1. Scope
TBD
2. Referenced Documents
TBD
3. Terminology
TBD
4. Summary of Test Method
TBD
5. Significance of Use
TBD
6. Apparatus (General Description)

6.1 The test engine is a Ford, spark ignition, four stroke, 4-cylinder gasoline turbocharged direct injection (GTDI) engine with a displacement of 2.0 L. Features of this engine include variable camshaft timing, dual overhead camshafts driven by a timing chain, four valves per cylinder and electronic direct fuel injection. It is based on the Ford Motor Co. 2012 Explorer engine with a displacement of 2.0 L.
6.2 Configure the test stand to accept a Ford 2.0L GTDI engine. All special equipment necessary for conducting this test is listed herein.
6.3 Use the appropriate air conditioning apparatus to control the temperature, pressure, and humidity of the Inlet air to meet the requirements in Table 4.
6.4 Use an appropriate fuel supply system (Figure 1**Error! Reference source not found.**).

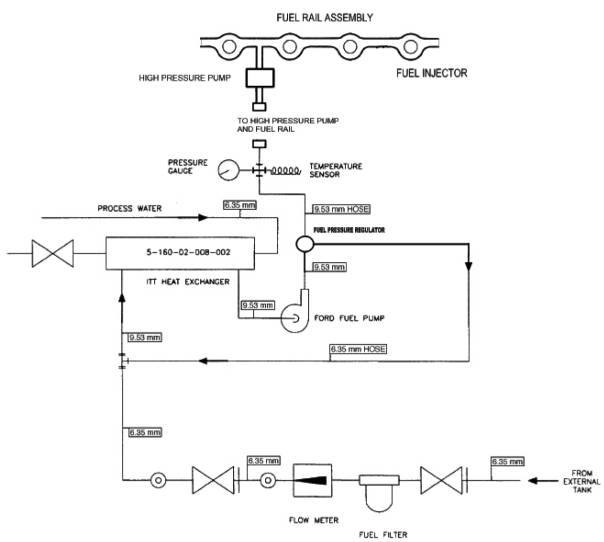


Figure 1. Fuel Supply System

6.5 The control and data acquisition system shall meet the requirements listed in Annex A3.
6.6 Coolant Conditioning Equipment
6.7 **Engine cooling system** – Use coolant inlet and outlet from the supplier shown in A9.2. Plumb the external coolant system as shown in Figures A2.2 and A2.3. Use coolant flow meter with and accuracy of +1%.
6.8 **Oil System Components**—All oil system components in the engine are production configuration with the exception of the modified oil pan, shown in figure A2
6.9 Oil Temperature Control – Oil temperature is controlled using the production oil cooler. Process water is run through water side of the oil cooler. Oil temperature thermocouples locations are shown in figure A2.15 and A2.16
6.10
6.11 Dynamometer

6.12
6.13 Instrumentation
6.14 The control and data acquisition system shall meet the requirements listed in Annex 3.

6.15 Combustion Analysis Equipment

7. Apparatus (The Test Engine)

7.1 LSPI Test Engine—The test engine parts are available from the Ford Motor Co. (A1.1, use parts list .xls). A detailed listing of all parts is given in Annex (A1, use parts list .xl).
7.2 Required New Engine Parts—.
7.3 Reusable Engine Parts—.
7.4 Specially Fabricated Engine Parts—The following subsections detail the specially fabricated engine parts required in this test method:
7.4.1 Inlet Air System (see Fig. A2.12) Inlet air system can be fabricated but must use the stock 2012 Explorer air cleaner assembly (A1.6) and MAF sensor.
7.4.2 Oil Pan – Modify the stock 2012 Explorer oil pan to add an oil drain plug in the location shown in Fig.. A2.1..
.
7.4.3 Cylinder Head – A modified cylinder head must be used that allows for installation of in cylinder pressure sensors. This assembly can be purchased from the supplier listed in A9.2.
7.4.4 Pressure Sensor Tubes – 3/8" OD steel tubing must be installed into the pressure sensor sleeves in the cylinder head to allow for installation of the in cylinder pressure sensors.
7.4.5 Valve Cover – The stock valve cover must be modified to allow the pressure sensor tubes to protrude through the cover. The location where the tubes protrude through the cover must be sealed to prevent oil from leaking through the penetrations.
7.4.6 Coolant Supply Manifold – Purchased from OHT
7.4.7 Coolant Return Manifold - Purchased from OHT
7.5 Special Engine Measurement and Assembly Equipment—Items routinely used in laboratory and workshop are not included. Use any special tools or equipment shown in the 2012 Explorer service manual for assembly. A list of these tools is shown in Annex A1.8. Complete any assembly instructions not detailed in Section 7 according to the instructions in the 2012 Explorer Service Manual.
7.5.1 Piston Ring Positioner—Use the piston ring positioner to locate the piston rings from the cylinder block deck surface by 38 mm. This allows the compression rings to be positioned in a consistent location in the cylinder bore for the ring gap measurement. Fabricate the positioner according to the details shown in Fig. A2.17.
7.5.2 Engine Service Tools—A complete list of special tools for the test engine is shown in Annex A1.8. The tools are available from a Ford dealership. These are designed to aid in performing several service items, in addition to the following specific service items that require special tools to perform the functions indicated (if not self-explanatory).
7.6 Engine Installation on the Test Stand—Functions that are to be performed in a specific manner or at a specific time in the assembly process are noted.
7.6.1 Mounting the Engine on the Test Stand—Mount the engine on the test stand so that the flywheel friction face is (0.0 ± 0.5)° from vertical. Three motor mounts are used (Quicksilver part# 6628-A) (X2.1.33) at the rear of the engine and mount? at the front of the engine attached to the front cover as shown in Figure A2.4 and Figure A2.5. Drawings of the mount brackets can be found in the Figure A2.6 and Figure A2.7. The engine must be at (0.0 ± 0.5)° role angle.
7.6.2 Flywheel: The flywheel bolts get lightly coated with Loctite 565 to prevent any oil from seeping out of the holes. Torque the flywheel to 108-115 Nm. The flywheel is obtained from the supplier in A9.2
7.6.3 Clutch and pressure plate - The clutch, pressure plate and spacer are obtained from the supplier in A9.2. Put the flat side on the clutch toward the engine. The spacer goes between the flywheel and pressure plate. Torque the pressure plate bolts to 25-33 Nm. Each clutch gets replaced every 6 runs.
7.6.4 Driveline: The driveline is greased every test. Driveline specifications:
Driveline Degree: 2 degrees
595 ± 13 mm installed length from flange to flange
1410 series flanges
2.75" pilot
3.75" bolt circle
3.50" x .083" stub and slip

7.7 Exhaust System and Gas Sampling Fittings:

7.7.1 A typical exhaust system, and fittings for backpressure probe, O2 sensors and thermocouple are illustrated in Figs. A2.8. Exhaust components should be constructed of either solid or bellows pipe/tubing. Other type flexible pipe is not acceptable.
7.7.2 The backpressure probe can be used until they become unserviceable. If the existing probes are not cracked, brittle, or deformed, clean the outer surface and clear all port holes. Check the probes for possible internal obstruction and reinstall the probes in the exhaust pipe. Stainless steel probes are generally serviceable for several tests; mild steel probes tend to become brittle after one test. Exhaust gas is noxious. (Warning—Any leaks in the connections to the sample probe will result in erroneous readings and incorrect air-fuel ratio adjustment.)
7.8 Fuel Management System:
7.8.1 Fuel Injectors:
(1) The fuel injectors.
(2) Inspect the O-rings to ensure they are in good condition and will not allow fuel leaks, replace if necessary. Install the fuel injectors into the fuel rail and into the cylinder head.
7.9 Powertrain Control Module: The engine uses a PCM provided by Ford Motor Company to run this test. The PCM contains a calibration developed for this test, use a PCM that contains calibration U502-HBBJ0-v1-7-VEP-371.VBF. The PCM module is available from the supplier listed in A9.2.
(1) The PCM power shall come from a battery (13.5 ± 1.5) V or a power supply that does not interrupt/interfere with proper PCM operation. Connect the PCM battery/power supply to the engine wire harness with an appropriate gage wire of the shortest practical length so as to maintain a dc voltage of (12 to 15) V and minimize PCM electrical noise problems. Ground the PCM ground wire to the engine. From the same ground point, run a minimum two gage wire back to the battery negative to prevent interruption/interference of the PCM operation. The power supply can also be used for the Lambda measuring devices.
7.10 Spark Plugs—Install new Motorcraft CYFS-12-Y2 spark plugs. Spark plugs come pre-gapped. Torque the spark plugs to 9 to 12 N·m. Do not use anti-seize compounds on spark plug threads.
7.11 Crankcase Ventilation System—The crankcase ventilation system is vent to the atmosphere and is not to be connected to the inlet.
7.12 Water to Air Turbocharger Intercooler - Use water to air intercooler (A9.5) capable of achieving the required air charge temperature and system pressure loss shown in Table ?. The intercooler accumulates significant amounts of blowby condensate during each test. The air side of the intercooler must be spray cleaned with Stoddard solvent, rinsed with hot water and left to air dry. Use commercial Aqua Safe descaler to clean the water side.
7.13 Intercooler Tubing: Fabricate the inlet air system with 51 mm ID stainless steel tubing from the turbocharger to the intercooler and 64 mm ID stainless steel tubing from the intercooler to the throttle body. The tubing length is not specified but should be the appropriate length to achieve the required air charge temperature and system pressure loss. Locate the MAPT sensor 305±25 mm from the intake surface of the throttle body and the intake air charge temperature thermocouple 1 inch downstream from the MAPT sensor. The post-intercooler turbo boost pressure measurement probe should be placed a minimum of 12 inches upstream from the MAPT sensor. The pre-intercooler turbo boost pressure measurement probe should be placed a minimum of 12 inches downstream from the turbocharger outlet. The measurements can be seen in Figure A2.13 and typical installation is shown in Figure A2.14.
7.14 External Hose Replacement—Inspect all external hoses used on the test stand and replace any hoses that have become unserviceable. Check for internal wall separations that could cause flow restrictions. Check all connections to ensure security.
7.15 Wiring Harness—There are two wiring harnesses used on the test stand, a dynamometer harness that connects to the stand power and PCM and an engine harness. Obtain the dynamometer wiring harness and engine wiring harness from the supplier listed in A9.2. Diagrams of these wire harnesses are shown in Figures A2.20 and A2.21 identifying connections.
7.16 Electronic Throttle Controller: Throttle is controlled using simulated accelerator pedal position signals. The dyno wiring harness is supplied with an Accelerator Pedal Position jumper cable with un-terminated pigtail leads. The test laboratory must connect two voltage command signals, Acc Pos Sensor 1 and Acc Pos Sensor 2, to the Accelerator Pedal Position jumper cable. The voltage control ranges for each signal are shown in Table 1.The wiring schematic and pin-out description for this connection is shown in Figure 2. Accelerator Position Wiring Schematic. The voltage signals must be run through a voltage isolator otherwise interference will occur between the lab DAC system and the engine ECU and throttle control will be erratic.

Table 1. Accelerator Position Sensor Control Ranges

Command Signal	Operating Range	Min Signal (Idle)	Max Signal (WOT)
Acc Pos Sensor 1	0-5.0 VDC	0.75 VDC (15%)	4.25 VDC (85%)
Acc Pos Sensor 2	0-2.5 VDC	0.375 VDC (15%)	2.125 VDC (85%)
Note: Acc Pos Senor 2 should always equal 50% of Acc Pos Sensor 1.			

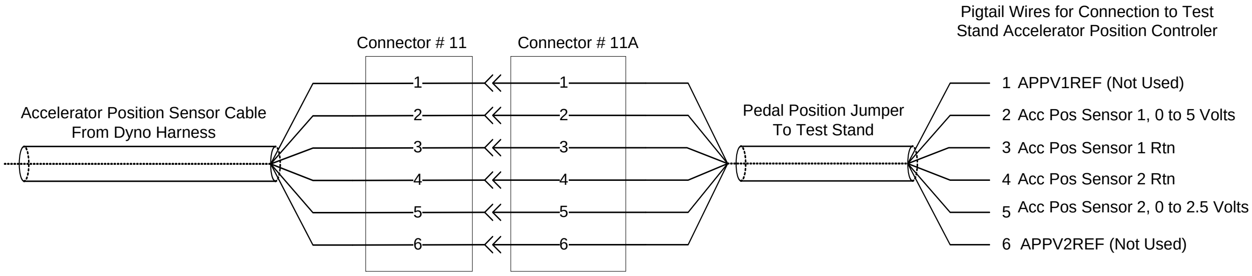


Figure 2. Accelerator Position Wiring Schematic

7.17 Water Pump, Water Pump Drive—Install the water pump and pulley, the crankshaft pulley, and tensioner according to the 2012 Explorer service manual. These are the only components needed to drive the water pump. All other production front end accessory drive components do not need to be installed. The engine cannot be used to drive any external engine accessory other than the water pump. Pull back tensioner and install water pump drive belt as shown in Fig. 6. Ensure that there is a minimum contact angle of 20° between the drive belt and the water pump pulley.

