IIIH Task Force Conference Call December 12, 2014

Attendees:
Chrysler: Jeff Betz
Infineum: Andy Ritchie, Gordon Farnsworth
Intertek: Adison Schweitzer, Charlie Leverett
Lubrizol: George Szappanos, Michael Conrad, Kevin OMalley
Afton: Ed Altman
Ashland: Amol Savant
TMC: Rich Grundza
SwRI: Karin Haumann, Sid Clark, Pat Lang
OHT: Matt Bowden
IMTS: Dave Passmore
Oronite: Kaustav, Sinha
Halterman: Tracy King
GM: Bruce Matthews

Karin opened the call indicating the primary topic for discussion would be the oil cooler and the presentation sent out by George Szappanos on the work Lubrizol has performed looking at the oil cooler oil flow(See Attachment 1). The work addresses the issue of the 60/40 oil bypass design and suggested relocation of the control thermocouple lower in the main oil gallery. George explained the options and indicated he wanted this to be a Task Force decision.

Jeff Betz commented he discussed blocking the by-pass with the oil pump release engineer and they indicated there is no way we should be blocking the designed by-pass engineered into the oil system. Jeff explained the system is engineered to by-pass 60% of the oil flow around the oil cooler by redirection through the oil filter / oil cooler adaptor.

The group, with direction from Ed Altman discussed concerns about trying to block the by-pass section of the oil filter / cooler adaptor. Charlie asked Karin to explain the initial work SwRI did using an alternate design adaptor in the valley that used an external oil cooler. Karin expressed concerns about adding and or removing oil from the system as SwRI experienced troubles with aeration in the engine with an additional volume being taken outside the engine.

The group discussed how we would accurately measure the two temperatures and settle on a control point of a mixture of the two at some point below the production cooler. The group reviewed Lubrizol's presentation and George explained how he tapped the main oil gallery below the oil filter / cooler adaptor to accurately measure the mixture temperature of the cooled and by-pass oil entering the mail oil gallery. Jeff commented the by-pass oil and the cooled oil are mixed very well as they enter the main oil gallery.

The group continued discussion indicating this is very good we identified this variable at this time. Andy Ritchie asked if we had an idea of the Delta between the two temperatures, Karin explained the difference is between the temperature coming from the oil pump entering the

main gallery before the cooler and the temperature of the oil exiting the cooler at the point the temperature is currently being recorded or controlled with that difference being about 1.5°C. Andy continued his question asking what happens to the engineered 60/40% designed by-pass when an oil rapidly oxidizes and starts the hockey stick up swing during rapid oxidation. The group indicated they wouldn't really know how much would be by-passing the oil cooler, where the by-pass could eventually exceed 60/40 %. Pat Lang asked Andy to clarify his question and Andy indicated his curiosity whether there are any implications they should be looking for that might be indicative of reasoning for some of the more recent results. Pat agreed this may be of concern where the sump temperature may increase as the oil cooler may not be experiencing full flow. Charlie and Pat reminisced about the oil cooler by-pass valve on the Modine Cooler on the Sequence IIIG where the by-pass flap or valve was welded closed on the cooler to force all of the oil through the cooler. The group agreed the cooling valve trim is running about 80% closed on the Chrysler Engine directing very little cooling flow through the cooler; however the group still expressed concerns about the performance of the cooler as the cooler is doing very little under current operations and if 100% of the oil was passing through the cooler the control valve would be functioning even closer to full closed.

Jeff suggested he wanted to see Lubrizol run their test with the temperature measurements to determine what the actual differences between the gallery and oil cooler temperatures are actually running. Amol asked about the oil filter by-pass and Jeff explained the filter does have a by-pass that actuates to by-pass the filter element on cold starts and will run the same flow through to the main oil gallery. The group discussed the by-pass system for the oil filter and the 60/40 by-pass system for the actual oil cooler. Jeff summarized it saying the oil cooler is a fork in the road where there is a 60/40 by-pass. A plugged oil filter will not affect the oil cooler.

Ed Altman questioned whether anyone felt an oil going thick would actually show an effect where the 40% flow through the oil cooler might be less due to the higher viscosity of the oil, i.e., change the ratio from 60/40 to 75/25 etc. The group discussed preferences for having 100% of the oil flowing through the oil cooler. Karin reminded everyone that all the development testing has had that oil flowing through the main oil gallery at the 60/40 by-pass rate and the temperature delta has yet to indicate a major problem. Karin again recommended following Georges recommendation for thermocouple locations to see what the actual delta shows. The group agreed this engine does not require a lot of cooling for the oil going through the engine; however some of the group felt this needs to be done correctly as this will be test for the next ten years.

