Ford Timing Chain Wear Procedure

Revision 6

Contents

Engine Teardown

Completely tear the engine apart. The only components not removed from their original position are the main bearings and rod bearings. Once the bearings are removed they never go back in in the exact same position, the measurements begin to vary after that. The engine needs to be rebuilt to remove stuck rings which is typical and can adversely affect blowby. First run engines need to be rebuilt also so they have a consistent bore finish with subsequent tests. Each engine can be run for a maximum of six runs.

Engine Measurements

The following measurements are taken before each test. They must meet the service limits in the 2012 Explorer workshop manual:

- Cylinder Bore measurements (top, middle, bottom). Using the bore ladder in Figure A1.4.
- Piston Ring Gaps (top and second ring).
- Main and rod journal measurements (horizontal diameter, vertical diameter, bearing inside diameter, clearance).
- Intake and exhaust valves measurements (guide diameter, stem diameter, clearance).
- Intake and exhaust valve spring measurements (spring free length, spring tension).
- Intake and exhaust valve lash measurements.

Engine Cleaning

After all the measurements, the engine is ready for cleaning. Put all of the following components into ultrasonic parts cleaner for 30 minutes:

- Cylinder block with main bearings. Oil jets are removed.
- Bare pistons without wristpins (The piston compression and oil rings are removed from each piston prior to going into the ultrasonic cleaner, they will get replaced with a new set)
- Bare cylinder head (No valvetrain components)
- OHT oil pan
- Front cover

The ultrasonic parts cleaner being used is made by Tierra Tech model MOT500NS, the solution is also provided by Tierra Tech. Ultrasonic solution 7 and B are used as described below:

Add solution once ultrasonic machine reaches a minimum of 140°F. DO NOT add the degreasers until the ultrasonic machine has reached a temperature of 140°F.

a. 5 ½ gallons of ultrasonic solution 7
b. ½ gallon of ultrasonic solution B
c. Change the soap and water solution at least after every 25 hrs. of use.

*Note: The solution shown above is based upon the MOT-500NS model (158 gallon capacity).

After 30 minutes, the parts are removed and immediately sprayed with hot water, then solvent and left to air dry.

The remaining components are spray cleaned with Stoddard solvent then blown out with pressurized air and left to air dry:

- Camshafts and all valve train.
- Intake manifold/ Throttle body (not being separated)
- Fuel pump housing with piston.
- Vacuum pump and oil screen.
- Intake and outlet of the turbocharger are lightly wiped down with solvent. The oil screen is also cleaned. (We don't clean the inside of the turbocharger)
- The carbon build up on the injectors is wiped of
- Oil Pump
- VCT solenoids are sprayed with solvent.
- Valve Cover
- Turbo charger oil lines
- Oil separator (PCV housing on the cylinder block)
- Oil pick up tube
- Oil squirters/jets
- Crankshaft
- Rods and pins
- All valvetrain
- The test batch camshaft sprockets and crankshaft gear.
- The test batch timing chain is cleaned as described in the *Timing Chain Cleaning Procedure.*

Engine Rebuild

After everything is cleaned, the engine is reassembled following the procedure in the 2012 Ford Explorer workshop manual. Below are the modifications and procedure that specifically apply for this test:

- Do not install the balance shaft housing; it cannot be used with the OHT oil pan. The balancer is removed and the oil passage is plugged with a CFM Balance Shaft Delete Kit (Part number 1-0180).
- Install a dummy PCV valve (PCV valve with the internal components removed) in oil separator on the side of the engine block. A functional PCV is located at the stand in the external crankcase ventilation system.
- The crankshaft is polished with 400 grit 3M utility cloth while it is still lightly coated in Stoddard solvent. A final finish is given using 600 grit crocus cloth. The crankshaft is cleaned with Stoddard solvent for the final time.
- The valves are lapped and new intake and exhaust valve seals are installed.
- The heater hose tube is removed from the block as shown in Figure 1 and plugged with a 5/8" freeze plug coated in RTV.

Figure 1: Cylinder Block Heater Hose Tube

- **<u>Deglazing Procedure</u>:** Deglazing is performed after ultrasonic cleaning under the following conditions to achieve a 9ra to 13ra and 30+5 degree crosshatch:
    1. Mount the engine block in an engine stand or suitable fixture so it is secure and will not move during deglazing operation.
    2. Rinse cylinder bores with Stoddard solvent.
    3. Deglaze cylinder bores using drill and hone shown in Figure 2 and Figure 3.
    4. Run the drill at 500 rpm horizontal drill speed for 25 to 35 vertical strokes over elapsed time of 20 to 25 seconds. There should be a steady supply of lubricant supplied during each stroke.
    5. 50/50 ratio, Stoddard Solvent (mineral spirits) and EF411, is the hone lubricant used.

6. Clean cylinders after honing deglazing with warm/hot water or hot water and Tide detergent using a brush, then oil cylinders with EF411.
7. Replace ball hone after deglazing 24 engine blocks
8. Measure surface finish and crosshatch.

Figure 2: Pneumatic Honing Drill

<u>Pneumatic Honing Drill</u>
Brand: Westward
1/2 Reversible Air Drill
Model: 5ZL26G
RPM: 500
Max Psi: 90

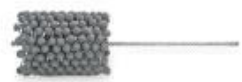

Figure 3: Cylinder Hone

<u>Flexible Cylinder Hone</u>
Brand: Flex Hone
Model: GB33432
Bore Dia.: 3-3/4"
Abrasive Material: Silicon Carbide Grit 320

- **<u>Crosshatch Procedure:</u>**

Materials:

1. Hatchview Software (http://digitalmetrology.myshopify.com/products/hatchview)
2. USB microscope.
3. Computer System Requirements: Windows XP, Vista or Windows 7 (32 or 64 bit), an available USB 2.0 port is required for live “video” viewing.

Preparation:

1. Cylinder should be clean of any oil or residue from honing to maintain consistency of measurements.
2. Adjust focus of camera while face of the camera is placed against the cylinder wall.
3. Set camera resolution to 640x480 and 30 fps.
4. Use the identification feature available in the program to title the image with cylinder number and test number.

