Ford Timing Chain Wear Procedure

Revision 3

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. We have found consistency in the measurements by not removing the bearings. Up to this point, the engines have been very clean after each test. The only reason for the rebuild has been stuck piston rings that adversely affect blowby. Each engine is good for a maximum of six runs.

Engine Measurements

The following measurements are taken before and after every test:

- Cylinder Bore measurements with torque plate installed (top, middle, bottom).
- 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. We are putting all of the following components into ultrasonic parts cleaner for 30 minutes or equivalent:

- 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

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)
- External oil separator (at the stand, used for blowby system)
- Heat exchanger (for blowby system)
- 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 marked and cleaned as described in the timing chain measurement procedure.

The ultrasonic parts cleaner being used is made by Tierra Tech model MOT500NS. 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).

Engine Rebuild

After everything is cleaned, the engine is reassembled following the specifications in the 2014 Ford Explorer workshop manual. Below are the modifications and procedures that specifically apply for this test:

- We are not using the crankshaft balancer; it cannot be used with the OHT oil pan. The balancer is removed and we plug the oil passage with a ½" freeze plug.
- The PCV valve on the engine block has been hollowed out; a functional PCV is located at the stand with the blowby tree/setup.
- The crankshaft is polished with 400 grit 3M utility cloth while it is still lightly coated in solvent. A final finish is given using 600 grit crocus cloth. The crankshaft is cleaned with solvent for the final time.
- The valves are lapped and new intake and exhaust valve seals are installed.
- The coolant tube shown below should be removed and plugged with a 5/8" freeze plug coated in rtv. The tube goes to the heater core when the engine is installed in a vehicle.

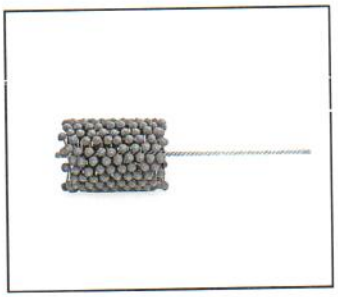
- **Honing Procedure:** Honing is performed after ultrasonic cleaning. Cylinders achieve a 9ra to 13ra and 45 degree crosshatch under the following conditions:

1. 500 rpm horizontal drill speed
2. 25 to 35 vertical strokes over elapsed time of 20 to 25 seconds
3. Stoddard solvent Pre-rinse

4. 50/50 ratio, Stoddard Solvent (mineral spirits) and EF411, hone lubricant.
5. Clean cylinders after honing with warm water or hot water and Tide detergent using a brush, then oil cylinders with EF411.

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

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



- 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". The ring placement is 1.5" from the deck.
- The Ford gasket kit Part # CJ5Z6079D is used to replace the necessary gaskets.
- The engine is assembled and all parts are lightly coated with EF411 oil. This includes also includes the timing chain and all other batched components.

Hardware

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?	1
OHT pick up tube	OHT	reused	1
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.

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	
Oil pan w/ dipstick	OHT	
Flywheel	OHT	
Cluthch w/ pressure plate	OHT	
Clutch spacer	OHT	
Bellhousing	OHT	
Dyno Harness	OHT	

Timing Chain Measurement

(The timing chain measurement procedure and hardware will change once we switch to a motorized rig)

Hardware:

1. The timing chain rig being used is from BHJ model# TSG-1-XL18.
2. Two pilot shafts from BHJ are also used.
3. Two crankshaft gears from the 2.0L Ecoboost engine are placed into the BHJ pilot shafts.
4. Large caliper able to measure up to at least 20 inches.
5. LSS Ultrasonic cleaner model 32V118.

Chain Cleaning Procedure:

1. Place a brand new timing chain into an ultrasonic bath for 20 minutes. The ultrasonic cleaner uses Stoddard solvent.
2. Let the chain dry and cool off for at least 2 hours before starting the measurement procedure.
3. The chain is cleaned in the ultrasonic cleaner before break in, after the break in, and at the end of test (-8hr, 0hr, 216hr).

