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SEQUENCE VI SURVELLANCE PANEL

Date – 17 Nov 22

ATTENDANCE

SWRI	Dan Engstrom, Christine Eickstead, Pat Lang, Travis Kostan
INTERTEK	Adrian Alfonso, Bill Buscher
LUBRIZOL	Andrew Stevens, Tony Catanese, George Szappanos
AFTON	Bob Campbell, Ben Maddock, Andrew Rohlfing, Joe Hoehr
ORONITE	Robert Stockwell, Ricardo Affinito
INFINEUM	Andy Ritchie, Doyle Boese
TMC	Rich Grundza
GM	Frank Cooney
TOYOTA	Teri Kowalski
OHT	Jason Bowden
TEI	
FORD	Mike Deegan, Rob Zdrodowski
VALVOLINE	Amol Savant
HALTERMAN	
GAGE PRODUCTS	Jim Carter
BP	
EXXONMOBIL	Paul Rubas
SHELL	Jeff Hsu
IMTS	Dave Passmore

MEETING –

1. **Attendance. See table above.**

2. **Approve Minutes from 7/14 call**
   Postponed until next meeting.

3. **New business**
   3.1 Review of Severity Task Force (VIE and VIF)
   Doyle presented summary of severity analysis that task force carried out.

   VIE:
   Fairly stable FEI performance year-over-year and no apparent shift with re-blends of ROs
   Travis – when did ICF go into effect?
   Rich – ICF was back applied based on how many tests were on a stand, not a hard date. Can go back as far as the first post-matrix test on a stand. Roughly April 2018.

   Doyle's analysis includes ICFs on all data
   Travis pointed out a small shift, smaller for FEI2 (542)
   1010 seems a bit below target with ICF, 544 a bit above target with ICF

   VIF:
   FEI2 cusum appears fairly linear throughout time, FEI1 seems fairly flat with shift around 200 tests
   FEI1 and FEI2 local maximum around April 2019
   RO performance relatively stable, some oils slightly severe and others slightly mild

   Adrian – The reason for the task force was a concern brought to the panel about cusum trends in VIE. Started looking at control charts, which told a different story than the cusum plot. Requested to form a task force to dive deeper into it. The task force continued the severity study with the VIF, which resulted in this presentation. Looking at the control charts, conclusion is that the test is not out of control even though cusum is showing a negative slope.

   Andrew – Other than mid-2019 shift in VIF, conclusion is that we don't intend to take significant action to make any changes to Seq VI. Trends consistent over life of the test.

   3.2 Fuel Samples Analysis

   Travis presented the fuel sample analysis presentation put together by Amanda
   Labs have been taking fuel samples before running reference tests quarterly to look for fuel changes over time
   Statisticians looked at the measured fuel properties in terms of reference test Yis and FEI residuals
   None of the correlations are strong for FEI1.

   A couple VIF data points were also included in the data. There is a weak positive correlation with EP (r^2 0.1/0.2 depending on methodology). Similar story with 80% distillation.

   FEI2 – weak correlation with net heat of combustion and saturates.
   Should we continue to do this? If the correlations are in fact real and this weak, it will take a significant amount of additional data to show actual correlation. Not a big concern for driving data.

Some parameters show correlation by lab – not related to severity, just by stand.
Labs similar in gravity, but below spec.
Aromatics similar across labs.

Summary – no strong correlations with data set that we have; pretty good size data set and good spread in FEI values. Does not seem to be strongly driven by any of the analyzed fuel properties. Fuel values taken at stand, some differences vs. spec limits.
Group did not go over presentation appendix.

Discussion:
Amol – Were all samples analyzed at Saybolt? Yes.
Andy – The test measure a relative difference between BL and candidate. Would be shocked to see fuel impact in test.
Rich – One of the correlations found was with net heating value, but that is a calculated value. The calculation is based on aromatic content, and 10%, 50%, and 90% pts. Both EP and net heating value highly correlated with each other due to calculation.
Amol – Some portion of top treated EEE?
Rich – Yes, fuel is EEE with DCA. Used to top treat with additive in the truck, but now all blended when fuel is put together. Fuel treat rate with DCA (top tier additive) is 283 ptb (pounds per thousand barrels), very miniscule amount.
Paul Rubas – COA says 267 ppm, results 283 ppm (~0.02%)
Bill Buscher – Make sure to update SP distribution lists with changes at Haltermann. Add Ed and William, remove Prasad. (Haltermann not in attendance)

Andrew – What is the feeling of the panel on whether we want to continue taking quarterly fuel samples?
Andrew can reach out to OEM and fuel supplier to vote on this.
Frank Cooney joined in end of fuel discussion.

