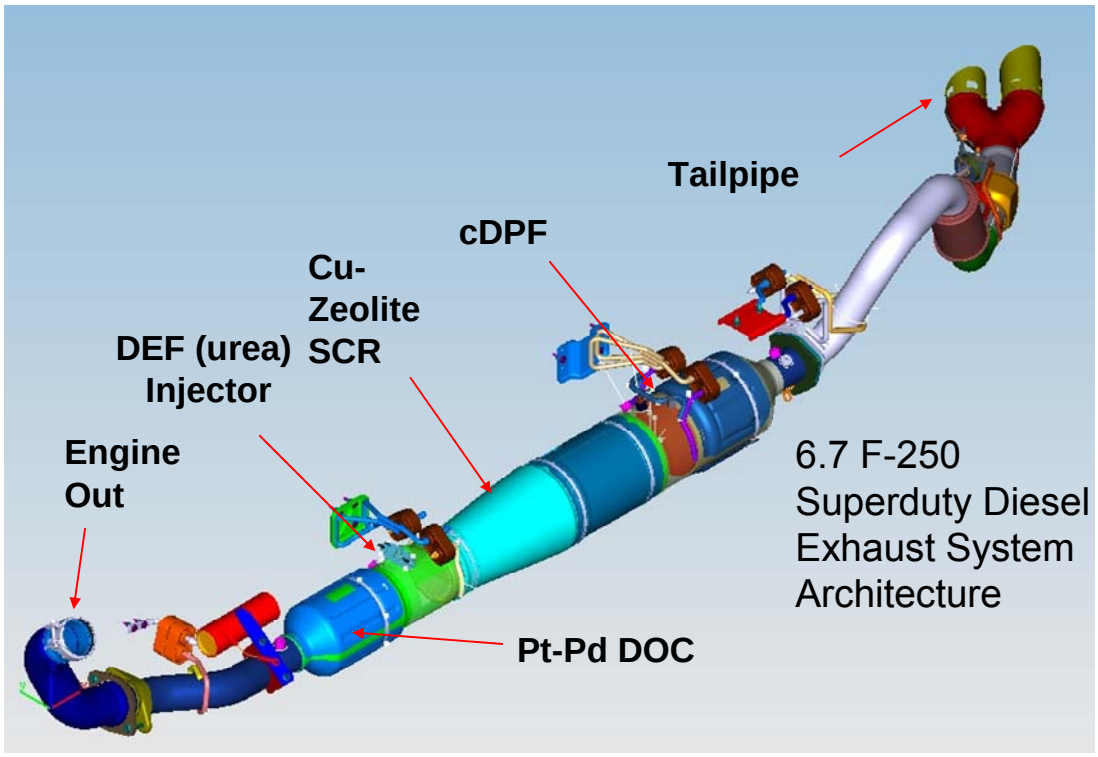
Actuators	Acronym	Sensors	Acronym
DEF (Reductant) System			
DEF Pump		DEF Temp-Level Combination Sensor	
DEF Tank Heater	Heater #1	DEF Pressure Sensor	
DEF Pump & Line Heater	Heater #2		
DEF Injector			
NOx Sensor System			
NOx Sensor Controller		NOx Sensor	
Boost System			
Variable Geometry Turbo Control	VGTC	Manifold Pressure Sensor	MAP
Turbocharger Wastegate Vacuum Control Solenoid	WGT_CV	Charge Air Cooler Temperature at Outlet	CACT1
		Mass Airflow Sensor	MAF
		Intake Air Temperature	IAT11
		Exhaust Back Pressure	EBP or P3
Exhaust Gas Recirculation System			
Exhaust Gas Recirculation Valve Control	EGRVC	Exhaust Gas Recirculation Valve Position	EGRVP
Exhaust Gas Recirculation Cooler Bypass Vacuum Control Solenoid	EGRCBV	Exhaust Gas Recirculation Cooler Gas Temperature at Outlet	EGR_COT
EGR Throttle Motor Control	TACM	EGR Throttle Position Sensor	TPS
Fuel System			
High Pressure Fuel Volume Control Valve	FVCV	High Pressure Fuel Rail Pressure Sensor	FRPS
High Pressure Fuel Pressure Relief Valve	FRPRV	Low Pressure Fuel Delivery Switch	FDPS
Fuel Injectors	INJ 1-8	Low Pressure Fuel Temperature Sensor	FTS
Low Pressure Fuel Pump and Filters	DFCM		
Water In Fuel Sensor	WFS		
Fuel Tank Level Sensor			
Glow Plug System			
Glow Plugs			
Glow Plug Controller	GPCM		
Exhaust System			
		Diesel Oxidation Inlet Temperature	DOC_IT or EGT11
		Diesel Oxidation Outlet Temperature	DOC_OT or EGT12
		Selective Catalytic Reduction Outlet Temperature	SCR_OT or EGT 13
		Upstream Catalyzed Diesel Particulate Filter Pressure	DPFP
		Downstream Diesel Particulate Filter Temperature	DPF_OT or EGT 14
Engine System			
Electric Clutch Fan Controller	FC-V	Cam Shaft Position Sensor	CMP
		Engine Coolant Temperature	ECT
		Crank Shaft Position Sensor	CKP
		Engine Oil Temperature	EOT
		Engine Oil Pressure Switch	EOP_SW
		Low Temperature Coolant Loop Temperature	ECT2
		Engine Fan Speed Sensor	FSS
		Environmental Temperature Sensor	ENV_T
		Barometric Pressure Sensor	BP

The dynamometer certified application of the 6.7L diesel engine has a similar layout to the chassis certified version. The main differences are the use of a single compressor stage on the boost system, lack of a wastegate, and a change in the order of the aftertreatment systems.

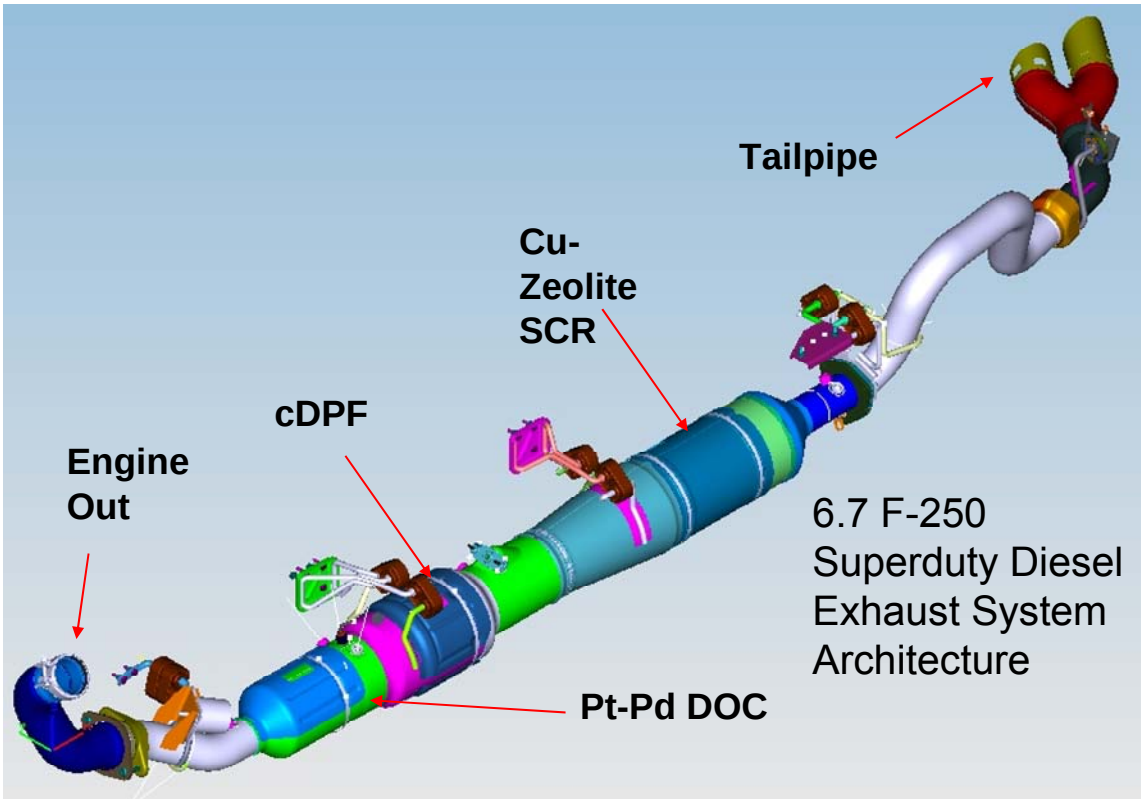
Dynamometer certified 6.7L exhaust system layout.



2011 MY 6.7L V8 Diesel Exhaust Features, Medium Duty, Chassis Cert



2011 MY 6.7L V8 Diesel Exhaust Features, Medium Duty, Dyno Cert



NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITOR

Diesel Oxidation Catalyst Efficiency Monitor

The Diesel Oxidation Catalyst (DOC) is monitored to ensure it is capable of converting hydrocarbons and carbon monoxide. The monitor is only run during aftertreatment regeneration events. After entering regen, there is a short delay to allow the DOC to achieve light-off temperature. Then the exotherm is monitored for a short period of time and normalized versus an expected exotherm (a function of post-injection fuel quantity and ambient air temp). The exotherm is defined as the DOC outlet temperature (EGT12) minus the DOC inlet temperature (EGT11). The normalized exotherm is filtered for a short period of time, and then compared to a threshold. If the normalized exotherm is below the threshold, a fault is indicated. No other preconditioning is required.

DOC Efficiency Monitor Summary:	
DTCs	P0420 – Catalyst System Efficiency Below Threshold
Monitor execution	Once per driving cycle during which an active DPF regeneration occurs
Monitor Sequence	None
Sensors OK	EGT11, EGT12, TCO, MAF, IAT
Monitoring Duration	4 minutes

Typical DOC Efficiency Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
DPF regeneration event		
Engine speed	1000 rpm	3000 rpm
Torque set point	100 Nm	1000 Nm
Engine coolant temperature	70 deg C	
DOC inlet temperature	200 deg C	500 deg C
PTO inactive		

Typical DOC Efficiency Monitor Malfunction Threshold:
Normalized exotherm is less than 40% of the expected exotherm for 60 seconds

Diesel Oxidation Catalyst DPF Regeneration Assistance Monitor

The DOC is monitored to ensure it is capable of generating a sufficient exotherm to allow DPF regeneration events by burning the soot which is stored in the Diesel Particulate Filter (DPF). This is accomplished with the same diagnostic described above for the DOC Catalyst Efficiency Monitor.

Diesel Oxidation Catalyst SCR Assistance Monitor

The DOC in this system is not utilized to provide any changes in the feedgas constituency that would aid in the proper SCR operation.

OXIDES OF NITROGREN (NOx) CONVERTING CATALYST MONITORING

Selective Catalyst Reduction Catalyst Efficiency Monitor

The SCR catalyst is monitored to ensure it is capable of NOx conversion. The concentration of NOx upstream of the SCR is calculated based on a model. NOx concentration downstream of the SCR is measured with a NOx sensor. Using these concentrations, the cumulative efficiency of the SCR catalyst is calculated and compared to a threshold. If the cumulative efficiency is below this threshold at the end of the sample period (approx 1 minute), a fault will be indicated.

The reductant, Diesel Exhaust Fluid (DEF), which is used as part of the SCR catalyst reaction, is monitored to ensure the tank is not refilled with an improper reductant. After the SCR Catalyst Efficiency Monitor has completed and the SCR has been determined to be functional, the efficiency monitor continues to calculate the cumulative efficiency of the system, with a calibrated wait time between iterations of the monitor. Successive values for cumulative efficiency are included in two filtering routines, one for short term efficiency and the other for long term efficiency. If the difference between the two filtered efficiencies becomes greater than a threshold, a fault is indicated. The short term efficiency needs to be less than 0.25 and the delta between short and long term efficiency needs to be greater than 0.10.

Monitor Summary:	
DTCs	P20EE – SCR NOx Catalyst Efficiency Below Threshold P207F – Reductant Quality Performance
Monitor execution	P20EE - Once per driving cycle P207F – Continuously (while entry conditions are met)
Monitor Sequence	P20EE test followed by P207F test
Sensors OK	NOx, EGT12, EGT13, ECT, DEF injection system, MAF, BP, O2, DPFP, EGR system
Monitoring Duration	P20EE – 2 Minutes, P207F – Dependent on driving conditions and DEF dilution

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
SCR Feedback Control Enabled		
TP NOx sensor lit off and valid		
Regeneration Cycle Not Requested		
Engine coolant temperature	70 deg C	
Ambient air temperature	-6.7 degC	
Barometric Pressure	81.2 kPa	120 kPa
Engine Speed	1000 rpm	3000 rpm
Torque Transients	-30 N-m/s,	+10 N-m/s
Exhaust Space Velocity	5000	120,000
SCR Inlet temp	180 degC	320 degC
Filtered rate of change of SCR inlet temp		30 seconds
Feedgas NOx	75	800
DEF storage	40% understored	10% overstored
Delay between iterations of monitor (for DEF Quality monitor)	1400 sec	
Short term efficiency (DEF Quality monitor)		0.25
Short term to long term efficiency delta (DEF Quality monitor)	0.1	

Typical Malfunction Thresholds:
P20EE: If the cumulative efficiency of the SCR Catalyst is less than 35% for approx 60 seconds., a fault is indicated. P207F: the short term Nox efficiency needs to be less than 0.25 and the delta between short and long term efficiency needs to be greater than 0.10. The fault will generally be detected within 1 hour under most conditions.

Selective Catalyst Reduction Feedback Control Monitors

The SCR system is monitored to ensure the proper closed loop control of the reductant injection. As part of the reductant injection control, a correction factor is adapted to account for long term drift of the system (injector, etc). This correction factor is monitored continuously. If the correction factor reaches a threshold in the positive or negative direction for a sufficient period of time, a fault will be indicated.

A SCR Time to Closed Loop monitor is implemented to ensure that SCR feedback occurs when expected. Once entry conditions are met, a timer is incremented. If the fraction of time in closed loop control is less than a threshold, a fault is indicated.

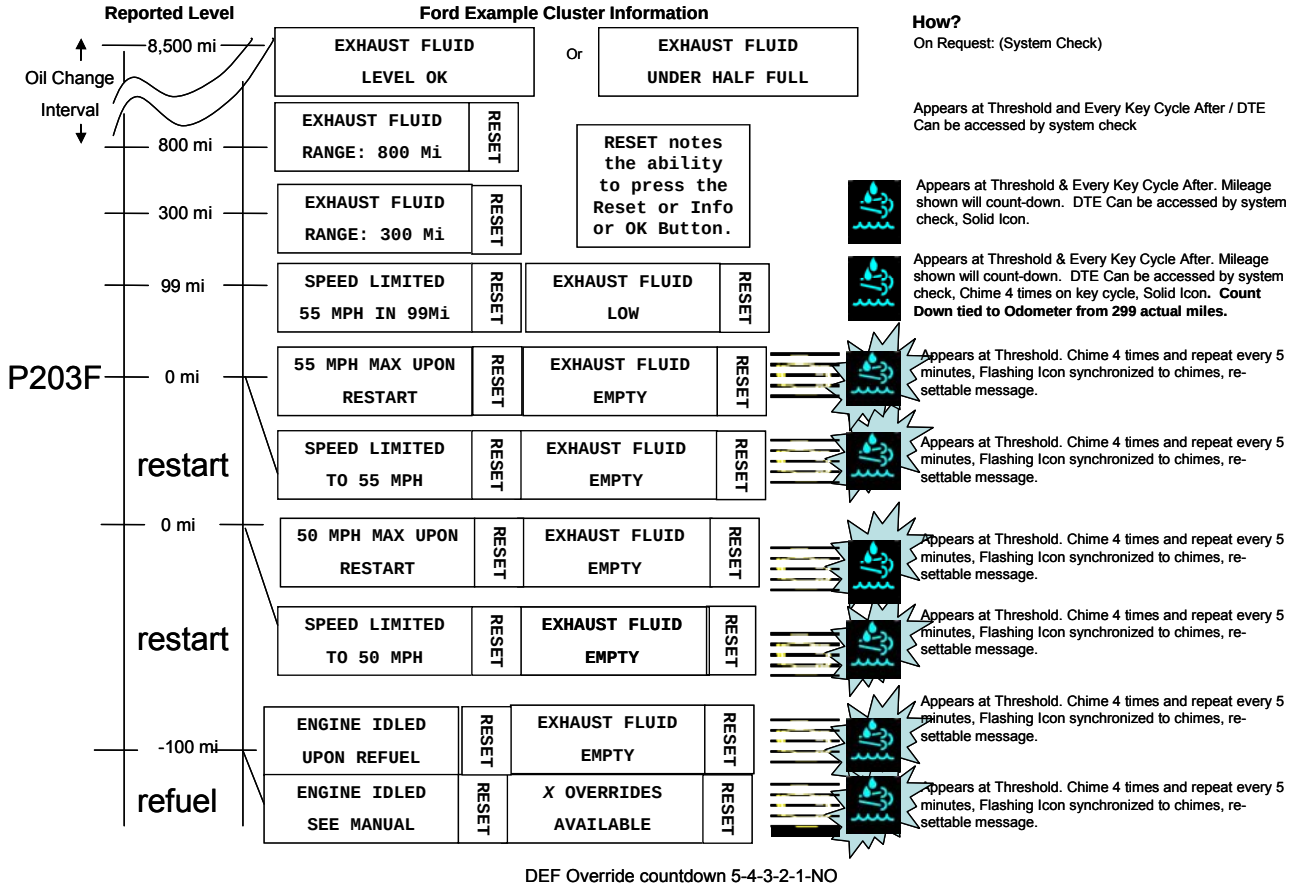
Monitor Summary:	
DTCs	P249D – SCR Feedback at Minimum Limit P249E – SCR Feedback at Maximum Limit P249C – SCR Time to Closed Loop
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	NOx, EGT12, EGT13,TCO, EGT11 EGT14, MAF, BP, IAT, DPFP, and EGR system
Monitoring Duration	5 minutes

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Low Temp Adaptation is enabled (Feedback monitor only)		
Engine speed	800 rpm	3000 rpm
Torque set point	0 Nm	1000 Nm
Barometric pressure	75 kPa	
Ambient temperature	-6.7 deg C	
Engine coolant temperature	70 deg C	
SCR temperature	160 deg C	550 deg C

Typical Malfunction Thresholds:
P249D: If the correction factor is clipped at its minimum value for 30 seconds then a fault is indicated. P249E: If the correction factor is clipped at its maximum value for 30 seconds then a fault is indicated. P249C: The error is set as soon as the fraction of closed loop operation vs expected is less than the threshold. The monitor needs to run for 300 seconds to call it complete.

Selective Catalyst Reduction Tank Level

The SCR system is monitored to ensure the level of DEF in the reductant tank is sufficient to achieve system performance. As part of the DEF level customer warning system, a fault will be recorded when the calculated mileage remaining of DEF is equal to 200 miles (The discrepancy between actual and reported mileage is due to expected tolerance of calculations). The calculated mileage remaining is derived from the three pin level sensor in the tank and the volume of DEF commanded to be injected over distance. This fault will be erased once the system senses a DEF refill event.



DEF Override countdown 5-4-3-2-1-NO

Monitor Summary:	
DTCs	P203F - Reductant Level Too Low
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	DEF Temp-Level Combination Sensor

MISFIRE MONITOR

Misfire System Overview

The 6.7L Diesel engine utilizes a Hall Effect sensor (CKP) that processes the edges of a 60-2 tooth stamped target wheel mounted on the crankshaft. The software gets an edge every 3 degrees and these edges are used for fuel injection timing, fuel quantity control, and the calculation of engine speed. A software algorithm corrects for irregularities of the teeth of the target wheel to improve crankshaft signal resolution. A second Hall effect sensor is used to processes the edges of the three-lobed camshaft (CMP) target. The CMP signal and the window of 2 missing teeth on the crankshaft target wheel indicate proper camshaft to crankshaft position for correct cylinder timing.

Misfire Algorithm Processing

The Misfire Monitor divides two rotations of the crankshaft into 16 half-segments, each 45 degrees of crankshaft rotation. The crankshaft speed shows increases due to combustion of fuel in the cylinder followed by decreases due to friction and other forces between cylinder firing events. The location of the half-segments is chosen such that for each cylinder one half-segment contains the majority of the higher crankshaft speed values (the "high" half-segment) and the other half-segment the majority of the lower crankshaft speed values (the "low" half-segment). The range of crankshaft speed within each half-segment is averaged. The sum of the eight low half-segment speeds is subtracted from the sum of the eight high half-segment speeds and the result divided by eight to get an average increase in speed due to combustion. The Misfire Monitor then calculates the difference between the high and low half-segments for a specific cylinder combustion event and increments a misfire counter for the firing cylinder if this value is less than 20% of the average increase in speed due to combustion described above.

The Misfire Monitor collects blocks of data consisting of 20 crankshaft rotations. Upon achieving the correct entry conditions for the Misfire Monitor as described below, the first block of 20 rotations is discarded to ensure stable idle operation. All subsequent blocks of data are counted unless vehicle conditions change such that the entry conditions are no longer satisfied. In this case, any data in the current partial block are discarded, along with the data from the block immediately prior, as stable idle cannot be ensured for these data. The Misfire Monitor completes once 50 valid blocks (1000 crankshaft revolutions) have been collected, and a fault is reported if a cylinder shows 350 or more misfire events (out of 500 possible combustion events) in this time.

Certain engine operating parameters are monitored to ensure misfire operates in a region that yields accurate misfire results. The table below outlines the entry conditions required for executing the misfire monitor algorithm.

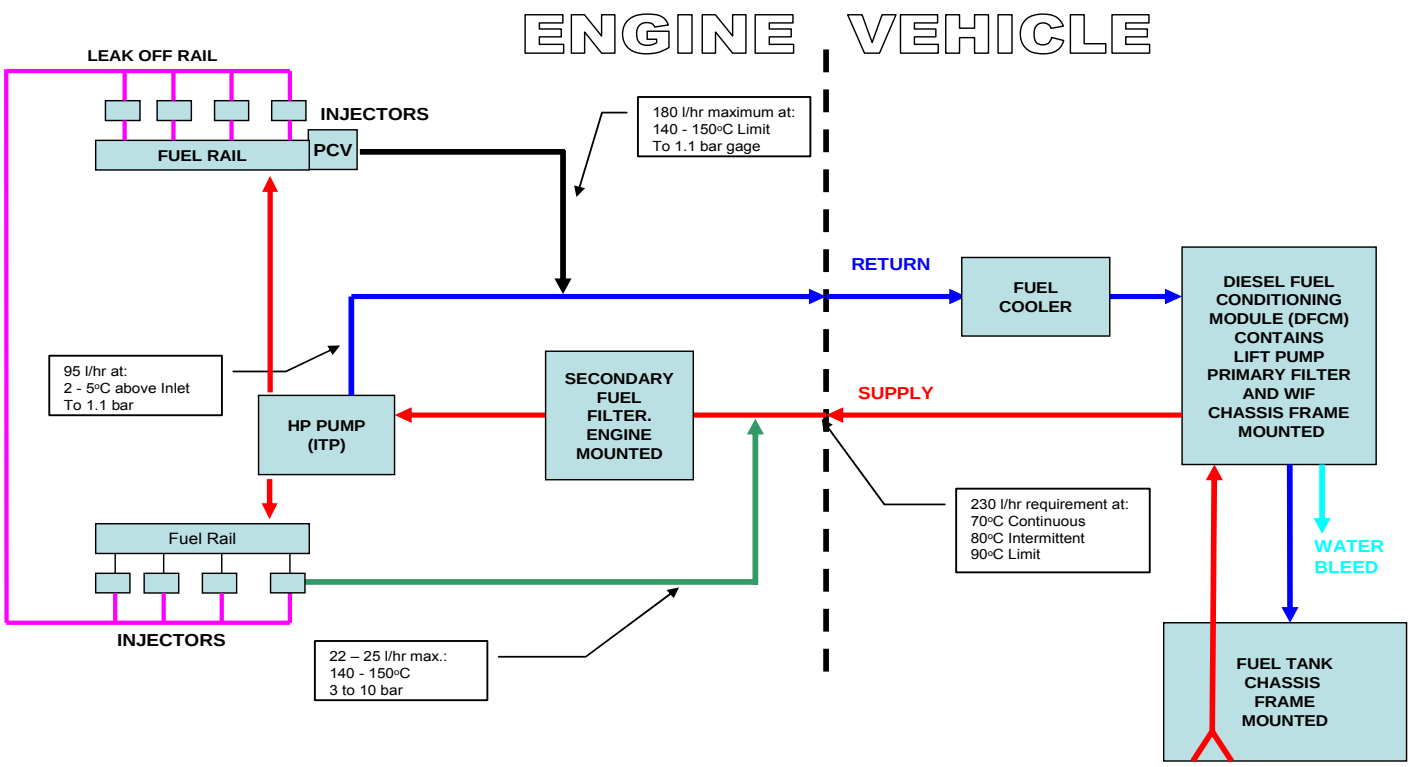
Misfire Monitor Operation:	
DTCs	P0300 – Random Misfire Detected P0301 – Cylinder 1 Misfire Detected P0302 – Cylinder 2 Misfire Detected P0303 – Cylinder 3 Misfire Detected P0304 – Cylinder 4 Misfire Detected P0305 – Cylinder 5 Misfire Detected P0306 – Cylinder 6 Misfire Detected P0307 – Cylinder 7 Misfire Detected P0308 – Cylinder 8 Misfire Detected
Monitor execution	Continuous, at idle
Monitor Sequence	None
Sensors OK	Engine Coolant Temperature (ECT), Vehicle Speed (VSS), Crankshaft Position Sensor (CKP) Injector Faults, Injector Bank Faults
Monitoring Duration	1000 revs

Typical Misfire Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Speed (Idle)	500 rpm	1150 rpm
Engine Coolant Temperature (ECT)	-7 deg C	
Vehicle Speed (VSS)		<= 2 km/hr
Total fuel mass	2.0 mg/stroke	40.0 mg/stroke

FUEL SYSTEM MONITOR

Fuel System Overview

Fuel injection pressure is measured by the high-pressure fuel rail sensor (FRP). Injection pressure is controlled by the high pressure pump and two regulating valves, a Pressure Control Valve (PCV), and a Fuel Metering Unit (MeUn), formerly known as Volume Control Valve (VCV).



Fuel Rail Pressure Sensor Circuit Check

Fuel Rail Pressure (FRP) Sensor Circuit Check:	
DTCs	P0192 - Fuel Rail Pressure Sensor A Circuit Low Input P0193 - Fuel Rail Pressure Sensor A Circuit High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Sensor Supply Voltage 1 OK (P06A6)
Typical Monitoring Duration	0.5 sec

Typical Fuel Rail Pressure Sensor Circuit Check Malfunction Thresholds:
FRP voltage < 0.13 V, or > 3.17 V

Fuel Rail Pressure (FRP) Rationality Check Operation:	
DTCs	P0191 - Fuel Rail Pressure Sensor "A" Circuit Range/Performance
Monitor Execution	Immediately Prior to Crank and After Key-off
Monitor Sequence	None
Sensors OK	Sensor Supply Voltage 1 OK (P06A6), FRP OK (P0192, P0193)
Typical Monitoring Duration	0.5 sec

Typical Fuel Rail Pressure Rationality Check Entry Conditions:		
Entry condition	Minimum	Maximum
Pre-crank: engine coolant temperature	-7 deg C	
Pre-crank: time engine off	600 sec	
After key-off: fuel temperature	-40 deg C	
After key-off: time since key off	12 sec	

Typical Fuel Rail Pressure Rationality Malfunction Thresholds:
FRP voltage < 0.251 V (-40 bar) or > 0.384 V (68 bar).

Fuel Rail Pressure Sensor Range Check:

When fuel rail pressure is controlled by the Pressure Control Valve, the Pressure Control Valve signal needed to maintain rail control is compared to an expected value. An adaptation factor for the Pressure Control Valve is calculated from the difference between observed and expected control values. Inaccuracy in the Rail Pressure Sensor Signal Slope is a potential cause of inaccuracy in the needed Pressure Control Valve signal along with physical errors in the PCV itself. If the adaptation factor required for the Pressure Control Valve exceeds a minimum or maximum control limit, then a code is set for rail pressure slope out of acceptable range.

Fuel Rail Pressure (FRP) Range Check Operation:	
DTCs	P016D - Excessive Time To Enter Closed Loop Fuel Pressure Control P228E - Fuel Pressure Regulator 1 Exceeded Learning Limits - Too Low P228F - Fuel Pressure Regulator 1 Exceeded Learning Limits - Too High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Sensor Supply Voltage 1 (P06A6), FRP (P0192, P0193)
Typical Monitoring Duration	P016D – 30 sec, P228E, P228F - 10 sec

Typical Fuel Rail Pressure Range Check Entry Conditions:		
Entry condition	Minimum	Maximum
P016D:		
Requested rail pressure	500 bar	1200 bar
Change in requested rail pressure		30 sec
Fuel temperature		40 deg C
P228E, P228F:		
Rail pressure set point	500 bar	1200 bar
Fuel Temperature		40 deg C
Time since engine start		30 sec

Typical Fuel Rail Pressure Range Check Malfunction Thresholds:

P016D: If the system is within the adaptation operating conditions, but fails to learn a new adaptation factor after 30 seconds, this DTC is set.

P228E, P228F: If the adaptation factor exceeds positive or negative thresholds which correspond to approximately a 20% deviation in the Rail Pressure Sensor slope, a DTC is set.

Fuel Temperature Sensor Circuit Check Operation:	
DTCs	P0181 – Fuel Temperature Sensor "A" Circuit Range/Performance P0182 – Fuel Temperature Sensor "A" Circuit Low P0183 – Fuel Temperature Sensor "A" Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	0.5 sec

Typical Fuel Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
P0181:		
Engine Off Time	8 hours	

Typical Fuel Temperature Sensor Circuit Check Malfunction Thresholds:

P0181: If after an 8 hour engine off soak, the difference in temperature between the fuel temperature sensor and the charge air cooler outlet temperature sensor exceeds 16 deg C or if the difference in temperature between the fuel temperature sensor and the charge air cooler outlet temperature sensor exceeds 13.2 deg C and no active block heater is detected, a DTC is set

FTS voltage < 0.0946 V (0.122.4 V = 150 deg C) or > 4.918 V (4.762 V = -40 deg C)

Volume Control Valve (VCV) Monitor Operation:	
DTCs	P0001 - Fuel Volume Regulator Control Circuit / Open P0002 - Fuel Volume Regulator Control Circuit Range/Performance P0003 - Fuel Volume Regulator Control Circuit Low P0004 - Fuel Volume Regulator Control Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	0.3 sec

Typical Volume Control Valve Monitor Malfunction Thresholds:
P0001 – If the volume control valve is not energized and the voltage from the volume control valve control chip is in the range 2.8 – 4.8 V (normal operation: electrical system voltage (~13.5V)
P0002 – Temperature of powerstage driver on ECM > 170 deg C
P0003 – If the volume control valve is not energized and the observed voltage from the volume control valve control chip is less than 2.8V (normal operation: electrical system voltage (~13.5V)
P0004 – If the volume control valve is energized and the current to the volume control valve exceeds 3.7A (normal operation: 2.2A maximum)

Fuel Pressure Control Valve (PCV) Monitor Operation:	
DTCs	P0089 - Fuel Pressure Regulator Performance P0090 - Fuel Pressure Regulator Control Circuit P0091 - Fuel Pressure Regulator Control Circuit Low P0092 - Fuel Pressure Regulator Control Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	0.3 sec

Typical Fuel Pressure Control Valve Monitor Malfunction Thresholds:
P0089 – Temperature of power stage driver on ECM is > 170 deg C
P0090 – The pressure control valve is not energized and the voltage from the pressure control valve control chip is in the range 2.8 – 4.8 V (normal operation: electrical system voltage (~13.5V)
P0091 – The pressure control valve is not energized and the voltage from the pressure control valve control chip is less than 2.8V (normal operation: electrical system voltage (~13.5V)
P0092 – The pressure control valve is energized and the observed current to the pressure control valve exceeds 5.1A (normal operation: 3.7A maximum)

Fuel Low Pressure Lift Pump Monitor Operation:	
DTCs	P0627 - Fuel Pump "A" Control Circuit / Open P0628 - Fuel Pump "A" Control Circuit Low P0629 - Fuel Pump "A" Control Circuit High P062A – Fuel Pump "A" Control Circuit Range/Performance
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	P0627, P0628, P0629 - 0.2 sec P062A – 0.5 sec

Typical Fuel Low Pressure Lift Pump Monitor Malfunction Thresholds:
P0627 – Lift pump NOT energized and the voltage from the lift pump control chip is between 2.8 – 4.8V (normal operation: electrical system voltage ~13.5V)
P0628 – Lift pump NOT energized and the voltage from the lift pump control chip is less than 2.8V (normal operation: electrical system voltage ~13.5V)
P0629 – Lift pump energized and the current to the lift pump exceeds 3.7A (normal operation: 2.2A maximum)
P062A – If the airbag deployment module sends a deployment signal and the fuel pump shows as energized via the fuel pump monitor signal or the status of the energizing request to the fuel pump and the monitoring signal from the fuel pump does not match

Fuel Injector Driver Circuit Monitor Operation:	
DTCs	P062D - Fuel Injector Driver Circuit Performance Bank 1 P062E - Fuel Injector Driver Circuit Performance Bank 2 P1291 - Injector High Side Short To GND Or VBATT (Bank 1) P1292 - Injector High Side Short To GND Or VBATT (Bank 2)
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	P062D, P062E – 0.5 seconds P1291, P1292 – 0.2 seconds

Typical Fuel Injector Driver Circuit Malfunction Thresholds:
P062D, P062E – Failure of injector driver of bank detected by IC Internal logic
P1291, P1292 – Short to ground or battery of bank detected by IC internal logic

Injection Circuits Monitor Operation:	
DTCs	P0201 - Injector Circuit / Open - Cylinder 1 P0202 - Injector Circuit / Open - Cylinder 2 P0203 - Injector Circuit / Open - Cylinder 3 P0204 - Injector Circuit / Open - Cylinder 4 P0205 - Injector Circuit / Open - Cylinder 5 P0206 - Injector Circuit / Open - Cylinder 6 P0207 - Injector Circuit / Open - Cylinder 7 P0208 - Injector Circuit / Open - Cylinder 8 P02EE – Cylinder 1 Injector Circuit Range/Performance P02EF – Cylinder 2 Injector Circuit Range/Performance P02F0 – Cylinder 3 Injector Circuit Range/Performance P02F1 – Cylinder 4 Injector Circuit Range/Performance P02F2 – Cylinder 5 Injector Circuit Range/Performance P02F3 – Cylinder 6 Injector Circuit Range/Performance P02F4 – Cylinder 7 Injector Circuit Range/Performance P02F5 – Cylinder 8 Injector Circuit Range/Performance P1201 – Cylinder #1 Injector Circuit Open/Shorted P1202 – Cylinder #2 Injector Circuit Open/Shorted P1203 – Cylinder #3 Injector Circuit Open/Shorted P1204 – Cylinder #4 Injector Circuit Open/Shorted P1205 – Cylinder #5 Injector Circuit Open/Shorted P1206 – Cylinder #6 Injector Circuit Open/Shorted P1207 – Cylinder #7 Injector Circuit Open/Shorted P1208 – Cylinder #8 Injector Circuit Open/Shorted P1261 – Cylinder #1 High To Low Side Short P1262 – Cylinder #2 High To Low Side Short P1263 – Cylinder #3 High To Low Side Short P1264 – Cylinder #4 High To Low Side Short P1265 – Cylinder #5 High To Low Side Short P1266 – Cylinder #6 High To Low Side Short P1267 – Cylinder #7 High To Low Side Short P1268 – Cylinder #8 High To Low Side Short
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	P0201 – P0208 – 0.3 seconds. P02EE – P2F5 – 0.3 seconds. P1201 – P1208 – 0.3 seconds. P1261 – P1268 – 0.3 seconds.

Typical Injection Circuits Malfunction Thresholds:
P0201 – P0208 – Injector open circuit detected by IC internal logic P02EE – P02F5 – Implausible injector response detected by IC internal logic P1201 – P1208 – Injector short circuit detected by IC internal logic P1261 – P1268 – Injector high side to low side short circuit detected by IC internal logic

Injector Code Missing/Invalid:

Injector Code Monitor Operation:	
DTCs	P268C – Cylinder 1 Injector Data Incompatible P268D – Cylinder 2 Injector Data Incompatible P268E – Cylinder 3 Injector Data Incompatible P268F – Cylinder 4 Injector Data Incompatible P2690 – Cylinder 5 Injector Data Incompatible P2691 – Cylinder 6 Injector Data Incompatible P2692 – Cylinder 7 Injector Data Incompatible P2693 – Cylinder 8 Injector Data Incompatible
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	None
Typical Monitoring Duration	0.5 seconds

Typical Injector Code Monitor Malfunction Thresholds:
P268C – P2693: Each injector has a code stored in EEPROM that provides information to the ECU about deviations of that injector from a theoretical average injector. If the injector code is missing or invalid, a DTC is set.

Fuel system pressure control:

Fuel Rail Pressure Monitors:

The pressure in the fuel rail is controlled by a closed-loop control strategy that is always active during vehicle operation. Two controllers may be used to control the rail pressure: the Pressure Control Valve and the Volume Control Valve. The Pressure Control Valve is used to control pressure at engine start and when fuel temperature is low. The Volume Control Valve is used to control fuel pressure under most other conditions. A third operation mode allows fuel rail pressure to be controlled by a combination of the Pressure Control Valve and Volume Control Valve; this mode is typically used to transition from control by one device to the other and in regimes where low fuel volume is required.

The fuel rail pressure is controlled either with the Pressure Control Valve, the Volume Control Valve, or both, depending upon engine operation condition. The high and low Fuel Rail Pressure Monitors detect when there is an excessive deviation from the desired fuel pressure when the controller has reached a control limit or when the minimum or maximum allowable rail pressures are exceeded. A code is set for Fuel Pressure Regulator Performance when the system is using both the Pressure Control Valve and the Volume Control Valve to regulate rail pressure and the rail pressure becomes too high, indicating a problem with the Pressure Control Valve.

Fuel Rail Pressure (FRP) Monitor Operation:	
DTCs	P0087 - Fuel Rail/System Pressure - Too Low P0088 - Fuel Rail/System Pressure – Too High P0089 - Fuel Pressure Regulator Performance P0093 – Fuel System Leak Detected – Large Leak
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	FRP (P0191, P0192, P0193)
Typical Monitoring Duration	P0087, P0088 – 1.4 sec P0089 – 1.0 sec P0093 – 2 sec

Typical Fuel Rail Pressure Monitor Malfunction Thresholds:
P0087: If the commanded rail pressure exceeds the measured rail pressure by 250 bar for 1.4 sec or if the measured rail pressure drops below 140 bar for 0.3 sec
P0088: If the measured rail pressure exceeds the commanded rail pressure by 250 bar for 1.4 sec or if the measured rail pressure exceeds 2150 bar for 0.3 sec
P0089: If measured rail pressure exceeds commanded rail pressure by 490 bar for 1.0 sec
P0093: If the set point needed for the volume control valve to maintain desired rail pressure exceeds 13,500 mm3/sec at idle or if the set point needed for the volume control valve to maintain desired rail pressure is 40% greater than the volume control valve set point as calculated from the requested injection quantity when not at idle

Injection Timing / Injection quantity

Zero Fuel Calibration:

Zero Fuel Calibration (ZFC) is an algorithm used to detect deviations in individual injector performance from nominal. In an overrun/decel fuel shut-off condition, fuel rail pressure is set to 300 bar and small injections are made from a single injector. The observed acceleration in crankshaft speed is detected and compared to the expected acceleration. If the observed acceleration deviates from the expected acceleration by more than 50%, then an additional routine is called adjusts the injection energizing time until observed acceleration matches expected. This information is then used to adjust all pilot injections on that injector to ensure correct fuel delivery. If the absolute energizing time observed for the test injection to yield the expected acceleration exceeds minimum or maximum limits, a code is set.

Zero Fuel Calibration (ZFC) Monitor Operation:	
DTCs	P02CC – Cylinder 1 Fuel Injector Offset Learning at Min Limit P02CD – Cylinder 1 Fuel Injector Offset Learning at Max Limit P02CE – Cylinder 2 Fuel Injector Offset Learning at Min Limit P02CF – Cylinder 2 Fuel Injector Offset Learning at Max Limit P02D0 – Cylinder 3 Fuel Injector Offset Learning at Min Limit P02D1 – Cylinder 3 Fuel Injector Offset Learning at Max Limit P02D2 – Cylinder 4 Fuel Injector Offset Learning at Min Limit P02D3 – Cylinder 4 Fuel Injector Offset Learning at Max Limit P02D4 – Cylinder 5 Fuel Injector Offset Learning at Min Limit P02D5 – Cylinder 5 Fuel Injector Offset Learning at Max Limit P02D6 – Cylinder 6 Fuel Injector Offset Learning at Min Limit P02D7 – Cylinder 6 Fuel Injector Offset Learning at Max Limit P02D8 – Cylinder 7 Fuel Injector Offset Learning at Min Limit P02D9 – Cylinder 7 Fuel Injector Offset Learning at Max Limit P02DA – Cylinder 8 Fuel Injector Offset Learning at Min Limit P02DB – Cylinder 8 Fuel Injector Offset Learning at Max Limit P262A – Fuel Injector – Pilot Injection Not Learned
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	
Typical Monitoring Duration	P262A – 5 sec, all other DTCs 30 sec

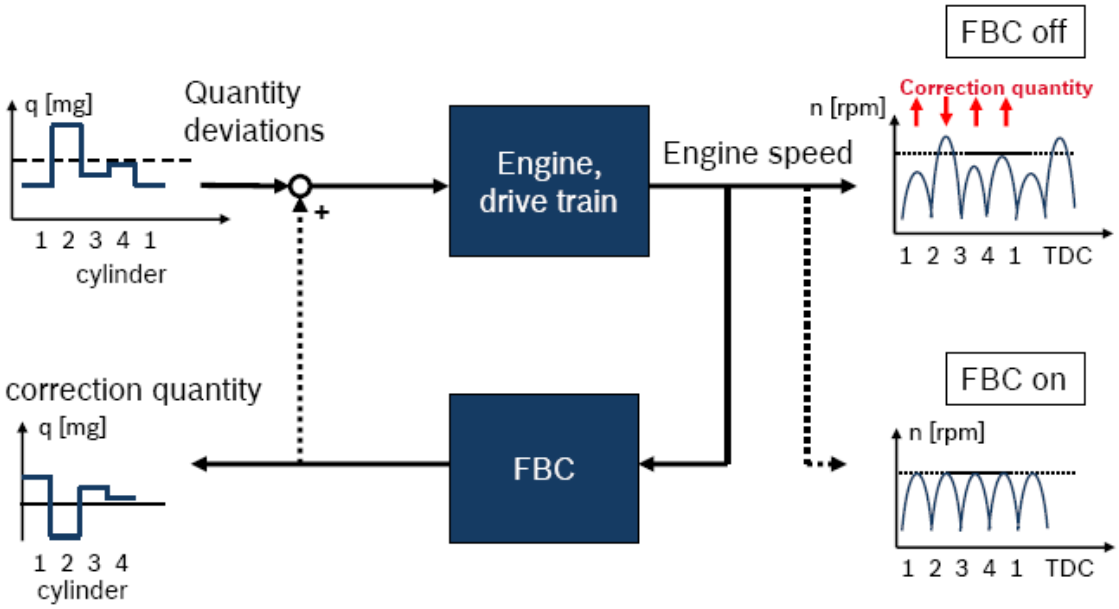
Typical Zero Fuel Calibration (ZFC) Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2, P02D3, P02D4, P02D5, P02D6, P02D7, P02D8, P02D9, P02DA, P02DB, P262A:		
Intake air temperature	0 deg C	
Fuel temperature	10 deg C	75 deg C
Engine coolant temperature	50 deg C	
System voltage	10 V	
Time in overrun/decel fuel shut-off		30 sec
Engine speed	890 rpm	1610 rpm
Boost pressure	750 mbar	
Accelerator pedal		2 %
Transmission gear (no gear change)	4 th	6 th
Torque converter locked		
Fuel Balance Control wheel learn complete		
Note: these are the entry conditions for the base function. The monitor runs whenever the base function runs.		

Typical Zero Fuel Calibration (ZFC) Monitor Malfunction Thresholds:
P02CC, P02CE, P02D0, P02D2, P02D4, P02D6, P02D8, P02DA: If the observed energizing time for the test injection is 156 us or more lower than the target 430 us energizing time for the given injector, the code is set. P02CD, P02CF, P02D1, P02D3, P02D5, P02D7, P02D9, P02DB: If the observed energizing time for the test injection is 254 us or more higher than the target 430 us energizing time for the given injector, the code is set. P262A: While in Zero Fuel Calibration mode, if the speed increase signal corresponding to a cylinder in which a test fuel injection is not programmed is higher than the speed increase signal corresponding to the cylinder in which the test fuel injection is programmed, the code is set.

Feedback control:

Fuel Balancing Control:

Fuel Balancing Control is an algorithm designed to reduce differences in injected fuel quantity from cylinder to cylinder. The increase in crankshaft speed due to individual cylinder combustion events is measured. The amount of fuel injected to each cylinder is then adjusted up or down to minimize the difference in increase in crankshaft speed from cylinder to cylinder. The total amount of fuel injected among all cylinders remains constant. The concept is shown in the graphic below.



FBC operates in closed-loop control in an engine speed range of 500-1150 rpm, and a commanded injection quantity of 3.5 – 50 mg/stroke. The maximum allowed correction in fuel quantity for an individual cylinder is given by the following table.

Fuel Balancing Control (FBC) Control Limits:			
Injection quantity requested before FBC correction (mg/stroke)			
Maximum allowable FBC correction (mg/stroke):	3.5	7.5	30
	2.3	5	10

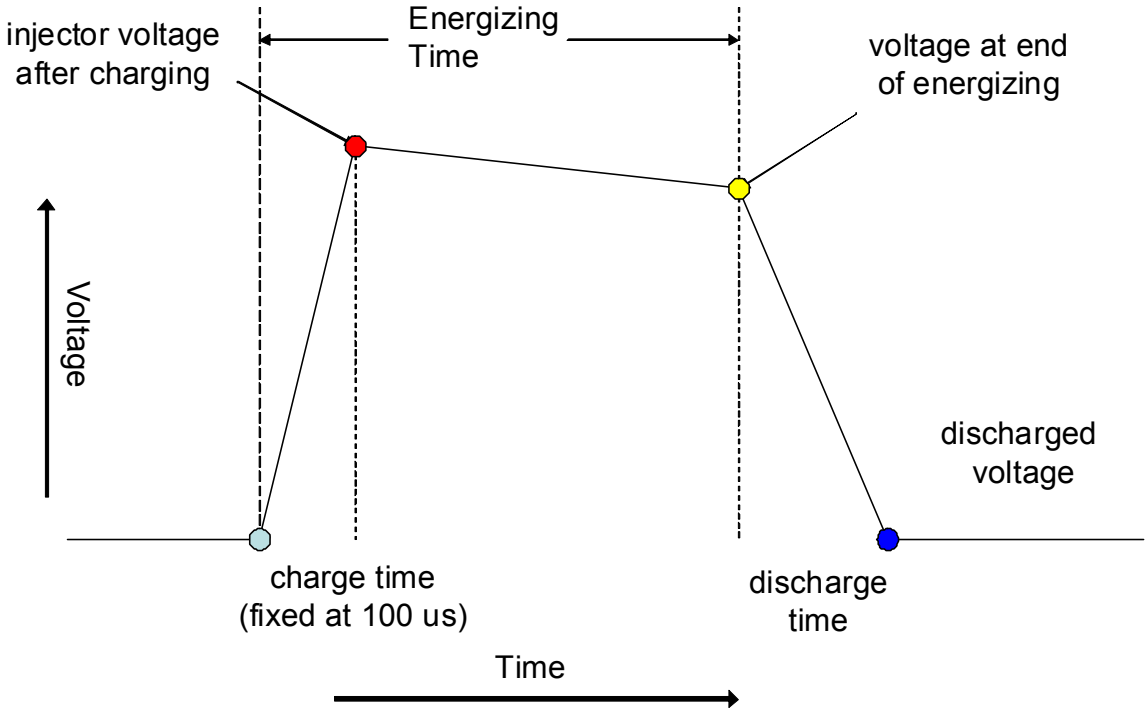
Fuel Balancing Control (FBC) Monitor Operation:	
DTCs	P0263 – Cylinder #1 Contribution/Balance P0266 – Cylinder #2 Contribution/Balance P0269 – Cylinder #3 Contribution/Balance P0272 – Cylinder #4 Contribution/Balance P0275 – Cylinder #5 Contribution/Balance P0278 – Cylinder #6 Contribution/Balance P0281 – Cylinder #7 Contribution/Balance P0284 – Cylinder #8 Contribution/Balance
Monitor Execution	continuous
Monitor Sequence	None
Sensors OK	CKP (P0335, P0336)
Typical Monitoring Duration	10 sec

Typical Fuel Balancing Control (FBC) Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0263, P0266, P0269, P0272, P0275, P0278, P0281, P0284:		
Engine speed	500 rpm	1150 rpm
Injection quantity	3.5 mg/stroke	30 mg/stroke
Not In Regeneration		
FBC wheel learn complete		

Typical Fuel Balancing Control (FBC) Monitor Malfunction Thresholds:
If the current correction for the injector exceeds 90% of the allowable correction for current operation conditions, the code is set.

Nominal Voltage Calibration:

Nominal Voltage Calibration (NVC) is a series of closed-loop controllers on the charge/discharge profile of fuel injectors during an injection event. NVC is designed to compensate for changes due to aging of the piezo stack and hydraulic control elements within individual injectors and of the injector charging circuitry to maintain consistent operation of these components over the life of the injector. The injector charge/discharge profile is shown in the figure below.