The group discussed temperature measurements and gaining a better understanding of what the real delta is, with Karin indicating she felt the difference is the temperature between the oil going into the gallery from the oil pump and the temperature of the oil exiting the oil cooler where it's currently measured.

George again referred to his presentation talking about where Lubrizol planned to thermocouple the block to gain a temperature reading of the mix of the two temperatures. The group discussed how far down the oil gallery below the oil filter / cooler adaptor to thermocouple the gallery for the Lubrizol test. George felt the thermocouple would be about

¾ inch below the mixing point. Ed Altman recommended starting the test and running for a few hours controlling off the original thermocouple and then change to the new gallery thermocouple to see what happens to the mixed oil temperature. Again George referred to what Lubrizol had done to drill and thermocouple the block, going through the tapped hole at the rear of the block to drill the access for the thermocouple for the new location. The group discussed potential problems with thermocouple applications where the test would most likely be lost if the thermocouple were to fail during a test.

Ed recommended removing the engine knock sensor for the test to possibly allow changing the thermocouple during a test if necessary. Jeff Betz indicated they could possibly cut the knock sensor calibration out of the ECU to allow easier access to the rear main oil gallery for the thermocouple location and possibly allow the thermocouple to be located even lower in the oil mix in the gallery.

Karin agreed to run a test using the new thermocouple location on REO2 running the exhaust back pressure at 4.5kPa. The group agreed to run the first 10 (Ten) hours using the normal thermocouple location and then switch to the new location to see the difference. George highly recommended not trying to modify the rear oil gallery on an assembled - ready for test engine.

Jeff recommended having Lubrizol and SwRI run their tests to see where to go with further testing. Karin indicated it would be mid-week before SwRI would be able to start their engine.

Lubrizol will run 434-1 and SwRI will run REO2.

Amol asked about usage of the ECM type NOx and Wide Band O2 Sensors. George indicated he was not sure the IIIF/IIIG type Air-to-Fuel control technology would work for the Chrysler Test. Pat cautioned the Chrysler does not use a feedback control loop for actual control and any such setup may not work on the Chrysler Test. The group again discussed AFR control and checking bank to bank control at each lab to confirm whether there truly is an offset between banks.

Karin agreed to send Amol a wiring diagram with information on setting up the ECU and dyno harness for the IIIH. George asked what everyone was using or if they were using any kind of anti-seize on their O2 and NOx Sensors and whether they could supply that information.

The call adjourned at 5:35 pm Eastern Time.

This is a compilation from notes recorded during the call, with comments from member participants during the Draft Review. Certain subjects may not necessarily be in exact order; however, they are believed to represent an accurate account of the call. If anyone feels changes or additional content may be necessary, please contact Sid Clark @ 586-873-1255 or Sidney.Clark@swri.org

