

# Sequence VG-A Task Force | MINUTES

Revision Date 04-06-2016 | Revision 1.0

<b>Relevant Test:</b>	Sequence VG-A
<b>Note Taker:</b>	CHTM
<b>Meeting Date:</b>	04-04-2016
<b>Lubrizol Attendees:</b>	CHTM
<b>Comments:</b>	Meeting to discuss the next steps in the Sequence VG-A development.

## ADDRESSING ITEMS FROM R. ROMANO EMAIL ON 03-31-2016:

### 1. Failing Lubrizol Sequence VG Reference Test:

- a. Lubrizol completed a Sequence VG reference test on 04-02-2016 that failed for oil screen clogging.
- b. The reference oil was REO1006-2.
- c. **Summary of Results:**
  - i. AES = 8.44                      Target = 8.65
  - ii. AEV = 9.04                    Target = 9.24
  - iii. RACS = 9.30                 Target = 9.40
  - iv. PSV = 7.97                    Target = 8.52
  - v. OSC (Logarithmic Version) = 3.51
- d. The severe OSC result was definitely a surprise (especially since the AES and RACS parameters did not show the same level of severity).
- e. The AES and RACS parameters were also extremely close to the target values for REO1006-2.
  - i. This deepens the mystery as to why Lubrizol's AES and RACS parameters are so severe with this same oil and the VG-A engine.

### 2. Fuel Rails:

- a. The VG procedure specifies the use of the F5AE-9F792-AC fuel rail (which uses a 2-bolt bracket for the pressure regulator).
  - i. Intertek, Southwest and Afton appear to be using this fuel rail.
  - ii. This fuel rail is obsolete and has not been available through Ford's dealer network for several years.
- b. Lubrizol is using the F2AE-9792-AA fuel rail (which uses a 3-bolt bracket for the pressure regulator).
- c. Romano distributed the following drawings to the group for review:
  - i. Print for F5AE-9F792-AC fuel rail
  - ii. Exploded drawing for 4.6L fuel system from Ford dealer catalog
- d. There was some confusion as to whether the print drawings match the hardware that the labs are actually using.

- i. As a result, Romano requested that each lab send him photographs of their fuel rail hardware (with information about where the fuel temperature and pressure are being measured).

### 3. High Fuel Pressure at Lubrizol:

- a. Lubrizol has higher fuel pressures than Intertek and Southwest (and probably Afton as well).
  - i. *Typical Lubrizol Fuel Pressures: 310-330kPa*
  - ii. *Typical Fuel Pressures at Intertek and Southwest: 260kPa*
- b. Intertek is supplying fuel to their test stands at a pressure of approximately 20psi.
- c. **Lubrizol Plan to Address Pressure Difference:**
  - i. Lubrizol was originally going to install a pressure regulator on the fuel circuit to manually adjust the pressure.
    1. However, this idea was canceled because the fuel circuit drawing in the VG procedure does not include any pressure regulators except the one that is on the fuel rail.
  - ii. Lubrizol is going to check the voltage being supplied to its fuel pump.
  - iii. Afton has offered to provide Lubrizol with an F5AE fuel rail to determine if this corrects the pressure difference.
- d. **Fuel Circuit on VH Test Stands:**
  - i. The VH engine was not equipped with a fuel return.
  - ii. As a result, the development labs had to install a manual pressure regulator between the fuel pump and the fuel rail.

### 4. Flow Test Oil Pumps:

- a. There was agreement among the labs that it is unlikely that there is enough variation in pump-to-pump manufacturing tolerances to account for the differences in oil pressure at the three labs.
  - i. As a result, there is no need to flow test the pumps.
- b. However, it was suggested that the labs could measure the unloaded length and spring rate of several relief springs from used pumps.

### 5. Standardize AFR Sensors:

- a. Intertek replaced the Innovate AFR sensors with the new Horiba MEXA-730 sensors on the stand that they are using for their VG-A testing.
  - i. They used a "mule" engine to confirm that the sensors are operating correctly.
- b. **AFR Control Strategy in Stage 3:**
  - i. Southwest and Intertek are using a slightly different control strategy than Lubrizol, Afton and Ashland.
  - ii. The Southwest and Intertek strategies use fuel flow as the feedback parameter when sending a false MAF signal to the PCM.
- c. **Standardize AFR Calibration:**
  - i. The decision was made to use an O<sub>2</sub> bottle to calibrate the AFR sensors once per reference period.
  - ii. This calibration should also be done any time that troubleshooting is performed on the AFR system.