Measurement:

1. The measurement is taken at the rear most longitudinal position of each cylinder.

2. The measurement is taken at 1.5 in. down from the top of the cylinder deck. A ruler is used to measure.
3. The measurement is to range for 25° to 35° with a target of 30°

- The piston rings are cleaned and wiped with EF411 to get the factory coating off. The 1st ring is gapped to .070” and the second ring is gapped to .075”. These gaps have been shown to produce acceptable blowby levels but may need to be adjusted to achieve the blowby levels in Table 9. The ring placement is 1.5” from the deck using ring positioner shown in Figure A1.3.
- The Ford gasket kit Part # CJ5Z6079D is used to replace the necessary gaskets.
- The engine is assembled according to the procedures in the 2012 Explorer workshop manual. All parts are lightly coated with EF411 oil.

- **Chain and Camshaft Installation Procedure:** Measure the test chain according to the *Timing Chain Measurement Procedure* prior to installing it in the engine. Install camshaft and timing chain according to the procedure in the 2012 Explorer work shop manual. If using the Ford camshaft alignment tool (Ford P/N 303-1565) be sure not to let it bind in slots at the rear of the camshafts. It should be loose after the timing chain installation is complete. Be sure camshaft positioning tool is flat before installing. Use a spanner on the harmonic balancer or a flywheel lock to hold the crankshaft. Alternate method, the crankshaft positioning crankshaft TDC timing peg (Ford P/N 303-507) can be used to hold the crankshaft in place while performing this installation. Install the timing chain with the lettering on the black link facing forward. This will insure the chain is installed in the same orientation if/when it is removed and reinstalled during the test. Coat the timing chain with test oil every time it is installed in the engine. Install the chain tensioner and guides according to the 2012 Explorer workshop manual. After tensioner is installed and the pin is pulled from the tensioner to release the tensioner arm, do not move or apply any force to the tensioner arm.

Hardware

Table 1: Rebuild Components

Rebuild Components			
Part Description	**Part #**	**Times per use**	**Quantity**
Head gasket	CJ5Z6051A	1	1
Head Bolts	AG9Z-6065-A	1	10
Main Bolts	AG9Z-6345-A	2	10
Exhaust/Turbo Gasket	CJ5Z9448A	1	1
Turbo Oil Return Gasket	CJ5Z6N652A	1	1
Pick up tube O-ring	3M4Z6625AA	1	1

Oil Filter Adaptor Gasket	1S7Z6840AA	1	1
Rear seal	1S7Z6K301BA	1	1
Front Seal	CM5Z-6700-A	6	1
Oil Cooler	BB3Z6A642A	1	1
*Timing Chain	CJ5Z-6268-A	1	1
*Crankshaft Gear	CJ5Z-6306-A	1	1
*Exhaust Camshaft Gear	CJ5Z-6C525-A	1	1
*Intake Camshaft Gear	CJ5Z-6256-B	1	1
*Chain Arm	CJ5Z-6K255-A	1	1
*Chain Guide	CJ5Z-6K297-A	1	1
*Chain Tensioner	CJ5Z-6K254-B	1	1
Cam Bolt	CV6Z-6279-A	1	2
Cam Diamond Washer	6M8Z-6278-A	1	2
Crank Bolt	1S7Z6A340AA	1	1
Crank Diamond Washer	1S7Z6378AA	1	2
Spark Plugs	CYFS12Y2	1	4
Pilot Bearing	D4ZZ7600A	1	1
*Piston Ring Kit	AG9Z-6148-A	1	4
Intake Valve Seal	3S4Z6571AA	1	8
Exhaust Valve Seal	1S7Z6571EA	1	8
Oil Pump Chain	CM5Z6A895A	1/engine	1
OHT pick up tube	OHT	reused	1
Oil pan w/ dipstick	OHT	reused	
Pick Up Tube Gasket	3M4G6625AA	1	1
Pilot Bearing	D4ZZ-7600A	1/engine	1
Fuel Pump Housing Gasket		1	1

*Batch controlled

Most of the gaskets and head bolts listed above come in the Ford gasket kit part # CJ5Z6079D.

Table 2: Additional Parts

Additional Parts		
Part Description	**Vendor**	**Part #**
Flywheel bolts	Ford	1S72-6379-AA
Acc Belt Tensioner	Ford	AE50-6A228-AA
Belt	Dayco	6PK1082
Starter	Ford	BB5Z-11002-A
Engine Mounts	Quicksilver	6628-A
Intercooler	www.frozenboost.com	Type 5 or 52
Oil Separator	Moroso	85485
HX for blowby		

Driveline	Machine Services Inc.	MSI-41/555-22
Inlet and Outlet water necks	OHT	
Flywheel	OHT	
Cluthch w/ pressure plate	OHT	
Clutch spacer	OHT	
Bellhousing	OHT	
Dyno Harness	OHT	

Timing Chain Measurement

- **Timing Chain Cleaning Procedure:**
  1. Place a brand new timing chain into an ultrasonic bath with Stoddard solvent for 20 minutes.
  2. Remove the chain from the ultrasonic cleaner and dip into room temperature Stoddard solvent to cool chain. Dip the chain in heptane or solvent 142 to prevent rust before measuring.
  3. Let the chain dry and cool off for at least 2 hours in the metrology lab before starting the measurement procedure. This will allow the temperature of the chain to stabilize. After measuring the chain coat with test oil.

- **Timing Chain Measuring Procedure:** Use chain measurement apparatus shown in Figure 4.

Figure 4: Chain Measurement Apparatus

1. Check calibration standard on measurement apparatus. If the indicator reading is less than ±0.0005" proceed to next step. If reading is larger, then investigate source of error.
2. Orient the sprockets of the measurement apparatus such that they are aligned with their alignment orientation marks.

3. Install chain on measurement apparatus with the “key” link in the standard (aligned) location.
4. Insure that the USB digital interface cable between the indicator and the computer is connected and that the first cell of the spreadsheet is selected into which the data will begin being entered.
5. Energize the drive motor on the chain measurement apparatus and run until a minimum of 30 chain lengths worth of reading have been captured (207 sprocket revolutions).
6. When complete, examine the averages for the three measurement ranges and verify the total range does not exceed ±0.0003”; if it does, repeat the measurement by overwriting the data.
7. Chain elongation = 2* (measurement-initial measurement)/nominal chain length. The nominal chain length is 43.125”.

