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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

Issued: February 11, 2011

Reply to: Dan Worcester
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The unapproved minutes of the 02.10.2011 Sequence VI Surveillance Panel Conference Call.

The meeting was called to order at 10:00 AM by Chairman Charlie Leverett.

Agenda

The Agenda is the included as Attachment 1.

Roll Call

The Attendance list is Attachment 2.

At the request of Charlie Leverett, LTMS 2 discussion was covered.

1.0 LTMS 2 Discussion

1.1 The call today was scheduled to strive for a unanimous vote. However, there were no changes in negative votes for approval of LTMS Version 2 for VID testing.

1.2 Jeff Clark referred to Section E of the existing LTMS document for the procedure to handle negatives. A minority negative can be ruled non-persuasive by a majority vote of the panel.

1.3 Jim Rutherford read the Goals from LTMS Version 2:

The Lubricant Test Monitoring System (LTMS) is a tool used to identify differences among industry test results. The purpose of the LTMS is to assist the industry to level the playing field for non-reference testing. No matter where or when a non-reference is tested, the goal of LTMS is to bring all results to parity. Adjustments within the system attempt to ameliorate problems when the cause cannot be identified or physically corrected.

- LTMS, although applied to reference oil tests and results, is intended to enhance our ability to measure performance of non-reference oils.
- LTMS should treat large and small labs equitably.
- LTMS should strive for standardization across test types with guidelines and criteria defined for deviations.
- LTMS should encourage on target results and improved precision.
- LTMS should systemically eliminate incentives for inappropriate engineering judgments.
- LTMS should promote reliability, integrity, and efficiency of testing.

Actions in the revision of LTMS are motivated by two desires. First, we want severity adjustment entities (a severity adjustment entity is the entity to which severity adjustments are applied – it could be a laboratory, a stand, an engine, or other identified entities) to be near enough to each other on the performance scale that we believe they are measuring the same oil characteristics. Second, we need enough data from a severity adjustment entity so that we know where it is on the performance scale relative to the rest of the industry.

1.4 Jim Rutherford then noted the Motion from the LTMS Statistical Sub-Group:
"We can continue to discuss the issues raised in the negative support documents. None are new to the STG. We have compromised in some cases among differing opinions but at this point the majority of the STG stands by our proposed improvement to LTMS. The majority believes it is technically and practically superior to the current system."

1.5 The decision was made that each negative should receive a Motion and then be voted on by the panel. The technical justifications for the negatives are included as Attachments 3-6. As part of this discussion, Ron Romano covered the Ford technical justification that Version 2 does not encourage labs to run on target, and that the Lambda limits are either incorrect or do not improve Version 1 in current use.

Motion – Declare the Ford argument non-persuasive.

Jim Rutherford / Doyle Boese / Failed 2-5-5

1.6 Jeff Clark stated that for TMC the Level 2 Zi issue on whether a trigger of that limit would mean shutting down the reference test or the lab would need to be resolved. GM and Ford agreed that significant modifications would be needed to change their negatives. Based on the above failed vote, no further action at the Panel level is needed. LTMS 2 is not approved for use in the VID test.

The meeting adjourned at 10:35 AM.

The next meeting will be at the call of the Chairman.

Sequence VI Surveillance Panel – Conference Call

02/10/2011

10:00-11:00 CST

Agenda

Chairman's Comments:

The objective of this conference call is to review the responses from the negative voters concerning LTMS v2, so if the panel agrees this will be the only issued covered in this conference call.

1.0) Roll Call

2.0) Approval of minutes

2.1) Approve the minutes from 01/18/2011 meeting.

3.0) Action Item Review

3.1 OHT to report VID engine usage and expected depletion date at all surveillance panel meetings. **Completed and will be on-going.**

3.2VID Engine Rebuild Task Force – Update

4.) Old Business

4.1) Review of responses from negative voters on LTMS V2.

5.) New Business

5.1) ?

6.) Next Meeting

6.1 At the call of the chairman

7.) Meeting Adjourned

ASTM SEQUENCE VI SURVEILLANCE PANEL – CC 02.10.2011

Name	Address	Phone/Fax/Email	Attendance
			GUESTS
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Mosher, Mark Voting Member Y	ExxonMobil 600 Billingsport Road Paulsboro, NJ 08066	Phone: 856-224-2132 Fax: 856-224-3628 mark_r_mosher@exxonmobil.com	ART ANDREWS
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Ford Motor Company
Ford Customer Service Division
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Diagnostics Service Center II
1800 Fairlane Drive
Allen Park, Mi. 48101

January 28, 2011

Charlie Leverett
ASTM Sequence VI Surveillance Panel Chairman
David L. Glaenzer
ASTM Sequence III Surveillance Panel Chairman

Subject: Reasons for Ford's negative votes on Sequence IIIG and VID LTMS v2

In general Ford is opposed to a system that doesn't encourage labs to run on target. Although, with LTMS2 this probably can be achieved to an extent if the Zi limits are tight enough and this is a problem with the VID, Zi limits too wide. Maybe should be around 2 max. The IIIG appears to have acceptable Zi limits for PVIS and WPD but no limit for ACLW is unacceptable. Additionally Ford is not in favor of a system that allows labs to bounce around their average without forcing consistency. This again can be made better by using tighter ei limits but even this allows labs to bounce around, just less. There is nothing in the system that shows changes in a lab from test to test like we have in LTMS1 using Ri. With LTMS2 we are no longer tracking precision. Having only ei allows variability.

Ford doesn't agree with the argument that we don't truly have targets. We do have them for each reference oil and if we didn't have targets then how can you have an SA which is applied to bring you back to target. Then the SA is a contradiction.

The above as far as Ford is concerned shows no advantage of LTMS2 over LTMS1, decreases precision, and removes incentives for running on target and precise. Only improvement is possibly the continuous SAs. These we might be willing to agree with and include in LTMS1. Since the remainder doesn't provide any advantage we don't see any reason to change from LTMS1. Just because the surveillance panels have been working on LTMS2 for close to 2 years isn't good enough reason to implement it. Actually that's probably a good reason not to. If it was better than LTMS1 we would have agreed to it sooner. Below are some specific issues Ford has with the VID and IIIG LTMS2 but the indicated changes are in no way an endorsement of LTMS2 with these changes, simply showing where they should have been in the first place.

IIIG: why is the increased calibration test frequency (Level 2) 125 days or 20 tests when LTMS1 is 75 days or 18 tests? This should be the same as LTMS1.
Zi and ei limits appear ok except ACLW. Based on LTMS1 ACLW limits should be the same as PVIS and WPD.

VID: why is the increased calibration test frequency (Level 2) 1400 hrs or 8 tests/ 1050 hrs or 6 tests when LTMS1 is 50% for the action alarm? The above numbers are only about a 15-20% change from calibration frequency today (10 full length or 1750 engine hours (1st 3 periods) and 7 full length or 1225 engine hours for subsequent periods.)
Zi limits should be 2.0
ei are also too lenient compared with the EWMA and Shewhart limits in LTMS1. Maybe something like Level 3=1.96 and Level 2=1.645

If you have any question please contact me.

Thanks

Ron Romano

Service Lubricants Technical Expert

To: Charlie Leverett (Chair, Sequence VID SP); Dave Glaenzer (Chair, Sequence IIIG)

From: Matthew Snider (General Motors)

Date: 02 February 2011

Re: **Support for GM negative vote on LTMS v2**

General Motors has several issues with the recently passed LTMSv2. First, GM disagrees with the overarching philosophy change ushered in by LTMSv2. A lubricant test fundamentally has a real target result. In a perfect world, running the same test procedure, using the same components, under the same conditions, would yield the same result, regardless of where the test is run. Unfortunately, the world is not perfect and test results are inherently noisy. Therefore, we need a Lubricant Test Monitoring System (LTMS) to help us identify real deviations from the background noise. Once a real deviation is identified, the onus is on the overseers of a test to determine and correct the cause of the deviation. In essence, a well designed LTMS system helps promote test accuracy by identifying deviations that require corrective action.

There is no question that determining and correcting the cause of a deviation is a heavy burden. Just because a task is difficult, however, is not a reason to simply give up. Unfortunately, giving up is exactly what LTMSv2 seeks to do. The emphasis of LTMSv2 is on internal lab consistency while paying little heed to inter-lab accuracy. LTMSv2 fundamentally changes the philosophy of test monitoring by suggesting that there is not a knowable test target that we should strive to meet, but rather that acceptable test performance is defined by each individual lab. In essence, LTMSv2 is the relativistic view of test monitoring. GM disagrees with this philosophy change.

GM also disagrees with the proposed reasons for LTMS modification. While the various iterations of LTMSv1 are not perfect, there has been no data provided showing a failure of LTMSv1 to monitor the effectiveness and accuracy of the various lubricant tests. That there have been changes made to LTMS over the years that often "deviat[e] from [the] original guidelines and spirit of LTMS"[1] is not the fault of the LTMS, but rather a failing of the Surveillance Panels and Test Development Task Forces. To the extent that we, the users of LTMSv1, have stunted its effectiveness through our own missteps, let us correct those missteps through reasonable modifications, not wholesale philosophy changes.