Measuring Procedure:

1. Each timing chain has 69 links. Mark the timing chain at link 1 (black reference link), link 23, and link 46.
2. Place timing chain onto rig as show in photos below.
3. Rotate the chain around the gears until link one is at TDC.
4. Appiy 100psi to the rig and turn it on to get the slack out of the chain.
5. Turn the rig off and turn it back off. A measurement with the caliper at link 1 can now be taken.
6. Repeat steps 3 to 5 for links 23 and 46. This completes one full revolution of the chain and three measurements.
7. Take a second measurement at each of the three links for a total of six measurements and two full revolutions of the chain.

*** A reference chain is used to maintain the integrity of the measurements. Steps I to 6 are used every time for the reference chain prior to measuring a test chain.

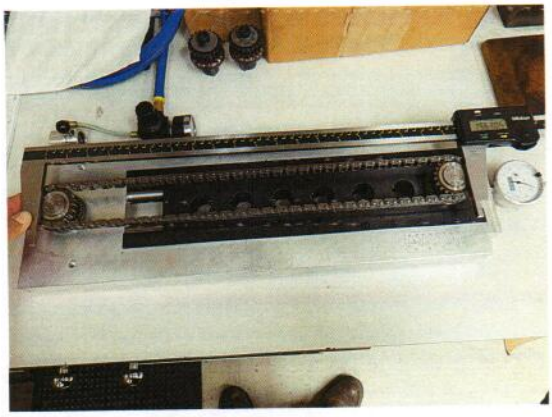
***The chain is left in metrology for 2hrs before the Break In, SOT and EOT measurements. This ensures that the chain has acclimated to the 70 deg C temperature in metrology.

Calculating Chain Stretch:

The average of the six chain measurements is taken as the final chain length. That value is then used in the equation below:

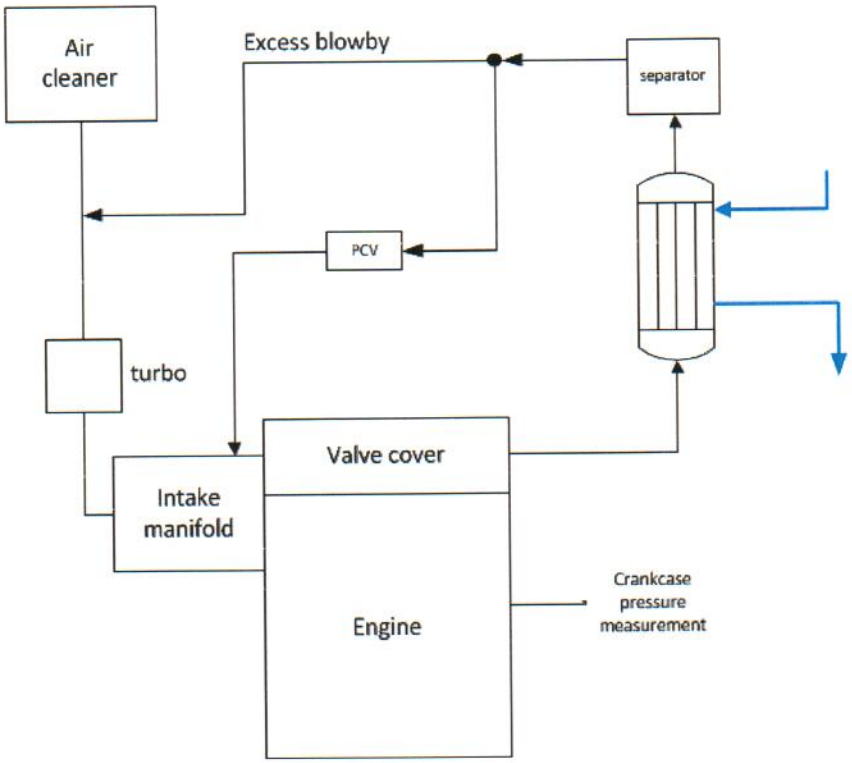
- (EOT-SOT) / (SOT) x 100%

  - SOT = average of measurements taken after the break in (t=0)
  - EOT = average of measurement taken at the end of the test (t=216hrs)
  - The measurement before break in is also taken to calculate the break in stretch.