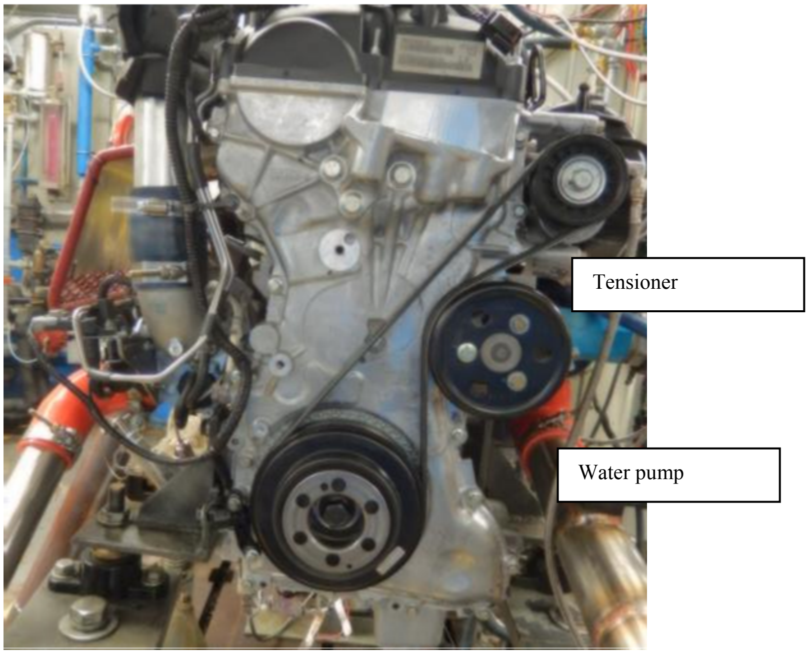


FIG. 6 Water Pump Drive Arrangement

7.18 Cylinder block oil separator - Install a dummy PCV valve (PCV valve with the internal components removed) in oil separator on the side of the engine block. This is the location to measure crankcase pressure.

8. Combustion Analysis Equipment

9. Engine Preparation

9.1 Engine Disassembly - See Ford 2.0L EcoBoost 2012 Explorer Shop Manual
9.2 Engine Measurements – Record the following engine measurements
9.2.1 Piston and bore measurements are shown in Table 2.
9.2.2 Record the piston to bore clearances at the top, 2nd and 3rd ring lands and the piston skirt. Use bore ladder shown in **Error! Reference source not found.** to determine bore diameter positions. Measure the bore in both the longitudinal and transverse directions. To determining the piston to bore clearance calculate the difference between the particular piston diameter and the middle bore diameter.
9.2.3 Record ring side clearances for the upper and lower compression rings (UCR, LCR). For determining ring side clearance take 4 measurements 90 degrees apart. Either check clearance with a thickness gauge or measuring the difference between the thickness of the ring and the height of the corresponding groove.
9.2.4 Measure cylinder head dimension shown in Table 3. For determining the valve stem to guide clearance measure the diameter of the valve stem 1.5 inches from the tip of the valve and the valve guide midway between the top and the bottom of the valve guide.

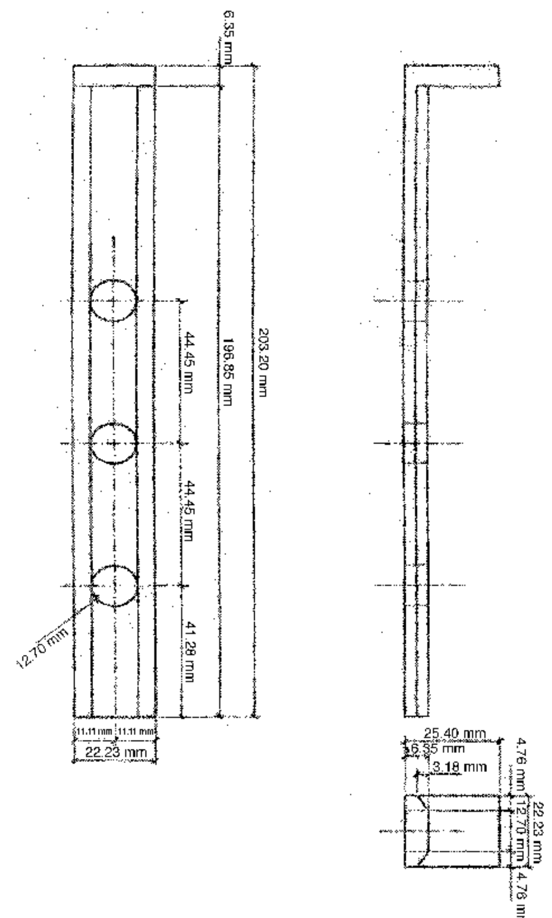


Figure 3. Bore Ladder

Table 2. Cylinder Bore and Piston Measurements

FLSPI Cylinder Bore and Piston Measurement Record

Block # / Run # : ____________ Date: ____________

Test Number: ____________ Tech: ____________

Cylinder Bore Measurements w/o Stress Plate

Finish Target: (9- 13 Ra) µin
Bore Gauge Set: 87.5 mm

Piston to Wall Clearance: (.0225 - .0475) mm
Cylinder Cross HatchTarget: (25°-35°) Deg

Cylinder bore diameter and surfiace finish

Cylinder Number	Location	Longitudinal Diameter (mm)	Transverse Diameter (mm)	Surface Finish (µin)
	Top			
1	Middle			
	Bottom			
	Average			
	Top			
2	Middle			
	Bottom			
	Average			
	Top			
3	Middle			
	Bottom			
	Average			
	Top			
4	Middle			
	Bottom			
	Average			

Use bore ladder

Piston to Bore Clearance

Cylinder Number	Location	Piston Diameter		Piston Clearance	
		Longitudinal (mm)	Transverse (mm)	Longitudinal (mm)	Transverse (mm)
	Top land				
1	2nd land				
	3rd land				
	Skirt				
	Top land				
2	2nd land				
	3rd land				
	Skirt				
	Top land				
3	2nd land				
	3rd land				
	Skirt				
	Top land				
4	2nd land				
	3rd land				
	Skirt				

Top land= ring land above upper compression ring
2nd land= ring land between upper and lower compression rings
3rd land= ring land between lower compression and oil rings
Skirt= 13-15 mm up from the bottom of the piston skirt

Ring Gap

Cylinder Number	Top Ring	Second Ring
Gap 1		
Gap 2		
Gap 3		
Gap 4		

Cross Hatch Measurement

Cylinder Number	Meas #1 (degrees)	Meas #2 (degrees)	AVG Cross Hatch (degrees)
1			
2			
3			
4			

Ring side clearance

Cylinder Number	Location	Clearance 0 (mm)	90 (mm)	Clearance 180 (mm)	270 (mm)	Average (mm)
	UCR					
1	LCR					
	UCR					
2	LCR					
	UCR					
3	LCR					
	UCR					
4	LCR					

Ring thickenss and groove height for side clearance calculation

Cylinder Number	Location	0 (mm)	90 (mm)	180 (mm)	270 (mm)
	UCR Thickness				
1	LCR Thickness				
	UCR Groove height				
	LCR Groove height				
	UCR Thickness				
2	LCR Thickness				
	UCR Groove height				
	LCR Groove height				
	UCR Thickness				
3	LCR Thickness				
	UCR Groove height				
	LCR Groove height				
	UCR Thickness				
4	LCR Thickness				
	UCR Groove height				
	LCR Groove height				

Mearsure ring side clearance either with a thickness guage
between the ring and ring groove with the ring installed
or by calculating the difference between the thickness
of the ring and the height of the ring groove with the ring uninstalled
Take 4 measurements 90 degrees apart

Table 3. Head Measurements

FLSPI HEAD DATA SHEET

HEAD # ____________ Engine # ____________

HEAD RUN # ____________ Test # ____________

DATE: ____________ Instrument Cntrl # (Valve Guide) ____________

Instrument Cntrl # (Valve Stem) ____________

	Valve Guide Diameter (5.51) mm	Valve Stem Diameter (5.5) mm	Clearance (0.03-0.07) mm
1A Intake			0
1B Intake			0
2A Intake			0
2B Intake			0
3A Intake			0
3B Intake			0
4A Intake			0
4B Intake			0

	Valve Guide Diameter (5.51) mm	Valve Stem Diameter (5.5) mm	Clearance (0.03-0.07) mm
1A Exhaust			0
1B Exhaust			0
2A Exhaust			0
2B Exhaust			0
3A Exhaust			0
3B Exhaust			0
4A Exhaust			0
4B Exhaust			0

Instrument Cntrl # (Length) ____________ Instrument Cntrl # (Tension) ____________

	SPRING FREE LENGTH (47mm)	SPRING TENSION (@28.5 mm)
1A Intake		
1B Intake		
2A Intake		
2B Intake		
3A Intake		
3B Intake		
4A Intake		
4B Intake		

	SPRING FREE LENGTH (47mm)	SPRING TENSION (@28.5 mm)
1A Exhaust		
1B Exhaust		
2A Exhaust		
2B Exhaust		
3A Exhaust		
3B Exhaust		
4A Exhaust		
4B Exhaust		

Instrument Cntrl # (Lash) ____________

Intake Valve Lash Measurement (.19 - .31) mm	
1F	
1R	
2F	
2R	
3F	
3R	
4F	
4R	

Exhaust Valve Lash Measurement (.30 - .42) mm	
1F	
1R	
2F	
2R	
3F	
3R	
4F	
4R	

Head Flatness: ____________ Initials: ____________

9.2.5 Compression Ratio – Measure compression ratio using WhistP/N ###

9.3 Engine Assembly – See Ford 2.0L EcoBoost 2012 Explorer Shop Manual

9.4 Engine Installation on Test Stand
9.5 Pressure Sensor Installation
9.6 New Engine Break In - Once a new engine has been installed on the test stand, perform the break-in procedure shown in Table 4. LSPI Break-In Procedure**Error! Reference source not found.**, using oil TMC 220.

Table 4. LSPI Break-In Procedure

Step	Speed (RPM)	Load (N-m)	Time per stage (Hr:Min)	Total Time (Hr:Min)
Charge engine with 4200 grams of new oil and new oil filter				
1	Idle	0	0:30	0:30
Oil Flush 1 -Shut engine down and drain used oil and remove oil filter. Allow oil to drain for 20 minutes. Install new oil filter and add 4200 grams of new oil.				
Start engine and let idle for 5 minutes				
2	1500	38	0:30	1:00
3	2000	72	0:30	1:30
4	2500	111	0:30	2:00
5	3000	135	0:30	2:30
6	3000	150	3:15	5:45
7	2000	72	0:15	6:00
8	3250	155	0:15	6:15
9	3500	155	0:15	6:30
10	3750	155	0:15	6:45
11	4000	155	1:15	8:00
Bring engine to idle for 5 minutes then shut down				
Oil Flush 2- Drain used oil and remove oil filter. Allow oil to drain for 20 minutes. Install new oil filter and add 4200 grams of new oil.				
Run one full test per section 12.3 for additional break in. After test is complete drain the oil, remove the oil filter, and proceed to section 12.1.				

- The controlled parameters during break in are listed in Table 5. All other controls are left wide open/free flowing. The engine does not produce enough heat in the early steps to reach all target temperatures. All controlled parameters are expected to be on target at the beginning of Step 4.

Table 5. Sequence CW Break-in Controlled Parameters

Break In Controlled Parameters	
Coolant Out Temp.	85 degC
Oil Gallery Temp.	100 degC
Inlet Air Pressure	0.05kPa
Air Charge Temp.	37 deg C
Inlet Air Temp.	30 degC

12. Calibration
13. Test Procedure

13.1 Oil Flush Procedure – For each new test, perform two oil flushes using test oil as detailed below.

1. Charge engine with 4200 grams of new oil and install a new oil filter.
2. Warm Up - Start engine and operate at Idle (900 rpm) for two minutes.
3. Ramp to 2000RPM and 70 N-m within two minutes. Control to test condition temperatures listed in Table 6. Maintain conditions for 15 minutes (including ramp time).
4. Ramp to idle within two minutes. Hold at idle conditions for two minutes (including ramp time).
5. Shut down engine.
6. Drain engine oil for 15 minutes.
7. Repeat for second flush.

Table 6. Test Temperature Conditions

Controlled Parameter	Set Point	Units
Coolant Out Temperature	95	degC
Oil Gallery Temperature	95	degC
Air Charge Temperature	43	degC
Inlet Air Temperature	30	degC

13.2 Test Start/Oil Seasoning Procedure:

1. Charge engine with 4200 grams of test oil and install new oil filter.
2. Warm Up - Start engine and operate at Idle (900 rpm) for two minutes
3. Ramp to 2000RPM and 100 Nm in 60 seconds. Control to test condition temperatures listed in Table 6. Run at these conditions for 15 minutes.
4. Ramp to 1750RPM and 269 Nm in 60 seconds.
5. Hold at 1750RPM, 269 Nm and control to test condition temperatures for 60 minutes.
6. Ramp to cool down conditions shown in Table 7**Error! Reference source not found.**. Maintain conditions for 15 minutes (including ramp times).

Table 7. Cool Down Conditions

Controlled Parameter	Set Point	Units	Ramp times (min)
Engine Speed	2000	RPM	1
Engine Load	50	Nm	1
Coolant Out Temp	45	degC	15
Oil Gallery	45	degC	15
Inlet Air Temp	30	degC	N/A
Air Charge	30	degC	N/A

7. Ramp to idle and hold for 2 minutes.
8. Shut down engine for a minimum of 10 minutes. Take oil dip and inspect engine and stand.
9. Restart Engine to Start Cycle 1

13.3 Test Cycle – The following test cycle procedure is conducted four times for one complete test.

1. Warm Up - Start engine and operate at Idle (900 rpm) for two minutes.
2. Ramp to 2000RPM and 100 Nm in 60 seconds. Control to test condition temperatures listed in Table 6. Run at these conditions for 15 minutes.
3. Ramp to test conditions listed in Table 8.