Nominal Voltage Calibration (NVC) Monitor Operation:	
DTCs	P1551 – Cylinder 1 Injector Circuit Range/Performance P1552 – Cylinder 2 Injector Circuit Range/Performance P1553 – Cylinder 3 Injector Circuit Range/Performance P1554 – Cylinder 4 Injector Circuit Range/Performance P1555 – Cylinder 5 Injector Circuit Range/Performance P1556 – Cylinder 6 Injector Circuit Range/Performance P1557 – Cylinder 7 Injector Circuit Range/Performance P1558 – Cylinder 8 Injector Circuit Range/Performance
Monitor Execution	continuous
Monitor Sequence	None
Sensors OK	Injector open circuit (P0201-0208), Injector performance (P02EE-02F5), Injector short circuit (P1201-1208), Injector high to low short (P1261-1268), ECT (P0117, P0118), RPS (P0191, P0192, P0193, P228E, P228F)
Typical Monitoring Duration	2 sec (set point voltage), 90 sec (other two tests)

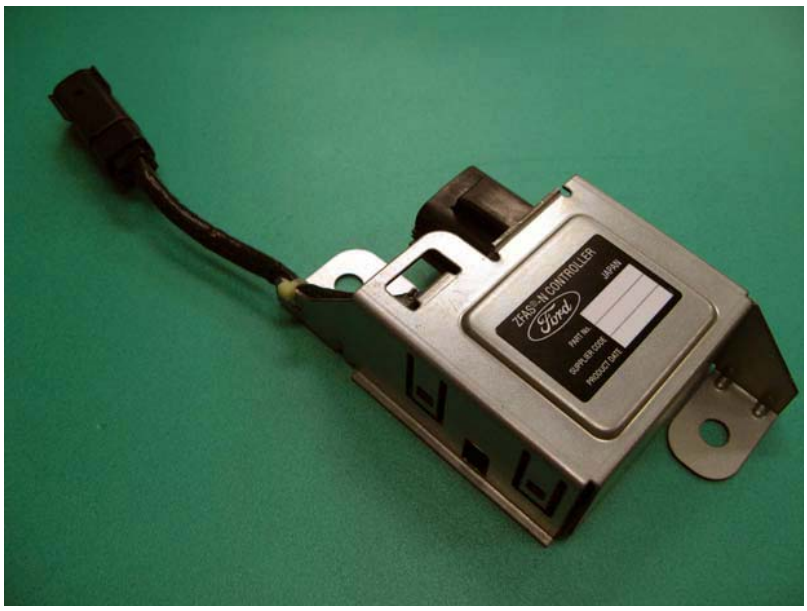
Typical Nominal Voltage Calibration (NVC) Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Rail pressure	1200 bar	1600 bar
Engine coolant temperature	70 deg C	100 deg C
Injection duration	300 us	
Single pilot-main injection profile		

Typical Nominal Voltage Calibration (NVC) Monitor Malfunction Thresholds:
If the set point voltage at end of energizing (yellow dot in figure) exceeds the allowable voltage given in the chart below for the current rail pressure set point or if there exists a persistent deviation between set and measured discharge time (yellow dot to blue dot in figure) or if there exists a persistent deviation between the set and measured voltage at end of energizing (yellow dot in figure)

Maximum Allowable Voltage At End of Energizing :				
Rail pressure (bar)	300	800	1200	2000
Maximum allowed voltage (V)	89	91	93	108

EXHAUST GAS SENSOR MONITOR

Air-Fuel Ratio Sensors: Tailpipe NOx and O2 Sensor Control Module





The NOx sensor control module is mounted to the vehicle frame under the body. It is used to control the combination tailpipe NOx and O2 sensor mounted in the diesel aftertreatment exhaust system downstream of the SCR and DPF. It communicates to the ECM via CAN to report NOx and O2 concentrations as well as sensor/controller errors.

The control module consists of a microprocessor, RAM, ROM, EEPROM, Ip1 circuit, Ip2 circuit, Rpvs circuit, heater driver, and temperature sensor. The EEPROM stores sensor and controller module calibration coefficients obtained during the manufacturing process. The Ip1 circuit consists of an ASIC (like that of a UEGO ASIC) that adjusts pumping current in the sensing element's Ip1 circuit for O2 detection. The Ip2 circuit adjusts the pumping current in the sensing element's Ip2 circuit for NOx detection. The Ip2 circuit consists of 2 bands: a wide range and a narrow range. The Rpvs circuit is a measurement of the resistance of the Vs cell of the sensor element. This measurement is used to estimate the temperature of the sensing element. The heater driver supplies a PWM voltage to the heater portion of the sensing element to maintain the element's target operational temperature. PID feedback from Rpvs is used to control and maintain the element temperature. The microprocessor processes all of the inputs from the sensing element and outputs to the CAN circuit. The temperature sensor in the controller module is used for compensating the temperature dependency of circuit components and for OBD rationality checks.

The NOx controller module interfaces with the vehicle via a power, signal ground, power ground, and CAN. The compensated O2 concentration, compensated NOx concentration, Rpvs, pressure compensation factors, sensor/module OBD (including monitor completion flags), module temperature, software ID, CALID, and CVN are communicated via CAN to the vehicle PCM.

NOx Controller Module Malfunctions	
DTCs	P06EA NOx Sensor Processor Performance (Bank 1 Sensor 1) U05A1 NOx Sensor "A" Received Invalid Data From ECM/PCM P225A NOx Sensor Calibration Memory (Bank 1 Sensor 1)
Monitor execution	continuous
Monitor Sequence	Ip2-N and Ip2-W range rationality – 50ppm < [NOx] < 100ppm
Sensors OK	not applicable
Monitoring Duration	5 seconds to register a malfunction

Typical NOx Controller Malfunction Thresholds
P06EA RAM failure, ROM CRC check error or EEPROM CRC check error Ip1 out of range – Ip1(VIP2.1) < 1.8V, Ip1(VIP2.1) > 2.2 V, Ip1(VIP2.2) < 0.2 V, or Ip1(VIP2.2) > 0.6V Ip2-W out of range – Vs+ ≥ 5.35V and Ip2-W > 4.8 V Ip2-N out of range – Vs+ ≥ 5.35V and Ip2-N < 0.2 V Ip2-N and Ip2-W range rationality – Integral value of differential between Ip2-N & Ip2-W ≥ 250 ppm Vp2 circuit failure – Vp2 < 250mV or Vp2 > 650mV Rpvs short to ground – Rpvs < 0.2V Temperature sensor short to battery > 4.5 V Temperature sensor short to ground < 0.45 V Temperature sensor open, between 0.45 V and < 0.48 V
U05A1 Erroneous Signal (Dew point reached with ignition off, etc.) Timeout (>1 second before message received)
P225A Calibration memory does not pass CRC check

The NOx sensor is primarily used to sense O2 and NOx concentrations in diesel exhaust gas. The sensor is mounted in a vehicle's tailpipe, perpendicular to exhaust gas flow. The sensor is typically mounted downstream of an SCR and DPF in an aftertreatment-equipped diesel exhaust system. The sensor interfaces to a NOx controller module that controls the sensor element's sense circuit and heater.

The NOx Sensor operates similarly to a UEGO sensor for measuring Ip1 (O2 concentration). Exhaust gas enters through a diffusion barrier into the 1st measurement chamber. The sensor infers an air fuel ratio relative to the stoichiometric (chemically balanced) air fuel ratio by balancing the amount of oxygen pumped in or out of the 1st measurement chamber. As the exhaust gasses get richer or leaner, the amount of oxygen that must be pumped in or out to maintain a stoichiometric air fuel ratio in the 1st measurement chamber varies in proportion to the air fuel ratio. By measuring the current required to pump the oxygen in or out, the O2 concentration can be estimated.

The Ip2 (NOx concentration) measurement takes place in a 2nd measurement chamber. Exhaust gas passes from the 1st measurement chamber through a 2nd diffusion barrier into the 2nd measurement chamber. The NOx present in the 2nd measurement chamber is dissociated into N2 and O2. The excess O2 is pumped out of the 2nd measurement chamber by the pumping current, Ip2. Ip2 is proportional to the NOx concentration in the measured gas.

The NOx sensor is equipped with a memory component which stores unique sensor characteristics used to compensate for part-to-part variation of the element during the manufacturing process. The memory stores Ip1 and Ip2 gains/offsets for each individual sensor.

The NOx module output is monitored by the ECU for positive and negative offsets, stuck, and rationality. The Tip-out portion of the plausibility test is responsible for detecting offsets. After the NOx sensor has reached dew point and light off, the signal is considered "valid". During an engine "decel fuel cut", it is assumed the engine out NOx is near zero. As long as conditions indicate no ammonia slip, any readings sent by the NOx sensor are offsets from zero. If the indicated error is too large, the code is set. The tip-in portion of the monitor is responsible for detecting "stuck" sensor. Over a series of "tip-in" events, approximately 5, the minimum and maximum NOx values are recorded. This delta is then compared to a minimum threshold, also approximately 5 ppm. If the delta is less than the threshold the code is set. Rationality (slope offset) is detected by the Diesel Particulate Filter Regeneration portion. This compares the output of the NOx sensor with an engine output NOx model when SCR catalyst conversion is near zero (during a DPF regen at high exhaust temperatures, >500 deg C). The delta between the values is filtered and then is compared to a threshold. An error > 20 ppm will indicate a fault and the code will be set

NOx – O2 Sensor Malfunctions	
DTCs	P0133 O2 Sensor Circuit Slow Response (Bank 1 Sensor 1) P0134 O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1) P164A O2 Sensor Positive Current Trim Circuit Performance (Bank 1 Sensor 1) P2A00 O2 Sensor Circuit Range / Performance (Bank 1 Sensor 1) P2200 NOx Sensor Circuit (Bank 1 Sensor 1) P2201 NOx Sensor Circuit Range/Performance (Bank 1 Sensor 1) P220E NOx Sensor Heater Control Circuit Range/Performance (Bank 1 Sensor 1) P2209 NOx Sensor Heater Sense Circuit Range/Performance (Bank 1 Sensor 1) P220A NOx Sensor Supply Voltage Circuit (Bank 1 Sensor 1)
Monitor execution	continuous
Monitor Sequence	Ip2 Open – 02 ≥ 5% or F/C > 3 seconds and O2 ≥ 19% Ip2 Crack – F/C > 5 seconds and O2 ≥ 19%
Sensors OK	not applicable
Monitoring Duration	X events per trip

Typical NOx – O2 Sensor Malfunctions Thresholds

P0133 As shown in figure below, during a transition from load to overrun/decel fuel shutoff, one of the following occurs:
The time for the observed O2 percentage to increase from the value under load by 30% of (21%-O2 percentage under load) exceeds a value dependent on air mass
OR
The time for the observed O2 percentage to increase from the value under load + 30% of the difference to the value under load + 60% of the difference exceeds 2.5 seconds
OR
The time for the observed O2 percentage to increase from the value under load to the value under load + 60% of the difference exceeds 7.5 seconds. (Used to detect completely inert sensors.)

(monitor operates when the vehicle is not undergoing particulate filter regeneration)

P0134 If there is no available O2 signal at 190 seconds after the sensor has achieved operating temperature

P164A In an extended overrun/decel fuel shutoff condition, an adaption factor is calculated for the response of the O2 sensor to ensure that the sensor reads 20.95% O2 in air. Code is set if adaption factor is outside the range 0.95 – 1.22.

P2A00 A calculated oxygen concentration is derived from fuel, boost, and EGR. Observed oxygen concentration is evaluated within three speed/load/air mass ranges. Code is set if observed oxygen concentration falls outside the range ((calculated O2 concentration – negative offset, calculated O2 concentration + positive offset). Ranges and allowable O2 concentration deviations are given in the table below.

(monitor operates when the vehicle is not undergoing particulate filter regeneration)

P2200 Vs, COM, Ip1 short to battery – ASIC Diag2=1 and Vs, COM, Ip1 ≥ 9V
Ip2 short to battery – Ip2 ≥ 4.8V
Vs, COM, Ip1 short to ground – ASIC Diag2=1 and Vs, COM, Ip1 < 9V
Ip2 short to ground – Ip2 ≤ 2V
Ip1 Open – Vs ≤ 225mV, Vs ≥ 625mV & -0.2mA ≤ Ip1 ≤ 0.2mA
Vs Open – Vs > 1.5V
COM Open – Rpvs > RpvsA (target Rpvs stored in sensor memory) or ASIC Diag1=1
Ip2 Open – Ip2-W ≤ 0.2V and Ip2-N ≤ 0.2V
Sensor Memory CRC check
Vs/Ip1 Cell Crack – Ip1 > 6.4mA
Ip2 Cell Crack – Ip2-W > 4.8V

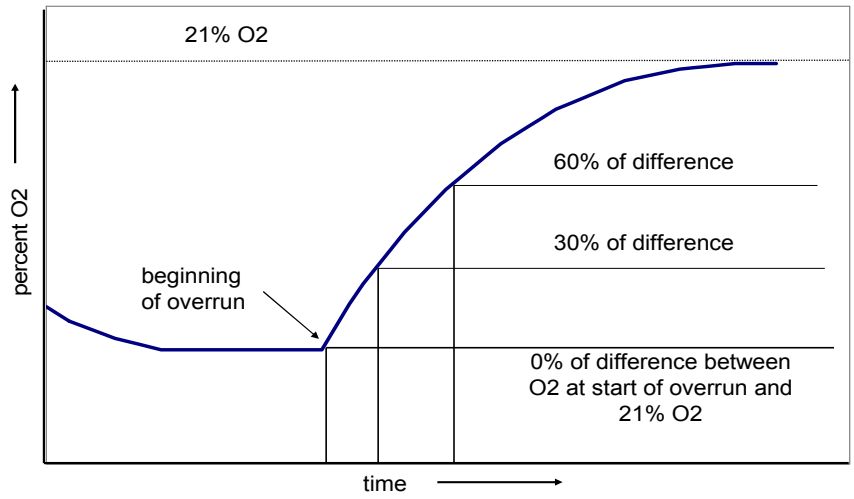
P2201 NOx Negative Offset – NOx Sensor error greater than 20 ppm offset
NOx Positive Offset – NOx Sensor greater than 15 ppm offset
Tip-in – Filtered tailpipe NOx on tip-in delta < 5 ppm
Regeneration – NOx sensor reading average delta to model value > 20 ppm

P220E Heater control failure – Rpvs ≥ 0.2V and Rpvs < TRpvs - 30Ω or Rpvs > TRpvs + 30Ω
Heater Open – Heater current < 0.4A
Heater short to battery – ∆ Heater Voltage > 0.2V
Heater short to ground – ∆ Heater Voltage > 0.2V
Heater performance failure – Heater current ≥ 0.4A and Heater Resistance ≥ 11Ω

P2209 NOx/O2 Availability – > 1 PL (Healing mode) per cycle or > 9 sec of Nox/O2 not valid

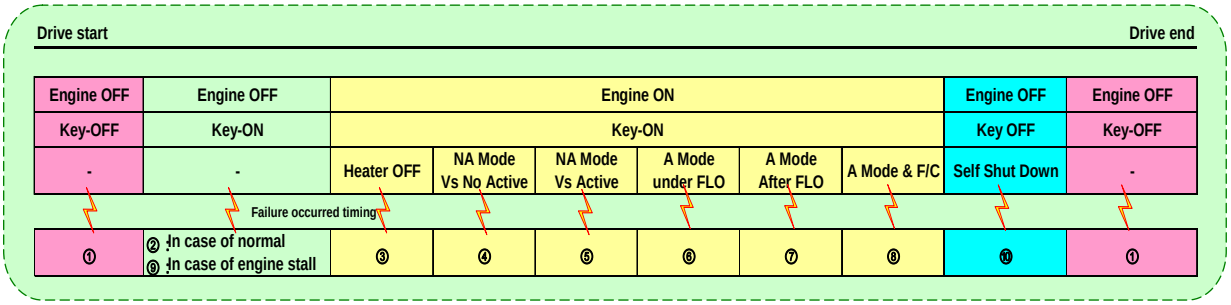
P220A Battery failure – Battery > 17V or Battery < 10V

P0133 (O2 slow response) monitor operation



Oxygen Sensor Plausibility Measurement (P2A00) Evaluation Ranges and Allowable Deviations:						
	Range 1		Range 2		Overrun	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Engine speed (rpm)	1200	2500	1200	2000	100	4000
Fuel injection quantity (mg/stroke)	20	38	12	19.5	0	0.5
Air mass (mg/stroke)	400	730	400	700	100	1000
Allowable deviation (% O2)	-5.1	6.3	-6.2	7.9	-4.6	6.3

NOx Sensor Operation Modes



Mode 1 – No voltage supply to module or sensor. Non-operational.
Mode 2 – Voltage is supplied to module, voltage is not supplied to the sensor.
Mode 3 – Voltage is supplied to module, voltage is not supplied to the sensor. Dew-point waiting period.
Mode 4 – Voltage is supplied to the module and to the sensor. The Vs cell of the sensor is not active.
Mode 5 – Voltage is supplied to the module and to the sensor. The Vs cell of the sensor is active.
Mode 6 – Voltage is supplied to the module and to the sensor. Sensor is in fast light-off to quickly heat sensing element to operational temperature.
Mode 7 – Voltage is supplied to the module and to the sensor. The sensor has exited fast light-off and O2 and NOx will be available during this mode.
Mode 8 - Voltage is supplied to the module and to the sensor. The sensor has exited fast light-off and O2 and NOx will be available during this mode. During this mode a fuel cut condition is present, as communicated by the PCM.
Mode 9 - Voltage is supplied to module, yet voltage is not supplied to the sensor.
Mode 10 - No voltage supply to module or sensor. Non-operational.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITOR

EGR Rate System Monitor

The EGR system is a closed loop EGR control system that uses an Air System Model EGR to estimate the percent of EGR in the cylinder. Airflow into the engine is modeled using a Mass Airflow Sensor (MAF) and a model of airflow over the throttle restriction. EGR mass flow is then calculated as the difference between the cylinder charge from the speed-density equation and this model of the mass airflow after the throttle. This model value of the actual EGR flow based on measured values is compared with the estimated EGR rate computed by the EGR rate controller. The EGR rate controller calculates the mass flow based on an open area estimate at the EGR valve and a modeled value of mass flow per open area. EGR open area estimate uses a combination of the area calculated from the modeled EGR rate and a calibrated curve of the expected open area based on EGR valve position.

Once the engine is warm and the system in closed-loop EGR control, the monitor awaits calibrated engine speed/load conditions selected for robust detection of high flow and low flow faults. When the engine enters the operational regime for robust detection, the calculated rate deviation (modeled – controller estimate) is compared to thresholds that are calibrated as a function of speed/load. An up/down counter is used that counts upward when the rate deviation exceeds the calibrated threshold and counts downward when the deviation falls below the threshold for the case of high flow. Similarly, the up/down counter counts upward when the rate deviation falls below a calibrated threshold and counts downward when it rises above the threshold for the case of low flow. Once the debounce counter exceeds a calibrated threshold for either high or low flow then a malfunction is detected. A low flow malfunction indicated (P0401) and a high flow malfunction in indicated (P0402)

EGR Flow Check Operation:	
DTCs	P0401 – Insufficient EGR Flow P0402 – Excessive EGR Flow
Monitor Execution	Continuous
Monitor Sequence	None
Monitoring Duration	

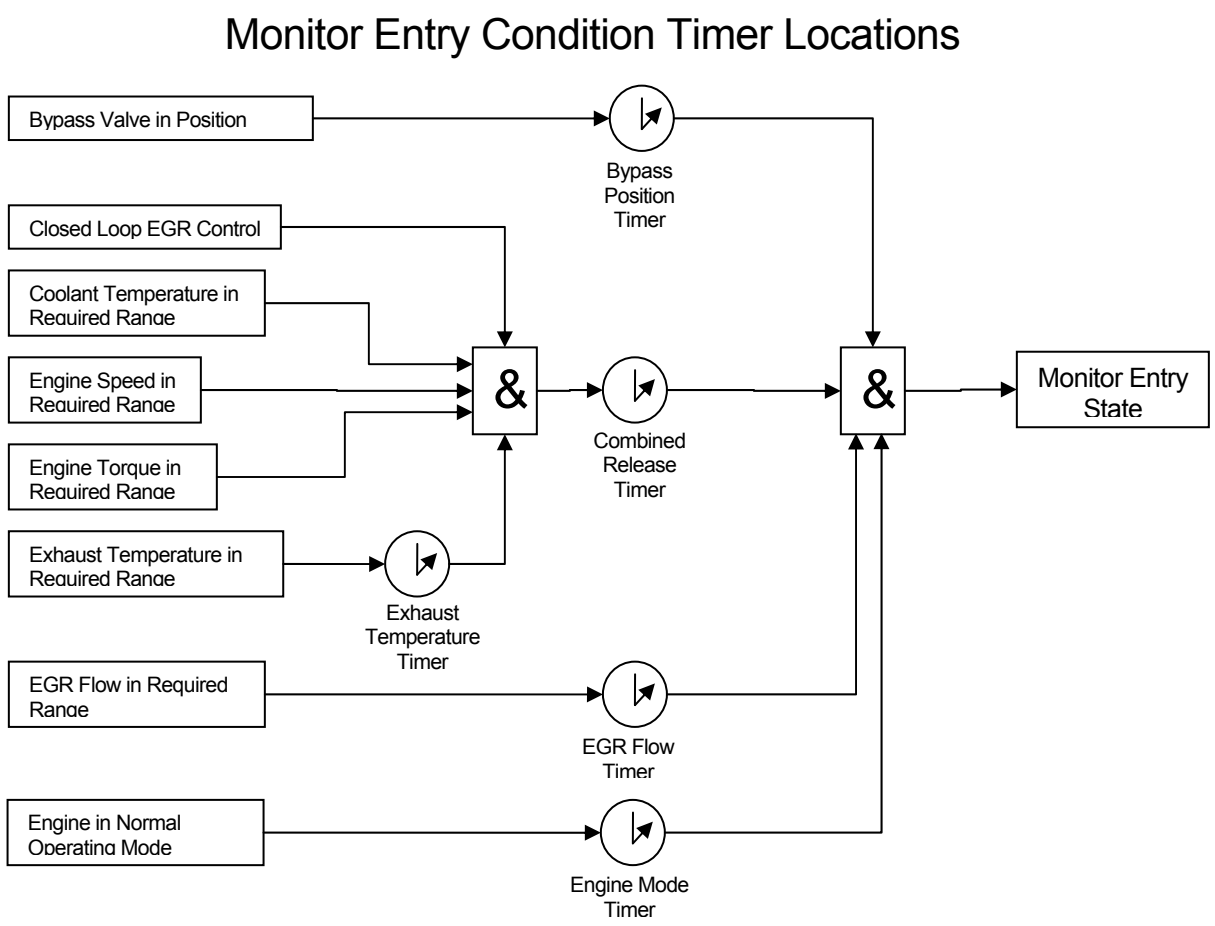
Typical EGR Flow Check Entry Conditions (High Flow Detection):		
Entry Condition	**Minimum**	**Maximum**
Engine RPM	600 rpm	2500 rpm
Engine Coolant Temperature	70 deg C	100 deg C
EGR Valve Position	0%	6%
EGR Rate Desired Value	0%	15%

Typical EGR Flow Check Entry Conditions (Low Flow Detection):		
Entry Condition	**Minimum**	**Maximum**
Engine RPM	600 rpm	2500 rpm
Engine Coolant Temperature	70 deg C	100 deg C
EGR Valve Position	40%	60%
EGR Rate Desired Value	0%	100%

Typical EGR Flow Rate Malfunction Thresholds:
AirCtl_rEGRModMaxDvtFlt > 28 (insufficient flow); AirCtl_rEGRModMinDvtFlt < -22 (excessive flow)

EGR Cooler / EGR Cooler Bypass Monitor

The functionality of the EGR cooler system, including the bypass valve, is monitored by means of comparing measured EGR gas temperature downstream of the EGR cooler assembly with measured coolant temperature in the main coolant loop when certain engine operating conditions exist. The operating conditions in which this detection can occur are the monitor entry conditions. Following changes in engine operating conditions, there is a delay before the changes are reflected in the EGR system temperatures. Because of this delay the entry conditions include a number of timers which must complete before the monitor is released. When a condition feeding a timer is no longer met, the timer resets. Two malfunction conditions, EGR overcooling and EGR undercooling can be detected using the EGR cooler monitors.



The undercooling monitor can detect when EGR is not being cooled sufficiently, for example, when the EGR cooler bypass is stuck in the bypass position. The entry conditions for EGR undercooling monitoring must be met for monitoring to take place. Once the entry conditions are met and while they continue to be met, the measured EGR temperature downstream of the EGR cooler assembly is compared to a threshold which is determined based on measured coolant temperature. A typical value for this threshold is 88 deg C above engine coolant temperature. If the measured EGR temperature downstream of the EGR cooler assembly is greater than the threshold, for a predetermined amount of time, a fault is detected.

EGR Cooler (Undercooling) Monitor:	
DTCs	P2457 – EGR Cooler Performance
Monitor execution	Once per driving cycle , once entry conditions are met
Monitor Sequence	None
Monitoring Duration	12 seconds to detected a malfunction

EGR Cooler/ECB Entry Conditions (Undercooling):		
Entry Condition	**Minimum**	**Maximum**
EGR Cooler Bypass Valve Command	Cooling Position	
EGR System in Closed-Loop Control		
Engine Coolant Temperature	70 deg C	130 deg C
Engine Speed	1100 rpm	3500 rpm
Engine Torque	200 Nm	1400 Nm
Exhaust Temperature	0 deg C	800 deg C
EGR Flow	20 Kg/h	150 Kg/h
Engine Operating Mode	Normal	

EGR Cooler/ECB Entry Timers (Undercooling):	
Timer	**Minimum Time**
Bypass Position Timer	5 sec
Combined Release Timer	1 sec
Exhaust Temperature Timer	5 sec
EGR Flow Timer	5 sec
Engine Mode Timer	100 sec

Typical Undercooling Malfunction Thresholds:
Measured EGR temperature downstream of the EGR cooler assembly > Coolant Temperature + 70

The overcooling monitor can detect when EGR is being overcooled, for example, when the EGR cooler bypass is stuck in the cooling position. The entry conditions for EGR overcooling monitoring must be met for monitoring to take place. Once the entry conditions are met and while they continue to be met, the measured EGR temperature downstream of the EGR cooler assembly is compared to a threshold which is determined based on measured coolant temperature. A typical value for this threshold is 16 deg C below engine coolant temperature. If the measured EGR temperature downstream of the EGR cooler assembly is less than the threshold, for a predetermined amount of time, a fault is detected.

EGR Cooler (Overcooling) Monitor:	
DTCs	P24A5 – Exhaust Gas Recirculation Cooler Bypass Control Stuck (Bank 1)
Monitor execution	Once per driving cycle , once entry conditions are met
Monitor Sequence	None
Monitoring Duration	12 seconds to detected a malfunction

EGR Cooler/ECB Entry Conditions (Overcooling):		
Entry Condition	**Minimum**	**Maximum**
EGR Cooler Bypass Valve Command	Cooling Position	
EGR System in Closed-Loop Control		
Engine Coolant Temperature	70 deg C	130 deg C
Engine Speed	575 rpm	900 rpm
Engine Torque	70 Nm	300 Nm
Exhaust Temperature	0 deg C	800 deg C
EGR Flow	25 Kg/h	150 Kg/h
Engine Operating Mode	Normal	

EGR Cooler/ECB Entry Timers (Overcooling):	
Timer	**Minimum Time**
Bypass Position Timer	5 sec
Combined Release Timer	5 sec
Exhaust Temperature Timer	5 sec
EGR Flow Timer	5 sec
Engine Mode Timer	100 sec

Typical Overcooling Malfunction Thresholds:
Measured EGR temperature downstream of the EGR cooler assembly < Coolant Temperature -16

EGR System Slow Response

Slow responding EGR systems are detected through the EGR Closed-loop control limits monitors.

EGR Closed-loop Control Limits Monitor

The control system is closed-loop around EGR rate during normal operation, and the limits of the control system are monitored by observing the control deviation calculated as the difference between the desired EGR rate set point (after dynamic correction) and the actual EGR rate determined from an Air System Model. The Air System Model EGR estimates the percent of EGR in the cylinder by modeling the induction system based on the Mass Airflow Sensor (MAF) reading and an estimate of the airflow over the throttle restriction. EGR mass flow is then calculated as the difference between the cylinder charge from the speed-density equation and this model of the mass airflow into the intake manifold. This model value of the actual EGR flow based on measured values is compared with the desired EGR rate set point. If there the deviation between the controller set point EGR rate and the modeled EGR rate exceed calibrated thresholds the system control limit malfunction is indicated.

If no air system faults are present, the control limit monitor functions continuously during closed-loop operation once the engine is warm (ECT>70C). Separate threshold maps are used to indicate the EGR system operation is at its control limits for both the high flow and low flow extremes. Control limit threshold maps are a function of engine torque and engine speed and are based upon the expected distribution of deviations from a statistical sampling. An up/down counter is used that counts upward when the control deviation exceeds the calibrated threshold and counts downward when the control deviation falls below the threshold for the case where the system operation is limited to EGR rates higher than the controller set-point. Similarly, the up/down counter counts upward when the rate deviation falls below a calibrated threshold and counts downward when it rises above the threshold for the case where the system operation if limited to EGR rates lower than the controller set-point. Once the counter exceeds a calibrated thresholds for either case a malfunction is detected (P04DA/P04D9).

EGR Closed-loop Control Limits Check Operation:	
DTCs	P04DA (Closed Loop EGR Control At Limit - Flow Too High) P04D9 (Closed Loop EGR Control At Limit - Flow Too Low)
Monitor Execution	Continuous
Monitor Sequence	None
Monitoring Duration	

Typical EGR Closed-loop Control Limits Check Entry Conditions:		
Entry Condition	Minimum	Maximum
No Air System Faults		
Engine coolant temperature	70 deg C	

Typical EGR Closed-loop Control – Threshold Map																
RPM/TRQ	**0**	**250**	**500**	**750**	**1000**	**1250**	**1500**	**1750**	**2000**	**2250**	**2500**	**2750**	**3000**	**3250**	**3500**	**3750**
0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
100	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
150	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
200	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
250	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
300	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
350	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
400	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
450	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
500	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
550	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
600	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
650	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
700	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
750	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

Mass Airflow Closed-loop Control Limits Monitor

During DPF regeneration the control system is closed-loop around air mass flow and the limits of the control system are monitored by observing the control deviation calculated as the difference between the desired air mass flow and the actual mass air flow determined from the MAF sensor. If no air system faults are present, the control limit monitor function continuously during closed-loop operation. Separate threshold maps are used to indicate the control system operation is at its limits for both the high flow and low flow extremes. Control limit threshold maps are a function of engine torque and engine speed and are based upon the expected distribution of deviations from a statistical sampling. An up/down debounce counter is used that counts upward when the control deviation exceeds the calibrated threshold and counts downward when the control deviation falls below the threshold for the case where the system operation is limited mass airflow higher than the controller set point. Similarly, the up/down counter counts upward when the rate deviation falls below a calibrated threshold and counts downward when it rises above the threshold for the case where the system operation is limited to mass airflow lower than the controller set-point. Once the counter exceeds calibrated thresholds for either case a malfunction is detected.

Mass Airflow Closed-loop Control Limits Check Operation:	
DTCs	P02EC - Diesel Intake Air Flow Control System - High Air Flow Detected P02ED - Diesel Intake Air Flow Control System - Low Air Flow Detected
Monitor Execution	Continuous
Monitor Sequence	None
Monitoring Duration	

Typical Mass Air Flow Closed-loop Control Limits Check Entry Conditions:		
Entry Condition	Minimum	Maximum
No Air System Faults		
Engine coolant temperature	70 deg C	

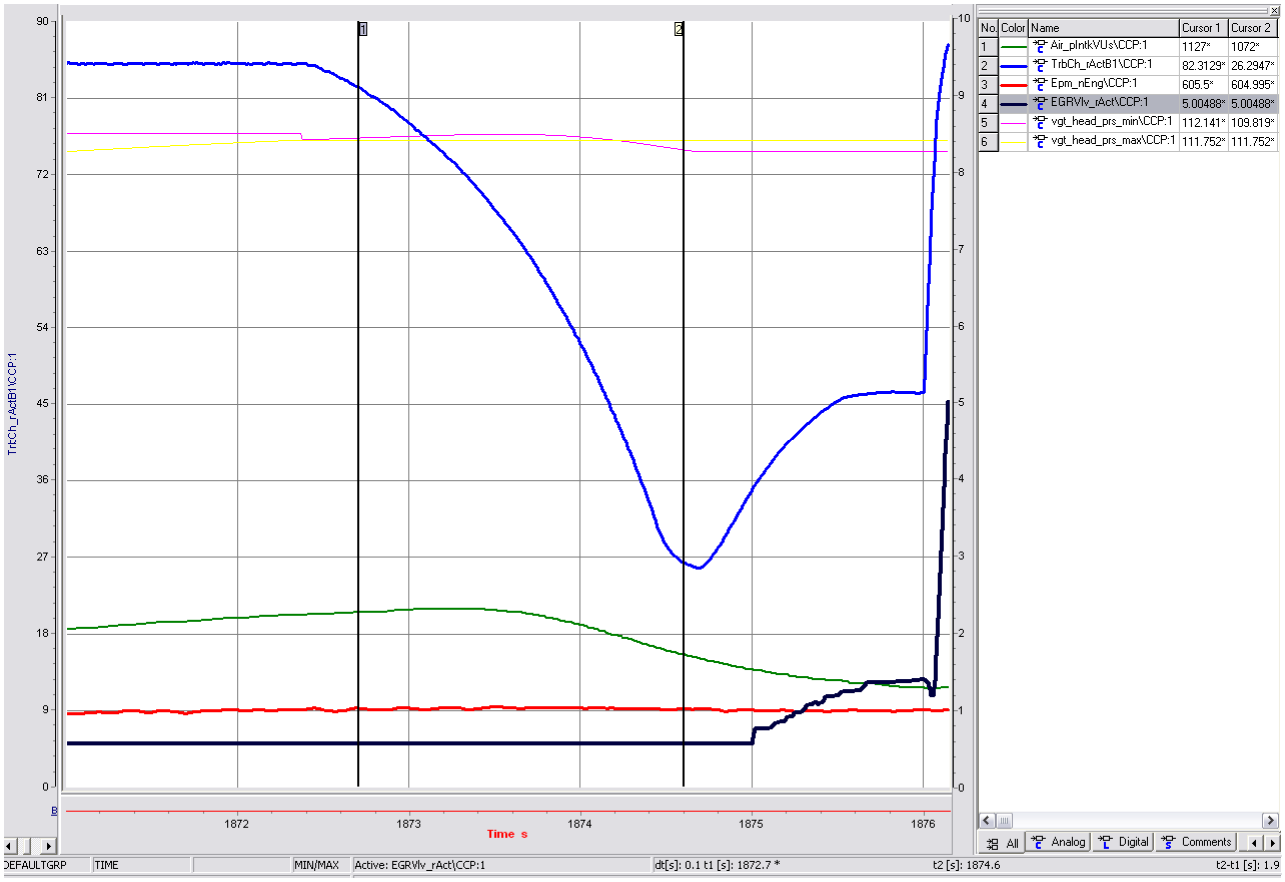
Typical Mass Airflow Closed-loop Control – Threshold Map

RPM/TRQ	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750
0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
100	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
150	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
200	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
250	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
300	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
350	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
400	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
450	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
500	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
550	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
600	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
650	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
700	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
750	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

BOOST PRESSURE CONTROL SYSTEM MONITORING

Intrusive Turbo Position and Response Monitoring

The 6.7L engine is equipped with an oil pressure actuated, variable vane turbocharger. Additionally, chassis cert applications have a wastegate for bypassing exhaust gas to assist with controlling boost while in heavy load situations. Neither the variable geometry turbo (VGT) nor the wastegate have position sensors, so turbo and wastegate position is inferred using a duty cycle to position transfer function. To verify actual position based on the nominal transfer function, an intrusive monitor sweep is performed. When entry conditions are met, the intrusive monitor for VGT closes the EGR valve, closes the wastegate, and then commands an inferred turbo position of 85%, then 25% within a calibratable time. The minimum and maximum MAP values are saved and compared to a threshold. If the desired separation in MAP pressure isn't achieved, a fault is detected. If the desired separation in MAP is achieved prior to the full 10 seconds allotted, the test is aborted and considered a pass.



In the example above, at 1871 seconds, the EGR valve is commanded closed, after 3 seconds with EGR off and turbocharger at 85% position, the turbocharger is opened up to. 25% position. The 25% position is held for up to 10 seconds. If desired separation of 2kpa at sea level is achieved, the monitor aborts and the test is considered a pass. If desired separation isn't achieved, the monitor remains at 25% position for 10 seconds, and then the test is completed and failed.

Note: this monitor also serves to monitor for a slow responding boost pressure system due to the time component of the threshold.

VGT Monitor:	
DTCs	P132B - Turbocharger/Supercharger Boost Control "A" Performance
Monitor Execution	Once per driving cycle
Monitor Sequence	VGT, then wastegate
Sensors OK	ECT, MAP, VS
Typical Monitoring Duration	13 seconds for full VGT monitoring cycle if pressure abort threshold hasn't been reached

Typical VGT Monitor Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine speed for learning	500 rpm	760 rpm
Pedal position allowed for learning		0.5 %
Engine coolant temperature for learning	70 deg C	124 deg C
Fuel quantity allowed for learning		20 mg/stoke
Vehicle speed for learning	3 mph	6-10 mph
Loop counts after brake cycle		800 counts
Barometric Pressure	67 kPa	1020 kPa
Time after engine start	120 seconds	

Typical VGT Monitor Malfunction Thresholds:
Response from 25% VGT position to 85% VGT position in 10 seconds results in a change in manifold pressure of 2 kPa or greater at sea level or 1.25 kPa at 8000 feet.

Intrusive Wastegate Monitoring

The intrusive wastegate monitor operates on the same principles and has the same entry conditions as the intrusive VGT monitor. It runs once the VGT monitor completes, using the same commanded VGT position (85%) and an EGR valve position up to 10%). The wastegate is commanded to 5% open for 2 seconds, then 95% open for 2 seconds. The minimum and maximum EBP values are saved and compared to a threshold. If the desired separation in EBP pressure isn't achieved, a fault is detected.

Wastegate Monitor:	
DTCs	P1249- Wastegate Control Valve Performance
Monitor Execution	Once per driving cycle
Monitor Sequence	VGT, then wastegate
Sensors OK	ECT, MAP, VS
Typical Monitoring Duration	4 seconds for full wastegate monitoring cycle if pressure abort threshold hasn't been reached

Typical Wastegate Monitor Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine speed for learning	500 rpm	760 rpm
Pedal position allowed for learning		0.5 %
Engine coolant temperature for learning	70 deg C	124 deg C
Fuel quantity allowed for learning		20 mg/stoke
Vehicle speed for learning	3 mph	6-10 mph
Loop counts after brake cycle		800 counts
Barometric Pressure	67 kPa	1020 kPa
Time since start	120 seconds	

Typical Wastegate Monitor Malfunction Thresholds:
Response from 5% wastegate position to 95% wastegate position in 2 seconds results in a change in exhaust backpressure of 2.0 kPa or greater at sea level or 1.25 kPa at 8000 feet.

Functional Overboost Monitoring

The 6.7L engine utilizes a closed loop boost pressure controller to maintain desired boost pressure set point under all temperature ranges and engine operating modes. The overboost monitor compares the desired vs. actual measured boost pressure while in a specific range of closed loop boost pressure operation. If the boost pressure governor deviation is greater than the calibrated threshold for 7 seconds, a fault is detected and the P-code is set. The closed loop monitoring window is defined as any inner torque above 50 nm, and any engine speed above 1500 rpm.

Overboost Monitor:	
DTCs	P0234 - Turbocharger/Supercharger "A" Overboost Condition
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	ECT, MAP, MAF,
Typical Monitoring Duration	7 seconds for fault detection

Typical Overboost Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Torque	50 Nm	
Engine Speed	1500	4000

Typical Overboost Monitor Malfunction Thresholds:
If desired boost pressure – actual boost pressure < -15.0 kPa for 7 seconds, a fault is detected.

Functional Underboost Monitoring

The underboost monitor works in a similar fashion to the overboost monitor by comparing the desired vs. actual measured boost pressure while in a specific range of closed loop boost pressure operation. If the boost pressure governor deviation is greater than the calibrated threshold for 7 seconds, a fault is detected and the P-code is set. The closed loop monitoring window is defined as any inner torque above 50 nm, and any engine speed above 1500 rpm. The threshold limit is wider for the underbooost monitor due to transient boost system response, compensation for boost pressure lag, and short term (1-2 second) momentary torque truncation when air path torque is kept high, but fueling is limited for component protection.

This diagnostic will detect a gross air path leak such as the turbo discharge or CAC discharge tube being blown off, major pre-turbo exhaust leaks, or a turbo stuck in the full open VGT position.

Overboost Monitor:	
DTCs	P1247 - Turbocharger Boost Pressure Low
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	ECT, MAP, MAF,
Typical Monitoring Duration	7 sec

Typical Overboost Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Torque	50 Nm	
Engine Speed	1500 rpm	4000 rpm

Typical Overboost Monitor Malfunction Thresholds:
If desired boost pressure – actual boost pressure > 50 kPa for 7 seconds, a fault is detected.

Threshold Underboost Monitoring

The pressure-based underboost diagnostic is adequate for detecting gross air system leaks; however, the emissions threshold leak to exceed the HC standard is approximately a one quarter inch NPT hole. With a leak of that magnitude, the closed loop boost pressure governor is capable of maintaining the desired boost pressure. The functional underboost monitor is not able to detect a leak of such size, so an additional boost system diagnostic is utilized since desired pressure is maintained in the system.

The closed loop boost pressure controller controls boost based predicted control targets and anticipated turbocharger position. The output value, in percentage, indicates the "control effort" required to maintain the desired boost pressure. With a boost system leak, the control effort increases. There is a temperature entry condition, torque entry conditions, a steady state requirement on manifold pressure, an exhaust temperature entry condition, an exhaust lambda entry condition, and a threshold map. If the threshold is exceeded for 4 seconds, a fault is detected.

Boost Leakage Monitor:	
DTCs	P0299 - Turbocharger/Supercharger "A" Underboost Condition
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	ECT, MAP, MAF
Typical Monitoring Duration	7 sec

Typical Boost Leakage Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Torque	200 Nm	700 Nm
Engine coolant temperature	-7 deg C	
Ambient air temperature	-7 deg C	
Barometric Pressure	75 kPa	110 kPa
MAP steady state pressure		100 kPa
TOxiCatUs Temperature	99 deg C	
Mass Air Flow		1300 kg/h
Not in Cold Start Warm-up Mode		
Regeneration Status	None	

Typical Boost Leakage Monitor Malfunction Thresholds:
If control effort percent is > threshold map for 4 seconds and Exhaust Lambda is less than 1.33, a fault is detected.

Typical Boost Leakage monitor (P0299) Threshold Map												
RPM/TRQ	**600**	**750**	**1000**	**1200**	**1600**	**2000**	**2250**	**2500**	**2750**	**3000**	**3250**	**3500**
0	50	50	50	50	50	50	50	50	50	50	50	50
100	50	50	50	50	50	50	50	50	50	50	50	50
150	50	50	50	50	50	50	50	50	50	50	50	50
200	50	50	20	12	12	12	12	12	12	25.5	25.5	25.5
250	50	50	20	12	12	12	12	12	12	27.5	27.5	25.5
300	50	50	20	12	12	12	12	12	12	27.5	27.5	25.5
350	50	50	20	12	12	12	12	12	12	27.5	27.5	25.5
400	50	50	20	12	12	12	12	15	15	25.5	25.5	25.5
450	50	50	20	12	12	12	12	15	16	25.5	25.5	25.5
500	50	50	20	12	12	12	12	18.5	18.5	25.5	25.5	25.5
600	50	50	20	12	12	12	12	18.5	22.5	25.5	25.5	25.5
700	50	50	20	12	12	12	12	18.5	22.5	25.5	25.5	25.5

Charge Air Cooler Monitoring

The 6.7L engine is equipped with an air to water charge air intercooler. The CAC is on a secondary coolant loop, independent from the main engine coolant system. The temperature at the outlet of the cooler is measured as TCACDs, however the temperature going into the cooler is modeled.

To detect a CAC under cooling situation, the efficiency of the cooler is modeled at various speeds and airflows via a 3d speed/airflow multiplier table, providing a modeled cooler out temperature. Cooler efficiency * compressor out temperature = modeled cooler out temp. This modeled cooler out temp is then compared to the measured coolant out temp, if the difference is greater than a threshold curve, a fault is detected and a p-code is set.

Charge Air Cooler Monitor:	
DTCs	P026A - Charge Air Cooler Efficiency Below Threshold
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	ECT, MAP, MAF
Typical Monitoring Duration	4 seconds for fault detection

Typical Charge Air Cooler Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Engine speed	1100 rpm	3350 rpm
Engine coolant temperature	70 deg C	
Ambient air temperature	-7 deg C	
Barometric Pressure	75 kPa	110 kPa
Manifold absolute pressure	120 kPa	
Intake air temperature	-7 deg C	
Injection quantity	20mg/stk	85mg/stk

Typical Charge Air Cooler Monitor Malfunction Thresholds:
If the difference of measured temperature and modeled temperature is less than -15 C deg at 0 deg C compressor out temp, or less than -10 C deg at 250 deg C compressor out temp, a fault is set.

PARTICULATE MATTER (PM) FILTER MONITORING

DPF Filter Efficiency and Missing Substrate Monitors

The DPF is monitored to ensure no leaks have developed in the substrate and that the filter has not been removed.

The DPF Missing Substrate monitor compares the measured pressure upstream of the DPF to a threshold which is a function of volumetric exhaust flow. A counter increments when the pressure is below the threshold and decrements when above the threshold. If the counter exceeds a threshold, a fault is indicated.

The DPF Missing Substrate monitor also satisfies the requirement to monitor the DPF for leakage. No additional p-code is used.

Monitor Summary:	
DTCs	P244A – Diesel Particulate Filter Differential Pressure Too Low
Monitor execution	Continuous while meeting entry conditions
Monitor Sequence	None
Sensors OK	EGT, DPFP, CKP, ECT (P0117, P0118), EGT13 EGT14, MAF, IAT
Monitoring Duration	90 sec

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Exhaust volumetric flow	300 m3/hour (P244A)	2400 m3/hour
Not a regeneration event		
Intake air temperature	-30 deg C	
Engine coolant temperature	-20 deg C	
DPF inlet temperature	150 degC	
Engine Indicated Torque	50 N-m	

Typical Malfunction Thresholds:
DPF Differential Pressure Test: (P244A) Measured DPF inlet pressure is below a threshold (function of engine exhaust volumetric flow) for 90 seconds. Typical values for threshold:

Flow (m^3/hr)	300	600	900	1200	1500	1800	2100	2500
Pressure (kPa)	7.99	15.02	27.94	47.13	72.80	104.94	143.45	204.61

DPF Frequent Regeneration Monitor

The DPF Frequent Regeneration monitor calculates the distance between aftertreatment regeneration events. The distance between successive regeneration events is calculated and the average distance is calculated for the two most recent regeneration events. If the distance between regen events is below a threshold, a fault is indicated.

Monitor Summary:	
DTC	P2459 – Diesel Particulate Filter Regeneration Frequency
Monitor execution	During each completed regeneration event
Monitor Sequence	None
Sensors OK	DPFP

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Regeneration runs to completion (not aborted by customer input or drive cycle)		
Not in “degraded regen” mode due to DPF pressure sensor error		

Typical Malfunction Thresholds:
A fault is stored when the average distance between regeneration events is below a threshold. Typical threshold is 42 km.

DPF Incomplete Regeneration Monitor

The DPF Incomplete Regeneration monitor is used to detect an event where the DPF is not fully regenerated. If a regeneration event is aborted due to duration and the restriction of the DPF is still above a threshold, a fault is indicated. Upon the first occurrence of an incomplete regen, the system is put into a "degraded" regen mode. Another regen will be forced in approximately 150 miles unless a normal regen is triggered by the soot load first.

Monitor Summary:	
DTC	P24A2 – Diesel Particulate Filter Regeneration Incomplete
Monitor execution	During each DPF regeneration cycle
Monitor Sequence	None
Sensors OK	EGT11, EGT12,EGT13, EGT14, DPFP, INJ
Monitoring Duration	20 minutes (maximum)

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Monitor is activated during Aftertreatment regeneration events		
Ambient air temperature	-6.7 degC	
Ambient pressure	75 kPa	
Engine speed	1000 rpm	3500 rpm
Engine Indicated Torque	150 N-m	1500 N-m
Engine Coolant Temperature	70 degC	
Minimum time with valid entry conditions (function of regen duration)		

Typical Malfunction Thresholds:
If the restriction is above a threshold, a fault is indicated.

DPF Feedback Control Monitors

The system is monitored to ensure that closed loop control of the regeneration event is initiated within a reasonable period of time. The monitor runs during a regeneration event and compares the time in closed loop control to the total time in regen. If the time in closed loop control is less than a threshold (a function of total time in regen), then a fault is indicated.

If the closed loop controller is saturated at its limits and the temperature is not within the desired limit, a timer will increment. If control is regained, the timer will decrement. At the end of the regeneration event, if this timer exceeds a threshold (a function of total time in regen), a fault is indicated

Note: Ford Motor Company 2011 diesel programs are using in-cylinder post injection to achieve regeneration, not external exhaust injection. The Post injection is monitored during this feedback monitor; there is no additional monitor for "active / intrusive injection"

Monitor Summary:	
DTC	P24A0 – DPF Temperature Control P249F – Excessive Time To Enter Closed Loop DPF Regeneration Control
Monitor execution	During an active regeneration event
Monitor Sequence	None
Sensors OK	TIA, TCO, AMP, EGT11, EGT12, EGT13, EGT14
Monitoring Duration	Once per regeneration event

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Speed	1200 rpm	3500 rpm
Indicated Torque Setpoint	200 Nm	1500 Nm
Ambient Temperature	-6.7 deg C	
Coolant Temperature	70 deg C	
Barometric Pressure	75 kPa	

Typical Malfunction Thresholds:
P249F - If the time in closed loop operation is less than a threshold (function of total time in regen), a fault is indicated. P24A0 - If the difference between desired and actual temperature is greater than a threshold for a sufficient period of time, a fault is indicated.