Andrew – Recommend that we need should stop quarterly fuel analysis.
Frank – How were the fuel properties selected that panel was tracking?
Andrew – Selected from data we had at the time, study fuel properties vs. reference FEI1 and FEI2 results
Frank to look through document in detail, looks comprehensive

Amol – Should we analyze fuel against either BL or candidate results instead of overall test performance?
Andy – Different fuels will burn differently.
Rich – With BL2-BL6 comparisons, looking at differences between 0.002 to 0.003 g of fuel. Meaningless to try to correlate with fuel properties.
Andrew – Reason for comparison BL-CAN is to remove any fuel differences and have a fair result
Travis – Agrees with Amol. If certain fuel properties can move the fuel consumption around, interesting to know and understand what fuel properties can drive severity of test.
Andy – If want macro effect, run EEE
Andrew – Would a difference in fuel relative to just BL impact a decision to continue or not continue sampling?
Bob Campbell – Is there a fuel impact on VI? No. Is there an impact on fuel consumption? Maybe interesting to study, could influence future specs. Already have a lot of data. |

Andy – Right thing to do is to keep sampling. Group needs to respect the fact that this is important to the sponsor.

Frank – Is the conclusion of the panel that fuel properties that we're monitoring do not have a significant impact on the test? If moving to a different fuel, it could impact test. Doesn't mean that there isn't a fuel property or different fuel that wouldn't move the test.
Andrew – Lubrizol ran a reference where they lost an injector but kept running. Still passed LTMS limits and invalidated after. Test passed since it is a relativistic between BL and RO. Sounds like is there more discussion about if we continue sampling or not. Analyze at one unified place, or analyze at own labs?
Pat – Whether or not can deem anything affecting fuel, I think that it needs to be sampled at some frequency (maybe lower) continuously. This helps avoid questions about fuel.
Andy – Agrees with Pat. Continue to do what we're doing.
Travis – Saybolt should continue to analyze fuel to avoid introducing a new variable. Lower frequency makes sense too.
Rich – Maybe change sampling frequency to semi-annual.

Frank – Was the purpose to monitor batch-to-batch data or fuel degradation in tanks?
Andrew – Purpose was the look for any potential effects.
Rich – There were two batches within the fuel analysis data. Large batches are being produced to cover ~1yr.
Frank – With two batches, don't know whether we can discern any batch-to-batch variation with two data points. To stop or even reduce frequency doesn't make sense since don't understand batch to batch variation.
Rich – The fuel supplier is supposed to pull quarterly samples to look for certain parameters. Don't know that samples pulled from stands at labs will tell us much about degradation. Should have data to monitor stability for length of fuel batches from supplier.

Jim Carter – Is there any comingling of batches?
Rich – Going from batch to batch, comingling is allowed when there is <10% fuel left in the tank and the lab documents both batches in the test report when switching. Not required to do that when dumping fuel from same batch.
Andrew – In time series, the fuel batches/analysis is comingled, but we can segregate that data out.
Frank – Focus on identifying time frames when new batches come in and increase the sample frequency when those samples come in. We covered storage degradation over two years with the analysis thus far but haven't covered batch to batch variation.
Rich – We have analysis that Todd did number of years ago; originally got fuel from two sources of same company. Blended to same fuel spec at two different locations. Northern labs would receive fuel from Michigan facility; SA labs would receive fuel from Channelview facility. Todd noted some differences in fuel spec but not necessarily performance. That's when supplier switched to all fuel coming out of one refinery and went to one large batch.
Frank – Approximately what date did we switch to single supply?
Andrew – 2018/2019?
Campbell – When a new fuel batch comes out, we have reference info from around that time. Therefore, we have data from a performance perspective.
Frank – There is no benefit to go back when it was two locations because it was indicated that there was variation. Need to look at data from when fuel coming from one supply point forward.
Rich – First large batch was produced in the end of 2019. Next large batch available in June 2021 (still being used today).
Frank – Don't think we have ability to conclude that fuel doesn't have impact on test because most of the data points we're looking at are just from two batches. Continue to study across batches.