Table 8. Test Conditions

Test Conditions			
Controlled Parameter	**Set Point**	**Units**	**Ramp times (min)**
Speed	1750 ±15	RPM	1
Load	269±2	Nm	1
Coolant Out Temperature	95±0.5	degC	< 20

Oil Gallery Temperature	95±0.5	degC	< 20
Air Charge Temperature	43±0.5	degC	< 20
Inlet Air Temperature	30±0.5	degC	< 20
Fuel Temperature	30	degC	NA

4. Hold until the following conditions are true:
   - Coolant Out Temp: 95 ± 0.5 degC
   - Oil Gallery Temp: 95 ± 0.5 degC
   - Inlet Air Temp: 30 ± 0.5 degC
   - Air Charge Temp: 43 ± 0.5 degC

   All the above temperatures should be met within a maximum of 20 minutes. If not, perform soft shut down and fix any issue preventing the test conditions from being met before trying again.
5. Once test conditions are met, allow engine to stabilize for five minutes.
6. After five minute stabilization, begin recording combustion analysis data using AVL Indicom for 175,000 combustion cycles.
7. Ramp to cool down conditions shown in Table 7. Maintain conditions for 15 minutes (including ramp times).
8. Ramp to idle and hold for 2 minutes.
9. Shut down for a minimum of 10 minutes. Take oil dip and inspect engine and stand

13.4 End of Test. Make sure everything is turned off:

- Fuel off
- Coolant pressure off
- Chilled water off

13.5 Record the operation and canbus data listed in Table 9. Recorded Test Points at a rate of 1/sec.

Table 9. Recorded Test Points

	TEST POINT	UNITS
Controlled	Engine Speed	rpm
	Engine Load	Nm
	Coolant Out Temp	deg C
	Oil Gallery Temp	deg C
	Air Charge Temp	deg C
	Inlet Air Temp	deg C
	Inlet Air Press	kPaG
	Exhaust Press	kPaA
	Fuel Temp	deg C
	Humidity	g/kg
Monitored	Fuel Flow	kg/hr
	Inlet Manifold Press	kPaA
	Barometric Press	kPaA
	Oil Pump Pressure	kPaG
	Oil Head Pressure	kPaG
	Oil Sump Temp	deg C
	Exhaust temp	deg C
	Crank Case Pressure	kPaG
	Fuel Pressure	kPaG
	Power	kW
PCM CAN BUS Channels	Ignition Timing Advance for #1 Cylinder	Deg
	Absolute Throttle Position	%
	Engine Coolant Temperature	Deg C
	Inlet Air Temperature	Deg C
	Equivalence Ratio (Lambda)	unitless
	Absolute Load Value	%
	Intake Manifold Absolute Pressure	kPa
	Fuel Rail Pressure	kPa
	Accelerator Pedal Position	%
	Boost Absolute Pressure - Raw Value	kPa
	Turbocharger Wastegate Duty Cycle	%
	Actual Intake (A) Camshaft Position	Deg
	Actual Exhaust (B) Camshaft Position	Deg
	Intake (A) Camshaft Position Actuator Duty Cycle	%
	Exhaust (B) Camshaft Position Actuator Duty Cycle	%
	Charge Air Cooler Temperature	Deg C
	Cylinder 1 Knock/Combustion Performance Counter	Count
	Cylinder 2 Knock/Combustion Performance Counter	Count
	Cylinder 3 Knock/Combustion Performance Counter	Count
	Cylinder 4 Knock/Combustion Performance Counter	Count

13.6 At the end of each 175,000 cycle run, report the following data from the AVL Indicom combustion analysis software for each engine cycle.

- PMAX
- CA02
- PMAXV
- PMINV
- KP_INT

This data will be used to determine the number of LSPI events for each test run according to the method described in section 13.

Appendix A. Determination of Test Results

Steps for calculating LSPI triggers adjustment for distribution skew and kurtosis:

I. Remove Invalid Cycles

Prior to performing the PP and MFB2 LSPI calculations described in this document, remove all invalid combustion cycles from both the PP and MFB2 data set. Use the following criteria to identify invalid cycles.

1. Remove all cycles with a MFB2 < -30 degrees
2. Remove all cycles with a PP < 20 bar.

Remove the entire cycle, including PP and MFB2 values, for any cycle that meets the conditions given above. These cycles are considered invalid and are not counted as LSPI cycles.

II. Remove PP LSPI cycles – (Individually for each cylinder)

1. Remove obvious outliers. The mathematical method of estimating quantiles decreases in accuracy the further from normality so obvious outliers should be eliminated prior to applying the method.
   a. Remove PP > 90 (I think we all agree that likely anything over 90 is a LSPI)
2. Determine the following statistics on the remaining results. I am assuming that there are built in functions for each of these. If not, I can provide them but we may want to reconsider this approach because the follow steps become increasing more complicated.
   a. Median
   b. Standard deviation (s)
   c. Skew (S)
   d. Kurtosis (K)
3. Determine the number of standard deviations for our distributions subject to skew and kurtosis corresponding to the 5 that is appropriate for a valid normal distribution.
   a. Simultaneously solve for *B*, *C* and *D* in the following three equations (where *S* and *K* are Skew and Kurtosis, respectively, from Step 2):

$$1 = B^2 + 2C^2 + 6BD + 15D^2$$

$$S = 8C^3 + 6B^2C + 72BCD + 270CD^2$$

$$K = 3B^4 + 60B^2C^2 + 60C^4 + 60B^3D + 936BC^2D + 630B^2D^2 + 4500C^2D^2 + 3780BD^3 + 10395D^4 - 3$$

Where S = Skew and K = Kurtosis.

   b. Then calculate *F*, an estimate of the quantile corresponding to *Z* = 5.

$$F = -C + BZ + CZ^2 + DZ^3$$

$$or$$

$$F = -C + B(5) + C(5^2) + D(5^3)$$

F will generally be on the order of 5 to 10 on the first iteration and 5 to 7 on the last iteration.

4. Those cycles with PP > Median +*F* s (where s is the standard deviation) are outliers (LSPI) and should be omitted.
5. If no outliers are found in Step 2, count the LSPI and the process is complete, else return to Step 2. The total number of outliers is from Steps 1a and 4.

III. Remove MFB02 LSPI Cycles – (individually for each cylinder)

1. Remove obvious outliers. The mathematical method of estimating quantiles decreases in accuracy the further from normality so obvious outliers should be eliminated prior to applying the method.
    a. Remove MFB02 < 0 (I think we all agree that likely anything under 0 is a LSPI)
2. Determine the following statistics on the remaining results. I am assuming that there are built in functions for each of these. If not, I can provide them but we may want to reconsider this approach because the follow steps become increasing more complicated.
    a. Median
    b. Standard deviation (s)
    c. Skew (S)
    d. Kurtosis (K)
3. Determine the number of standard deviations for our distributions subject to skew and kurtosis corresponding to the -5 that is appropriate for a valid normal distribution.
    a. Simultaneously solve for *B*, *C* and *D* in the following three equations (where *S* and *K* are Skew and Kurtosis, respectively, from Step 2):

$$1 = B^2 + 2C^2 + 6BD + 15D^2$$

$$S = 8C^3 + 6B^2C + 72BCD + 270CD^2$$

$$K = 3B^4 + 60B^2C^2 + 60C^4 + 60B^3D + 936BC^2D + 630B^2D^2 + 4500C^2D^2 + 3780BD^3 + 10395D^4 - 3$$

Where S = Skew and K = Kurtosis.

    b. Then calculate *F*, an estimate of the quantile corresponding to *Z* = -5.

$$F = -C + BZ + CZ^2 + DZ^3$$

$$or$$

$$F = -C + B(-5) + C(-5)^2 + D(-5)^3$$

F will generally be on the order of -4 to -10 on the first iteration and -4 to -7 on the last iteration.

4. Those cycles with MFB02 < Median +*F* s (where s is the standard deviation) are outliers (LSPI) and should be omitted.
5. If no outliers are found in step 2, count the LSPI and the process is complete, else return to Step 2. The total number of outliers is from Steps 1a and 4.

IV. Report LSPI Cycles

Report the following data for each cylinder

1. Total number of combined LSPI cycles (containing both a PP and MFB2 LSPI trigger)
2. Total number of LSPI cycles containing only a PP trigger
3. Total number of LSPI cycles containing only a MFB2 trigger
4. Number of Invalid Cycles
5. Skew, Kurtosis, and F values for each iteration of the PP and MFB2 analysis

Appendix B. PCM CANBUS Parameter IDs

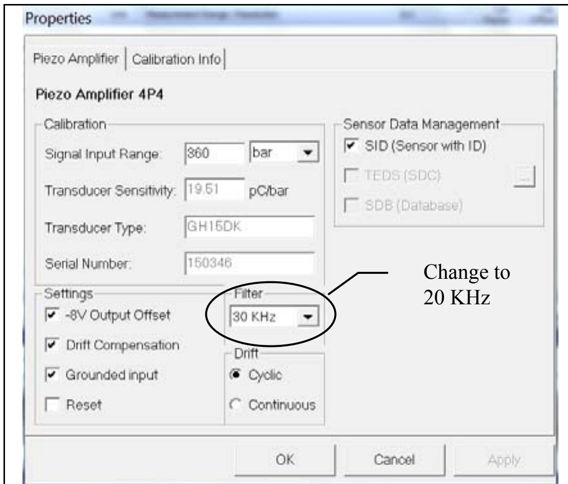
B.1. CAN Bus Data –Set up the data acquisition software to record the following Parameter IDs from the engine's PCM:

Table 10 PCM CANBUS Parameter IDs

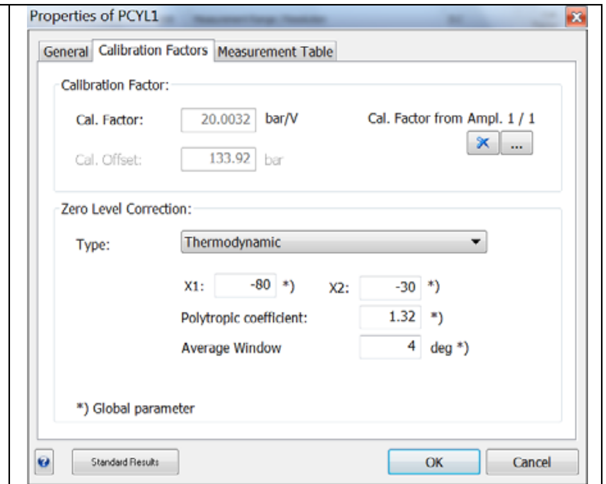
Mode	PID Number (Hex)	Parameter Description	Type	Bytes	Scale	Offset	Minimum	Maximum	Units
1	0E	Ignition Timing Advance for #1 Cylinder	Unsigned Numeric	1	0.5	-64	-64	63.5	Deg
1	11	Absolute Throttle Position	Unsigned Numeric	1	0.392156862745	0	0	100	%
1	05	Engine Coolant Temperature	Unsigned Numeric	1	1	-40	-40	215	Deg C
1	0F	Intake Air Temperature	Unsigned Numeric	1	1	-40	-40	215	Deg C
1	34	Equivalence Ratio (Lambda)	Unsigned Numeric	2	0.000030518044	0	0	2	unitless
1	43	Absolute Load Value	Unsigned Numeric	2	0.392156862745	0	0	25700	%
1	0B	Intake Manifold Absolute Pressure	Unsigned Numeric	1	1	0	0	255	kPa
1	23	Fuel Rail Pressure	Unsigned Numeric	2	10	0	0	655350	kPa
1	49	Accelerator Pedal Position	Unsigned Numeric	1	0.392156862745	0	0	100	%
22	033E	Boost Absolute Pressure - Raw Value	Unsigned Numeric	2	0.007629394531	0	0	499.992370605469	kPa
22	0462	Turbocharger Wastegate Duty Cycle	Unsigned Numeric	2	0.003051757813	0	0	199.996948274955	%
22	0318	Actual Intake (A) Camshaft Position	Signed Numeric	2	0.0625	0	-2048	2047.9375	Deg
22	0319	Actual Exhaust (B) Camshaft Position	Signed Numeric	2	0.0625	0	-2048	2047.9375	Deg
22	0316	Intake (A) Camshaft Position Actuator Duty Cycle	Unsigned Numeric	2	0.003051757813	0	0	199.996948242188	%
22	0317	Exhaust (B) Camshaft Position Actuator Duty Cycle	Unsigned Numeric	2	0.003051757813	0	0	199.996948242188	%
22	0461	Charge Air Cooler Temperature	Signed Numeric	2	0.015625	0	-512	511.984375	Deg C
22	05AC	Cylinder 1 Pre-Ignition Counter	Unsigned Numeric	1	1	0	0	255	Count
22	05AD	Cylinder 2 Pre-Ignition Counter	Unsigned Numeric	1	1	0	0	255	Count
22	05AE	Cylinder 3 Pre-Ignition Counter	Unsigned Numeric	1	1	0	0	255	Count
22	05AF	Cylinder 4 Pre-Ignition Counter	Unsigned Numeric	1	1	0	0	255	Count

Appendix C. AVL Indicom Settings

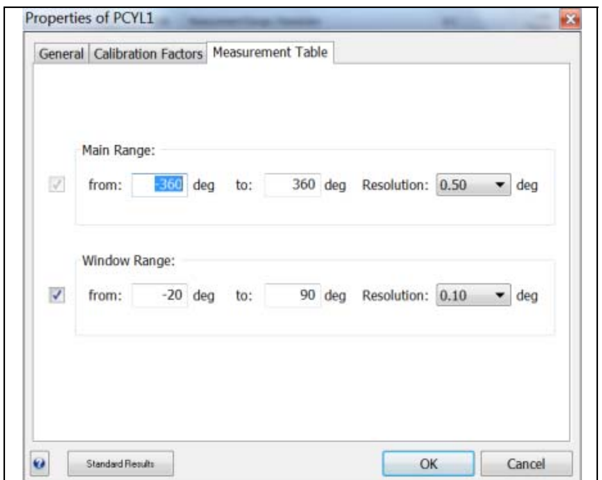
Amplifier and Pressure Sensor Settings (accessed through the "Sensor" menu)