Thanks, Sid

Chrysler IIIH oil cooler flow issue

George Szappanos

12/9/2014

Lubrizol

background

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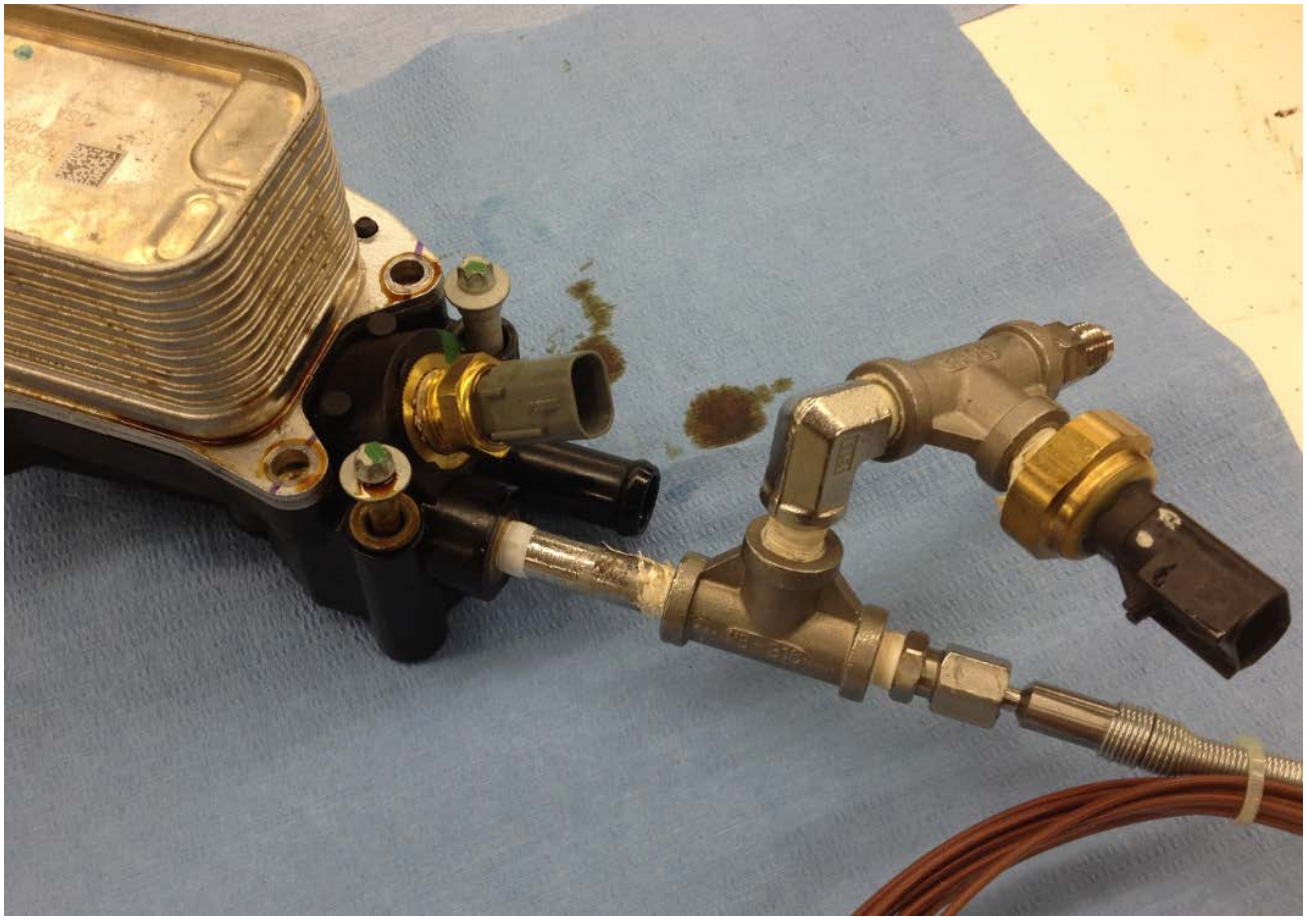
This investigation was prompted by the observation that there were discrepancies between the temperature measured at the oil cooler outlet (oil gallery temp) and the other measured oil temperatures