Stand Installation/ Maintenance

- **Crankcase Ventilation System:** The metal parts of the crankcase ventilation system get flushed with Carburetor cleaner (Chemtool B12) or any equivalent solvent after every test. Then blown out with pressurized air and are left to air dry. All the hoses (ie tygon) get replaced every test. If using a smooth bore Teflon braided stainless steel hose, these can be reused after cleaning in an industrial degreaser (Penmul L460). A diagram of the crankcase ventilation system is shown in Figure 5.

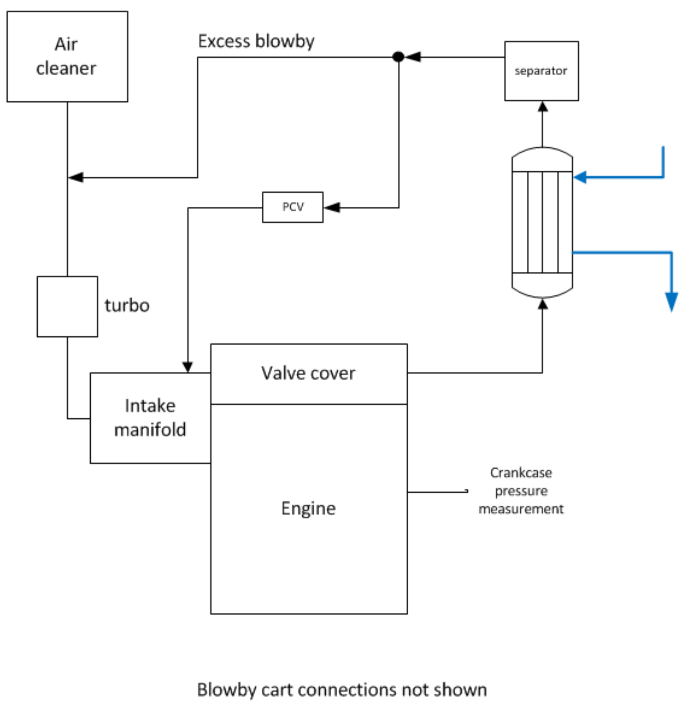

Figure 5: Crankcase Ventilation System

- **Blowby Heat Exchanger and Oil Separator:** Use ITT Heater exchanger S-160-02-008-002 and Moroso oil separator, Part number 85487. Disassemble and soak both in Penmul L460 for 24hrs. Rinse with hot water, then rinse a final time with Stoddard solvent and let air dry.

- **Stand Alignment:**
  - Roll Angle: 0 degrees
  - Driveline Degree: 2 degrees
  - Tilt: 0 degrees
- **Engine Mounts/Brackets:** Four motor mounts are used (Quicksilver part# 6628-A) as shown in Figure 6 and Figure 7. Drawings of the mount brackets can be found in the Figure A1.1 and Figure A1.2.

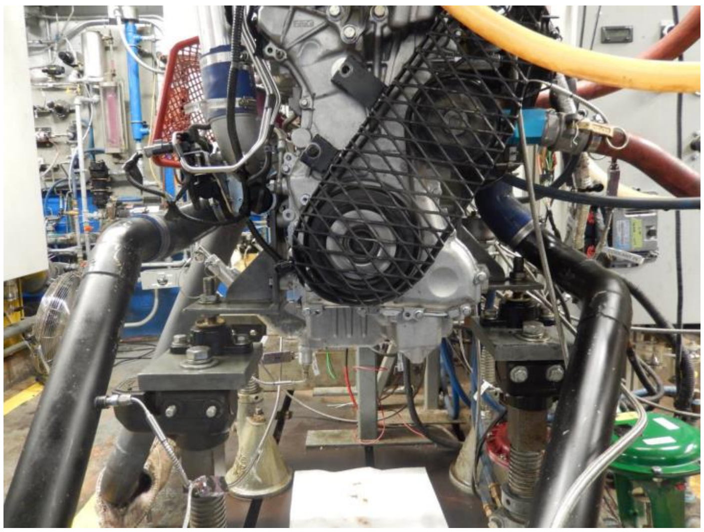

Figure 6: Motor mounts front

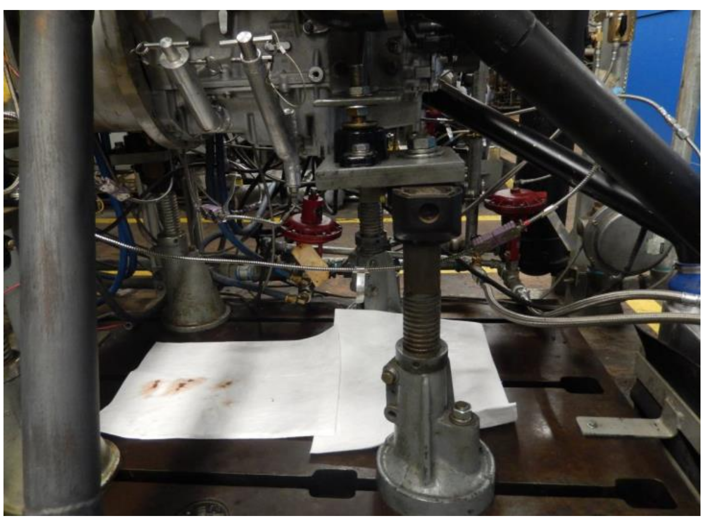

Figure 7: Motor mounts side

- **Water to Air Turbocharger Intercooler:** Use Type 5 or Type 52 intercooler from www.frozenboost.com. 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.

- **Intercooler Tubing:** Fabricate the intake air system with 36±6 inches long 2 inch ID stainless steel tubing from the turbocharger to the intercooler and 36±6 inch 2 1/2 inch ID stainless steel tubing form the intercooler to the throttle body. Locate the MAPT sensor 12±1 inches from the intake surface of the throttle body and the intake air charge temperature thermocouple 1 inch downstream from the MAPT sensor. The post turbo boost pressure measurement probe should be placed a minimum of 12 inches upstream from the MAPT sensor. The measurements can be seen in Figure 8.