Amplifier Settings



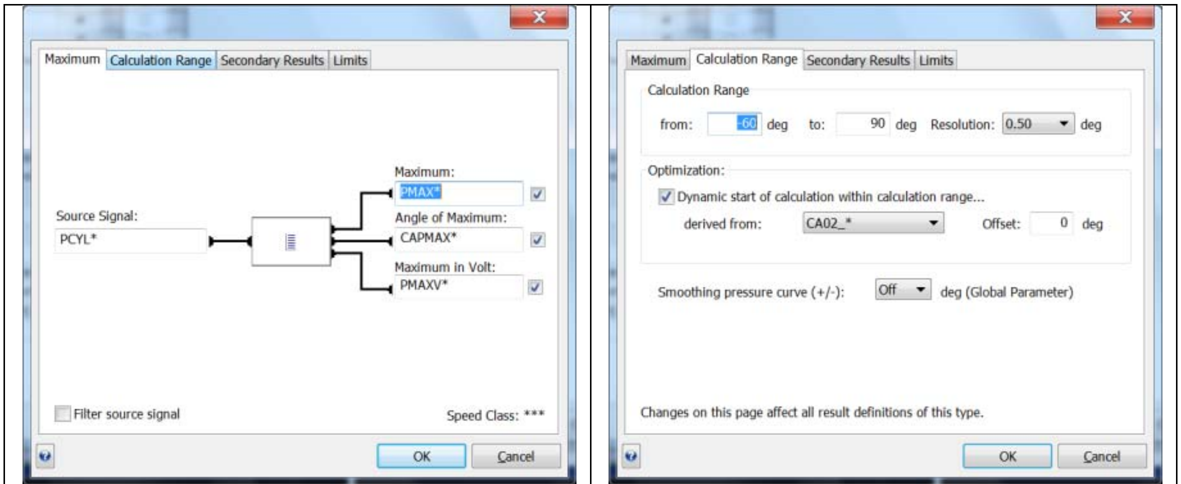
Pressure Sensor Settings



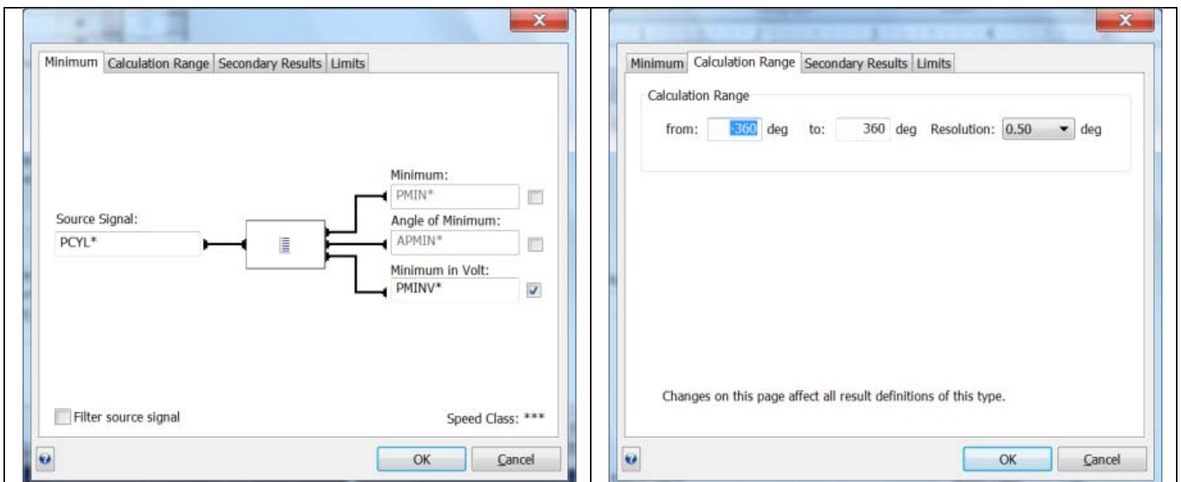
Pressure Sensor Settings

A.