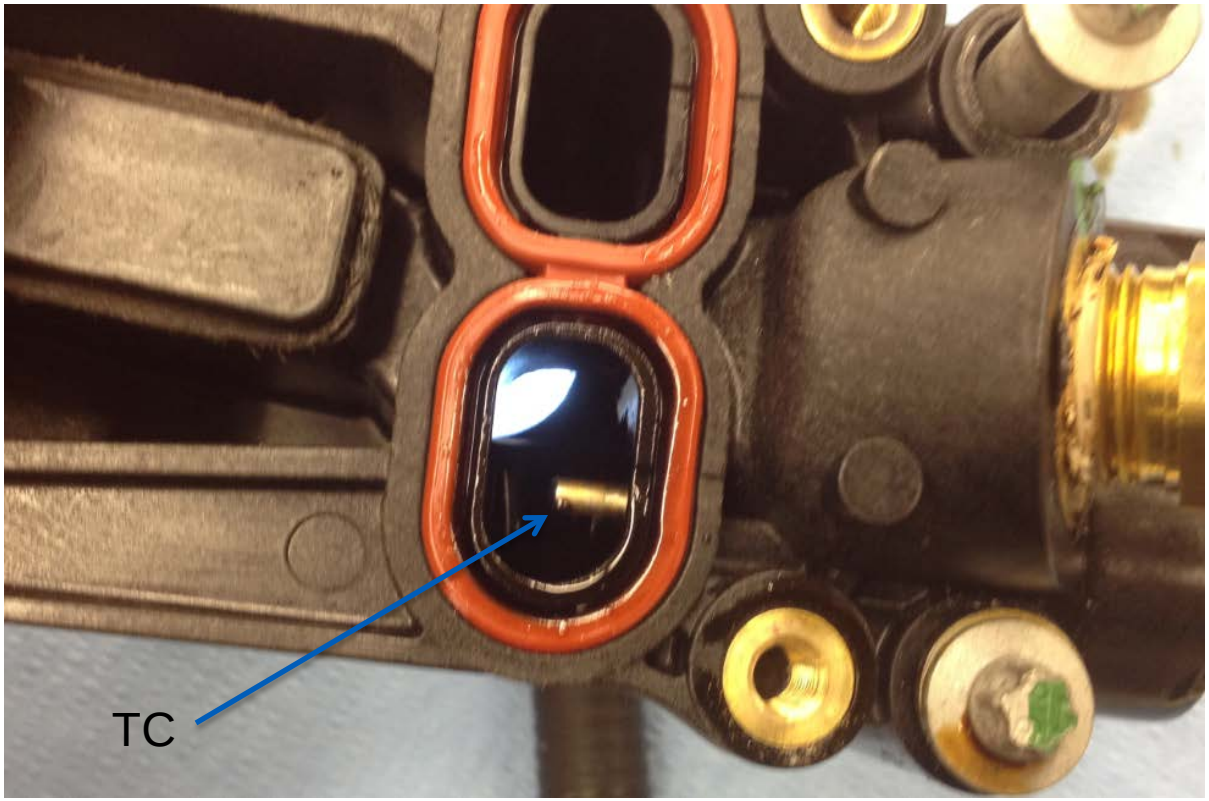
Lubrizol

- The IIIH engine's oil temperature is monitored by installing a thermocouple into the oil cooler housing

