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Unapproved Minutes of the May 27, 2010 CAT C13 Surveillance Panel Meeting San Antonio, TX

The meeting was called to order at 8:35 am by Chairman Jim Gutzwiller. The attendance is show in **Attachment 1**.

Meeting Minutes

The minutes of previous meetings were approved without objection (Clark, Moritz).

Parts Supply Report / 5 Year Test Life

Hind Abi-Akar of CAT indicated that there are no parts supply issues foreseen through 2015 or beyond.

Method to Control Boost

Jim McCord discussed the concept of allowing boost control to be achieved by bleeding off excess boost pressure. This would allow closed loop control of the boost leak to keep the boost pressure in spec. CAT indicated that they believed turbo speed wouldn't be an issue and the panel generally supported Jim's idea. Jim was tasked with refining the details and experimenting with the control and reporting back to the panel.

LTMS Version 2 Overview

Presented by Martin Chadwick of Intertek and shown in **Attachment 2**. The C13 panel will join the Mack / Cummins conference calls for fleshing out further details and next steps.

Engine Harness Failures

Jim McCord noted that over the last 6 months he is seeing frequent engine harness failures. Jim asked if the engine harness has changed. Jim will correspond with CAT to see if a possible cause can be found.

The meeting adjourned at 10:20 a.m.

Attachment 1

CAT C13 Meeting Attendance
San Antonio, TX
May 27, 2010

Name	Company
Jim Moritz	Intertek
Jim Gutzwiller	Infineum
Brad Carter	Intertek
Zack Bishop	TEI
Jim Matasic	Lubrizol
Mark Cooper	ChevronOronite
Doyle Boese	Infineum
Joel Moreno	Haltermann
Tom Wingfield	ChevronPhillips
Barbie Green	ChevronPhillips
Chris Castanien	Lubrizol
Mark Sutherland	ChevronOronite
Jim Rutherford	ChevronOronite
Jim McCord	SwRI
Jeff Clark	TMC
Martin Chadwick	Intertek

Present by Phone Conference

Hind Abi-Akar	CAT
Kevin Daly	CAT
Jade Katinas	CAT
Dwight Bowden	OH Technologies
Jason Bowden	OH Technologies
Adam Bowden	OH Technologies
Matt Bowden	OH Technologies

Attachment 2

C13 LTMSv2

Martin Chadwick
05/27/2010

LTMSv2 C13 Overview

- Reference acceptance criteria comparison
- Concepts in LTMSv2
- LTMSv2 walk through
- LTMSv2 summary
- Severity adjustments
- Severity limits
- SP considerations
- C13 lab charts

C13 Reference Acceptance Criteria

Original LTMS (from past CAT tests)

- Test Severity
 - $|Y_i| < 1.75-2.00$
- Lab Precision (Y_{i+1} is from the lab)
 - $R_i < 1.74-1.96 = |Y_i - Y_{i+1}| < 2.51-3.18$
 - $Q_i < 0.580-0.653 \gg \text{EWMA } |Y_i - Y_{i+1}| < 1.46-1.54$
 - Shut down all stands and start two references if $Q_i > 0.860-0.979 \gg \text{EWMA } |Y_i - Y_{i+1}| > 1.76-1.89$
- Stand Precision (Y_{i+1} is from the stand)
 - $R_i < 1.74-1.96 = |Y_i - Y_{i+1}| < 2.51-3.18$
 - $Q_i < 0.622-0.823 \gg \text{EWMA } |Y_i - Y_{i+1}| < 1.51-1.72$

The original LTMS has four different precision metrics

Current C13 LTMS

- Test Severity
 - $|Y_i| < 2.00$

LTMSv2

- Lab Severity
 - Z_i within limits defined by SP
- Lab Precision
 - $|e_i| < 2.066^*$

$$e_i = Y_i - Z_{i-1}$$

* For lambda = 0.2

Concepts in LTMSv2

- LTMSv2 is designed to make the best use of the reference tests available to promote a level field for candidate testing.
- Different laboratories, parts batches, fuel batches, time periods, etc. may perform at different levels of severity. This concept is the same that justifies the use of severity adjustments.
 - The EWMA severity result (Z_i) is the best estimate of current laboratory severity and Z_i limits define how far off target a laboratory can operate. These limits are parameter specific and defined by the SP on a case by case basis (more on this later).
 - The prediction error ($e_i = Y_i - Z_{i-1}$) defines the level of agreement between the current test (Y_i) and the best estimate of laboratory severity (Z_{i-1}). These limits represent a balancing act between requiring additional references when a severity shift or excessive test variability is suspected and minimizing additional referencing for normal test variability.