DPF Restriction Monitor

The DPF is monitored for conditions where it may be overloaded. The monitor compares the calculated restriction of the DPF to two thresholds. By exceeding the first threshold for a sufficient period of time, a wrench light will be illuminated. By exceeding the second threshold for a sufficient period of time, a wrench light and a MIL will be illuminated and engine output will be limited and EGR is disabled.

Monitor Summary:	
DTCs	P2463 – Diesel Particulate Filter Restriction – Soot Accumulation P246C - Diesel Particulate Filter Restriction – Forced Limited Power
Monitor execution	Continuous while meeting entry conditions
Monitor Sequence	None
Sensors OK	DPFP
Monitoring Duration	300 seconds

Typical Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Speed	625 rpm	

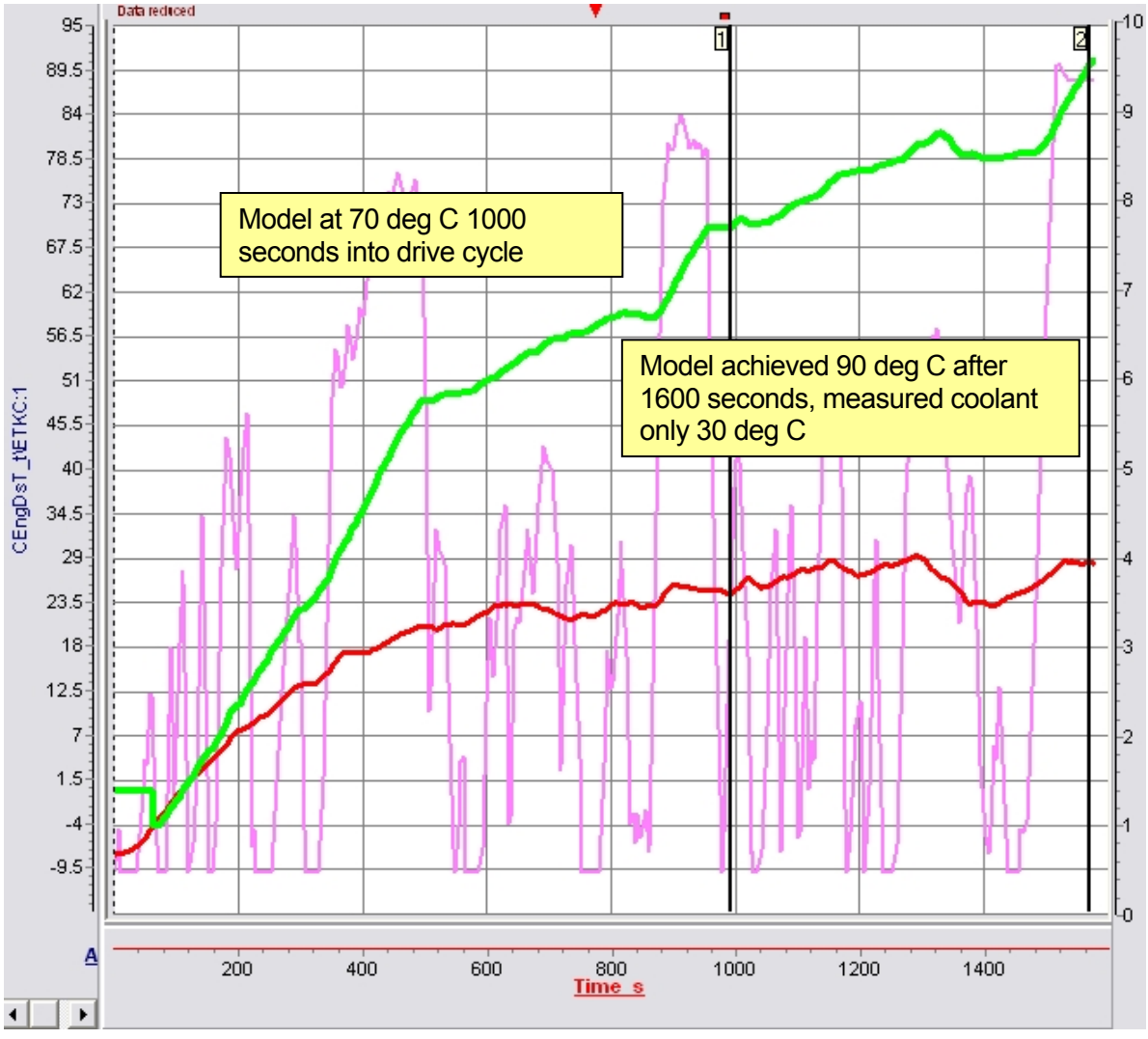
Typical Malfunction Thresholds:
Diesel Particulate Filter Restriction – Soot Accumulation (P2463) (Wrench Light) Calculated normalized restriction is 1.5 times the normal value for soot load. Diesel Particulate Filter Restriction – Forced Limited Power (P246C) (Immediate MIL and Wrench Light) Calculated normalized restriction is 2.0 times the normal value for soot load.

ENGINE COOLING SYSTEM MONITORING

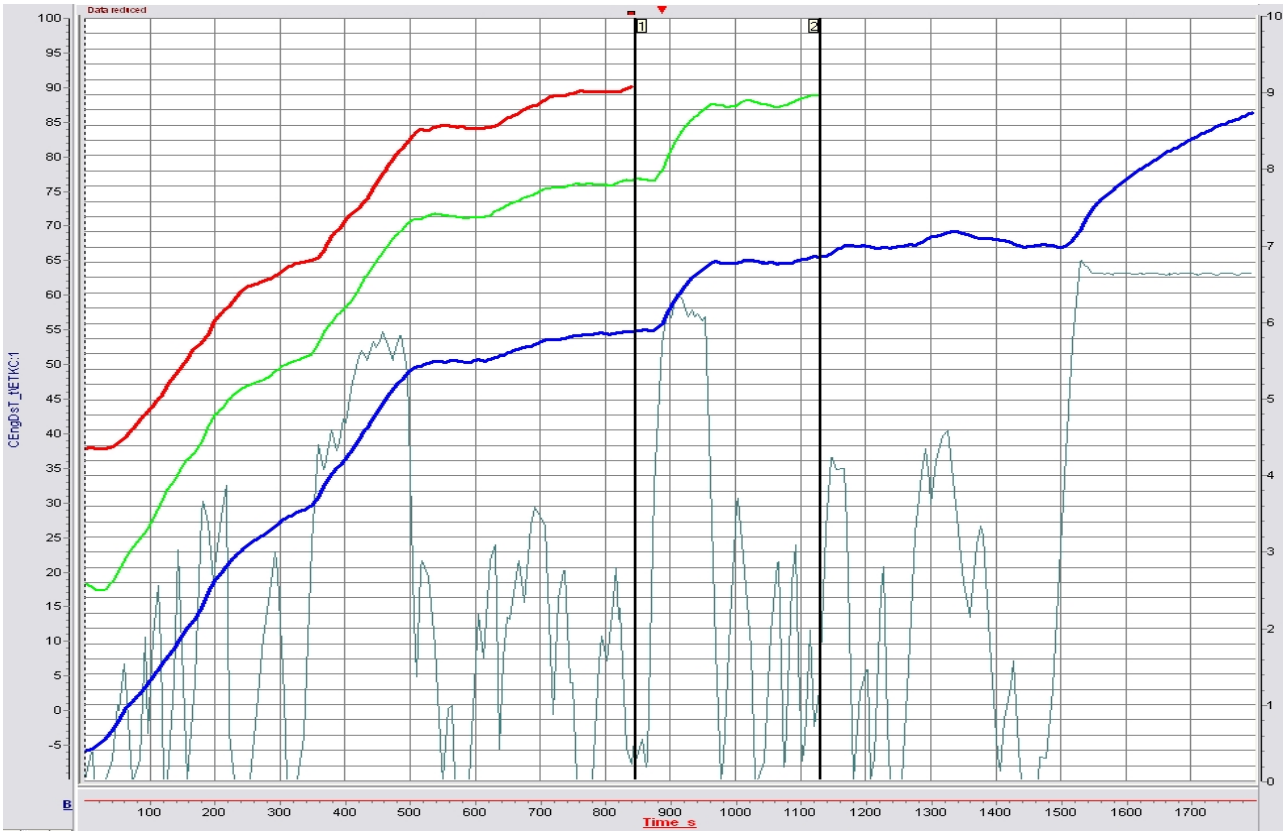
Thermostat Monitor

The Thermostat Monitor checks that the thermostat is operating properly by modeling Engine Coolant Temperature (ECT) based on engine fueling, engine speed, vehicle speed, and the ambient temperature. There are increment and decrement portions to the model; the increment is based on engine speed and fuel quantity, while the decrement is derived from calculated radiator efficiency based on coolant delta temp to ambient and vehicle speed. The model is delayed by 60 seconds after engine start to negate potential errors due to block heater use. It is also suspended while in catalyst warm-up mode due to errors in fuel quantity heat being contributed to the coolant.

Once that estimation reaches the thermostat start-to-open temperature, if the actual measured ECT has not reached a minimum warm-up temperature and the driver has not spent too much time in part fuel cut off (over 30%), too low load (over 70%), too high vehicle speed (over 70%), or too low vehicle speed (over 70%) - then the thermostat is determined to be stuck open.



Warmup at -7 deg C on Unified Drive Cycle, DTC set when modeled temp reaches 90 deg C. Measured coolant temperature was only at 30 deg C.



Warm-up profiles with nominal thermostat on Unified Drive Cycle at -7, 21 and 38 deg C ambient start temperatures.

Thermostat Monitor:			
DTCs	P0128 –Coolant Temp Below Thermostat Regulating Temperature		
Monitor Execution	Once per driving cycle		
Monitor Sequence	None		
Sensors OK	Engine Coolant Temperature (ECT), Intake Air Temperature (IAT), Vehicle Speed (VS)		
Typical Monitoring Duration	Nominal time it takes for engine to warm up to thermostat "Start-To–Open" temperature – see approximate times below. (Note: Unified Drive Cycle is 23.9 minutes long)		
	Ambient Temperature	Drive Cycle	Completion Time
	-7 deg C	Unified Drive Cycle + 70 mph cruise	33 min
	21 deg C	Unified Drive Cycle	19 min
	38 deg C	Unified Drive Cycle	14 min

Typical Thermostat Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Modeled engine coolant temperature	90 deg C	
Engine coolant temperature at start	-7 deg C	54 deg C
Intake air temperature at start	-7 deg C	
Ratio of time that the vehicle speed is above, 85 km/hr, to the total monitoring time		70%
Ratio of time that the engine fueling is below 20 mg/str to the total monitoring time		30%
Ratio of time that the engine torque is below 60 n/m to the total monitoring time		70%
Ratio of time that the vehicle speed is below 45 km/hr to the total monitoring time		70%

Typical Thermostat Monitor Malfunction Thresholds:
Measured Engine Coolant Temperature < 70 deg C

Primary Coolant Temp Dynamic Monitoring

To ensure the primary ECT sensor has not stuck below normal operating range, a simple dynamic check to verify a minimum rise in coolant temperature over a calibratable time has been implemented. If coolant temperature at start is greater than -35 deg C and less than 54 deg C, the monitor is enabled. At -35 deg C, the coolant is expected to rise up to -7 deg C in 291 seconds or less. If -7 deg C coolant temp. is not achieved in the required 291 second timeframe, a fault is detected. At a -7 deg C start temp, the coolant is expected to rise to 40 deg C in 5450 seconds- assuming worst case with EGR off, vehicle idling in neutral with heater on. Again, if the minimum temperature is not achieved in the required time, a fault is detected. This diagnostic is used in conjunction with the oil vs. coolant plausibility check, thermostat model, and SRC checks to verify proper ECT operation and engine warm-up.

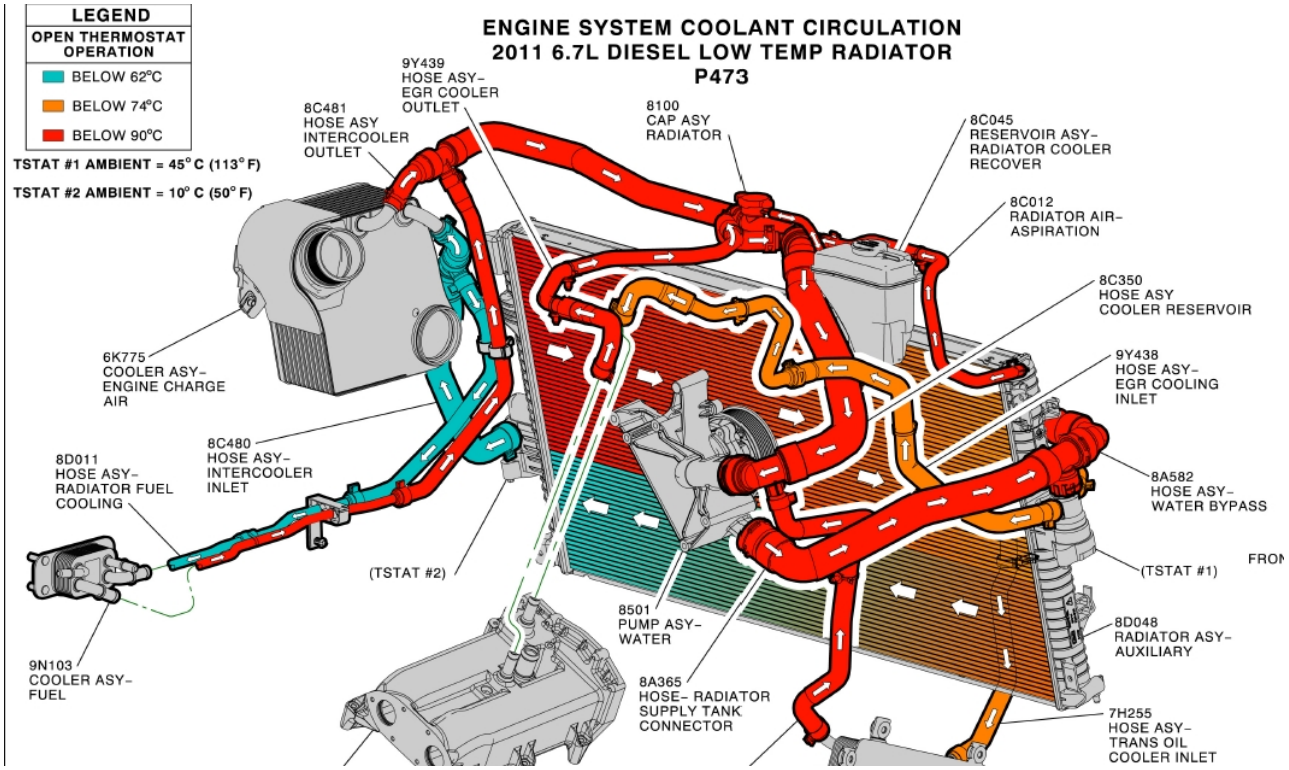
ECT Dynamic Monitor:	
DTCs	P0116 - Engine Coolant Temperature Sensor 1 Circuit Range/Performance
Monitor Execution	Once per trip
Monitor Sequence	None
Sensors OK	ECT
Typical Monitoring Duration	291 seconds at -35 deg C start temp. idle only 5150 seconds at -7 deg C start temp, idle only

Typical ECT Dynamic Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
Engine coolant temperature	-35 deg C	54 deg C
Engine speed	400 rpm	

Typical ECT Dynamic Monitor Malfunction Thresholds:
291 seconds at -35 deg C start temp to rise to -7 deg C
5150 seconds at -7 deg C start temp to rise to 40 deg C

Secondary Coolant Temp Dynamic Monitoring

The 6.7L engine has a secondary coolant loop with two thermostats, a 20C thermostat for the charge air cooler and fuel cooler, and a 45C thermostat for the EGR cooler and trans cooler. System schematic below:



The dynamic check to detect a stuck ECT2 sensor is identical in function to the dynamic check used for the primary coolant loop. A minimum rise is expected over a calibratable amount of time,

ECT2 Dynamic Monitor:	
DTCs	P2183 - Engine Coolant Temperature Sensor 2 Circuit Range/Performance
Monitor Execution	Once per trip
Monitor Sequence	None
Sensors OK	ECT2,
Typical Monitoring Duration	5750 sec at -35C, 200 at 25C

Typical ECT2 Dynamic Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
ECT2	-35 deg C	45 deg C
Engine Speed	400 rpm	

Typical ECT2 Dynamic Monitor Malfunction Thresholds:
within the time duration, must reach 25C

COLD START EMISSION REDUCTION STRATEGY MONITORING

Cold Start Emission Reduction System Monitor

The Post DOC temperature is monitored during a cold start for the CSER System Monitor. The modeled Post DOC temperature rise is compared to the measured Post DOC temperature rise. Specifically, the monitor compares the maximum temperature rises. An error is detected if the difference between the modeled and measured Post DOC maximum temperature rise is above a threshold.

Error if DTPost_DOC_model – DTPost_DOC_meas > Threshold

- DTPost_DOC_model = MAX(TPost_DOC_model) – INIT(TPost_DOC_model)
- MAX(TPost_DOC_model) = maximum of TPost_DOC_model during EOM3 ON and calibratable time after EOM3 switched to OFF
- INIT(TPost_DOC_model) = TPost_DOC_model when EOM3 ON
- Same method is used to calculate DTPost_DOC_meas

An error will also be detected if the modeled vs. measured post DOC maximum temperature rise is above a threshold.

CSER System Check Operation:	
DTCs	P050E – Cold Start Engine Exhaust Temperatures Too Low
Monitor execution	During EOM3 Operation, once per drive cycle
Monitor Sequence	None
Sensors OK	TIA, EGT1, EGT2, MAF, MAP, P3
Monitoring Duration	300 seconds

Typical CSER System entry conditions:		
Entry condition	Minimum	Maximum
Engine in EOM3 Mode		
Ambient Temperature	0 deg C	
Ambient Pressure	75 kPa	
Engine Coolant Temperature		50 deg C
Engine Soak Time	6 hr	
Engine Speed	750 rpm	2300 rpm
Engine Load (Torque)	50 Nm	700 Nm
Percentage of time with speed/torque conditions met	50%	
No Sensor Errors		
No Error in Air Path, EGR, Boost, Fuel Path, Fuel Quantity, Timing and Pressure Monitors		

Typical CSER System malfunction thresholds:
Modeled vs. Measured Post DOC Temperature Rise > 45 deg C.

Cold Start Emission Reduction Component Monitor

For all 2010 and subsequent model year vehicles that incorporate a specific engine control strategy to reduce cold start emissions, the OBD II system must monitor the components to ensure proper functioning. The monitor works by validating the operation of the components required to achieve the cold start emission reduction strategy, namely intake throttle and fuel balancing control.

Cold ITH Governor Deviation

The throttle valve has a component level diagnostic to make sure that the valve is not stuck or sticking in a manner such that it cannot reach the desired position. The monitor runs if a jammed valve is not already detected, position control is in closed-loop control, adaptive learning is not active, and EOM3 is active.

If the position governor deviation is above a maximum calibrated threshold then counter starts to count up for the detection of a permanent positive control fault. The rate at which the counter counts up is a function of the magnitude of the governor deviation and valve position. If the counter reaches a calibrated threshold then a jammed valve malfunction is detected. Similarly, if the position governor deviation is below a minimum calibrated threshold then a second counter starts to count up for the detection of permanent negative control deviation fault. Again, the rate at which the counter counts up is a function of the magnitude of the governor deviation and valve position. If the counter reaches a calibration threshold then a jammed valve is detected.

Actuator Jammed Valve Check Operation:	
DTCs	P02E1 – Diesel Intake Air Flow Control Performance,
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	1-5 seconds to register a fault. Dependent on magnitude and valve position during malfunction.

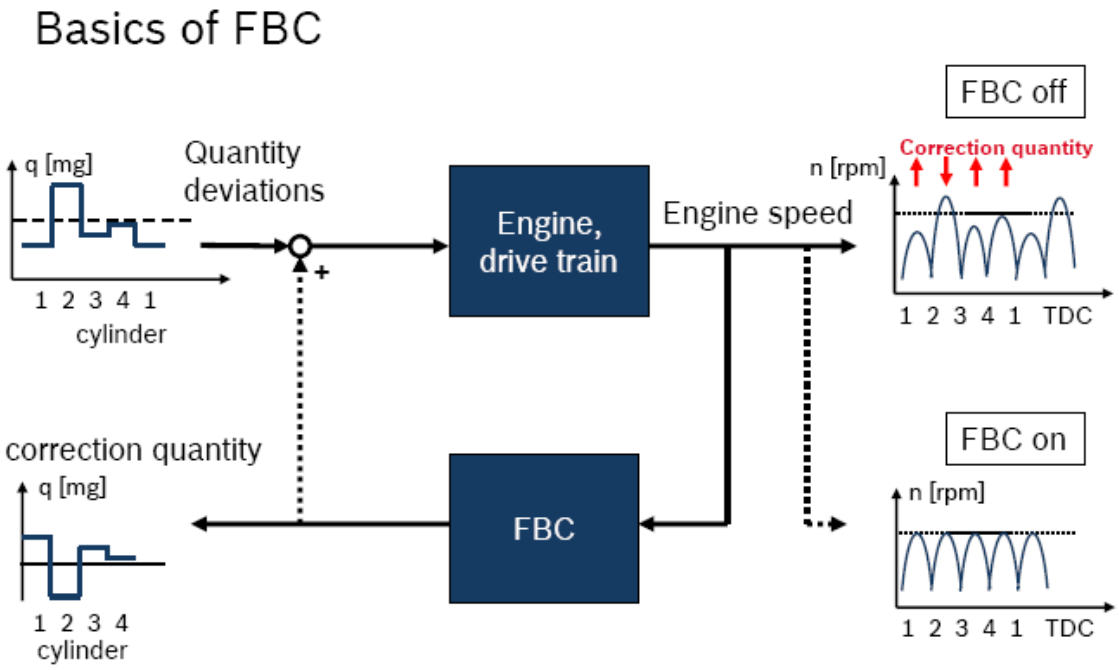
Typical Actuator Jammed Valve Entry Conditions:
Entry Condition
Governor Active (closed-loop position control)
Adaptive Learning Not Active
Jammed Valve Fault Not Present on Actuator

Typical Throttle Jammed Valve Check (P02E1) Malfunction Thresholds:
Position Governor Deviation > 12.5% or <-12.5 % and Counter Output > 100 %

Counter Rate Example: output: %/s x: Position Governor Deviation y: Valve Position						
x\y	**-100**	**-90**	**-80**	**-60**	**-40**	**-20**
0	20	20	20	20	20	20
20	20	20	20	20	20	20
40	20	20	20	20	20	20
60	20	20	20	20	20	20
80	20	20	20	20	20	20
100	100	80	20	20	20	20

Cold FBC

Fuel Balancing Control is an algorithm designed to reduce differences in injected fuel quantity from cylinder to cylinder. The increase in crankshaft speed due to individual cylinder combustion events is measured. The amount of fuel injected to each cylinder is then adjusted up or down to minimize the difference in increase in crankshaft speed from cylinder to cylinder. The total amount of fuel injected among all cylinders remains constant. The Cold FBC runs exactly the same as the normal FBC monitor, only difference is that it will run during EOM3 instead of EOM0. The concept is shown in the graphic below.



FBC operates in closed-loop control in an engine speed range of 500-1150 RPM, and a commanded injection quantity of 3.5 – 50 mg/stroke. The maximum allowed correction in fuel quantity for an individual cylinder is given by the following table.

CSER Component Monitor: Cold FBC Control Limits:			
	Injection quantity requested before FBC correction (mg/stroke)		
	3.5	7.5	30
Maximum allowable FBC correction (mg/stroke):	2.3	5	10

When the current correction for a given cylinder exceeds 99% of the allowable correction for the current conditions, a code is set.

CSER Component Monitor: Cold FBC Monitor Operation:	
DTCs	P0263 – Cylinder #1 Contribution/Balance P0266 – Cylinder #2 Contribution/Balance P0269 – Cylinder #3 Contribution/Balance P0272 – Cylinder #4 Contribution/Balance P0275 – Cylinder #5 Contribution/Balance P0278 – Cylinder #6 Contribution/Balance P0281 – Cylinder #7 Contribution/Balance P0284 – Cylinder #8 Contribution/Balance
Monitor Execution	P0263 – During EOM3 after a cold start P0266 – During EOM3 after a cold start P0269 – During EOM3 after a cold start P0272 – During EOM3 after a cold start P0275 – During EOM3 after a cold start P0278 – During EOM3 after a cold start P0281 – During EOM3 after a cold start P0284 – During EOM3 after a cold start
Monitor Sequence	None
Sensors OK	Crankshaft Position Sensor "A" Circuit (P0335) Crankshaft Position Sensor "A" Circuit Range/Performance (P0336)
Typical Monitoring Duration	10 sec

Typical CSER Component Monitor: Cold FBC Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
EOM3 Active		
Engine speed	500 rpm	1150 rpm
Injection quantity	3.5 mg/stroke	30 mg/stroke
Engine Temperature		
Barometric Pressure		
FBC wheel learn complete		

Typical CSER Component Monitor: Cold FBC Monitor Malfunction Thresholds:
If the current correction for the injector exceeds 90% of the allowable correction for current operation conditions, the code is set.

Engine Sensors

Air Temperature Rationality Test

An air temperature rationality test is performed once every drive cycle, after a long soak of 6 hours or greater. At key on, a temperature sample is taken of each of the following sensors: Ambient Air (AAT), Intake Air (IAT), Charge Air Cooler outlet (CACT1), EGR Cooler outlet (EGT COT), and Secondary Coolant Temperature (ECT2). Once a cold start has been confirmed, the temperature samples are compared against each other, and the temperature differences compared against a threshold. One sensor must fail plausibility with all four other sensors to set a fault for the sensor in question. If one or more sensors fail plausibility with three or fewer sensors, a general temperature plausibility fault is set. If a block heater has been detected, or if any sensor has been flagged for a pending signal range malfunction, the plausibility check is not performed.

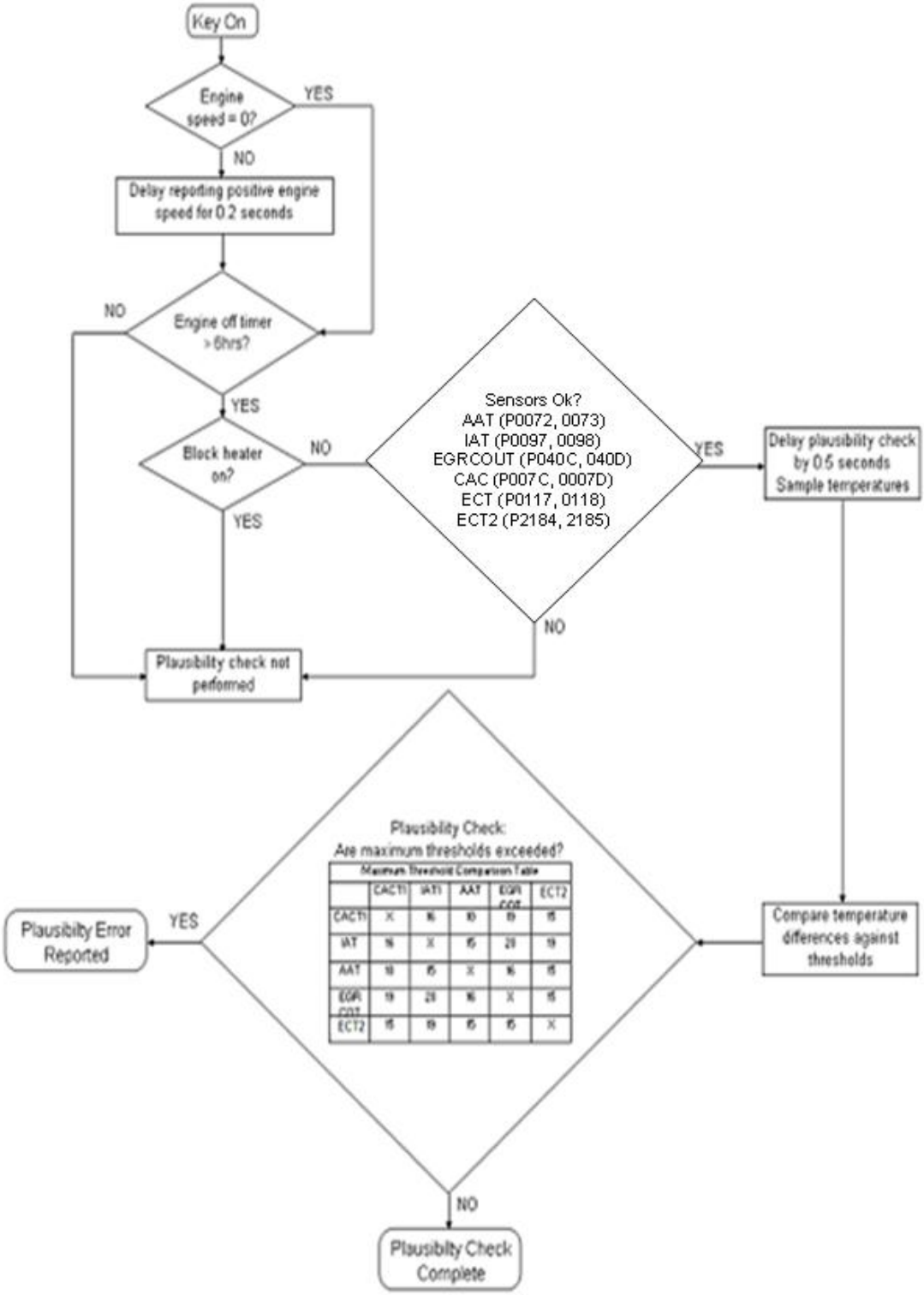


Figure : Air Temperature Plausibility Check Flow Chart

Ambient Air Temperature (AAT) Sensor Circuit Check:	
DTCs	P0072 – Ambient Air Temperature Circuit Low P0073 – Ambient Air Temperature Sensor Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	2 sec.

Typical Ambient Air Temperature Sensor Circuit Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	9 V	16.25 V
Key On		

Typical Ambient Air Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 V (-40 deg C) or voltage > 4.99 V (108 deg C)

Ambient Air Temperature Physical Range Check

A physical range check of ambient air temperature is performed on each drive cycle. It compares the measured value of ambient air temperature to a threshold of 72 deg C, if the threshold is exceeded a fault is detected.

Ambient Air Temperature (AAT) Sensor Physical Range Check:	
DTCs	P0070 - Ambient Air Temperature Circuit
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073),
Typical Monitoring Duration	4 seconds

Typical Ambient Air Temperature Sensor Plausibility Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	9 V	16.25 V
Key On		

Typical Ambient Air Temperature Sensor Plausibility Check Malfunction Thresholds:
If AAT > 72 deg C for 4 seconds a fault is detected and the code is set.

Ambient Air Temperature Rationality Check	
DTCs	P0071 – Ambient Air Temperature Sensor Range/Performance
Monitor Execution	Once per driving cycle. The check is disabled if a block heater is in use.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), EGT11 (P0548, P0549), EGRCOT (P040D, P040C), ECT (P0117, P0118), EOT (P0197, P0198), CACT1 (P007C, P007D)
Typical Monitoring Duration	0.5 sec

Typical Ambient Air Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	N/A
Engine coolant temperature	-35 deg C	121 deg C

Typical Ambient Air Temperature Rationality Check Thresholds:	
AAT Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
CACT1	10 deg C
IAT1	15 deg C
EGRCOT	16 deg C
ECT2	20 deg C

Ambient Air Temperature Plausibility Check

An air temperature vs. environmental temp plausibility check is performed on each drive cycle. It compares the absolute difference of IAT1 and AAT, if the difference is greater than 55C for 5 minutes and vehicle speed is above 80.5 km/h when coolant temp is less than 100 deg C, a fault is detected.

Ambient Air Temperature (AAT) Sensor Plausibility Check:	
DTCs	P009A - Intake Air Temperature /Ambient Air Temperature Correlation
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	5 minutes

Typical Ambient Air Temperature Sensor Plausibility Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	9 V	16.25 V
Vehicle Speed	80.5 km/h	
IAT1 Temp	-40 deg C	121 deg C
Coolant Temp	-40 deg C	100 deg C
Environmental Temp	-40 deg C	80 deg C
Key On		

Typical Ambient Air Temperature Sensor Plausibility Check Malfunction Thresholds:
If IAT1 – AAT > 55 deg C for 5 minutes, a fault is detected and the code is set.

Charge Air Cooler (CACT1) Sensor Circuit Check:	
DTCs	P007C – Charge Air Cooler Temperature Sensor Circuit Low P007D – Charge Air Cooler Temperature Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	4 sec

Typical Charge Air Cooler Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.092 V (161 deg C) or voltage > 4.90 V (-43 deg C)

Charge Air Cooler Temperature (CACT1) Rationality Check:	
DTCs	P007B - Charge Air Cooler Temperature Sensor Circuit Range/Performance
Monitor Execution	Once per drive cycle. The check is disabled if a block heater is in use.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), EGT11 (P0548, P0549), EGRCOT (P040D, P040C), ECT (P0117, P0118), EOT (P0197, P0198), CACT1 (P007C, P007D)
Typical Monitoring Duration	0.5 sec

Typical Charge Air Cooler Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Coolant Temp	-35 deg C	121 deg C

Typical Charge Air Cooler Temperature Functional Thresholds:	
CACT1 Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
AAT	10 deg C
IAT1	16 deg C
EGRCOT	19 deg C
ECT2	20 deg C

Intake Air Temperature (IAT) Sensor Circuit Check:	
DTCs	P0112 - Intake Air Temperature Sensor Circuit Low P0113 - Intake Air Temperature Sensor Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	4 sec.

Typical Intake Air Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 volts (137 deg C) or voltage > 4.91 volts (-25 deg C)

Intake Air Temperature Rationality Check	
DTCs	P0111 – Temperature Sensor Circuit Range/Performance
Monitor Execution	Once per drive cycle. The check is disabled if a block heater is in use.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), EGT11 (P0548, P0549), EGRCOT (P040D, P040C), ECT (P0117, P0118), EOT (P0197, P0198), CACT1 (P007C, P007D)
Typical Monitoring Duration	0.5 sec

Typical Intake Air Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Coolant Temp	-35 deg C	121 deg C

Typical Intake Air Temperature Functional Thresholds:	
IAT Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
AAT	15 deg C
CACT1	16 deg C
EGTCOT	20 deg C
ECT2	20 deg C

EGR Cooler Downstream Temperature (EGR COT) Sensor Circuit Check:	
DTCs	P040C – Exhaust Gas Recirculation Temperature Sensor Circuit Low P040D – Exhaust Gas Recirculation Temperature Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	3 sec.

Typical EGR Cooler Downstream Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 volts (961 deg C) or voltage > 4.90 volts (-46 deg C)

EGR Cooler Downstream Temperature Rationality Check	
DTCs	P041B – Exhaust Gas Recirculation Temperature Sensor Circuit Range/Performance
Monitor Execution	Once per drive cycle. The check is disabled if a block heater is in use.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), EGT11 (P0548, P0549), EGRCOT (P040D, P040C), ECT (P0117, P0118), EOT (P0197, P0198), CACT1 (P007C, P007D)
Typical Monitoring Duration	0.5 sec

Typical EGR Cooler Downstream Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Coolant Temp	-35 deg C	121 deg C

Typical EGR Cooler Downstream Temperature Functional Thresholds:	
EGRCOT Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
AAT	16 deg C
CACT1	19 deg C
IAT1	20 deg C
ECT2	20 deg C

Secondary Engine Coolant Temperature (ECT2) Sensor Circuit Check:	
DTCs	P2184 - Engine Coolant Temperature Sensor 2 Circuit Low P2185 - Engine Coolant Temperature Sensor 2 Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	2 sec.

Typical Secondary Engine Coolant Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key On		
Battery Voltage	9 V	16.25 V

Typical Secondary Engine Coolant Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 (163 deg C) volts or voltage > 4.91 volts (-44 deg C)

Secondary Engine Coolant Temperature Rationality Check	
DTCs	P2182 – Engine Coolant Temperature Sensor 2 Circuit
Monitor Execution	Once per drive cycle. The check is disabled if a block heater is in use.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), EGT11 (P0548, P0549), EGRCOT (P040D, P040C), ECT (P0117, P0118), EOT (P0197, P0198), CACT1 (P007C, P007D)
Typical Monitoring Duration	0.5 sec

Typical Secondary Engine Coolant Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Coolant Temp	-35 deg C	121 deg C

Typical Secondary Engine Coolant Temperature Functional Thresholds:	
ECT2 Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
AAT	20 deg C
CACT1	20 deg C
IAT1	20 deg C
EGRCOT	20 deg C

Barometric Pressure and Manifold Absolute Pressure

Barometric Pressure (BP) Sensor Circuit Check:	
DTCs	P2227 – Barometric Pressure Sensor "A" Circuit Range/Performance P2228 – Barometric Pressure Circuit Low Input P2229 – Barometric Pressure Circuit High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P2227 – 1 sec P2228, P2229 –.5 sec.

Typical Barometric Pressure Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Battery voltage (IVPWR)	9 V	16.25 V

Typical Barometric Pressure Sensor Circuit Check Malfunction Thresholds:
P2227 – Observed pressure less than 50 kPa
P2228 - Voltage less than 0.25 V. (6.3 kPa)
P2229 - Voltage greater than 4.85 V. (115 kPa)

Manifold Absolute Pressure (MAP) Sensor Circuit Check:	
DTCs	P0107 - Manifold Absolute Pressure/BARO Sensor Low Input P0108 - Manifold Absolute Pressure/BARO Sensor High Input
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0107, P0108 - 2 sec.

Typical Manifold Absolute Pressure Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key-on		
Battery voltage (IVPWR)	9 V	16.25 V

Typical Manifold Absolute Pressure Sensor Circuit Check Malfunction Thresholds:
P0107 – Voltage less than .1 V (50 kPa)
P0108 – Voltage greater than 4.745 V (390 kPa)

Manifold Absolute Pressure (MAP) / Barometric Pressure (BP) Rationality Check:	
DTCs	P0069 – MAP/BARO Correlation
Monitor Execution	Once per trip
Monitor Sequence	None
Sensors OK	BARO (P2228, P2229), MAP (P0107, P0108)
Typical Monitoring Duration	1.5 sec.

Typical MAP / BP Rationality Check Entry Conditions:		
Entry condition	Minimum	Maximum
P0069 - MAP / BARO Correlation:		
Key-on		
Battery voltage (IVPWR)	9 V	16.25 V
Engine Speed (N)	0 rpm	437.5 rpm

Typical MAP / BP Rationality Check Malfunction Thresholds:
P0069 - The difference between MAP and BARO is greater than 4.5 kPa, or less than -8 kPa.

Turbine Upstream Pressure Sensor Plausibility Checks

The turbine upstream pressure sensor has two plausibility checks to determine if the sensor is operating correctly. The first check looks for an offset in the turbine upstream pressure sensor when the engine is not running. This check compares the measured turbine upstream pressure to the measured environmental pressure under specific entry conditions. If the pressure difference exceeds the threshold, for a predetermined amount of time while the entry conditions are met, a fault is set.

Turbine Upstream Pressure Sensor Offset Plausibility Check Operation:	
DTCs	P0471– Exhaust Pressure Sensor "A" Circuit Range/Performance
Monitor execution	Continuous in pre-drive state.
Monitor Sequence	None
Monitoring Duration for stuck midrange	5.0 seconds to register a malfunction

Turbine Upstream Pressure Sensor Offset Entry Conditions		
Entry Condition:	**Minimum**	**Maximum**
Turbine Upstream Pressure Sensor is not Frozen		
Ambient Pressure	750 hPa	
Ambient Air Temperature	5 deg C	
Coolant Temperature	5 deg C	
Engine State is Pre-Drive (key on, prior to crank)		
No Turbine Upstream Pressure Sensor		

Typical Upstream Turbine Pressure Sensor Plausibility Check Malfunction Thresholds:
(Turbine Pressure Sensor – Ambient Pressure Sensor) > 75 hPa

The second check compares the measured turbine upstream pressure to a model of the turbine upstream pressure under specific entry conditions. If the difference between the measured and modeled pressure is greater than a threshold, for a predetermined amount of time while the entry conditions are met, a fault is set.

Turbine Upstream Pressure Sensor -Model Plausibility Check Operation:	
DTCs	P0471– Exhaust Pressure Sensor "A" Circuit Range/Performance
Monitor execution	Continuous when entry conditions are met.
Monitor Sequence	None
Monitoring Duration for stuck midrange	2.0 seconds to register a malfunction

Turbine Upstream Pressure Sensor Offset Entry Conditions		
Entry Condition:	**Minimum**	**Maximum**
Turbine Upstream Pressure Sensor is not Frozen		
Coolant Temperature	50 deg C	
Engine Speed	1300 rpm	2400 rpm
Engine Torque	500 Nm	1400 Nm
Ambient Air Temperature	5 deg C	
Ambient Pressure	745 hPa	

Typical Upstream Turbine Pressure Sensor Plausibility Check Malfunction Thresholds:
(Turbine Pressure Model – Turbine Pressure Sensor) > 900 hPa

Upstream Turbine Pressure Sensor Signal Range Check

Reductant Pressure Sensor Open/Short Check Operation:	
DTCs	P0472 - Exhaust Pressure Sensor "A" Circuit Low P0473 - Exhaust Pressure Sensor "A" Circuit High
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	2 seconds to register a malfunction

Typical Reductant Pressure Sensor Check Malfunction Thresholds:
Pressure sensor voltage < 0.100 volts or Pressure sensor voltage > 4.8 volts

EGR Valve Position Sensor

Analog inputs checked for opens or shorts by monitoring the analog -to-digital (A/D) input voltage.

EGR Valve Position Sensor Check Operation:	
DTCs	P0405 (EGR Sensor "A" Circuit Low) P0406 (EGR Sensor "A" Circuit High)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	3 seconds to register a malfunction

Typical EGR Valve position sensor check malfunction thresholds (P0405,P0406):
Voltage < 0.30 volts or Voltage > 4.70 volts

Throttle Position Sensor

Analog inputs checked for opens or shorts by monitoring the analog -to-digital (A/D) input voltage.

Throttle Position Sensor Check Operation:	
DTCs	P02E9 (Diesel Intake Air Flow Position Circuit High), P02E8 (Diesel Intake Air Flow Position Circuit Low).
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	3 seconds to register a malfunction

Typical TP sensor check malfunction thresholds (P02E8,P02E9):
Voltage < 0.08 volts or Voltage > 4.92 volts

EGR Downstream Temperature Sensor Dynamic Plausibility Check

The EGR Downstream temperature sensor rationality test checks to make sure that the sensor is not stuck in a range that causes other OBD to be disabled. If after a long (8 hour) soak and ECT < 70°C, then the temp at start is compared to the temp after a calibrated elapsed runtime. If the change in temperature downstream of the EGR cooler is below the minimum calibrated threshold (5°C), then the sensor is assumed to be stuck in range.

EGR Downstream Temperature Sensor Dynamic Plausibility Check Operation:	
DTCs	P040B – EGR Temperature Sensor "A" Circuit Range/Performance
Monitor execution	Once per driving cycle
Monitor Sequence	None
Monitoring Duration for stuck midrange	0.5 seconds to register a malfunction

Typical EGR Downstream Temperature Sensor Dynamic Plausibility check entry conditions:		
Entry Condition	**Minimum**	**Maximum**
Engine-off time (soak time)	480 min	
Engine run timer	300 sec	
Engine Coolant Temperature	70°C	
Engine Coolant Temperature at Start		70°C
Engine Speed	1000 rpm	3000 rpm
Engine Torque	100 N-m	300 N-m
EGR Valve Positions (Actual)	10%	60%

Typical EGR Downstream Temperature Sensor Plausibility check malfunction thresholds:
TEGRDs (at 300 sec) – TEGRDs (at Start) < dtMinDyn (5°C) then sensor is stuck in range.

Engine Coolant & Engine Oil Correlation

The engine coolant temperature sensor reading and engine oil temperature sensor readings are tested for plausibility once per drive cycle after a long soak (6hrs or more). The values of the coolant and oil temperature sensor readings are recorded at start up. Once it has been determined that the enable conditions have been achieved, upper and lower thresholds are determined based on the engine-off time. The difference of the initial oil and coolant temperatures are compared to this threshold. If the lower threshold is not achieved, a fault is reported. If the lower threshold is met, but the upper threshold is not achieved and a block heater is not in use, a fault is reported. If a block heater is detected and the diference is greater than 40C, a fault is reported.

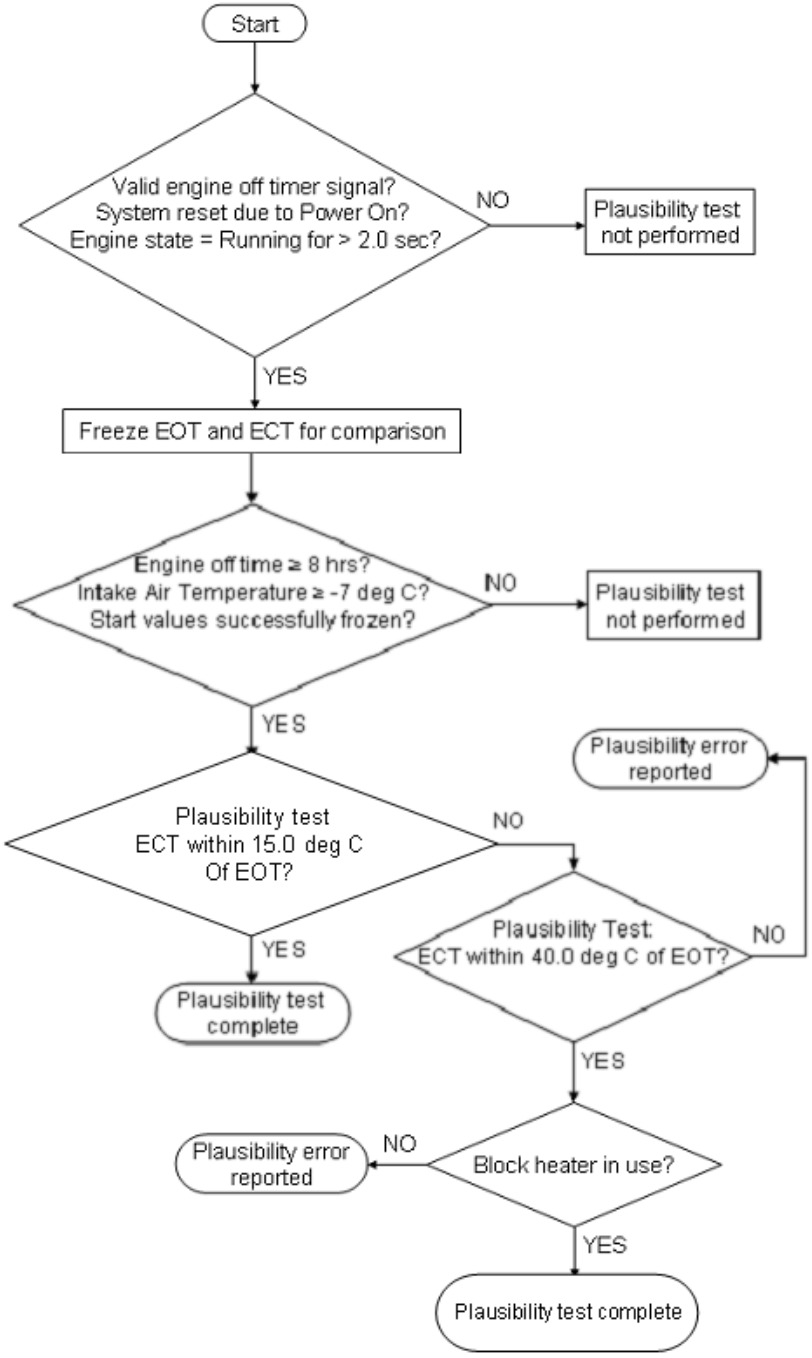


Figure #: ECT/EOT Plausibility Correlation Test Flow Chart

Engine Coolant Temperature (ECT) Sensor Circuit Check:	
DTCs	P0117 - Engine Coolant Temperature Sensor Circuit Low P0118 - Engine Coolant Temperature Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	2 sec.

Typical Engine Coolant Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key On		
Battery Voltage	9 V	16.25 V

Typical Engine Coolant Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 (163 deg C) volts or voltage > 4.91 volts (-44 deg C)

Engine Coolant Temperature Rationality Check	
DTCs	P012F – Engine Coolant Temperature / Engine Oil Temperature Correlation
Monitor Execution	Once per drive cycle.
Monitor Sequence	None
Sensors OK	AAT (P0072, P0073), IAT1 (P0112, P0113), ECT (P0117, P0118), EOT (P0197, P0198)
Typical Monitoring Duration	Immediate when conditions exist

Typical Engine Coolant Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Intake Air Temp	-7 deg C	
Engine “Running” Time	2 sec	

Typical Engine Coolant Temperature Functional Thresholds:	
ECT Rationality is confirmed against EOT:	
Absolute Temperature Difference	15 deg C

Engine Coolant Temperature in range Rationality Check	
DTCs	P0196 –Engine Oil Temperature Sensor Range/Performance
Monitor Execution	Once per drive cycle.
Monitor Sequence	None
Sensors OK	ECT (P0117, P0118), EOT (P0197, P0198)
Typical Monitoring Duration	Immediate when conditions exist

Typical Engine Coolant Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	6 hrs	
Engine Coolant Temp	70C	

Typical Engine Coolant Temperature Functional Thresholds:	
ECT Rationality is confirmed against EOT:	
Absolute Temperature Difference	35 deg C

Engine Oil Temperature (EOT) Sensor Circuit Check:	
DTCs	P0197 - Engine Oil Temperature Sensor Circuit Low P0198 - Engine Oil Temperature Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	Not Applicable
Typical Monitoring Duration	2 sec.