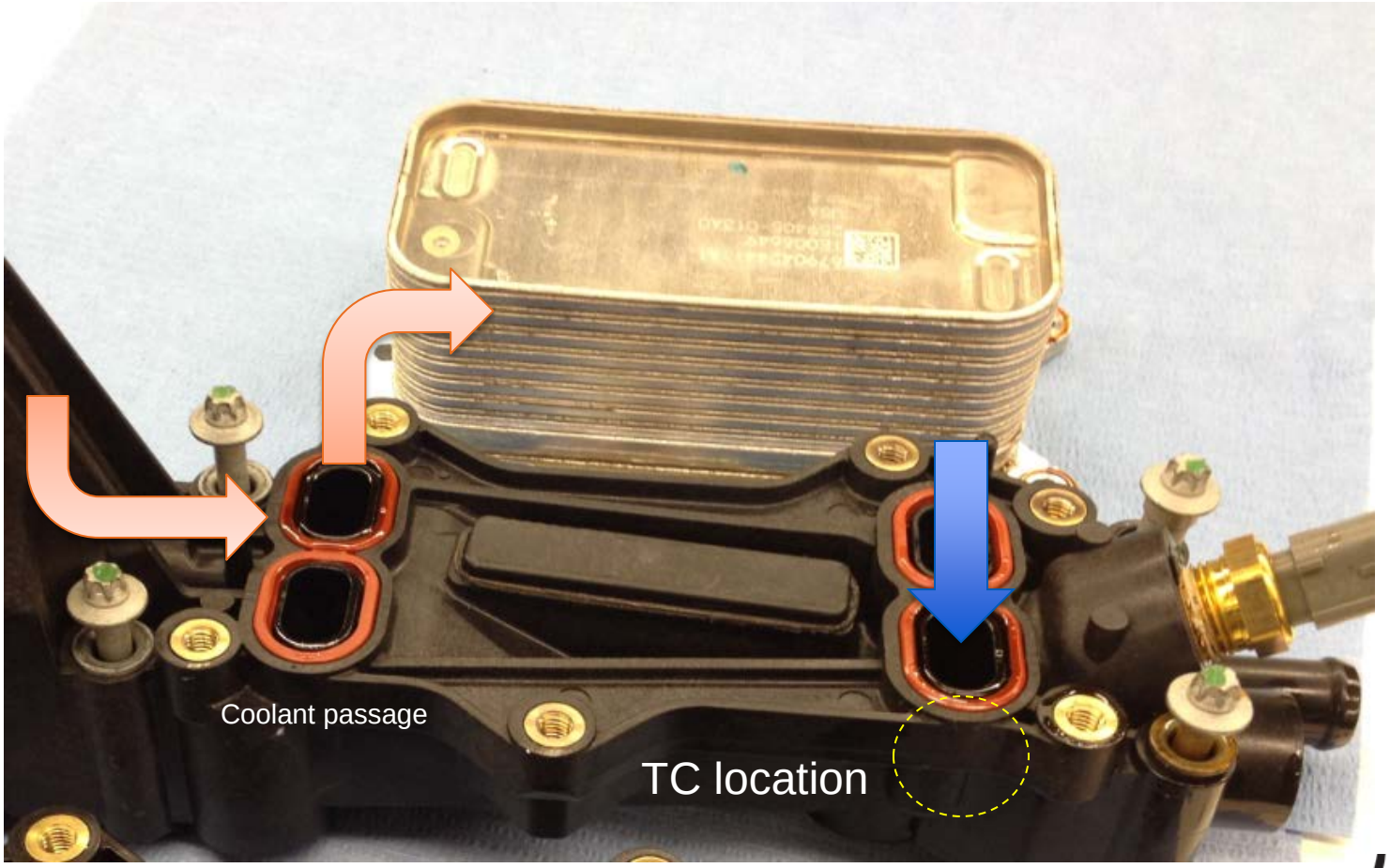


- It is presumed that the oil will circulate past the thermocouple before entering the engine block and main oil gallery

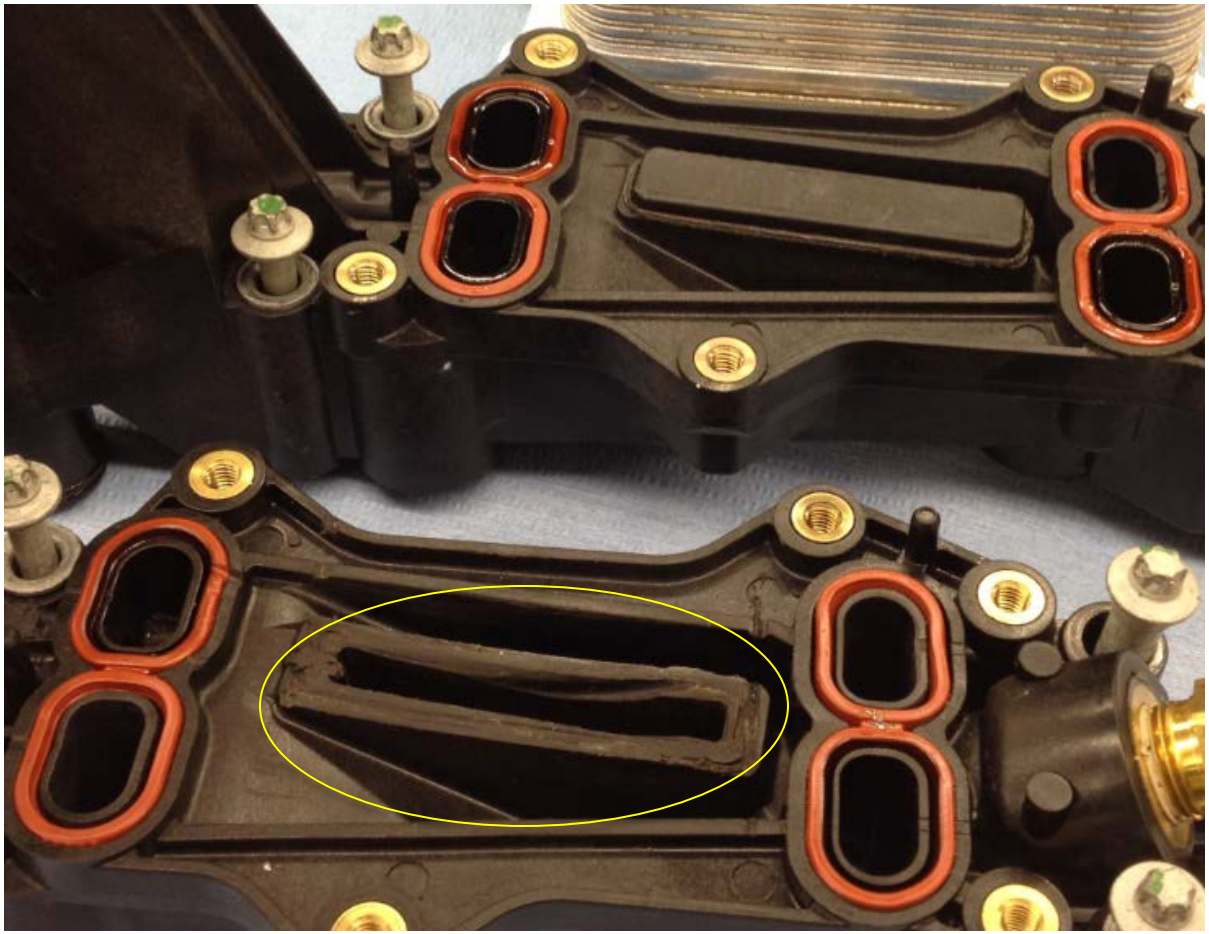
(viewed from bottom side)