Passage of the LTMSv2 appears to be at least partly motivated by improper considerations. ASTM is a technically driven, performance-based standard setting organization that does not include financial considerations in its deliberations. Therefore, the use of "economic realities" as justification to "rejuvenate the [LTMS] system"[2] is powerful evidence that we, the Surveillance Panel, are, at least in part, relying on fundamentally wrong reasons for LTMS modification. As a result, we should reject outright this nontechnical justification and any consequences stemming from it.

Finally, GM takes issue with application of the LTMSv2 methodology. This is an issue on which GM treads cautiously given that we are not statisticians by training. GM appreciates the high degree of competency of the LTMSv2 Task Force and the diligence and patience they exercised in developing the LTMSv2 proposal. However, GM believes the LTMS Task Force has taken valid concepts of time series modeling and misapplied them to LTMSv2. As an example, two recent papers describe time

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[1] LUBRICANT TEST MONITORING SYSTEM 2D ED., Draft 18.2, at 3, *available at*: ftp://ftp.astmtmc.cmu.edu/docs/LTMS%20v2%20Task%20Force%20Documents

[2] *Id.*

series modeling as a means for process adjustment and control.[3] Both papers acknowledge the difficulties that can occur when using traditional control charts for nonstationary processes. The papers discuss the use of two types of charts to monitor nonstationary processes. The first is an Exponentially Weighted Moving Average (EWMA) chart, which functions as a common cause adjustment chart with adjustments made relative to a target value. Rather than adjusting to a target value, however, LTMSv2 uses a EWMA chart to "promote similar severity across severity adjustment entities"[4] without adjusting to a target value. Thus, the thrust is for laboratories to be internally consistent rather than accurate to a target.

The second chart is based on EWMA residuals and functions as a special cause chart. The purpose of this special cause chart is to alert test overseers of a change in the process that requires further investigation. LTMSv2 uses this special cause chart, but misapplies it. Rather than seek assignable causes when a process deviates beyond action limits, LTMSv2 uses the chart to determine if "we know the relative performance of the severity adjustment entity well enough to adequately severity adjust using the Z_i."[5] In essence, LTMSv2 does not demand action based on deviations in the process, but rather allows the errors in the system to continue.

Finally, GM finds the arguments made in the Test Monitoring Center's (TMC) Memorandum 11-001 regarding TMC Concerns on LTMS Version 2, dated January 10,

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[3] *See* Bisgaard, S, Kulahci, M., *Using a Time Series Model for Process Adjustment and Control,* QUALITY ENGINEERING*,* 20:134-141 (2008); Box, G. E. P., Paiagua-Quinones, C., *Two Charts: Not One*, QUALITY ENGINEERING, 19:93-100 (2007).

[4] LUBRICANT TEST MONITORING SYSTEM *supra* note 1 at 9.

[5] *Id.*

2011, persuasive.[6] GM hereby formally incorporates the TMC's memorandum, in its entirety, into this "Support for Negative Vote on LTMSv2."

For the reasons stated above, GM voted negative on LTMSv2. GM is certain there are reasonable modifications that can be made to the current LTMS of each test. GM would be pleased to work on LTMS modifications that strengthen the quality of engine oil testing.

Respectfully,

Matthew Snider
General Motors
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[6] 11-001, *TMC Concerns on LTMS Version 2*, Jan. 10, 2011, *available at*: ftp://ftp.astmtmc.cmu.edu/docs/LTMS%20v2%20Task%20Force%20Documents/TMC%20Concerns.pdf

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Two Charts: Not One

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"No process, except in artificial demonstrations by use of random numbers, is steady and unwavering."
W. Edward Deming (1986)

ABSTRACT Difficulties can occur in the operation of traditional control charts. A principal reason for this is that the data coming from a typical operating process do not vary about a fixed mean. It is shown how by using a nonstationary model a continuously updated *local mean level* is provided. This can be used to produce (a) a *bounded* adjustment chart that tells you when to adjust the process to achieve maximum economy and (b) a Shewhart monitoring chart seeking assignable causes of trouble applied to the deviations from the *local mean*. Estimation of the mean and "standard deviation" are not required.

KEYWORDS bounded adjustment chart, EWMA estimate, IMA time series, monitoring chart, noise, nonstationarity, quality control chart, stationarity, white noise.

1. INTRODUCTION

Suppose observations $y_1, y_2, \ldots, y_n$ are made of a process characteristic at fixed time intervals. A broad definition of the purpose of statistical quality control is to use such data to search for signals in noise. The nature of a chart designed to do this depends on the specification of the noise and the specification of the signal. Although Shewhart (1931) discussed this problem in a wider context, it came to be known as accepted doctrine that the *noise* should be represented by independently and identically distributed (IID) variation about the target. We will call this *white noise*[1] and denote such white noise series by $a_1, a_2, \ldots, a_n$. In its original, form the signal consisted of a "spike", representing a deviation from target occurring during one time period. This was later extended by some investigators to include other likely signals (see for example, the Western Electric Rules (1956) and later alternatives).

2. INTENDED OPERATION OF A MONITORING CHART

The intended mode of operation of a standard Quality Control (QC) chart is illustrated in Figure 1.

[1]It was further assumed that its distribution would be approximately normal.

$$y = f_1(x_1, x_2, \ldots, x_n) + f_2(x_{n+1}, x_{n+2}, \ldots)$$

Known Unknown (noise)

FIGURE 1 **Ideal operation of a quality control chart to move a previously unknown source of trouble x_{n+1} (special cause) from the unknown to the known.**

The deviation y from target is represented here as a function of a number of known operating variables $x_1, x_2, \ldots, x_n$ and a number of unknown factors $x_{n+1}, x_{n+2}, \ldots,$ that constitute the noise. A sufficiently extreme deviation from target can point to a "special cause" and possibly an assignable cause of trouble x_{n+1} that can be rectified and so transferred from the unknown to the known. This kind of operation will be called process monitoring or more colloquially "debugging" the process. It can have three desirable results:

(a) causes of trouble may be identified and permanently eliminated,
(b) it may be possible to fix the newly found factor x_{n+1} at its best level and so improve the process, and
(c) the level of the residual noise will be reduced, somewhat making it easier to discover other assignable causes.

3. DIFFICULTIES

It is realized that charts based on this previously accepted doctrine often did not behave very well. Thus for example, Alwan and Roberts (l995) found that "in a sample of 235 'expert' control chart applications in training manuals for SPC, it was found that over 85% of control charts displayed misplaced control limits." They concluded that "the assumptions on which control charts are constructed are violated by real world data." As a consequence of similar findings many authors have proposed modifications to the original charts and/or of the models on which they are based. It is necessary therefore to say something about models for noise that represents what will happen if no control action is taken.

4. WHAT IS A GOOD MODEL?

A good model is an approximation, preferably easy to use, that captures the essential features of the studied phenomenon and produces procedures that are robust to likely deviations from ideal assumptions. The model defined above, which takes IID noise into consideration does not meet these criteria, significantly takes no account of the obvious fact that data taken closer together in time will be more alike than data that are separated more widely. Thus we must expect that observations taken in sequence will be serially dependent. Such considerations have led to a number of studies about the behavior of QC charts where successive observations are assumed to be "autocorrelated" (see e.g., Montgomery and Mastrangelo, 1991; Vasilopoulos and Stamboulis, 1978). Now the autocorrelation function is a sequential listing of correlations between observations taken one step apart, two steps apart, and so on, and only has meaning if we limit ourselves to stationary models. More generally what is meant therefore is that there will be "serial dependence" between successive observations.

5. NONSTATIONARY MODELS

One way in which serial dependence can be modeled is by the use of nonstationary ARIMA models (autoregressive integrated moving average models) introduced in the 1960's by Box and Jenkins (1963). See also Box, Jenkins, and Reinsel (1994). In particular, these authors pointed out that a model in this class of particular value is the simple integrated moving average (IMA) model for which

$$y_t - y_{t-1} = a_t - \theta a_{t-1} \qquad (1)$$

In this model, θ is called the "smoothing constant" and for the purpose of this article, its value will be assumed to lie between zero and one. The a_t*'s* are random IID variables with zero mean and standard deviation, σ_a. Since this model is nonstationary, it has no fixed mean, however, a local measure of location at any time origin t and a forecast from that origin, is estimated by the exponentially weighted moving average (EWMA)

$$\hat{y}_t = \lambda(y_{t-1} + \theta y_{t-2} + \theta^2 y_{t-3} + \cdots). \qquad (2)$$

where $\lambda = 1 - \theta$ and will be called the *nonstationarity parameter.*

For example, for $\lambda = 0.2$,

$$\hat{y}_t = 0.2y_{t-1} + 0.16y_{t-2} + 0.13y_{t-3} + 0.10y_{y-4} + \cdots$$

In practice, EWMA's are often calculated using the simple updating (recursive) formula,

$$\hat{y}_{t+1} = \lambda y_t + \theta \hat{y}_t \tag{3}$$

The later behavior of the series $\hat{y}_t$ is insensitive to the choice of the initial value $\hat{y}_0$ and to get this "recursive" calculation started, $\hat{y}_0$ can be set equal to the target value. Alternatively, it can be "back-forecasted" by turning the series around so that $\hat{y}_0$ becomes the last value from the reversed series.

6. THE GENERATION OF NOISE

Two reasons for persistence of the belief in serial independence have been

(a) it would be mathematically convenient if it were true,
(b) a graph like that in Figure 2a can mislead us, because it implies that during each individual time period, there occurs what has variously been called "a common cause"[2], "a random shock", or "an innovation."