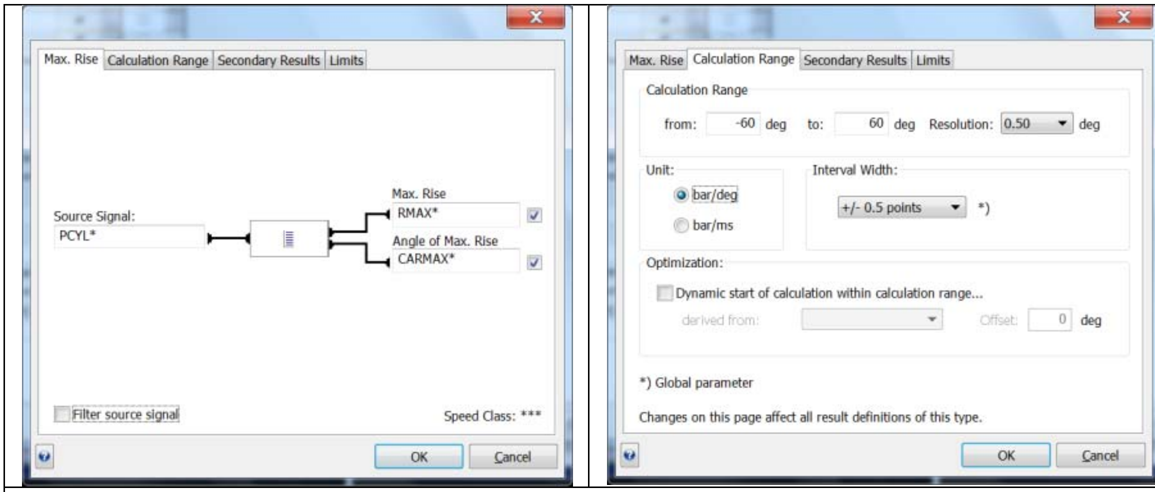
Standard Results Settings



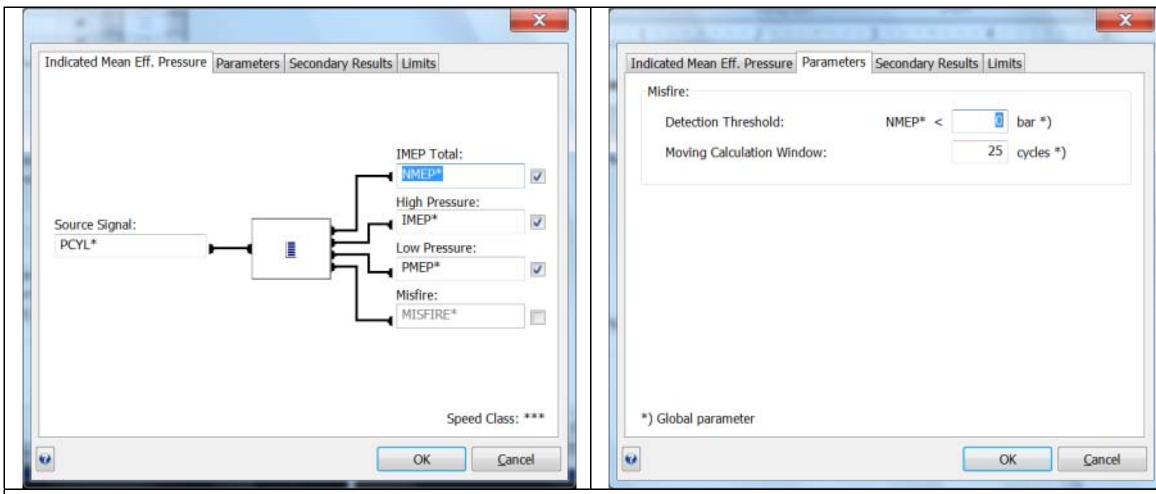
PCYL MAX Settings



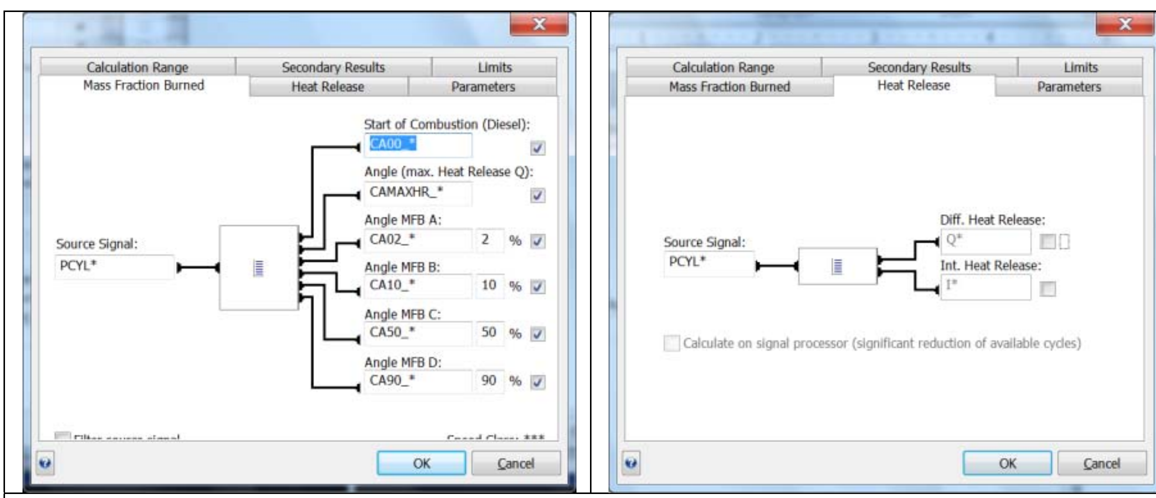
PCYL MIN Settings



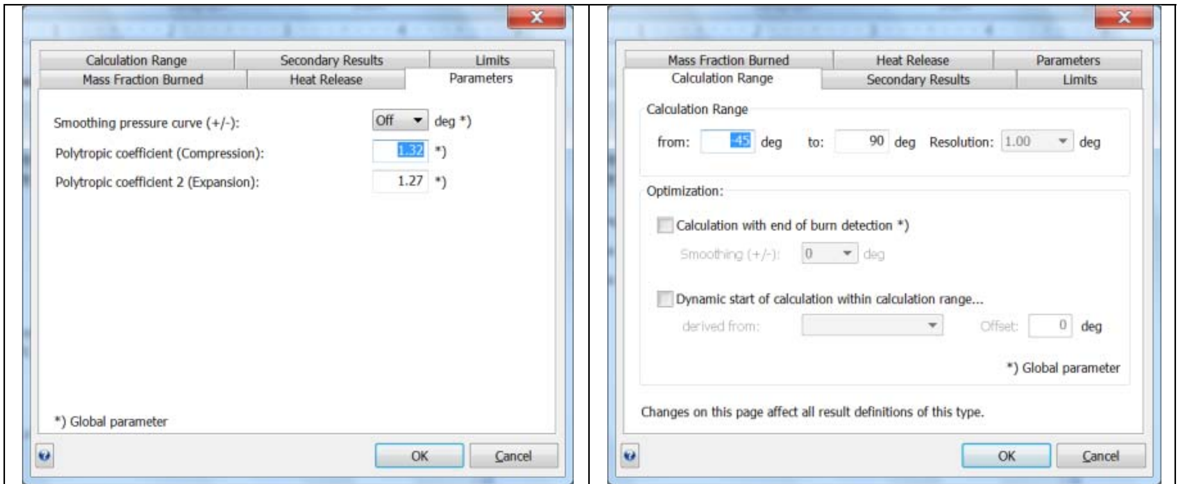
PCYL Max Rise Settings



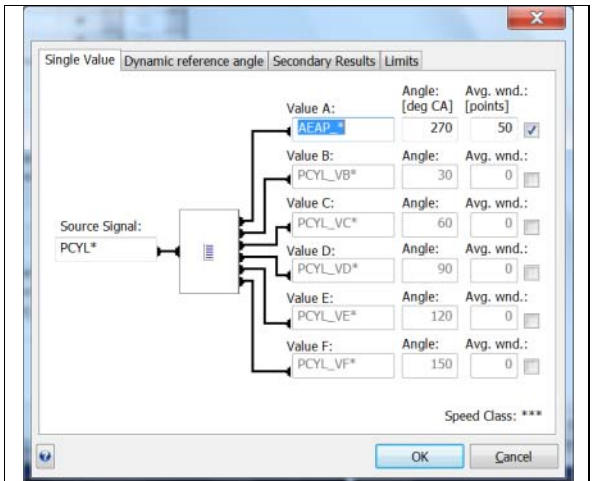
PCYL IMEP Settings



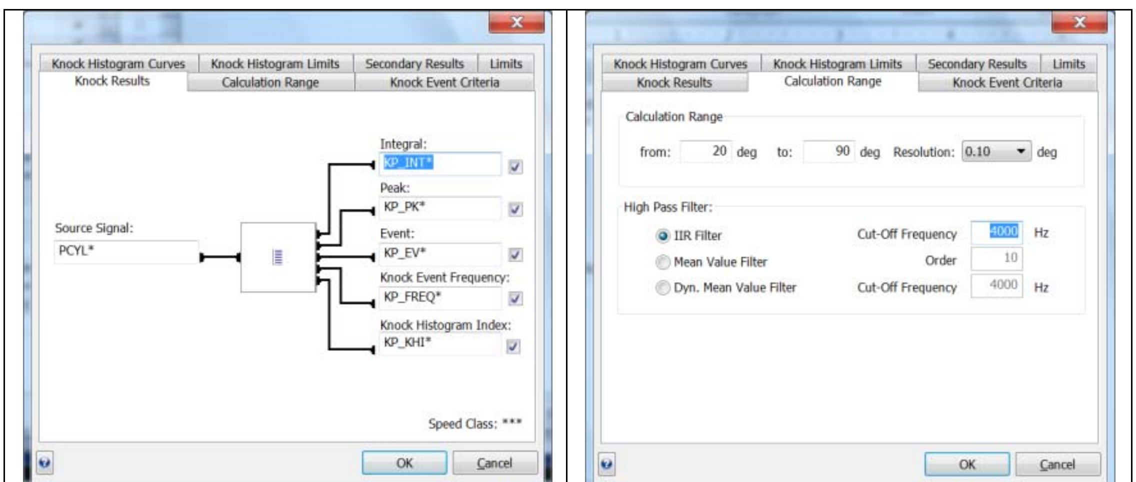
PCYL Heat Release Settings



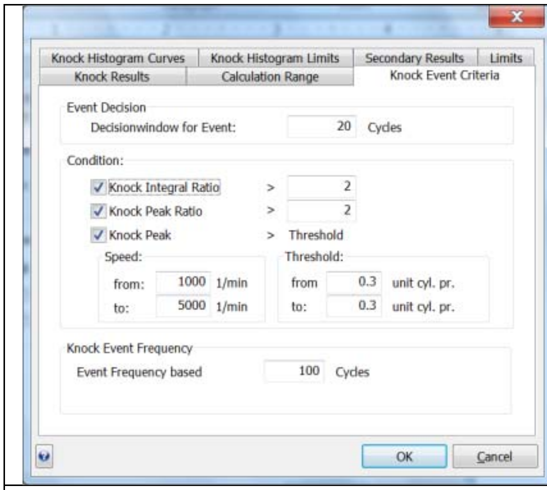
PCYL Heat Release Settings



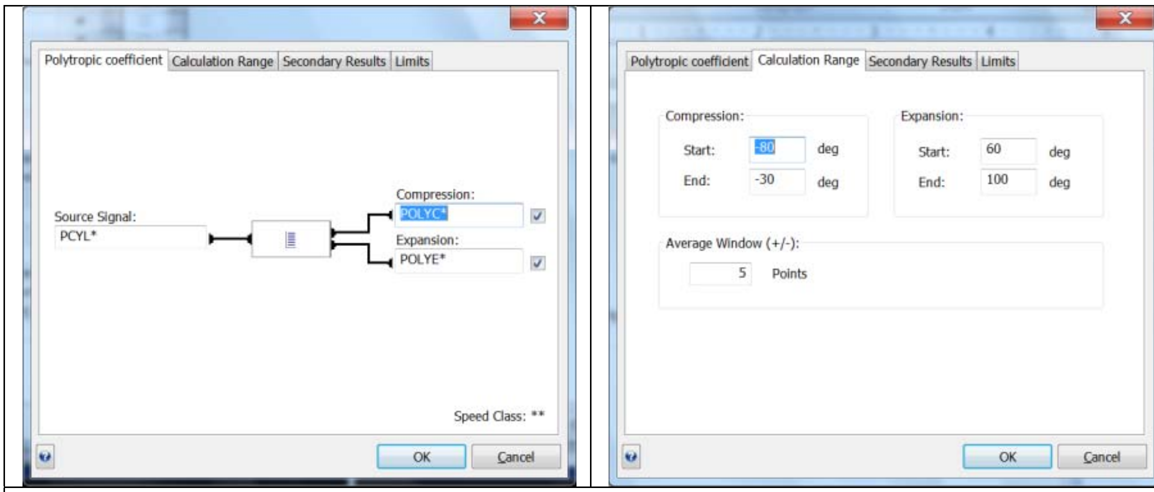
PCYL Single Value Settings



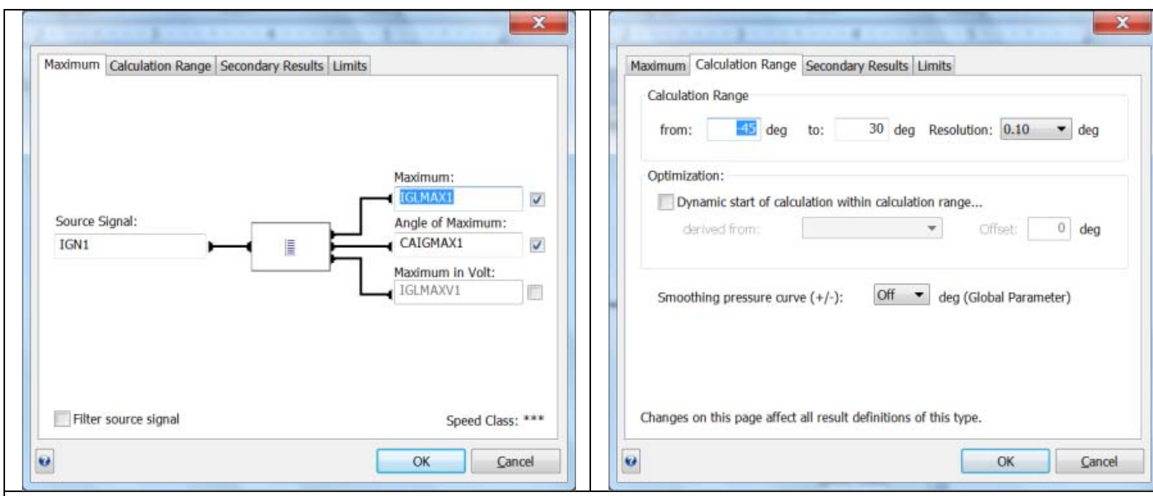
PCYL Knock (Cylinder Pressure) Settings



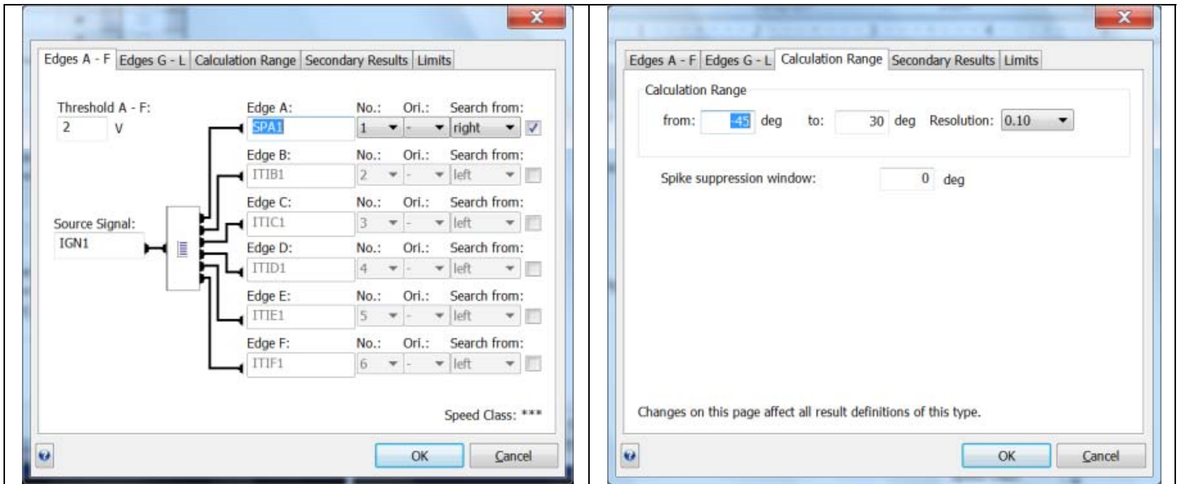
PCYL Knock (Cylinder Pressure) Settings



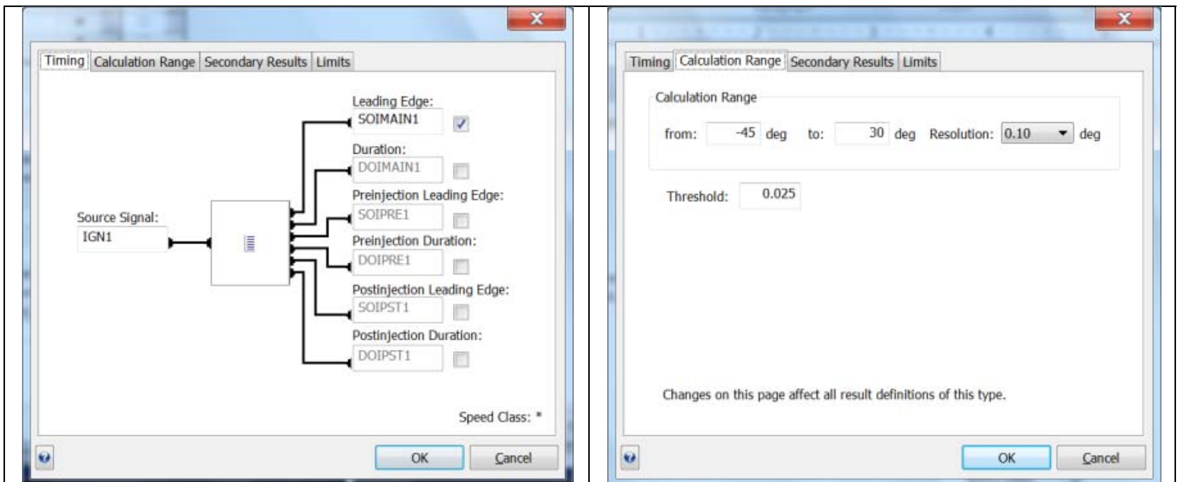
PCYL Polytrophic Coefficient Settings



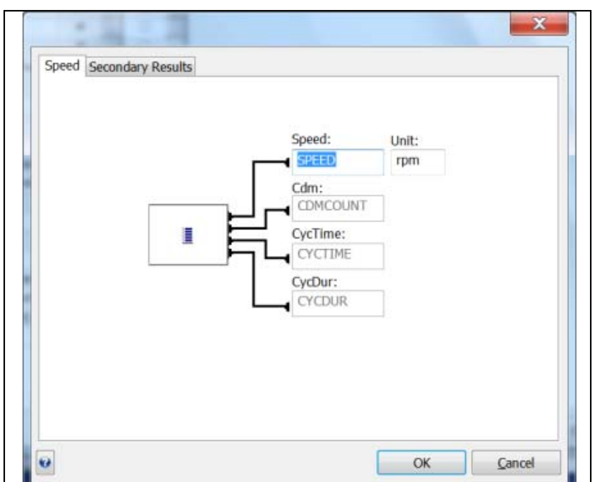
IGN1 MAX Settings



IGN1 Edge Detection Settings



IGN1 Timing Settings

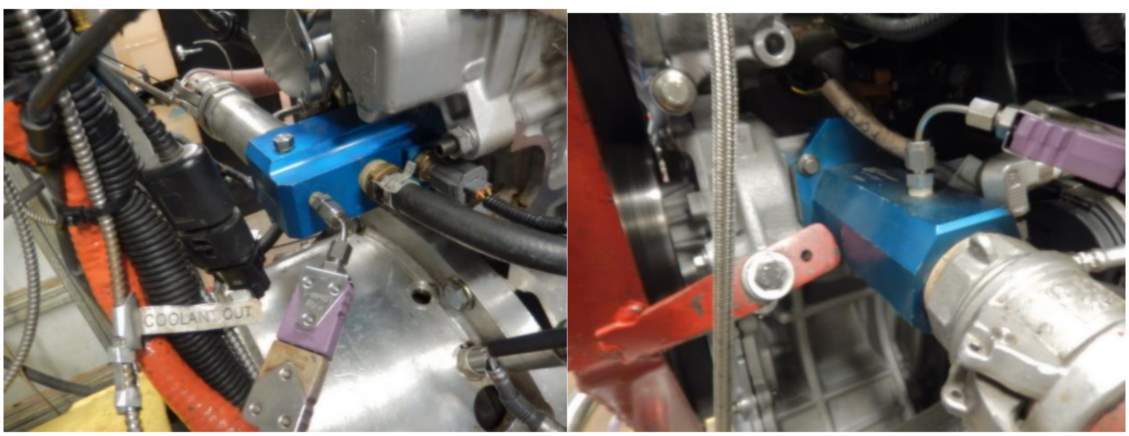


Speed Settings

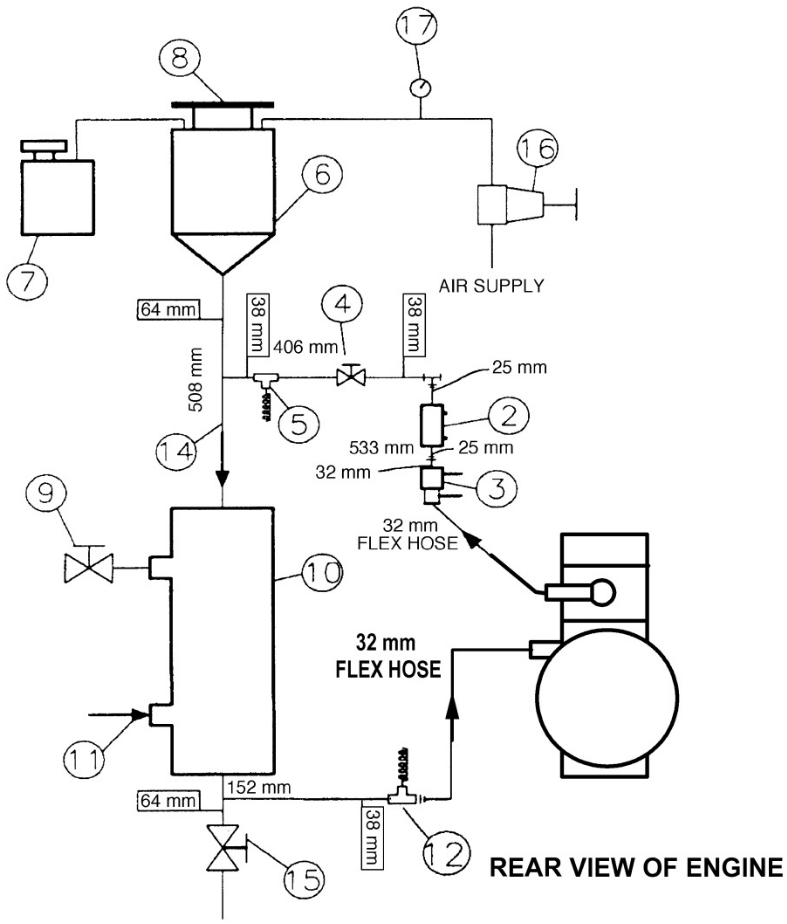
<u>Channels To Report</u>

- PMAX*
- CA02*
- PMAXV*
- PMINV*
- KP_INT*

Oil pan
Figure A2.1



Coolant in and out connections and thermocouple locations
