

Sequence VH Stand Inspections | MINUTES

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Relevant Test:	Sequence VH
Note Taker:	Christopher Mileti, Rich Grundza (TMC) and Jerry Brys
Meeting Date:	Week of September 19 th
Lubrizol Attendees:	
Comments:	Sequence VH stand inspections at Southwest, Intertek, Afton, Ashland and Lubrizol. This document is a summary of the Lubrizol and TMC notes.

1. INTERTEK VISIT:

a) Chain Tensioner Spacer Plates:

- i) Intertek has run all of their recent tests with the chain tensioner spacer plates installed.
 - (1) However, they noted that the new (VH) cylinder heads were not designed to use the spacer plates.
- ii) **Afton comments:**
 - (1) Afton has encountered low cylinder head pressure with the VH engine.
 - (2) They found that the presence of the spacer plates had no impact on the cylinder head pressure.
 - (3) In fact, they are of the opinion that the timing chain alignment is better without the plates installed.
- iii) **Lubrizol comments:**
 - (1) Lubrizol originally recommended using the spacer plates with the VG-A engine configuration only.
 - (a) The VG-A engine used the older VG cylinder heads in conjunction with the new VH engine block.
 - (b) The spacer plates were needed on the older cylinder heads to reduce the possibility of oil hemorrhaging.
 - (2) Lubrizol confirmed that the spacer plates are no longer needed with the Sequence VH engine.

b) Oil Pressure in Stage 2:

- i) Afton noted that the cylinder head oil pressure [with the VH engine] can drop quickly in Stage 2.
 - (1) The head pressure can drop to approximately 90kPa even though the pump pressure remains at 200kPa.
- ii) The group questioned whether the oil pump bypass could be playing a role in this issue.
- iii) The oil pump for the VH engine is the same part number as the pump used for the VG engine.
- iv) **Ford comments:**
 - (1) *Could the camshaft journal bores be playing a role in the loss of cylinder head oil pressure?*
 - (2) It may be useful to run a trial with cylinder heads that have not been line-bored.

(3) SWRI has several cylinder heads that have not been line-bored.

(a) They are willing to run a trial to evaluate if these heads generate higher oil pressures.

v) Lubrizol comments:

(1) Lubrizol uses a small amount of sealer around the camshaft tie downs directly above the cylinder head oil inlet.

(2) This helps prevent oil hemorrhaging.

vi) Afton comments:

(1) The cylinder head oil pressure can be as high as 400kPa when the oil temperature is low.

vii) SWRI comments:

(1) Lower pressure in the cylinder heads may actually be an indication of a higher oil flow.

viii) Cylinder Heads and Camshaft Bearings:

(1) The lower camshaft bearing has a hole to lubricate the journals.

(2) The group needs to confirm with TEI that the aluminum and lead camshaft bearings have identical dimensions.

(3) The camshaft bearings do not have tangs to hold them in place.

(a) No lab has seen any indication of the camshaft bearings spinning.

(4) The Sequence VG cylinder head used a small post with two holes (i.e. a restrictor) to maintain oil pressure.

(a) The Sequence VH cylinder head uses a small groove (or channel) to maintain oil pressure.

ix) The group agreed on the following action items:

(1) Exchange camshaft journal bore clearance measurements for their VH engines.

(2) Check the diameters of the chain tensioner bleed holes.

(3) Evaluate the SWRI cylinder heads that have not been line-bored.

c) MAP Sensor Configuration:

i) There are several different MAP (manifold absolute pressure) sensor configurations being used throughout the Industry.

ii) Some labs are connecting their sensors to a vacuum signal, and other labs have left their sensors unconnected.

d) Ron Francis Wiring harness:

i) The Ron Francis wiring harnesses are not assembled.

(1) They are shipped as a box of wires that must be assembled by the lab.

ii) Intertek is trying to farm this wiring harness assembly out to TEI.

e) Gear on Front of Crankshaft:

i) The teeth should be oriented outwards.

ii) The part number is XW1E-12A227-AC.

f) Water Pumps:

i) There are two different water pumps available for the VH engine.

ii) SWRI has switched to a water pump used on the Ford Cobra.