But there is no reason for such causes to be confined to a single time period. A more realistic approximation is shown in Figure 2 where some innovations are completed within one time period, others occupy longer periods, and some very long periods. The last ones, in a previous publication, were called as "sticky innovations" by Box and Kramer (1992), and earlier by Muth (1960) they were termed as "permanent components" (as contrasted with transitory components) of the noise. The sticky innovations are represented in Figure 2 by lines ending in arrows. Examples of their occurrence would be: when a car tire hits a sharp stone, and from that time onward the tire is slightly damaged, or when corrosion produces a tiny crater in the surface of a drive shaft and remains there. Such permanent innovations also occur when any procedure in manufacturing is slightly changed in a manner not regarded as important, or perhaps not even consciously realized, with no one appreciating that a slight change has been made.

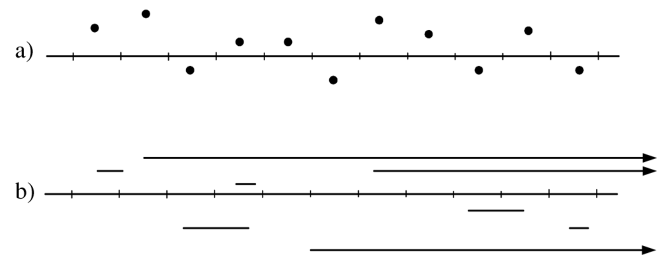

FIGURE 2 **Representations of noise.**

The accumulation of undetected permanent components of the noise produces "nonstationarity". Particularly, in the works of Muth (1960) and Box and Kramer (1992), showed that a sum of random (transitory) noise and sticky (permanent) innovations produce the IMA nonstationary model of Eq. (1) with the EWMA in Eq. (2), which is an optimal estimate of current location.

Nonstationarity reflects the steady process of disorganization, or increase in "entropy", that occurs in any uncontrolled system. This happens in accordance with a fundamental physical law: the second law of thermodynamics. The purpose of QC is, so far as possible, to nullify the effect of this inexorable law.

It can do this in two ways:

(a) by using a monitoring chart to remove "assignable" causes that after allowance for nonstationarity, are large enough to be distinguished from residual noise, and
(b) by using an adjustment chart to nullify nonstationary effects, such as drifts and step changes, that have no assignable cause or that have known causes about which nothing can be done.

7. THE NEED FOR TWO CHARTS

How can QC charts be modified to take care of nonstationarity[3]?

It is essential to remember that a nonstationary series has no fixed mean. It is the target value, T that stays fixed. However, on the assumption of an IMA noise model, a local estimate of the process level at time t is the EWMA $\hat{y}_t$ of Eq. (2). This estimate is a weighted average of the recent data that is continually

[2]As was pointed out by Pyzdek (1990) what is called a *special cause* and what is called a *common cause* entirely depends on the level of the residual noise. If this can be reduced, more "*special causes*" may become evident.

[3]This is now recognized, in particular in the specifications for Six Sigma in which considerable allowance is made for "*process drift*" (see e.g., Box and Luceño, 2000).

updated. Thus at time t, a current estimate of how far the process is off-target is $\hat{y}_t - T$. So we need a bounded adjustment chart that provides a continuous update of this estimate, $\hat{y}_t - T$, and that tells us when the discrepancy is sufficiently extreme to warrant adjustment of the process. In addition we need a process monitoringchart to search for special and possibly assignable causes after nonstationarity is allowed for. This is provided by a Shewhart chart applied to the residuals, $y_t - \hat{y}_t$. It uses the fact that on the assumption of the adequacy of the nonstationary model, the IID residuals will be approximately independent.

Thus we need two QC charts instead of one chart:

(a) a bounded adjustment chart for $\hat{y}_t - T$ with limits that tell us when to adjust.
(b) a Shewhart monitoring chart for $y_t - \hat{y}_t$ that after nonstationarity is allowed for tells us when to look for assignable causes.

7.1. The Adjustment Chart

The appropriate adjustment chart was introduced by Box and Jenkins (1963) who showed, on the assumption of a quadratic off-target loss and for an IMA time series disturbance that the optimal adjustment procedure required changes to be made only when an EWMA of deviations from target $\hat{y} - T$, fell outside the fixed parallel limits, at say $\pm L$. This is a bounded adjustment chart bearing a superficial resemblance to a Shewhart chart. However, the positions of the limit lines at $\pm L$ are obtained quite differently. These are chosen so that after adjustment, the series has the smallest standard deviation for a given *average adjustment interval* (AAI) or equivalently, that the run length is maximized for a given small percentage *inflation of the standard deviation* (ISD). This "inflation" is with respect to a theoretical minimum standard deviation that would be obtained if adjustment were allowed after each time interval. It is the standard deviation of the residuals $y_t - \hat{y}_t$. Graphs that, to a sufficient approximation, relates L/σ and the AAI with λ and the %ISD, is shown in Figure 5. This is based on the earlier more exact tables given in the works of Box and Jenkins (1963), Box, Jenkins, and MacGregor (1974), Box (1991a,b), and Box and Luceño (1997).

7.2. The Monitoring Chart

A Shewhart chart of the residuals $y_t - \hat{y}_t$ provides a monitoring chart, not affected by the changing base level. A chart of this kind was proposed by Berthouex, Hunter, and Pallesen (1978) and later by other authors (see for example, Alwan and Roberts, 1995; Montgomery and Woodall, 1997; Vander Wiel, 1996).

Of course, the signal being sought might not be a spike. But, just as extended rules are available for standard control charts, the same extended rules may be used for the residual monitoring chart also. More generally, a procedure (Box and Ramírez, 1992) is available for finding the best "detector" for virtually any signal in any noise. This is the *Cuscore* statistic based on the Fisher's efficient score and has been shown by Viveros and Ferrer (1999) to have the maximum intrinsic sensitivity[4]. Applications of these ideas for processes at Monsanto Fibers Division, were discussed by Baxley (1994).

7.3. An Illustration

For illustration, consider the generated nonstationary "process data" y_t shown in Figure 3a for which the parameters were $\lambda = 0.2$ and $\sigma_a = 1^*$. Figure 3b contains the bounded EWMA's with limit lines at $L = \pm 1.25$ So that $L/\sigma_a = \pm 1.25$. It can be seen that $\hat{y}_{59}$ crosses the upper limit line causing a negative adjustment (shown by an arrow) to bring the EWMA to the target value (zero). Adjustments of this kind do not upset the calculation of subsequent EWMA's because the adjustment equally affects the data value y_t and its EWMA estimate $\hat{y}_t$. It is not necessary to repeat the "start up" procedure.

After $\hat{y}_{148}$ crosses the lower limit, the process is again adjusted to the target value. The cumulative adjustment series A_t is shown in Figure 3c. The adjusted chart in Figure 3b can be regarded as the series $\hat{y}_t + A_t$, while Figure 3d shows the *adjusted process* value $y_t + A_t$. It will be seen that for this series of 200 observations, only two adjustments are needed to remove major nonstationarity in the series. The theoretical average adjustment interval given by

[4]This is a measure of the quickness with which the statistic reacts to a change in the value of a parameter.

*How estimates for these parameters can be obtained is discussed in the next section.