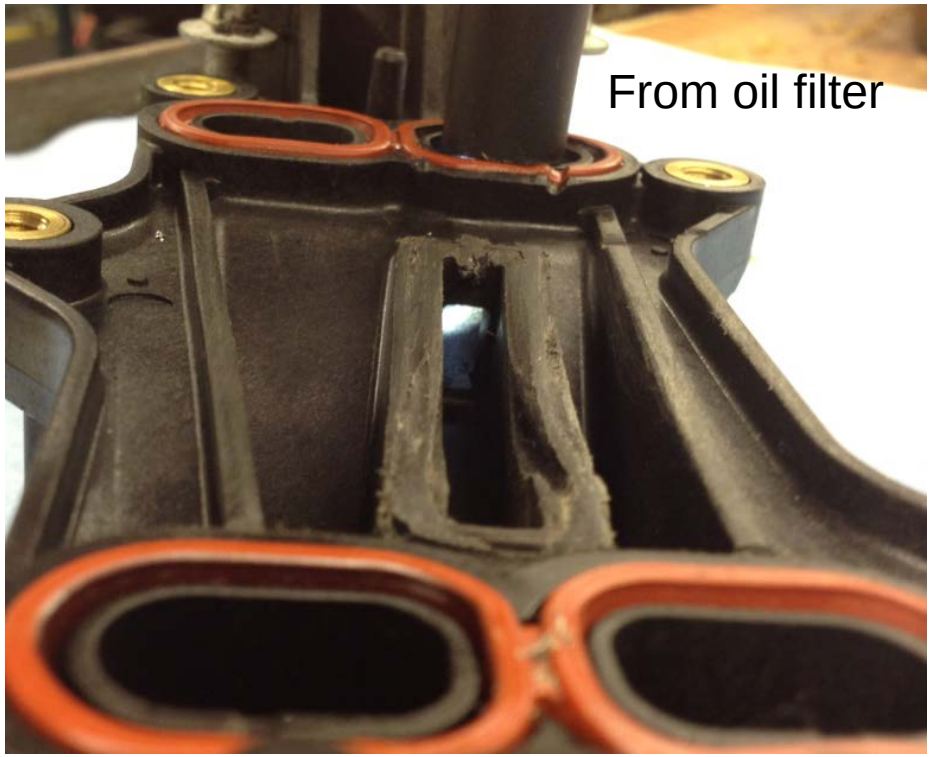
- The oil flow path is out of the filter and through the cooler (shown removed and set behind)