(1) This pump was approved for the Sequence VG test approximately 1-year ago.

(2) It has a shroud around the impeller to increase its flow output.

(3) The part number is PW470.

g) Oil Filter Housing:

i) Some of the labs have concerns about the oil filter housing gasket.

ii) **Intertek:**

- (1) They are using the old housing adaptor (F1AE-6884-AG) with the orange gasket.
iii) The part number for the new oil housing adaptor is F1AE-6884-AH.

h) Discussion about Oil Temperature Issues at Afton:

- i) Afton is having problems controlling the oil inlet temperature during Stage 1.
(1) They acknowledged that it may be an oil pressure problem and not necessarily a temperature problem.
- ii) Afton is getting approximately 4-6 runs out of a set of VG cylinder heads.
(1) Intertek, on the other hand, is getting approximately 20-runs out of a set of VG cylinder heads.
(2) The labs agree that the valve guides are usually the first component of the heads to exceed the allowable specifications.
(3) The cylinder heads will last longer if the procedure is modified to only include the measurements at the center of the valve guide.
- iii) The VH cylinder heads have one less bolt on the camshaft tie-downs than the VG cylinder heads.
(1) The "missing" bolt is directly above the port where the oil enters the cylinder head.

i) Proper Orientation of Pistons and Connecting Rods in VH Engine:

- i) The connecting rods should be installed so the "bump" is facing the rear of the engine.
ii) The pistons should be installed so that the notch on the crown is facing forward.
iii) The orientation instructions in the Sequence V procedure and the 4.6L service manual do not match.
(1) The Sequence VH procedure needs to be updated to match the service manual.

j) Vacuum Line Connections on External PCV System:

- i) Some of the labs questioned whether one or two vacuum lines should connect the throttle body to the PCV valve.
ii) The consensus was to utilize two vacuum ports on the throttle body.
(1) These two ports would then be combined into a single line that connects to the PCV valve.

k) Oil Pick-Up Tube:

- i) All of the labs are using the Sequence VG oil pick-up tube.

l) Crankshafts:

- i) The VG and VH crankshafts are identical.

m) Pistons:

- i) The Sequence VH pistons are not tin-plated.

n) Fuel Injectors:

- i) The purple or brown fuel injectors can be used in the VH engines.
(1) The yellow fuel injectors can no longer be used.
- ii) The purple and brown fuel injectors are functionally identical.
(1) The brown injectors are the "European" version of the purple injectors.
(2) The brown and purple fuel injectors do not have the same part number.

o) Cylinder Head Cleaning:

i) Intertek:

- (1) They remove the threaded plugs at the back of the oil gallery prior to cleaning.

(2) They do not remove the press-in coolant gallery plugs (i.e. freeze plugs) during cleaning.

ii) Ultrasonic Cleaner:

(1) The group needs to decide whether this cleaning equipment will be allowed for the Sequence VH test.

(a) It is not currently listed in the procedure.

(2) SWRI is using the ultrasonic cleaner to clean "junkyard" VG blocks prior to honing.

(3) Intertek is only using the ultrasonic cleaner for cylinder heads.

(a) The hardware is dipped in Penmul, then rinsed, and then placed in the ultrasonic cleaner for 1-hour.

p) Camshafts:

i) The VG and VH camshafts are not identical.

ii) Intertek has found some new VH camshafts that were warped.

(1) These warped camshafts will not spin freely once they are installed in the cylinder head.

q) Stand Inspection:

i) Intertek is using a Rosemount 8732EMT2A1NSM4 coolant flow meter.

ii) Cold process water is entering the back of their exhaust manifolds.

iii) Intertek welded closed the small opening between their throttle body and throttle body elbow.

(1) Lubrizol did the same thing.

iv) They removed the fuel pressure sensor from their fuel rail and welded the opening closed.

v) Interestingly, the Intertek ECT and TPS pigtails use black wires.