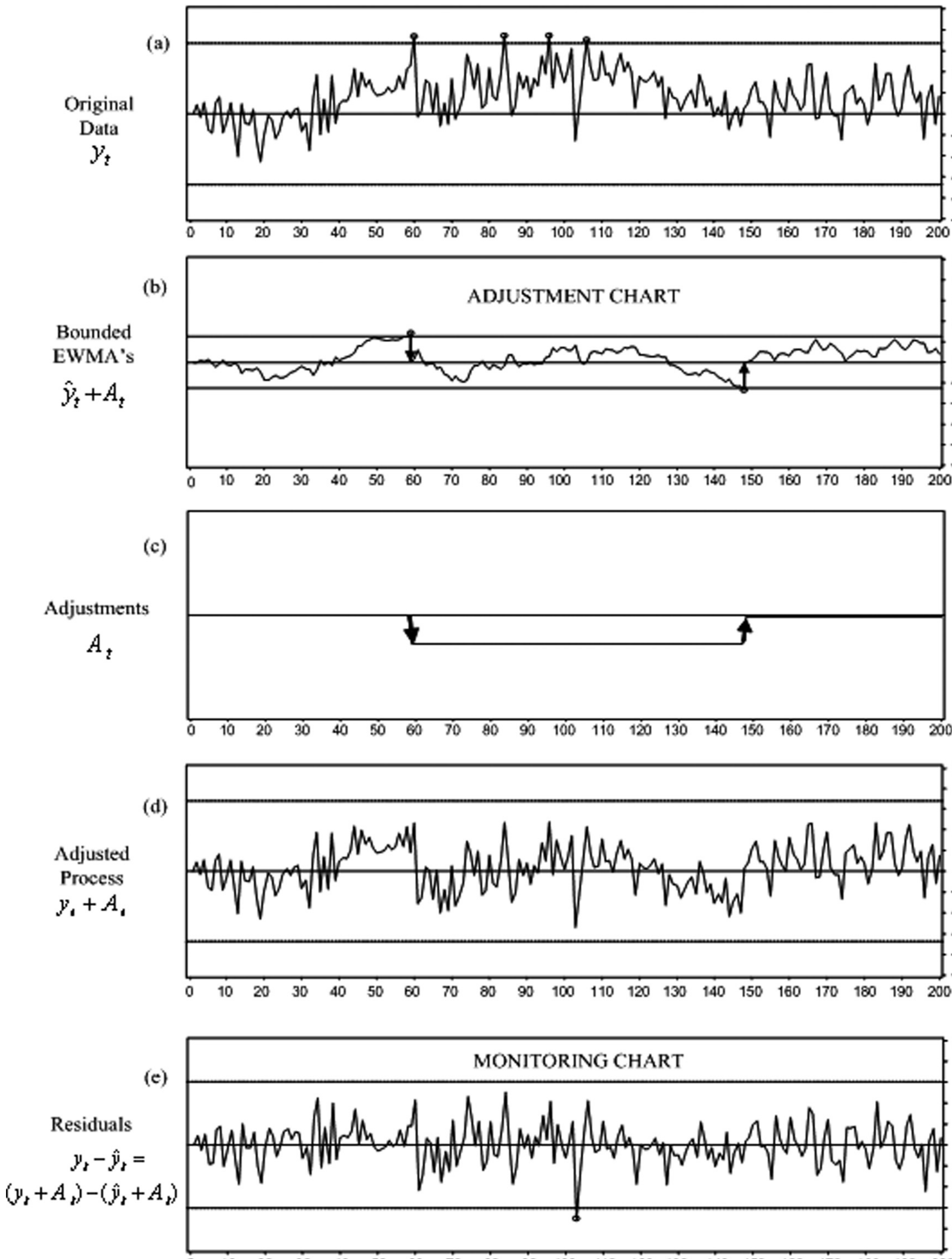

FIGURE 3 **(a) The unadjusted "process" series (observations 60, 84, 96, and 106 above $+3s_y$ limit), (b) the bounded adjustment chart, (c) the adjustments applied at times 59 and 148, (d) the adjusted process, (e) the residual series to which $3\sigma_a$ Shewhart limits are applied for the detection of special causes after misleading nonstationarity is removed. One point below the $-3\sigma_a$ limit is detected at observation 103.**

the chart in Figure 5 is about 50 (with so few observations this agreement must be regarded as fortuitous). A graph of the residuals $y_t - \hat{y}_t$ is shown in Figure 3e. These are calculated by subtracting $\hat{y}_t + A_t$ in Figure 3b from $y_t + A_t$ in Figure 3d (see the charts). They provide the data for the monitoring chart. It will be seen that while in Figure 3e that a now one point, that might indicate an assignable

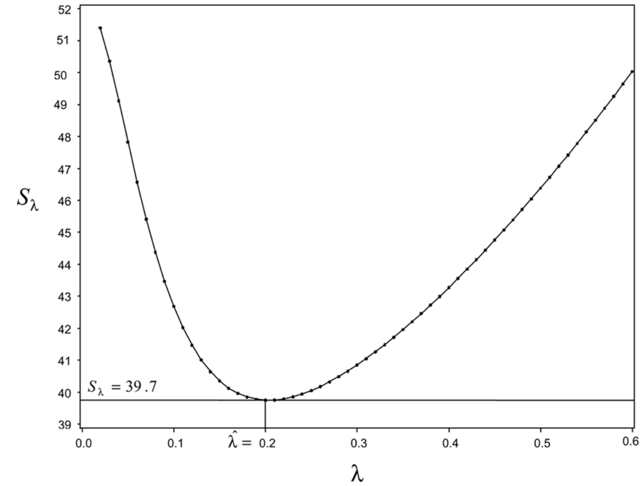

FIGURE 4 **Plot of the sum of squared deviations S_λ against λ.**

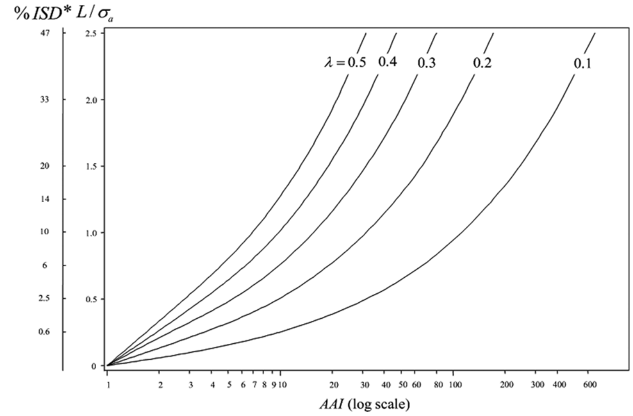

FIGURE 5 **A chart from which the AAI and the %ISD may be obtained for different values of L/σ and λ. * % ISD varies slightly depending on λ, but average values given here supply an adequate approximation.**

cause at observation 103, is below the 3σ limit line. In practice only the *adjustment chart* (Figure 3b) and the *monitoring chart* (Figure 3e) nedd be displayed, the other charts are included here for explanatory purposes.

7.4. Estimating λ

Notice that in the standard QC procedure you need to choose (estimate, guess) a value for the mean and standard deviation, and the behavior of this procedure is very sensitive to such choices. In this new process all you need is a value for λ, and the method is very insensitive to this choice. To get started any value of λ between, say 0.1 and 0.3, would usually do quite well to begin with. After some data, say 50 observations, you can get a least squares estimate of λ as follows. If e_t denotes the difference between the forecast $\hat{y}_t$ made at time $t-1$ and the realized value y_t at time t, you can calculate the "errors"[5] $e_t = y_t - \hat{y}_t$ for the whole series. Now for any given series and any fixed value of λ you can calculate the sum of squares of these errors S_λ and if you repeat the calculations for several values of λ, say $\lambda = 0.0,\ 0.1,\ 0.2, \ldots, 1.0$, you can draw a graph of S_λ against λ like the one shown in Figure 4. The minimizing value of λ then produces the estimate $\hat{\lambda}$ and $S_{\min}/(n-1)$ provides the estimate $\hat{\sigma}^2$, and hence $\hat{\sigma}$.

We illustrate the procedure using the first 50 values of the series plotted in Figure 3a. The data y_t are deviations from the target value. Then for these deviations, the target value is zero and we use $\hat{y}_1 = 0$ to start the calculations. For illustration we have listed in Table 1, the values of $y_t, \hat{y}_t$, and e_t for the first 50 observations. Values $\lambda = 0.2$. Values of S_λ for $\lambda = 0.0,\ 0.1,\ 0.2, \ldots, 1.0$ are plotted in Figure 4. Thus for this, rather short series of observations the minimizing values of $\hat{\lambda} = 0.2$ and $S_{\min}$ is 39.7, so $S_{\min}/(49) = 0.81$, $\hat{\sigma}^2 = 0.81$, and $\hat{\sigma} = 0.9$.

8. ROBUSTNESS OF THE EWMA

To check the robustness of the EWMA when the model differs from the ideal, Box and Luceño (1997) ran an investigation with two other nonstationary models. What is here called Model 2 was proposed by Barnard (1959); and in this model, the sizes of a series of jumps in level were assumed to be normally distributed and the periods between jumps to follow a Poisson distribution. A third possibility (Model 3), proposed by Box and Luceño (1997) postulated three randomly sequenced states. In state one, the mean would stay fixed; in state two, the mean would experience a normally distributed random jump in level; and in state three, the mean would experience a normally distributed random change in slope. As before the lengths of these states were simulated by random drawings from a Poisson distribution. It turned out that the EWMA provided a good estimate of location for data from all three models. It was also shown that the choice of the smoothing constant θ in the EWMA was very robust to deviations from the ideal. Such considerations and

[5]If you used $\hat{y}_t$ as a forecast of y_t, then they would be the forecast errors.

TABLE 1 Values of the Series Used to Generate Figure 4

t	y_t	$\hat{y}_t$	$e_t = y_t - \hat{y}_t$	t	y_t	$\hat{y}_t$	$e_t = y_t - \hat{y}_t$
1	0.4	0.0	0.4	26	−0.2	−0.5	0.3
2	−0.2	0.1	−0.3	27	0.2	−0.4	0.6
3	0.5	0.0	0.5	28	0.3	−0.3	0.6
4	−0.8	0.1	−0.9	29	−0.8	−0.2	−0.6
5	−0.9	0.0	−0.9	30	−0.4	−0.3	−0.1
6	0.5	−0.2	0.7	31	−1.8	−0.3	−1.4
7	0.8	−0.1	0.9	32	0.7	−0.6	1.3
8	−0.9	0.1	−1.0	33	1.9	−0.4	2.2
9	−0.4	−0.1	−0.3	34	−1.0	0.1	−1.1
10	0.5	−0.2	0.7	35	0.7	−0.1	0.8
11	−0.7	0.0	−0.7	36	−0.9	0.0	−0.9
12	−2.0	−0.2	−1.9	37	1.8	−0.1	2.0
13	0.5	−0.5	1.0	38	−0.5	0.3	−0.7
14	−0.5	−0.3	−0.1	39	0.4	0.1	0.3
15	−0.5	−0.4	−0.1	40	0.6	0.2	0.5
16	0.2	−0.4	0.6	41	0.6	0.3	0.3
17	−1.3	−0.3	−1.0	42	1.0	0.3	0.7
18	−2.3	−0.5	−1.8	43	2.2	0.5	1.7
19	−1.0	−0.8	−0.2	44	0.8	0.8	0.0
20	−0.1	−0.9	0.8	45	2.0	0.8	1.2
21	−0.3	−0.7	0.4	46	1.3	1.0	0.3
22	−1.2	−0.6	−0.6	47	1.6	1.1	0.5
23	−0.8	−0.7	−0.1	48	1.1	1.2	−0.1
24	−0.1	−0.8	0.6	49	0.9	1.2	−0.3
25	0.1	−0.6	0.8	50	0.9	1.1	−0.2

practical experiences by many experimenters have confirmed that the IMA model and the EWMA estimate of location are widely useful as parsimonious approximation. Of course, no model is universally applicable and some examples will occur where the use of an elaborate model, possibly of the ARIMA class, is justified. Remember, however, that a model containing more parameters will not necessarily do better. We must pay for every additional parameter that needs to be estimated by an increase in the residual variance.