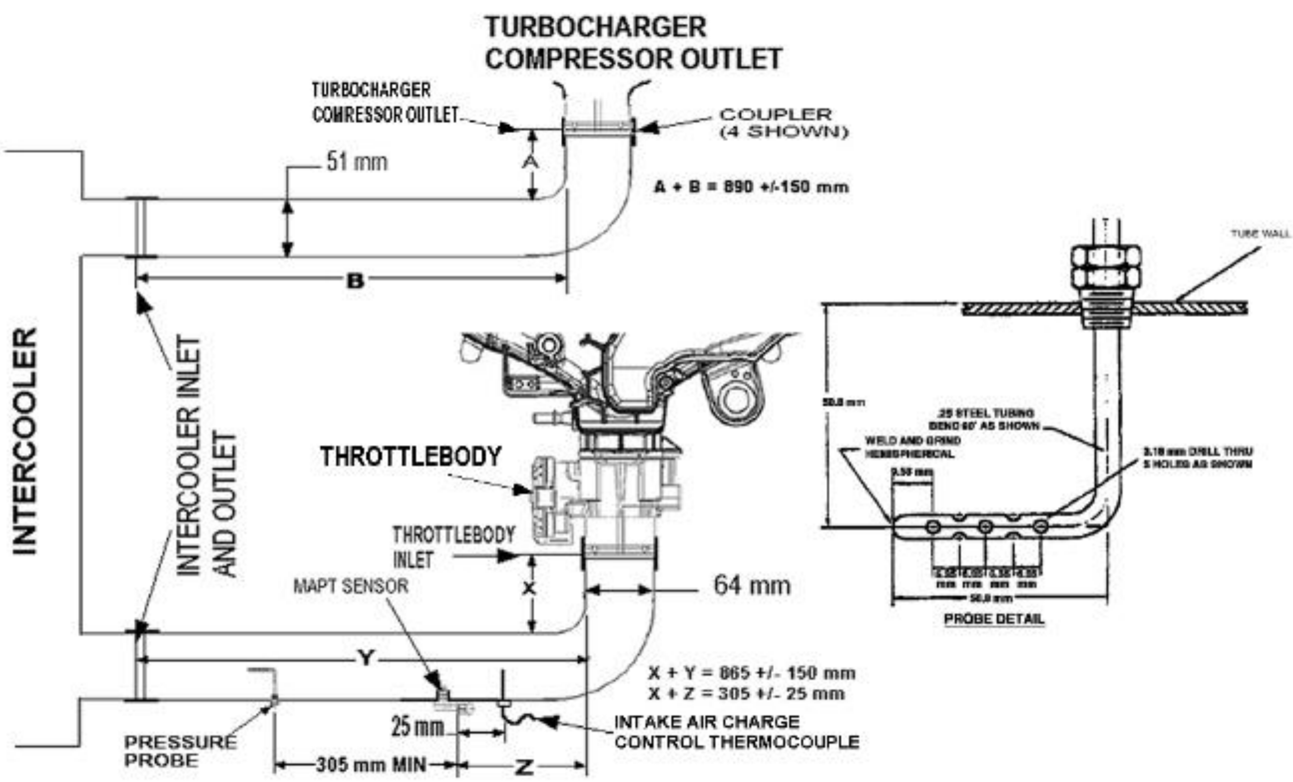

Figure 8: Intercooler Tubing Measurements and Instrumentation

- **Exhaust:** Figure 9 illustrates how the exhaust is instrumented.

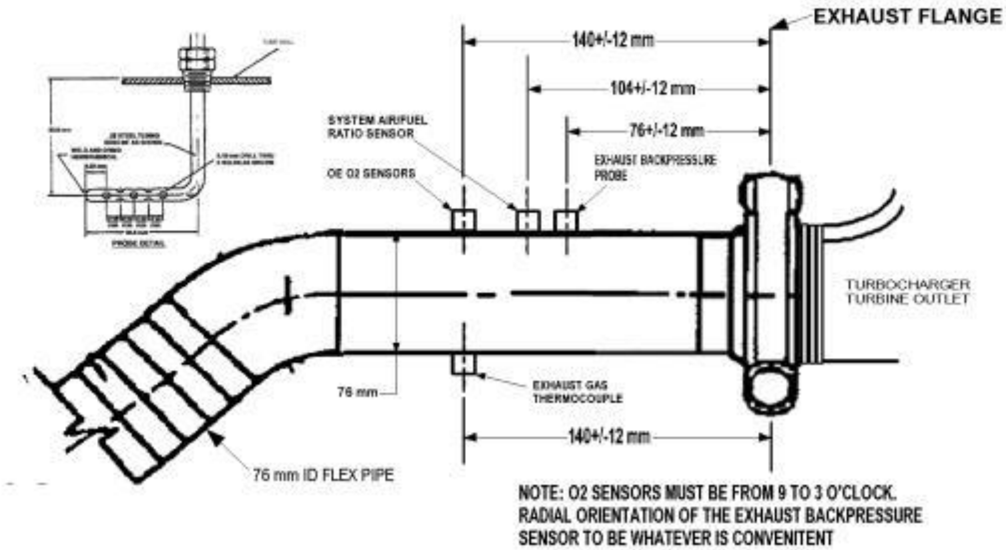

Figure 9: Exhaust Measurements and Instrumentation

- **Flywheel:** The flywheel bolts get lightly coated with Loctite 565 to prevent any oil from seeping. Torque the flywheel to 108-115 Nm.

- **Clutch and pressure plate:** Install the clutch, pressure plate and spacer supplied by OHT in Table 2. Put the flat side on the clutch toward the engine. The spacer goes between the flywheel and pressure plate. Each clutch gets replaced every 6 runs.

- **Driveline:** The driveline is greased every test. Driveline specifications:
  - 21.5" collapsed length from flange to flange
  - 1410 series flanges
  - 2.75" pilot
  - 3.75" bolt circle
  - 3.50" x .083" stub and slip

- **Coolant:** The stand receives Shell Zone Dex-Cool concentrate mixed 50/50 with deionized water.

- **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 U5J0110D1VEPfn13_78_2.

- **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 3.The wiring schematic and pin-out description for this connection is shown in Figure 10.