(1) The ECT and TPS pigtails purchased by Lubrizol use white wires.

vi) Their manifold absolute pressure (MAP) sensor is connected to the wiring harness but is not connected to a vacuum signal.

vii) TMC Notes:

(1) The engine coolant (inlet) thermocouple is not located 12 to 16-inches from the face of the housing to the block.

(2) The oil heat exchanger outlet is not located at proper height.

2. SOUTHWEST VISIT:

a) Stand Inspection:

i) A Sequence VG utility engine is currently installed on the stand.

ii) SWRI has a heater (similar to the one on the IVB Golden Stand) on their load cell.

iii) SWRI is using Ron Francis wiring harnesses.

iv) PCV System:

(1) SWRI and Intertek are not using the elbow on their PCV valves.

(2) SWRI and Intertek appear to be using different hoses on their PCV systems.

(a) Are they the same diameter?

(b) SWRI is using clear Tygon hose.

(3) Intertek noted that they are using stainless steel hardware on their PCV plumbing.

v) There is consensus among the group that the VH engines run more efficiently and use less fuel.

(1) Lubrizol noted that the "swirl feature" was added to the cylinder head combustion chamber to better mix the air and fuel charge prior to combustion.

- (2) This more efficient operation is most likely the reason that the oil temperature is lower in Stage 1.
- (3) The VH intake manifold absolute pressure set-point would need to be increased in order to get an operating temperature that is equivalent to that of the VG engine in Stage 1.
 - (a) The MAP set-point would probably need to be increased to 71kPa-72kPa.

vi) TMC Notes:

- (1) The engine coolant (inlet) thermocouple is not located 12 to 16-inches from the face of the housing to the block.

b) Honing:

- i) The honing procedure for the VH engine is identical to that of the VG engine.
- ii) SWRI is using an SJ-400 surface analysis tool to characterize their honing.
 - (1) They typically see R_a values of 8 to 10.
 - (2) The R_a specification is 7 to 13.

c) Discussion about Stage 2 Blowby Specification:

- i) The VH procedure uses the same blowby specification as the VG procedure.
 - (1) The 120HR blowby average needs to be between 60LPM-70LPM.
 - (2) Any piston ring adjustments need to be made within the first 48HRS of the test.
- ii) Many of the labs would like to see the allowable range for the 120HR blowby average expanded to 60LPM-75LPM.
 - (1) This would almost completely eliminate the need for piston ring adjustments.
 - (2) This would, in turn, further improve lab-to-lab and test-to-test consistency.

d) Wrap-Up Meeting:

- i) All of the labs are concerned about controlling the oil temperature during Stage 1.
 - (1) Lubrizol is the only lab that has not yet encountered a problem controlling the oil temperature.
 - (a) However, Lubrizol is very concerned that this problem will manifest during the cold winter months of Cleveland.

(2) Option #1:

- (a) As discussed earlier, one option is to increase the load on the engine.

(3) Option #2:

- (a) The process water can be heated prior to entering the oil heat exchanger.
- (b) This heating can be done with an immersion heater (i.e. Watlow).

(4) Option #3:

- (a) The temperature control system for the rocker arm cover can be duplicated for the oil circuit.
- (b) The rocker arm cover system uses separate heat exchangers to cool and heat the fluid.
- (c) A solenoid could be installed so that this system is only active in Stage 1.
- (5) The advantage to Options #2 and #3 is that none of the completed Sequence VH prove-out tests would need to be invalidated.
- (6) Options #2 and #3 will need the following wording added to the VH procedure, "Allow for the active control of the process water temperature upstream of the oil heat exchanger."

3. AFTON VISIT:

a) Stand Inspection:

i) TMC Notes:

- (1) The air starter hub adds considerable mass to dyno.
 - (a) The lab agreed to remove this hub and install a 12V starter on the engine.
- (2) The passenger-side exhaust coolant lines do not match the procedure.
- (3) The hose that connects the driver-side rocker arm cover to the oil separator is collapsed.
- (4) The PCV valve has 2nd vacuum connection (which is plugged).