FIG. A2.2


17
8
16
6
7
AIR SUPPLY
64 mm
38 mm
4
38 mm
406 mm
25 mm
508 mm
5
2
14
533 mm
25 mm
32 mm
3
9
32 mm
FLEX HOSE
10
32 mm
FLEX HOSE
11
152 mm
64 mm
38 mm
12
15
REAR VIEW OF ENGINE

NOTE 1—Observe temperature sensor locations in thermostat housing and at water pump inlet.
NOTE 2—Components of Engine Cooling System—
(1) Thermostat housing with temperature sensor
(2) Sight glass
(3) Flowmeter
(4) Flow control valve
(5) Optional temperature control sensor
(6) Fabricated coolant reservoir
(7) Constant full expansion tank
(8) Pressure radiator cap (MOTORCRAFT RS40 P/N D2YY-8100-A)
(9) Process water control valve (regulated by temperature controller with three remote set points)
(10) Heat exchanger (ITT Standard P/N 5-030-06-048-001 TYP.)
(11) Process water supply (shell side)
(12) Tee with temperature sensor for coolant inlet; located (300 to 400) mm upstream of pump inlet at the block face
(13) Water pump inlet with temperature sensor
(14) Engine coolant (tube side)
(15) Coolant system drain valve
(16) Coolant pressure regulator
(17) Coolant pressure gage
(18) External coolant pump

FIG. A2.3 Typical Engine Cooling System Schematic (cont.)