9. A STATIONARY OR NONSTATIONARY MODEL?

It is easy to formulate models which although technically stationary have realizations that appear nonstationary. (For example, the autoregressive model $y_t = 0.99\, y_{t-1} + at$.) Such series can wander off and deviate from the mean by large amounts and for long periods of time. The question, as always, then is which model produces the more useful approximation. It will almost invariably be the nonstationary model which does this. In particular this model does not need any assumption about the existence of a mean.

9.1. Putting this into Practice

The basic calculation required to put this procedure into practice is elementary. All you need is the expression in Eq. (3). Notice, that if we design our adjustment chart using a small value of λ, such as 0.2, the variance would not increase very much even if the process were (theoretically) in a perfect state of control. On the other hand, if the process were slightly out of control with the true value of λ slightly greater than zero, a very large increase in variance could result if no adjustment action was taken.

ACKNOWLEDGEMENT

We are grateful to Professor J. S. Hunter for suggesting a simple way of expressing this calculation.

Suppose $\lambda = 0.3$, say, the new EWMA $\hat{y}_{t+1}$ is a combination of 30% of the new data value y_t and 70% of the previous EWMA $\hat{y}_t$.

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MEMORANDUM: 11-002

DATE: February 2, 2011

TO: Charlie Leverett, Seq. VI Surveillance Panel Chair

FROM: Jeff Clark

SUBJECT: TMC Comment in Support of LTMS Version 2 Negative

The purpose of this memo is to provide support for the TMC's negative vote regarding the LTMS v2 proposal that was passed at the January surveillance panel meeting. Some of the TMC's concerns were previously stated in TMC Memorandum 11-001, dated January 10, 2011, which is attached for reference. The TMC still stands by the position stated in the memo, and based on the proposal as voted on, believes that the issues enumerated in the memo have not been addressed.

An additional examination of VID reference data, when used to compare v1 with v2, reveals a troubling aspect of v2 in relation to test engines that have been abandoned. The vast majority of engines that were abandoned with v1 would calibrate under v2. The resulting change in overall all severity is shown in the table below.

Parameter	LTMS v1 Yi	LTMS v2 Yi
FEI1	-0.091	-0.218
FEI2	-0.109	-0.220

It is important to note that not only is a change in severity observable, but the v2 system fails to catch the impact of a process change. All of the abandoned engines are A, B, or C builds. To date, none of the D builds have been abandoned. The A, B, and C builds involved tearing down and reassembling with different rings. The D builds were not torn down and reassembled; they were assembled at GM using the slightly higher tension rings. LTMS v1 identifies this difference and prevents engines from being used once they become too severe. LTMS v2 would allow these engines to calibrate.

The goal of the calibration system is not to simply allow labs and stands to calibrate. It is to provide for quality candidate testing on a level playing field. As passed, the LTMS v2 would allow a doubling of engine severity and would not distinguish results from before and after a process change. The v2 passed by the surveillance panel moves testing further from target, weakens the detection power of the calibration system, and demonstrates no benefit in its implementation.

Please contact me if you have any questions.

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MEMORANDUM:	11-001
DATE:	January 10, 2011
TO:	Passenger Car and Heavy Duty Surveillance Panel Chairs
FROM:	Jeff Clark
SUBJECT:	TMC Concerns on LTMS Version 2

Both the Seq. III and VID panel chairs have solicited concerns regarding LTMS Version 2 proposals. This memo documents the TMC's concerns in general about LTMS v2, and where noted, specific concerns about the existing proposals. Following an internal review of the LTMS v2 Draft and the VID and IIIG proposals, the TMC has several concerns as stated below. While this list is not comprehensive, it covers what are currently the priority issues the TMC feels are in need of further examination by the surveillance panels.

Change in testing philosophy

LTMS v2 introduces a change in testing philosophy that no longer puts a primary emphasis on test labs running at similar severity levels. The primary emphasis is to use Severity Adjustments to correct the bias between test labs. ***Recent industry exercises have shown that laboratory SAs might not be adequately accounting for lab differences.*** For example, the Seq. IIIG TMC 1010 results were severity adjusted and lab differences still existed.

LTMS v2 does not make a clear argument why standardized testing conditions (same oil, same fuel, same hardware, same timeframe, same test method) should produce different results between labs. More troubling is a reliance on the SAs as a solution to these differences when recent evidence suggests the SAs fall short of this goal. It seems a more prudent effort than introducing a new LTMS would be to investigate why the SA system may be performing inadequately and why labs are not running at similar severity levels.

Potential Increased in Error for Candidate Test Results

A major objective of both LTMS v1 and v2 is to ensure the proper use of candidate Severity Adjustments. LTMS v1 uses a combination of criteria (Yi, Ri, Qi) in this attempt, while LTMS v2 substitutes Ei criteria for the Yi, Ri, and Qi criteria of LTMS v1. In layman's terms, LTMS v2 looks for a change from where a lab has been previously running, while LTMS v1 looks at the severity of the current test (Yi) as well as a change in severity from the previous test (Ri), and ongoing changes in severity (Qi).

Solely relying on Ei potentially exposes candidate tests to increased error. A theoretical case as shown in **Attachment 1** illustrates this. The plot shows a lab running in a very stable manner (Yi and Zi at 1.0 std. dev.) until test 'i+1'. At this point the lab begins to bounce around the Zi curve by ± 1.7 std. deviations. If this variation were to continue on as shown, the average SA Error is approximately 1.9 std. deviations. LTMS v2 Ei criteria allows lab calibration in this scenario and thus exposes candidate tests to the SA Error. LTMS v1 criteria does not allow calibration in this scenario and thus does not expose candidates tests to the error. The theoretical example shows what would be possible with the use of LTMS v2.

A real data example of this same issue is shown in **Attachment 2**. The charts show lab data that, for a run of tests, the results stray from the Zi curve. LTMS v2 would grant calibration to several of these tests that LTMS v1 would not. The issue isn't that more reference tests would pass in LTMS v2. ***The real concern, and this cannot be overstated, is that by allowing calibration in these instances, candidate test results are exposed to SAs that do not reflect where the lab was running at the time of the test.*** Based on this example, the table below shows the potential magnitude of these errors had this occurred in any of several test types. ***It is worth noting that the application of Yi, Ri, and Qi criteria would prevent the errors shown below.***

Test	Parameter	Pass / Fail Limit	Error
VID	FEI2 (%)	1.3	± 0.3
Seq. IIIG	WPD (merits)	4.0	± 1.3
VG	AES (merits)	8.0	± 1.0
T-12	Ring Weight Loss (Mack Merits)	105[A]	+ 200 / - 306[B]
T-11	Soot at 12 cSt (%)	6.0	± 0.5

[A]P/F shown is in mg, max allowable by T-12 merit system.
[B]Error is expressed in Mack Merits, at the Merit Anchor point of 70 mg. Error in mg is ± 53.5.

LTMS v2 Does Not Encourage On-target Results and Improved Precision

Encouraging on target results and improved precision is a stated goal of LTMS v2, see Section 1.A of the LTMS v2 Draft. Current proposals (IIIG and VID) have Zi limits for LTMS v2 at or beyond existing Yi limits of LTMS v1. These levels combined with Ei limits would allow a lab, on both individual tests and on an on-going basis, to operate further from target than is currently allowed. There is no way in which this can be stated to encourage on-target results and improve precision. It will likely do just the opposite and it runs completely counter to the stated goal of LTMS v2. ***On-target results and improved precision can only be achieved by real improvements in testing practices, not by a change in control chart structure.*** In layman's terms, changing the measuring stick doesn't improve the product; you need to actually improve the process.

No Clear Benefit

Any implementation of LTMS v2 must bring with it a clear benefit to engine oil testing in order for it to be justified. The TMC has concerns, as stated above, that the industry will be taking on significant risk to by adopting LTMS v2 as it is now drafted. Additionally, in the opinion of the TMC, the current proposals do not add benefit to the industry testing and the TMC is concerned that implementation will actually damage testing quality.

Please contact me if you have any questions regarding the TMC's concerns about LTMS v2.