4. ASHLAND VISIT:

a) Stand Inspection:

- i) Their intake plenum is upside-down, so the air cleaner box is actually behind the engine.
- ii) They have two separate water lines to supply their exhaust system.
 - (1) One water line goes to the exhaust manifold, and the other goes to the spacer plate.
- iii) They are using the brown fuel injectors.
- iv) They are not using an elbow on the PCV valve.
 - (1) Lubrizol and Afton appear to be the only two labs to be using this elbow.
- v) Ashland is using a Toshiba coolant flow meter.
 - (1) They appear to be very happy with its performance.
 - (2) They are still using a Barco venturi valve to measure rocker arm cover flow.
- vi) Most of the labs continue to use J-Type thermocouples.
- vii) The location of their coolant temperature outlet thermocouple needs to be adjusted in order to be completely compliant with the procedure.
- viii) They are only achieving an oil temperature (inlet) of 67°C when the heat exchanger control valve is completely closed.

ix) TMC notes:

- (1) The engine coolant (inlet) thermocouple is not located 12 to 16-inches from the face of the housing to the block.
- (2) The thermostat housing and intake appear to be different.
 - (a) The lab will verify that it is using the proper hardware.
- (3) The air cleaner box and air intake tube enter from the rear of the engine.
 - (a) The air cleaner box and air intake tube are mounted on the front of the engine at the other labs.
- (4) There is no sight glass in engine coolant system.
- (5) There is no device to balance the rocker arm cover coolant flow (from left-to-right).
 - (a) There appears to be a 2LPM difference in coolant flow between the left-side and right-side of the engine.
- (6) The exhaust system coolant connections are not compliant with the procedure.

5. LUBRIZOL VISIT:

a) External Oil Lines:

- i) The group agreed that each lab should audit the volume of their external oil lines to confirm that they are procedurally compliant.
- ii) Some labs plan to physically measure the volume.
- iii) Other labs plan to calculate the volume.

b) PCV valve:

- i) Lubrizol is still using the elbow on its PCV valve.

- ii) The group agreed that all labs need to remove this elbow for future tests.
- iii) The group noted that Lubrizol's PCV hoses may be slightly longer than those at the other labs.

c) AFR Controls:

- i) Lubrizol is controlling its AFR with the Horiba MEXA-730 wide-band lambda sensors.
- ii) It is using the ECM NO_x sensors to measure NO_x levels and to provide “referee” lambda measurements.
 - (1) A yellow light will eliminate if the Horiba and ECM lambda measurements deviate by a predetermined value.

d) The group needs to review the instructions in the VH procedure that deal with the plumbing for the exhaust manifolds.

e) TMC Notes:

- i) Lubrizol is utilizing both Horiba and ECM sensors in its exhaust pipes.
- ii) The hoses that connect the rocker arm covers to the oil separators are longer than those at the other labs.
- iii) The water outlet and thermostat housing hardware is different than what is being used at the other labs.
- iv) The left-side of exhaust coolant plumbing is not compliant with the procedure.

Action Items	Person responsible	Completion Date
Follow-up on cylinder head oil pressure action items (Section 1b).	All labs	
Update the Sequence VH procedure so that the piston and connecting rod installation instructions match the 4.6L service manual.	Ford	
Add ultrasonic cleaning to the VH procedure.	All labs	
Confirm with TEI that the lead and aluminum camshaft bearings have identical dimensions.	All labs	
Discuss expanding the 120HR blowby average to 60LPM-75LPM.	All labs	
Modify the Sequence VH procedure to allow for process water temperature adjustments prior to the oil heat exchanger.	Ford	
Modify the VH procedure to specify that the PCV elbow <u>not</u> be used.	Ford	
Review the instructions in the VH procedure that deal with the exhaust manifold plumbing. Are they correct?	All labs	
Change cylinder head valve guide measurement limits in VH procedure.	Ford	

Follow-up Notes/Updates:	Initials	Date Added

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