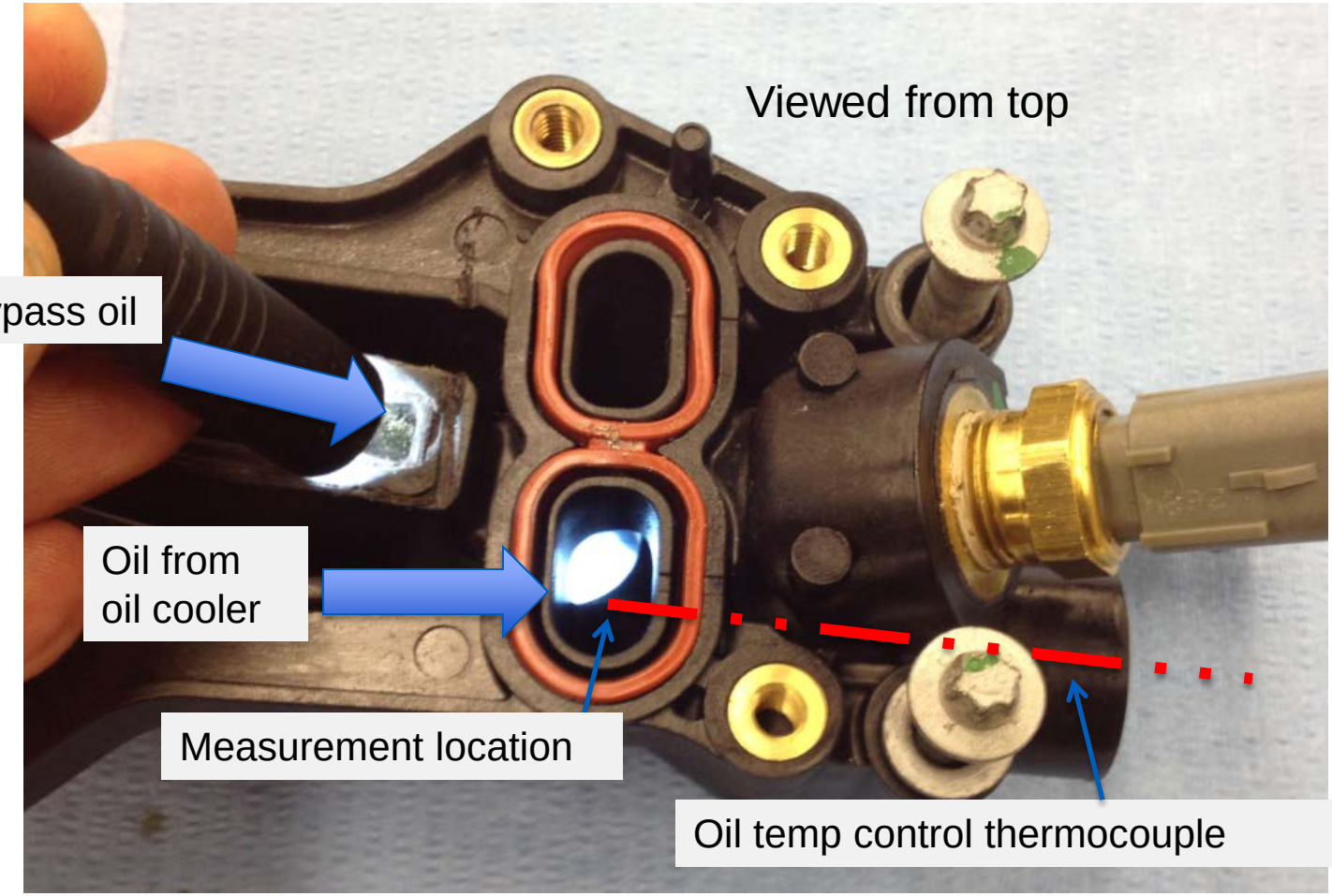
- However, there is a second HIDDEN channel that bypasses the oil cooler (shown with top sawed off)



- This passage is a direct bypass of the oil to the block
- Oil from the filter flows through BOTH the oil cooler as well as this bypass



- Only a portion of the total oil flow is being measured



Implications

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- The actual oil temperature entering the engine is higher than being measured due to the uncooled bypass oil flow
- The split between the oil cooler and uncooled bypass flow is estimated at 50% but unknown
- Variations in the construction and manufacture of the cooler and adaptor will result in different effective oil temperatures
- As the oil thickens or plugs, more oil will bypass and therefore the real engine oil temperature will increase

Lubrizol

suggestions

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- Must measure REAL oil temperature
- Requires that it be measured immediately before entering the main oil gallery (block)
- Options:
  1. Find an alternate location downstream of the oil cooler, in the block (see next slide)
  2. Install a remote oil cooler
     - This design was presented by LZ in June
  3. Modify the oil cooler adaptor (plug the bypass passage)
  4. Use the oil pump temperature as the control feedback