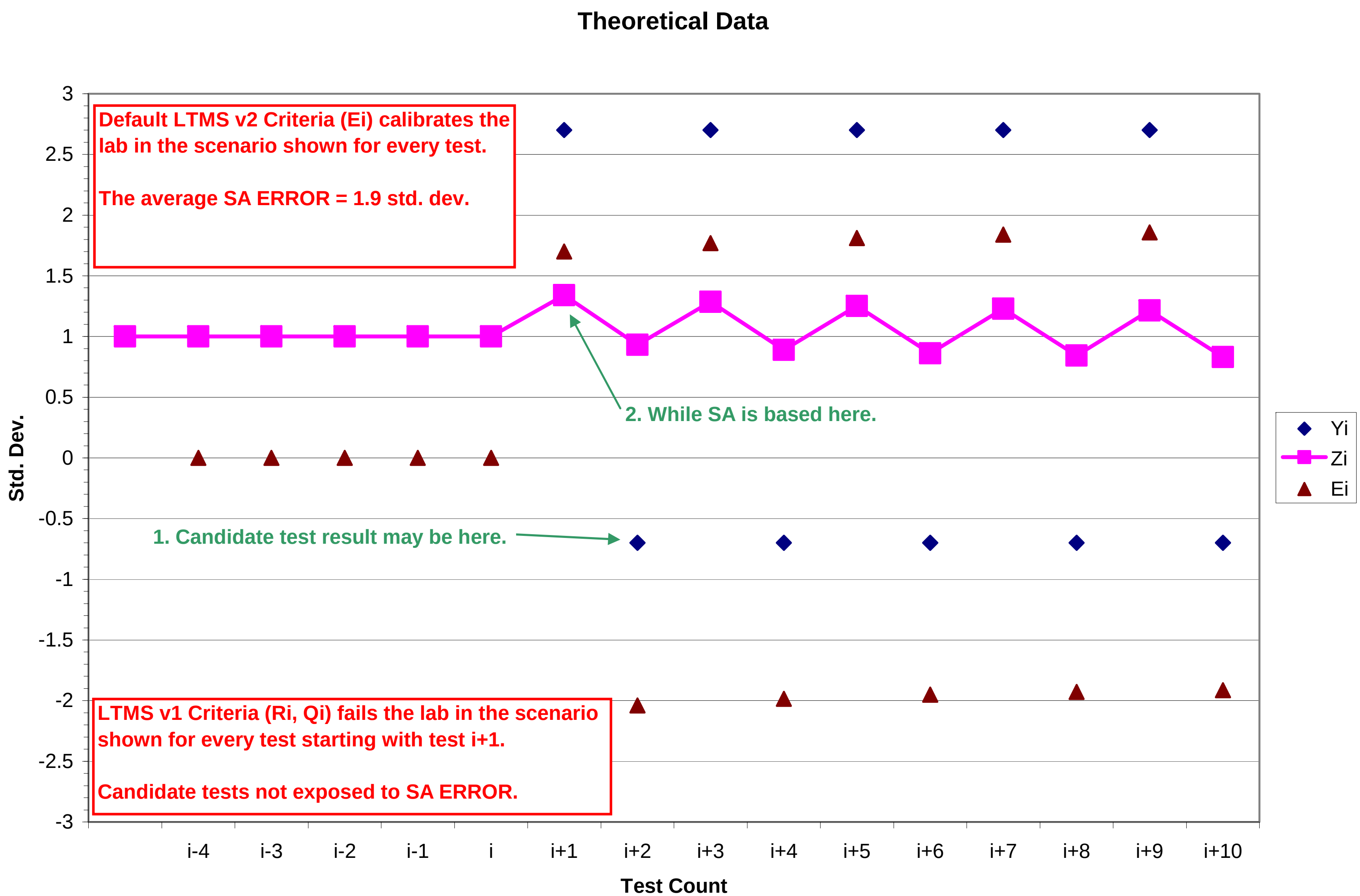
JAC/jac

Attachments

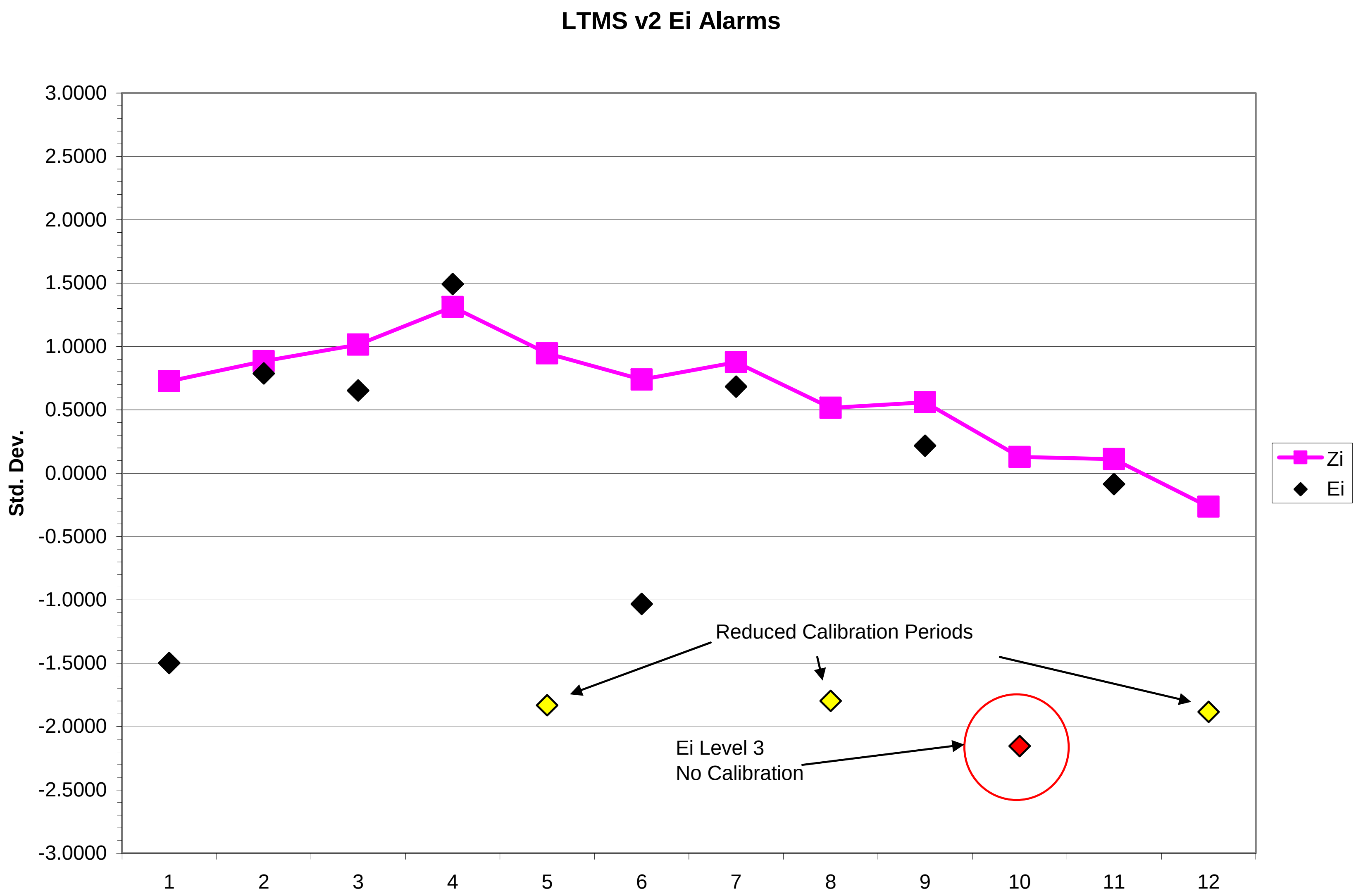
c: F. M. Farber, TMC
TMC Engineers
ftp://ftp.astmtmc.cmu.edu/docs/LTMS v2 Task Force Documents/TMC Concerns.pdf