Typical Engine Oil Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Key On		
Battery Voltage	9 V	16.25 V

Typical Engine Oil Temperature Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 (163 deg C) volts or voltage > 4.91 volts (-44 deg C)

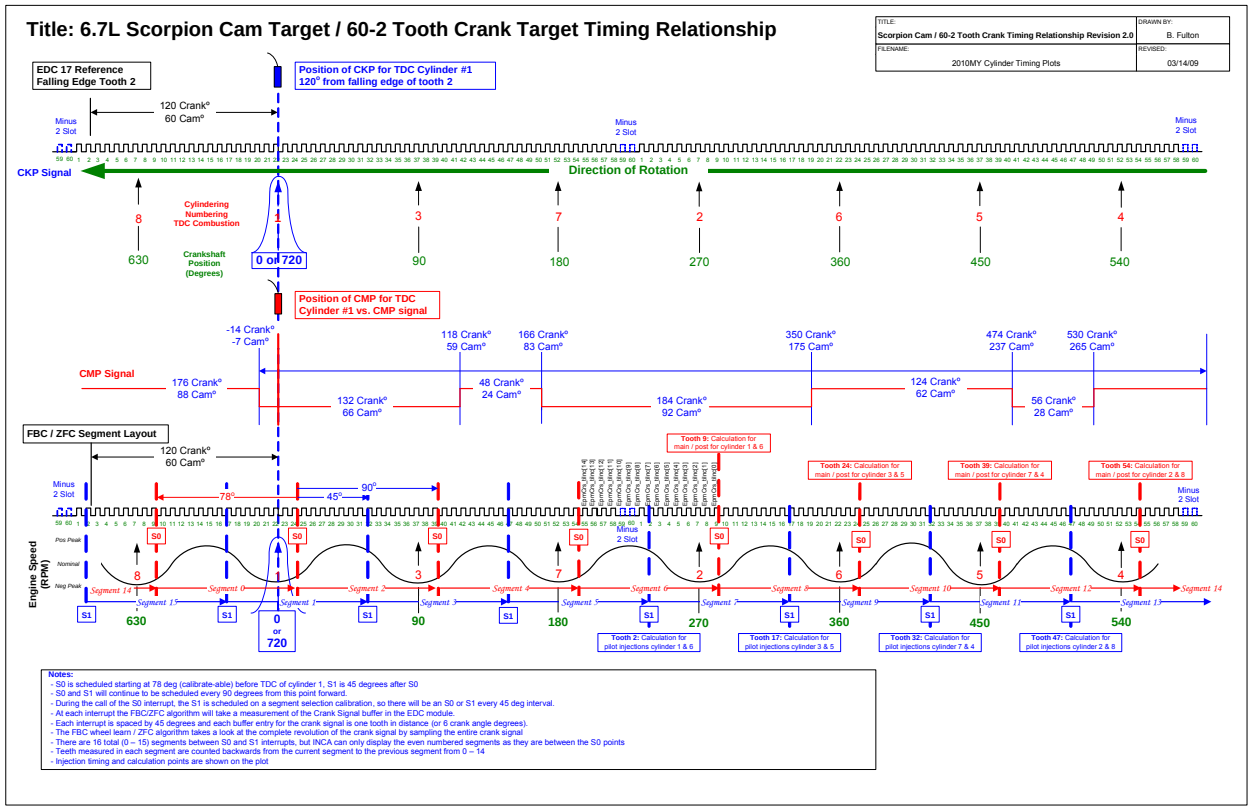
Engine Coolant System Leak Check:	
DTCs	P2560 - Engine Oil Temperature Sensor Circuit Low
Monitor execution	Continuous

Monitor Sequence	None
Sensors OK	ECT and OIL temp.
Typical Monitoring Duration	5 sec.

Typical Engine Oil Temperature Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Engine Oil Temp	70C	

Typical Engine Oil Temperature Sensor Circuit Check Malfunction Thresholds:
Oil Temperature is greater then coolant temperature by 50C

Cam and Crank Sensor:



Camshaft and Crankshaft Sensor Monitor Operation:	
DTCs	P0016 – Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A) P0315 – Crankshaft Position System Variation Not Learned P0335 – Crankshaft Position Sensor "A" Circuit P0336 – Crankshaft Position Sensor "A" Circuit Range/Performance P0340 – Camshaft Position Sensor "A" Circuit (Bank 1 or single sensor) P0341 – Camshaft Position Sensor "A" Circuit Range/Performance (Bank 1 or single sensor)
Monitor Execution	P0016 – Continuous P0315 – Continuous P0335 – Continuous P0336 – Continuous P0340 – Continuous P0341 – Continuous
Monitor Sequence	None
Sensors OK	P0016 – Sensor Supply Voltage 1 (P06A6), Sensor Supply Voltage 2 (P06A7) P0315 – Sensor Supply Voltage 1 (P06A6), Crankshaft Sensor (P0335, P0336) P0335 – Sensor Supply Voltage 1 (P06A6) P0336 – Sensor Supply Voltage 1 (P06A6) P0340 – Sensor Supply Voltage 2 (P06A7) P0341 – Sensor Supply Voltage 2 (P06A7)
Typical Monitoring Duration	P0016 – 3.6 sec ,P0315 – 5000 sec of overrun/decel fuel shut-off P0335 – 1.8 sec, P0336 – 1.8 sec, P0340 – 3 sec, P0341 – 1.2 sec

Typical Camshaft and Crankshaft Sensor Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0016 – Engine running or cranking		
P0315 – Overrun/decel fuel shut-off		
P0335 – Engine running or cranking		
P0336 – Engine running or cranking		
P0340 – Engine running or cranking		
P0341 – Engine running or cranking		

Typical Camshaft Sensor Monitor Malfunction Thresholds:

P0016 – If the location of the gap on the crankshaft sensor wheel occurs at a location on the camshaft sensor wheel that is more than 18 degrees from the expected location for two detection attempts, the code is set

P0315 – If after 5000 total seconds of overrun/decel fuel shut-off, the system has been unable to learn crankshaft wheel deviation corrections, the code is set

P0335 – If no signal is detected from the crankshaft sensor, the code is set

P0336 – If the gap in the 60-2 tooth wheel is not detected for three revolutions, the code is set

P0340 – If no signal is detected from the camshaft sensor, the code is set

P0341 – If the segment profile detected does not match the segment profile shown in the figure above, the code is set

Mass Air Meter

The 6.7L engine utilizes a frequency-based hot film air meter. The digital output varies its period to indicate a change in mass air flow. If the period is outside of a specified range, a fault is detected and the appropriate P-code is set.

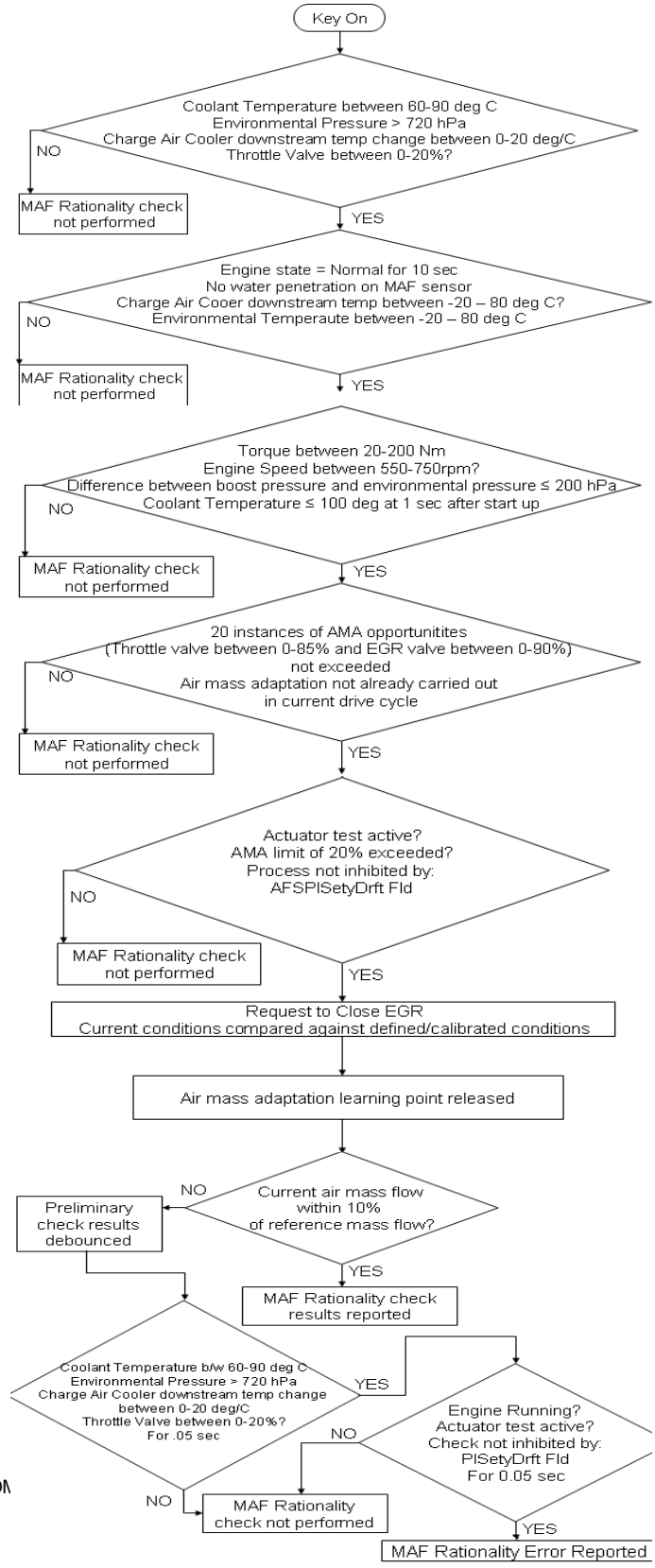
MAF Sensor Circuit Check:	
DTCs	P0100 – Mass or Volume Air Flow "A" Circuit P0102 – Mass or Volume Air Flow "A" Circuit Low P0103 – Mass or Volume Air Flow "A" Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	P0100 – 1.5 sec P0102 – 2 sec P0103 – 2 sec

MAF Sensor Circuit Check Entry Conditions:		
Entry condition	Minimum	Maximum
Battery voltage	9 V	16.25 V
Key on		

MAF Sensor Circuit Check Malfunction Thresholds:
P0100 – hard coded, not visible in software
P0102 – period less than 62 us
P0103 – period greater than 4000 us

MAF Rationality Check

A rationality check of the mass air flow sensor is performed each time an air mass adaption (AMA) executes. AMA adapts at two points- one at idle, the other at a specific speed/load. The ratio between the mass air flow and the reference mass air flow is calculated with the EGR valve in the closed position. This ratio is compared against a threshold once AMA has been released. The release of this plausibility check occurs under strict engine operating and environmental conditions to minimize the affect of outside influences on mass air flow. At each AMA event, the corrected value is stored for each point. These stored values are compared to a threshold, if the stored values are greater than a threshold a fault is detected, as the air meter has drifted outside of its nominal operating range. The figure below outlines the strategy for the rationality check.



Mass Air Flow Sensor Functional Check Operation:	
DTCs	P2073 – Manifold Absolute Pressure/Mass Air Flow - Throttle Position Correlation at Idle P2074 – Manifold Absolute Pressure/Mass Air Flow - Throttle Position Correlation at Higher Load
Monitor Execution	Once per drive cycle
Monitor Sequence	None.
Sensors OK	MAF (P0100, P0101, P0102), BP (P2228, P2229), EGRP (P0405, P0406, P0404, P0042E, P042F, P1335),
Typical Monitoring Duration	Continuous

Typical Mass Air Flow Sensor Functional Check Entry Conditions:		
Entry condition	Minimum	Maximum
Barometric Pressure	75 kPa	110 kPa
Engine Coolant Temperature	70 deg C	90 deg C
Throttle Valve	0%	20%
CAC Downstream Temperature	-20 deg C	80 deg C
Ambient Air Temperature	-20 deg C	80 deg C
Time engine running Normal	10 seconds	
No Water Penetration Detected in Sensor		
Engine Coolant Temperature at 1 second after key on		100 deg C
Difference in Barometric Pressure versus Pressure in Induction Volume		20 kPa
Engine Torque	20 Nm	200 Nm
Engine Speed	550 rpm	750 rpm

Typical Mass Air Flow Sensor Functional Check Malfunction Thresholds:
If the final AMA stored value in either the idle or higher load cell is greater than 15% or less than -15%, a fault is detected and the appropriate P-code is set.

Mass Air Flow Sensor Plausibility Check Operation:	
DTCs	P1102 – Mass Air Flow Sensor In Range But Lower Than Expected P1103 – Mass Air Flow Sensor In Range But Higher Than Expected
Monitor Execution	Continuous
Monitor Sequence	None.
Sensors OK	MAF (P0100, P0101, P0102), BP (P2228, P2229), EGRP (P0405, P0406, P0404, P0042E, P042F, P1335),
Typical Monitoring Duration	10 seconds

Typical Mass Air Flow Sensor Plausibility Check Entry Conditions:		
Entry condition	Minimum	Maximum
Barometric Pressure	75 kPa	110 kPa
Engine Coolant Temperature	70 deg C	121 deg C
Ambient Air Temperature	-20 deg C	80 deg C
Time engine running Normal	5 seconds	
Key On		

Typical Mass Air Flow Sensor Plausibility Check Malfunction Thresholds:
If Mass Air Flow is greater than AFS_dmMinThresMoB1, or less than AFS_dmMaxThresMoB1 for 10 seconds, a fault is detected and a P-code is set.

Minimum AFS Threshold Map								
RPM	**400**	**600**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**
Airflow	**0**	**25**	**100**	**130**	**130**	**150**	**180**	**210**

Maximum AFS Threshold Map								
RPM	**600**	**750**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**
Airflow	**300**	**400**	**540**	**850**	**1100**	**1350**	**1550**	**1550**

DEF Pressure Sensor

The DEF pressure control system uses the measured DEF pressure in a feedback control loop to achieve the desired DEF pressure. The DEF injection algorithm uses actual DEF pressure in its computation of DEF injector pulse width.

The DEF sensor is a gauge sensor. Its atmospheric reference hole is near the electrical connector. The DEF pressure sensor has a nominal range of 0 to 0.8 MPa (0 to 8 bar, 0 to 116 psi). This pressure range is above the maximum intended operating pressure of 0.5 MPa. The sensor voltage saturates at slightly above 0.5 and slightly below 4.5 volts.



DEF Pressure Sensor

DEF pressure is often a vacuum when the system purges after running. Vacuums cannot be measured by the DEF pressure gauge sensor as voltages will not be lower than 0.5 Volts.

DEF Pressure Sensor Transfer Function		
DEF Pump Pressure (PSI) = 29 * Voltage - 14.5		
Volts	**Pressure, MPa (gauge)**	**Pressure, psi (gauge)**
5.00	0.8	116
4.50	0.8	116
3.50	0.6	87
2.50	0.4	58
1.00	0.1	14
0.500	0.0	0
0.250	0.0	0

Reductant Pressure Sensor Signal Range Check

Reductant Pressure Sensor Open/Short Check Operation:	
DTCs	P204C - Reductant Pressure Sensor Circuit Low P204D - Reductant Pressure Sensor Circuit High
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	0.4 seconds to register a malfunction

Typical Reductant Pressure Sensor Check Malfunction Thresholds:
Pressure sensor voltage < 0.20 volts or Pressure sensor voltage > 4.8 volts

A reductant Pressure Sensor that is substantially in error results in a DEF system fault (over or under injection). If actual DEF pressure exceeds measured pressure, more DEF than that which would be expected is injected and vice versa. This error would show up in the long term adaption trim (DEF LTA).

Reductant Pressure Plausibility Check before Start-up

If the hydraulic circuit of the DEF system (pump, pressure line, & injector) is completely empty, i.e. purge cycle was successfully completed during previous drive cycle, the DEF pressure is expected to read 0 kPa. Based on sensor tolerances the deviation from zero is limited to 30 kPa.

Reductant Pressure Plausibility Check Operation:	
DTCs	P204B (SRC error for Reductant Pressure Sensor)
Monitor execution	Continuous, prior to pressure build-up
Monitor Sequence	P204B is inhibited by active P204C or P204D codes
Sensors/Actuators OK	none
Monitoring Duration	0.6 seconds to register a malfunction

Typical Reductant Pressure Plausibility Check Entry Conditions:		
Entry Condition	Minimum	Maximum
DEF pump and line not primed		0
DEF system not pressurized		
DEF tank and pump not frozen	True	

Typical Reductant Pressure Plausibility Check Malfunction Thresholds:
P204B: > 30 kPa for 0.6 sec

DEF Pressure Build-up Check at Start-up

After the fill cycle is completed, the injector is closed and the system pressure is expected to rise.

Reductant Pressure Functional Check:	
DTCs	P20E8 – Reductant Pressure too Low
Monitor execution	Once during pressure build-up
Monitor Sequence	P20E8 is inhibited by active P204B, P204C or P204D codes
Sensors/Actuators OK	Reductant pressure sensor, Reductant pump motor, injector
Monitoring Duration	1 event (3 times 15 seconds)

Typical Reductant Pressure Plausibility Check Entry Conditions:		
Entry Condition	Minimum	Maximum
DEF pump and line not primed		0
DEF system not pressurized		
DEF tank not frozen	True	

Typical Reductant Pressure Plausibility Check Malfunction Thresholds:
P204B: pressure does not exceed 350 kPa after 45 sec with spinning pump

DEF System Pressure Control

DEF pressure is maintained via:

- Feedback knowledge of sensed pressure.

A set point pressure is determined by engine operating conditions (500 kPa over exhaust backpressure). If a pressure increase is desired, the urea pump motor speed is increased by increasing the PWM output. Pressure decreases are analogous; as the system has a backflow throttle, pressure will decrease to 0 unless the pump motor in run continuously.

Reductant Pressure Control (Normal) Functional Check Operation:	
DTCs	P20E8 - Reductant Pressure Too Low P20E9 - Reductant Pressure Too High
Monitor execution	Continuous
Monitor Sequence	P20E8 & P20E9 are inhibited by active P204b, P204C or P204D codes
Sensors/Actuators OK	reductant pump pressure sensor, reductant pump motor, reductant injector
Monitoring Duration	> 10 sec (resp. > 60 sec, see below)

Typical Reductant Pressure Control (Normal) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
DEF system pressure in closed loop control previously	True	

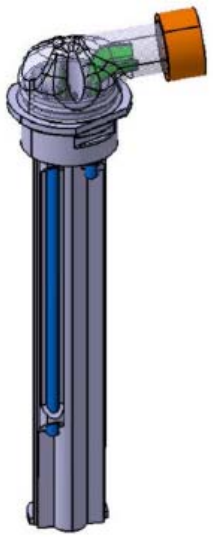
Typical Reductant Pressure Control (Normal) Functional Check Malfunction Thresholds:
P20E8: < 400 kPa for 60 sec respectively < 300 kPa for 10 sec P20E9: > 650 kPa for 10 sec respectively > 790 kPa for 1 sec

Reductant Tank Level Sensor

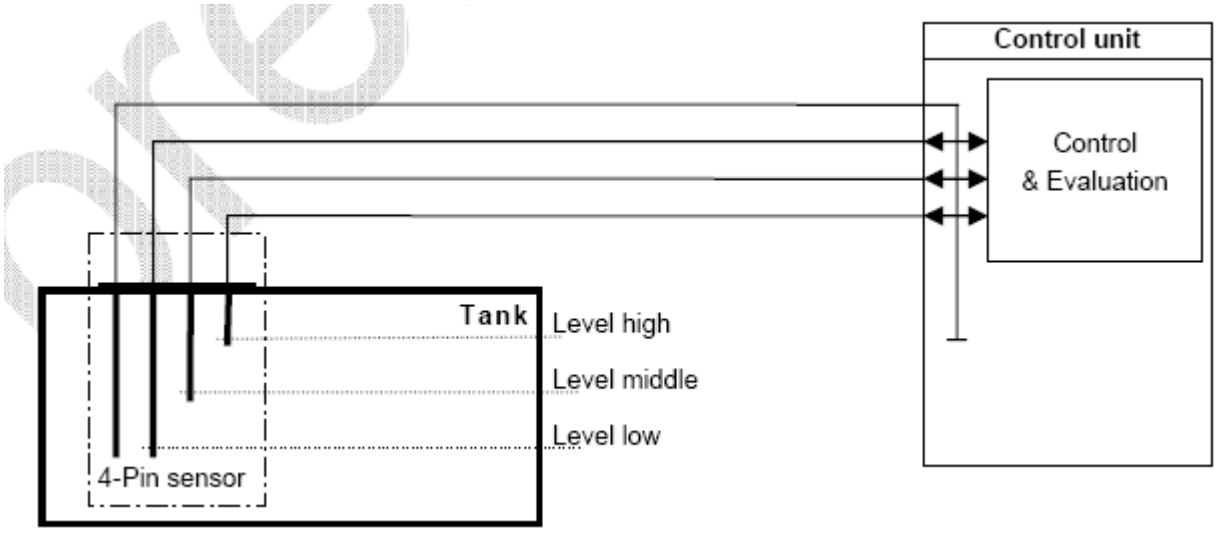
The task of the discrete level sensor is to measure the tank level at 3 different heights. The determination of a reductant level is limited to liquid reductant. Frozen reductant cannot be detected. The measured level will be used to update the calculation of remaining quantity in the reductant tank.

The level sensor consists of four high-grade stainless steel pins. The length of each pin defines the tank level (height) which is to be checked. Only three pins can be used for level evaluation. The fourth pin is used as ground pin. Due to the electrical conductivity of Urea the level sensor will determine whether the tank level is above or below the respective level sensor position. This information will be directly evaluated by the ECU.

Reductant Tank Level Sensor:



Reductant Tank Level Sensor Circuit Tree:



Reductant Tank Level Sensor Circuit Checks

Reductant Tank Level Sensor Open/Short Check Operation:	
DTCs	P203D - Reductant Level Sensor "A" Circuit High (SRC max – pin 1 & SCB) P21AB - Reductant Level Sensor "B" Circuit High (SRC max – pin 2) P21B0 - Reductant Level Sensor "C" Circuit High (SRC max – pin 3) P203A - Reductant Level Sensor Circuit (OL) P203C - Reductant Level Sensor Circuit Low (SCG)
Monitor execution	Continuous, every 4 seconds (3x 1 sec to read from each individual pin, 1 sec for diagnosis)
Monitor Sequence	None
Sensors OK	None
Monitoring Duration	0.5 seconds to register a malfunction within diagnostic mode

Typical Tank Level Sensor Open/Short Check Malfunction Thresholds:
P203D, P21AB & P21B0: voltage > 3.24 Volts (Signal range check max. for pin 1, 2 & 3)
P203D: no calibration thresholds available, SCB fault information is sent directly from power stage
P203C: no calibration thresholds available, SCG fault information is sent directly from power stage
P203A: no calibration thresholds available, OL fault information is sent directly from power stage

The Reductant Tank Level Sensor and the Reductant Tank Temperature Sensor share the same ground wire. Therefore an open load or short circuit to battery on the ground wire (reference pin) will set codes for both sensors.

Reductant Tank Level Sensor Plausibility Check

If a certain level pin is covered by liquid all pins below this level should be covered as well and send the same information. If this is not the case, an error flag will be set.

Reductant Tank Level Sensor Plausibility Check Operation:	
DTCs	P203B – Reductant Level Sensor Circuit Range/Performance
Monitor execution	Continuous
Monitor Sequence	none
Sensors/Actuators OK	Reductant Level sensor signal range checks
Monitoring Duration	60 seconds to register a malfunction

Typical Reductant Tank Level Sensor Plausibility Check Malfunction Thresholds:
no calibration thresholds available

Reductant Tank Temperature Sensor

The Reductant Tank Temperature sensor is mounted internal to the Reductant Tank Level Sensor. It is used to control the activation of the Reductant Tank Heater as well as an enabler to the Level Sensor (which cannot read level when the reductant is frozen).

Transfer Function

Temperature Deg C	Resistance (Ohms)
-40	336
-30	177
-20	97
-10	55
0	32
10	20
20	12
30	8
40	5.3
50	3.6
60	2.5
70	1.8
80	1.2

Reductant Tank Temperature Circuit Range Check	
DTCs	P205C Reductant Tank Temperature Sensor Circuit Low P205D Reductant Tank Temperature Sensor Circuit High
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	not applicable
Monitoring Duration	0.4 seconds to register a malfunction

Typical Intake Reductant Tank Temperature Circuit Range Check Malfunction Thresholds
P205C: voltage < 0.097 Volts P205D: voltage > 3.201 Volts

Plausibility Check

On every cold start of the vehicle (min. soak time > 6 hours) the value of the tank temperature sensor is expected to be close to the environmental temperature.

Reductant Tank Temperature Plausibility Check	
DTCs	P2043 Reductant Temperature Sensor Circuit Range/Performance
Monitor execution	At cold start conditions / extended soak time
Monitor Sequence	P2043 is inhibited by active P205C or P205D codes
Sensors OK	Ambient temp sensor, exhaust gas temp. sensor upstream SCR catalyst, engine coolant temperature sensor (downstream)
Monitoring Duration	counts intermittent events per trip

Typical Reductant Tank Temperature Plausibility Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine off timer	6 hours	
Reductant Tank Fluid level	10 %	100 %
Max (ambient temp, SCR catalyst temp., engine coolant temp.) - Min (ambient temp., SCR catalyst temp., engine coolant temp.)		10 deg C

Typical Reductant Tank Temperature Plausibility Check Malfunction Thresholds
Reductant tank temperature – ambient temperature > 20 deg C or < -20 deg C

Exhaust Gas Temperature Sensor Rationality Test

Each EGT Sensor is checked continuously for proper circuit continuity and out of range high values. In addition, a rationality test is performed once every drive cycle, after a soak of 4 hours or greater. The rationality test consists of two components, the first being a comparison against modeled values, and the second being a key-on 5-way temperature sensor comparison. At key-on, a temperature sample is taken of each of the following sensors: Ambient Air (AAT), Exhaust Gas Temperature (EGT11), Exhaust Gas Temperature (EGT12), Exhaust Gas Temperature (EGT13), and Exhaust Gas Temperature (EGT14). Once the engine starts and a cold start has been confirmed, the model comparison tests begin. The model comparison tests ensure that each sensor correlates with an expected modeled value, and a fault is set if the difference is significant and persistent. When the model comparison tests are complete, the temperature samples from key-on are compared against each other, and the temperature differences are compared against a threshold. One sensor must fail key-on plausibility with four other sensors to set a fault. If two sensors fail plausibility with three other sensors a general fault is set (P117B). The rationality tests rely on entry conditions that include engine operation time, minimum modeled temperature, minimum engine coolant temperature, and minimum engine torque. Once the entry conditions have been met, the model comparisons continue for several minutes to ensure a robust detection. The modeled value for EGT11 is based on Modeled Turbo Temperatures. The modeled value for EGT12 is based on EGT11. The modeled value for EGT13 is based on EGT12. The modeled value for EGT14 is based on EGT13.

Exhaust Gas Temperature (EGT) Sensor Circuit Check:	
DTCs	P0545 – Exhaust Gas Temperature Circuit Low (Sensor 1) P0546 – Exhaust Gas Temperature Sensor Circuit High (Sensor 1) P2478 – Exhaust Gas Temperature Out Of Range (Sensor 1) P2032 – Exhaust Gas Temperature Circuit Low (Sensor 2) P2033 – Exhaust Gas Temperature Sensor Circuit High (Sensor 2) P2479 – Exhaust Gas Temperature Out Of Range (Sensor 2) P242C – Exhaust Gas Temperature Circuit Low (Sensor 3) P242D – Exhaust Gas Temperature Sensor Circuit High (Sensor 3) P247A – Exhaust Gas Temperature Out Of Range (Sensor 3) P2470 – Exhaust Gas Temperature Circuit Low (Sensor 4) P2471 – Exhaust Gas Temperature Sensor Circuit High (Sensor 4) P247B – Exhaust Gas Temperature Out Of Range (Sensor 4)
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	2 sec.

Typical Exhaust Gas Temperature Sensor Circuit Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	9 V	16.25 V
Key On		

Typical Exhaust Gas Temperature Sensor Circuit Check Malfunction Thresholds:

Voltage < 0.10 volts or voltage > 4.90 volts

Out Of Range test is based on Engineering Units and is high-side only. The Out Of Range Threshold is typically set to 1100 deg C. Transfer function of the sensors does not allow for unique circuit range and engineering range thresholds on the low-side.

The Exhaust Gas Temperature Sensor is a PTC Thermistor that provides an analog output voltage proportional to the exhaust gas temperature. This EGT sensor is capable of being used anywhere in the exhaust gas stream. Some possible applications are listed below:

EGT	Exhaust Gas Temp
EGR_CIT	EGR Cooler Inlet Exhaust Gas Temp
EGR_COT	EGR Cooler Outlet Exhaust Gas Temp
DPF_IN	Diesel Particualte Filter Inlet Exhaust Gas Temp
DPF_OUT	Diesel Particulate Filter Outlet Exhaust Gas Temp
SCR_IN	SCR Inlet Exhaust Gas Temp
SCR_OUT	SCR Outlet Exhaust Gas Temp

EGT Sensor Transfer Function

Vout = (Vref * R sensor) / (1K + R sensor)

Response Time: 1 time constant = 15 sec for 300 deg C step @ 10m/sec gas flow

Volts	A/D Counts in PCM	Ohms	Temperature, deg C
0.10		short circuit	n/a
0.73		171	-40
0.84		202	0
1.09		277	100
1.30		350	200
1.48		421	300
1.64		490	400
1.79		556	500
1.91		619	600
2.02		691	700
2.13		740	800
2.17		768	850
2.34			1100
4.90		open circuit	n/a

Exhaust Gas Temperature Rationality Check	
DTCs	P0544 – Exhaust Gas Temperature Sensor Circuit (Sensor 1) P2031 – Exhaust Gas Temperature Sensor Circuit (Sensor 2) P242A – Exhaust Gas Temperature Sensor Circuit (Sensor 3) P246E – Exhaust Gas Temperature Sensor Circuit (Sensor 4) P117B – Exhaust Gas Temperature Sensor Correlation
Monitor Execution	Once per driving cycle.
Monitor Sequence	Correlation Test completes after the Model Comparison Tests.
Sensors OK	
Typical Monitoring Duration	Model Comparison Test Monitor Duration is 200 to 400 seconds.

Typical Exhaust Gas Temperature Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Engine Off Time	4 hrs	N/A
Coolant Temp	68 deg C	N/A
Engine Run Time	120 seconds	
Modeled Sensor Temp	120 deg C for EGT11 100 deg C for EGT12 95 deg C for EGT13 90 deg C for EGT14	
Engine Torque	100 Nm	

Typical Exhaust Gas Temperature Rationality Check Thresholds:	
Each EGT Rationality is confirmed against 4 other sensors (absolute temperature difference thresholds):	
Key-On Comparison Threshold	50 deg C
Modeled Comparison Threshold	180 deg C for EGT11, 80 deg C for EGT12, 60 deg C for EGT13, 60 deg C for EGT14
Modeled Comparison Duration	Comparison Test will run for 200 to 400 seconds. Fault must persist for 20 seconds for robust detection.

Diesel Particulate Filter Over Temperature Check:	
DTCs	P200C– Diesel Particulate Filter Over Temperature (Bank1) P200E – Catalyst System Over Temperature (Bank 1)
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	3 sec.
Thresholds	P200C – Pre DPF > 830C or Post DPF > 950C or Post DPF Temp Sensor Circuit failure

	P200E - The conditions for P200C have been met for 3 seconds and vehicle speed is less than 1 km/hr

Diesel Particulate Filter Pressure Sensor Rationality Test

The DPFP Sensor is checked continuously for proper circuit continuity, rationality, and expected dynamic behavior. The rationality test compares the raw DPFP value in engineering units to a threshold, with the expectation that there will be a minimum pressure observed whenever sufficient exhaust flow is present. An additional rationality test compares the measured change in DPFP to an expected change, which is based on changing exhaust flows. If exhaust flow is increasing, the change in DPFP is expected to be increasing. If exhaust flow is decreasing, the change in DPFP is expected to be decreasing. The dynamic test runs continuously as long as exhaust flows are sufficiently dynamic. The fault threshold in kPa is a function of changing exhaust flow.

Diesel Particulate Filter Pressure (DPFP) Sensor Circuit Check:	
DTCs	P2454 – DPFP Sensor Circuit Low P2455 – DPFP Sensor Circuit High
Monitor Execution	Continuous
Monitor Sequence	None
Sensors OK	Not applicable
Typical Monitoring Duration	2 sec.

Typical Diesel Particulate Filter Pressure Sensor Circuit Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Battery Voltage	9 V	16.25 V
Key On		

Typical Diesel Particulate Filter Pressure Sensor Circuit Check Malfunction Thresholds:
Voltage < 0.10 volts or voltage > 4.90 volts

The DPFP sensor is a single port gauge sensor that provides an analog output voltage that is proportional to pressure and is typically used before and after a DPF (Diesel Particulate Filter) to monitor the differential pressure.

DPFP Sensor Transfer Function		
DPFP volts = 0.082 * kPaG Delta Pressure) + 0.45		
Volts	A/D Counts in PCM	Delta Pressure, kPa Gauge
0.10	20	-4.3
0.45	92	0
1.27	260	10
2.09	428	20
2.91	595	30
3.73	763	40
4.55	931	50
4.90	1003	54.3

Diesel Particulate Filter Pressure Sensor Rationality Check	
DTCs	P2453 – DPFP Sensor Circuit Range/Performance P2456 – DPFP Sensor Circuit Intermittent/Erratic
Monitor Execution	Continuous.
Monitor Sequence	None.
Sensors OK	
Typical Monitoring Duration	2 seconds.

Typical Diesel Particulate Filter Pressure Sensor Rationality Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Exhaust Volume	500 m3/hour	None.
Dynamic Exhaust Volume	> 100 m3/h/s or < -100 m3/h/s	None.

Typical Diesel Particulate Filter Pressure Sensor Rationality Check Thresholds:	
Performance Threshold	1 kPa minimum for exhaust flows > 500 m3/hour
Dynamic Threshold	The threshold for the dynamic test is a function of dynamic exhaust flow. Typical values range from 0.1 kPa at 100 m3/h/s to 2 kPa at 800 m3/h/s.

Diesel Particulate Filter Pressure Offset Test

The DPFP Sensor is checked during after-run conditions (period where the key is turned off, however the ECU is still powered), to verify that the sensor has not drifted from the ambient with no exhaust flow. This test is performed by comparing the sensed pressure to a threshold (due the the gauge sensor, this value should be 0)

Diesel Particulate Filter Pressure Sensor Offset Check	
DTCs	P2452 – DPFP Sensor Circuit "A"
Monitor Execution	Afterrun
Monitor Sequence	None.
Sensors OK	DPFP Sensor
Typical Monitoring Duration	1 second.

Typical Diesel Particulate Filter Pressure Sensor Offset Check Thresholds:
Exhaust Pressure Sensor value > 10hPa

Engine Outputs

EGR Valve Actuator Signal Range Check

The diagnostics for the circuit range check on the pwm signal to the EGR valve are internal to the h-bridge PWM power-stage. Open load, short-circuit to ground, and short-circuit to battery are detected on both the positive and negative control lines to the actuator.

EGR Valve Actuator Short to Battery (P0490) Check Operation:	
DTCs	P0490 – EGR "A" Control Circuit High
Monitor execution	Continuous; when Power-stage ON
Monitor Sequence	None
Monitoring Duration	0.35 seconds to register a malfunction

EGR Valve Actuator Open Load (P0403) Check Operation:	
DTCs	P0403 – Exhaust Gas Recirculation "A" Control Circuit
Monitor execution	Continuous; when Power-stage OFF
Monitor Sequence	None
Monitoring Duration	0.35 seconds to register a malfunction
EGR Valve Actuator Short Circuit (P0489/P0490) Check Operation:	
DTCs	P0489 – EGR "A Control Circuit Low, P0490 – EGR "A" Control Circuit High
Monitor execution	Continuous; when Power-stage ON
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction.

EGR Valve Actuator Jammed Detection

The EGR valve has a component level diagnostic to make sure that the valve is not stuck or sticking in a manner such that it cannot reach the desired position. The monitor runs if a jammed valve is not already detected, position control is in closed-loop control, and adaptive learning is not active. A minimum engine speed is used as an entry condition.

.

If the position governor deviation is above a maximum calibrated threshold then counter starts to count up for the detection of a permanent positive control fault. If the counter reaches a calibrated threshold then a jammed valve malfunction is detected. Similarly, if the position governor deviation is below a minimum calibrated threshold then a second counter starts to count up for the detection of permanent negative control deviation fault. If the counter reaches a calibration threshold then a jammed valve is detected.

EGR Valve Jammed Check Operation:	
DTCs	P042E – Exhaust Gas Recirculation "A" Control Stuck Open
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	5 seconds to register a malfunction

Typical Actuator Jammed Valve Entry Conditions:		
Entry Condition	**Minimum**	**Maximum**
Governor Active (closed-loop position control)		
Adaptive Learning Not Active		
Jammed Valve Fault Not Present on Actuator		
RPM	700 rpm	

Typical EGR Valve Jammed Check (P04DA/P04D9) Malfunction Thresholds:
EGRVlv_rGovDvt > 8.60

Throttle Valve Actuator Signal Range Check

The diagnostics for the circuit range check on the pwm signal to the throttle valve are internal to the h-bridge PWM power-stage. Open load, short-circuit to ground, and short-circuit to battery are detected on both the positive and negative control lines to the actuator.

Throttle Valve Actuator Open-Load (P02E0) Check Operation:	
DTCs	P02E0 – Diesel Intake Air Flow Control Circuit / Open
Monitor execution	At start; when Power-stage is OFF and if Jammed Valve is detected.
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction

Throttle Valve Actuator Short Circuit (P02E2/P02E3) Check Operation:	
DTCs	P02E2- Diesel Intake Air Flow Control Circuit Low; P02E3- Diesel Intake Air Flow Control Circuit High
Monitor execution	Continuous; when power stage ON
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction.

Throttle Valve Actuator Jammed Detection

The throttle valve has a component level diagnostic to make sure that the valve is not stuck or sticking in a manner such that it cannot reach the desired position. The monitor runs if a jammed valve is not already detected, position control is in closed-loop control, and adaptive learning is not active.

If the position governor deviation is above a maximum calibrated threshold then counter starts to count up for the detection of a permanent positive control fault. The rate at which the counter counts up is a function of the magnitude of the governor deviation and valve position. If the counter reaches a calibrated threshold then a jammed valve malfunction is detected. Similarly, if the position governor deviation is below a minimum calibrated threshold then a second counter starts to count up for the detection of permanent negative control deviation fault. Again, the rate at which the counter counts up is a function of the magnitude of the governor deviation and valve position. If the counter reaches a calibration threshold then a jammed valve is detected.

Actuator Jammed Valve Check Operation:	
DTCs	P02E1 – Diesel Intake Air Flow Control Performance,
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	1-5 seconds to register a fault. Dependent on magnitude and valve position during malfunction.

Typical Actuator Jammed Valve Entry Conditions:
Entry Condition
Governor Active (closed-loop position control)
Adaptive Learning Not Active
Jammed Valve Fault Not Present on Actuator

Typical Throttle Jammed Valve Check (P02E1) Malfunction Thresholds:
Position Governor Deviation > 12.5% or <-12.5 % and Counter Output > 100 %

Counter Rate Example: **output: %/s x: Position Governor Deviation y: Valve Position**						
x\y	**-100**	**-90**	**-80**	**-60**	**-40**	**-20**
0	20	20	20	20	20	20
20	20	20	20	20	20	20
40	20	20	20	20	20	20
60	20	20	20	20	20	20
80	20	20	20	20	20	20
100	100	80	20	20	20	20

ECB Valve Actuator Signal Range Check

ECB Actuator Open-Load Check Operation:	
DTCs	P2425 - Exhaust Gas Recirculation Cooling Valve Control Circuit Open Load
Monitor execution	At Start; when Power-stage is OFF.
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction

ECB Actuator Short-Circuit (P2426/P2427) Check Operation:	
DTCs	P2426- Exhaust Gas Recirculation Cooling Valve Control Circuit Low, P2427- Exhaust Gas Recirculation Cooling Valve Control Circuit High
Monitor execution	Continuous; when power stage ON
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction.

Urea System Pressure Control

Urea pressure is maintained via:

- Feedback knowledge of sensed pressure.

A set point pressure is determined by engine operating conditions (500 kPa over exhaust backpressure). If a pressure increase is desired, the urea pump motor speed is increased by increasing the PWM output. Pressure decreases are analogous; as the system has a backflow throttle, pressure will decrease to 0 unless the pump motor in run continuously.

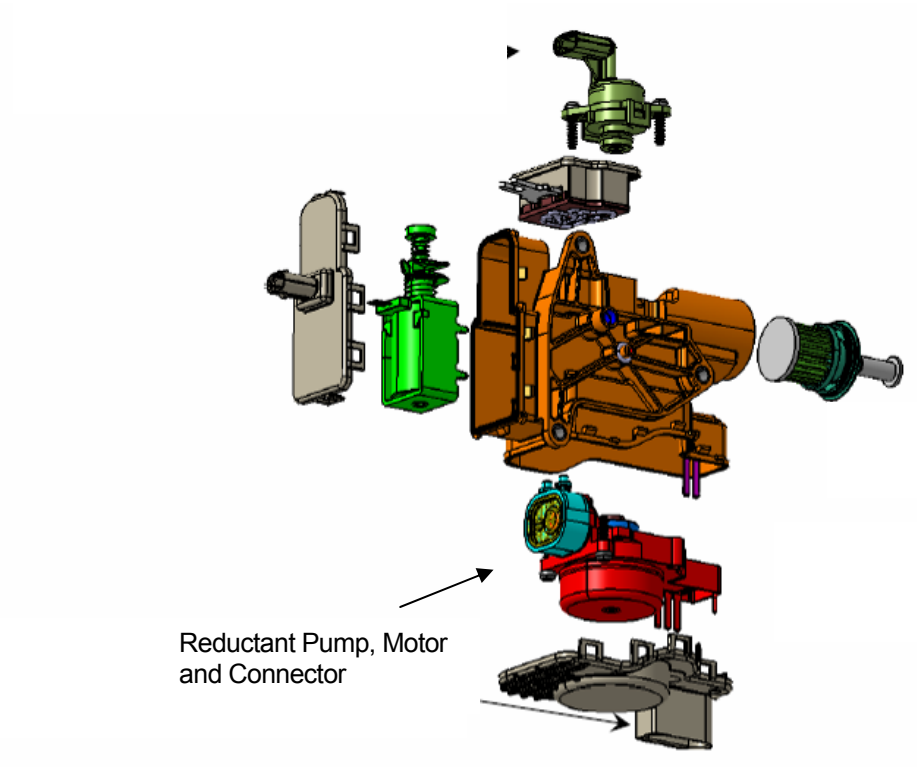
Urea Pump Pressure Control (Normal) Functional Check Operation:	
DTCs	P20E8 (Reductant Pressure Too Low) P20E9 (Reductant Pressure Too High)
Monitor execution	continuous
Monitor Sequence	P204C and P204D must complete before setting P20E8 or P20E9
Sensors/Actuators OK	Urea pump pressure sensor, Urea pump motor, Urea injector
Monitoring Duration	> 60 sec

Typical Urea Pump Pressure Control (Normal) Functional Check Entry Conditions:		
Entry Condition	Minimum	Maximum
Reductant system pressurized and ready to inject		

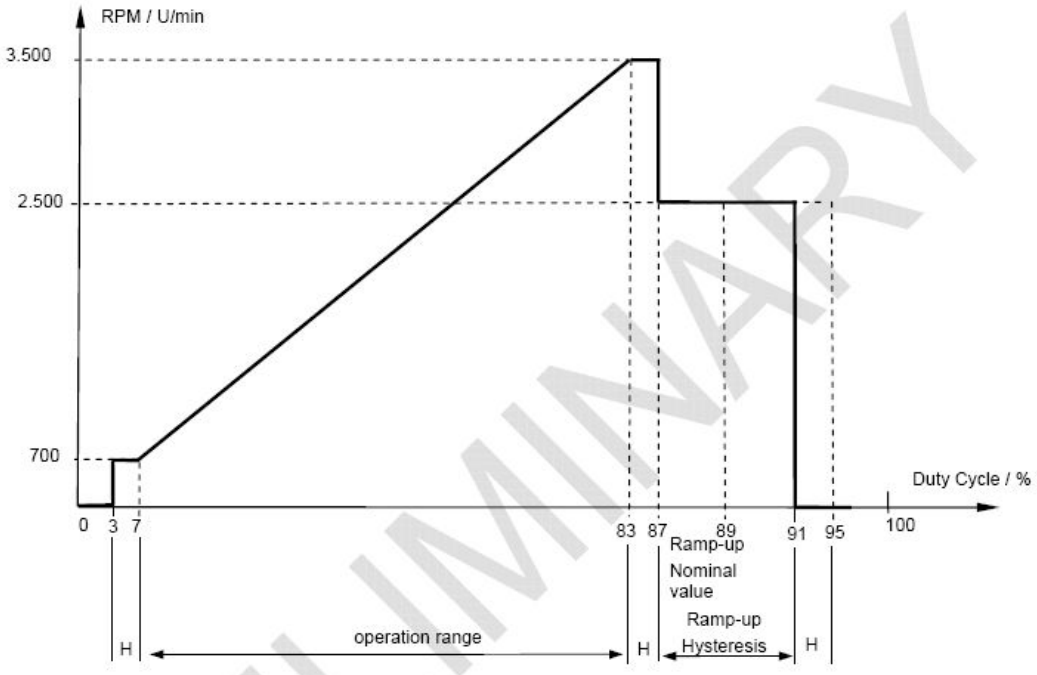
Typical Urea Pump Pressure Control (Normal) Functional Check Malfunction Thresholds:
P20E8: < 350 kPa
P20E9: > 700 kPa

Reductant Pump Motor

The Reductant Pump is driven by a brushless DC electric 12 volt motor. The pump is a positive displacement diaphragm design connected to the motor by a connecting rod and an eccentric on the motor shaft.



Reductant Pump Motor speed is controlled by a PWM driver in the engine ECU. Increasing the duty cycle of the PWM increases the Pump Motor speed. PWM duty cycles between 87 and 95 are reserved for diagnostics.



PWM-Duty Cycle – rpm set-point characteristic

H = Hysteresis-range

PRELIMINARY

Reductant Pump Motor Circuit Checks

Reductant Pump Motor Open/Short Check Operation:	
DTCs	P208A – Reductant Pump Control Circuit Open P208C – Reductant Pump Control Circuit Low P208D – Reductant Pump Control Circuit High
Monitor execution	Continuous – Open and Low with driver off / High with driver on
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	Circuit Open / Low: 8 seconds to register a malfunction Circuit High: 2 seconds to register a malfunction

Typical Reductant Motor Check Malfunction Thresholds:
No calibration thresholds available, fault information is sent directly from power stage.
P208A - Reductant Pump Control Open Circuit > 5.80 volts
P208C - Reductant Pump Control Circuit Low < 3.50 volts
P208D - Reductant Pump Control Circuit High > 2.2 amps

Reductant Pump Motor Functional Check

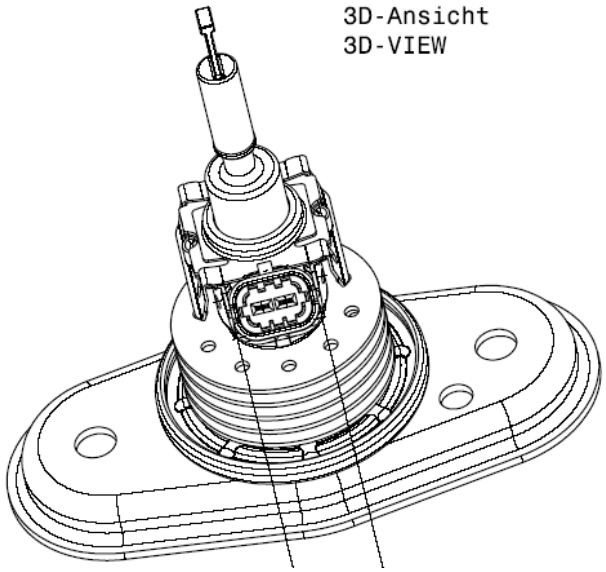
The functional check monitors the Pump Motor Speed Deviation. This test is run if the commanded pump speed is within normal operating range, i.e. duty cycle 6.5 to 80 %. In this test if the internal RPM measurement of the Reductant Pump Motor speed is not matching the commanded speed within a certain percentage, a fault is detected and the system is shut down for this key cycle.

Reductant Pump Motor Control (Normal) Functional Check Operation:	
DTCs	P208B – Reductant Pump Control Range/Performance
Monitor execution	continuous
Monitor Sequence	P208A , P208C, P208D must complete
Sensors/Actuators OK	Reductant pump pressure sensor, Reductant injector
Monitoring Duration	5 sec for fault detection

Typical Reductant Pump Motor Control (Normal) Functional Check Malfunction Thresholds:
P208B: > 300 RPM error

Reductant Dosing Valve (Injector)

The reductant dosing valve is used to meter and atomize the reductant liquid before it is mixed with the exhaust gas. Normal operating frequency is between 3 Hz and .3 Hz. The cooling body contains heat sink fins to keep the injector and reductant below the boiling point. If the sensed temperature is nearing the maximum temperature threshold, reductant spray will be increased in quantity to actively cool the valve.