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New location suggestion

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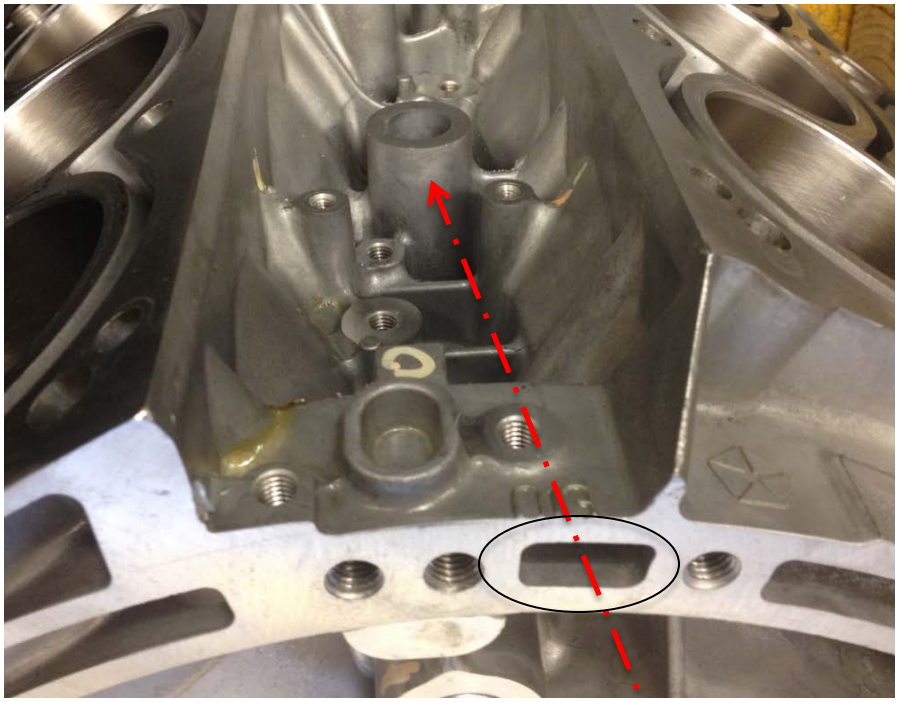
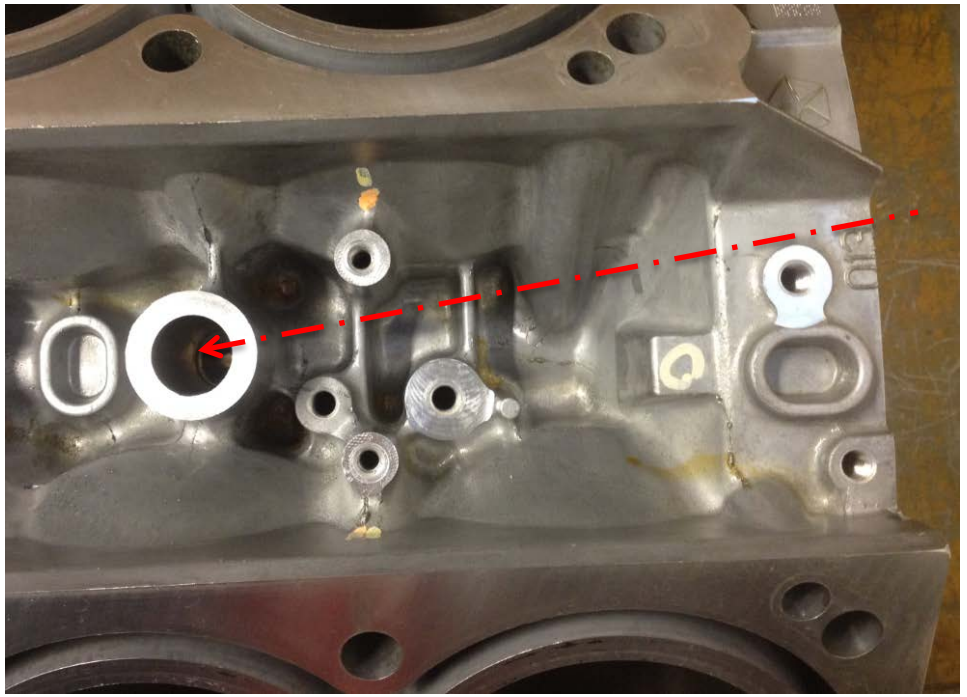
- Drill tap 1/8” NPT hole in the supply to the main oil gallery; a larger hole needs to be machined in the rear of the block (circled) through the rectangular cavity
- Install short 2” TC underneath oil cooler adaptor





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