Table 3: 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			

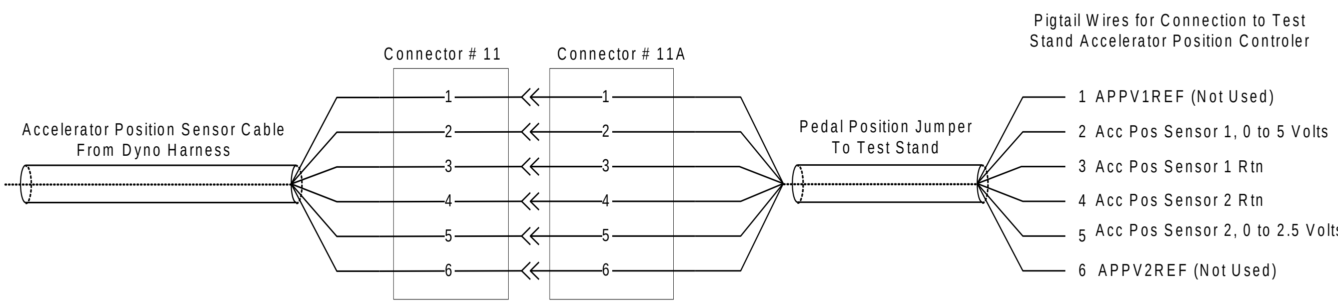

Figure 10: Accelerator Position Wiring Schematic

Engine Break In

Be sure the test chain has been measured according to the *Timing Chain Measurement Procedure* before running the break in.

The break in procedure shown in Table 4 has 12 stages and is 8.25hrs long. There are 30 second ramps between stages that are counted as part of the 8.25hrs. The engine is flushed during the break-in procedure. There are a total of 3 oil flushes as shown in Table 4; the oil is drained for 15 minutes after each flush. The timing chain is removed from the engine after break in and cleaned then measured. The chain is lubricated in new test oil before being reinstalled.

Table 4: Ford 2.0L Ecoboost Break in Procedure

Stage	Speed (RPM)	Load (N-m)	Time per stage (Hr:Min)	Total Time (Hr:Min)
Charge engine with 3600 grams of new test 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. Add 3600 grams of new oil and install new oil filter				
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				
Oil Flush 2- Shut engine down and drain used oil and remove oil filter. Add 3600 grams of new oil and install new oil filter.				
12	Idle	0	0:15	8:15
Oil Flush 3- Shut engine down and drain used oil and remove oil filter.				

Remove the timing chain for cleaning and 0hr measurement according to the *Timing Chain Cleaning Procedure* and *Timing Chain Measurement Procedure*. After measuring the chain, coat the chain in new test oil and install it back into the engine using the procedure described in the *Chain and Camshaft Installation Procedure*. Add 3600 grams of new test oil for the final oil charge.

Only the parameters listed below in Table 5 are controlled during the break in. All other controls are left wide open/free flowing. The controlled parameters may not hit their set points until around the beginning of stage 3 when the engine is fully warm. A fan can be used to cool the turbocharger during the break if necessary. The fan cannot be used when running the test cycles.

Table 5 : 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

Test Start

The test is ready to begin when the timing chain is reinstalled after the break in measurement and the final test oil charge is added. Conduct the test according to the operational parameters shown in Table 6. The test stages and ramps are shown in Table 7.

Table 6: Test Operational Parameters

Parameter	Units	Stage 1	Stage 2
Duration	Min	120	60
Engine Speed	RPM	1550	2500
Torque	NtM	50	128
Oil Gallery Temperature	degC	50	100
Coolant Out Temperature	degC	45	85
Coolant Flow	LPM	40	70
Blowby HX Flow	LPM	12	
Inlet Air Pressure	kPa	0.05	
Inlet Air Temperature	degC	32	
Exhaust Back Pressure	kPa	104	107
Air Charge Temperature	degC	30	
AFR	Lambda	0.78	1
Blowby HX Inlet Temperature	degC	20	85

- **Start of test**: Start the engine and let Idle for 5 minutes then start the 30 minutes ramp to stage 1 conditions. The 5 minutes of idle do not count toward the total test timer. Use the ramping conditions shown in Table 7. Use this same start up procedure when starting after each 24 hour shutdown.
  - Each cycle is 4 hours long and contains Stage 2-1 ramp 30 minutes, Stage 1 120 minutes, Stage 1-2 ramp 30 minutes, Stage 2 60 minutes.
  - First cycle after a shutdown and at start of test is 4 hours plus a 30 min ramp to stage 1 conditions, Stage 1 120 minutes, stage 1-2 ramp 30 minutes, stage 2 60 minutes and Stage 2-1 ramp 30 minutes.

- The ramps between stages are 30 second speed/load ramp and 30 minutes to stabilize at stage conditions.

Table 7 : Stages and Ramps

Stage	Description	Time (min)
Warm Up	Engine Idles	5
Stage 1.1	30 sec speed and load ramp,30min temperature ramp, to Stage 1	30
Stage 1	Stage 1 conditions	120
Stage 1.2	30 sec speed and load ramp, 30min temperature ramp, from stage 1 to Stage 2.	30
Stage 2	Stage 2 conditions	60
Stage 2.1	30 sec speed and load ramp, 30min temperature ramp, from stage 2 to Stage 1.	30

- **Test duration**: The test contains 54 cycles for a total of 216hrs.

- **Schedules shutdowns**: The engine is shut every 6th cycle for oil level check and to take an oil sample.

- **Oil Sampling and Leveling Procedure**: Run 30 min at Stage 2 conditions then 30 sec ramp to idle, idle for 5 minutes. Take the oil sample during these 5 minutes of idle. Purge 5 fl oz before taking oil sample. The oil sample size is 2 fl oz. After these 5 minutes of idle and the sample is taken, shutdown engine and immediately return the 5 fl oz purge back into the engine through the oil fill cap and let the engine sit 20 min before making oil level measurement. Table 8 further describes the *Oil Sampling and Leveling Procedure*.

Table 8: Oil Sampling and Leveling Procedure

	Test Hours	23.5	47.5	71.5	95.5	119.5	143.5	167.5	191.5	215.5
	Test Cycles	6	12	18	24	30	36	42	48	54
1	Engine idles for 5 minutes of stage time, take sample during this period	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.	5 min.
2	Remove a 150 ml (5 oz) purge:	5 oz.	5 oz.	5 oz.	5 oz.	5 oz.	5 oz.	5 oz.	5 oz.	5 oz.
3	Remove a 60 ml (2 oz) sample:	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.
4	Engine shuts down at 5 minutes of stage time. Record shutdown time:									
5	Return purge to engine; initial here:									
6	Oil level check time at 25 minutes of stage time (shutdown + 20 min.). Record oil level check time:									
7	Check oil level at 25 minutes of stage time. Read from center of dipstick. Record oil level in millimeters (mm):									
8	Re-start engine when ignition light comes on (after 30:00 minutes of stage time). Record start-up time:									

- **Blowby:** The first five stage 2 blowby measurements should average between 65 LPM and 75LPM. This can be seen in Table 9.