Frank – Point is that a batch changeover is coming, probably beneficial to catch the changeover as soon as possible instead of having a set sampling frequency.
Rich – Sample shortly after lab introduces new batch, then 6 months after that?

Campbell – Not sure what we get from that, supplier produces fuel to CoA and tests it, put in truck and send to labs to test. We can always go and look at if there is an inflection in test results with a batch change, but struggle to find value in labs taking sample after new batch.
Frank – What that would get us is, over enough batches, it may lead us to conclude that we don't have all important properties of fuels identified.
Travis – How many batches have we had for the life of the test?
Buscher – Only two since we switched to bigger batches, but before that we had frequent EEE batches. Every tanker effectively was a different batch previously since dosed with top tier additive in truck.

Travis – This test started out severe because of a target setting issue and how PM data was analyzed. Test hasn't changed severity level over life of test over full number of batches.
Andrew – From the analysis done, there has not been a change in severity. It is one of most consistent tests over time. If there was any "shift", it was immediately coming out of PM due to statistics.
Campbell – Group went through a grueling exercise 3 years ago to define the fuel spec. If we sample fuel more and look at the same fuel properties as the CoA, we get same story we get now. Nothing to suggest that fuel is degrading or that fuel doesn't meet spec. Unless we run a different set of fuel analysis, not going to get a different story than we have today.

Frank – Was a DoE done at one time with selection of fuel properties?
Bob –No DOE. Just a study of what was in the CoA and tightening up the fuel spec so we don't impart a shift. Specs were reasonable or tight enough that fuel suppliers felt it allowed for blending tolerances but not so wide that could impart more variability than they needed.

Frank – The question is, are fuel properties that we're monitoring the correct ones to evaluate an impact on the test? GM would like to continue focus on this. Focus has to be on window when going from one batch to another. If we see significant change, look closer at other fuel properties that may be influencing. Don't have the answer to this because we don't have enough batches.

Jim Carter – If we go back into the ancient history of this fuel, it's based on old EPA emissions cert fuel. Was a relatively cost-effective fuel to use for this purpose. Worked very well over the years.
Frank – Not looking to create additional burden, just want to capture element of potential variability.
Campbell – If we push this back to the fuel supplier and they do further detailed hydrocarbon analysis, maybe that's a better way to look at correlation with severity. Fuel supplier issue and not a lab issue?
Frank – Maybe partially, but key is that we have samples of the fuel and start test on new fuel batch with significant change in RO performance, then go into detailed analysis.

Travis – Don't actually have a severity change in this test, really a target.
Pat – In Bob's camp with analysis. We always compare fuel samples to the CoA and always meeting it. We're all trying to get smarter on fuel and learn if there are any attributes that influence it. Maybe we need to sample at a less frequent rate but get smarter on what we look at.
Bob – Suggest to push analysis to fuel supplier, make them fully fingerprint fuel batches. Labs aren't smart enough to know what that analysis is, fuel supplier question.

Travis shared slides related to the VIE PM data and target setting. Slide 52 of presentation; control chart of FEI2 EWMA severity chart. Same document as presented in Pittsburgh. Right out of the gate, this test went severe. Discussion around if the targets had been updated, it may have fixed problem. How could we have done this better? Without the correction factor implemented, the control charts are relatively flat throughout life of the test. Not a major severity shift that we saw. Slide 55 shows PM data and then data after PM. Equal weighting given to every laboratory, whether contributed a single data point of 10 data points. Target for each of the ROs

based off of the average of each of the 6 labs individual averages. Two labs were mild in PM (B and F). If we combine B and F, those two labs got 1/3 of weight in target setting. After PM, those two labs no longer ran the test.

Rich – After the PM, stand mix increased which adds a level of complexity. Expectation is that stands will calibrate, but that doesn't mean that they'll all be at same severity level.
Travis – If all labs are not running at equal frequency, can't expect that control charts will stay on target.
Andy – EWMA chart will always move if the mix of labs/stands changes. Unusual thing would be for it to be completely steady. Important observation for everybody to understand/recognize that it's an imperfect system and will see it walk around.