Reductant Dosing Valve Circuit Checks

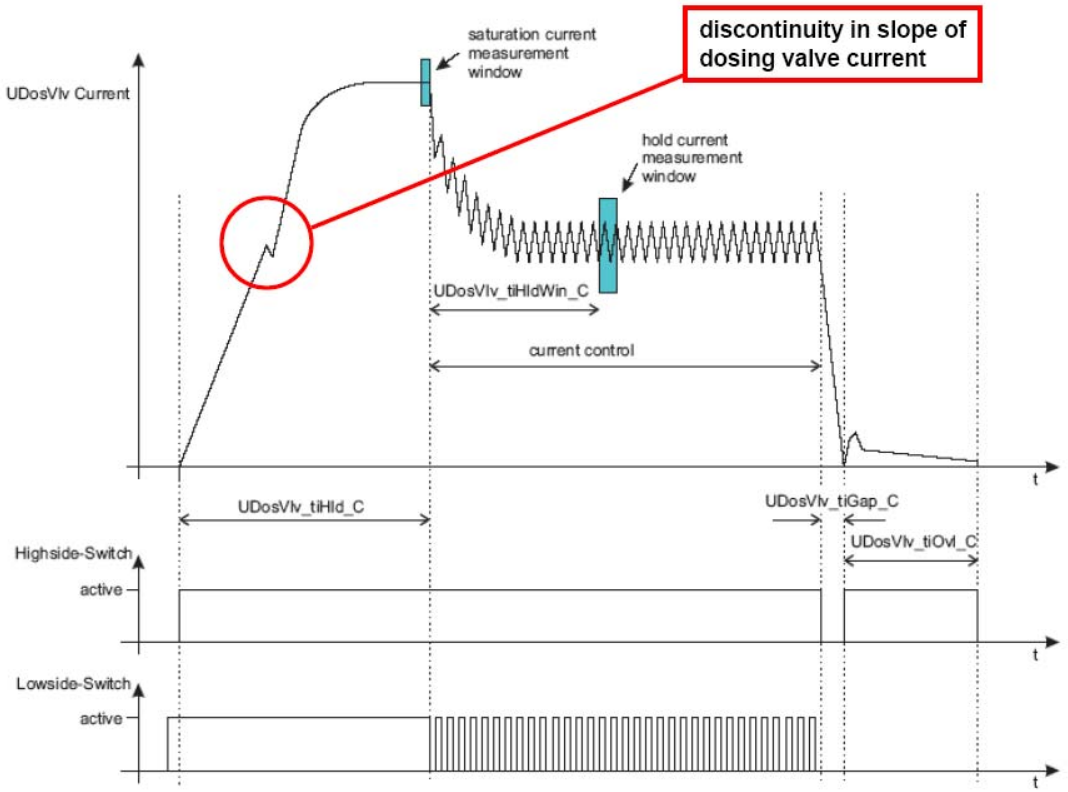
Reductant Dosing Valve Circuit Check Operation:	
DTCs	P2047 – Reductant Injection Valve Circuit / Open (Bank 1 Unit 1) P2048 – Reductant Injection Valve Circuit Low (Bank 1 Unit 1) P2049 – Reductant Injection Valve Circuit High (Bank 1 Unit 1)
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	2 seconds to register a malfunction

Typical Reductant Dosing Valve Circuit Check Malfunction Thresholds:
No calibration thresholds available, fault information is sent directly from power stage
P2047 – Reductant Injection Valve Circuit / Open (Bank 1 Unit 1) - >5.80 volts
P2048 – Reductant Injection Valve Circuit Low (Bank 1 Unit 1) - < 3.2 volts HS, < 3.5 volts LS
P2049 – Reductant Injection Valve Circuit High (Bank 1 Unit 1) - > .4 volts HS, >2.2 amps LS

Reductant Dosing Valve Functional Check

The functional check monitors the movement of the injector needle. When the injector needle reaches its upper position (injector open, begin of injection period) a discontinuity in the slope of the dosing valve current occurs.

This functional check monitors the presence of this discontinuity. If it does not occur the injector is either stuck open or stuck closed. In both case the system cannot be operated and will be shut down.

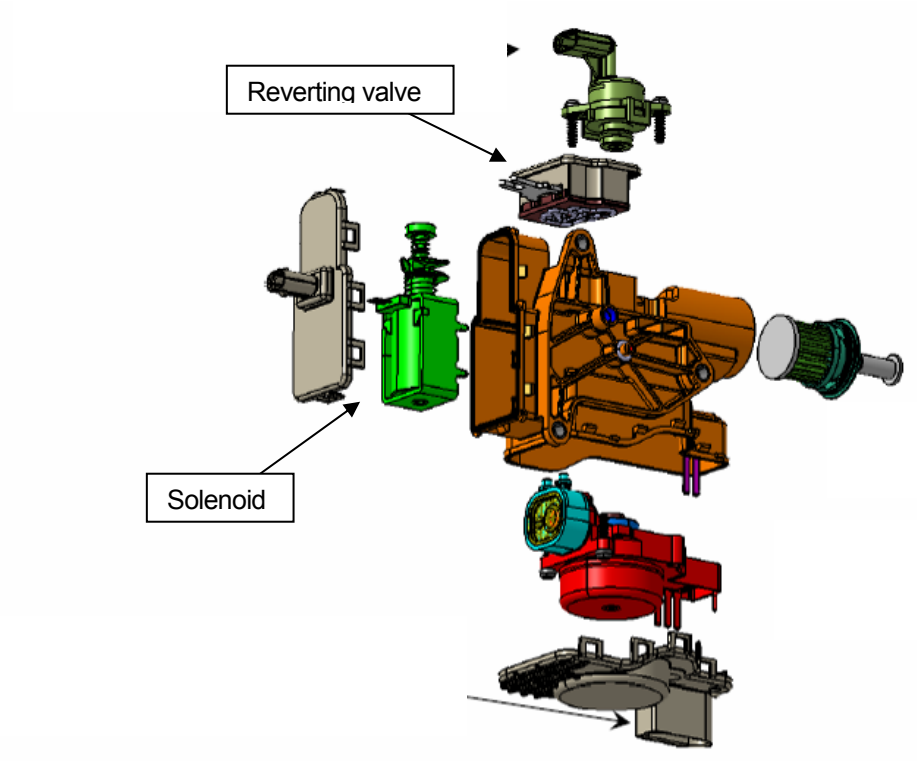


Reductant Injection Functional Check Operation:	
DTCs	P208E - Reductant Injection Valve Stuck Closed (Bank 1 Unit 1)
Monitor execution	Once per injection stroke
Monitor Sequence	P208E is inhibited by active P2047, P2048 or P2049
Sensors/Actuators OK	Reductant pump motor, Reductant pressure sensor
Monitoring Duration	50 injection strokes for fault detection

Typical Reductant Injection Functional Check Malfunction Thresholds:
No calibration thresholds available, fault information is sent directly from power stage

Reverting Valve

In order to reverse the Reductant flow direction (for line purge) a 4-2-way valve (reverting valve) needs to be switched. The valve is switched by a solenoid.



Reverting Valve Circuit Checks

Reverting Valve Circuit Check Operation:	
DTCs	P20A0 – Reductant Purge Control Valve Circuit / Open P20A3 – Reductant Purge Control Valve Circuit High P20A2 – Reductant Purge Control Valve Circuit Low
Monitor execution	Continuous – Open and Low with driver off / High with driver on
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	2 seconds to register a malfunction

Typical Reverting Valve Circuit Check Malfunction Thresholds:
No calibration thresholds available, fault information is sent directly from power stage

Reverting Valve Functional Check

The functional check monitors the pressure for no increase when the purge cycle is started. To run this test the vehicle ignition is turned off, then a calibrated delay time (7 sec) is used. Once the delay expires, the pump and reverting valve are accuated. For a successful test result, the pressure must not increase by another threshold (500 hPa) within the given purge time – Typically purge is 5 seconds.

If the test is not successfully passed the purge cycle will be terminated immediately because of the risk of uncontrolled injection of reductant into the exhaust pipe.

Reverting Valve Functional Check Operation:	
DTCs	P20A1 - Reductant Purge Control Valve Performance
Monitor execution	continuous
Monitor Sequence	P20A1 is inhibited by active P20A0 , P20A3 or P20A2
Sensors/Actuators OK	reductant pump pressure sensor, reductant injector, reductant pump motor
Monitoring Duration	7 secs after key off with no monitoring. Then 5 seconds of monitoring with pump on reverting valve actuated (purge)

Typical Reverting Valve Functional Check Malfunction Thresholds:
P20A1 Max. pressure increase >500 hPa error during purge (reverse flow expected) - 1 event > 500 hpa during the monitoring window.

Urea Heaters

Aqueous urea water solution (Diesel Exhaust Fluid) freezes at -11°C (12 deg. F). In order to keep the fluid liquid at low ambient temperatures, the system includes 3 heaters:

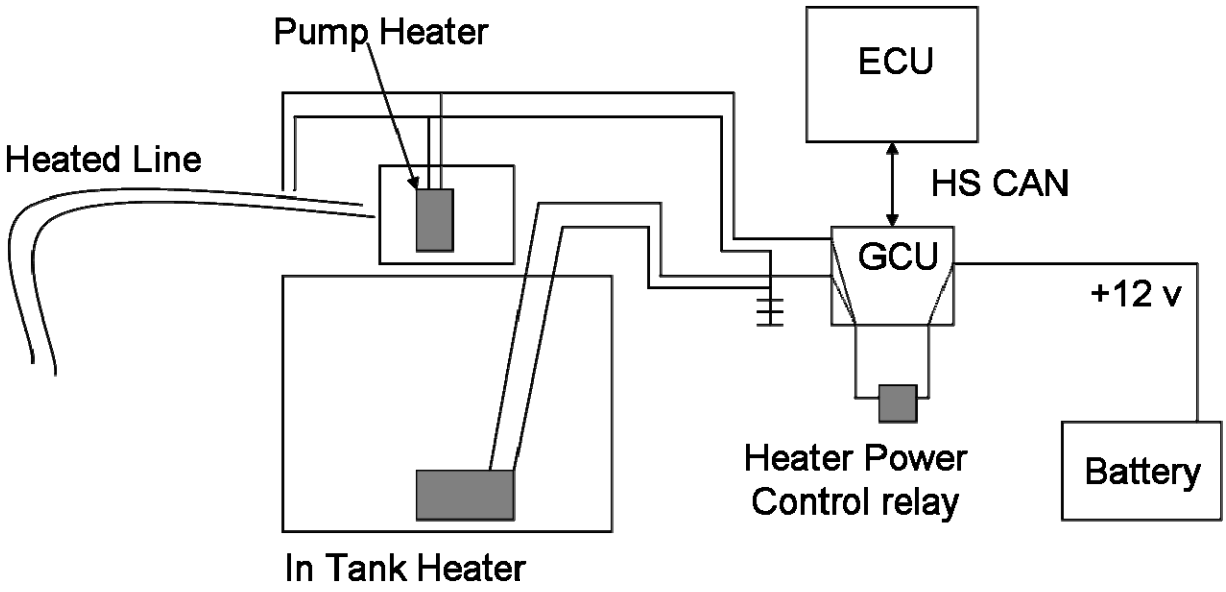
- tank heater (PTC heater element – self regulating)
- pump heater (PTC heater element – self regulating)
- pressure line heater (Resistance heater)

The heater power stages are located in the glow plug control module (GPCM). The tank heater is connected to heater power stage #1. The pressure line & pump heater are connected in parallel to heater power stage #2.

All SCR-heater related circuit checks are performed inside the GCU. The information is sent via CAN to the engine control module (ECM).

Additionally the GCU sends the supply voltage and the actual heater current for each circuit to the ECM.

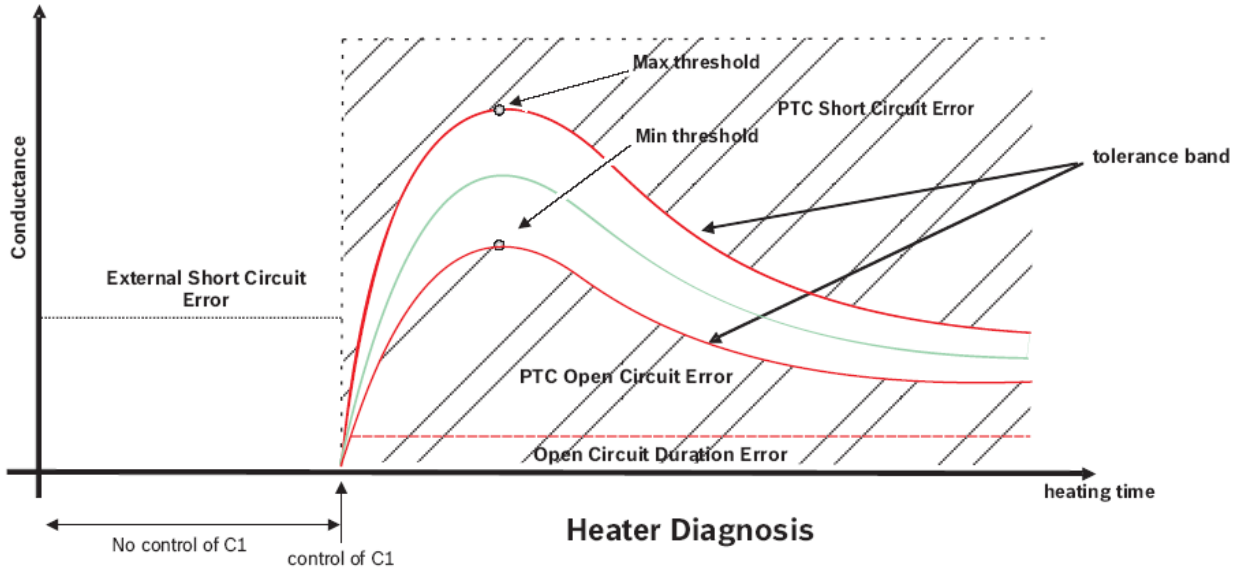
Based on this information the heater plausibility checks are performed on the ECM.



Reductant Heater Plausibility Checks

Based on the information of heater voltage and heater current, the actual conductance at peak power is calculated for each heater circuit. This value is checked against the nominal value including tolerances.

Typical characteristic of PTC heater conductance:



Reductant Heater Plausibility Check Operation:	
DTCs	P20BA – Reductant Heater "A" Control Performance P20BE – Reductant Heater "B" Control Performance
Monitor execution	Once per drive cycle (at peak heater power)
Monitor Sequence	P20B9, P20BB, P20BC must complete for P20BA P20BD, P20BF, P20C0 must complete for P20BE
Sensors/Actuators OK	none
Monitoring Duration	1 event for fault detection

Typical Reductant Heater Plausibility Check Malfunction Thresholds:
P20BA: > nominal conductance of heater circuit #1 + max. tolerance or < nominal conductance of heater circuit #1 – max. tolerance
P20BE: > nominal conductance of heater circuit #2 + max. tolerance or < nominal conductance of heater circuit #2 – max. tolerance

Additional plausibility check for heater circuit #2:

Pump heater & pressure line heater are connected in parallel to heater power stage #2. In order to be able to detect a failure of just one of both heaters, the conductance of heater circuit #2 is continuously checked against a minimum threshold. E.g. if the pressure line heater gets disconnected after peak conductance occurred, neither the plausibility check nor the circuit checks inside the GCU can detect this error. Therefore this continuous check becomes necessary.

Reductant Heater Plausibility Check Operation (Heater Circuit #2):	
DTCs	P20BE – Reductant Heater "B" Control Performance
Monitor execution	Continuously, if heater “B” is activated
Monitor Sequence	P20BD, P20BF, P20C0 must complete for P20BE
Sensors/Actuators OK	Pressure line heater
Monitoring Duration	2200 ms for fault detection

Typical Reductant Heater Plausibility Check Malfunction Thresholds (Heater Circuit #2):
P20BE: conductance of heater circuit #2 < 0.3 Ω^{-1}

Reductant tank heater performance check (heater circuit #1):

The tank heater is located in close proximity to the tank temperature sensor. Therefore the tank temperature sensor can be used to monitor the tank heater performance.

When the tank heater is activated, the tank temperature is expected to rise. If this is not the case a fault will be set. If the vehicle is operated for several consecutive short drive cycles, the test may require more than one drive cycle to complete.

Reductant Heater Performance Check Operation (Heater Circuit #1):	
DTCs	P209F – Reductant Tank Heater Control Performance
Monitor execution	Once per heat cycle (after cold start)
Monitor Sequence	P20B9, P20BB, P20BC must complete for P209F
Sensors/Actuators OK	tank temperature sensor, tank heater
Monitoring Duration	2200 ms for fault detection

Typical Reductant Heater Performance Check Malfunction Thresholds (Heater Circuit #1):
P209F: temperature increase < 0.5°C

Engine Control Unit (ECU) Monitor Operation:	
DTCs	P0600 - Serial Communication Link P0601 - Internal Control Module Memory Checksum Error P0606 - Control Module Processor P0607 - Control Module Performance P060A - Internal Control Module Monitoring Processor Performance P060B - Internal Control Module A/D Processing Performance P060D - Internal Control Module Accelerator Pedal Position Performance P0611 – Fuel Injector Control Module Performance P061A - Internal Control Module Torque Performance P061B - Internal Control Module Torque Calculation Performance P061C - Internal Control Module Engine RPM Performance P062B - Internal Control Module Fuel Injector Control Performance P062F - Internal Control Module EEPROM Error P06A6 - Sensor Reference Voltage "A" Circuit Range/Performance P06A7 - Sensor Reference Voltage "B" Circuit Range/Performance P06A8 - Sensor Reference Voltage "C" Circuit Range/Performance P167F - Non-OEM Calibration Detected P2507 - ECM / PCM Power Input Signal Low P2508 - ECM / PCM Power Input Signal High P2610 – ECM / PCM Engine Off Timer Performance

Monitor Execution	P0600, P0606, P0607, P060A, P060B, P060D, P0611, P061A, P061B, P061C, P062B, P062F, P06A6, P06A7, P06A8, P167F, P2507, P2508, P2610, – Continuous P0601 – Postdrive
Monitor Sequence	None
Sensors OK	none
Typical Monitoring Duration	P0600, P0601, P0606, P0607, P060A, P060B, P060D, P061B, P061C, , P062B, P062F, P06A6, P06A7, P06A8, P167F, P2507, P2508, P0611 – 5 sec P061A – 0.1 sec , P2610 – 8 sec

Typical Engine Control Unit (ECU) Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0600, P0606, P0607, P060A, P060B, P060D, P061A, P061B, P061C, P062B, P062F, P06A6, P06A7, P06A8, P167F, P2507, P2508, P2610: ECU energized (key-on, engine running, or post-drive before ECU shutdown)		
P0601: Post-drive		
P0611: Engine running or cranking		

Typical Engine Control Unit (ECU) Monitor Malfunction Thresholds:

P0600 – – A data transfer between chips in the ECU either is not possible or has invalid check bytes

OR Communication is interrupted between the CPU and the monitoring module

P0601 – An error is detected in the post-drive ROM test

P0606 – A powerstage shutoff command is active OR A communications error exists between the powerstage controller chip and the CPU

P0607 – A software reset is detected by the ECU

P060A – An irreversible error occurs with an operating system function call OR An irreversible error occurs in the test of the monitoring module

P060B – Failure on power-up calibration done for the A/D conversion module and A/D conversion time performed on ECU start OR >249 mV reading in the cycle following grounding of a specific voltage OR Cyclical conversion of a predetermined voltage results in <4727 mV or >4830 mV reading.

P060D – If either pedal voltage 1 or pedal voltage 2 < 742 mV and (pedal voltage 1) – 2 * (pedal voltage 2) > 547 mV OR If pedal voltage 1 and pedal voltage 2 >= 742 mV and (pedal voltage 1) – 2 * (pedal voltage 2) > 1055 mV

P0611 – If the raw voltage detected by an internal ECU voltage measurement for fuel system Nominal Voltage Calibration falls below 0 mV or above 3300 mV for the monitoring duration

P061A – Commanded inner torque > permissible inner torque at current engine operating condition

P061B – The energizing time for Zero Fuel Calibration is <10 ms or > 850 ms (beyond limits for P02CC-P02DA) OR The difference between programmed energizing time and actual energizing time exceeds 127.2 us or The requested time for start of energizing of a given fuel injection is outside the crank angle regime permitted for that injection

OR The correction in requested fuel injection quantity due to transient pressure effects within the fuel injector as calculated by the control software and as calculated by the monitor exceeds 5 mg for an injection

P061C – The engine speed calculated by the control software and the engine speed calculated by the monitor deviate by more than 400 RPM

P062B – If an error is detected in a requested post injection OR If requested energizing time exceeds 200 us when the controller is operating in overrun/decel fuel shut-off mode

P062F – An error is detected in an EEPROM read, write, or erase operation

P06A6 – Voltage output of sensor supply 1 is <4.7 V or >5.3 V

P06A7 – Voltage output of sensor supply 2 is <4.7 V or >5.3 V

P06A8 – Voltage output of sensor supply 3 <4.7 V or >5.3 V

P167F – a non-OEM calibration has been detected

P2507 – The 5V internal ECU supply is <4.2 V

P2508 – The 5V internal ECU supply is > 5.5 V

P2610 – If, during a key off event, engine coolant temperature decreases by 30 degrees and the engine off timer has not incremented at least 1200 seconds OR If, while running for 1200 seconds as measured by ECU timer, the timer used for engine off time and the time as determined by the secondary timer differ by at least 100 seconds OR In afterrun, if a requested 8 second stop timer measurement is <7.52 seconds or >8.48 seconds

Idle Speed and Fuel Monitor Operation:	
DTCs	P0506 - Idle Control System - RPM Lower Than Expected P0507 - Idle Control System - RPM Higher Than Expected P054E - Idle Control System - Fuel Quantity Lower Than Expected P054F - Idle Control System - Fuel Quantity Higher Than Expected
Monitor Execution	P0506, P0507, P054E, P054F - Continuous
Monitor Sequence	None
Sensors OK	P0506 - Engine Coolant Temperature (P0116, P0117, P0118, P0128, Crankshaft Sensor (P0335, P0336), P0507 - Engine Coolant Temperature (P0116, P0117, P0118, P0128, Crankshaft Sensor (P0335, P0336), P054E - Engine Coolant Temperature (P0116, P0117, P0118, P0128, Crankshaft Sensor (P0335, P0336), P054F - Engine Coolant Temperature (P0116, P0117, P0118, P0128, , Crankshaft Sensor (P0335, P0336),
Typical Monitoring Duration	P0506 – 5 sec P0507 – 5 sec P054E – 5 sec P054F – 5 sec

Typical Idle Speed and Fuel Monitor Entry Conditions:		
Entry condition	Minimum	Maximum
P0506, P0507:		
Engine idle speed governor active (define this more completely)		
Engine Coolant Temperature (°C)	0	120
Vehicle Speed (kph)		1
Engine RPM	300 (stall speed)	1500 (300 rpm above max requestable idle speed)
P054E, P054F:		
Engine running		

Typical Idle Speed and Fuel Monitor Malfunction Thresholds:
P0506 – If observed idle speed is 100 or more RPM below requested idle speed
P0507 – If observed idle speed is 160 or more RPM above requested idle speed
P054E – If calculated torque required for idle is 30+% below the minimum threshold of (insert threshold)
P054F – If calculated torque required for idle is 30+% above the maximum of threshold of (insert threshold)

Lack of Communication Codes:

CAN Communications Error

The TCM receives information from the ECM via the high speed CAN network. If the CAN link or network fails, the TCM no longer has torque or engine speed information available. The TCM will store a U0073 fault code and will illuminate the MIL immediately (missing engine speed) if the CAN Bus is off. The TCM will store a U0100 fault code and will illuminate the MIL immediately (missing engine speed) if it stops receiving CAN messages from the ECM.

ECU CAN Communication Malfunctions	
DTCs	U0073 - Control Module Communication Bus "A" Off U0074 - Control Module Communication Bus "B" Off U0101 - Lost Communication with TCM U0102 - Lost Communication with Transfer Case Control Module U0121 - Lost Communication With Anti-Lock Brake System (ABS) Control Module U0151 - Lost Communication With Restraints Control Module U0212 - Lost Communication With Steering Column Control Module U029D - Lost Communication With NOx Sensor "A" U0307 - Software Incompatibility with Glow Plug Control Module U0407 - Invalid Data Received from Glow Control Module U059E - Invalid Data Received from NOx Sensor "A"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	continuous

Typical Malfunction Thresholds
U0073 CAN Chip Driver detect CAN line short or open > 10 ms
U0074 CAN Chip Driver detect CAN line short or open > 10 ms
U0101 TCM master message not received for 1 sec
U0102 TCCM master message not received for 5 sec
U0121 ABS master message not received for 5 sec
U0151 RCM master message not received for 10 sec
U0212 SCCM master message not received for 5 sec
U029D Nox sensor master message not received for .75 sec
U0307 – Glow module reporting "safe glow" mode
U0407 - Calibration Verification Number not received by ECU
U059E - Calibration Verification Number not received by ECU

Vehicle speed is received by the ECU over CAN from the ABS system or (if the ABS system is faulted on all 4 wheel speed sensors) the TCU through Output Shaft Speed calculation to wheel speed

VS Communication Plausibility Malfunctions	
DTCs	P0500 Vehicle Speed Sensor "A"
Monitor execution	continuous
Monitor Sequence	None
Sensors OK	not applicable
Monitoring Duration	continuous

Typical Malfunction Thresholds
VS signal is missing from the CAN system for 0.5 Seconds.

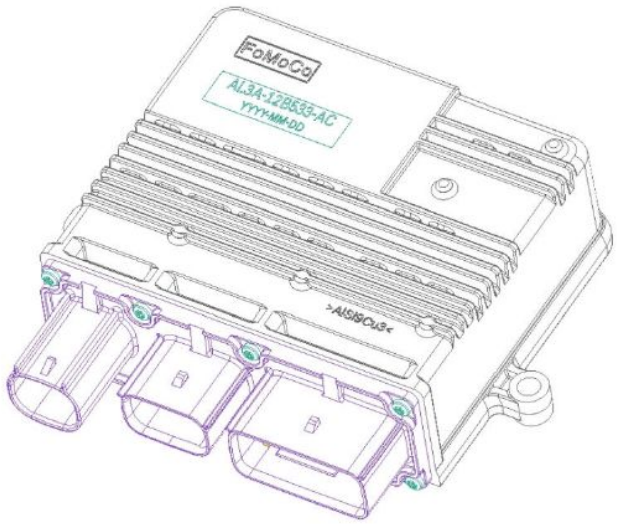
Glow Plugs

The diesel engine uses glow plugs to assist with cold weather starting and combustion until the cylinder is warm enough to operate normally. The glow plugs are duty cycle controlled and will overheat if constant 12V is applied.

The glow plugs are operated by the Glow Plug Control Module (GPCM). It contains 8 high current smart MOSFET drivers, one for each glow plug. Glow time and intensity are calculated on the basis of CAN signals (rpm, torque, engine coolant temp, air temp and BP.) The module also contains 3 drivers for the DEF (NOx reductant) heating and thawing system.



GPCM



The GPCM is connected to the ECU via Diesel high speed CAN. All data and diagnostics pass over this non-public communication bus. The standard operating voltages for the GPCM are 6.5 volts to 16 volts. Limited operation between 5.5v and 6.5v on the lower range and no operation below 5.5v. Glow function is disabled below 6.5v and above 16.5v.

Glow Plug Module Operational Checks:	
DTCs	U0106 – Lost Communication with GPCM P0381 – Glow Plug/Heater Indicator Circuit P064C – Glow Plug Control Module P06DF – Glow Plug Module Memory Checksum Error P138B – Glow Plug Module System Voltage P20C2 – Reductant Heater "C" Control Performance
Monitor execution	P06DF, P0381 at power up, otherwise continuous
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	~1 second to register a malfunction

Glow Plug Module: Malfunction Thresholds:
Communication lost for > 5 seconds
Cluster detects wait to start lamp in wrong state (off when commanded on)
Any internal driver circuits detect fault (not switching or over temp) > 1 sec (glow plugs, urea heaters or relay)
RAM checksums do not match expected
GPCM main power feed voltage too low / too high / open circuit (< 6.5 volts or > 16 volts)
Low voltage detected on the Reductant Heater Circuit "C" < 5 volts

Glow Plug Circuit Open Load Check Operation:	
DTCs	P0671 – Cylinder 1 Glow Plug Circuit / Open P0672 – Cylinder 2 Glow Plug Circuit / Open P0673 – Cylinder 3 Glow Plug Circuit / Open P0674 – Cylinder 4 Glow Plug Circuit / Open P0675 – Cylinder 5 Glow Plug Circuit / Open P0676 – Cylinder 6 Glow Plug Circuit / Open P0677 – Cylinder 7 Glow Plug Circuit / Open P0678 – Cylinder 8 Glow Plug Circuit / Open P20B9 – Reductant Heater "A" Control Circuit / Open P20BD – Reductant Heater "B" Control Circuit / Open P20C1 – Reductant Heater "C" Control Circuit / Open
Monitor execution	Glow plugs in heating mode. Heaters operational
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	~1 second to register a malfunction

Glow Plug Circuit Open Load: Malfunction Thresholds:
Individual glow plug circuit current < 1 A, Individual reductant heater circuit current < .2 A

Glow Plug Circuit Short to Battery Check Operation:	
DTCs	P066B – Cylinder 1 Glow Plug Circuit High P066D – Cylinder 2 Glow Plug Circuit High P066F – Cylinder 3 Glow Plug Circuit High P067B – Cylinder 4 Glow Plug Circuit High P067D – Cylinder 5 Glow Plug Circuit High P067F – Cylinder 6 Glow Plug Circuit High P068D – Cylinder 7 Glow Plug Circuit High P068F – Cylinder 8 Glow Plug Circuit High P20BC – Reductant Heater "A" Control Circuit High P20C0 – Reductant Heater "B" Control Circuit High P20C4 – Reductant Heater "C" Control Circuit High
Monitor execution	Glow plugs in heating mode. Heaters operational
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	~1 second to register a malfunction for glow plugs 250 ms to register a malfunction for the reductant heaters

Glow Plug Circuit Short to Battery: Malfunction Thresholds:
Individual glow plug circuit = 0 Amps current, Individual reductant heater circuit = 0 Amps current

Glow Plug Circuit Short to Ground Check Operation:	
DTCs	P066A – Cylinder 1 Glow Plug Circuit Low P066C – Cylinder 2 Glow Plug Circuit Low P066E – Cylinder 3 Glow Plug Circuit Low P067A – Cylinder 4 Glow Plug Circuit Low P067C – Cylinder 5 Glow Plug Circuit Low P067E – Cylinder 6 Glow Plug Circuit Low P068C – Cylinder 7 Glow Plug Circuit Low P068E – Cylinder 8 Glow Plug Circuit Low P20BB – Reductant Heater "A" Control Circuit Low P20BF – Reductant Heater "B" Control Circuit Low P20C3 – Reductant Heater "C" Control Circuit Low
Monitor execution	Glow plugs in heating mode. Heaters operational.
Monitor Sequence	none
Sensors OK	none
Monitoring Duration	~3 second to register a malfunction for glow plugs 250 ms to register a malfunction for the reductant heaters

Glow Plug Circuit Short to Battery: Malfunction Thresholds:
Individual glow plug circuit > 20 Amps current > 1 second
Individual glow plug circuit > 70 Amps current for > .2 ms
Reductant heater relay (circuit "A" & "B") > 15 Amps current > 250 ms
Reductant heater relay (circuit "C") > 6 Amps current > 250 ms

Glow Plug Circuit Resistance Out of Range Check:	
DTCs	P06B9 – Cylinder 1 Glow Plug Circuit Range / Performance P06BA – Cylinder 2 Glow Plug Circuit Range / Performance P06BB – Cylinder 3 Glow Plug Circuit Range / Performance P06BC – Cylinder 4 Glow Plug Circuit Range / Performance P06BD – Cylinder 5 Glow Plug Circuit Range / Performance P06BE – Cylinder 6 Glow Plug Circuit Range / Performance P06BF – Cylinder 7 Glow Plug Circuit Range / Performance P06C0 – Cylinder 8 Glow Plug Circuit Range / Performance
Monitor execution	Glow plugs in heating mode.
Monitor Sequence	After Open circuit, short to battery and short to ground testing
Sensors OK	none
Monitoring Duration	~3 second to register a malfunction

Glow Plug Circuit Short to Battery: Malfunction Thresholds:
Individual circuit > 2 ohms resistance

Turbocharger Actuator Signal Range Check

The diagnostics for the circuit range check on the pwm signal to the turbocharger VGT actuator are internal to the PWM power-stage. Open load, short-circuit to ground, and short-circuit to battery are detected on the single control line to the actuator.

Turbocharger Control Circuit Open Load/Short to Ground/Short to Power:	
DTCs	P132A - Turbocharger/Supercharger Boost Control "A" Electrical
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction

Wastegate Vacuum Solenoid Signal Range Check

The 6.7L chassis cert engine is equipped with a vacuum actuated wastegate. Vacuum is supplied at all times to the wastegate vacuum regulating valve, which is controlled via PWM signal. When a PWM signal is applied to the vacuum regulating valve, the valve opens and vacuum is applied to the wastegate, and the wastegate opens. There is an intrusive monitor to verify wastegate movement, and in addition there are open load/short circuit to ground/battery diagnostics on the vacuum regulating valve.

The diagnostics for the circuit range check on the pwm signal to the wastegate vacuum control solenoid are internal to the PWM power-stage. Open load, short-circuit to ground, and short-circuit to battery are detected on the single control line to the solenoid.

Wastegate Open Load Operation:	
DTCs	P0243 - Turbocharger/Supercharger Wastegate Solenoid "A"
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction

Wastegate Short Circuit Check Operation:	
DTCs	P0245 – Turbocharger/Supercharger Wastegate Solenoid "A" Low P0246 – Turbocharger/Supercharger Wastegate Solenoid "A" High
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	2 seconds to register a malfunction.

Miscellaneous ECU Errors:

VID Block Configuration Errors

The following fault codes are immediate malfunction lamp codes (1 drive cycle) and reflect that the Vehicle Identification Block has been improperly configured.

VID Block Configuration	
DTCs	P0602 - Internal Control Module Keep Alive Memory (KAM) Error P0610 - Control Module Vehicle Options Error P1635 - Tire/Axle Out of Acceptable Range P1639 - Vehicle ID Block Corrupted, Not Programmed

ECU Main Relay	
DTCs	P068A – ECM/PCM Power Relay De-Energized Too Early
Monitor execution	Continuous
Monitor Sequence	None
Monitoring Duration	0.5 seconds to register a malfunction.

Comprehensive Component Monitor - Transmission

General

The MIL is illuminated for all emissions related electrical component malfunctions. For malfunctions attributable to a mechanical component (such as a clutch, gear, band, valve, etc.), some transmissions are capable of not commanding the mechanically failed component and providing the remaining maximum functionality (functionality is reassessed on each power up)- in such case a non-MIL Diagnostic Trouble Code (DTC) will be stored and, if so equipped, the Wrench" Light will flash.

Transmission Inputs

Transmission Range Sensor Check Operation:	
DTCs	P0706 - Out of range signal frequency for PWM TRS P0707, P0708 - Low /High duty cycle for PWM TRS
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	
Monitoring Duration	5 seconds of signal out of range

Typical TRS check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
battery voltage	7v	18v

Typical TRS malfunction thresholds:
PWM TRS: Frequency > 175 Hz or < 75 Hz, Duty Cycle > 90% or < 10%

Output Shaft Speed Sensor Functional Check Operation:	
DTCs	P0720 – OSS circuit P0722 – OSS no signal
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	TSS, Wheel Speed
Monitoring Duration	30 seconds

Typical OSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	drive	
Engine rpm (above converter stall speed) OR	3000 rpm	
Turbine shaft rpm (if available) OR	1500 rpm	
Output shaft rpm	300 - 650 rpm	
Vehicle speed (if available)	12.5 - 15 mph	

Typical OSS functional check malfunction thresholds:
Circuit/no signal - vehicle is inferred to be moving with positive driving torque and OSS < 100 to 200 rpm for 5 to 30 seconds

Turbine Shaft Speed Sensor Functional Check Operation:	
DTCs	P0715 – TSS circuit P0717 – TSS no signal
Monitor execution	Continuous
Monitor Sequence	None
Sensors OK	OSS, Wheel Speed
Monitoring Duration	30 seconds

Typical TSS functional check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Gear selector position	Forward range	

Engine rpm (above converter stall speed) OR	3000 rpm	
Output shaft rpm OR	600 - 650 rpm	
Vehicle speed (if available)	12.5 - 15 mph	

Typical TSS functional check malfunction thresholds:
Circuit/no signal - vehicle is inferred to be moving with positive driving torque and TSS < 200 rpm for 5 – 30 seconds

System voltage:	
DTCs	P0882 – voltage out of range low P0883 – voltage out of range high
Monitoring execution	electrical - continuous

Transmission Fluid Temperature Sensor Functional Check Operation:	
DTCs (non-MIL)	P0712, P0713 or P0710 - Opens/shorts P1711 – in range failures P1783 – Transmission overtemperature (non-MIL fault, TFT > 275 deg F for 5 seconds)
Monitor execution	continuous
Monitor Sequence	none
Sensors OK	ECT substituted if TFT has malfunction
Monitoring Duration	5 seconds for electrical, 600 seconds for functional check

Typical TFT Stuck Low/High check entry conditions:		
Auto Transmission Entry Conditions	Minimum	Maximum
Engine Coolant Temp (hot or cold, not midrange)	> 100 ^{o}F	< 20 ^{o}F
Time in run mode	500 – 600 sec	
Time in gear, vehicle moving, positive torque	150 sec	
Vehicle Speed	15 mph	
Time with engine off (cold start) OR	420 min	
Engine Coolant Temp AND Trans Fluid Temp (inferred cold start)		122 ^{o}F

Typical TFT malfunction thresholds:
Opens/shorts: TFT voltage <0.05 or > 4.6 volts for 5 – 12 seconds TFT Stuck low/high, i.e. TFT stuck at high temperature or stuck at low temperature): Stores a fault code if TFT stabilizes (stops increasing if temperature < 70 deg F, stops decreasing if temperature > 225 deg F) before reaching the temperature region where all MIL tests are enabled (70 to 225 deg F). If TFT remains constant (+/- 2 deg F) for approximately 2.5 minutes of vehicle driving outside the 70 to 225 deg F zone a P0711 fault code will be stored. Old logic used to indicate a "pass" for a single delta, and

not test until the normal operating region (70-225 deg F) was reached.

CAN:	
DTCs	U0073 – CAN bus off U0100 – Lost communication with ECM
Monitoring execution	Continuous
Monitoring sequence	none

Transmission Outputs

Transmission Solenoid Power Control (TSPC – provides power to all transmission solenoids:	
DTCs	P0657 – TSPC1 fault, impacts SSA, SSC, SSE P2669 – TSPC2 fault, impacts SSB, SSD, TCC and LPC
Monitoring execution	electrical - continuous
Monitor sequence	Disables individual solenoid circuit fault detection if either above DTC sets and power is removed from all solenoids (one relay, removes power from both TSPC1 and TSPC2 wires)

Shift Solenoid Check Operation:	
DTCs	SS A - Electrical: P0750 (Open), P0973 (short to ground), P0974 (short to power) Functional: P0751 (stuck off), P0752 (stuck on) SS B - Electrical: P0755 (Open), P0976 (short to ground), P0977 (short to power) Functional: P0756 (stuck off), P0757 (stuck on) SS C - Electrical: P0760 (Open), P0979 (short to ground), P0980 (short to power) Functional: P0761 (stuck off), P0762 (stuck on) SS D - Electrical: P0765 (Open), P0982 (short to ground), P0983 (short to power) Functional: P0766 (stuck off), P0767 (stuck on) SS E - Electrical: P0770 (Open), P0985 (short to ground), P0986 (short to power) Functional: P0771 (stuck off), P0772 (stuck on)
Monitor execution	electrical - continuous, functional - continuous
Monitor Sequence	None
Sensors OK	TRS, TSS and OSS ok for functional diagnostics
Monitoring Duration	0.5 to 5 seconds for electrical checks, 3 clutch failed to apply (stuck off) or release (stuck on) events for functional check

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions (with turbine speed)	Minimum	Maximum
Gear ratio calculated	each gear	
Throttle position	positive drive torque	

Typical Shift Solenoid mechanical functional check entry conditions:		
Entry Conditions (without turbine speed)	Minimum	Maximum
Rpm drop is obtained	each shift	
Throttle position	positive drive torque	

Typical Shift Solenoid malfunction thresholds:
Electrical circuit check: Output driver feedback indicates an open, short to ground or open circuit for 0.5 – 5.0 seconds

Gear Ratio Check Operation:	
DTCs	P0731 - incorrect gear 1 ratio P0732 - incorrect gear 2 ratio P0733 - incorrect gear 3 ratio P0734 - incorrect gear 4 ratio P0735 - incorrect gear 5 ratio P0729 - incorrect gear 6 ratio P0736 - incorrect reverse ratio 6
Monitor execution	Continuous, in each gear
Monitor Sequence	None
Sensors OK	TSS, OSS, wheel speed
Monitoring Duration	12 seconds

Typical Forward Gear Ratio check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear selector position	forward range, > 8 seconds	
Engine Torque	100 NM	
Throttle position	10%	
Not shifting	> 0.5 seconds	
Engine/input Speed	550 rpm	
Output Shaft Speed	250 rpm	1350 rpm

Typical Neutral Gear Ratio check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear selector position	forward range, > 1 second	
Absolute value of Engine rpm – Turbine rpm		150 rpm
Output Shaft Speed		500 rpm

Typical Gear Ratio malfunction thresholds:
Forward gear check: > 20% error in commanded ratio for > 12 seconds

Typical Shift Completion check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear selector position	forward range	
Transmission Fluid Temp	50 ^{o}F	
Engine/input Speed	1200 rpm	
Output Shaft Speed	256 rpm	

Typical Shift Completion malfunction thresholds:	
Up-shift rpm check:	rpm does not drop by > 30 rpm
Down-shift rpm check:	rpm does not increase by > 30 rpm
Up-shift rpm check:	rpm increases (flares) by > 300 rpm

Torque Converter Clutch Check Operation:	
DTCs	Electrical: P0740 (open), P0742 (short to ground), P0744 (short to power) Functional: P0741 (stuck off), P2758 (stuck on) Note: P2758 is non-MIL, all other TCC DTC's are MIL
Monitor execution	electrical - continuous, mechanical - TCC fails to apply 3 times (stuck off) or fails to release 3 times (stuck on)
Monitor Sequence	None
Sensors OK	TSS, OSS
Monitoring Duration	Electrical – 5 seconds, Functional - 3 lock-up or release events

Typical TCC mechanical functional check stuck off entry conditions:		
Entry Conditions	Minimum	Maximum
Throttle Position	steady	
Engine Torque	positive drive torque	
Transmission Fluid Temp	70 ^{o}F	225 ^{o}F
Commanded TCC pressure (0 rpm slip)	55 psi	none
Not shifting		

Typical TCC malfunction thresholds:
Electrical circuit check: Output driver feedback circuit does not match commanded driver state for 0.5 – 5.0 seconds
Mechanical check, stuck off: Slip across torque converter > 100 for 3 seconds after each of 3 lock events
Mechanical check, stuck on: Slip across torque converter < 20 rpm with converter commanded off in at least 3 different gears

Pressure Control Solenoid Check Operation:	
DTCs	P0960, P0962, P0963 - PC A opens/shorts P0961 - PC A current range
Monitor execution	Continuous
Monitor Sequence	none
Sensors OK	
Monitoring Duration	Electrical: 5 seconds,

Typical Pressure Control Solenoid mechanical functional check entry conditions:		
Entry Conditions	Minimum	Maximum
Gear ratio calculated	each gear	
Transmission Fluid Temperature	70 ^{o}F	225 ^{o}F
Throttle Position	positive drive torque	

Typical Pressure Control Solenoid malfunction thresholds:
Electrical circuit check: Output driver feedback circuit does not match commanded driver state for 0.5 – 5.0 seconds Electrical current check: Feedback current out of range for 0.5 seconds

Transmission Control Module (TCM)

TCM	
DTCs	P0604 – RAM fault present P0605 – ROM fault present P0607 – CPU reset fault P06B8 – NVRAM error
Monitoring execution	Once per driving cycle at start-up except reset monitoring which is continuous
Monitor sequence	non

ADLER (chip that controls the transmission solenoids):	
DTCs	P1636 – lost communication (over internal SPI network) with ADLER chip
Monitoring execution	electrical - continuous
Monitor sequence	Transmission enters mechanical limp home (get P, R, N and 5M with open TCC and max line) if the main micro cannot communicate with the ADLER chip

Transmission ID (TRID) block (contains solenoid characterization data	
DTCs	P163E – programming error (checksum fault) P163F – TRID data not programmed
Monitoring execution	Start-up – TRID is a portion of flash memory, either it is present at start-up or not
Monitor sequence	Transmission solenoid data missing, enters limited operating mode (P, R, N and 3rd gear with open TCC).

6R140 (RWD) Transmission with external PCM or TCM

Transmission Control System Architecture

Starting in 2011 MY 6R140 replaces 5R110W in Super Duty truck applications.

The 6R140 is a 6-speed, step ratio transmission that is controlled by an external PCM (gas engine applications) or TCM (Diesel engine applications). For Diesel the TCM communicates to the Engine Control Module (ECM), ABS Module, Instrument Cluster and Transfer Case Control Module using the high speed CAN communication link. The TCM incorporates a standalone OBD-II system. The TCM independently processes and stores fault codes, freeze frame, supports industry-standard PIDs as well as J1979 Mode 09 CALID and CVN. The TCM does not directly illuminate the MIL, but requests the ECM to do so. The TCM is located outside the transmission assembly. It is not serviceable with the exception of reprogramming.

Transmission Inputs

Transmission Range Sensor

6R140 uses a Non-contacting Pulse Width Modulated Transmission Range Sensor (TRS) that provides a duty cycle signal for each position. This signal is transmitted at a frequency of 125 Hz. The PCM / TCM decode the duty cycle to determine the driver-selected gear position (Park, Rev, Neutral, OD, 3, 2, 1). This input device is checked for frequency out of range (P0706), duty cycle out of range low (P0707) and duty cycle out of range high (P0708)

Speed Sensors

The Turbine Shaft Speed (TSS) sensor and Output Shaft Speed (OSS) sensor are Hall effect sensors.

The Turbine Shaft Speed sensor is monitored by a rationality test, if engine speed and output shaft speed are high and a gear is engaged, it can be inferred that the vehicle is moving. If there is insufficient output from the TSS sensor a fault is stored (P0715).

The Output Shaft Speed sensor is monitored by a rationality test. If engine speed and turbine speed are high and a gear is engaged, it can be inferred that the vehicle is moving. If there is insufficient output from the OSS sensor a fault is stored (P0720).

Transmission Fluid Temperature

The Transmission Fluid Temperature Sensor is checked for out of range low (P0712), out of range high (P0713), and in-range failures (P0711). P1783 sets if TFT exceeds 275 deg F for 5 seconds, indicating transmission overtemperature (non-MIL failure).

Transmission Outputs

Shift Solenoids (SS)

6R140 has 5 shift solenoids:

- SSA – a Variable Force Solenoid (VFS) that controls CB1234 (a brake clutch, grounds an element to the case, that is on in 1st, 2nd, 3rd and 4th gear)
- SSB – a VFS that controls C35R (a rotating clutch on in 3rd, 5th and Reverse)
- SSC – a VFS that controls CB26 (a brake clutch on in 2nd and 6th gear)
- SSD – a VFS that controls CBLR (a brake clutch on in 1st gear with engine braking and Reverse)
- SSE – a VFS that controls C456 (a rotating clutch on in 4th, 5th and 6th gear)

Output circuits are checked for opens, short to ground and short to power faults (codes listed in that order) by the "smart driver" (see ADLER below) that controls the solenoids (SSA P0750, P0973, P0974; SSB P0755, P0976, P0977; SSC P0760, P0979, P0980; SSD P0765, P0982, P0983; SSE P0770, P0985, P0986).

The shift solenoids are also functional tested for stuck on and stuck off failures. This is determined by vehicle inputs such as gear command, and achieved gear (based on turbine and output speed). In general the shift solenoid malfunction codes actually cover the entire clutch system (solenoid, valves, seals and the clutch itself since using ratio there is no way to isolate the solenoid from the rest of the clutch system)

For SSA thru SSE Diagnostics will isolate the fault into clutch functionally (non-electrical) failed off (SSA P0751, SSB P0756, SSC P0761, SSD P0766. SSE P0771) and clutch functionally failed on (SSA: P0752, SSB: P0757, SSC: P0762, SSD: P0767, SSE: P0772).

Gear ratio errors:

If ratio errors are detected that do not match an expected pattern for a failed solenoid then gear ratio error fault codes (1st gear – P0731, 2nd gear – P0732, 3rd gear – P0733, 4th gear – P0734, 5th gear – P0735 or 6th gear – P0729) will be stored.

Torque Converter Clutch

The Torque Converter Clutch (TCC) solenoid is a Variable Force Solenoid. TCC solenoid circuit is checked electrically for open, short to ground and short to power circuit faults internally by the "smart driver" that controls the solenoids (P0740, P0742, P0744).

The TCC solenoid is checked functionally for stuck off faults by evaluating torque converter slip under steady state conditions when the torque converter is fully applied. If the slip exceeds the malfunction thresholds when the TCC is commanded on, a TCC malfunction is indicated (P0741).

The TCC solenoid is monitored functionally for stuck on faults (P2758) by monitoring for lack of clutch slip when the TCC is commanded off, but this code is non-MIL because while a stuck on TCC solenoid may cause driveability complaints and/or cause engine stalls it does not impact emissions or fuel economy.