Table 9: 2nd Stage Blowby Readings

Stage 2 Blowby Readings		
Test Hours	Blowby Reading	Use these boxes for AVG.
Break In 2.5-2.7		
22.5-22.7		
46.5-46.7		
70.5-70.7		
94.5-94.7		
118.5-118.7		
142.5-142.7		Blowby average between 65-75LPM.
166.5-166.7		
190.5-190.7		
214.5-214.7		

Appendix 1

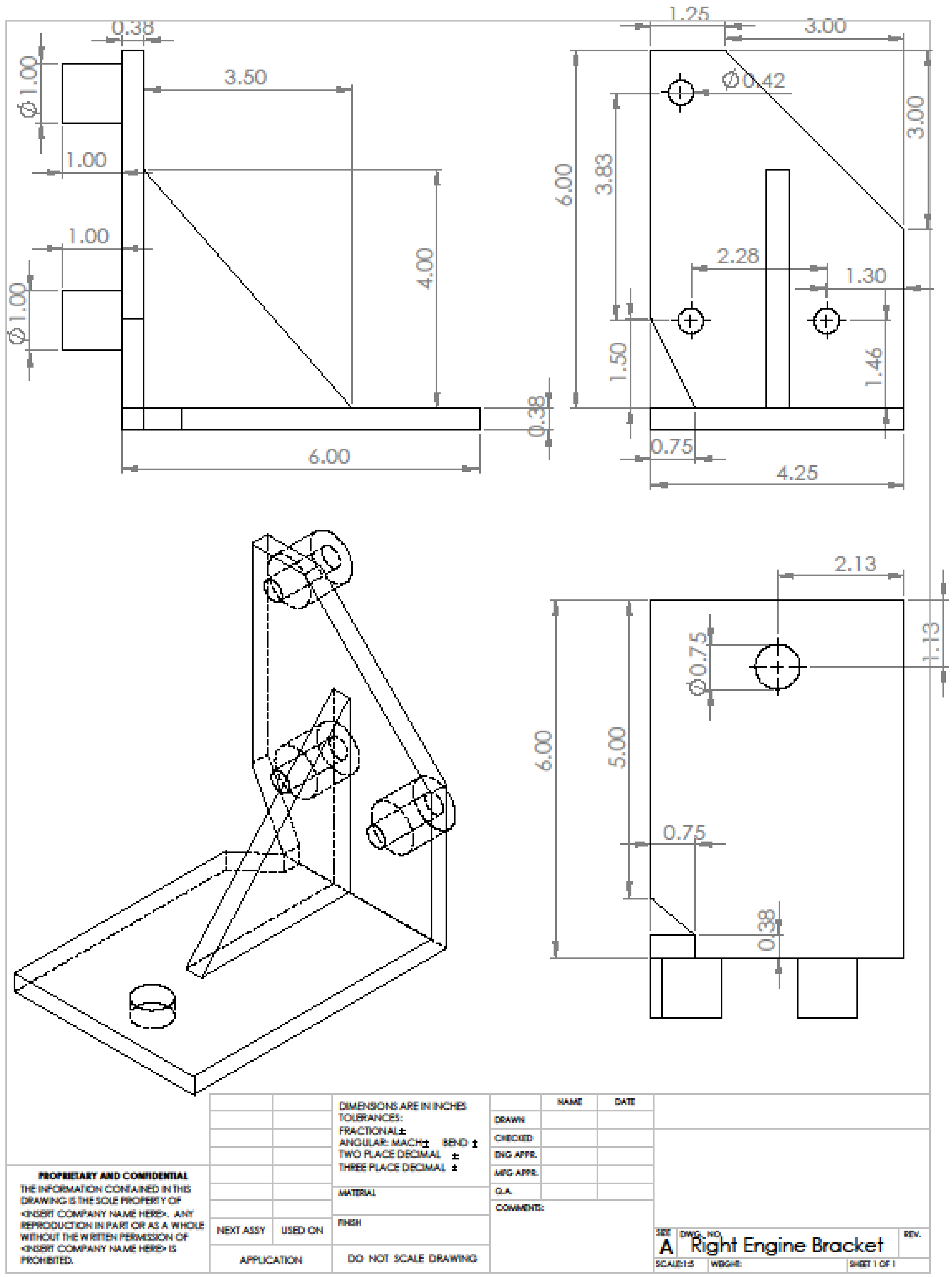

Figure A1.1: Right Engine Bracket

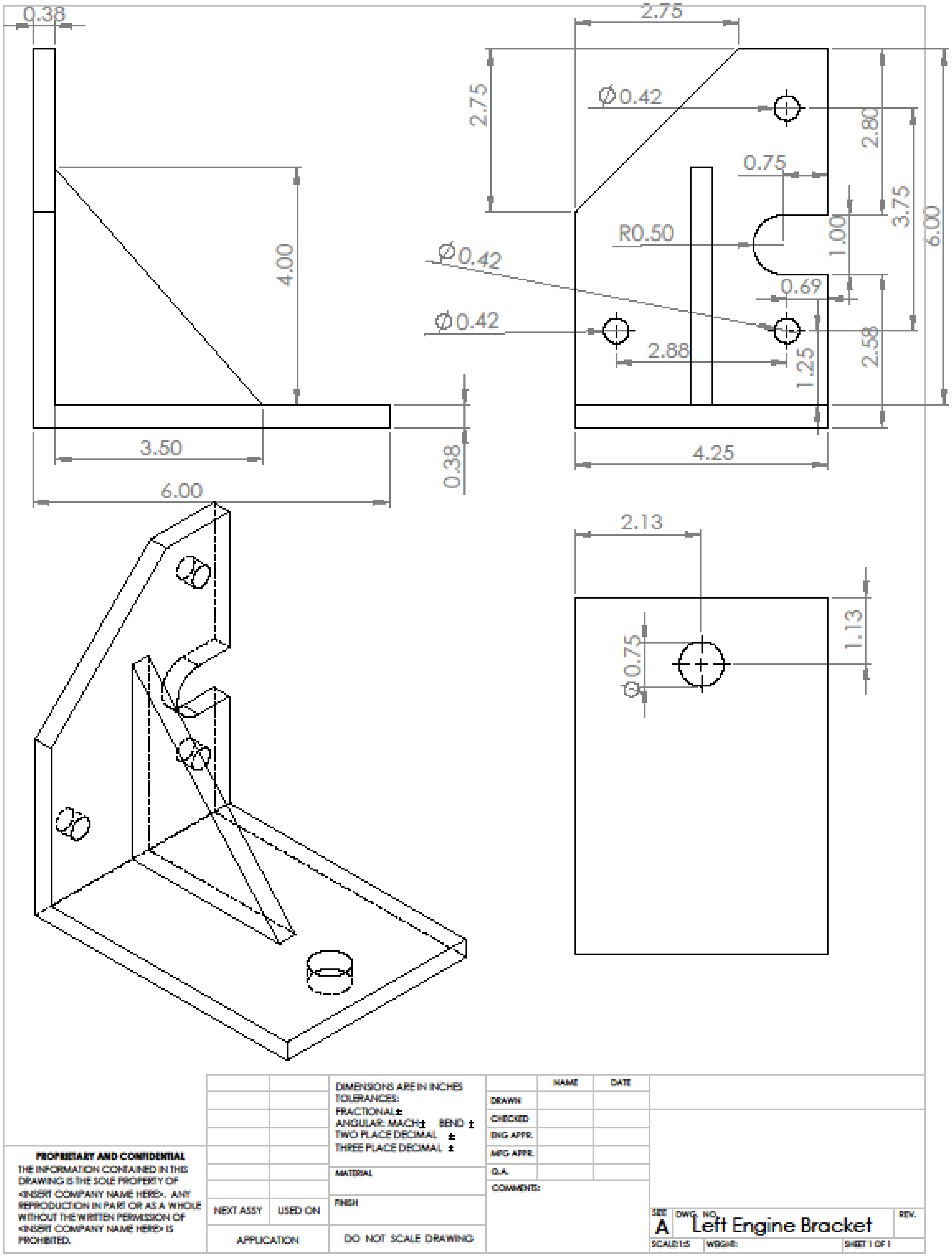

Figure A1.2: Left Engine Bracket

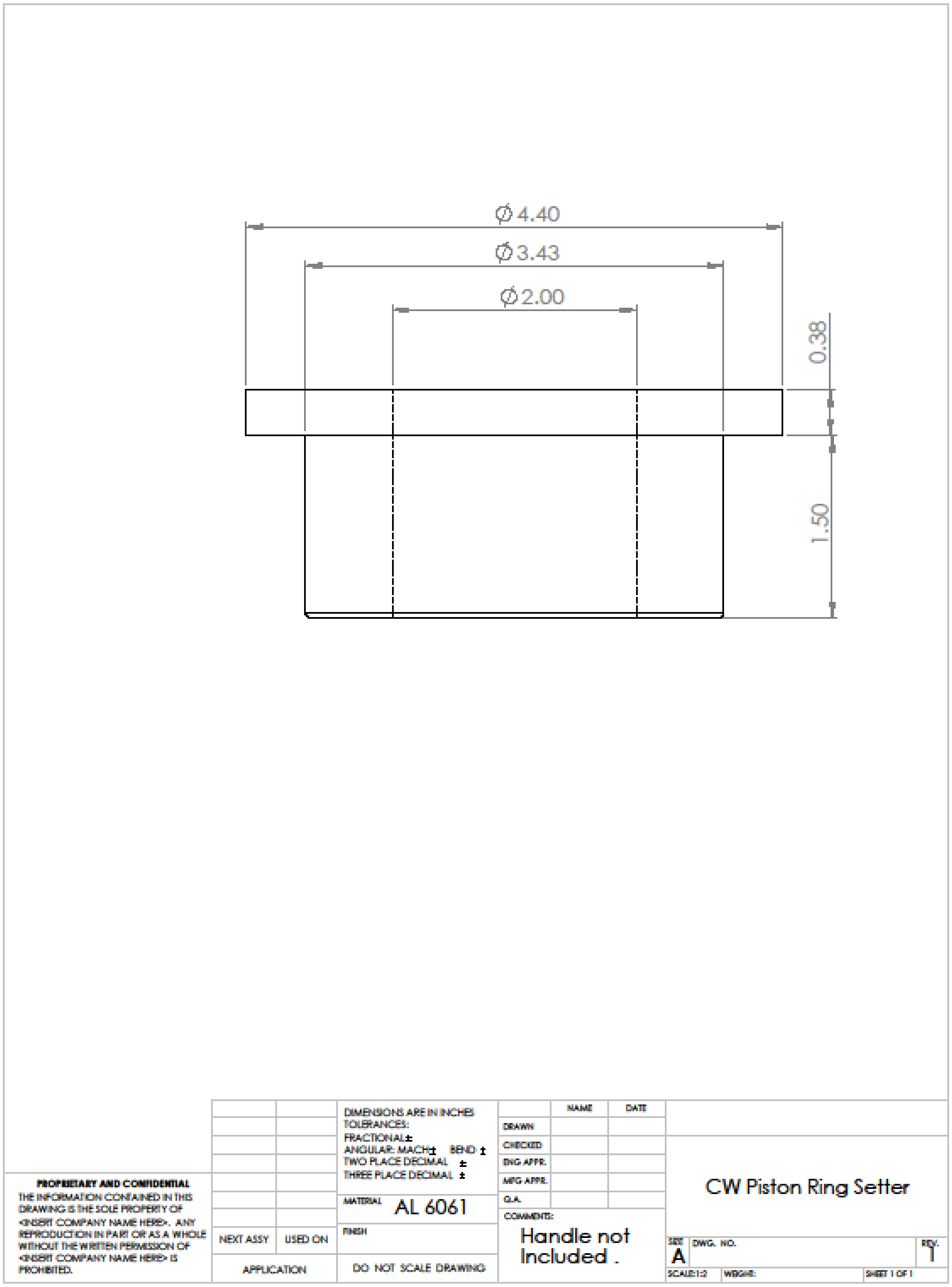

Figure A1.3: CW Piston Ring Setter

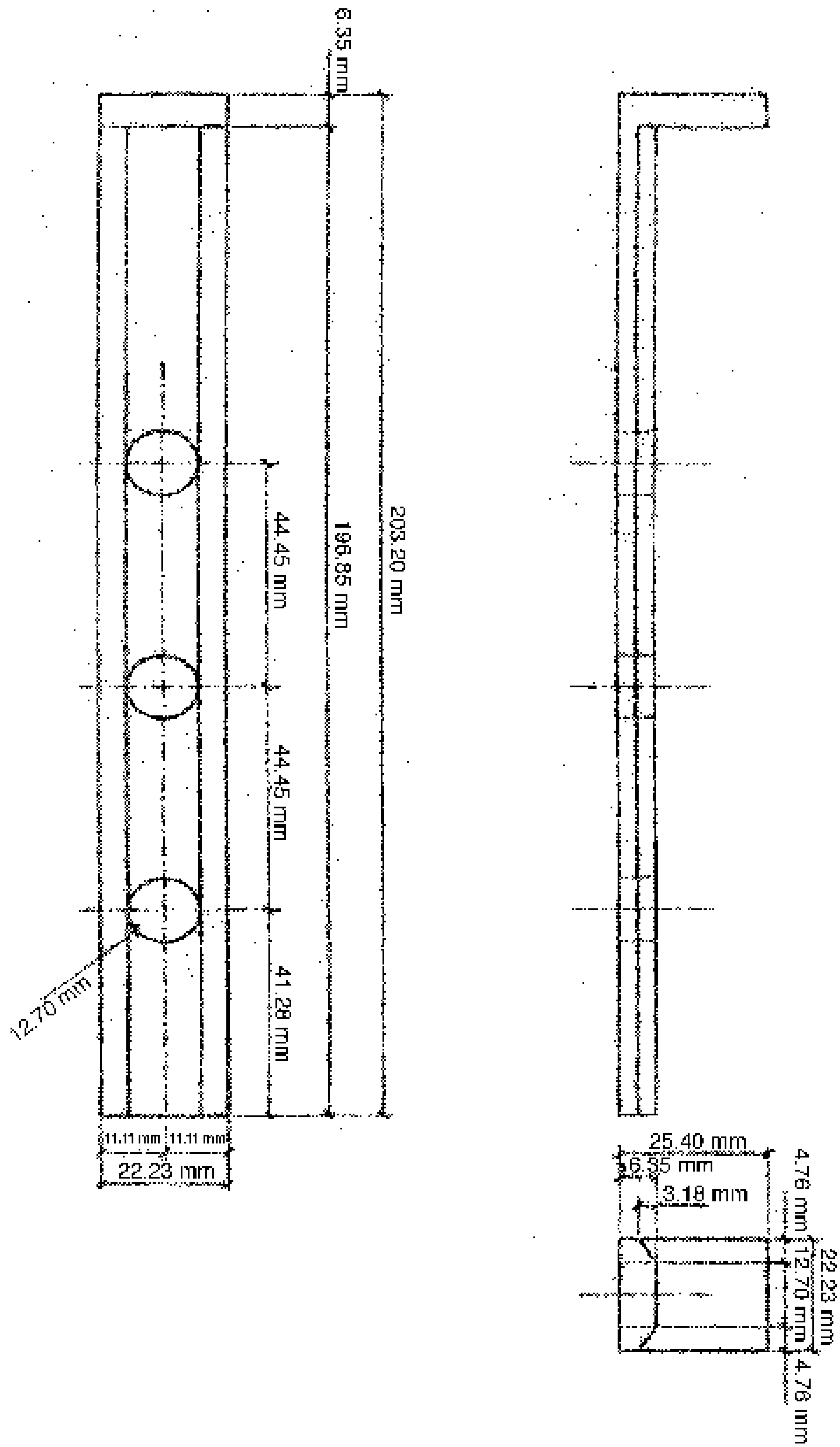

Figure A1.4: Bore Ladder

CW Head Build Data Sheet

Head #: ____________ **Engine #:** ____________

Head Run #: ____________ **Tests#:** ____________

Date: ____________

	Valve Guide Diameter (mm)	Valve Stem Diameter (mm)	Clearance (mm)
1A Intake			
1B Intake			
2A Intake			
2B Intake			
3A Intake			
3B Intake			
4A Intake			
4B Intake			

