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MEMORANDUM: 05-007

DATE: February 16, 2005

TO: Sequence III Surveillance Panel

FROM: Michael T. Kasimirsky

SUBJECT: Additional Sequence IIIG Severity Analysis Results

On February 1, 2005, the Sequence III Surveillance Panel held a teleconference to discuss the most recent Percent Viscosity Increase (PVIS) and Weighted Piston Deposit (WPD) performance of the Sequence IIIG test. The TMC analysis of this performance, published in TMC Memorandum 05-005, was the main topic of discussion on this teleconference. Several questions were raised on that call and the TMC was asked to address those questions with additional analyses. The results of those analyses are shown below, along with the question that was raised:

Assuming that powdered metal connecting rods are the cause of the most recent severity shift, how much additional data is needed to show the WPD trend is statistically significant and how much additional data is needed to estimate the size of the shift? This question was posed to John Zalar, ASTM TMC Administrator and statistician, for his opinion on the subject. The data was analyzed again, this time excluding the first two tests on powdered metal (PM) connecting rods (Testkeys 51027 and 51028) since they did not use the correct torquing procedure for the PM rods. When that data was excluded, the WPD trend that was previously identified *is* statistically significant and the existing data (N=10) can be used to estimate the severity shift.

The data was further analyzed to determine what effect additional data points would have on the estimates of the severity shift, assuming PM rods are the cause of the shift. Using PVIS as an example, the effects of additional testing on the confidence intervals of the estimates were determined. With the currently available data, the 95% confidence interval of that estimate is ±0.4431. With 20 additional data points, the 95% confidence interval shrinks to ±0.2287, assuming the observed mean and standard deviation remain constant.

Have engine blocks affected test severity? The Surveillance Panel requested that the effects of engine blocks on reference oil test performance be reviewed. The LTMS data was analyzed and no block effect can be identified. There is simply too much variation in the current block hardware data for it to have caused the most recent trend in test severity. For example, the six most recent data points have been very consistent in PVIS and WPD performance. Those six tests were performed on three different production runs of "2004" engine blocks. Going back further, but still within the trend period shown on the control charts, shows blocks from several different calendar years in the data. The data could be combined by

years, for example, for the purposes of analyzing the data but this would be arbitrary and make the results meaningless. To my knowledge, no changes to the blocks have been made in quite some time (if ever), in either materials or manufacturing techniques, so there is little reason to suspect the blocks in the first place.

Have piston rings affected test severity? The performance of the various piston ring batches was also reexamined. As was stated previously, *yes*, there *is* a difference in the performance of some ring batches on PVIS and WPD. On the attached PVIS and WPD control charts, the tests using BC4 rings have been circled on the CUSUM plot at the bottom of the page. All BC4 ring tests show mild results on viscosity increase and severe results on WPD. Although, there are several tests on earlier BC3A rings which are consistent in performance with subsequent tests on BC4 rings. Also note, that seven of the ten data points on BC4 rings were run using PM rods. Given that, it may be difficult to conclude that piston rings are the sole culprit without having supplier data documenting a physical change like exists with the PM rods.

In addition, the blowby results (all readings) were analyzed for differences associated with piston ring batch. The only consistent differences in blowby performance were found between BC2 rings and BC4 rings. Since the BC2 rings were run entirely on the old honing technique, this difference is not unexpected. The BC3 and BC3A ring batches were not found to be different than the BC4 rings on blowby performance. The analysis was repeated, this time excluding all the data using the old honing technique, and that analysis also showed no consistent differences in blowby performance between ring batches. The new honing data was also examined for differences in oil consumption associated with ring batch and no significant differences were found.

Do the individual ratings that make up the WPD result tell us anything? The individual WPD rating results were also analyzed. Since we know that the deposits within the engine are not consistent across all pistons, the results were analyzed on a by-position basis, i.e. by groove 1 piston 1, groove 1 piston 2, etc. In addition, the three reference oils were also analyzed independently since they do not perform exactly the same (reference oil 434 in particular) and no targets exist to normalize the results via a Y_i calculation. Oil 434 showed some differences on ORLD results associated with rod type, but only on five of six pistons (piston 6 did not show the difference), and two of those differences were only significant at a 90% confidence level, rather than the normal benchmark of 95%. Oil 434 also showed differences on 11 of 12 piston skirt varnish ratings (piston 2, thrust side, was the lone exception) associated with rod type, but again only at the 90% confidence level. Oils 435 and 438 did not show any consistent differences associated with rod type. Given the milder performance of reference oil 434 compared to the other two oils (target means of 4.80, 3.59, and 3.20 merits, respectively) it is not unexpected to only see a difference on this oil and not the other two.