Electronic Pressure Control (EPC)

The EPC solenoid is a variable force solenoid that controls line pressure in the transmission. The EPC solenoid is monitored for open, short to ground or short to power faults by the "smart driver" that controls the solenoid. If a short to ground (low pressure) is detected, a high side switch will be opened. This switch removes power from all 7 VFSs, providing Park, Reverse, Neutral, and 5M (in all forward ranges) with maximum line pressure based on manual lever position. This solenoid is tested for open (P0960), short to ground (P0962), and short to power (P0963) malfunctions.

Transmission Solenoid Power Controll (TSPC)

6F140 PCM or TCM has a internal high side switch called TSPC that can be used to remove power from all 7 solenoids simultaneously. If the high side switch is opened, all 7 solenoids will be electrically off, providing Park, Reverse, Neutral, and 5M (in all forward ranges) with maximum line pressure based on manual lever position.

Due to current limitations TSPC is split into 2 pins / wires at the PCM / TCM. TSPC A provides power to SSA, SSC and SSE. TSPC B provides power to SSB, SSD, TCC and LPC. Each wire can be tested independently; P0657 sets for an issue with TSPC-A, P2669 sets for an issue with TPSC-B.

Although there are 2 pins and wires between the PCM / TCM and the transmission bulkhead connector the PCM / TCM contains only one TSPC internally – so the FMEM for either wire being failed is to open TSCP inside the PCM / TCM, which removes power from all 7 solenoids, providing P, R, N and 5th gear with open TCC and max line as FMEM for any TPSC faults.

ADLER (chip that controls all 7 solenoids) diagnostics:

The solenoids are controlled by an ADLER chip. The main micro sends commanded solenoid states to the ADLER, and receives back solenoid circuit fault information.

If communication with the ADLER is lost a P1636 fault code will be stored. If this failure is detected the states of the solenoids are unknown, so the control system will open the high side switch (removes power from all the solenoids), providing P, R, N and 5M with open TCC and max line pressure.

TRID Block

The TRID block is a portion of flash memory that contains solenoid characterization data tailored to the specific transmission to improve pressure accuracy.

The TRID block is monitored for two failures:

- TRID block checksum error / incorrect version of the TRID (P163E)
- TRID block not programmed (P163F)

If the TRID block is unavailable FMEM action limits operation to P, R, N and 3rd gear based on manual lever position until the issue is correct.

Transmission Control Module (TCM – Diesel only)

The TCM has the same module diagnostics as a PCM:

P0604 - Powertrain Control Module Random Access Memory (RAM) Error indicates the Random Access Memory read/write test failed.

P0605 - Powertrain Control Module Read Only Memory (ROM) Error indicates a Read Only Memory check sum test failed.

P0607 - Powertrain Control Module Performance indicates incorrect CPU instruction set operation, or excessive CPU resets.

P06B8 - Internal Control Module Non-Volatile Random Access Memory (NVRAM) Error indicates Permanent DTC check sum test failed

.

CAN Communications Error

The TCM receives information from the ECM via the high speed CAN network. If the CAN link or network fails, the TCM no longer has torque or engine speed information available. The TCM will store a U0073 fault code and will illuminate the MIL immediately (missing engine speed) if the CAN Bus is off. The TCM will store a U0100 fault code and will illuminate the MIL immediately (missing engine speed) if it stops receiving CAN messages from the ECM. A U0401 fault codes will be stored if the ECM sends invalid/faulted information for the following CAN message items: engine torque, pedal position.

TCM voltage

If the system voltage at the TCM is outside of the specified 9 to 16 volt range, a fault will be stored (P0882, P0883).

On Board Diagnostic Executive

The On-Board Diagnostic (OBD) Executive is a portion of the PCM strategy that manages the diagnostic trouble codes and operating modes for all diagnostic tests. It is the "traffic cop" of the diagnostic system. The Diagnostic Executive performs the following functions:

- Stores freeze frame and "similar condition" data.
- Manages storage and erasure of Diagnostic Trouble Codes as well as MIL illumination.
- Controls and co-ordinates the execution of the On-Demand tests: Key On Engine Off (KOEO) and Key On Engine Running (KOER).
- Performs transitions between various states of the diagnostic and powertrain control system to minimize the effects on vehicle operation.
- Interfaces with the diagnostic test tools to provide diagnostic information (I/M readiness, various J1979 test modes) and responses to special diagnostic requests (J1979 Mode 08 and 09).
- Tracks and manages indication of the driving cycle which includes the time between two key on events that include an engine start and key off.

The diagnostic executive also controls several overall, global OBD entry conditions.

- The battery voltage must fall between 9.0 and 16.25 volts to initiate monitoring cycles.
- The engine must be started to initiate the engine started, engine running, and engine off monitoring cycles.
- The Diagnostic Executive suspends OBD monitoring when battery voltage falls below 11.0 volts.

The diagnostic executive controls the setting and clearing of pending and confirmed DTCs.

- A pending DTC and freeze frame data is stored after a fault is confirmed on the first monitoring cycle. If the fault recurs on the next driving cycle, a confirmed DTC is stored, freeze frame data is updated, and the MIL is illuminated. If confirmed fault free on the next driving cycle, the pending DTC and freeze frame data is erased on the next power-up.
- Pending DTCs will be displayed as long as the fault is present. Note that OBD-II regulations required a complete fault-free monitoring cycle to occur before erasing a pending DTC. In practice, this means that a pending DTC is erased on the next power-up after a fault-free monitoring cycle.
- After a confirmed DTC is stored and the MIL has been illuminated, three consecutive confirmed fault-free monitoring cycles must occur before the MIL can be extinguished on the next (fourth) power-up. After 40 engine warm-ups, the DTC and freeze frame data is erased.

The diagnostic executive controls the setting and clearing of permanent DTCs.

- A permanent DTC is stored when a confirmed DTC is stored, the MIL has been illuminated, and there are not yet six permanent DTCs stored.

- After a permanent DTC is stored, three consecutive confirmed fault-free monitoring cycles must occur before the permanent DTC can be erased.
- After a permanent DTC is stored, one confirmed fault-free monitoring cycle must occur, following a DTC reset request, before the permanent DTC can be erased. For 2010MY and beyond ISO 14229 programs a driving cycle including the following criteria must also occur, following the DTC reset request, before a permanent DTC can be erased:
    - Cumulative time since engine start is greater than or equal to 600 seconds;
    - Cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds (medium-duty vehicles with diesel engines certified on an engine dynamometer may use cumulative operation at or above 15% calculated load in lieu of at or above 25 miles per hour for purposes of this criteria); and
    - Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds.
- A permanent DTC can not be erased by a KAM clear (battery disconnect). Additionally, its confirmed DTC counterpart will be restored after completion of the KAM reset (battery reconnect).

Exponentially Weighted Moving Average

Exponentially Weighted Moving Averaging is a well-documented statistical data processing technique that is used to reduce the variability on an incoming stream of data. Use of EWMA does not affect the mean of the data; however, it does affect the distribution of the data. Use of EWMA serves to “filter out” data points that exhibit excessive and unusual variability and could otherwise erroneously light the MIL.

The simplified mathematical equation for EWMA implemented in software is as follows:

New Average = [New data point * “filter constant”] + [(1 - “filter constant”) * Old Average]

This equation produces an exponential response to a step-change in the input data. The "Filter Constant" determines the time constant of the response. A large filter constant (i.e. 0.90) means that 90% of the new data point is averaged in with 10% of the old average. This produces a very fast response to a step change. Conversely, a small filter constant (i.e. 0.10) means that only 10% of the new data point is averaged in with 90% of the old average. This produces a slower response to a step change.

When EWMA is applied to a monitor, the new data point is the result from the latest monitor evaluation. A new average is calculated each time the monitor is evaluated and stored in Keep Alive Memory (KAM). This normally occurs each driving cycle. The MIL is illuminated and a DTC is stored based on the New Average store in KAM.

In order to facilitate repair verification and DDV demonstration, 2 different filter constants are used. A “fast filter constant” is used after KAM is cleared/DTCs are erased and a “normal filter constant” is used for normal customer driving. The “fast filter” is used for 2 driving cycles after KAM is cleared/DTCs are erased, and then the “normal filter” is used. The “fast filter” allows for easy repair verification and monitor demonstration in 2 driving cycles, while the normal filter is used to allow up to 6 driving cycles, on average, to properly identify a malfunction and illuminate the MIL.

In order to relate filter constants to driving cycles for MIL illumination, filter constants must be converted to time constants. The mathematical relationship is described below:

Time constant = [(1 / filter constant) - 1] * evaluation period

The evaluation period is a driving cycle. The time constant is the time it takes to achieve 68% of a step-change to an input. Two time constants achieve 95% of a step change input.

I/M Readiness Code

The readiness function is implemented based on the J1979 format. Clearing codes using a scan tool results in the various I/M readiness bits being set to a “not-ready” condition. As each non-continuous monitor completes a full diagnostic check, the I/M readiness bit associated with that monitor is set to a “ready” condition. This may take one or two driving cycles based on whether malfunctions are detected or not.

Power Take Off Mode

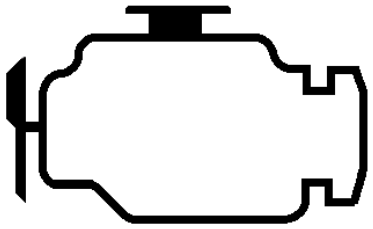
While PTO mode is engaged, the I/M readiness bits are set to a “not-ready” condition. When PTO mode is disengaged, the I/M readiness bits are restored to their previous states prior to PTO engagement. During PTO mode, only CCM circuit checks continue to be performed.

Serial Data Link MIL Illumination

The OBD-II diagnostic communication messages utilize an industry standard 500 kbps CAN communication link.

The instrument cluster on some vehicles uses the same CAN data link to receive and display various types of information from the PCM. For example, the engine coolant temperature information displayed on the instrument cluster comes from the same ECT sensor used by the PCM for all its internal calculations.

These same vehicles use the CAN data link to illuminate the MIL rather than a circuit, hard-wired to the PCM. The PCM periodically sends the instrument cluster a message that tells it to turn on the MIL, turn off the MIL or blink the MIL. If the instrument cluster fails to receive a message within a 5-second timeout period, the instrument cluster itself illuminates the MIL. If communication is restored, the instrument cluster turns off the MIL after 5 seconds. Due to its limited capabilities, the instrument cluster does not generate or store Diagnostic Trouble Codes.



Calculated Load Value

$$\text{LOAD_PCT (PID \$04)} = \frac{\text{Current Calculated Torque}}{\text{Maximum Engine Torque at conditions}}$$

Where:

- Current Calculation of torque is derived from the injected quantity of torque producing fuel and engine speed.
- Maximum Engine Torque is derived from the maximum curve.

I/M Readiness

The readiness function is implemented based on the SAE J1979/ISO 15031-5 format. Clearing codes using a scan tool results in the various I/M readiness bits being set to a "not-ready" condition. As each non-continuous monitor completes a full diagnostic check, the I/M readiness bit associated with that monitor is set to a "ready" condition. This may take one or two driving cycles based on whether malfunctions are detected or not. The readiness bit for comprehensive component monitoring is immediately considered complete since they are continuous monitors. The table below shows which monitors must complete for I/M readiness.

I/M Readiness bit	**Controlling Monitor**
Boost Pressure	P0234 P0299 P026A P132B P1249
CCM	Always Ready
EGR	P0401 P0402 P2457 P24A5
Exhaust Gas Sensors	P0133 P2A00 P2201 P06EA P2200
Fuel System	P0088 P0093 P0088 P0089 P02CC P02D0 P02D8 P02CE P02D6 P02D4 P02D2 P02DA
HC Catalyst	P0420
Misfire	P0301 P0303 P0307 P0302 P0306 P0305 P0304 P0308 P0300
Nox Catalyst	P20EE P249C
PM Catalyst	P244A P249F

Power Take Off Mode

While PTO mode is engaged, the I/M readiness bits are set to a “not-ready” condition. When PTO mode is disengaged, the I/M readiness bits are restored to their previous states prior to PTO engagement. During PTO mode, only CCM circuit checks continue to be performed.

In-Use Monitor Performance Ratio

Manufacturers are required to implement software algorithms that track in-use performance for each of the following components:

The table below shows which monitors must complete to increment each IUMPR numerator.

IUMPR Counter Numerator	**Controlling Monitor**
NMHCCatalyst (500 Mile Denominator)	P0420
NOxCatalyst	P20EE
PMFilter	P244A
EGSensor	P2201 P0133 P2A00 P164A
EGR System Monitoring (No VGT currently on Ford Diesel Products)	P0401 P0402 P2457 P24A5
Boost Pressure	P132B P0299 P026A P0234 P1249
Fuel System	P02CC P02D0 P02D8 P02CE P02D6 P02D4 P02D2 P02DA

Mode$06 Results

Mode$06 results are included for:

Mode$06 Test Result	Controlling Monitor
HEGO 11	P0133 P2A00 P164A P2201 P0420
Cat Bank 1	P0420
Diesel EGR	P0401 P0402 P2457 P24A5
Fuel System	P02CD P02D1 P02D9 P02CF P02D7 P02D5 P02D3 P02DB
Boost Pressure Control	P132B P0234 P0299 P1249 P026A
Nox Catalyst	P20EE
Misfire	P0301 P0303 P0307 P0302 P0306 P0305 P0304 P0308
PM Catalyst	P244A

EA11-003

FORD

1-20-2012

Appendix O

REVIEW / ITEM	VIN 9	VIN 8	ESN	EBD	VBD	WSD	DEALER	FAIL DATE	VEHICLE MILEAGE	CLAIM #	CLAIM $	HPP SN	FAIL MODE
R20090475065	1FTWW31R0	9E[redacted]	0662853	01/08/09	03/10/09	03/24/09	20672	04/11/09	481	053531	$13,658	J0826/S00685	454D01014
R20090475077	1FTWF31R4	9E[redacted]	0678861	03/03/09	03/05/09		07590	04/22/09	7	626650	$2,214	J0904/S00067	
R20090208008	1FTWW31R2	9E[redacted]	0651848	11/21/08	12/02/08	01/23/09	B6208	03/12/09	1,550	410667	$3,657	J0820/S01325	454R01001
R20090208007	1FTWW31R3	9E[redacted]	0636785	09/30/08	10/02/08		A6040	10/21/08	26	432548	$23,213	J0813/S00649	454D08002

COMMENTS
SN J0826/S00685 - ROUGH RUN CONCERN - NUMEROUS INJECTOR FAILURES - HPP TO CONTI - FAILED TORQUE-TO-TURN (HIGH) - NO ITP SCUFFING - ALL SLIDE SHOES AND ECCENTRIC SCUFFED - CRACKE
ENGINE DIED WHILE DRIVING- J0904/S00067 - NO CAPS - TALL FITTINGS REMOVED - SENT FOR ANALYSIS ONLY
TRUCK STALLED ON ROAD - DTC P0087, P200E - PCV DAMAGED IN TRANSIT - PUMP TO CONTI FOR ANALYSIS - PCV was smashed to the point of infinite resistance. CONTI replaced it, functional tested, N
FUEL SYSTEM FULL OF METAL DEBRIS - PUMP TO CONTI - SCUFFED ITP - PUMP TO RODING FOR FURTHER EVALUATION

:D #3 CYLINDER

TF. Pump disassembled for inspection Clean pump through and through... nothing suspicious, no corrosion - TNI

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
2	2011	1FT7W2ATXE[redacted]	1087.95	8-Oct-10	20-Oct-10	PREMIER FORD L-M INC	5613801	[redacted]	2.00E+03	BC3Z	9A543	A	E68	42	2-Dec-10	2	137424	1684	$1,131.77	$2,219.72	14.5	5928	*	NA	MS	
3	2011	1FT8W3BT6BE[redacted]	605.68	30-Mar-10	10-Apr-10	LONG MCARTHUR, INC.	40098401	[redacted]7	2.00E+03	BC3Z	9A543	A	D02	D1	19-Apr-10	1	292	1381	$1,138.75	$1,744.43	8	5254	*	NA	KS	32103
4	2011	1FDGF5GT9BE[redacted]	159.96	17-Mar-10	31-May-10	AUTOS DE TLAXCALA, S.A. DE C.V	99061	47[redacted]	2.00E+03	BC3Z	9A543	A	L65	D4	8-Jun-10	1	3677	114	$1,294.65	$1,454.61	8.9	M1375	*	NA	TL	32103
5	2011	1FT8W3DTXBE[redacted]	61.26	21-Apr-10	13-May-10	CROWSON AUTO WORLD	5096001	7[redacted]	2.00E+06	BC3Z	9G282	A	D42	42	16-Jul-10	3	9098	4319	$243.07	$304.33	1	7011	*	NA	MS	100103
6	2011	1FDRF3HTXBE[redacted]	461.82	########	18-Jun-10	BILL JARRETT FORD-MERCURY, INC	237320B	[redacted]	2.00E+03	BC3Z	9A543	A	E29	42	14-Jul-10	1	14565	3053	$1,163.32	$1,625.14	6	4993	*	NA	FL	32103

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
7	2011	1FDUF4GT8BE[redacted]	753.02	########	8-Jun-10	DEWEY FORD	52028301	2894949	2.00E+03	BC3Z	9A543	A	D36	55	9-Aug-10	3	18051	360	$1,000.52	$1,753.54	8.8	6580	*	NA	IA	32103
8	2011	1FT8W3DTXBE[redacted]	3015.23	########	19-Jul-10	JOE CUNNINGHAM FORD LTD.	6360301	2482062	2.00E+03	BC3Z	9A543	A	E29	63	19-Jul-10	0	37942	71	$2,600.34	$5,615.57	35.8	B7233	*	NA	BC	32103
	2011	1FT7W2BT3E[redacted]	350.06	20-Apr-10	16-Aug-10	WHITE FORD LINCOLN, L.L.C.	1787871	4355101	2.00E+03	BC3Z	9A543	A	E68	D1	13-Oct-10	2	90952	2355	$1,065.31	$1,415.37	5.2	6577	*	NA	LA	
9																										

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
10	2011	1FT8W3DT4BE[redacted]	949.19	6-Apr-10	18-Oct-10	CASA FORD LINCOLN MERCURY					9E964				23-Oct-10			440	$1,249.69	$2,198.88					TX	
11	2011	1FT8W3BT7B[redacted]	1308.54	24-Aug-10		WATERLOO FORD LINCOLN SALES LTD.	67577802	4234330	2.00E+03	BC3Z	9A543	A	E68	D8	15-Sep-10	-1	98484	18	$1,425.19	$3,021.06	13.7	A6010	*	NA	AB	
12	2011	1FT7W2BT4E[redacted]	1208	14-Apr-10	17-Sep-10	RANDALL REED'S PLANET FORD	49173101	4469171	2.00E+03	BC3Z	9A543	A	E29	42	17-Nov-10	3	125148	4900	$6,014.22	$7,222.22	14.2	4462	*	NA	TX	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
13	2011	1FT8W3BT3BE[redacted]	698.76	16-Sep-10	30-Sep-10	C. HARPER FORD, INC.	132750A	9292900	2.00E+03	BC3Z	9A543	A	D02	42	24-Nov-10	2	139585	5822	$6,374.55	$7,073.31	9	3233	*	NA	PA	
14	2011	1FT8X3BT2BE[redacted]	931.79	5-Apr-10	15-Jul-10	GEORGE COOPER FORD INC	088057A	*	2.00E+03	BC3Z	9A543	A	D02	55	10-Nov-10	4	117206	5033	$1,106.30	$2,248.09	11.7	6645	*	NA	MD	
15	2011	1FT8W3BT2E[redacted]	1380.98	########	26-Jun-10	WAYNE FORD	164637A	2568800	2.00E+03	BC3Z	9A543	A	E29	42	30-Nov-10	6	182714	10180	$7,925.72	$9,306.70	12.1	20685	*	NA	NJ	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
16	2011	1FT8W4DT0[redacted]2	745.43	12-Oct-10	8-Jan-11	JIM CLICK FORD, LINCOLN-MERCURY	28601401	7472000	2.00E+03	BC3Z	9A543	A	E68	D8	8-Jan-11	0	179720	226	$1,230.77	$1,976.20	8.3	20402	*	NA	AZ	
17	2011	1FDUF5HTXB[redacted]	472.51	########	17-Jun-10	GREGG SMITH FORD L-M, INC.	7140151	8855505	2.00E+03	BC3Z	9A543	A	E29	42	30-Dec-10	7	176222	2212	$1,148.68	$1,621.19	7.1	5080	*	NA	MO	
18	2011	1FT7W2BT1BE[redacted]	1692.9	22-Apr-10	14-Jun-10	ST. GEORGE FORD LINCOLN MERCURY	51120302	6743200	2.00E+03	BC3Z	9A543	A	D02	42	10-Jan-11	8	211430	30344	$5,634.42	$7,327.32	19.8	7969	*	NA	UT	
19	2011	1FT7W2BT1E[redacted]	1541.74	24-Sep-10	23-Dec-10	LEIF JOHNSON FORD	834613A	4543711	2.00E+03	BC3Z	9A543	A	D02	42	26-Jan-11	2	213526	1780	$6,002.52	$7,544.26	17.1	4465	*	NA	TX	
20	2011	1FT7X2BT4BE[redacted]	1513.06	31-Mar-10	31-May-10	KARL KLEMENT FORD	10306201	6271101	2.00E+03	BC3Z	9A543	A	D42	42	3-Jan-11	8	224406	32663	$5,578.36	$7,091.42	17.9	2631	*	NA	TX	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
21	2011	1FT7W2BT3BE[redacted]	1304.76	2-Jun-10	21-Oct-10	HINESVILLE FORD CO	6458301	3683505	2.00E+03	BC3Z	9A543	A	D36	42	22-Dec-10	3	230400	7313	$1,497.03	$2,801.79	16.6	4858	*	NA	GA	
22	2011	1FT7X2BT6BE[redacted]	764.19	########	2-Jun-10	ROD BAKER FORD SLS INC					9A543				18-Nov-10			3524	$5,797.97	$6,562.16					IL	
23	2011	1FT8W3BTXB[redacted]																								
24	2011	1FT8W3CT3B[redacted]	303.17	12-Oct-10	31-Dec-10	BORMAN MOTOR COMPANY	61210402	5254500	2.00E+03	BC3Z	9A543	A	L87	42	21-Feb-11	2	252191	656	$1,131.77	$1,434.94	3.5	20428	*	NA	NM	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
25	2011	1FT8W3BT5BE[redacted]	1727.9	9-Mar-10	17-Jul-10	MULLINAX FORD	617028A	8452900	2.00E+03	BC3Z	9A543	A	D21	1	27-Jan-11	7	254637	16075	$7,672.15	$9,400.05	19.7	3277	*	NA	FL	
26	2011	1FDUF5GT8E[redacted]	1440.17	12-Aug-10	15-Nov-10	EXCEL FORD LINCOLN, LP	876002	6933821	2.00E+03	BC3Z	9A543	A	D42	42	20-Jan-11	3	264715	8988	$5,536.70	$6,976.87	17.2	2871	*	NA	TX	
27	2011	1FT7W2BTXB[redacted]6	618.16	8-Jun-10	30-Sep-10	SILSBEE FORD, INC.	249401	3853724	2.00E+03	BC3Z	9A543	A	E68	42	7-Mar-11	6	288701	8917	$1,349.34	$1,967.50	7.7	2549	*	NA	TX	
28		1FD0X5HT6BE[redacted]																								

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
29	2011	1FT8W3BT2BE[redacted]	434.96	12-Oct-10	30-Nov-10	NORTH CASCADE FORD	162919A	8551551	2.00E+03	BC3Z	9A543	A	E68	D1	7-Mar-11	4	293480	2678	$1,121.67	$1,556.63	5	9700	*	NA	WA	
30	2011	1FT8W3BT1BE[redacted]	1447.75	########	30-Jun-10	DELONG FORD-MERCURY, INC.	4697001	6235001	2.00E+03	BC3Z	9A543	A	D50	49	24-Jan-11	7	296559	26920	$5,533.80	$6,981.55	18	8351	*	NA	NV	
31	2011	1FT7W2BT4BE[redacted]	1457.41	8-Jun-10	12-Jul-10	RAMSEY FORD OF ELKTON	089267A	3983600	2.00E+03	BC3Z	9A543	A	D42	63	17-Feb-11	8	302740	14395	$5,895.26	$7,352.67	18.3	6645	*	NA	MD	
32	2011	1FDUF5HT7BE[redacted]	252.07	10-Jan-11		TRI STAR FORD SOMERSET, INC.	133113A	4456575	2.00E+03	BC3Z	9A543	A	E68	1	15-Mar-11	-1	313774	213	$1,131.77	$1,383.84	3.5	9968	*	NA	PA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
33	2011	1FT7W2BT1BE[redacted]	431.14	15-Oct-10	31-Dec-10	MCKIE FORD LINCOLN MERCURY, INC.	70319901	3481400	2.00E+03	BC3Z	9A543	A	N50	42	4-Apr-11	4	358340	4507	$1,255.29	$1,686.43	5.2	3105	*	NA	SD	
34	2011	1FD0W4HT3BEB[redacted]	732.9	23-Aug-10	22-Oct-10	CONWAY FORD, INC.	180527A	3655596	2.00E+03	BC3Z	9A543	A	D42	42	24-Feb-11	5	357818	6670	$5,752.77	$6,485.67	10.2	1092	*	NA	SC	
35	2011	1FD8W3HT2BE[redacted]	1715.46	15-Sep-10	24-Sep-10	UNION CITY FORD LINCOLN, INC.	7330701	8858833	2.00E+03	BC3Z	9A543	A	D02	42	15-Mar-11	6	398345	9246	$6,147.74	$7,863.20	25.6	5959	*	NA	TN	
36	2011	1FD0X4GT8E[redacted]	381.43	1-Oct-10	3-Jan-11	SHEEHY FORD MERCURY	42663101	7984791	2.00E+03	BC3Z	9A543	A	D02	42	25-Mar-11	3	397624	540	$1,305.56	$1,686.99	4.1	4224	*	NA	VA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
37	2011	1FDUF5HT1E[redacted]	2647.81	1-Jun-10	4-Aug-10	ZAROWNY MOTORS ST.PAUL LTD	61753701	6454468	2.00E+03	BC3Z	9A543	A	D02	1	22-Feb-11	7	368504	15635	########	########	25.8	B6032	*	NA	AB	
38	2011	1FT8W3DT3E[redacted]									9A543							16,248		$2,306.11					NC	
39	2011	1FT8W4DT4BE[redacted]	524.46	9-Apr-10	29-Jun-10	ROY O'BRIEN, INC.	48927201	7767600	2.00E+03	BC3Z	9A543	A	D02	42	7-Apr-11	10	421367	11524	$1,065.31	$1,589.77	5.7	2934	*	NA	MI	
40	2011	1FT7W3BT2BE[redacted]	482.21	15-Mar-11	28-Mar-11	SIMI VALLEY FORD	1940651	5830333	2.00E+03	BC3Z	9A543	A	D42	42	2-May-11	2	447833	439	$1,038.83	$1,521.04	4.9	7022	*	NA	CA	
41																										
42	2011	1FT7W2BT5E[redacted]	1643.49	10-Jun-10	1-Jul-10	ALLAN VIGIL FORD LINCOLN, INC.	20573103	*	2.00E+03	BC3Z	9H529	B	D02	49	29-Mar-11	10	454832	21117	$6,696.23	$8,379.72	17.1	804	*	NA	GA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
43	2011	1FDRF3HTXB[redacted]	444.92	22-Oct-10	16-Dec-10	JOE MACHENS FORD LINCOLN MERCURY	66469301	4454411	2.00E+03	BC3Z	9A543	A	E68	D8	########	5	475226	9897	$1,078.29	$1,523.21	4.8	8006	*	NA	MO	
44	2011	1FT7W2BTXB[redacted]	1939.91	26-Aug-10	17-Sep-10	JORDAN FORD, LTD.	8782751	6533673	2.00E+03	BC3Z	9H529	A	E29	42	10-Feb-11	5	482895	17788	$7,571.58	$9,511.49	22.3	4546	*	NA	TX	
45	2011	1FDUF5GT5BE[redacted]	646.57	28-Apr-10	25-Jul-10	BIG M FORD LINCOLN LTD.	16458701	5274406	2.00E+03	BC3Z	9A543	A	D03	42	3-May-11	10	489591	40125	$1,550.57	$2,197.15	7.2	A6035	*	NA	AB	
46	2011	1FT7W2BT7E[redacted]	2343.89	16-Aug-10	29-Sep-10	KEN GARFF FORD	69618902	7636800	2.00E+03	BC3Z	9A543	A	D41	42	25-Apr-11	7	492887	17935	$6,269.22	$8,613.11	25.4	8254	*	NA	UT	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
47	2011	1FT7W2BT5E[redacted]9	463.35	10-Jun-10	1-Jul-10	FAIRWAY FORD OF AUGUSTA INC	7602551	8549200	2.00E+03	BC3Z	9H529	B	D21	42	18-Jan-11	7	531334	20071	$2,952.80	$3,566.15	5.1	229	*	NA	GA	
48	2011	1FDUF4GT8BE[redacted]	1217.3	########	17-Jun-10	CENTRAL FORD	8072651	9277888	2.00E+03	BC3Z	9A543	A	D02	42	21-Apr-11	11	548966	3	$1,596.59	$2,884.74	11.8	2	*	NA	CA	
49	2011	1FT8X3BT8BE[redacted]	1344.06	5-May-10	17-Jan-11	DAN PILSON AUTO CENTER, INC.	090696A	2346461	2.00E+03	BC3Z	9A543	A	D02	42	9-Jun-11	5	586021	18210	$6,230.39	$7,607.60	17.1	4640	*	NA	IL	
50	2011	1FD0W5HT1B[redacted]	1586.99	5-Nov-10	15-Apr-11	FREEDOM FORD SALES LIMITED	435172A	4627575	2.00E+03	BC3Z	9A543	A	E29	42	########	2	583906	2361	$2,156.03	$3,743.02	15.4	B6270	*	NA	AB	
51	2011	1FD8W3GT6[redacted]7	735.31	19-Apr-11		FIVE STAR FORD	500604A	4988838	2.00E+03	BC3Z	9A543	A	E29	42	6-May-11	-1	620351	207	$1,273.78	$2,009.09	8.2	2486	*	NA	TX	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
52	2011	1FDUF5GT4E[redacted]	476.4	10-Mar-10	14-Jun-11	OLATHE FORD LINCOLN	4487951	7820881	2.00E+03	BC3Z	9A543	A	E29	42	14-Jun-11	0	665420	906	$1,117.18	$1,593.58	5	5238	*	NA	KS	
53	2011	1FDRF3HT6BE[redacted]3	388.91	2-Jul-10	12-Oct-10	WOMACK SUNSHINE FORD	129707A	2431220	2.00E+03	BC3Z	9A543	A	E68	42	10-Jun-11	9	664508	7075	$1,016.13	$1,405.04	5.3	2959	*	NA	KS	
54	2011	1FT7W2BT4BE[redacted]	202.1	18-Jan-11	31-Mar-11	BOB MAXEY FORD, INC.	30183901	3929200	2.00E+03	BC3Z	9H529	A	L65	7	30-Jun-11	4	651217	10274	$477.08	$679.18	2.1	9834	*	NA	MI	
55	2011	1FT7X2BTXBE[redacted]	2324.31	25-Mar-10	17-May-10	BICKFORD MOTORS, INC.	708591A	5682122	2.00E+03	BC3Z	9A543	A	D42	42	20-Apr-11	12	633961	41587	$8,330.87	########	23.8	8680	*	NA	WA	
56	2011	1FT8W3DTXBE[redacted]	474.35	17-Nov-10	30-Dec-10	BOWDEN FORD LINCOLN CO.	161923A	6649541	2.00E+03	BC3Z	9A543	A	D02	42	21-Jun-11	6	654165	31940	$1,175.23	$1,649.58	5.7	4406	*	NA	TX	
57	2011	1FT8X3CT6E[redacted]	894.98	20-Oct-10	4-Nov-10	CAZENAVE MOTOR CO., INC.	179001	2654040	2.00E+02	BC3Z	9A564	A	D02	42	########	7	633283	18622	$5,788.96	$6,683.94	14.4	6568	*	NA	LA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
58	2011	1FT8W3BT5BE[redacted]	359.39	10-Feb-11	4-Apr-11	MCLEAN FORD, INC.	008224A	7894477	2.00E+02	BC3Z	9A564	A	E29	42	17-Jun-11	3	653970	4290	$4,397.30	$4,756.69	4.4	3729	*	NA	NY	
59	2011	1FT8W3BT4E[redacted]	772.07	########	21-Jun-10	BOB BELL FORD	845585A	*	2.00E+03	BC3Z	9A543	A	D03	42	9-Jun-11	12	670095	28371	$1,209.82	$1,981.89	8.3	2107	*	NA	MD	
60	2011	1FDUF5HT6E[redacted]	738.15	5-May-10	20-May-10	WILSON MOTORS	508973A	7524201	2.00E+03	BC3Z	9A543	A	D21	42	9-Jun-11	13	732376	10903	$5,137.21	$5,875.36	8.8	8539	*	NA	OR	
61	2011	1FD0X5HT8BE[redacted]	1386.21	25-May-10	19-Jul-10	MCCOMBS FORD WEST	11951601	5091000	2.00E+03	BC3Z	9A543	A	D50	42	22-Jun-11	12	705549	81980	$5,527.75	$6,913.96	16.1	4545	*	NA	TX	
62	2011	1FT8W3BT0BE[redacted]	1258.27	1-Apr-10	30-Apr-10	BARBER BROTHERS FORD, INC.	5430601	8293447	2.00E+03	BC3Z	9A543	A	D02	42	13-Jun-11	14	716704	35537	$5,996.88	$7,255.15	13.6	2928	*	NA	UT	
63	2011	1FT7W2BTXBE[redacted]	331.8	25-Feb-11	20-May-11	SHERWOOD GROVES FORD	1518801	2652107	2.00E+03	BC3Z	9A543	A	E68	42	22-Jun-11	2	723545	1437	$1,032.86	$1,364.66	5	3245	*	NA	PA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
64	2011	1FTRF3BT8BE[redacted]	542.56	13-Sep-10	30-Sep-10	CHARLES ALLEN FORD LINCOLN, INC.	2775201	2242000	2.00E+03	BC3Z	9A543	A	D03	42	11-Jul-11	10	763116	18500	$1,283.49	$1,826.05	6.9	6875	*	NA	OK	
65	2011	1FT8W3DT9BE[redacted]	1192.35	14-Oct-10	8-Apr-11	DON BOHN FORD	468012A	3477000	2.00E+03	BC3Z	9A543	A	D21	42	12-Jul-11	4	797707	12565	$5,798.31	$6,990.66	13	6582	*	NA	LA	
66	2011	1FT7W2BTXBE[redacted]	644.75	25-Feb-11	20-May-11	ALLAN VIGIL FORD LINCOLN, INC.	21763802	3643673	2.00E+03	BC3Z	9A543	A	E68	42	21-Jul-11	3	801039	1586	$1,507.87	$2,152.62	6.5	509	*	NA	GA	
67	2011	1FT8W4DT0E[redacted]	819.64	29-Mar-10	8-Apr-10	HOLLINGSWORTH RICHARDS FORD	70528501	9275555	2.00E+03	BC3Z	9H529	A	D02	42	14-Jun-11	15	801223	33015	$5,672.20	$6,491.84	9	1196	*	NA	LA	
68	2011	1FT8W3BT9BE[redacted]	490.3	12-Apr-11	27-May-11	RICH FORD SALES, INC.	32058301	2920000	2.00E+03	BC3Z	9A543	A	E68	D1	2-Aug-11	3	829820	6157	$1,241.90	$1,732.20	5	20307	*	NA	NM	
69	2011	1FDGF4GT3BE[redacted]	52.26	20-Aug-10	10-May-11	AUTOMOTRIZ REYNOSA, S.A. DE C.V.	196081	9222840	2.00E+03	BC3Z	9A543	A	D02	42	10-Aug-11	4	831782	2392	$1,256.11	$1,308.37	6	M3037	*	NA	TM	
70	2011	1FT8W3CT6BE[redacted]	964.75	25-Mar-10	23-Jun-10	SUNRISE FORD COMPANY	40614401	4616000	2.00E+03	BC3Z	9A543	A	E68	42	12-Jul-11	13	833624	50996	$6,207.87	$7,172.62	12.5	4846	*	NA	FL	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
71	2011	1FT8W3DT6BE[redacted]	1647.64	9-Mar-10	15-Jun-10	BRYDEN FORD, INC.	8247201	2482128	2.00E+03	BC3Z	9A543	A	D21	42	21-Jul-11	14	849321	24144	$6,428.12	$8,075.76	17	20028	*	NA	IL	
72	2011	1FT7W2BTXBE[redacted]	1492.29	6-May-10	31-May-10	HUDSPETH MOTORS INC	608571	7433200	2.00E+03	BC3Z	9A543	A	D02	42	16-Jul-11	14	854261	42177	$7,487.66	$8,979.95	20.7	5894	*	NA	AR	
73	2011	1FT7X3BT2B[redacted]	1219.87	18-May-10	26-May-10	PAUL MILLER FORD, INC.	295077B	*	2.00E+03	BC3Z	9A543	A	D02	42	20-Jul-11	15	852211	22429	$5,776.96	$6,996.83	13.3	1723	*	NA	KY	
74	2011	1FT8W3DT0BE[redacted]	601.64	14-Dec-10	9-Mar-11	BANKSTON FORD OF BURLESON	288785A	2958121	2.00E+03	BC3Z	9A543	A	N50	42	11-Aug-11	6	955314	22540	$1,596.79	$2,198.43	6.5	6902	*	NA	TX	
75	2011	1FT7W2BT4E[redacted]	1464.28	21-Oct-10	17-Jan-11	KIGHTLINGER MOTORS, INC.	20908101	2749660	2.00E+03	BC3Z	9A543	A	D02	42	20-Jun-11	6	795382	7184	$7,033.47	$8,617.35	22.6	633	*	NA	PA	
76	2011	1FT8W3BT6E[redacted]	1627.76	11-Nov-10	6-Dec-10	M G M FORD LINCOLN SALES LTD.	23478901	3466621	2.00E+03	BC3Z	9A543	A	D03	42	27-Jun-11	7	794251	14030	$2,516.78	$4,144.55	16	A6792	*	NA	AB	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
77	2011	1FD8W3HT6E[redacted]	1622.6	18-Jun-10	26-Jul-10	GLENN POLK FORD	737401	6688770	2.00E+03	BC3Z	9A543	A	D21	42	6-Jul-11	12	795404	80870	$6,257.71	$8,131.31	20.4	779	*	NA	TX	
78		C[redacted]																								
79																										
80	2011	1FT7W2AT2BE[redacted]	1690.04	7-Jan-11	29-Jan-11	MAC HAIK FORD	086575A	9325000	2.00E+03	BC3Z	9A543	A	D21	42	5-Aug-11	7	872385	8826	$5,837.15	$7,527.19	18.9	4511	*	NA	TX	
81	2011	1FT8W3DT0BE[redacted]	601.64	14-Dec-10	9-Mar-11	BANKSTON FORD OF BURLESON	288785A	2958121	2.00E+03	BC3Z	9A543	A	N50	42	11-Aug-11	6	955314	22540	$1,596.79	$2,198.43	6.5	6902	*	NA	TX	
82	2011	1FT7W2BT1BE[redacted]	1270.23	24-Nov-10	8-Dec-10	EXCEL FORD LINCOLN, LP	1315001	6933821	2.00E+03	BC3Z	9A543	A	E29	42	22-Aug-11	9	977151	17464	$5,443.20	$6,713.43	14.7	2871	*	NA	TX	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
83	2011	1FT7X2BT5BE[redacted]	998.88	15-Sep-10	6-May-11	BOWEN SCARFF FORD-LINCOLN	307817D	8521480	2.00E+03	BC3Z	9A543	A	L65	D1	18-Aug-11	4	979213	7005	$1,555.04	$2,553.92	10.5	8588	*	NA	WA	
84	2011	1FT8W4DT8E[redacted]	1157.57	3-Aug-10	30-Aug-10	PLANET FORD	57152302	7193700	2.00E+03	BC3Z	9A543	A	N12	42	8-Aug-11	12	930574	35480	$5,801.06	$7,078.63	12.6	2091	*	NA	TX	
85	2011	1FT7W2BT1BE[redacted]4	655.6	7-Sep-10	30-Dec-10	WHITE FORD LINCOLN, L.L.C.	1851621	4355101	2.00E+03	BC3Z	9A543	A	D21	42	22-Aug-11	8	1090941	29827	$1,407.19	$2,062.79	8.8	6577	*	NA	LA	
86	2011	1FT7W2BT2E[redacted]	2037.94	10-Sep-10	1-Nov-10	THE FREDERICK MOTOR COMPANY	11143601	6636111	2.00E+03	BC3Z	9A543	A	N12	42	22-Aug-11	10	1115490	12738	$6,069.64	$8,107.58	21.4	42	*	NA	MD	
87	2011	1FT8W3DT8BE[redacted]	1363.21	23-Jun-10	30-Jul-10	MARSHALL FORD LINCOLN	140420A	9350665	2.00E+03	BC3Z	9A543	A	E29	42	18-Aug-11	13	1127144	56073	$5,790.75	$7,153.96	17.1	427	*	NA	TX	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
88	2011	1FT7W2BT7BE[redacted]	1440.43	########	1-Jun-10	SAN AUGUSTINE MOTOR CO	4651201	2752371	2.00E+03	BC3Z	9A543	A	D02	30	15-Sep-11	16	1140683	21915	$6,085.90	$7,526.33	16.8	4548	*	NA	TX	
89	2011	1FT7W2BT4BE[redacted]	512.85	########	9-Jun-10	HARBIN MOTOR COMPANY, INC.	201525A	5741819	2.00E+03	BC3Z	9A543	A	D42	42	27-Jul-11	14	1214513	67901	$5,705.42	$6,318.27	6.8	378	*	NA	AL	
90	2011	1FT8W3BTXE[redacted]8	1353.59	3-Aug-10	23-Oct-10	DAN WIEBOLD FORD	253289A	4664615	2.00E+03	BC3Z	9A543	A	L69	42	9-Sep-11	11	1218700	26561	$5,887.64	$7,241.23	14.7	8325	*	NA	ID	
91	2011	1FT8W3DT9BE[redacted]	503.35	11-Oct-10	22-Sep-11	ATCHINSON FORD SALES, INC.	092414A	6979161	2.00E+03	BC3Z	9A543	A	E68	D8	23-Sep-11	1	1232164	177	$991.87	$1,495.22	5.3	2731	*	NA	MI	
92	2011	1FT8W3DT3BE[redacted]	330.54	23-Apr-10	24-May-10	TOWNSEND FORD	035697A	7520401	2.00E+03	BC3Z	9A543	A	D42	41	14-Sep-11	16	1231091	27880	$1,057.05	$1,387.59	4.1	429	*	NA	AL	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	MY	VIN	LABOR COST	PROD DATE	WARRANTY START DATE	DEALERSHIP	RO NUMBER	PHONE #	WCC CODE	PART NUMBER PREFIX	PART NUMBER BASE	PART NUMBER SUFFIX	CCC CODE	COND CODE	REPAIR DATE	TIS	CLAIM KEY	MILEAGE	MATERIAL COST	TOTAL COST	LABOR HOURS	DEALER CODE	DEALER SUB CODE	REGION CODE	STATE / PROVINCE	CPSC CODE
93	2011	1FDGF5GTXBE[redacted]	46.54	3-Sep-10	3-Mar-11	TABASCO AUTOMOVILISTICA, S.A. DE C.V.	2564601	3120133	2.00E+03	BC3Z	9A543	A	E29	D4	29-Sep-11	8	1246794	12621	$1,141.22	$1,187.76	2.2	M1331	*	NA	TA	
94	2011	1FT7W2BT7BE[redacted]	1166.3	6-Dec-10	5-Jul-11	HUNTERSVILLE FORD	27138201	8756547	2.00E+03	BC3Z	9A543	A	D02	42	12-Sep-11	3	1250794	6500	$1,286.39	$2,452.69	13.1	9151	*	NA	NC	
95	2011	1FT8W3BTXBEE[redacted]	1361.81	7-Sep-10	27-Sep-10	TIPTON FORD, INC.	249500A	5647337	2.00E+03	BC3Z	9A543	A	D02	49	10-Sep-11	12	1258701	23360	$5,583.01	$6,944.82	16.9	4521	*	NA	TX	
96	2011	1FT8X3BT8E[redacted]	1058.18	4-Jun-10	23-Dec-10	ALL AMERICAN FORD OF KINGSTON, LLC	030017A	3387800	2.00E+03	BC3Z	9A543	A	D02	42	12-Sep-11	9	1268935	23787	$2,792.67	$3,850.85	11.2	4036	*	NA	NY	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
97	2011	1FDGF5GTXBE[redacted]	112.13	3-Sep-10	3-Mar-11	TABASCO AUTOMOVILISTICA, S.A. DE C.V.	2564501	3120133	2.00E+03	BC3Z	9A543	A	E29	D4	5-Oct-11	8	1267047	12621	$1,158.34	$1,270.46	5.3	M1331	*	NA	TA	
98	2011	1FT7W2BTXE[redacted]	1095.89	22-Jul-10	20-Oct-10	TIPTON FORD, INC.	249786A	5647337	2.00E+03	BC3Z	9A543	A	D42	42	19-Sep-11	12	1345650	51151	$5,671.94	$6,767.83	13.6	4521	*	NA	TX	
99	2011	1FDUF4GT2BE[redacted]	425.96	23-Jun-10	8-Nov-10	YOUNG FORD	48173401	5982599	2.00E+03	BC3Z	9A543	A	E68	42	4-Oct-11	12	1346435	28819	$1,144.35	$1,570.31	5	5898	*	NA	NC	
100	2011	1FDUF4GT4BE[redacted]	1846.78	########	6-Aug-10	THEODORE ROBINS, INC.	9802351	6420010	2.00E+03	BC3Z	9A543	A	D50	49	17-Aug-11	13	1334890	18703	$5,861.61	$7,708.39	17.6	5508	*	NA	CA	
101	2011	1FD0W4GT4BE[redacted]	655.3	########	14-Jul-10	TARVER FORD	7458601	6253030	2.00E+03	BC3Z	9A543	A	D02	63	24-Aug-11	14	1336199	24699	$5,808.24	$6,463.54	7.5	8924	*	NA	LA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
102	2011	1FT8W3BT8BE[redacted]	1546.6	2-Jun-11	16-Jun-11	J. O. WILLIAMS MOTORS, INC.	10280401	8452222	2.00E+03	BC3Z	9A543	A	D02	42	6-Sep-11	3	1322568	11659	$5,893.47	$7,480.07	19	2502	*	NA	TX	
103	2011	1FD0W4HT1BE[redacted]	698.19	13-Jan-11	4-Feb-11	GWINNETT PLACE FORD LINCOLN	268655A	4762090	2.00E+03	BC3Z	9A543	A	E29	42	12-Oct-11	9	1389064	15206	$1,413.83	$2,112.02	7.2	3573	*	NA	GA	
104	2011	1FT7W2BT2BE[redacted]	1191.45	9-Mar-10	7-Jun-10	KILGORE FORD	3350901	9842006	2.00E+03	BC3Z	9A543	A	D02	49	30-Aug-11	15	1389330	46690	$5,951.27	$7,142.72	14.4	4084	*	NA	TX	
105	2011	1FTBF2BT3BE[redacted]	1451.7	20-Oct-10	15-Feb-11	EXCEL FORD LINCOLN, LP	1327902	6933821	2.00E+03	BC3Z	9A543	A	D02	42	26-Aug-11	7	1400603	18556	$5,742.28	$7,193.98	16.8	2871	*	NA	TX	
106	2011	1FT8W3DT0BE[redacted]	583.86	20-Jul-10	6-Nov-10	BILLY HOWELL FORD LINCOLN, INC.	053646A	8872311	2.00E+03	BC3Z	9A543	A	D50	42	17-Oct-11	12	1410443	29850	$1,062.72	$1,646.58	6.2	341	*	NA	GA	

	A	B	C	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	**MY**	**VIN**	**LABOR COST**	**PROD DATE**	**WARRANTY START DATE**	**DEALERSHIP**	**RO NUMBER**	**PHONE #**	**WCC CODE**	**PART NUMBER PREFIX**	**PART NUMBER BASE**	**PART NUMBER SUFFIX**	**CCC CODE**	**COND CODE**	**REPAIR DATE**	**TIS**	**CLAIM KEY**	**MILEAGE**	**MATERIAL COST**	**TOTAL COST**	**LABOR HOURS**	**DEALER CODE**	**DEALER SUB CODE**	**REGION CODE**	**STATE / PROVINCE**	**CPSC CODE**
107	2011	1FT7W2BT8BE[redacted]	952.89	30-Aug-10	15-Sep-10	JASON ZOELLNER FORD LINCOLN	1235002	2842001	2.00E+03	BC3Z	9A543	A	D02	42	30-Sep-11	13	1432416	28981	$5,737.72	$6,690.61	12.7	9913	*	NA	NE	
108	2011	1FT7W2BT4BE[redacted]	898.2	16-Jun-10	30-Dec-10	ROBIN MOTOR CO INC	1844301	2764567	2.00E+03	*	9A543	*	D02	1	16-Sep-11	9	1447650	9060	$6,049.59	$6,983.89	11.7	6472	*	NA	LA	
109	2011	1FT8W3DT9E[redacted]	1372.62	29-Mar-10	1-Jun-10	HINDER FORD, INC.	142751A	2722200	2.00E+03	BC3Z	9A543	A	D42	42	20-Jun-11	13	777133	19545	$6,298.87	$7,671.49	15.4	120	*	NA	MD	
110	2011	1FDRF3GT9BE[redacted]									9A543							5495		$0.00					FL	