Figure A2.4: Motor mounts, front

Figure A2.5: Motor mounts, rear

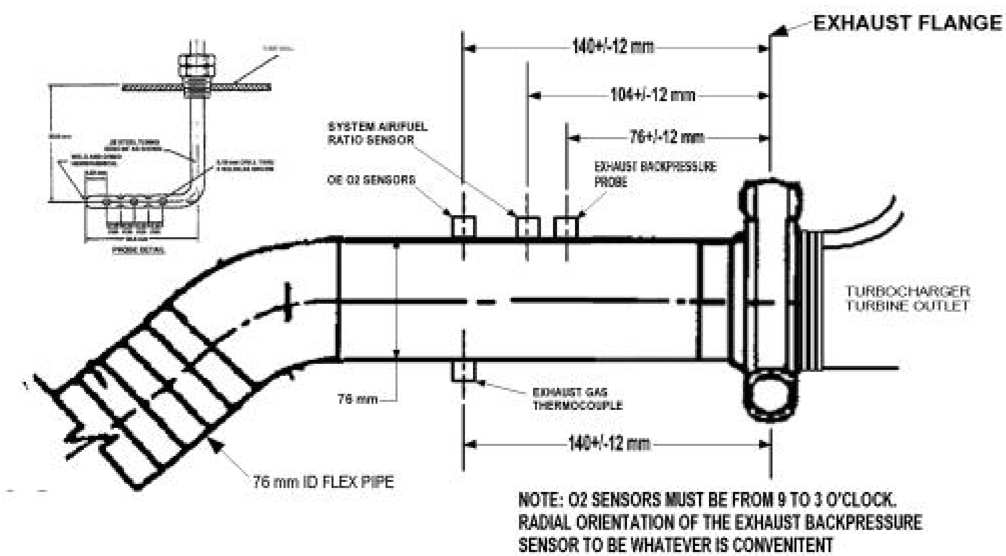


Figure A2.8: Exhaust Measurements and Instrumentation

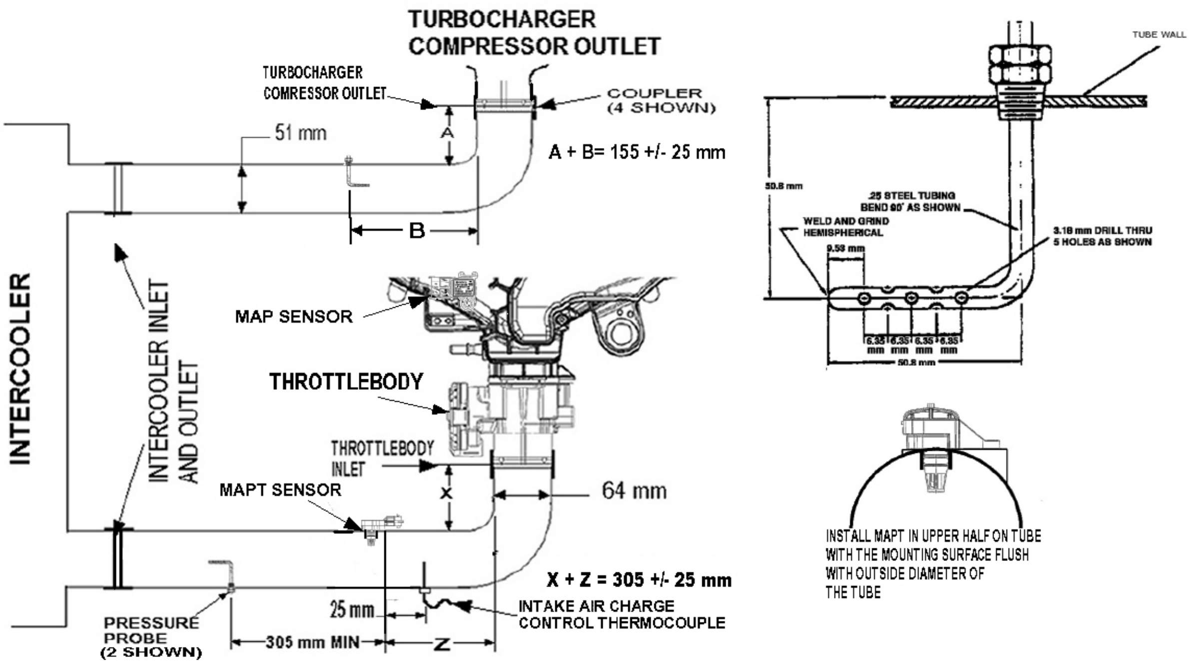


Figure A2.13: Intercooler Tubing Measurements and Instrumentation

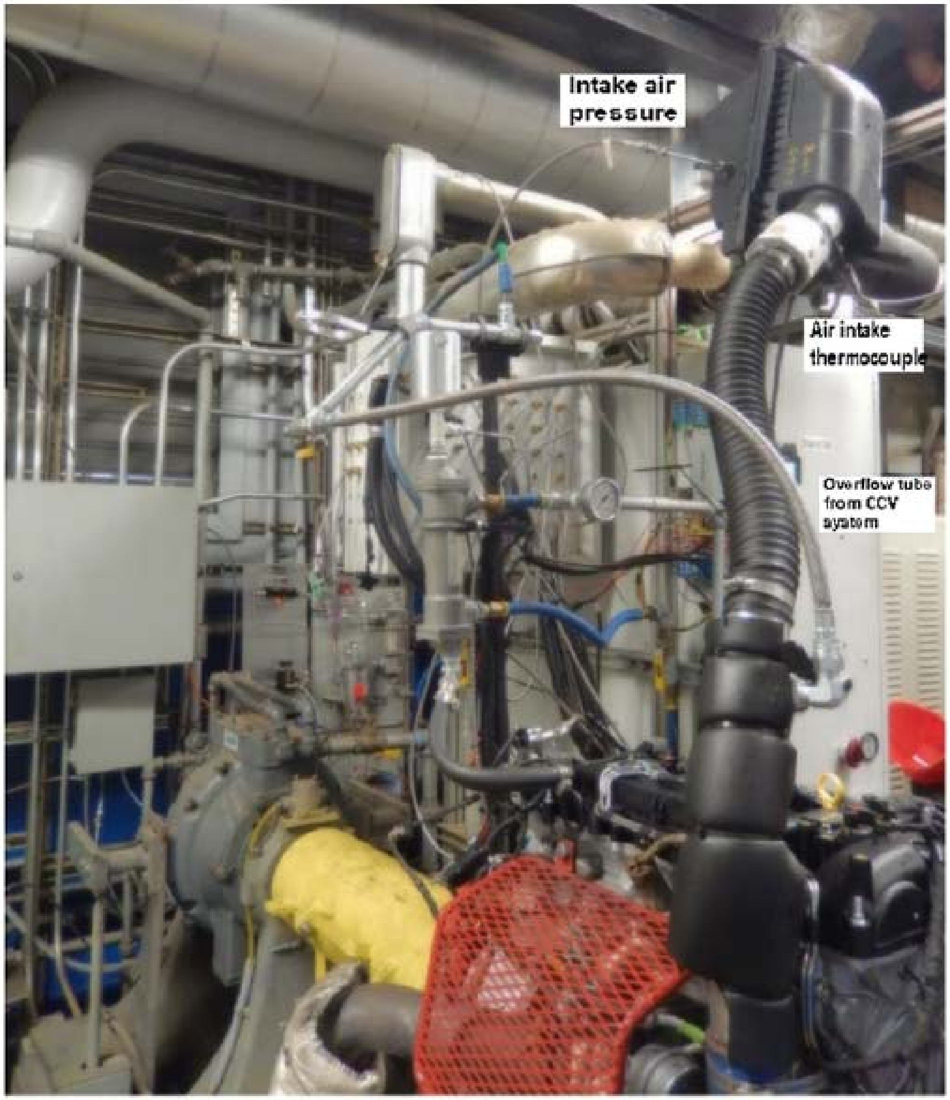


FIG. A2.12 Typical air inlet system

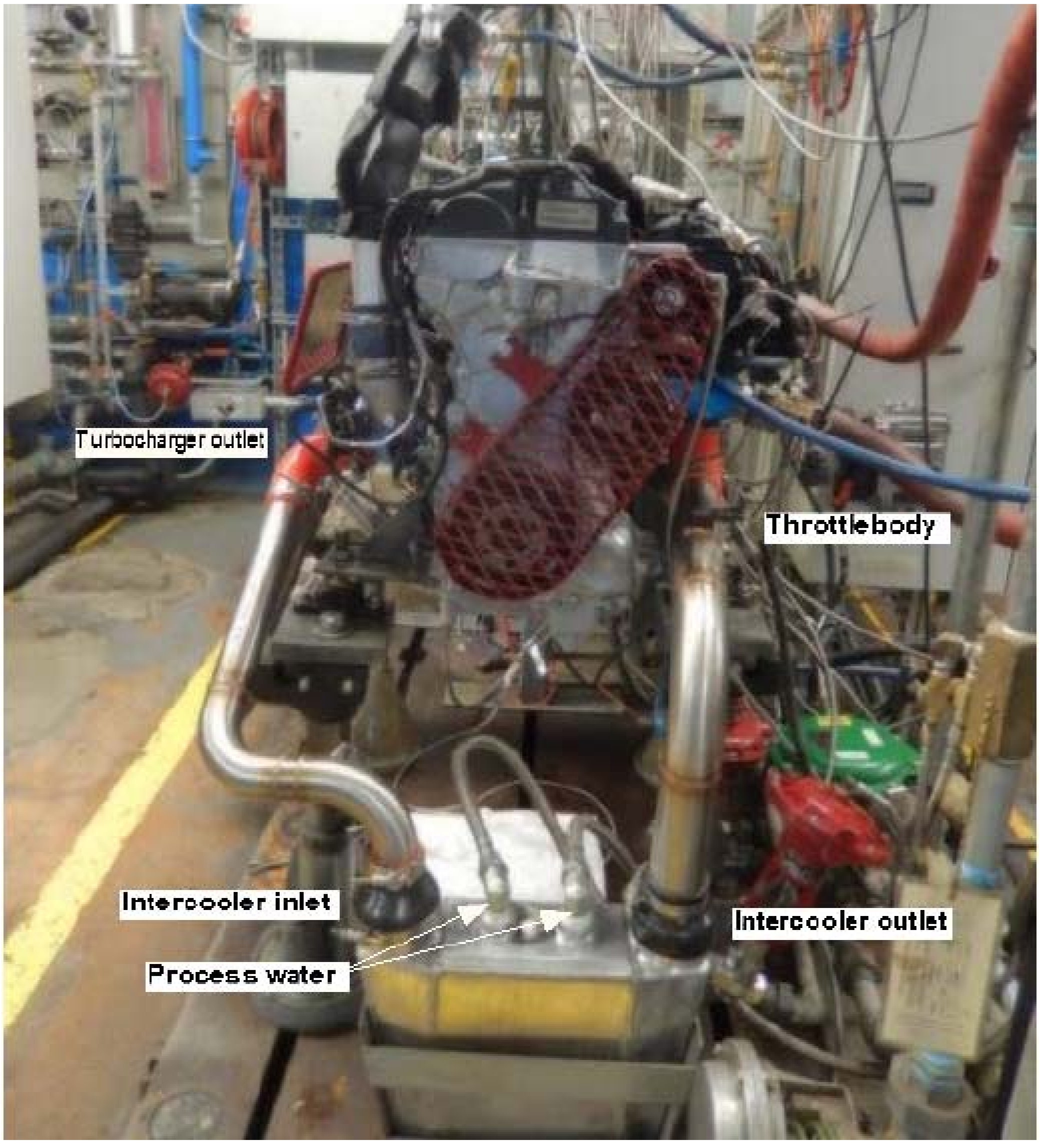


Figure A2.14 Typical intercooler installation

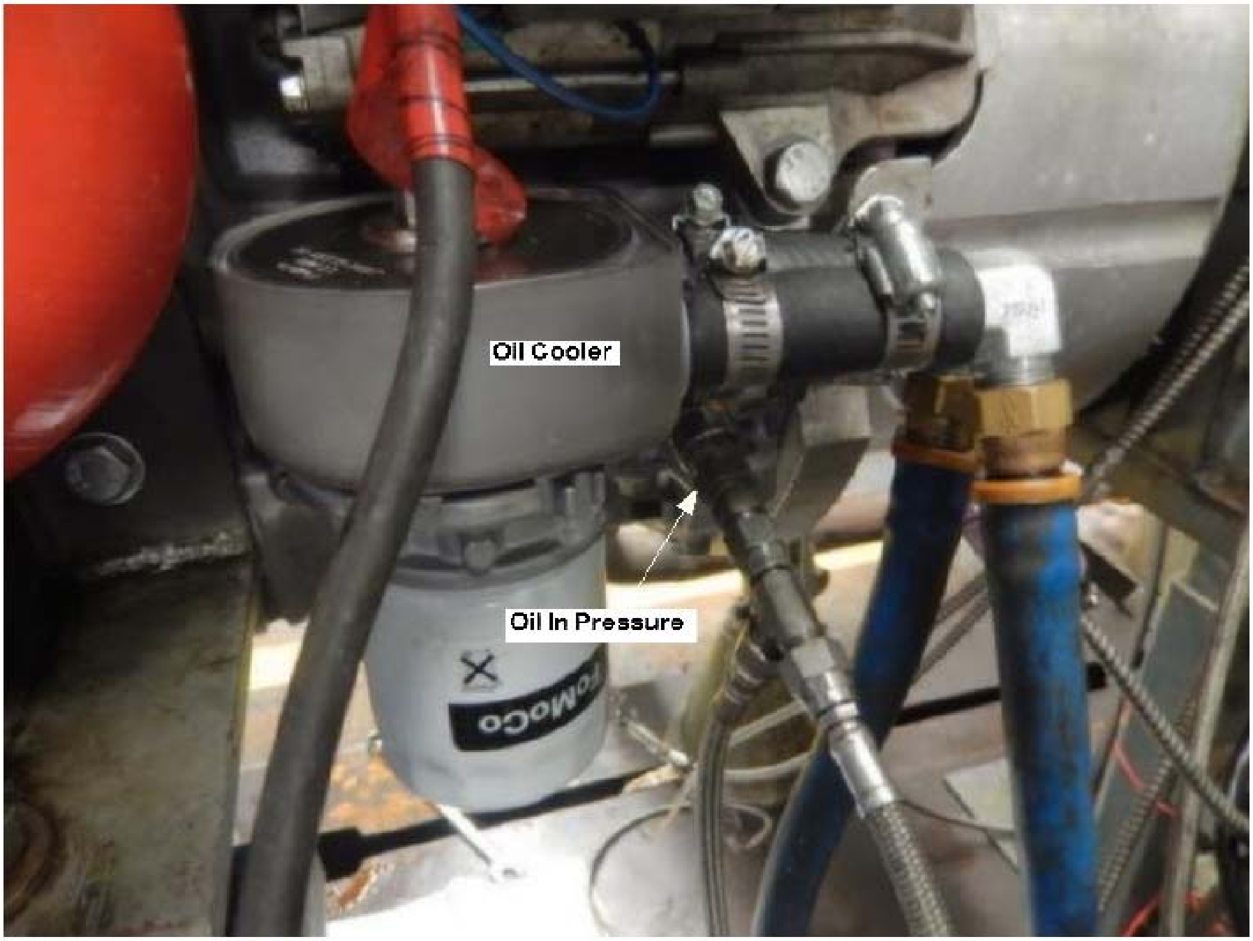


Figure A2.15Oil cooler showing oil gallery pressure location

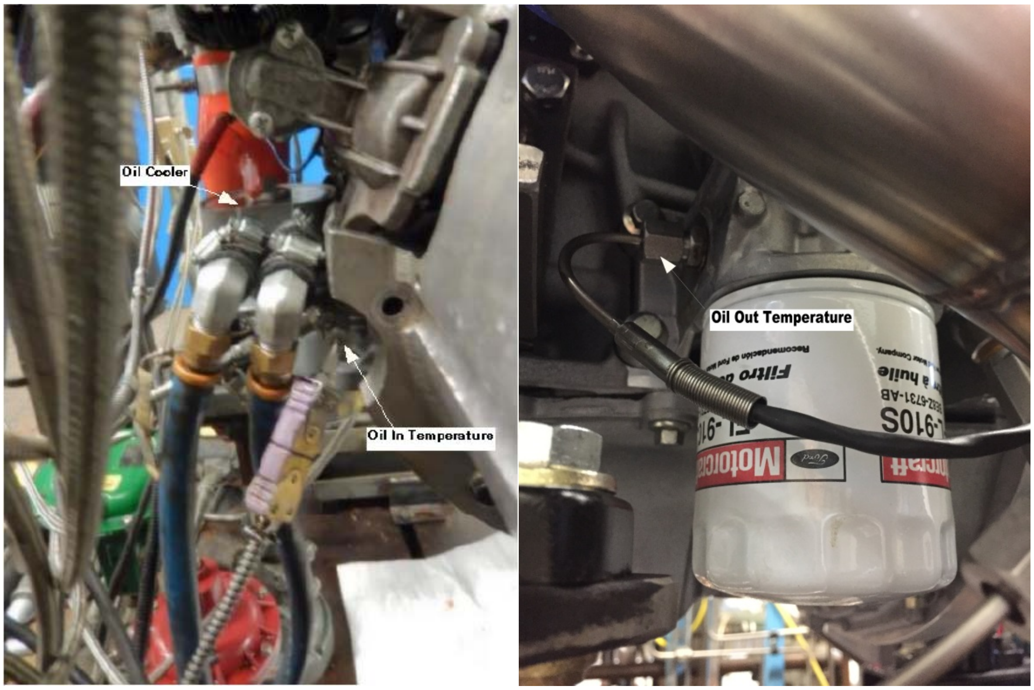
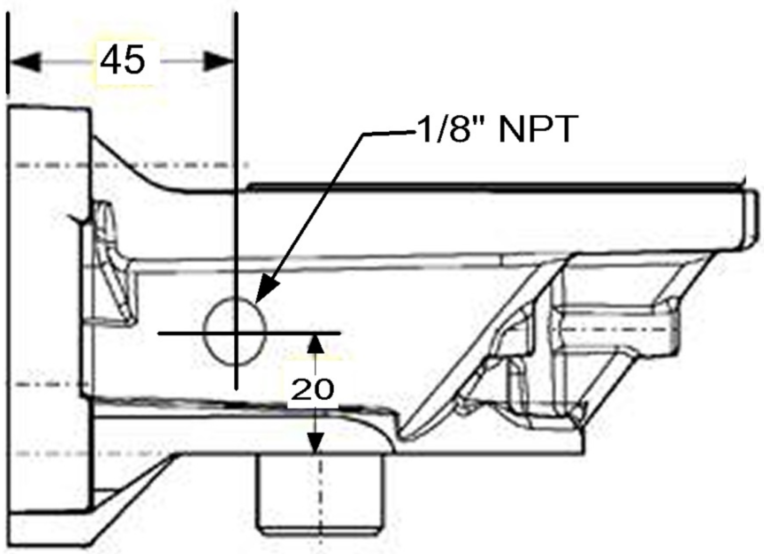
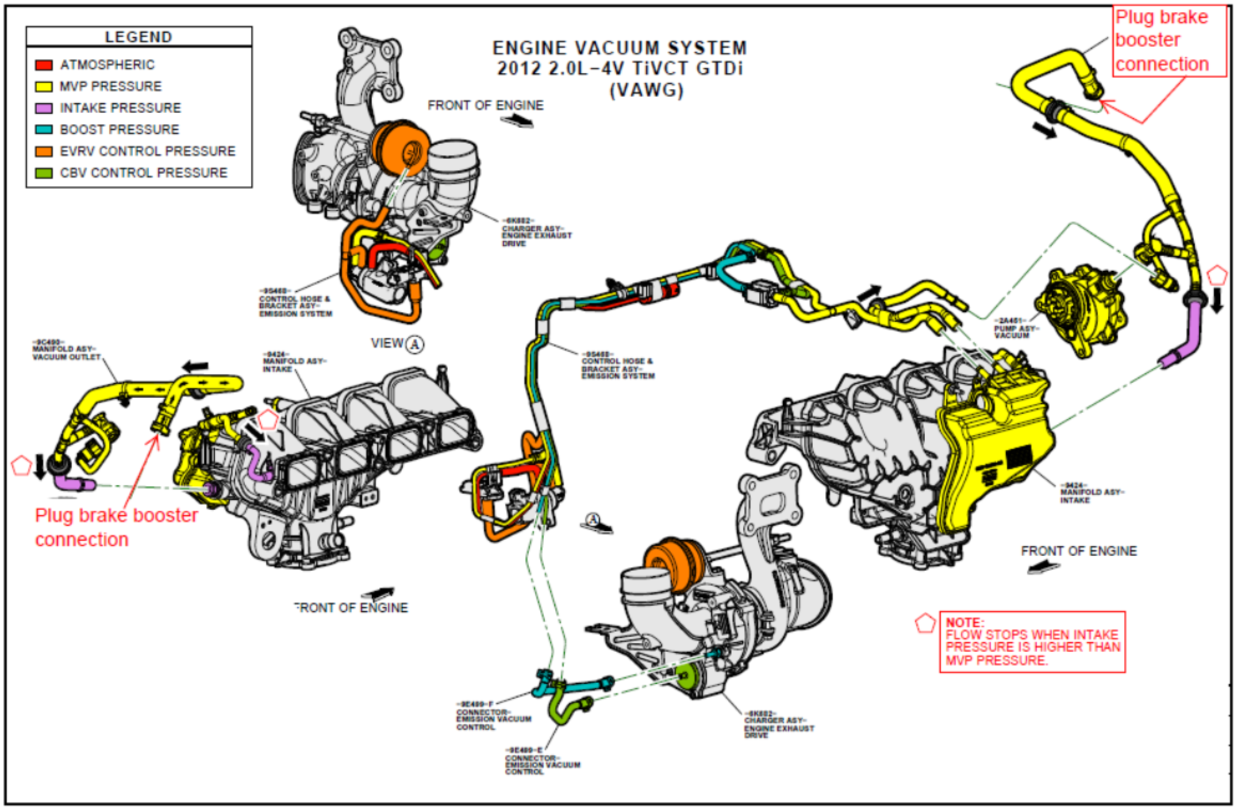


Figure A2.16 Oil cooler showing oil temperature locations



Oil Out temperature location in oil filter adapter
Figure A2.16 Oil cooler showing oil temperature locations



Vacuum System
Figure A2.19

A3. CONTROL AND DATA ACQUISITION REQUIREMENTS

A3.1 *General Description*:

A3.1.1 The data acquisition system shall be capable of logging the operational data in digital format. It is to the advantage of the laboratory that the system be capable of real time plotting of controlled parameters to help assess test validity. The systems shall be capable of calculating real time quality index as this will be monitored throughout the test as designated in A2.5.

A3.1.2 Control capability is not dictated by this procedure. The control system shall be capable of keeping the controlled parameters within the limits specified in Table 5 and maintain the quality index shown in A2.5.

A3.1.3 Design the control and data acquisition system to meet the requirements listed below. Use the recommendations laid out in the Instrumentation Task Force Report and Data Acquisition Task Force Report for any items not addressed in Annex A3.

A3.2 *Digital Recording Frequency*—The maximum allowable time period over which data can be accumulated is one second. This data can be filtered, as described in A3.6, and will be considered a reading.

A3.3 *Steady State Operation*:

A3.3.1 This portion of the test will be the entire time at Stage 1 and 2 conditions. Stage 1 and 2 conditions are reached by the end of the ramping periods. Calculate the quality index using values reported to the accuracy levels in Table A3.1.

TABLE A3.1 Accuracy Levels of Data Points to be Used in QI Calculations

Parameter	Field Length
Speed	
Humidity	

Parameter	Field Length
Temperature	
Torque	
Inlet Air Pressure	
Exhaust Backpressure	
Coolant Outlet Pressure	
Coolant Flow	

TABLE A3.2 L and U Constants and Over and Under-Range Values

Parameter	Stages	L	U	Over-Range	Under-Range
Coolflow	1				
Cooloutt	1				
	2				
Exhbprs	1				
	2				
Humidity	1, 2				
Intairpr	1, 2				
Intairt	1, 2				
Oilint	1				
	2				
Speed	1				
	3				
Torque	1				
	2				
Cooloutp	1, 2				
BBint	1				
	2				

TABLE A3.3 Maximum Allowable Time Constants

Control Parameter	Time Constant, s
Engine speed, r/min	0.5
Torque, Nm	0.7
Engine oil in, °C	0.6
Engine coolant out, °C	0.6
Engine coolant flow, L/min	8.0
Blowby in, °C	0.6
Inlet, air, °C	0.6
Inlet air press, kPa	0.2
Exhaust back pressure, kPa	0.2
Engine coolant pressure	2.0

A3.3.2 The time intervals between recorded readings shall not exceed 1 min. Data shall be recorded throughout the length of each stage.

A3.4 *Transitions* :

A3.4.2 During the transition, the time intervals between all recorded readings shall not exceed 2 seconds..

A3.5 *Quality Index*:

TBD

A3.6 *Time Constants*:

A3.6.1 Filtering can be applied to all control parameters. The amount of filtering applied shall not allow time constants to exceed the values listed in Table A2.3. This time constant shall pertain to the entire system, running from the sensor to the display and data acquisition.