Could the WPD shift be a rating issue? The question was raised if the recent WPD shift could be related to some change in how deposits on the pistons are rated and not a change in the deposits themselves. The last Light Duty Rating Workshop took place in May 2004 and is well before the most recent shift in the reference oil data. In addition, Scott Parke, the Light Duty Rating Task Force Chairman informed me that this workshop did not introduce anything new to the Sequence III rating process and only consisted of the raters generating data using current techniques. As you may recall, there were some questions regarding the definition of the undercrown area in the test procedure, but he assured me that the raters were simply looking to have the term clarified for outside users and this did not change how they perform the undercrown ratings.

What is the magnitude of the current severity shifts on PVIS and WPD? The LTMS data was analyzed and several estimates of the current severity shifts were calculated, based upon the PM rod data. These estimates are shown in the following table:

	PVIS	WPD	WPD (Lab F data removed)
Average Δ/s	-1.0206	-0.8881	-1.2056
Average Δ[C]	-0.2979[A]	-0.533[B]	-0.723[B]

[A] In transformed units.
[B] In reported units.
[C] Calculated using the most recent severity adjustment standard deviations of 0.2919 and 0.600 respectively.

In the above estimates, the data from Lab F was removed from the second WPD estimate to show the effect of Lab F's data on the WPD results. Note that previous analysis has shown that Lab F data is different than the other labs. Removing the Lab F data from the PVIS estimates does not result in a large change in the estimate of the shift so that result was not shown. However, the PVIS data should be screened in the same manner as the WPD data, i.e. the Lab F data is either in for both or out for both calculations, so if the Surveillance Panel's desire is to not consider this data it should be removed from the PVIS calculation and the results recalculated.