Stand Installation/ Maintenance

- **Blowby System:** The blowby system gets flushed with B12 or any equivalent solvent after every test. Then it gets blown out with pressurized air and is left to air dry. All the hoses get replaced every test. The PCV on the engine is hollowed out. The diagram below outlines the blowby system.

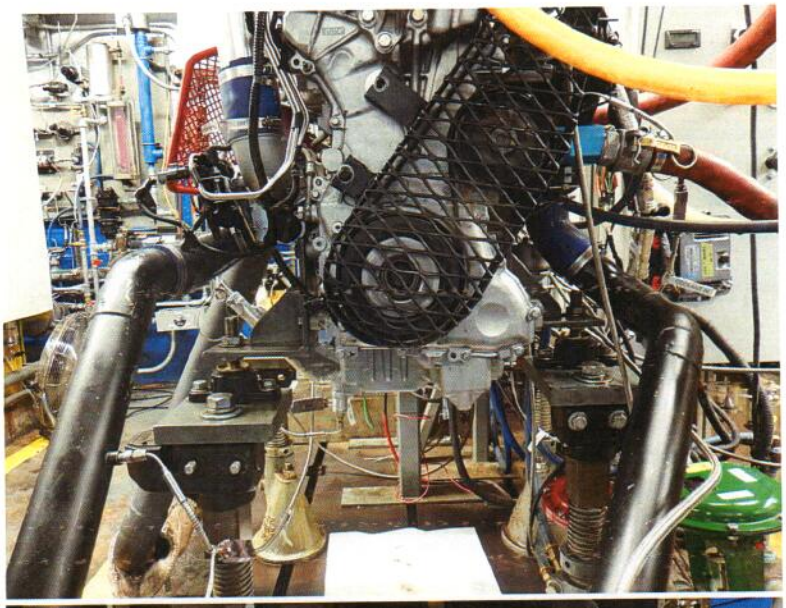


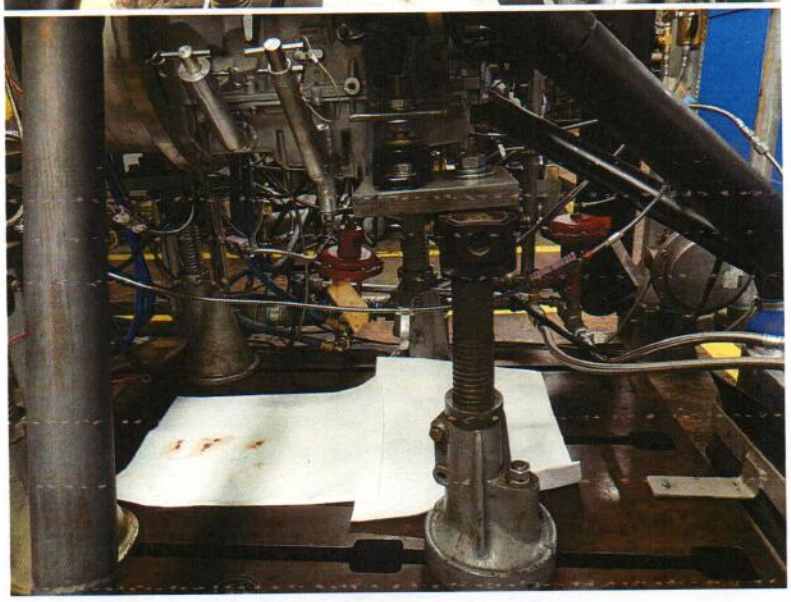
Blowby cart connections not shown

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 the photos below. Drawings of the mount brackets can be found in the appendix.