### 6. Main Engine Coolant Flow:

- a. **Calibration of Barco:**
  - i. Lubrizol is in the process of changing its calibration procedure so that its stands deliver more realistic Stage 2 coolant flow measurements.

1. It is using a 4-point calibration with an upper limit of 120L/min.
- ii. Intertek uses an equation to calibrate their Barco meters at three separate flow rates.
- iii. The group agreed that the Barco meter can be replaced for the VG-A test.
  1. Afton plans to replace the Barco with a Micro Motion unit (which is easier to calibrate over a wide range of flow rates).

**b. Control Set Points for VG-A Test:**

- i. The group agreed to utilize coolant flow set points for Stage 2 and Stage 3 of the VG-A test.
- ii. *VG-A Coolant Set Points:*
  1. Stage 1 =  $48 \pm 2$  L/min
  2. Stage 2 =  $118 \pm 2$  L/min
  3. Stage 3 =  $28 \pm 2$  L/min
- iii. The engine's water pump should have no problem maintaining the Stage 2 flow rate.

**7. Chain Tensioners:**

- a. There is the potential for oil hemorrhaging when the VH chain tensioners are installed on the VG cylinder heads without the spacer plate.
- b. As a result, the decision was made to use the spacer plates on both chain tensioners of the VG-A engine.
  - i. RTV can also be applied to the side of the spacer plate that contacts the cylinder head.

**8. Aluminum Camshaft Bearings:**

- a. Southwest noted more variability and more clearance with the new aluminum camshaft bearings.
- b. Intertek noted that the aluminum bearings appeared to be tighter.
- c. **Cylinder Head Line Boring to Accommodate Bearings:**
  - i. Lubrizol is exclusively using cylinder heads that were line bored by E&E.
  - ii. Afton is using cylinder heads that were line bored by AER.
  - iii. Southwest and Intertek need to confirm which vendor modified their cylinder heads.
  - iv. Afton has had problems in the past with cylinder heads that have been line bored by AER.
    1. AER did not always reinstall the end caps in their correct location along the cylinder head.
  - v. The labs are to use plastigauge to measure (and report) the clearances of the aluminum camshaft bearings.

**9. New Batch of VG-Style Piston Rings:**

- a. The new VG piston rings should have shipped on March 28<sup>th</sup>.
- b. However, the decision was made to continue to use the current batch of VG piston rings through the duration of VG-A prove-out and Precision Matrix testing.
- c. Afton is willing to donate their inventory of existing VG piston rings as needed.

**FORWARD ACTION PLAN:**

**1. DJ Fuel Batch:**

- a. Afton and Ashland will be purchasing “DJ” fuel from Haltermann so that they can begin VG-A testing.

**2. Next Round of Testing:**

- a. The labs are to make an attempt to run an additional VG-A prove-out test with REO1009 before the Intertek supplied engines are tested.
- b. This will allow the labs to evaluate the changes that are outlined above.

Action Items	Person responsible	Completion Date
Send photographs of fuel rails to Ron Romano.	IAR, SWRI, LZ, Afton and Ashland	
Check the fuel pump voltage.	LZ	
Afton to send Lubrizol an F5AE-9F972-AC fuel rail.	Afton	
Measure the spring rate and unloaded length of several used VG oil pumps.	IAR, SWRI, LZ, Afton and Ashland	
Use O2 bottles to calibrate AFR sensors once per reference period (if this procedure is not already in place).	IAR, SWRI, LZ, Afton and Ashland	
Incorporate Stage 2 and Stage 3 flow set points into VG-A procedure.	IAR, SWRI, LZ, Afton and Ashland	
Install chain tensioner spacer plates on VG-A engines (with RTV as needed).	IAR, SWRI, LZ, Afton and Ashland	
Standardize on Horiba MEXA-730 AFR sensors.	IAR, SWRI, LZ, Afton and Ashland	
Confirm whether VG-A cylinder heads were line bored by AER or E&E.	IAR and SWRI	
Measure the clearances of the aluminum camshaft bearings using plastigauge.	IAR, SWRI, LZ, Afton and Ashland	
Confirm that each lab has received shipment of the new VG piston rings.	IAR, SWRI, LZ, Afton and Ashland	

Follow-up Notes/Updates:	Initials	Date Added