Jason – Does this support historically that we update targets after 5, 10, 30 tests?
Travis – That was the point of this exercise. If you would have updated targets in the Seq. VI test, chart would look the same. Reason is methodology used. Issue lies the in fact that 2 labs carry 1/3 of weight. If we still give those labs 1/3 of the weight, charts won't change. Influence will always be there.
Rich – Bad mojo to update targets once we go live with test that has SAs.
Travis – If we can get data quick enough, we can consider updating targets. Don't want to do years later
Jason –If the test is shifting, we haven't taken immediate action to change that. If we change the target over time after 30 tests, wouldn't it be a similar effect?
Rich – The impacts of changing targets is tremendous
Travis – We can't come up with a general rule, but to consider options is still important
Rich – If we see a shift with assignable cause, implement change that effects all tests (candidate data seeing same effect). If charts are driven by lab severity, as long as labs are calibrating and not getting beyond range of SAs, proper course probably not to do anything
Andy – There is no perfect way to do this. Agree with principal that get better answers with more data
Jason – We may not be capturing everything in PM data, a lot more stands involved, etc.

Bob – Issue with updating targets after 10, 20, 30 tests is that it takes years to get that much reference data. Changes in piston batches, fuel, etc. baked into targets.
Rich – We could have made a better assessment a month or two later, but lag between data used for targets and when test went live. Labs didn't get calibration status right out of PM. Control chart process may not be practical when dealing with lubricant testing since we can't necessarily dial each and every stand.

Andy – biggest reason for trying to fix it is optics. Is it really necessary to expose ourselves to that scrutiny and criticism if it's a function of how we did it at the start and what changed subsequently?
Andrew – We collectively understand what we're looking at. Broader understanding of charts will help avoid situations been in recently.
Travis – Problem is once you have a graph outside of control limits, we still have to monitor how far we can go before we have a problem. Still need bands.
Andy – This is a common item across industry, but we're on a path to understanding it better. Not far along with what we want to do about it.
Travis – Group needs to recognize that most of what happened in EWMA charts is due to mix of labs, not a severity shift.
Mike – We should start putting together history of a test and have it written down
Bob – Those details should end up in the research report
Robert – Labs may have been doing the exact same thing all along and we're doing better than we realized.
Andy – Needs to be an event list for each test
Rich – TMC tries to capture test events and puts out industry timelines (new fuel batch, ILs, target update). Lost in minutia.

Travis – We need a dedicated doc that lists everything by date and can compare severity issues against.
Andy – There is an event list that gets reported out each quarter
Bob – A timeline exists on the ASTM website for each test.
Rich shared ASTM website and timeline.

Andrew – It should be a surveillance panel chair's responsibility to maintain the timeline.
Rich – Tries to maintain, but usually catch events when preparing the semiannual report. May be a couple months behind.
Campbell – Maybe the outcome is that during panel meetings, we ask Rich to add to timeline.
Stevens – This should be in the handbook, write down what should be and should not be on timeline.
Campbell – Add to agenda for SP meetings.

Andrew – Back to the motion to move to semiannual fuel testing, should we amend to only analyze on batch changeover and do more detailed analysis?
Rich – Should we amend the motion: pull a fuel sample after batch change and 9 months later?
Bill – When a lab pulls a sample, we know if there was a change between the inventory tank and when it got to the lab
Rich – The fuel samples are being pulled at the stand, so they're representative of what was used in that reference.
Bill – There's not much to gain by pulling fuel right after new batch and comparing to CoA, but routinely doing it has more value.
Rich – We're looking for effects, not changes. Looking to see if we can tie a number of parameters to changes in severity.
Andrew – seems like once every 6 months is agreeable.
Bill – Adrian's comment was that we've proven that we haven't seen any effect. Vote for a motion to drop the whole thing. But agree that 6 months is favorable.

MOTION 1 – Sample fuel once every 6 months instead of once per quarter with same sampling routine and analysis. VIE is the primary goal, but VIF data is acceptable if not running VIE references.

Proposed – Andrew Stevens
Second – Robert Stockwell

Votes – *Roll Call –*

Company	*Voter*	*Approve*	*Waive*	*Disapprove*
SwRI	Dan Engstrom	■		
IAR	Bill Buscher	■		
Lubrizol	Andrew Stevens	■		
Afton	Ben Maddock	■		
Oronite	Robert Stockwell	■		
Infineum	Andy Ritchie	■		
TMC	Rich Grundza	■		
Ford	Mike Deegan	■		
GM	Frank Cooney	■		
Shell	Jeff Hsu	■		
ExxonMobil	Paul Rubas	■		
Valvoline	Amol Savant	■		
BP				
Haltermann		■		
OHT	Jason Bowden	■		
TEI				
Gage Products	Jim Carter	■		
IMTS	Dave Passmore		■	
	Totals –	*14*	*1*	*0*

Outcome – The motion passes.