A3.6.2 Maximum allowable system time constants for the controlled parameters are shown in Table A3.3

Customer :
Date of Email:
AM:

ENGINEERING ASSEMBLY	**A1.1**				
Current Ford Service Part Number	**Current Ford Engineering Part**	**Description**			
BB5Z-6006-A	**BB5E-6006-AD**	**2.0L ENGINE ASY LB**			
REUSEABLE ENGINE PARTS (A1.2)					
Current Ford Service Part Number	**Current Ford Engineering Part**	**Description**			
BB5Z9F593B	BB5E9F593BA	**INJECTOR ASY**			
CJ5Z9D280A	CJ5E9D280BF	**MANIFOLD ASY - FUEL SUPPLY**			
CJ5Z9D440A	CJ5E9B374BC	**COVER - FUEL PUMP**			
Fasteners	(A1.3)				
Current Ford Service Part Number	**Current Ford Engineering Part**	**Description**			
F5TZ6A785A	F57E6A785AC	**SEPARATOR ASY - OIL, EXT**	SCREW M6x25 hex	14	W/P, W OUT, TSTAT,
W500033S437	W500033S437	**BOLT - FLANGED HEX.**	BOLT M10X25	2	LFT EYES
W500114S442	W500114S442	**BOLT**	Bolt M6X1.25X55	3	Tensioner assy FEAD
W500212S437	W500212S437	**SCREW**	BOLT M6X14	14	RR CVR, VAC HOSE,
W500214S437	W500214S437	**BOLT - HEX.HEAD**	BOLT M6X20	8	OIL SEP
W500221S437	W500221S437	**BOLT - HEX.HEAD**	BOLT M8X14	3	WP PULLEY
W500224S437	W500224S437	**BOLT**	BOLT M8X25	11	OIL PAN
W500300S437	W500300S437	**BOLT**	BOLT M8X1.25X33.25	1	FRT CVR behind crk pu
W500301S437	W500301S437	**BOLT**	BOLT M6X35	2	COILS
W500310S437	W500310S437	**BOLT - HEX.HEAD**	BOLT M8X35	2	KNOCK SNS
W500313S437	W500313S437	**BOLT**	BOLT M8X50	10	INT MANF/FU RAIL
W500328S437	W500328S437	**BOLT**	BOLT M10X80	3	FRT CVR
W500414S442	W500414S442	**BOLT**	BOLT M6X20	2	FU PMP
W503275S437	W503275S437	**BOLT - HEX. HEAD - FLANGED**	BOLT&WSHR M6X20	2	TC OIL LINE
W505531S442	W505531S442	**SCREW**	BOLT M6X12	1	TC WTR LINE
W506976S442	W506976S442	**SCREW**	SCREW M6X25	1	MAP SNS
W520214S440	W520214S440	**NUT**		4	Front cover engine mo
W700115S437	W700115S437	**SCREW AND WASHER ASY**	BOLT&WSHR M10X11.5	1	BLK RT FRT
W701183S300	W701183S300	**DOWEL - BUSH**	BUSH 11.6X14.1X12	2	HD TO BLK GUIDE
W701219S437	W701219S437	**BOLT**	BOLT M6X16	4	CS POS SNS, CRKS
W702426S303	W702426S303	**BOLT - HEX.HEAD**	BOLT M8X1.25X13	6	press plate to flywheel
W702492S437	W702492S437	**STUD**	STUD M8X15+M8X35	1	ground lf frt side of blo
W702700S437	W702700S437	**STUD**	STUD M8X40+M8X16	4	CVR FU PMP
W703383S437	W703383S437	**BOLT**	BOLT M7X39	23	C/S CAPS
W703643S430	W703643S430	**BOLT**	BOLT M6X23	2	Chain guide
W703649S300	W703649S300	**PIN**	PIN 10X40	1	CHAIN GUIDE TENSION
W704474S437	W704474S437	**STUD**	M10 X 1.5 X 22 + M10 X 1.5 X	4	Turbo/Exhaust studs
W706282S430	W706282S430	**BOLT**	BOLT M6X45	2	OIL P/U
W706284S437	W706284S437	**BOLT**	BOLT M8X90	2	OIL PAN
W706487S437	W706487S437	**BOLT-OIL COOLER FILTER**			BOLT-OIL COOLER FIL

Customer :
Date of Email:
AM:

Current Ford Service Part Number	Current Ford Engineering Part	Description				
W711261S437	W711261S437	**BOLT**	STUD M6X25+M6X15		1	FRT CVR
W711574S439	W711574S439	**STUD**			4	Front cover engine mo
W712022S430A	W712022S430	**BOLT - HEX.HEAD**	BOLT M8X101		4	OIL PUMP
W713095S403	W713095S403	**NUT**	NUT M10		4	Turbo/Exhaust nuts
W715323S300	W715323S300	**WASHER - COPPER, T/C OIL LINE**			4	Turbo Oil feed pipe wa
W715638S443	W715638S443	**STUD**	STUD M6X30+M6X10		2	COILS
~~**W715848S437**~~	~~W715848S437~~	~~**BOLT**~~	~~BOLT M6X19~~		~~1~~	~~OIL CHN TEN~~
W716137S437	W716137S437	**BOLT**	BOLT M6X14		2	T/C OIL DRAIN LINE
W716735S437	W716735S437	**BOLT**	M6 X 1 X 25		17	front cover
W716841S900	W716841S900	**PIN, BELL HOUSING**			5	pin, bellhousing and le
1L5Z6379AA	W706161S300	**BOLT**	M12 X 1 X 18.5			Flywheel to crank
1S7Z6A340AA	1S7G6K340BC	**BOLT, CRK SHFT PULLEY**				
1S7Z6K282AA	1S7G6K282AB	**BOLT, CHAIN TEN**				
AG9Z6065A	AG9G6065BA	**BOLT - HEX.HEAD, CYL HEAD**				
AG9Z6345A	AG9G6345AC	**BOLT - BEARING CAP - HEX. HEAD**				
BB5Z6214A	BB5E6214CA	**BOLT - CONNECTING ROD**				
CV6Z6279A	CV6E6279AA	**BOLT, CAMSHAFT**				
TEST PARTS LIST	(A1.4)					
Current Ford Service Part Number	**Current Ford Engineering Part**	**Description**				
7T4Z9601A	7T439601AA	**ELEMENT ASY - AIR CLEANER**				
1S7Z6378AA	1S7G6378AB	**WASHER,CRK DIAMOND CRUSH**				
6M8Z6278A	6M8G6278AA	**WASHER, CAM, DIAMOND CRUSH**				
Gaskets List	(A1.5)					
Current Ford Service Part Number	**Current Ford Engineering Part**	**Description**				
CJ5Z6079D	CJ5E6079AC	**KIT - GASKET**				
1S7Z6571EA	1S7G6A517BG	**SEAL - VALVE STEM EX**				
1S7Z6840AA	1S7G6A636AD	**GASKET, OIL FILTER ADPT**				
1S7Z6K301BA	1S7G6A321AA	**SEAL - CRANKSHAFT REAR OIL**				
1S7Z8507AE	1S7G8507AF	**GASKET - WATER PUMP**				
3M4Z6625AA	3M4G6625AA	**GASKET, OIL PMP P/U TUBE**				
3M4Z8255A	3M4G8K530AB	**GASKET, T/STAT HSG**				
3S4Z6571AA	3S4G6A517AA	**SEAL - VALVE STEM INT**				
9L8Z9E936A	9L8E9E936AA	**GASKET, T/B**				
AA5Z9E583A	AA5E9E583AA	**SEAL, FU PUMP**				
AG9Z9P431A	AG9G9P431AA	**GASKET, T/C COOL LINE**				
BB5Z2A572B	BB5E2D224BB	**GASKET - VACUUM PUMP**				
BB5Z6584A	BB5E6K260AB	**GASKET, CAM COVER**				

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Current Ford Service Part Number	Current Ford Engineering Part	Description				
BB5Z6L612A	BB536L612AA	**GASKET, EXHAUST**				
BG9Z9229A	BG9E9U509AB	**KIT - "O" RING, FU INJ**				
BR3Z6C535B	BR3E6P251BA	**SEAL - VALVE VCT**				
CB5Z9276A	CJ5E9A420BA	**GASKET, FU PUMP CVR**				
CJ5Z6051A	CJ5E6051EC	**GASKET - CYLINDER HEAD**				
CJ5Z6N652A	CJ5E6N652AA	**GASKET, T/C OIL DRAIN LINE**				
CJ5Z8255A	CJ5E8255AA	**SEAL - THERMOSTAT**				
CJ5Z9439A	CJ5E9439AA	**GASKET - INTAKE MANIFOLD**				
CJ5Z9448A	CJ5E9448BA	**GASKET, EX MANIFOLD**				
CM5Z6700A	CM5E6700AB	**SEAL ASY - CRKSHAFT OIL - FRT**				

TEST STAND SET UP PARTS (A1.6)

Current Ford Service Part Number	Current Ford Engineering Part	Description				
AG9Z9D930B	AG9T9H589BE	**WIRE ASY, FE INJ**				
1S7Z12A699BB	1S7A12A699BB	**SENSOR - ENGINE KNOCK**				
6M8Z6C315AA	6M8G6C315AB	**SENSOR - CRANKSHAFT POSITION - CPS**				
8F9Z9F472A	8F9A9Y460AB	**SENSOR ASY, O2**				
8V2Z12B579A	8V2112B579AA	**SENSOR ASY, MAF**				
9L8Z6G004E	9L8A6G004BC	**SENSOR ASY, CYL HD TMP**				
AA5Z9A600B	AA539A600AD	**CLEANER ASY - AIR**				
AE5Z6A228A	AE5Q6A228AA	**PULLEY ASY - TENSION BELT**				
AE5Z8620A	AE5Q6C301AA	**V-BELT**				
AG9Z6K679A	AG9G6K679BC	**PIPE - OIL FEED, T/C**				
AG9Z6K868A	CJ5E6K868AA	**VALVE ASY, ENG PST OIL COOL**				
AG9Z6L092A	AG9G6K677BC	**HOSE - T/C OIL DRAIN**				
AG9Z8555A	AG9G8A506BB	**HOSE - WATER INLET, T/C**				
AG9Z9F479A	AG919F479AB	**SENSOR ASY, MAP**				
BV6Z9F479A	BV619F479AA	**SENSOR ASY, MAPT**				
AS7Z6B288A	AS7112K073AA	**SENSOR - CAMSHAFT POSITION**				
BB3Z6A642A	BB3E6A810AA	**KIT ENGINE OIL COOLER**				
BB5Z11002C	BB5T11000AA	**STARTER MOTOR ASY**				
BB5Z5A231A	BB535A281AA	**CLAMP - HOSE, T/C TO EXH**				
BB5Z6C640A	BB536K863CE	**CONNECTION - AIR INLET T/B END**				
BB5Z6C640B	BB536K863DF	**CONNECTION - AIR INLET, I/C END**				
BB5Z6C646C	BB536C646CD	**DUCT - AIR, TURBO END**				
BB5Z6C646D	BB536C646DF	**DUCT - AIR, INTERCOOLER END**				
BB5Z6C683A	BB5E6L663AA	**FILTER ASY (T/C SCREEN)**				
BB5Z9647A	BB539647AB	**BRACKET, AIRBOX**				
BB5Z9661A	BB539643AA	**COVER, AIRBOX**				
BB5Z9B659B	BB539F805DE	**HOSE - AIR, TURBO END**				
BB5Z9B659E	BB539F805CG	**HOSE - AIR, AIR BOX END**				

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Current Ford Service Part Number	Current Ford Engineering Part	Description
BM5Z9F972A	BM5G9F972BA	**SENSOR - FUEL INJECTOR PRESSURE**
BR2Z9E499A	BR2E9E499AA	**CONNECTOR, VAC CONTRL, T/C**
CB5Z6K682F	CB5E6K682BF	**TURBO CHARGER**
CB5Z8592A	CB5E8592AB	**CONNECTION - WATER OUT, T/C**
CB5Z8K153B	CB5E8B535AC	**TUBE - WATER OUTLET**
CB5Z9424D	CB5E9424AF	**MANIFOLD ASY - INTAKE**
CB5Z9S468C	CB5E9S468AF	**HOSE, EMS (VAC HARNESS)**
CJ5Z9J323B	CJ5E9J323BC	**TUBE ASY FE PMP TO FE MAN**
CM5Z12029A	CM5E12A366CA	**COIL ASY - IGNITION**
CP9Z9E926A	CM5E9F991AD	**THROTTLE BODY AND MOTOR ASY**
D4ZZ7600A	D4ZA7120AB	**SLEEVE, PILOT BEARING**
DU5Z12A581U	DU5T12C508UE	**WIRE ASY, ENGINE MAIN**
YS4Z6766A	YS4G6766DA	**CAP ASY - OIL FILLER**
5M6Z8509AE	5M6Q8509AE	**PULLEY - WATER PUMP**
AG9Z6312B	AG9E6D334AA	**PULLEY - CRANKSHAFT**

SPECIAL PARTS	(A1.7)
OHT PART NUMBER	**DESCRIPTION**
OHTVH-005-1	HOUSING, FLYWHEEL
OHTVH-006-1	FLYWHEEL, MODIFIED, 2.0L
K0047-07	CLUTCH (SACHS)
VH006-8-2	PLATE, PRESSURE
OHTVH-007-1	HARNESS, DYNO, 2.0L
OHTVH-008-1	INLET, COOLANT
VH008-1	CLIP, RETAINER, SENSOR, COOLANT INLET
VH008-2	SEAL, COOLANT INLET
OHTVH-009-1	OUTLET, COOLANT
VH009-6	SEAL, COOLANT OUTLET
OHTVH-011-1	SHIM, CLUTCH PRESSURE PLATE
TEI	CYLINDER HEAD, INSTRUMENTED
OHTVH-004-1	MOUNT, FRONT, FORD 2.0L
85 ESCORT	RUBBER ISOLATOR, FRONT MOUNT
6628-A	RUBBER ISOLATOR, REAR MOUNT (Quicksilver)

Service tools (A1.8)

Camshaft alignment tool

Timing peg

Crankshaft position sensor alignment tool

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FP-FR TUBE, VAC PMP			
VCT VLV, OIL SQRT			6
lley			
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POS SNS			
ck			
NER SIDE			
TER			

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sher			
ft side of block			

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