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
2	CHECKING FOR FUEL LEAK, FOUND FUEL IN VALLEY ON TOP OF ENGINE. VACUUMED FUEL OUT SEVERAL TIMES ANDRAN ENGINE TO FIND THE LEAK. COULD NOT FIND. ADDEDDYE TO FUEL	FILTER AND CHECKED WITH BLACK LIGHT. FOUND LEAK COMING FROM UNDER HP PUMP.REMOVE INTAKES AND REPLACE PUMP. ALSO REPLACED ONE TIME USE FUEL LINES. REMOVED EGR COOLER TO REPLACE LINES	FUEL/DRIVEABILITY CUSTOMER STATES STRONG FUEL SMELL AFTER ENGINE IS WARMED UP.	123462	S07	USA	V25	F7	F04	S11	29-Dec-10					1/10/2011	Fuel pump replacement	1/10/2011 - fuel pump received, forwarding to Bosch for investigation. CQIS report said fuel was seen coming from bottom of the pump, which is where shaft seal leaks are typcially seen. VIN forwarded to ChEP for build history check 2/1/2011 - shaft seal confirmed as split by Bosch in FH, in similar manner to other pumps.	Open		Split shaft seal
3	LEAKING NO START DIAG KOEO & KOEC P0087 CK FOR FUEL LEAK R&I UPPER & LOWER INTAKES R&R BOTH FUEL LINES AT HIGH PSI FUEL PUMP TO LH FUEL RAIL RECHK STILL LEAKS TECH HOTLINE R&I SERP BELT FAN & VAC P	UMP R&R HIGH PRESSURE FUEL PUMP & BOTH FUEL LINES LINES MAY NOT BE REUSED NECESSARY TO INSTALL NEW LINES 2ND TIME REQ M NO APPLICABLE LABOR OP PUBLISHED FOR MODEL YEAR	C S VH LOST POWER THEN DIED, NOW CRANKS NO START C S HAS FUEL SMELL RIGHT SIDE OF ENGINE AREA	785	USA	153538	S07	USA	*	V52	F7	F04	@	Engine	603100012413		Fuel pump replacement	8D submitted by Bosch; root cause is out-of-process double HT of cylinder head by Bosch. CCRG decision to monitor based on very low probability of additional field failures.	Closed		Fuel pump cyl head crack - double heat treatment
4	SE REVISA VISUALMENTE ENCONTRANDO UNA FUGA DE COMBUSTIBLE POR LA TUERCA DEL TUBO DE CARGA DE ALTA PRESION DE LA BOMBA DE COMBUSTIBLE DE ALTA PRESI ON SE HACE AUTO PRUEBA SIN GENERAR CODIGOS SE RE	PORTA ATT # DE REPORTE AE5AP001 Y SE DESMONTA TUBOS DE INYECCION, BOMBA DE DIESEL, MULTIPLES Y SE ENCONTRO QUE LA BOMBA DE COMBUSTIBLE DE ALTA PRESION FUGA DIESEL SE REMPLAZA , SE UTILIZA MT YA QUE EN	TIRA DIESEL POR PARTE SUPERIOR DE MOTOR Y NO ARRANCA	912	MEX	2M3122	2	MEX	*	V44	F7	F04	@			6/18/2010	Fuel pump replacement				Fuel pump cyl head crack - double heat treatment
5	EEC QUICK TEST P0087 P008A PINPOINT TESTED AND REPLACED THE FUEL PUMP AND TEST DROVE		LOSE OF POWER THEN ENG LIGHT CAME ON	662	USA	123488	1	USA	*	V52	F7	F04	@			7/27/2010	Fuel pump replacement	Parts not returned.	closed		Not returned
6	PUMP VERIFIED CHECK ENG LIGHT FOUND HIGH PRESSURE PUMP NOT WORKING FOUND CODE P0087 CHECK FUEL PRESSURE ALL OK PERFORMED PINPOINT TEST PP AND M LEAD TO HIGH PRESSURE PUMP REPLACEMENT REPLACED PUMP STI	L WILL NOT START CONTACTED HOT LINE SENDING FSE	CUST STATES CRANK NO START	863	USA	127054	S07	USA	*	V29	F7	F04				8/18/2010	Fuel pump replacement	8/23/2010 - Bosch optical inspection of debris showed sand contaminants, and sand would precipitate pump failure. Bosch SEM/EDS analysis showed Si,Al, Ca oxides, confirming sand. Sand seen on inlet filter to pump. Fuel cooler supplier also found sand inside the cooler. Filters given to Larry Castleberry for investigation with Sogefi. Source of sand not known.	Open		fuel contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTR Y CODE**	**SALES DEALER CODE**	**TRANSAC TION CODE**	**COUNTR Y SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
7	FOLLOW DIAG SHEET TESTED GROUND CODE PO191 VERIFIED CONCERN FOLLOWED ON LINE PC ED FOLLWED PIN POINT TEST M1 FOUND CODE P0191 WENT TO PP M2, CKD LOW PSI FUEL SYST:OK, WENT TO M3 CKD FUEL QUAL:OK, WE B	ALANCE PIDS AOK, M8 ALL CYLINDERS BALANCE AOK, M11 MONITOR ED FRP VOLTAGE AOK, FRPV AT .31 VDC, M13 CKD FUEL RAIL PSI NO INC, M14, CK VCV OP AOK, M15, CKD PCM AOK, REPLACED HIGH PRESSURE FUEL PUMP, RE	NO POWER EEC LIGH IS ON HOTLINE CONTACT ID 103963735 MT VERFD ACT TIME FOR MULTIPLE TESTS FOR DSR AND DSE	515	USA	141782	S07	USA	*	V52	F7	F04	@			8/30/2010	Fuel pump replaceme nt	9/9/2010 - pump received in Dearborn, Bosch notified 9/17/2010 - pump was TNI @ Bosch. Pump was returned to Ford and used to replace a leaking pump on durability engine running in 12G. 9/21 - no issues seen with pump on dyno engine.	Closed		TNI
8	DIAG & REPAIR FOR CHECK ENGINE LIGHT ON WITH LACK OF POWER EEC TEST KOEO PASS,KOEC P0087 FUEL RAIL PRESSURE LOW,PERFORM PPT M,N/F/F.KOER PASS,FUEL TANK WAS AT ABOUT 1/8 TANK,PUT S OME FUEL IN TRUCK PO	WER IS BACK,ROAD TEST SEEMS OK.LOW OIL P RESSURE LIGHT CAME ON AFTER STALL NORMAL. THIS WAS THE FIRST ATTEMPT AT REPAIR,PERFORM PPT M AND ME WI TH N/F/F,R&I UPPER AND LOWER INTAKES TO GAIN ACCESS,R&R	REPAIR FOR CHECK ENGINE LIGHT ON AND WHILE CUSTOMER WAS DRIV ING THE LOW OIL PRESSURE LIGHT CAME ON AND TRUCK QUIT CUST W AITED A FEW MINUTES AND TRUCK RESTARTED	250	CAN	4B7233	2	CAN	*	V29	F7	F04				9/23/2010	Fuel pump replaceme nt	Part not returned	Closed		Not returned
9	VERIFIED NO START EEC TEST. NO CODES. VISUAL INSP. FUEL LEAKING FROM ENG. FOUND FUEL LEAK & RH HIGH PRESS PMP FITTING TO HP FUEL RAIL RMVD UPPER INTAKE & INST NEW FUEL LINES AS PER WSM. RESTORED TRUCK & RETEST. STILL LEAK. RMVD UPPER INTAKE & FUEL LINES & INSP. FUEL LINE FITTINGS & PMP FITTINES. NO CONCERN FOUND. REPLACED LINES AGAIN & RESTORED VEH. STILL LEAK. RMVD UPPER INTAKE, FUEL LINES,	318	CK WHILE DRIVING RPMS SHOT UP AND SAID SYS SHUTTING DOWN. WOULD NOT RESTART. VACCUUM PMP OF HIGH PRESS FUEL PMP. FOUND HAIRLINE CRACK ON RH HP PUMP FITTING. REPLACED HP FUEL PMP & BOTH FUE	123634	S07	USA	V25	F7	F04	S11	16-Nov-10				502100007246	########	Fuel pump replaceme nt	11/17 - pump requested back by hot process / overnight shipping, Bosch alerted to perform immediate teardown 11/24 - pump received, Bosch notified. Photos taken in Materials office show crack in RH HP port @ 6 o'clock. KTP records show this VIN has engine with serial number from list of engines built with fuel pumps containing a double heat treated pump cylinder head.			Fuel pump cyl head crack - double heat treatment

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
10	PERFORMED DIAG DTCS FUEL RAIL PRESSURE LOW. HAS EXCESSIVE FUEL LEAK AROUND HIGH PRESSURE PUMP REMOVED UPPER INTAKE. INSPECTED LEAK AT RH SIDE HIGH PRESSURE PUMP LINE FITTING CONNECTOR. ORDERED LINE REPLACED FUEL LINE. STILL HAS LEAK AT SAME SPOT. ORDERED AND REPLACED HIGH PRESSURE PUMP, REMOVED EGR COOLER ASSEMBLY TO REPLACE FUEL LINE ASSEMBLY. FOUND HAIR LINE CRACK ON HIGH		CUSTOMER STATES DIESL ENGINE CRANKS BUT WONT START												402100005549	########	Fuel pump replacement	11/19 - pump received and returned to Bosch. Photos taken in Materials office show crack in RH HP port @ 6 o'clock. Pump given to Bosch. KTP and Bosch records show this VIN has engine with serial number from list of engines built with fuel pumps containing a double heat treated pump cylinder head.			Fuel pump cyl head crack - double heat treatment
11	RESUBMISSION OF IN TRANSIT DAMAGE CHARGEBACK AS WARRANTY REPAIR.REPLACE PUMP AND LINES AS PER TECH HOTLINE..ALL DOCS WERE FAXED AND ON 11/19/10 WAS CHA RGED BACK STATING PLEASE FILE WARRANTY CLAIM. WAS TOWED TO DEALER FROM AUTOPORT AND THEN TOWED BACK ONCE REPAIR WAS COMPLETED.PLEASE REVIEW AS PER 2 17 OF WPM.SEE REPAIR 01 OF THIS REPAIR ORDER.	780	REPAIR FOR FUEL LEAK AT REAR OF VEHICLE	4B6230	2	CAN	V25	F7	F04	S11	24-Nov-10						Fuel pump replacement	Worked with Ford of Canada engineers on diagnostics, which led to the conclusion, after the fuel pump was changed and the new pump also developed a shaft seal leak, that the return system must be blocked. A large piece of debris (related to the hose manufacturing process?) was found in the return hose between fuel cooler and DFCM. Larry Castleberry responsible for 8D. 8D received from hose supplier.	Closed		Shaft seal leak - high back pressure
12	PERFORMED KOER KOER SELF TEST RETIEVED DTCS P127A.PERFORMED PPT M PER DTC CK OIL LEVEL OK.CK FUEL QUALITY FOUND SMALL DEBIR OF WHAT LOOK LIKED RUST.REMOVED FRP AND INSPECTED HIGH PRESSURE RAIL F CLEANED FUEL TANK AND RE	INSTALLED.REMOVED FAN SHROUND AND STATOR TO GAIN ACESS.REPLACED HIGH PRESSURE PUMP.REMOVED ALL NESSECARY COMPONENTS PER WORKSHOP MANUAL TO GAIN ACESS TO ALL 8 INJECTORS AND LINE.RE	C S CHECK ENGINE LIGHT IS ON SEE RO#491166 FOR RECENT REPAIR	152026	S07	USA	V29	F7	F04	S11	20-Dec-10					########	Fuel pump replacement	Note - entire fuel system replaced. CQIS report states rust was found in the rail and elsewhere, so why Ford paid for this repair is unknown. 12/23 - PCV returned from this vehicle from an earlier repair has rust on it, a sure sign of water in the fuel. 1/10/2011 - entire fuel system received. Injectors will be scrapped, pump forwarded to Bosch for photographing evidence of water contamination (rust). 1/25/2011 - Bosch sent photos of rust on overflow valve, HP outlet ports	Closed		Fuel contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
13	VERIFY CONCERN EEC TEST P2291 NO PINPOINT TEST IN MANUAL CONTACT HOTLINE MONITOR PIDS EGT 11 14 ECT EOT FRP AND VERIFY OK FRP ONLY 223 PSI INSPECT FILTERS FOUND LIFT PUMP NOISEY REP PUMP AND RETESTNO START REM	UPPER & LOWER INTAKE MANIFOLDS & VCV FOUND BRASS SHAVINGS IN PUMP REP ENTIRE HP FUEL SYS INCLUDING 8 INJECTORS HPP AND ALL LIINES & FILTERS DRAIN & FILL TANK & ALL LOW SIDE LINES OK NOW	TOWED IN NO START. CHECK & ADVISE	171725	S07	USA	V52	F7	F04	S11	30-Dec-10					1/10/2011	Fuel pump replacement	1/10/2011 - all 8 injectors and fuel pump returned. CQIS report has technician comments saying that fuel pump replacement was performed, then entire fuel system replaced after pump alone didn't fix it, and brass shavings were found in on-engine fuel filter and in fuel flowing to #1 injector, although no debris seen in pump VCV (which would make sense if the pump was the second pump on the engine). 7 injectors disposed of, remaining injector and pump sent to Bosch to check / photograph evidence of rust. 1/27/2011-injector & pump TNI @ Bosch. I asked for disassembly next. 1/28/2011 - nothing found in either part.	Closed		TNI
14	CHECKED VEHICLE,CRANKS WON'T RUN.CHECKED OIL AND FUEL ,OK.CHECKED UNDERNEATH FOR LEAKS,NONE VISIBLE.PULLED CODES,P0087,LOW HIGH FUEL PRESSURE.HIGH FUEL PRESSURE READING 0.CHECKED	MANUAL AND ONLINE FOR CODE THEN CALLED HOTLINE,THEY SENT A PINPOINT TEST TO FOLLOW.FOLLOWED TEST M1 M17 AND CALLED HOTLINE BACK.CHECKED LOW FUEL PRESSURE,FILTER AND FLOW,OK.TOLD TO PULL INTAKE AND PULL VCV VALVE TO CHECK	TOWED TO SHOP ENGINE STALLED OUT WONT START **********FAXED OVER 8 PAGES OF THE REPAIR ORDER TO 1 866 934 2749 ATTN LB4 ON 12/07/2010 @ 5:48PM. HAVE CONFERMATION TH	113446	S07	USA	V52	F7	F04	S11	13-Dec-10					1/14/2011	Fuel pump replacement	1/14/2011 - pump received, forwarded to Bosch. Pump is on the list of double heated suspect parts. Verified under materials group magnifier - a crack in the LH port. 1/25/2011 - Bosch FH confirmed crack and that pump is part of suspect batch, forwarded pump to Feuerbach for metallurgical analysis (confirmation of perlite percentage).	Open		Fuel pump cyl head crack - double heat treatment
15	VERIFY CUSTOMER CONCERN IDS TEST SYS KOEC P228F PERFORM PIN POINT TEST M UP TO M14 WHERE IDS HIGH PRESSURE FUEL TEST WOULD ABORT CLEAR CODE ROAD TEST CK ENG LIGHT CAME BACK ON AND SYS WENT INTO	LIMITED POWER MODE RETEST CODE P0087 IN KOEC HOOK UP FUEL PRESSURE GAUGE AND TEST FOR BASE ENG FUEL PRESSURE VERIFY AT 70 PSI CONTACT FORD HOTLINE 104206020AS PER HOTLINE ADVISED TO SKIP PIN POINT TEST M14.	CUST STATES CK ENG LIGHT IS ON. ADD'L TECK COMMENTS: INSPECTION FOUND CONTAMINIATION IN VCV CAVITY. RE CONTACT FORD. FORD ADVISED TO REPLACE ALL COMPONENTS OF HIGH PRESSURE FUEL SYS AND FLUSH ENTIRE L	113044	S07	USA	V29	F7	F04	S11	24-Jan-11					1/25/2011	Fuel pump replacement	Contamination seen on VCV inlet screen and in VCV pocket. Unknown why Ford paid for this repair! 2/17 - part provided to Bosch to look for rust. 2/23 - Bosch confirmed internal corrosion on VCV and in pump	closed		fuel contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
16	HIGH PRESSURE FUEL PUMP LEAKING AT FRONT OF PUMP. M TIME USED TO PERFORM LEAK DIAG. NECESSARY TO R&I UPPER AND LOWER INTAKE TO LOCATE SOURCE OF LEAK. ALSO NECESSARY TO STEAM CLEAN ENGINE S FIND	THAT FUEL IS PUDDLING UP IN ENGINE VALLEY. INSPECT ALL LINES, NO LEAKS AT LINES. CHECK TOP OF HIGH PRESSURE PUMP, NO LEAKS FOUND. CLEAN AREA AND RUN ENGINE TO DETERMINE THAT LEAK IS COMMING FROM FRONT OF PU	CUSTOMER STATES ENGINE LEAKING DIESEL FROM THE REAR CHECK AND ADVISE E68	171176	S07	USA	V25	F7	F04	S11	21-Jan-11					1/25/2011	Fuel pump replacement	Leak at front of fuel pump - sounds like a shaft seal leak 2/2 - pump received, Bosch notified for pickup 2/15 - Bosch FH confirms shaft seal is split. Sending to Feuerbach for further investigation 9/29 - requested final report from Ken Romak 10/3 - updated report from Bosch confirms the seal is from the suspect date range	Closed		Split shaft seal
17	SEE NOTES IN HOTLINE CONTACT # 104266012,SERVICE REP TO ADD COMENTS TO CASE ON 1 19 2011.PER PHONE CLOSING OUT REPAIR AT THIS TIME DIFFERENT FAILED PART #	660	THE CHECK ENGINE LIGHT IS ON	153900	S07	USA	V29	F7	F04	S11	20-Jan-11					1/25/2011	Fuel pump replacement	VCV, PCV, and HP Pump were replaced trying to solve a P0088 issue. Code reappeared, and FSE came per CQIS, but it had gone away by that point and was still gone after the customer drove the truck for a week 2/23/2011 - PCV TNI @ Jihlava, fuel pump TNI @ Bosch FH	closed		TNI
18	9A543 CK HARD START CK FUEL SY CONTAMINATED AND REPL HIGH PRESS PUMP AND SYS. REPL ALL INJECTORS, R/R TANKFUEL TANK AND	CLEAN AND ALL FUEL LINES AS REQUESTED THE DIAG ON THE PUMP IS CLEAN FUEL AND METAL DEBRIS	CRANKS NO START	156402	S07	USA	V52	F7	F04	S11	7-Feb-11					2/16/2011	Fuel pump replacement	2/16 - Possible DEF contam - CQIS first mentions a tech said he smelled DEF, then later the dealership said fuel was good. Parts returned to Bosch to look for DEF contam. 2/24 - pump report received from Bosch with pictures of pump corrosion. 2/25 - rail returned so PCV can be examined for corrosion 3/29 - Bosch report confirms corrosion on PCV valve	closed		Fuel contamination
19	1780 INJECTION PUMP FAILED, 9A543 ELECTRONIC ENGINE CONTROL DIAGNOSIS, PINPOINT TEST, RELATIVE COMPRESSION TEST, PID MONITOR, TIME TO R&I PRESSURE CONTROL VALVE, REPLACE INJECTION PUMP,	REPLACE ALL 8 FUEL INJECTORS, REPLACE BOTH FUEL INJECTOR SUPPLY RAILS, REPLACE FUEL COOLER, REPLACE FUEL PUMP, FLUSH ALL FUEL LINES, REPLACE INJECTION PUMP HIGH PRESSURE LINES, R&I FUEL TANK	D01 C S WHILE DRIVING REDUCED PWR DISPLAYED THEN HEARD CLANK NOISE IN ENGINE AND MOTOR DIED CRANKS NO START	152300	S07	USA	V52	F7	F04	S11	8-Feb-11					2/16/2011	Fuel pump replacement	Entire fuel system replaced. 2/16 - fuel system received, only pump being sent to Bosch, to check for rust or other contaminants. 2/23 - pump report received from Bosch - contamination found.	Open		Fuel contamination
20	9A533 42 PERFORM KOEO P0087 PERFORM PIN PIONT TEST M PERFORM STEP M2 CHECK LOW FUEL PSI PASS PERFORM M3 CHECK FUEL CLEAN PASS M4 CHECK RELATIVE COMPRESSION PASS PERFORM M11 CHECK	PIDS FRP PSI AND VOLTS VOLTS PASS PSI LOW 328 PSI FAIL M13 REMOVE FUEL RETURN LINE AND CHECK FOR STEADY FUEL PASS M15 COMMAND VCV AND PCV AS PER PIN PIONT TEST WITH FUEL PUMP RUNNING	CUSTOMER STATES THE ENG HAD A LOSE OF POWER & IT DIED WILL NOT RESTART JUST SPINS OVER	152020	S07	USA	V52	F7	F04	S11	14-Feb-11					2/16/2011	Fuel pump replacement	Complete fuel system replaced. CQIS says dealer couldn't see fuel contamination. Send pump to Bosch when it comes in. 2/25 - one injector returned, NOT going to Bosch, still waiting on rest of the components. Pump received and returned to Bosch 4/7/2011 - Bosch teardown found sand contamination in pump.	Closed		Fuel contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
21	ONCERN. ANY TIME VECHILE GOING INTOWOT MODE C HECKENGINE LIGHT COMES ON AND VEHICLE GOES I NTO REDU CED POWER MODE. CODES P0087 AND P127A STORED. PERFORMED PPT M1 P0087, M2 PID CHA NGED,	M3 SUFFICIENT CLEAN FUEL, M4 .1, M8 P OWER BALANCE PASSED, M11 PASSED, M13 FRP PRES SURE CHANGED WITH PRESSURE ONLY REACHING 24K, M14 HIGH PRESSURE FUEL TEST FAILD, COULD NOT REACH & HOLD HIGH PRESSURE, ENGINE	CUST STATES ENGINE JERKING AND LOSES POWER CHECK ENGINE LIGHT COMES ON AND IT READS LOSS OF POWER ININSTRUMENT CLUSTER PERFORMED EEC TEST AND TEST DR OVE TO VERIFY C	124216	S07	USA	V52	F7	F04	S11	16-Feb-11					2/23/2011	Fuel pump replacement	Waiting on part return. This truck took an extremely long time to fix per CQIS. THE VEHICLE HAS HAD THE HPP, PCV, VCV, FRP SENSOR AND FUEL FILTERS REPLACED. And later all 8 injectors, which finally resolved the problem. 4/1 - all 8 injectors received. Not returned to Bosch, because latest status on vehicle is that PCV/DRV change solved the issue. 1st 2 DRVs showed damaged at Bosch. Could be due to vehicle wiring issue.	Open		Misdiagnosis
22	CRANK NO START. KEY IN ON POSITION LOW PSI PUMP MAKES NOISE. LOW PRESS OVER 115PSI. HOTLINE 104186152. RECK PSI PER HOTLINE, 65PSI, NO START. P0089 P0087. PPT ME. FUEL CLEAN. REL COMP OK. RETEST W	FSE. REPL HI PSI PUMP, ALL METAL LINES, ALL 8 INJ, BOTH FILTERS, FLUSHED LINES, REFLASH PCM PER FSE. BLED AIR FROM SYSTEM. RESTART. MIL ON. PPT AK. LOCKING TABS FOR PINS IN C1390 NOT HOLDING. REPL CONNEC	CHECK REDUCE ENGINE POWER CAME ON MESSAGE CENTER, VEHICLE DIED WHILE DRIVING													2/23/2011	Fuel pump replacement	2/23/2011 - pump returned to Bosch. Bosch found non-metallic sand / silicate on inlet screen and inside the pump	closed		Fuel contamination
23																2/28/2011	Fuel pump replacement	Engine rebuilt, and then would not start. Many hours spent on diagnostics with hotline, issue was finally resolved by changing HP pump. Is not in AWS. Pump being forwarded to Bosch. 4/8/2011 - Bosch report shows pictures of corrosion inside pump due to fuel contamination	Closed		Fuel contamination
24	VERIFIED CUSTOMERS CONCERN, FOUND THE LEAK COMING FROM THE HIGH PRESSURE PUMP, CONTACTED TECHLINE,	TECHLINE ADVISED TO REPLACED THE HIGH PRESSURE FUEL PUMP REMOVED THE PUMP AND	CUST STATES DIESEL LEAK SOP CK ADVISE	152211	S07	USA	V45	F7	25-Feb-11							2/28/2011	Fuel pump replacement	Dealer says they found a fuel leak, potentially a shaft seal leak from cracked shaft seal, although engine build date should be outside the suspect range. 510100076497 3/11/2011 - pump received and forwarded to Bosch. Pump built 12Aug, in the suspect build range. 3/22 - Bosch confirmed split shaft seal. Pump had been inspected, so this is a ICA containment escape.	closed		Split shaft seal

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
25	VERIFIED CONCERN, PERF DIESEL DAIG, PERF VISUAL INSPECTION PASS, CHECK OIL LEVEL FULL, PERF KOEO, P0087, P0275, P2291 PRESENT, CLEAR CODES RETEST P2291 PRESENT, PERF PPT M STEP M2 MONITOR LP PRESSURE	SWITCH AND FPL CMD, NO CHANGE ON PIDS, M3 PERF CLEAN FUEL TEST, FUEL IS CLEAN, M15 CHECK FUEL PRESSURE CONTROL VALVE OPERATION, REMOVED DRIVERS SIDE FENDER WELL TO GAIN ACCES TO FUEL RETURN LINE,	CUST STATES TRUCK DIED WHILE DRIVING, NOW CRANK NO START FUEL RAILS.REASSEMBLED ENGINE.M TIME TO REPLACE	124218	S07	USA	V52	F7	28-Feb-11							3/1/2011	Fuel pump replacement	3/10 - fuel pump and injectors and RH rail were returned, injectors scrapped, pump will go to Bosch for corrosion check. 3/25 - LH rail returned, scrapped. 4/7/ - report received from Bosch saying pump failed due to contamination. Photos showed fibers. No mention of rust, so I asked, am waiting for reply. Engine was produced 2Mar2010, after ChEP 5D for fiber contamination	Open		Fuel contamination
26	BALANCE AND RELATIVE COMPRESSION P0088 FUEL S YSTEM DEBREE TEST HAS DEBREE AT FUEL VOLUME C ONTROLE MODULE PERFORM MANUEL COMPRESSION TES T CYL 8 DUE TO RELATIVE COMPRESSION LOW	MANUE L COMPRESSION ISGOOD NO WATER IN FUEL REPLAC E HPP ALL 8 INJECTOR S FUEL RAILS AND LINES RE PLACE FUEL FILTERS OIL WAS OVERFULL CHANGED O IL AND FILTER DUE TO FUEL CONTAMINATION REFIL L COOLANT INSTALL 1QA FOR ALL IN	CUSTOMER STATES LOST POWER SHOWING ON DISPLAY VERIFIED CONCERN PERFORM KOEO KOER FUEL PRESS URE TEST DATA LOGGER INJECTOR ELECTRIC POWER	152707	S07	USA	V52	F7	3-Mar-11							3/4/2011	Fuel pump replacement	Waiting for parts, will send pump to Bosch to be checked for corrosion 3/25 - RH rail returned, scrapped LH rail returned, going back to Bosch 5/5 - Fuel pump TNI @ Bosch.	Closed		TNI
27	HIGH PRESSUREINJECTION PUMP FAILED. TEST DIESEL ENGINE PERFORMANCE DIAGNOSTICS. PINPOINT TEST.TEST FUEL PRESSURE.FOUND FUEL IN VALLEY OF ENGINE.CLEAN & DRY.ALLOW ENGINE TO IDLE.NO LEAKS	DETECTED AT IDLE.CLEAR CODES ROAD TEST.DURING ROAD TEST.MIL CAMEON.ENGINE VALLEY FULL OF FUEL.ADD DYE.HPP LEAKING .REPLA CED HPP PER HOTLINE AND FUEL LINES.CLEAR CODE ROAD TEST.RETESTED.	CUSTOMER STATES FUEL LEAKING.	152088	S07	USA	V25	F7	15-Mar-11							3/16/2011	Fuel pump replacement	Leak in valley. In CQIS report tech says leak is from the cylinder head itself. This ESN is NOT on the list of suspect pumps 4/27 - pump returned, being returned to Bosch. 6/1 - report from Germany showed large casting inclusion caused the failure. 8d ongoing, with Bosch incoming quality having lead. - 8D concludes Bosch supplier has state of the art casting quality, no further improvement possible. Ford experts concur.	Closed		Casting inclusion
28																	Fuel pump replacement	3/25/2011 - PCV and fuel pump Returned to Bosch 5/4 - fuel pump TNI @ Bosch	Closed		TNI

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
29	CHECKED AND FOUND FUEL COMING FROM ENGINE. PERFORMED PINPOINT TESTS AND FOUND HIGH PRESURE FUEL PUMP AS CAUSE. REMOVEDAND REPLACED PUMP AND ROAD TESTED OK.	360	CUSTOMER STATES THE ENGINE IS LEAKING FUEL VERY BAD AND THEVEHICLE RUNS POOR, CHECK AND ADVISE.AND NOW THE VEHICLE WILL NOT START AND THERE IS FUEL LEAKINGFROM DOWN IN THE MOTOR , CHECK A	174539	S07	USA	V25	F7	16-Mar-11							3/17/2011	Fuel pump replacement	Leak reported, but no CQIS report so no additional detail available 3/31 - returned to Bosch 4/29 - Bosch found a crack through the cylinder head, and massive corrosion inside the pump. This failure mode has been seen a few times in Europe where there has been massive corrosion.	Open		Fuel contamination
30	HOTLINE REQ COMPLETE REPLACE OF HP FUEL SYSTEM RNR 8 INJECTORS RNR HPP RNR FUEL RAILSRNR FUEL LINES DROPPED TANK AND CLEANED OUT BACK FLUSHED REST OF LINES REPLACED SMALLFUEL LOW PRESSURE LINE	REINSTALLED ALL COMPONENTS REPROGRAMMED ALL INJECTORS RETESTEDALL OK VERIFIED REPAIR VISUAL ALL OK VERF CONCERN DRAIN TANK INSTALLED NEW FUEL FILTER ADDED NEW FUEL TEST DRIVE P0087	REDUCED POWER LIGHT ON DASH VEH WONT GO OVER 35MPS CHECK AND ADVISE VISUAL ALL OK VERIFIED CONCERN DRAINED TANK INSTALLED NEW FUEL FILTERS ADDED NEW FUEL TEST DROVE P0087CODES PERFORMED HP	156461	S07	USA	V44	F7	17-Mar-11							3/18/2011	Fuel pump replacement	Complete fuel system replaced. CQIS says dealer couldn't see fuel contamination. Send pump to Bosch when it comes in. 3/31 - Pump & injectors returned to Bosch 4/18 - Bosch reported severe corrosion / water contamination. The injectors from this engine also had severe corrosion	Open		Fuel contamination
31	EHG LEAKING FUEL. REMOVE INTAKE AND CHECK FUEL LEAKS..FOUND HIGH PRESSURE FUEL PUMP HAS LARGE CRACK. CALLED HOTLINE. TOLD TO REPLACE PUMP AND LINES. REPLACED PUMP TWO LINES FROM PUMP TO RAIL. CHECK FOR	FUEL LEAKS. OKAY REASSEMBLE ENGINE. TRY TO START. NO START. RETREIVE CODE FOR FUEL PRESSURE ONLY. 1600 PSI. CALL HOTLINE ON PHONE. TOLD TO TAKE PUMP APART AND INSPECT. FOUND METAL IN SCREEN. REPLACE	CHECK ENGINE LIGHT ON	127542	S07	USA	V52	F7	21-Mar-11							3/22/2011	Fuel pump replacement	Fuel leak from a large crack in the pump reported. Entire fuel system replaced when debris found in the old pump's VCV pocket. Hot return of the pump requested. Send to Bosch for corrosion inspection. 4/15 - pump received from field, had been disassembled by dealership. Body casting was broken apart on LH side, part of the casting broke off. Pump returned to Bosch. 4/29 - Bosch report received showing corrosion, and also non-metallic (sand?) debris.	Closed		Fuel contamination
32	VERIFY CONCERN NO START FUEL LEAK, PERFORM EEC TEST P0087 P2291, PERFORM VISUAL INSPECTION, FOUND FUEL LEKING AT HIGH PRESSURE PUMP RIGHT HEAD FITTING, REMOVED UPPER AND LOWER INTAKE FOR ACCESS, FOUND HIGH	PRESSURE PUMP HEAD CRACKED, REMOVED COOLING FAN AND VACUUM PUMP, REPLACED HIGH PRESSURE FUEL PUMP AND FUEL SUPPLY LINES, REINSTALLED COOLING FAN,VACUUM PUMP, AND UPPER	CUST STATES VEH WILL NOT START	147146	S07	USA	V25	F7	24-Mar-11							3/25/2011	Fuel pump replacement	Fuel leak reported. Dealer sent photos showing cracked RH cylinder head. Pump SN is well after containment / PCA date for double heat treated issue. Hot return process requested on pump. 3/31 - returned to Bosch 4/6 - Bosch found an inclusion in the head casting. 8D says their casting process is best possible, no additional steps planned.	Closed		Casting inclusion

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
33	CHECKED FOR CODES, NONE IN ANY MODULE. WARMED UP ENGINE AND TRACED NOISE TO FUEL SYSTEM, CHECKED TSB AND SSM. CHECKED PRIMARY FUEL FILTER DRAIN VALVE AND WATER IN FUEL SENSOR SEALS. LOOK OK. PULL PULLED UPPER AND	LOWER INTAKE MANIFOLD AND PULLED CONTROL VALVE FROM PUMP TO CHECK FOR DEBRIS. VALVE SCREEN CLEAN AND FREE OF DEBRIS. REPLACED HIGH PRESSURE PUMP AND REASSEMBLED ENGINE. BLED FUEL SYSTEM A	WHINNING NOISE COMING FROM ENGINE	156427	S07	USA	V39	F7	11-Apr-11							4/12/2011	Fuel pump replacement	HP fuel pump replaced for noise 4/27 - Fuel pump received, forwarded to Bosch for investigation 5/5 - TNI @ Bosch	Closed		TNI
34	VERIFIED CONCERN. CHECKED OASIS. INSTALLED IDS RETRIEVED CODES P0546 AND P0305. FOUND EGT SENSOR 1 CONNECTOR DAMAGED REPLACED EGT SENSOR 1. PERFORMED POWER BALANCE TEST FOUND #1AND #5 DROPPIND	(DEAD MISS). PERFORMED RELATIVE COMPRESSIONTEST 0% ON ALL CYLINDERS. PERFORMED HOTLINE REQUEST CONTACT ID 104 392 340. SENT FUEL SAMPLE TO PREDICTIVEMAINTENANCE SERVICES TO HAVE FUELS	CUSTOMER REQUESTS DIAGNOSIS CHECK ENGINE LIGHT IS ON. CUSTSTATES VEHICLE IS MISSING.	121298	S07	USA	V52	F7	11-Apr-11							4/12/2011	Fuel pump replacement	Tech reported strong smell of ammonia, and flushed debris from HP pipes into a can, but didn't see debris at VCV. Fuel sent out to a lab and came back good, so 2 weeks after truck initially came in, the dealership replaced fuel system at Ford's expense. 4/27 - injectors received, will be scrapped except 1 sent to Bosch. Fuel pump received and returned to Bosch. 5/11 - Bosch teardown showed internal corrosion from contaminated fuel	Closed		Fuel contamination
35	CONCERN EXISTS AS CUSTOMER STATES PERFORMED KOEO CMMDTC TESTS RETREIVED DTC P2291 PERFORMED PINPOINT TEST M M1 RETREIVED DTC P2291 M2 DID STATE CHANGED FROM LOW TO NOT LOW M3 RETREIVED FUEL SAMPLE APPEARS	TO BE IN GOOD CONDITION M5 FUEL FLOW WAS ALWAYS PRESENT REGARDLESS OF DUTY CYCLE REPLACED FUEL PRESSURE REGULATOR PER PINPOINT CONCERN STILL PRESENT PERF PINPOINT M AGAIN AND STEP M15 FAILED SKIP	CUSTOMER STATES DIED AND WOULD NOT RESTART	123219	S07	USA	V52	F7	25-Apr-11							4/26/2011	Fuel pump replacement	From CQIS, VCV was found covered with metallic debris, indicating pump failure. Pump debris in turn would have blocked fuel return, leading to high backpressure and injector piezo stack can crush from high backpressure. Waiting on parts return. 5/13 - parts returned and sent to Bosch to check for signs of corrosion 5/20 - rails received, will be scrapped. 6/14 - Bosch found corrosion inside pump. CQIS updated.	Closed		Fuel contamination
36	VERIRY VEHICLE WILL NOT START EEC TEST PPT TEST AND MONITOR PIDS FIND NOT FUEL PRESSURE R AND R UPPER INTANK R AND R FAN SHROUD R AND R	HIGH PRESSURE FUEL PUMP FIND FITTING CRACKED REPLACED PUMP AND LINES RE CHECK AND ROAD TEST AFER COMPLETI ON OF REPAIRS	CUST STATES VEHICLE CUT OFF WHILE DRIVING WILL NOT RESTART	127595	S07	USA	V52	F7	25-Apr-11							4/26/2011	Fuel pump replacement	Jim Rauch overnighting pump to Dearborn 5/5 - pump returned, going to Bosch on 5/6. It does have a crack in the port of the RH cylinder. Fuel pump was mfg in July 2010, after double HT containment date. 6/1 - reviewed 8D with Bosch Feuerbach - pump was manufactured without ECM deburrig. Estimated 3 pump exposure. Next mtg 6/7 9/23 - Bosch 8D closure requested after 2 months with 0 internal rejects, down from 80/mo when this part was produced.	Open		Fuel pump cyl head crack - ECM deburring step missing

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
37	ATTN:904 OUTSIDE. BATTERIES COMPLETELY DEAD. PUSH TRUCK INTO SHOP & PLACE ON CHARGER. CHECK OIL LEVEL. 6 OVER FULL. NO COOLANT IN DEGAS BOTTLE. DRAIN 10 LITERS OF COOLANT FROM OIL DRAIN, PERFORM EEC TEST.	CODES P0087, P0674, & P068A IN PCM & P0706, P0707, P0884, P1921 IN TCM. RECORD FREEZE FRAME DATA FOR CODE P0087. CLEAR CODE & RETEST. P0674 HARD FAULT. TRY TO START. ENGINES KNOCKS ON CRANKI	ENGINE STALLED WHILE DRIVING VEHICLE WAS TOWED TO SPRUCELAND FORD WHERE IT WAS DETERMINED THAT THERE IS 1 CYLINDER THAT HAS NO COMPRESSION. DETERMINE FAULT AND ADVISE	4B6032	E84	CAN	V52	F7	14-Apr-11							4/15/2011	Fuel pump replacement	Engine failed, and wouldn't start after long block replacement until the fuel pump was replaced. 6/24 - pump finally returned. Given to Bosch 9/20 - pump TNI @ Bosch FH	closed		TNI
38																4/27/2011	Fuel pump replacement	4/27 - Bosch notified to pick up pump. Unknown problem 5/5 - TNI @ Bosch	Open		TNI
39	IDS DIAG P2291, PINPOINT TEST, DCL MONITOR RECORDER. FRP 231 PSI CRANKING, CHECK OASIS, CONTACT HOTLINE PERFORM PPT	M, R&R UPPER AND LOWER INTAKE INSPECT VCV OK. NECC TO REPLACE H P PUMP, RETEST AND ROAD TEST OK.	TOWED IN OUT FRONT CRANK NO START	148010	S07	USA	V52	F7	2-May-11							5/3/2011	Fuel pump replacement	Per CQIS, tech later found a problem with upfitter wiring harness corrosion. There was also a P1291 code. Pump was returned from field and NOT forwarded to Bosch.	Closed		Misdiagnosis
40	PERFORM DIESEL ENGINE PERFORMANCE AND VISUAL INSPECTION DTC P0088. PINPOINTEST M. INSTALLED FUEL PRESSURE AND COMMAND VCV LOW	FUEL FLOWING ,COMMAND VCV HIGH STILL FLOWING.REMOVE FUEL HIGH PRESSURE PUMP AND REPLACE. RETESY OK. ROAD TEST 60 MLIS OK. MT. 1.5 DIAG.	CUSTOMER STATES HAS NO POWER	171447	S07	USA	V52	F7	F04	502110134795	10-May-11					5/18/2011	Fuel pump replacement	5/23 - pump received and going to Bosch. PCV was previously replaced on this truck. 8/2 - fuel pump TNI @ Bosch	Closed		TNI
41																5/18/2011	Fuel pump replacement	Livonia Trans dyno test engine with 2672 hours, weep from shaft seal area, pump given to Bosch	Open		Shaft seal leak - high back pressure
42	CONFIRM SPINS BUT WILL NOT START. EEC TEST P2291 MONITOR FUEL PRESSURE 0PSI WHEN CRANKING. 5000 NEEDED TO RUN PERFORM FUEL CONTAMINATION CHECK, FOUND DEF IN FUEL WATER DRAIN FOR DIESEL FUEL. DEF WAS	ADDED TO THE DIESEL TANK THAT CAUSED ALL THE CORROSION. FOLLOWED 6.7 FUEL SYSTEM CONTAMINATION JOB AID. REPLACE HP PUMP,ENGINE MOUNTED HP FUEL ILINES, BOTH HP FUEL RAILS, 8 INJECTORS, LOW PRESS	LOSS OF POWER ACCELERATION ALL ENGINE TEMPERTURES	121214	E84	USA	V52	F7	F04	12-May-11					E1116 0912090001147 [redacted]	5/13/2011	Fuel pump replacement	AWS says DEF was found in fuel. Why did Ford pay for this? If fuel pump returns, send to Bosch for photographing.	Closed		DEF contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
43	VERIFIED. LEAK IN ENG AREA. FUEL PUMP UNABLE TO PINPOINT HOT LINE. R I UPPER INTAKE BORESCOPE FUEL SYS LEAK AT	FRONT OF PUMP. HOTLINE R R HIGH PSI PUMP. R R PUMP RETEST NO LEAKS. ROAD TEST OP NORMAL. MT NO SLTS BORESCOPE	FUEL LEAK ADVISE	153792	S07	USA	V25	F7	F04	18-May-11					E1116 1810100082531 [redacted]	5/19/2011	Fuel pump replacement	Sounds like a front shaft seal leak… 5/27 - received, passed to Bosch. 8/3 - report from Bosch FH shows new seal failure mode due to glue curing problem. 8D needed 9/22 - latest 8D revises procedures at supplier, further update from seal supplier Bruss will be reviewed in meeting on 10/7. Ford TS Tom Smith hasn't experienced with this failure mode on other parts.	Closed		Shaft seal failure - glue problem
44	CUST BROUGHT VEH IN COMPLAINING OF ROUGH IDLE, LACK OF PWR. IDS DIAG SHOWED THAT CONTRIBUTION CODE FOR CYL #1 HAD RETURNED. CLEARED CODE, ROAD TESTED CONFIRMED ENG WAS RUNNING ROUGH DTC P0263 HAD RETURNED	AGAIN. REPLACE #1 FUEL INJ. ROAD TESTED VEH, ENG MISS CONCERN CORRECTED BY INJ REPLACEMENT RETESTED FOR DTC, PASS. SHOP FOREMAN ROAD TESTED VEH OVERNIGHT, FOUND THAT ENG NO LONGER MISFIRED BUT	C S CHK ENG LIGHT ON,RUNNING ROUGH, FUEL MILEGE HAS DROPPED ALSO WHEN STARTING WITH REMOTE START IT STARTS FINE BUT WHEN STARTING MANUALLY IT TAKESA FEW TURNS TO START VEH REPORT (CONT FROM TECH ST	152752	E84	USA	V29	F7	F04	20-May-11					E1116 2008100059007 [redacted]	5/23/2011	Fuel pump replacement	Complete fuel system replaced, after multiple injector replacements didn't fix the problems. The vehicle was going to (has been) bought back from the customer because of the difficulty / time involved in fixing the issue. 6/2 - PCV received. was found to have corrosion @ Bosch 8/5 - fuel pump returned to Bosch w/o VCV. Bosch installed known good part, tested, was TNI. 8/16 - Bosch material analysis of injector contamination confirmed urea in the fuel	Closed		Fuel contamination
45	CONFIRMED CONCERN.HAS CODE P2291.USED PINPOINT TEST M: LOW PSI PUMP COMMANDS ON PASSES CLEAN SUFFICIENT FUEL TEST, REL COMP OK.FCP SENSOR NOT BIASED.CL EAN FUEL RETURNING TO PUMP, STEP M17 PASSES.REPL FUEL VOLUME	CONTROL VALVE, SOLENOID .REASSEMBLED & RETEST NO START,HAS CODE P0090.USED PPT ME,GOT TO STEP ME5 FPCU VALVE FAILS @8OHMS OF RESISTANCE.REPL VALVE & RETEST NO START.CONTACT HOTLINE REFER	DIAG AND ADVISE FOR INTERMIT NO START	4B1298	E72	CAN	V52	F7	F04	24-May-11					E1116 0504100017186 [redacted]	5/25/2011	Fuel pump replacement	9/20 - Pump TNI @ Bosch FH	Closed		TNI
46	VERIFIED SURGE AND RUNS ROUGH AT IDLE AND AT TIMES WHILE DRIVING. PERFORMED SUFFICIENT CLEAN FUEL TEST NON TAXED (DYED RED) DIESEL FUEL PRESENT WITH NO APPARENT CONTAMINATES	CONTACTED HOTLINE AND WAS DIRECTED TO RETEST FOR AERATION AND BASE FUEL SYSTEM CONCERNS. FUEL TRIMS POLARIZED AND MISFIRES PRESENT DURING POWER BALANCE TEST AND ENHANCED.	INTERN. SURGES AT FREEWAY SPEEDS AND BACK FIRES (POPS)	156594	S07	USA	V52	F7	F04	24-May-11					E1116 0208100051760 [redacted]	5/25/2011	Fuel pump replacement	6/9 - fuel pump and injectors received. Injectors scrapped, fuel pump sent to Bosch to check for signs of corrosion, debris (sand), etc.. CQIS reports that debris was found in VCV, leading to entire fuel system change. 8/5 - fuel pump TNI @ Bosch	Closed		TNI

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
47	THIS REPAIR IS A CONTINUING CONCERN OF RO 73958 PER DERRIC WENZEL REPLACE	REMAINING INJECTORS EGR VALVE AND SENSOR CONTACT ID 104186071 WPI	CUST STATES VEH AT TIMES VEH STALLS OUT	121214	E84	USA	V52	F7	F04	6-Jun-11					E1116 0912090001147 [redacted]	6/7/2011	Fuel pump replacement	DEF contaminated per CQIS. Why did Ford pay?! 8/5 - Bosch didn't find pump damage, but found DEF crystals in a fuel rail, and 2 of 8 injectors had crushed piezo stacks	closed		DEF contamination
48	MA5 REPLACE FUEL FILTERS RECHECK PRESSURE NO CHANGE FUEL PRESS AT LOW PRESS FUEL PUMP OUTLET PORT FUEL PRESS AT 18 PSI MA7 DISCONNECT LOW PRESS SUPPLY LINE FROM INLET OF FUEL PUMP MEASURED	0H6 INLET RESTRICTION MA8 CHECK FUELK PUMP SUPPLY VOLTGE AT 12 VOLTS TEST LAMP ILLUMINATES BRIGHT .REPLACE LOW FUEL SYS FUEL PUMP MODULE RETEST FUEL PRESS NOW 66 PSI	TOWED IN,,CUST STATES WILL CRANK BUT NOT START,STATES CHECK ENGINE&LOW FUEL PRESSURE LIGHTS CAME ON,TURN TRUCK OFF THEN,TIRED TO START WOULD NOT START ADVISE. DRIVESHAFT IS DISCONNECTED	171040	S07	USA	V52	F7	F04	10-Jun-11					E1116 1702100007934 [redacted]	6/13/2011	Fuel pump replacement	7/22 - pump received. Per CQIS, changing the pump didn't fix the problem, which was eventually traced to the LP fuel pump	Closed		Misdiagnosis
49	VERIFY CONCERN,FOUND NO CRANK EEC TEST,P0087,LOW FUEL PRESSURE FUEL PUMP NOISY,PERFORM DIAGNOSTICS AWITH PINPOINT TEST FOUND CODE P2291 PPT M1 M16 REMOVE PRESSUR CONTROL VALVE, FOUND FAILED,REMOVE FUEL	TANK,INSPECT FOR CONTAMINATION NONE,FOUND HIGH SPRESSURE FUEL PUMP FAILED,REPLACE PUMP,ALL INJECTORS,FUEL RETURN LINE,FUEL HIGH PRESSURE PUMP TO RAIL LINE,PUMP CAME APART,METAL THROUGHOUT FUEL SYSTE	DIED AND WONT RESTART	141679	S07	USA	V52	F7	F04	21-Jun-11					E1116 0103100010046 [redacted]	6/21/2011	Fuel pump replacement	Entire fuel system replaced. 7/22 - fuel pump returned to Bosch for analysis 9/19 - report received from Bosch. Fuel pump had corrosion, and internal overheating from poor lubricity fuel.	Open		Fuel contamination
50	INSP FOR CEL ON,DIESEL DIAG,IDS TEST CODES P0087 P2291,PPT TEST FOR CODES,FOUND LOW PRESS TAKING TOO LONG TO SWITCH PID TO NOT LOW,CONTACT HTLINE 10457722,PID SHOULD CHANGE WITH NO LAG,INT RESTRICTION	TESTS,AERATION TESTS,NO AIR IN FUEL,REPL LOW PRESS PUMP,BLED SYS,CLEAR CODES,MT TIME REQ FOR FURTHER DIAG,BOTH CODES LED TO M17,REQS BOTH PCV & HI PRESS PUMP,R&R FUEL LINES FOR ACCESS,REPL HI PRESS P	E29 INSPECT AND ADVISE FOR CEL IS ON IN THE DASH CONT.... OF 5MINS THERE WAS AN AIR BUBBLE THAT APPEARED FROM LINE,LET RUN ANOTHER 5MINS & 2 3 MORE APPEARED FROM RETURN LINE	4B6270	S07	CAN	V29	F7	F04	21-Jun-11					E1116 2810100087591 [redacted]	6/21/2011	Fuel pump replacement	Per CQIS, problem was eventually traced to the switching valve on this two-tank vehicle	Closed		Misdiagnosis
51	313 HIGH PRESSURE FUEL PUMP ,FUEL LINES TO PUMP, FUEL RAIL PRESSURE SENSOR CORROSION AT PINS TEST DROVE SEVERAL MILES AND VERIFIED CONCERN, PULLED CMDTC P0191,P0087,P2291...RAN PIN POINT TEST M.LEAD TO	TAKE FUEL SAMPLE,CLEAN,RELATIVE COMPRESSION PASSED,MONITORED PID DATA FOR FRP FOUND THE VOLTAGE OFF PER REFERENCE VALUES IN SECTION 6.FOUND AT 0.25V NEEDS TO BE 0.27 0.34V	SES LIGHT IS ON, REDUCE ENGINE SPEED DISPLAYS AND VEHICLE SHUTS OFF, RESTARTS AFTER 15 MINUTES AND WILL GO ANOTHER 40 MILES. CUSTOMER STATED BOTH POSITIVE BATTERY CLAMPS LOOSE AND HE ERT	152020	S07	USA	V29	F7	F04	29-Jun-11					E1116 0104110150153 [redacted]	6/29/2011	Fuel pump replacement	8/5 - fuel pump received but not sent back to Bosch, as per CQIS, changing the pump didn't fix the problem. FRP was received and sent back to Bosch 9/20 - report received from Bosch showing corrosion on the sensor terminals. Requested part to share with wiring harness engineer	Open		Misdiagnosis