MOTION 2 – When a new fuel batch is received, labs are to take a fuel sample and analyze prior to the first reference on the new batch. Labs to retain a 1-qt sample for 1 year.

Proposed – Frank Cooney
Second – Mike Deegan

Votes – *Roll Call –*

Company	*Voter*	*Approve*	*Waive*	*Disapprove*
SwRI	Dan Engstrom	■		
IAR	Bill Buscher	■		
Lubrizol	Andrew Stevens	■		
Afton	Ben Maddock	■		
Oronite	Robert Stockwell	■		
Infineum	Andy Ritchie	■		
TMC	Rich Grundza	■		
Ford	Mike Deegan	■		
GM	Frank Cooney	■		
Shell	Jeff Hsu	■		
ExxonMobil	Paul Rubas	■		
Valvoline	Amol Savant	■		
BP				
Haltermann		■		
OHT	Jason Bowden	■		
TEI				
Gage Products	Jim Carter	■		
IMTS				
	Totals –	*14*	*0*	*0*

Outcome – The motion passes unanimously.

3.3 Introduction of BL6

Rich presented the BL6 vs. BL2 comparison. There were a few outliers in the plots, one explained by rich AFR in Stage 5 and 6. If we exclude the rich result, total fuel consumed suggests that BL6 is less fuel efficient than BL2 by 41g (in terms of weighted fuel consumed, about 8g). BL5 and BL6 are exact matches in terms of analytical results. If the batches are truly different, it may result in 1-1.5 sigma shift (back calculated based on a couple reference results). Assumes that candidate oil is the same.

Amol – Valvoline had an instance where an ECT wire frayed, causing issues with fuel control and went rich. This ECM doesn't always throw a code or set a MIL state.
Andy – What are we going to do?
Rich – Nothing we can do, start over again?
Stevens – What does not rolling BL6 in look like? What options are available?
Andy – Not rolling it in is a big deal, we're not able to blend it again. Then, the test becomes unavailable. Scale and scope is big. Don't know what the course of action is if we don't try to accept as is.
Amol – We can create an offset/correction factor just for BL6.
Travis – Yes, we can create a BL offset, but we need more data to feel confident in a correction factor.

Andy – Base stock comes from Singapore, and it's a special exercise to get it. Going to have an offset, doesn't have FM and can quantify/it's measurable. Proceed that it needs to be addressed as different and need to make appropriate decisions to introduce it.
Andrew – Do we know all of the options now or should we come up with them and discuss? Not going to throw away or adjust the BL6 batch, but it does potentially impact results.
Rich – If the shift is real, we have to deal with it.
Bill – If it shifts everyone's RO performance but doesn't push anyone out, can we live with SAs correcting it?
Rich – We'll have to pull off the ICF at some point in time if it shifts this.
Amol – Is there an option to have an offset in the engine hour correction factor?
Andrew – What's the timeframe for figuring out how to handle it?
Bob – Labs need to get back With rich on inventory of BL5. SA path forward isn't viable, so need to come up with ICF for BL6 or adjust RO targets (set different BL5 and BL6 targets). We need to know when we need to do it by.

Travis – Engine to engine is very different, and lab differences are very important in this test. We need to generate more data.
Rich – It's hard to deny that there's not something going on.
Stevens – In agreement about issue but need to know timeframe and what data needs to be generated.
Campbell – TMC gets inventory levels for labs, then meet about it ASAP.
Rich – Action: reach out to labs to get BL5 and FO5 inventory,
Andrew– Action: set up meeting for week of 11/21
Andrew – 10 mins over time, revisit other items in next meetings
Rich – We're going to need to introduce 542-5 and will need to do it soon (next couple months). Propose using current targets and hope for best
Rich – Labs can use FO6, but no one has yet. Thought process is that flush oil is just BL with a lot of detergent.

Andy – VIE/VIF parts forecast will be updated by Bill/Pat. Prognosis of VIE/VIF test life is important. Update Angela's forecast sheet.

3.4 Reblends of Reference Oils

- Status of 1011-1

- 543-1, 1010-2, and 542-5 Introductions

Discussion tabled until next meeting.

3.5 HF 20003 Update

- Off-spec

- Shipping delays

Discussion tabled until next meeting.

4. **Next Meeting**
   Week of 21 Nov 2022

5. **Meeting adjourned.**