- **Water to Air Intercooler:** Type 5 or Type 52 intercooler from www.frozenboost.com. The intercooler catches significant amounts of blowby after each test. The air side of the intercooler is spray cleaned with Stoddard solvent, rinsed with hot water and left to air dry.

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

- **Clutch:** The clutch gets installed with the spacer supplied by OHT. The spacer goes between the flywheel and pressure plate. Each clutch gets replaced every 6 runs.

- **Driveline:** The driveline is greased every test.
- **Blowby HX and oil Seperator:** Leave both in Penmul L460 for 24hrs. Rinse with hot water, then rinse a final time with solvent and let air dry.
- **Coolant:** The stand receives Shell Zone Dex-Cool concentrate mixed 50/50 with deionized water.

Engine Break In

The break in procedure has 12 stages and is 8.25hrs long. There are 30 second ramps between stages that are counted as part of the 8.25hrs. There are a total of 3 oil flushes, the oil is drained for 15 minutes 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.

2.0L Ecoboost Break-in

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 -Drain used oil and change filter. Add 3600 grams of new oil.				
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
Oil Flush 2- Drain oil only. Add 3600 grams of new oil.				
12	Idle	0	0:15	8:15
Oil Flush 3- Drain used oil and remove oil filter.				
Pull the chain for cleaning and 0hr measurement.				
Coat the chain in new test oil and reinstall.				
Final Test Oil Charge- Add 3600 grams of new oil and new oil filter.				

Only the parameters listed below are controlled during the break in. All other controls are left wide open/free flowing. The controlled parameter will not hit their set points until around the beginning of stage 3 when the engine is fully warm.

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. Use fan on break-in

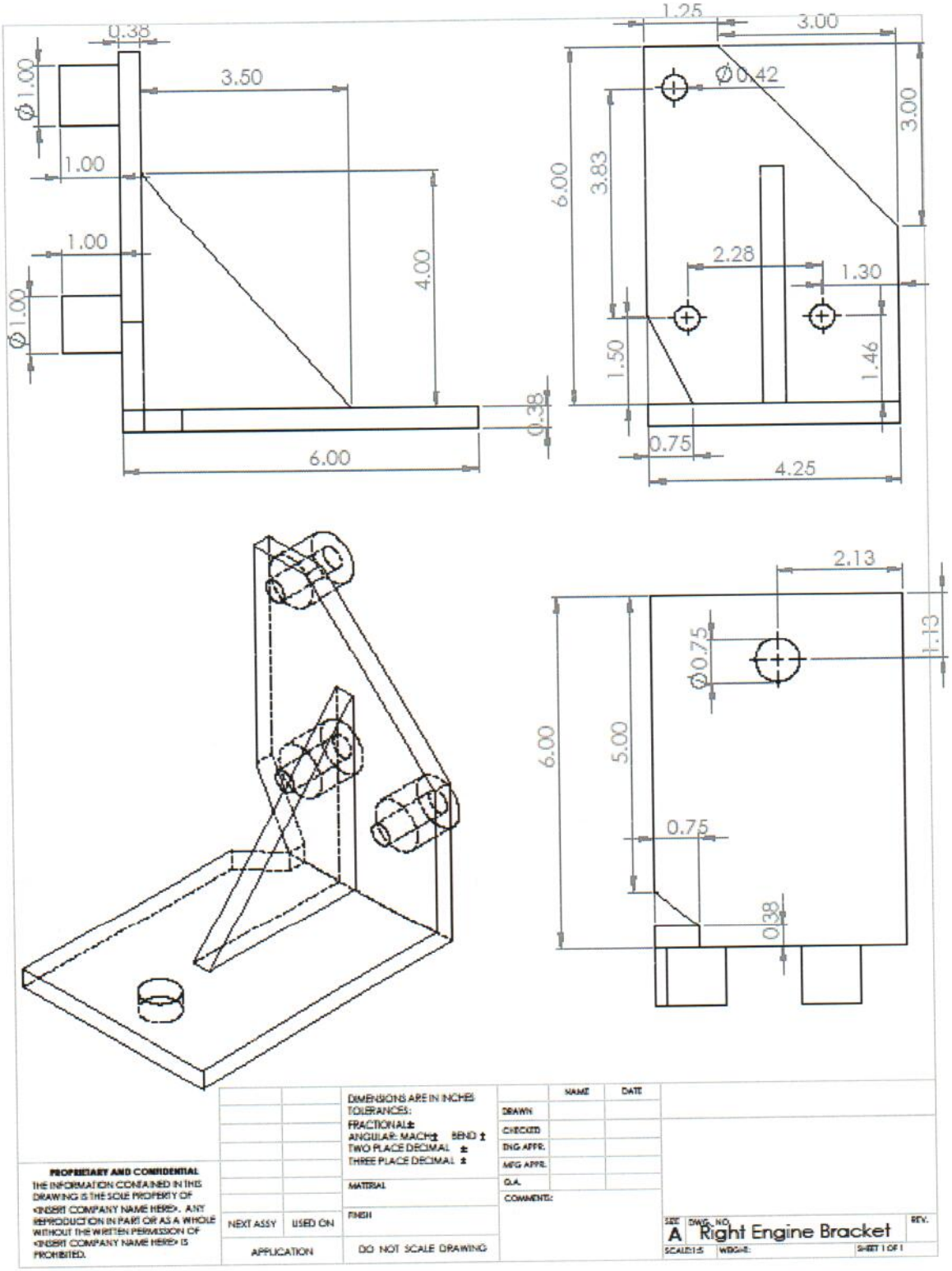
Parameter	Units	Stage 1	Stage 2
Duration	Min	120	60
Engine Speed	RPM	1550	2500
Torque	NtM	50	128
Oil Gallery Temperature	degC	50	100
Coolant Out Temperature	degC	45	85
Coolant Flow	LPM	40	70
Blowby HX Flow	LPM	12	
Inlet Air Pressure	kPa	0.05	
Inlet Air Temperature	degC	32	
Exhaust Back Pressure	kPa	104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