	Valve Guide Diameter (mm)	Valve Stem Diameter (mm)	Clearance (mm)
1A Exhaust			
1B Exhaust			
2A Exhaust			
2B Exhaust			
3A Exhaust			
3B Exhaust			
4A Exhaust			
4B Exhaust			

	Spring Free Length (mm)	Spring Tension @28.7mm
1A Intake		
1B Intake		
2A Intake		
2B Intake		
3A Intake		
3B Intake		
4A Intake		
4B Intake		

	Spring Free Length (mm)	Spring Tension @28.7mm
1A Exhaust		
1B Exhaust		
2A Exhaust		
2B Exhaust		
3A Exhaust		
3B Exhaust		
4A Exhaust		
4B Exhaust		

Intake Valve Lash Measurement (mm)	
1F	
1R	
2F	
2R	
3F	
3R	
4F	
4R	

Exhaust Valve Lash Measurement (mm)	
1F	
1R	
2F	
2R	
3F	
3R	
4F	
4R	

Head Flatness: ____________ **Mechanic Initials:** ____________

Figure A1.5: CW Head Build Data Sheet

CW Cylinder Bore Measurement Record

Block #: ____________ **Test #** ____________

Block Run #: ____________ **Date:** ____________

Cylinder Bore Measurements

Finish Target (RA):
Bore Gauge Set: XXX mm

Out of Round (limit): 0.0XXmm
Taper (limit): 0.0XX mm

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

Cylinder Number	Top Ring Gap (mm)	Second Ring Gap (mm)
1		
2		
3		
4		

REGAP/EOT

Cylinder Number (mm)	Top Ring Gap (mm)	Second Ring Gap (mm)
1		
2		
3		
4		

Approved ____________

Block Flatness: ____________ **Mechanic Initials:** ____________

Figure A1.6: CW Cylinder Bore Measurement Record

CW Engine Measurment Record

Engine Number: ______________________ **Date:** ______________________

Test Number: ______________________ **Technician:** ______________________

Main Bearing Journals (mm)

Journal Number	Horizontal Diameter	Vertical Diameter	Bearing Inside Diameter	Clearance
1				
2				
3				
4				
5				

Rod Bearing Journals (mm)

Journal Number	Horizontal Diameter	Vertical Diameter	Bearing Inside Diameter	Clearance
1				
2				
3				
4				

Crankshaft End Play (mm) ______________________

Figure A1.7: CW Engine Measurement Record