More Concepts in LTMSv2

- Due to the large number of process variables and interactions in engine lube tests unusual or outlier results may not always be rare events. It is in the best interest of the industry to include these tests when analyzing data and minimize (without eliminating) the impact to future candidate testing. This also acknowledges that a reference test that follows a failing result may receive a different level of attention even if no specific cause for the failing result is available.
 - The Undue Influence procedure compares each failing reference result with the follow up result to determine if the original failing result should have a reduced impact on the estimate of laboratory severity (Z_i).
 - Undue Influence Method
 - If $|Y_i - Y_{i+1}| \leq e_i$ reference acceptance limit, then Y_i is equal to the value originally determined.
 - If $Y_i > Z_{i-1}$ and $Y_i - Y_{i+1} > e_i$ reference acceptance limit, then let $Y_i = e_i$ reference acceptance limit + Z_{i-1} .
 - If $Y_i \leq Z_{i-1}$ and $Y_i - Y_{i+1} < -e_i$ reference acceptance limit, then let $Y_i = -e_i$ reference acceptance limit + Z_{i-1} .
 - i = test that originally triggered an additional reference.
 - $i-1$ = test prior to alarm trigger, and
 - $i+1$ = test immediately following alarm trigger.

More Concepts in LTMSv2

- The current laboratory prediction error ($e_i = Y_i - Z_{i-1}$) provides some indication of the appropriateness of the current estimate of laboratory severity (Z_i). Large estimates of prediction error indicate more data is required to properly estimate laboratory severity and very small estimates of prediction error indicate less data is required to properly estimate laboratory severity.
 - Reference interval reductions occur when any parameter defined by the SP exceeds the selected limit.
 - Reference interval increases occur when all parameters defined by the SP are less than the selected limit.
 - Suggested e_i limits from LTMSv2

	Selected Z	Limit for Lambda = 0.2	Limit for Lambda = 0.3
Reference Acceptance	$z(0.975)$	1.960	2.126
20% Reference Interval Reduction	$z(0.950)$	1.645	1.784
20% Reference Interval Extension	NA	0.500	0.500

Be aware that all reference interval modifications are intended to be to candidate count only. Time intervals should be established based on the maximum amount of time the SP considers reasonable between two references in a laboratory; the LTMSv2 recommendation is 1 year.