Distribution: Email

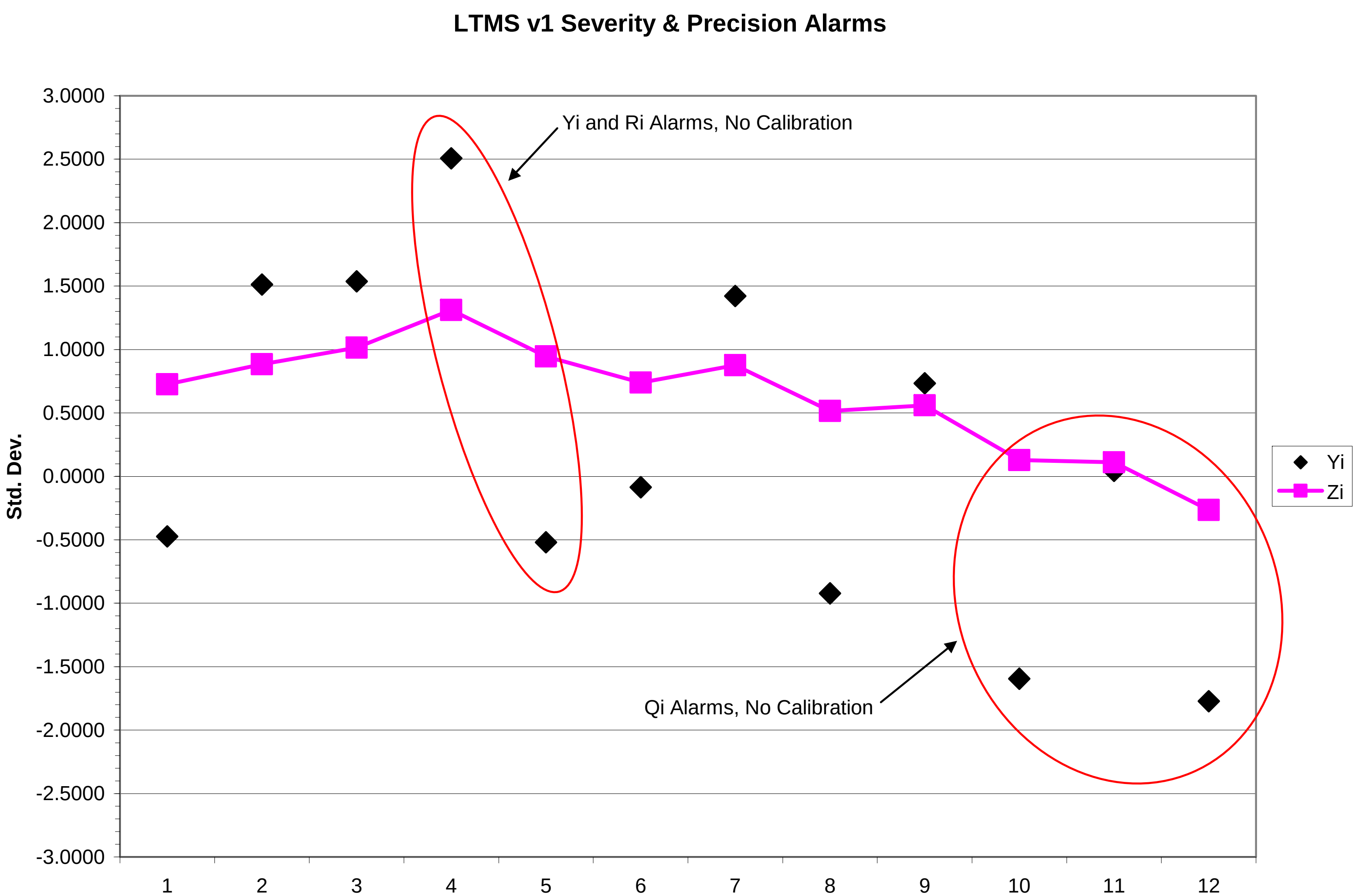
Attachment 1



Attachment 2



Attachment 2 (cont.)



Attachment 2
Real Test Data Example

Yi	Zi	Ri	Qi	Ei	v1 Cal?	v2 Cal?	Potential SA Error
-0.4728	0.7259	-1.0118	-0.6548	-1.4983	y	y	-0.7871
1.5130	0.8833	1.0581	-0.1409	0.7871	y	y	-0.6533
1.5366	1.0140	-1.9597	-0.6866	0.6533	y	y	-1.4919
2.5059	1.3123	0.0373	-0.4694	1.4919	n	y	1.8324
-0.5201	0.9459	1.8523	0.2271	-1.8324	n	y - reduced	1.0321
-0.0862	0.7394	-0.7459	-0.0648	-1.0321	y	y	-0.6830
1.4224	0.8760	0.6232	0.1416	0.6830	y	y	1.7980
-0.9220	0.5164	1.3513	0.5045	-1.7980	y	y - reduced	-0.2164
0.7328	0.5597	0.7629	0.5820	0.2164	y	y	2.1545
-1.5948	0.1288	1.3381	0.8088	-2.1545	n	n	0.0857
0.0431	0.1117	0.7472	0.7903	-0.0857	n	y	1.8847
-1.7730	-0.2653	0.9102	0.8263	-1.8847	n	y - reduced	-0.2653

Max SA Error =
2.1545

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MEMORANDUM: 11-001

DATE: January 10, 2011

TO: Passenger Car and Heavy Duty Surveillance Panel Chairs

FROM: Jeff Clark

SUBJECT: TMC Concerns on LTMS Version 2

Both the Seq. III and VID panel chairs have solicited concerns regarding LTMS Version 2 proposals. This memo documents the TMC's concerns in general about LTMS v2, and where noted, specific concerns about the existing proposals. Following an internal review of the LTMS v2 Draft and the VID and IIIG proposals, the TMC has several concerns as stated below. While this list is not comprehensive, it covers what are currently the priority issues the TMC feels are in need of further examination by the surveillance panels.

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[A]P/F shown is in mg, max allowable by T-12 merit system.

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JAC/jac

Attachments

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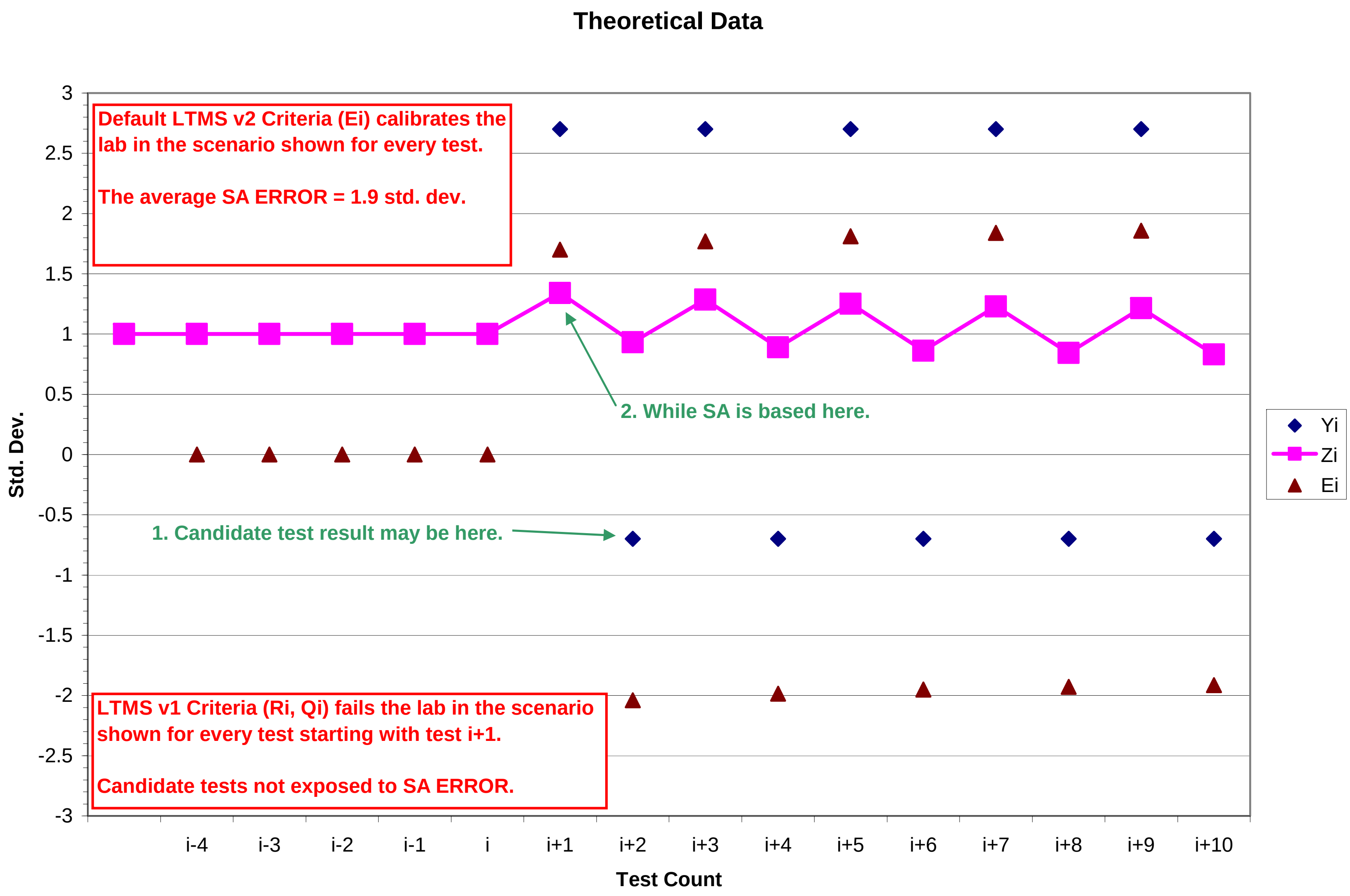
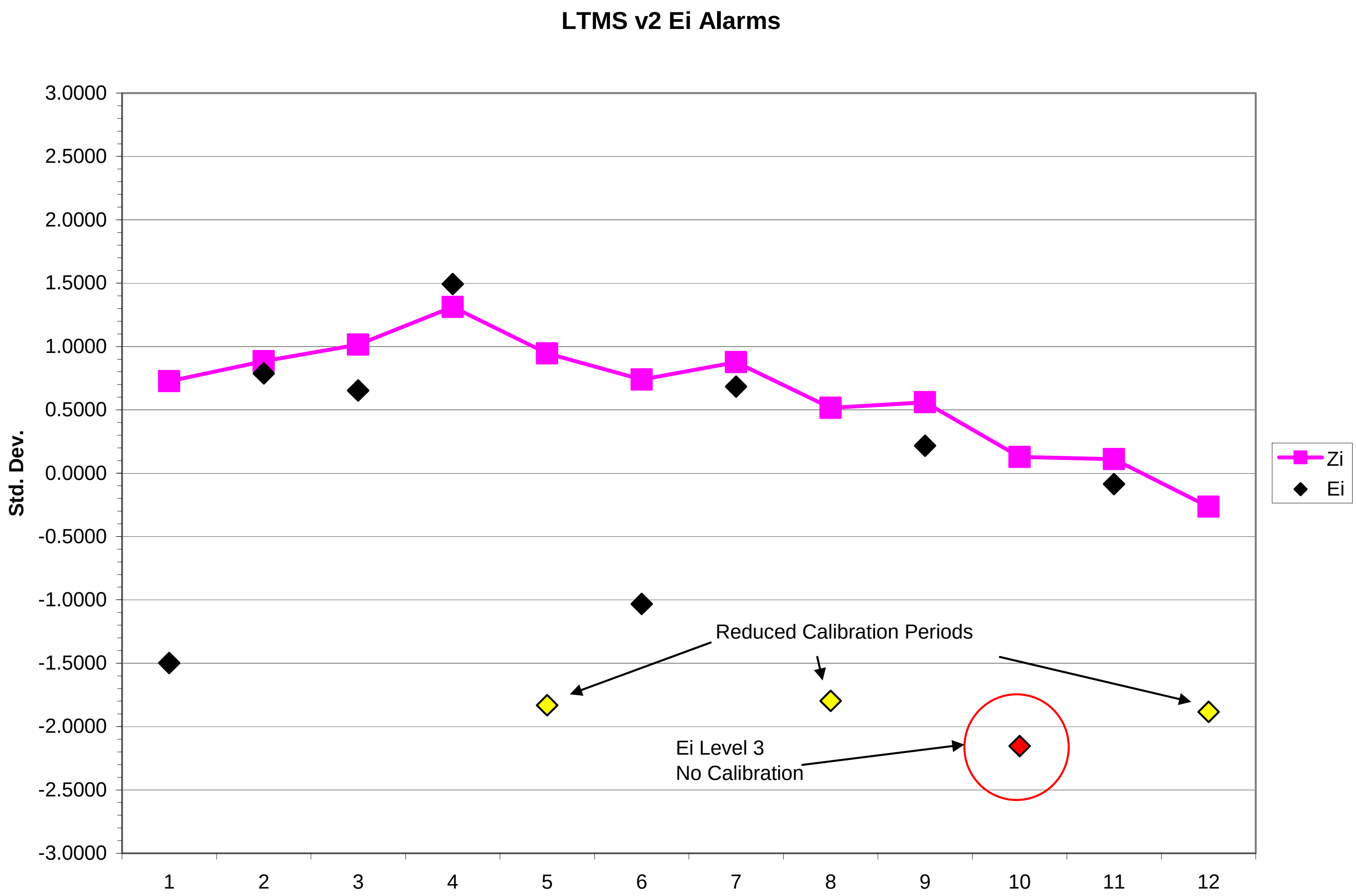
Distribution: Email