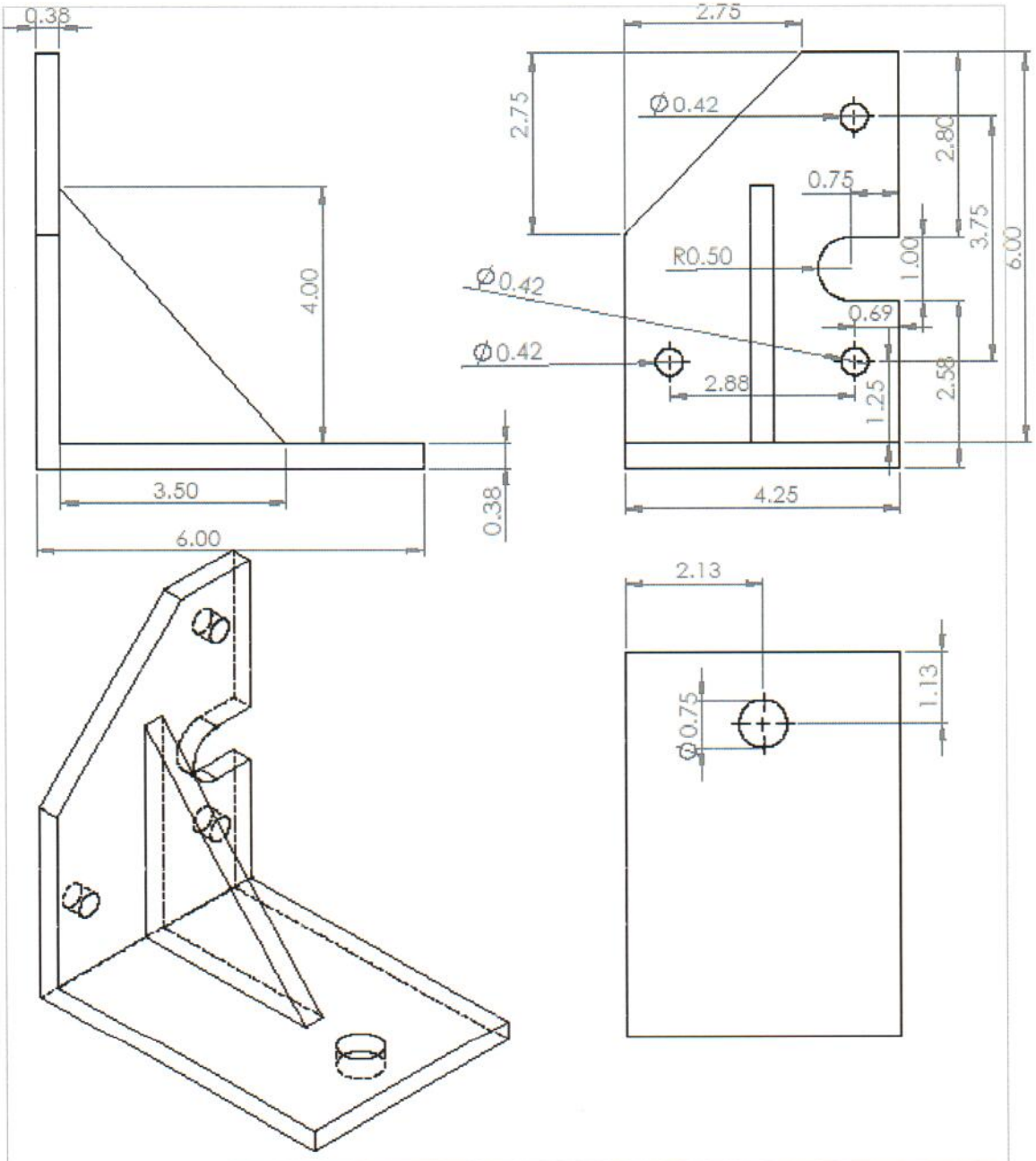
- Each cycle is 4 hours long and contains Stage 2-1 ramp, 30 minutes, Stage 1, 120 minutes, Stage 1-2 ramp, 30 minutes, Stage 2, 60 minutes.
- First cycle after a shutdown and at start of test is 4 hours contains 30 min ramp to stage 1 conditions (30 second speed/load ramp), Stage 1 120 minutes, stage 1-2 ramp 30 minutes, stage 2 60 minutes.
- Measure chain before the break in, after the break in/0h,r and at 216hrs.
- Run test for 54 cycles/216hrs.
- For 6th cycle shutdown procedure, run 30 min at Stage 2 conditions then 30 sec ramp to idle, idle for 5 minutes and take oil sample during these 5 minutes of idle. Purge 4 fl oz before taking oil sample. The oil sample size is 2 oz. After this 5 minutes of idle and

sample is taken, shutdown engine and let sit 20 min before making oil level measurement.

- **Blowby:** The first five stage 2 blowby measurements should average between 60 LPM and 70 LPM.
- **PCM:** Test PCM has locked intake and exhaust VCT's and goes to .78 Lambda in 1st stage conditions.

Appendix


0.38
3.50
Ø1.00
1.00
1.00
Ø1.00
4.00
0.38
6.00
1.25
3.00
Ø0.42
3.00
6.00
3.83
2.28
1.30
1.50
1.46
0.75
4.25
2.13
1.13
Ø0.75
6.00
5.00
0.75
0.38
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
MATERIAL
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
SIZE A
DWG. NO.
Right Engine Bracket
REV.
SCALE:1:5
WEIGHT:
SHEET 1 OF 1



		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE	
			DRAWN			
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		MATERIAL	Q.A.			
NEXT ASSY	USED ON	FINISH	COMMENTS:			
APPLICATION		DO NOT SCALE DRAWING	SIZE A	DWG. NO. Left Engine Bracket		REV.
			SCALE:1:5	WEIGHT:		SHEET 1 OF 1