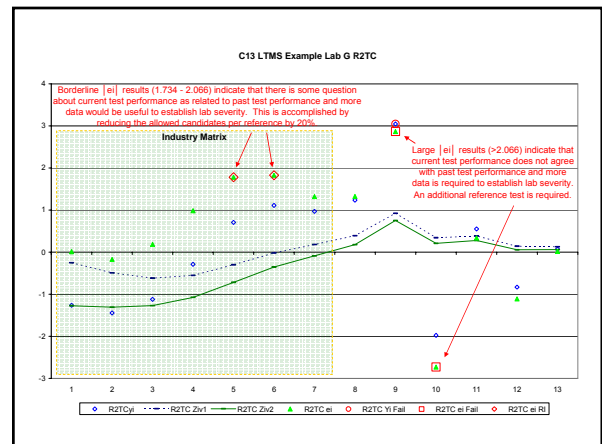
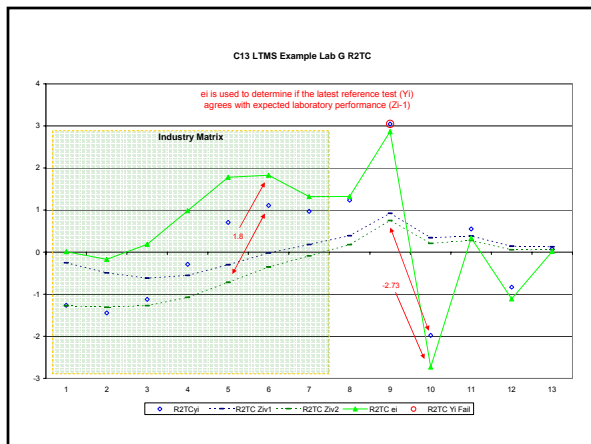
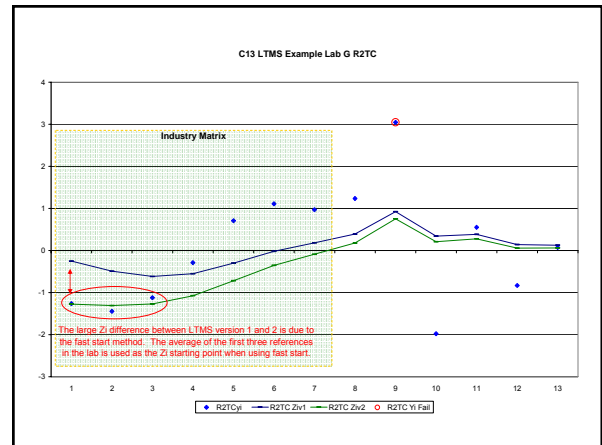
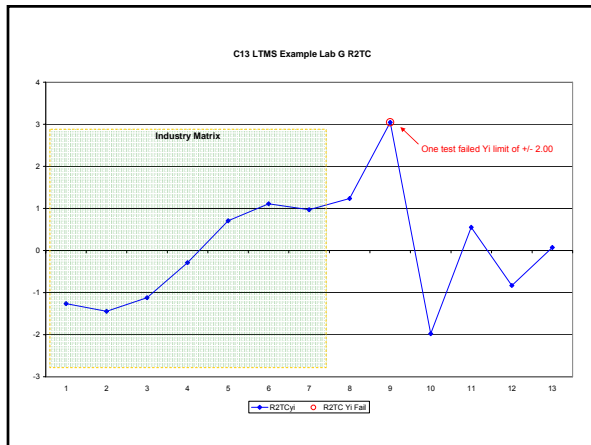
More Concepts in LTMSv2

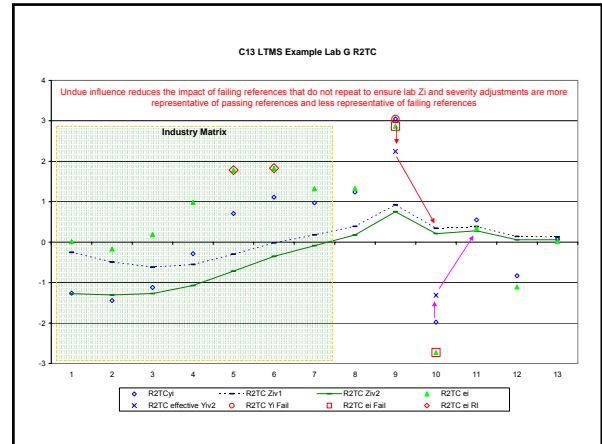
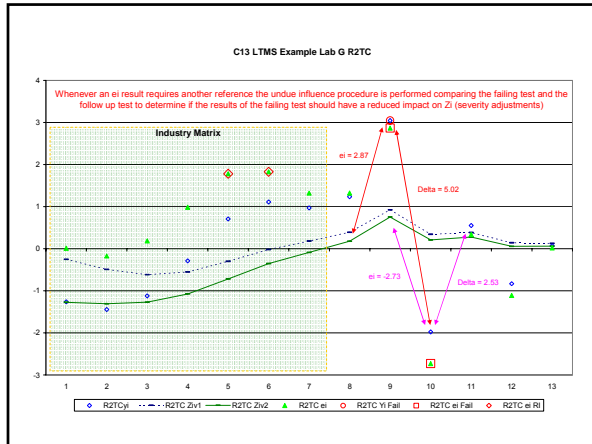
- On target performance of all laboratories should be encouraged.
 - In order to provide a tangible encouragement LTMSv2 includes a 40% reference interval extension for laboratories that are both on target and precise.
 - $|Z| < 0.50$ and $|e_i| < 0.50$ for parameters defined by the SP = 40% reference interval extension
- Continuous severity adjustments (no dead band) provide the best opportunity to promote a level field for candidate testing.
 - The dead band concept assumes that there is a high likelihood that a laboratory will be performing "on target" the majority of the time and prevents the normal test variability from producing severity adjustments. However, the nature of target setting and historical data indicates that generally laboratories operate with some small amount of consistent bias and shifts in test severity may occur at any time. These conditions are best compensated for with continuous severity adjustments and a measure of the applicability of the current adjustment (e_i).