MTK/mtk

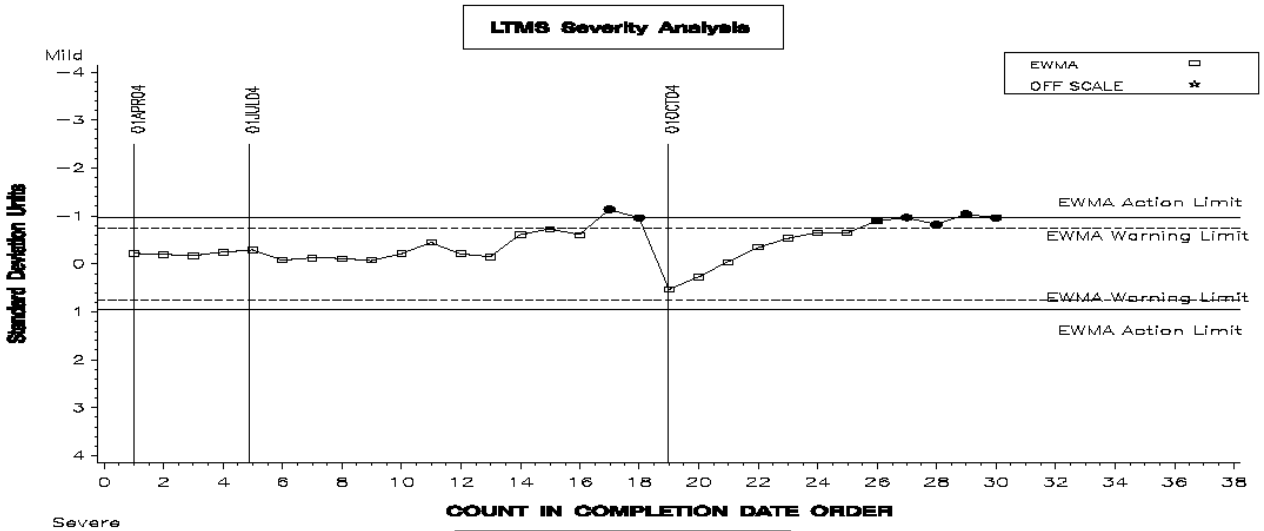
Attachments

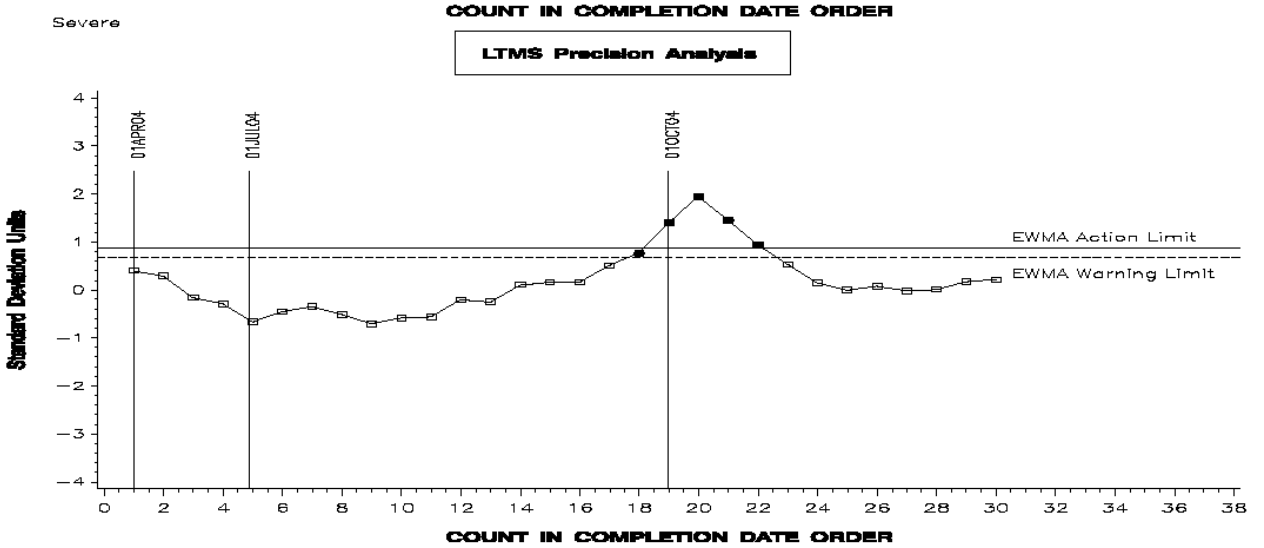
c: ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiii/memos/mem05-007.mtk.doc

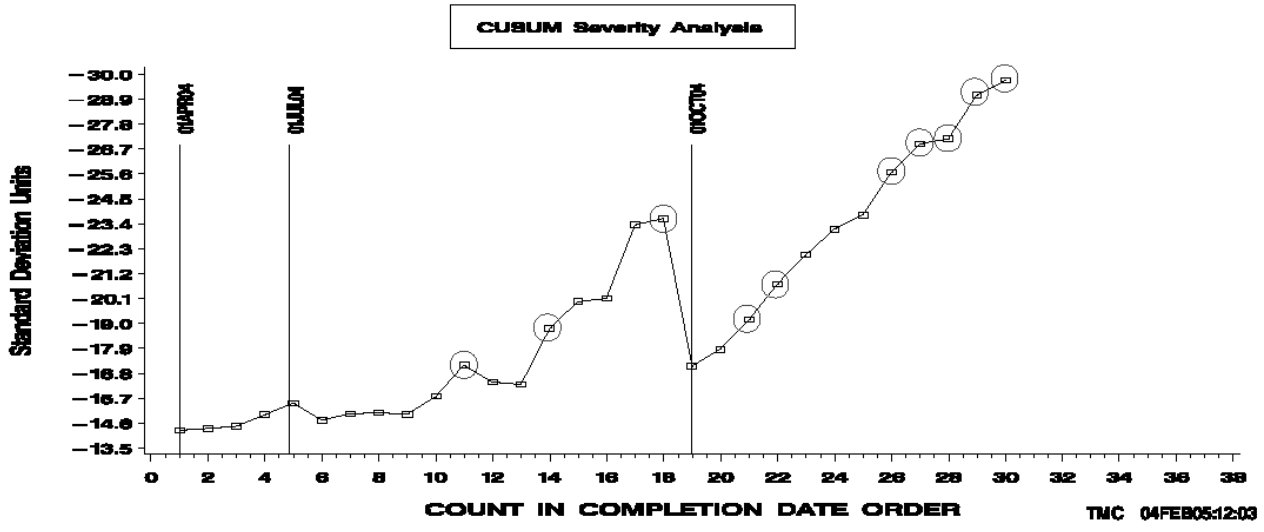
Distribution: Electronic Mail

SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA

VISCOSITY INCREASE







SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA

AVERAGE WEIGHTED PISTON DEPOSITS