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
52	RAN SELF TEST P0087 VERIFEID A FUEL LEAK AT THE HIGH PRESSURE FUEL PUMP ON BOTH SIDES RR UPPER AND LOWER INTAKES TO GAIN ACCESS	TO RR THE PRESSURE LINES FROM THE PUMP ON BOTH SIDES,REPL HIGH PRESSURE PUMP AND LINES AND RETEST	CHECK ENGINE LIGHT CAME ON VEHICLE DIED WHILE DRIVING SMOKE STATING COMING FROM UNDER THE HOOD. ONCE VEHICLE WAS STOPPED DIESEL FUEL LEAKING ALL OVER THE PLACE	153201	S07	USA	V29	F7	F04	12-Jul-11					E1116 0902100006456 [redacted]	7/12/2011	Fuel pump replacement	8/15 - returned to Bosch	Open		Need report
53	FOUND LARGE FUEL LEAK COMING FROM CENTER OF FRONT OF ENGINE. REMOVED UPPER AND LOWER INTAKE MANIFOLD TO ACCESS FUEL INJE CTION PUMP & FOUND FUEL LEAKING FROM THE R H PUMP CYLINDER,FUEL	INJECTION PUMP BAD. R&R HIGH PRESSURE FUEL INJECTION PUMP ASSY. TEST DROVE, OK. THIS TICKET WAS FILED AWAY BY OUR PREVIOUS SERVICE MANAGER. I AM TRYING TO GET THINGS CLEANED UP AND ORGANIZED FO	CUSTOMER STATES BROKE DOWN ON ROAD	153543	S07	USA	V25	F7	F04	12-Jul-11					E1116 1606100038734 [redacted]	7/12/2011	Fuel pump replacement	8/15 - returned to Bosch, but w/o VIN because there was no paperwork in the box.	Open		Need report
54	9527 CC 07 PERFORM DIAG, FOUND FUEL LEAKING, REPLACED #8 FUEL INJECTOR AND PROGRAM	TO PCM, MTIME TO DIAG AND BLEED FUEL SYSTEM, RECHECK, OK.	CUST STATES THAT HE HAS A LEAK FROM THE ENG OR DIFF AREA	148004	2	USA	V44	F7	F04	7-Jul-11					E1116 1503100011975 [redacted]	7/7/2011	Fuel pump replacement	7/22 - fuel pump received and not returned to Bosch. CQIS said the engine had piston to valve contact.	Closed		Collateral damage
55	CONFIRM CRANK NO START.P0087,P2291 REFER TO HI PRESS FUEL.PPT M. M1,NO INJ CIRCUIT CODES,MONITOR FUEL SWITCH PID,DOES CHANGE WITH KEY ON,FUEL QUAILTY QUANTITY TEST, PASS, M15 FOR P2291, ACCES PIDS FOR VOL & PRESS,R&R FUEL LINE	FROM LEFT FUEL RAIL,MON FUEL FLOW,FUEL ALWAYS FLOW,DIRECTED TO REPLACE PRESS CONTROL VAVLE.REPLACE PRESS CONTROL VALVE.RERAN M15,SAME CONCERN.CONTACT HOTLINE,DIRET	C S VEHICLE LOST POWER WHILE DRIVING, VEHICLE PULLED OVER AND ENGINE DIED, ENGINE CRANKS OVER BUT WONT START.	174540	S07	USA	V52	F7	F04	1-Jul-11					E1116 0111100088795 [redacted]	7/1/2011	Fuel pump replacement	No additional CQIS information 7/22 - fuel pump received and returned to Bosch PCV returned to Bosch 9/23 - PCV TNI @ Bosch, given to Dave Currie for vehicle testing. Still need report from Bosch.	Open		Need report
56	USE IDS TO RUN EECTEST P0087 P2291 PULL FUEL SAMPLE SAMPLE CLEAN CHECK FUEL PRESSURE LOW SIDE 55 PSI RUN	PINPOINT TEST M1 YEWS M2 YES M3 NO M15 YES M17 YES R ABND R UPPER AND LOWER INTAKE TO REPLACE HPP CLEAR CODES AND ROADTEST	CUSTOMER SAYS THE VEHICLE CRANKS BUT WONT START	152032	S07	USA	V52	F7	F04	8-Jul-11					E1116 2909100074607 [redacted]	7/8/2011	Fuel pump replacement	9/20 - Pump TNI @ Bosch FH	closed		TNI
57	VERIFY CONCERN RUN NUMEROUS TEST. PPT TEST LEAD TO PUMP REPLACEMENT. AFTER NO START CALLED HOTLINE STILL COULD NOT FIND THE PROBLEM. FSE CHRIS FURNESS GOT INVOLVED. AFTER TALKING BACK & FORTH GOT VEHICLE	STARTED. FUEL COMING OUT OF 2 INJ. REPLACED 2&4 NO START. REPLACED 1&3 STARTED BUT BLEW OFF RETURN LINE. WAS TOLD TO CHANGE RETURN LINE. ENGINE STARTED BUT REDUCED ENGINE POWERDISPLAYED. COULD NOT	VEHICLE STOPPED ON CUSTOMER AT TRAFFIC LIGHT	123054	S07	USA	V52	F7	F04	1-Jul-11					E1116 3101110124109 [redacted]	7/1/2011	Fuel pump replacement	8/5 - injectors not returned yet. 9/2 - fuel rail and fuel pump returned to Bosch 9/29 - told Ken Romak I'm still waiting for the report 10/17 - Bosch found corrosion on suction valves and overheated bearings, evidence of poor quality fuel	closed		Fuel contamination

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
58	PER TSB 11 6 10, PERFORMED DIAG CHECK, STEP 1, CK HARNESS 12B637, NO, STEP 2, UNPLUGGED INJECTORS AND CHECK FOR	CONTINUITY, YES, REPLACED ALL 8 INJECTORS AS PER BULLETIN, PROGRAMMED AND CHECK,OK.	CHECK ENGINE LIGHT WAS ON, TRUCK LOST POWER WHILE TOWING	113527	S07	USA	V29	F7	F04	8-Jul-11						7/8/2011	Fuel pump replacement	Notified via e-mail by Alex Hernandez at ChEP, who forwarded photos showing the body of the pump had fractured. Replied with inspection procedure and requested results and return of the pump. Bosch inspected and verbally said massive corrosion seen. Waiting for report	Open		Fuel contamination
59	PERFORM PCED DIESEL DIAGNOSIS, FOUND CODE P2291 IN PCM, MONITOR PIDS, 0 PSI FRP WHILE CRANKING AND .28V. FOLLOW PPT M, NO CHANGE IN FRP WHEN COMMANDING LIFT PUMP ON OR OFF, PASSES PPT M, LEADS ME TO PPT MA,	PPT MA INSTRUCTS ME TO DRIVE THE TRUCK, THE TRUCK DOES NOT RUN. PCED HAS NO DIAGNOSIS FOR THIS PROBLEM, CHECKD FOR FUEL FLOW FROM LIFT PUMP, HAS FLOW, NO TOOLS AVAILABLE TO	CRANKS NO START	127039	S07	USA	V52	F7	F04	13-Jul-11					E1116 1904100022831 [redacted]	7/13/2011	Fuel pump replacement	8/15 - Fuel pump returned to Bosch 9/20 - Bosch report confirms failure is due to DEF contamination. Updated CQIS report.	closed		DEF contamination
60	VERIFY,CK CODES,CHECK FUEL, FOUND METAL, CALLED HOTLINE,REPLACED HIGH PRESS PUMP, INJECTORS AND FILTERS AS SUGGESTED, RECHECKED	CODES AND TD, OK INFORMATION REQUESTED WAS SENT VIA FAX INFORMATION REQUESTED WAS SENT VIA FAX	***FORD WRO***THE CUSTOMER STATES THERE IS A FAIL SAFE INDICATOR ON THE DASH, THE VEHICLE SHUT OFF AND IT WONT START?	174411	S07	USA	V52	F7	F04	27-Jul-11					E1116 1702100007992 [redacted]	7/27/2011	Fuel pump replacement	Why was entire system changed at our expense? 9/2 - fuel pump received and returned to Bosch 10/17 - Bosch found laquered fuel deposits on various surfaces in the pump, indicative of poor quality fuel. Bearings had overheated.	closed		Fuel contamination
61	HIGH PRESSURE FUEL PUMP VERIFIED CONCERN. IDS DIAG KOEO AND HAD CODE P0087 FOR FRP TOO LOW ENGINE CRANKING. IDS DATALOGGER PIDS FRP AND FRP DSD AND FOUND FRP TO BE AT ONLY 360PSI KOEO AND WHILE CRANKING AND .3VOLTS. CHECKED BASE FUEL PSI AND IS AT 7PSI	210	CUSTOMER STATES THE VEHICLE STALLED AND CRANKS BUT WILL NOT START CHECK AND ADVISE.	152567	E72	USA	V44	F7	F04	21-Jul-11					E1116 1205100028219 [redacted]	7/21/2011	Fuel pump replacement	Entire fuel system replaced. 9/20 - pump TNI @ Bosch FH. CQIS updated.	Closed		TNI
62	VERIFIED CONCERN PERFORMED DIAG FOUND RETURN LINE HAD COME APART AT THE T FROM CYL #1 AND #2 REASSEMBLED FUEL LINE AND FOUND WE COULD ONLY GET 1600 PSI FUEL PRESURE CONTACTED HOTLINE AND WAS ADVISED TO REPLACE THE FUEL RETURN LINE ASSY. REPLACED AND AFT	801	CUSTOMER STATES TURNS OVER NO START	156653	S07	USA	V52	F7	F04	25-Jul-11					E1116 2203100014047 [redacted]	7/25/2011	Fuel pump replacement	Complete fuel system replaced 9/2 - examined PCV and saw it was heavily rusted, which is evidence of excessive water in the fuel. Part not returned to Bosch.	Closed		Fuel contamination
63	FOUND FUEL LEAKING FROM BELOW HIGH PSI PUMP. R&R PUMP,STARTED ENGINE,HAD SLIGHT LEAK FROM LINE AT PUMP TO DRIVERS SIDE RAIL.R&R LINE. TEST OK TRIED TODO PRIOR APPROVAL BUT STATED IT WAS ONLY REQUIRED FOR 6.0L AND 6.4L DIESEL COMPONENTS MT FOR FUEL L EAK D	570	FUEL LEAK UNDER ENGINE.	121022	S07	USA	V25	F7	F04	26-Jul-11					E1116 1002110128167 [redacted]	7/26/2011	Fuel pump replacement	9/2 - this pump and pump replaced later received and forwarded to Bosch for analysis 10/24 - pump shaft seal rolled. This is due to high back pressure on the vehicle side, as from a pinched return fuel line.	Closed		Shaft seal leak - high back pressure

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
64	INSPECT FOR NO START, CRANKS & NO START. EEC TEST P2291 PERF PP TEST M1 M3 M15 FRP KOEO 289 PSI. REPL FRP SENSOR IN LH FUEL RAIL. KOEO F000 PSI STILLNO START CONDIITION. CONTINUE STEP 15 REMOVED FUEL PRESS REG AND INSPECT. M17 FOUND FLOW FROM LH FUEL RAIL	405	HARD TO START IN MORNINGS, NOW NO START	152401	S07	USA	V52	F7	F04	3-Aug-11					E1116 0309100065161 [redacted]	8/3/2011	Fuel pump replacement	9/2 - fuel pump received and returned to Bosch.	Open		Need report
65	C S ENG STALLED OUT&WONT RESTART EXH FLUID LIGHT CAME ON BEFORE STALLING TOWED TO SHOP.DED HARDSTART NO START DIAG,SPINS WONT START KOEO TEST P2291,P0087,PINPOINT TEST M TO M17.PID MONITOR TEST FOUND LP FUEL SWITCH CHANGES,PERFORM SUFFICIENT FUEL SYS TEST	504	C S ENG STALLED OUT&WONT RESTART EXH FLUID LT CAME ON BEFORE STALLI	123050	S07	USA	V52	F7	F04	11-Aug-11					E1116 0610100077655 [redacted]	8/11/2011	Fuel pump replacement	Complete fuel system replaced 9/2 - VCV w/metal debris returned to Bosch to check for signs of corrosion 9/23 - fuel pump minus VCV received and returned to Bosch. 10/17 - fuel pump failure attributed to poor lubricity fuel	closed		Poor lubricity fuel
66	VERIFIED ENGINE LEAKING FUEL. LEAKING FROM VALLEY OF ENGINE. TRACED LEAK TO HIGH PRESSURE FUEL PUMP SEALS AT TOP OF PUMP. TORE DOWN TO HIGH PRESSURE FUEL PUMP & FOUND LEAKING EXTERNALLY FROM PUMP SEAL. REMOVED BOTH FRONT FENDER SPLASH SHIELDS TO ACCES	678	DIESEL REPAIRS FUEL LEAK MILEAGE VERIFIED CORRECT FOR REPAIR DATE,PER ADVISOR AND TECH IN/OUT	121022	S07	USA	V25	F7	F04	12-Aug-11					E1116 1002110128167 [redacted]	8/12/2011	Fuel pump replacement	9/2 - this pump and pump replaced again. A pump was previously received and forwarded to Bosch for analysis 10/24 - pump shaft seal rolled. This is due to high back pressure on the vehicle side, as from a pinched return fuel line.	closed		Shaft seal leak - high back pressure
67	FAULTY HP FEUL PUMP PUTTING METAL INTO FAUL SYSTEM CC42 RETRIEVED DTCS POO89 MONTORIED FRP FOUND VEHICLE ONLY BUILDS 425 PSI OF HP FUEL CONTACTED HOLTLINE WAS INSTRUCTED TO TAKE FUEL SAMPLE FOUND NO CONTAMINATION IN SYSTEM REMOVED INTAKE MANIFOLD UPPER	225	ENGINE DIAGNOSIS TOW IN WONT START	123378	E84	USA	V52	F7	F04	12-Aug-11					E1116 2901100004814 [redacted]	8/12/2011	Fuel pump replacement	complete fuel system replaced 9/2 - fuel pump received and returned to Bosch 10/17 - Bosch found corrosion on cylinder head inside pump, evidence of excessive water in fuel	closed		Fuel contamination
68	HIGH PRESSURE PUMP LEAKING FUEL. VERIFIED THE VEHICLE LEAKING FUEL FROM THE HIGH PRESSURE FUEL PUMP. NECESSARY TO REMOVE THE UPPER AND LOWER INTAKE MANIFOLDS TO GAIN ACCESS TO THE FUEL SUPPLY LINE, REMOVED TH E FUEL RAIL. REMOVED THE HIGH PRESSURE FUEL	505	CHECK FOR A FUEL LEAK AT ENGINE IT WILL LEAVE A LARGE PUDDLE ON THE GROUND AND WILL NOT START	152540	S07	USA	V25	F7	F04	18-Aug-11					E1116 2803110147899 [redacted]	8/18/2011	Fuel pump replacement	High Pressure Fuel Pump leak 9/23 - fuel pump returned to Bosch. Has a cylinder head crack, the top with the suction valve in it is almost completely fractured off. This was seen in the past from very heavy corrosion. On this pump, heavy corrosion visible in outlet of HP port	Open		Fuel contamination
69	EN ESTA UNIDAD NO PRENDIA Y SE PROCEDIO A CHECAR Y SE ENCONTRO LA BOMBA DA ADA QUEBRADA COMPLETA O DESNIVELADA Y SE PROCEDIO A REEMPLAZARLA JUNTO CON LAS LINEAS Y SE LIMPIARON LOS RIELES Y BOLBILA CONTROL DE PRESION CORRIGIENDO LA FUGA Y FALLA DE LA	918	NO ENCINEDE TIRA DIESEL	2M2164	2	MEX	V52	F7	F04	19-Aug-11					E1116 0908100054445 [redacted]	8/19/2011	Fuel pump replacement	Pump leak? Pumps don't return from Mexico unless there are special circumstances, so this incident will not be tracked any further.	Closed		Not returned
70	HIGH PRESSURE FUEL PUMP FAILURE INSPECT AND FOUND LOW PRESSURE RETURN LINE IN FRONT OF #1 INJECTOR SPLIT.R&R LOW PRESSURE RETURN HOSE,VEHICLE STILL WOULD NOT START.IDS TEST KOEO,KOER,PID MONITOR. FUEL PRESSURE AT 260 PSI.PIN POINT TEST,R&R VCV AND FOUN	772	CUST STATES LEAKING FUEL ON RIGHT SIDE OF ENGINE, EXHIBITS CRANK NO START. PLEASE CHECK AND ADVISE CUSTOMER READ CODE AND IS SAID LOW FUEL PRESSURE. DRIVESHAFT NEEDS TO BE INSTALLED BEFORE	124526	E72	USA	V25	F7	F04	19-Aug-11					E1116 1503100012111 [redacted]	8/19/2011	Fuel pump replacement	Complete fuel system replaced 9/23 - pump received and returned to Bosch. Had been partially disassembled by the dealer. Roller in one tappet had siezed. No obvious signs of corrosion. 10/17 - Bosch photos show overheated shaft bearings, likely due to poor lubricity fuel.	Closed		Poor lubricity fuel

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
71	IDS TEST PINPOINT TEST RI INTAKE MANIFOLDS FOUND METAL IN HIGH PRESS SYS RR HPP FAILED METAL THROUGH OUT SYS RR HPP FUEL MANIFOLD FLUSH SYS RR FUEL FITLERS CLEAN TANK WPI REPAIR HAS BEEN REVIEWED AN	815	STALLED WHILE DRIVING TOWED IN	141497	S07	USA	V52	F7	F04	23-Aug-11					E1116 0203100010672 [redacted]	8/23/2011	Fuel pump replacement	Complete fuel system replaced 9/23 - pump received and returned to Bosch 10/17 - corrosion in pump found @ Bosch, and overheated bearings.	Closed		Fuel contamination
72	VERIFIED CONCERN. EEC DIAG. DTC P2291. PINPOINT TEST M. M1 Y, M2 Y, M3 N, M15 Y, M17 Y. FOUND HIGH PRESSURE PUMP FAILED. REPLACED HIGH PRESSURE PUMP. RETEST. CONCERN STILL PRESENT. CONTACT TECH HOTLINE. ID#	104734227. CHECKED FRP SENSOR FOR DEBRIS NONE FOUND. REPORT BACK TO HOTLING. CHECKED LOW PRESSURE SYSTEM AS PER HOTLINE NO LEAKS FOUND. REMOVED GLOW PLUGS AND MIST TEST PER HOTLINE. FOUND #7 IN	C.S. ALL OF A SUDDEN VEH DIED, LIGHT SAID REDUCING POWER, CRANK NO START	123580	S07	USA	V52	F7	F04	24-Aug-11					E1116 0904100019414 [redacted]	8/24/2011	Fuel pump replacement	Complete fuel system replaced. Previously the fuel pump was replaced and later found to have debris in it, but the first pump wasn't accompanied by a system change, so there was still debris. 9/2 - pump received and returned to Bosch 12/8 - report received with photos of internal corrosion from water	closed		Fuel contamination
73	PERFORMED VISUAL INSPECTION AND FOUND NO CONCERNS RAN OASIS AND FOUND NO RELATED TSBS PERFORMED KOEO TEST AND CONTINUOUS CODES RECEIVED CODES P0087 AND P2291 FOLLOWED PP TESTS M1, M2, MA5, MA6, MA7, MA8 WHICH LED TO LOW FUEL PRESSURE PUMP BEING FAULTY REPLACED PUMP AND RESTORED BASE FUEL PRESSURE BUT STILL WILL NOT START PERFORMED PP TESTS M1, M2, M15 LED TO FAULTY FUEL PRESSURE CONTROL SOLENO	*	CUSTOMER STATES ENGINE CRANKS WILL NOT START METAL CONTAMINATION CAME FROM.	147098	S07	USA	V52	F7	F04	24-Aug-11					E1116 0405100025842 [redacted]	8/24/2011	Fuel pump replacement	Complete fuel system replaced 9/2 - pump received and returned to Bosch 9/23 - injectors received and scrapped.	Open		Need report
74	12650DD 0.2 12650D45D 0.3 12650D81D 0.5 12650D6 0.5 9424A10 3.5 MT12650 1.0 NOTE:MTIME FOR HAVING TO MANUALLY RETRIEVE AND ENTER AS BUILT DATA INTO THE NEW PCM BECAUSE THE DATA COULD NOT BE LOADED FROM THE OLD PCM..... VEHICLE WAS BROUGHT BACK	817	INSPECT FOR ENGINE NOISE AND LOSS OF POWER UPON TAKEOFF	123071	S07	USA	V39	F7	F05	2-Sep-11					E1116 0312100101865 [redacted]	9/2/2011	Fuel pump replacement	This vehicle had long block replacement.	closed		Misdiagnosis
75	REMOVED UPPER & LOWER INTAKES ABD FOUND HIGH PRESSURE FUEL PUMP CRACKED. REPLACED HIGH PRESSURE FUEL PUMP, SUPPLY AND RETURN LINES. REINSTALLED THE UPPER AND LOWER INTAKES. BLED FUEL SYSTEM. VEHICLE EVALUATED COOLANT FOUND IT TO BE GOOD. REFILLED BOTH SYS	814	CUSTOMER STATES VEHICLE WONT START TOWED IN	144112	S07	USA	V52	F7	F04	11-Aug-11					E1116 1310100081057 [redacted]	8/11/2011	Fuel pump replacement	Pump body cracked. 9/2 - pump received and returned to Bosch 10/17 - As expected, Bosch found corrosion on multiple internal components, includiing plunger spring seat and on VCV	closed		Fuel contamination
76	CHECKED FOR NO START VERIFIED CONCERN CHECK OASIS FOUND NOTHING CHECKED INERTIA SWITCH OK CK LOW FUEL PRES OK CK HI FUEL PUMP PRES CRANK 320PSI INJ ELECT TEST OK OIL LEVEL OK CK RELATIVE COMP OK IDS TEST P0301 0089 2291 0263 0269 R&R LFT SIDE END HEAT SHI	403	CONCENR FOR VEH QUIT DRIVING AND WILL NOT RESTART TECH CONT: PWR BALANCE TEST#1 MISSING CHECK WIRES TO #1 WITH ENG INJ IS BOUNDING IN ITS SEAT REMOVE 1 INJ INSPECT REPLACE #1	4B6198	S07	CAN	V52	F7	F04	11-Aug-11					E1116 2910100088325 [redacted]	8/11/2011	Fuel pump replacement	From CQIS, #1 injector was also loose on this engine.	Open		Not returned

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
77	ROM LOW TO NOT LOW.REMOVE PRIMARY FILTER HOUS ING CK.O RING,BLED AIR FROM FUEL SYST.CRANK E NG.,ELECT PUMP GETS NOISY AGAIN.BLED FUEL SYS T AT SECONDARY FILTER CK.FOR AIR IN FUEL OK.C RANK ENG.OVER AGAIN FRP GOES TO 1200PSI THEN DROPS FUEL PUMP IS NOSEY A	940	CUSTOMER STATES ENGINE STARTED KNOCKING //ENG.KNOCKIN DIED WILL NOT START PERF.EEC DI AG P0087,P2A00,P164A,PPT M DATALOGGER TST FUE L RAIL PRESS.@0PSI,LOW PRESS.SWITCH TOGGLES F	152521	E72	USA	V52	F7	F04	11-Aug-11					E1116 2805100031611 [redacted]	8/11/2011	Fuel pump replacement	Entire fuel system replaced. Per CQIS, no sign of contamination. No sign that the corrosion guide was used either!	Open		Not returned
78																	Fuel pump replacement	Failed at KTP, sent to Bosch for analysis 9/19 - initial report received, stating pump appears to have run dry. Narendra and I had examined parts at Bosch FH and that appeared to be the case. KTP studying how to eliminate starting attempts where priming has failed.	Open		Started without fuel (run dry)
79																	Fuel pump replacement	Failed at KTP, sent to Bosch for analysis 9/19 - initial report received, stating debris found as root cause. 9/28 - debris elemental analysis sent	closed		fuel contamination
80	VERIFIED CONCERN. PUSHED VEHICLE INTO STALL. VISUAL INSPECTION, PASS. CHECKED OIL LEVEL, PASS. RAN KOEO SELF TEST. FOUND CODES P0087 AND 2291. RAN OASIS AND PERFORMED PINPOINT TEST M1, DTCS P0087 AND 2291 PRESENT. M2, TURNED ON FUEL PUMP FROM IDS, LOW	713	ENGINE DIED WHILE DRIVING WENT INTO FAILSAFE WILL NOT START	152733	S07	USA	V52	F7	F04	26-Aug-11					E1116 2212100109496 [redacted]	8/26/2011	Fuel pump replacement	9/23/2011 - fuel pump changed, returned to Bosch. 9/30/2011 - PCV returned to Bosch 10/17 - Bosch found evidence of poor lubricity fuel, via overheated and siezed bearings. This failure mode has only just started to be seen.	closed		Poor lubricity fuel
81	12650DD 0.2 12650D45D 0.3 12650D81D 0.5 12650D6 0.5 9424A10 3.5 MT12650 1.0 NOTE:MTIME FOR HAVING TO MANUALLY RETRIEVE AND ENTER AS BUILT DATA INTO THE NEW PCM BECAUSE THE DATA COULD NOT BE LOADED FROM THE OLD PCM..... VEHICLE WAS BROUGHT BACK	817	INSPECT FOR ENGINE NOISE AND LOSS OF POWER UPON TAKEOFF	123071	S07	USA	V39	F7	F05	2-Sep-11					E1116 0312100101865 [redacted]	9/2/2011	Fuel pump replacement	Long block replaced earlier. Not known how this can lead to fuel pump replacement.	Open		Not returned
82	DIAGNOSIS PERFORM KOEO KOER FUEL PRESSURE AND DATALOGGER P0087 P2291 PERFORM FUEL DEBREE T EST FOUNDMETAL SHAVINGS IN FUEL SYSTEM REFER ENCED JOB AID NO RUST NOR WATER CONTAMINATION FOUND CONTACT HOT LINE ID 104791315 REPLACED HPP ALL 8 INJECTORS ANDBOTH	903	CHECK OUT PULL OVER SAFE LIGHT CAME ON AND EN GINEDIED WILL NOT RESTART VERIFIED CONCERN PERFORM H ARD START NO START	152571	S07	USA	V29	F7	F04	6-Sep-11					E1116 1611100093800 [redacted]	9/6/2011	Fuel pump replacement	Returned to Bosch 10/17 - Bosch found evidence of poor lubricity fuel. Photos show overheated pump shaft bearings. This is one of the first claims of this type	Closed		Poor lubricity fuel

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
83	VERIFED CONCERN RAN ADDED OIL DYE AND CONFIREMD THAT IT IS NOT AN OIL LEAK PERFORMED INSPECTION AND NOTED LARGE AMOUNT OF FUEL POOLING IN THE INTAKE MANIFOLD LEAKING DOWN TO BOTTOM OF ENGINE. RAN OASIS NO TSBS OR SSMS FOR THIS CONCERN. CONTACTED HOTLI	253	CHECK AND ADVISE VEHICLE IS LEAKING OIL AND OR FUEL	174026	S07	USA	V44	F7	F04	6-Sep-11					E1116 0909100067608 [redacted]	9/6/2011	Fuel pump replacement	12/8 - pump TNI @ Bosch	Closed		TNI
84	VERIFED CONCERN.FOUND NO CRANK NO START.PERFORMED VISUAL INSPECTION,OIL AND FUEL LEVEL OK. PERFORMED KOEO SELF TEST FOUND DTC P22981.PERFORMED PPT M. CHECKED FUEL QUALITY FROM DHCFM OK.REPLACED FPCV PER PPT RETEST STILL HAS NO START.REM OVED FVCM.FOUND SC	281	N12 CUSTOMER REPORTS THAT ENGINE STARTED MAKING A NOISE AND QUIT RUNNING	152014	S07	USA	V49	F7	F05	31-Aug-11					E1116 2107100047347 [redacted]	8/31/2011	Fuel pump replacement	Pump returned to Bosch 10/17 - pump failure attributed to poor lubricity fuel by Bosch. Fuel pump driveshaft bearing areas show signs of overheating	Closed		Poor lubricity fuel
85	VERIFY, EEC TEST, FOLLOW PC/ED PP7 M FOR P0087. PPT TEST STEP ON BLUE SHEET (FUEL FLOW DOES NOT STOP) LED TO REPL OF VOLUME CONTROL VALVE. CLEAR CODES, RETEST. P0087. FOLLOW PP7 M FOR P0087. BLUE SHEET (FUEL FLOW AND STOPS WHEN COMMANDED) LED TO REPL OF P	318	DIES WHILE DRIVING CHECK ENGINE LIGHT ON	123634	S07	USA	V52	F7	F04	19-Sep-11					E1116 0408100052986 [redacted]	9/19/2011	Fuel pump replacement	9/30/2011 - fuel pump and PCV returned to Bosch 12/8 - pump TNI @ Bosch	Open		TNI
86	HIGH PRESSURE FUEL PUMP FAILED, METAL THROUGHOUT THE ENTIRE FUEL SYSTEM FROM THE HIGH PRESSURE PUMP. PERFORMED SELF TEST, P0087, P0089, P2291, P2A00	CMDTCS IN MEMORY. VEHICLE CRANKS BUT WILL NOT START. FOLLOWED PINPOINT TEST M TO STEP M17. CONTACTED HOT	CUSTOMER STATES ENGINE MADE NOISE, ENGINE QUIT RUNNING ALSO THE REDUCED POWER LIGHT CAME ON	127414	S07	USA	V49	F7	F05	21-Sep-11					E1116 2608100061700 [redacted]	9/21/2011	Fuel pump replacement	9/30/2011 - PCV received but not returned. Pump not received, and AWS says pump failed.	Closed		Not returned
87	PERFORM FUEL SYSTEM CONTAMINATION DIAG MT RI PRES CONTROL VALV VOL CONTROL VALV HIGH PRES PUMP HIGH PRES PUMP OUTLET PORTS & HIGH PRES PUMPOVERFLOW VALV TO CHK FOR FUEL QUALITY NO CORROSION NO RUST FOUND TO CAUSE FAILURE MT DRAIN FUEL TANK & ONLY METAL	903	CHECK ENGINE LIGHT CAME ON DIED WHILE DRIVING PERFORM TEST FOR NO START RECEIVE CODE PA200 P0087 P2291 PERFORM PINPOINT TEST M2 MONITOR PIDS M3 DID NOT SEE METAL M15 CONNECT HOSE & TES	152444	E72	USA	V29	F7	F04	22-Sep-11					E1116 1406100037383 [redacted]	9/22/2011	Fuel pump replacement		Open		Not returned

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
88	SCAN P2291 P0087 PIN POINT TEST M TO M15 FUEL FLOW REPLACED FUEL PRESURE CONTROL SOLENIOD NO START CONTACT HOTLINE CK FUEL PRESSURE AND RE RUN M15 AND REMOVE PRESURE LINE SERV MANUAL NOT CLEAR ON LINE WHICH LINE TO REMOVE REPLACE IPC REGULATOR AT HP PUMP	936	CHECK ENGINE DIED WHILE DRIVING WONT RESTART	152689	S07	USA	V52	F7	F04	23-Sep-11					E1116 2604100024061 [redacted]	9/23/2011	Fuel pump replacement		Open		Not returned
89	NO START,CK CODES, P0087,CKLOW PRESSURE FUEL SYSTEM,OK REMOVED PRIME FUEL FILTER NO WHITE FLAKES,CK FOR DEBRIS,REMOVED UPPER LOWER INTAKE MANIFOLD,REMOVED VCV AND FOUND METAL CONTAMINATION,FUEL QUALITY GOOD,NO FLAKES,WAS TOLD TO REPLACE COMPLETE HIGHPRESS	256	CUST STATES CHECK ENGINE LIGHT IS ON ALL THE TIME WHILE DRIVING REDUCED POWER LIGHT CAME ON AND ENGINE DIED.	121586	E72	USA	V52	F7	F04	30-Sep-11					E1116 2204100023464 [redacted]	9/30/2011	Fuel pump replacement		Open		Not returned
90	DIAG. VERIFIED THE CONCERN NO RUN. RAN OASIS AND TSBS RAN CODES AND FOUND A P2291 ICP TO LOW WHILE CRANKING AND P2032. WENT IN AND MONITIORED THE PIDS WHILE CRANKING HAD 1200 PSI WHILE CRANKING WHICH IS LOW. WENT TO PINPOINT STEPS M1 M15 AND M15 LEAD	208	CUSTOMER STATES FUEL GUAGE SHOWS 1 4 TANK OF FUEL. VEHICLE IS OUT OF FUEL. REMOVE FUEL TANK AND FUEL LINES TO REMOVE METAL CONTAMINATION. REPLACED EGT SENSOR AFTER TEST DRIV	156593	S07	USA	V25	F7	F04	30-Sep-11					E1116 2207100047856 [redacted]	9/30/2011	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed.	Open		Need report
91	VERIFY CUSTOMER CONCERN. PERFORMED FUEL LEAK DIAG. FOUND FUEL LEAKING FROM HIGH PRESSURE FUEL PUMP WEAK HOLE. REMOVED UPPER & LOWER INTAKE MANIFOLD ASSY'S REMOVE COOLING FAN & VACUUM PUMP ASSY TO ACCESS HIGH PR ESSURE PUMP DRIVE GEAR. REM	734	E68 CUSTOMER STATES FUEL LEAKS	148400	S07	USA	V25	F7	F04	3-Oct-11					E1116 0510100077109 [redacted]	10/3/2011	Fuel pump replacement	Sounds like a front shaft seal leak…	Open		Not returned
92	RAN EEC TEST WITH PINPOINT M FOUND HIGH PRESS FUEL PUMP FAULTY NOT ENOUGH PRESS TO SPECS NECC TO REPLACE PUMP RETEST OK	205	CHECK LOSS OF POWER	121407	S07	USA	V52	F7	F04	3-Oct-11					E1116 2402100009233 [redacted]	10/3/2011	Fuel pump replacement		Open		Not returned

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
93	DA O INTERNO DE LA BOMBA DE ALTA PRESION DE COMBUSTIBLE PROVOCANDO PERDIDA DE BOMBA DE ALTA PRESION Y POTENCIA AL CIRCULAR Y OCASIONANDO LUZ DE CHECK ENGINE EN EL TABLERO CON EL CODIGO P088 Y P0087.REQ.REEMPLAZO DE BOMBA DE ALTA PRESION DE COMBUSTIBLE.RE	919	LUZ DE MOTOR Y MARCA POTENCIA REDUCIDA DE MOTOR	2M1331	E84	MEX	V29	F7	F04	4-Oct-11					E1116 1908100058425 [redacted]	10/4/2011	Fuel pump replacement		Open		Not returned
94	NO START DIAG NO ICP PRESSURE.PULLED DTC P2291.LOW FUEL PRESSURE CHKS 60PSI.HIGH FUEL PRESS ONLY 300PSI.AT TIMES ONLY 80 PSI.PERFORMED PP TST M.M16 DETERMINED NO FUEL FLOW.REPLACED VOLUME CONTROL VALVE AND PRESS CONTROL VALVE.VEH THEN STARTD AND RAN FOR	704	CHECK ENGINE LIGHT CAME ON WHILE DRIVING, VEHICLE LOST POWER THEN CUT OFF, NOW VEHICLE WILL CRANK BUT NOT START	121745	S07	USA	V52	F7	F04	4-Oct-11					E1116 2211100096389 [redacted]	10/4/2011	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. However, this pump had visible DEF crystals in the VCV pocket.	Closed		DEF contamination
95	WARRANTY. HOTLINE CONTACT ID#104831646. VERIFIED NO START CONCERN. PERFORMED EEC SELF TEST. Y P0087. PERFORMED PINPOINT TEST M. M1 P0087. M2 LOW PRESSURE FUEL PUMP COMMAND AND MONITER STATE CHANGED WHEN COMMANDED. M3 SUFFIENT CLEAN FUEL TEST PASSED.	936	D02 C S MESSAGE CENTER READ PULL OVER SAFELY AND SHUT OFF VEHICLE, NOW VEHICLE SPINS OVER NO START	152766	S07	USA	V52	F7	F04	5-Oct-11					E1116 3008100062702 [redacted]	10/5/2011	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. 12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel
96	VERIFY VEHICLE CRANKS BUT DOES NOT START, PERFORM SELF TEST, P0087,P062A,P2291,P242D. TAKE FUEL SAMPLE, FOUND METAL, PERFORM PINPOINT TEST M, M2 FUEL SYSTEM LOW SIDE OPERATING NORMALLY, M3 FUEL SAMPLE TEST METAL, M15 CHECK FUEL PRESSURE CONTROLE VALVE OP	845	C S CHECK ENGINE LIGHT ON	113304	S07	USA	V52	F7	F04	6-Oct-11					E1116 1205100028487 [redacted]	10/6/2011	Fuel pump replacement	12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
97	DA O INTERNO DE LA BOMBA DE ALTA PRESION DE COMBUSTIBLE PROVOCANDO PERDIDA DE LA BOMBA DE ALTA PRESION POTENCIA AL CIRCULAR Y OCASIONANDO LUZ DE CHECK ENGINE EN EL TABLERO CON EL CODIGO P088 Y P087.REPORTE BI2ES013	919	LUZ DE MOTOR Y MARCA POTENCIA REDUCIDA DE MOTOR	2M1331	E84	MEX	V29	F7	F04	6-Oct-11					E1116 1908100058425 [redacted]	10/6/2011	Fuel pump replacement		Open		Not returned
98	VERIFIED CONCERN, RAN SELF TEST AND GOT DTCS P0087 AND P2291, PERFORMED PPT M1 YES P0087 PRESENT, M2 MONITORED PIDS FOR CHANGE IN LP FUEL SW AND CHANGES TO NOT LOW WHEN PUMP IS TURNED ON, M3 FUEL CLEAN,M4 PERFORMED RELATIVE COMPRESSION AND ALL CYLIND	936	D42 C S WHILE DRIVING THE TRUCK WENT INTO REDUCED POWER MODE AND THEN DIED	152183	E72	USA	V52	F7	F04	14-Oct-11					E1116 2311090000816 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. 12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel
99	CHECK FOR FUEL LEAK, FOUND FUEL LINE, HIGH PRESURE LINE FROM RIGHT SIDE OF HP PUMP LEAKING AT INLET OF PUMP, RUN OASIS, CHECK FOR TSBS. FOUND LINE HAS ALREADY BEEN REPLACED ONCE REMOVE UPPER AND LOWER INTAKE, REMOVE FUEL LINE AND INSPECT FUEL LINE,LOOKS O	704	CUSTOMER STATES THE VEHICLE QUIT RUNNING , FUEL RUNNING OUT VEHICLE	121208	S07	USA	V25	F7	F04	14-Oct-11					E1116 1006100036039 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. The complaint was a fuel leak at the HP port			Need report
100	CONTACT 104787735 CHECKED FOR ENGINE NOISE AND NO POWER, PULLED CODES P0087,P008A,P2A00 PPT M1 YES,M2 NO,MA1 YES,MA2 YES,MAE NO,35PSI MA5 NO,MA6 NO,MA7 NO 1IN.VAC,MA8 YES. REPLACE FUEL PUMP AND RETESTED NO MORE CODE BUT HIGH PRESSURE FUEL PUMP VERY NOISEY	949	DIAG AND REPORT CUST STATES FOUND SHAVINGS OF METAL IN FRAMERAIL FILTER, PUMP IS NOISEY LONG CRANK BEFORE STARTING AT TIMES, CHECK ENGINE LIGHT ON LOW FUEL PRESSURE LIHGT CAME ON AND ENGINE POWER REDU	171095	S07	USA	V44	F7	F04	13-Oct-11					E1116 1205100028242 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. Says fuel pump only was replaced first 12/8 - pump TNI @ Bosch	Open		TNI
101	TECH INSPECTED, FOUND CODES P0087, P0093, P2456, P0884, CHECKED FUEL RAIL PRESSURE, HOTLINE CHECK FOR METAL DEBRIS AT H P PUMP, RECOMMEND REPLACE FUEL SYSTEM TECH REPLACED H P FUEL PUMP, ALL INJECTORS, FUEL COOLER, ALL FUEL LINES, AND FLUSHED FUEL TANK,	337	C STATES VEHICLE WILL NOT START	152054	S07	USA	V52	F7	F04	13-Oct-11					E1116 1105100027554 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. 12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
102	METAL DEBRIS ALL THRU ICK FUEL SAMPLE FOR CONTAMINATIONS OR DEF FLUID IN FUEL NONE FOUND CK PRIMARY FUEL FILTER METALDEBRIS IN FILTER HOTLINE SAID TO REPLACE HIGH PRESSURE FUEL SYSTEM AND CLEAN FUEL TANK R R FUEL TANK AND CLEANED PERFORM PROCEDUREC FUE	903	TOW IN LOW OIL LITE CAME ON ENG DIED NO START VERIFIED CONCERN VEHICLE WAS TOWED IN AN D WOULD NOT START RAN DIESEL DIAG RET DTC P2291 REMOVED VCV SOLONOID FOUND	152650	S07	USA	V52	F7	F04	12-Oct-11					E1116 1605110167093 [redacted]	########	Fuel pump replacement	12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel
103	DIESEL DIAG AND FOUND CODE P0087. NESS TO RUN PINPOINT TEST M AND FOUND FAILED LOW PRESSURE FUEL PUMP. NESS TO R&R LOW PRESSURE FUEL PUMP AND TEST DRIVE AND FOUND THE HIGH PRESSURE FUEL PUMP WHINING. PERFORM THE HIGH PRESSURE FUEL TEST AND FOUND THE P	770	C S THAT THE SES LIGHT IS ON AND THE MESSAGE CENTER SAYS LOW FUEL PRESSURE.	121025	S07	USA	V29	F7	F04	19-Oct-11					E1116 0301110111303 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Low pressure fuel pump was first replaced. 12/8 - pump TNI @ Bosch	Closed		TNI
104	DIAG P0087 P2291 PPT M1 YES P0087 PRESENT M2 YES PID CHANGES M3 NO FUEL GOOD M4 YES CYL OK M11 YES FRP PRESSURE AND VOLTA WITHIN RANGE M12 YES STEADY STREAM OF FUEL M15 NO PIDS AFTER CRACKING LINE LOOSE UND EXTENSIVE METAL SHAVINGS PRESENT HOTLINE SAIDE	903	C S DIED WHILE DRIVING WILL CRANK NO START....SEE EARL DUE TO METAL CONTAMINATION PUMP SENDER FUEL LINE	152442	S07	USA	V52	F7	F04	19-Oct-11					E1116 0203100010354 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. 12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	Closed		Poor lubricity fuel
105	P0093 P2291 VIEW FRP WHILE CRANKING IS 500 PSI PERFORM PPT M REMOVED LEFT FENDER WHELL PRI MED FUELSYSTEM NO START PPT M1 YES M2 YES M3 NO M4 YES M1 1 YES M12 NO CONCERN M15 NO CONTACT TECH HOTLINE ADVISED TO RERUN PPT M DID AN D SAME RESULTS RECONTACT	903	CHECK OUT DIED WHILE DRIVING VERIFIED CONCERN PERFORM DIESEL ENGINE HARD S TART NO START DIAGNOSIS KOEO KOER DATALOGGER DELAYED ENTRY DUE TO DIFFICULT CONCERN	152567	S07	USA	V52	F7	F04	20-Oct-11					E1116 1310100081017 [redacted]	########	Fuel pump replacement	10/21/2011 - returned to Bosch for analysis. Entire fuel system changed. 12/8 - Bosch found internal damage, most likely due to poor quality (low lubricity) fuel	closed		Poor lubricity fuel
106	INOP CK FOR NO START, TRUCK WOULD NOT START, CK FOR CODES P2291. MONITOR FRP ONLY BUILDING 60 PSI. CK PER PIN POINT TEST M17. CK FOR DEBREE IN FUEL LINE. REMOVE PRIMARY FUEL FILTER AND DRY OUT PER TSB 11 10 10. NO CORROSION OR DEBRIS IN FUEL. FUEL WAS CLE	770	CHECK ENGINE DIED WHILE DRIVING (55 MPH) NOW ONLY SPINS.	121449	S07	USA	V44	F7	F04	21-Oct-11					E1116 2306100041500 [redacted]	########	Fuel pump replacement		Open		Not returned

	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	**TECH COMMENTS 1**	**TECH COMMENTS 2**	**CUSTOMER COMMENTS**	**AREA CODE**	**COUNTRY CODE**	**SALES DEALER CODE**	**TRANSACTION CODE**	**COUNTRY SOLD**	**QRT CODE**	**VFG CODE**	**AWS VEHICLE LINE CODE**	**VRT CODE**	**TIS FLAG**	**CLAIM BINNED FUNCTION**	**Engine Serial Number**	**Date added**	**FIE error state**	**Investigation status**	**Open / Closed**	**Cyl #**	**Root Cause**
107	RUN TESTS KOEO PASS, KOEC P2291,P0087,P2A00. PINPNT TEST LEADS TO M1 M4 GO TO M11. FOR NO STRT VOLT @ FRP .32V, FRP A 372 PSI, ERRASED CODES P2291. PNPNT M 15. PRES @HSNG 90LB PRES @ INJ PMP 70PSI. CONTACTED HOTLINE. RE RUN TESTING. REPLACED FRP SENSOR. R	308	CUSTOMER STATES THE VEHICLE DIED AND WONT START ALL PCM BULK HARNESS, WASHER FLUID TANK, SILENCE	156431	S07	USA	V52	F7	F04	24-Oct-11					E1116 1608100057510 [redacted]	########	Fuel pump replacement	12/8 - Bosch found internal corrosion on a variety of surfaces, including the cam lobe and inlet valves.	closed		Fuel contamination
108	EEC SYSTEM DIAGNOSIS QUICK TEST M TIME TO REMOVE ALL GLOW PLUGS DUE TOHYDRO LOCK PERFORM RELATIVE COMPRESSION MANUAL COMPRESSION TEST REMOVE AND INSTALLPRESSURE CONTROL VALVE TO FIND DEBRIS IN FUEL SYSTEM REPLACE HIGH PRESSURE FUEL PUMP REPLACE ALL HIGH P	337	TRUCK CRANKS WILL NOT START	123267	S07	USA	V52	F7	F04	25-Oct-11					E1116 3105100032015 [redacted]	########	Fuel pump replacement		Open		Not returned
109	DIESEL DIAG CODES P0090 FUEL PRESSURE REGULATOR P0193 FRP SENSOR HIGH INPUT P2291 ICP TOO LOW ENGINE CRANKING WITH KOEO	MONITOR THE FOLLOWING PID VALUES FRPA 31900 PSI FRPACMD 5750 70PSI FRPDSD 5750 70PSI FRPCV 07 PVCV 32 82 1 GO TO PINPOINT TEST MEFOR C	CUSTOMER STATES WHILE DRIVING OIL PRESSURE LITE AND CK ENGINE LITE CAME ON AND VEHICLE LOSS POWER TO 50MPH,ALMOST STALLED.THEN BATTERY LITE CAME ON AND VEHICLE WENT DEAD	127420	S07	USA	V52	F7	F04	8-Aug-11					E1116 1803100013068 [redacted]		Fuel pump replacement	9/23 - fuel pump returned to Bosch 10/17 - Bosch found corrosion inside fuel pump	Closed		Fuel contamination
110	VERIFY CONCERN PERFORM EEC TEST DTCS P0087 P2291 P228E P228F P1140 PRESENT GO TO PPT M1 Y M2 Y M3 YES EXCESSIVE AMOUNT OF WATER IN FUEL CONTACT HOTLINE REMOVED VCV SOLENOID AND INSPECT FOUND RUST AND METAL PARTICLES	PRESENT REMOVE FUEL TANK AND INSPECT FOUND WATER GELLED IN BOTTOM OF TANK REMOVE SAMPLE AND TEST FOUND UREA PRESENT REPLACE HPFP ALL 8 INJECTORS ALL HIGH PRESSURE FUEL LINES BOTH	C S VECH LOST POWER WHEN DRIVING, AFTER SHUT DOWN VECH WILL CRANK BUT WILL NOT START.														Fuel pump replacement	We received the pump but it was not returned to Bosch b/c DEF had been identified as root cause. Ford split cost w/customer under some type of customer loyalty program	Closed		DEF contamination