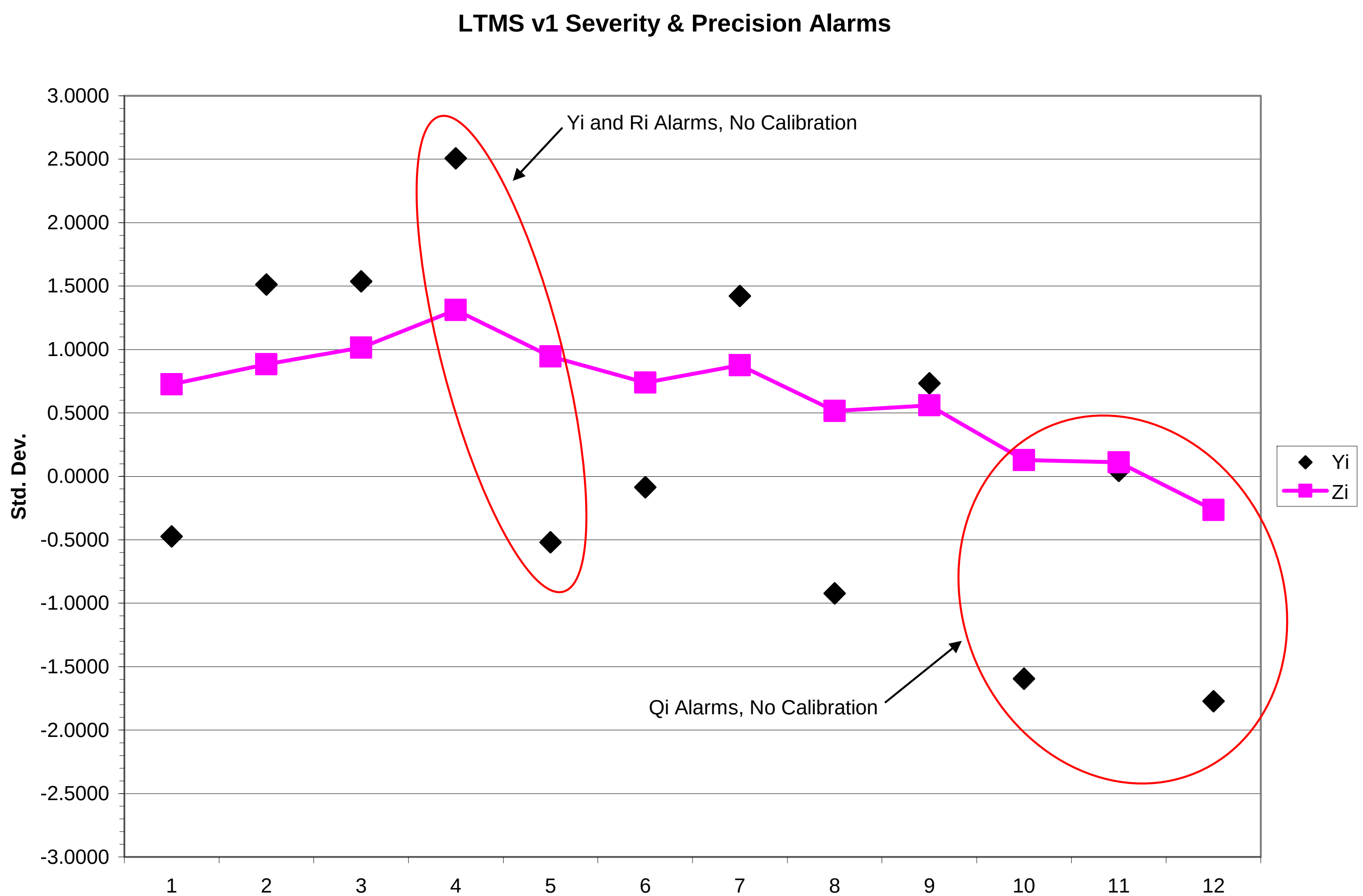
Attachment 1



Attachment 2



Attachment 2 (cont.)



Attachment 2
Real Test Data Example

Yi	Zi	Ri	Qi	Ei	v1 Cal?	v2 Cal?	Potential SA Error
-0.4728	0.7259	-1.0118	-0.6548	-1.4983	y	y	-0.7871
1.5130	0.8833	1.0581	-0.1409	0.7871	y	y	-0.6533
1.5366	1.0140	-1.9597	-0.6866	0.6533	y	y	-1.4919
2.5059	1.3123	0.0373	-0.4694	1.4919	n	y	1.8324
-0.5201	0.9459	1.8523	0.2271	-1.8324	n	y - reduced	1.0321
-0.0862	0.7394	-0.7459	-0.0648	-1.0321	y	y	-0.6830
1.4224	0.8760	0.6232	0.1416	0.6830	y	y	1.7980
-0.9220	0.5164	1.3513	0.5045	-1.7980	y	y - reduced	-0.2164
0.7328	0.5597	0.7629	0.5820	0.2164	y	y	2.1545
-1.5948	0.1288	1.3381	0.8088	-2.1545	n	n	0.0857
0.0431	0.1117	0.7472	0.7903	-0.0857	n	y	1.8847
-1.7730	-0.2653	0.9102	0.8263	-1.8847	n	y - reduced	-0.2653

Max SA Error =
2.1545

Dan Worcester

From: Tracey King [tek1@chrysler.com]
Sent: Friday, January 28, 2011 1:45 PM
To: Glaenzer, Dave
Cc: Altman, Ed; Greg Seman; Romano, Ron (R.); Bruce Matthews; teri.kowalski@tema.toyota.com; Bradley Cosgrove
Subject: Negative on LTMS V2 inclusion

Chrysler votes negative vote for adaption of LTMS v2 by the IIIG and VID surveillance Panels. We are concerned that LTMS2 will reduce the effectiveness of ASTM engine tests at proving engine oil quality.

We are opposed to a system that doesn't encourage labs to run on target. LTMS v2 allows labs to bounce around their average without attempting to force them to improve consistency. There is nothing in the system that shows changes in a laboratories test management from test to test like we have in LTMS1.

No data has been presented that demonstrates that LTMS2 provides an improvement over LTMS1. Existing data demonstrates that LTMS2 decreases precision and removes incentives for running on target. The only improvement provided by LTMS2 is the continuous SA, which could be included in LTMS1.

Reduced calibration test frequency for LTMS2 from LTMS1 also contributes to a decrease in test precision.

Chrysler is concerned about the effect of excessive statistical manipulation of engine test results on oil quality. If LTMS2 is adopted, we are considering requiring that companies seeking an approval at Chrysler include the raw data along with the standard test report so that we may evaluate the extent of the statistical manipulation on a case by case basis.

Best regards,

Tracey King
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Organic Materials Engineering
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