These are the major concepts that relate to an existing test type. LTMSv2 also includes recommendations for reference oil selection, target setting, introducing new hardware and stands, and other critical aspects of test management.

LTMSv2 Walk Through

- To demonstrate how LTMSv2 applies to past test results an example from Lab G Second Ring Top Carbon follows.
 - This example uses $\lambda = 0.2$ as the default λ recommended in LTMSv2
 - Please remember that this example is at best a rough guide only since the actions that would have been specified by the new system were never acted on and vice-a-versa.





LTMSv2 C13 Summary

- If the default LTMSv2 limits were applied to all past charted C13 reference results for all chartable parameters the results can be summarized as below.

LTMSLAB	N Size	Fail LTMSv1	Fail LTMSv2	20% Reduced Interval LTMSv2	20% Extended Interval LTMSv2	40% Extended Interval LTMSv2
A	14	1	1	2	0	0
B	4	0	0	0	0	0
D	4	0	0	0	0	0
F	6	1	1	1	0	0
G	13	2	3	3	0	0
Total	41	4	5	6	0	0

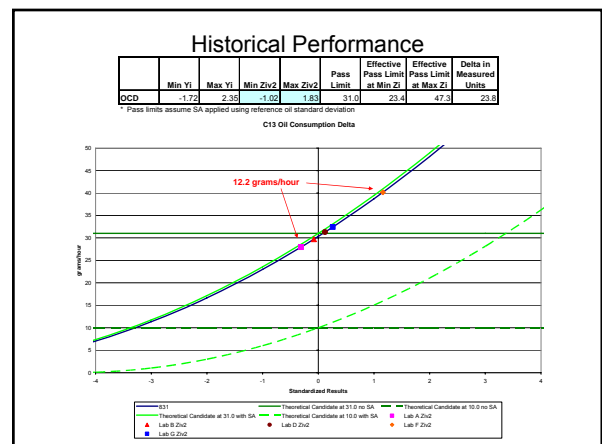
- This is one possible scenario only and decisions made by the SP can radically change the outcome.

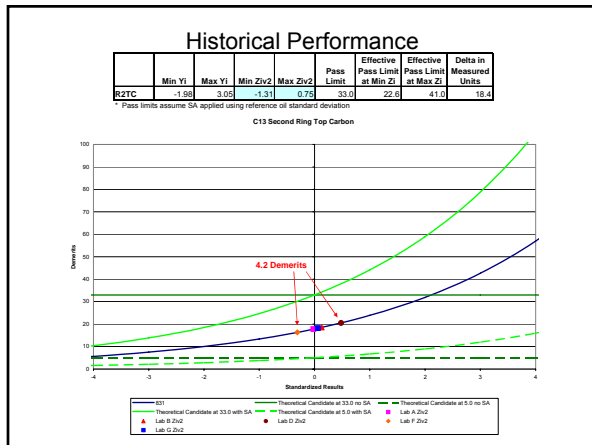
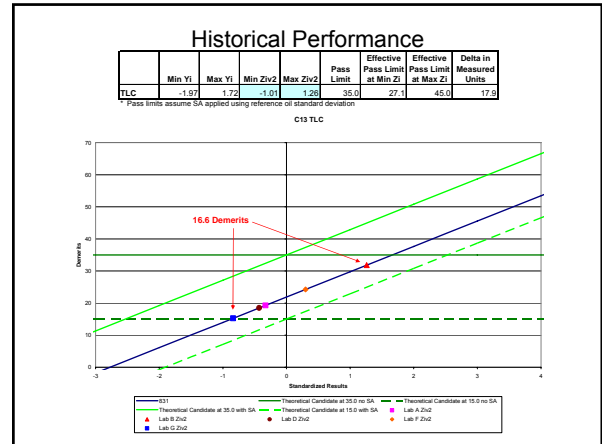
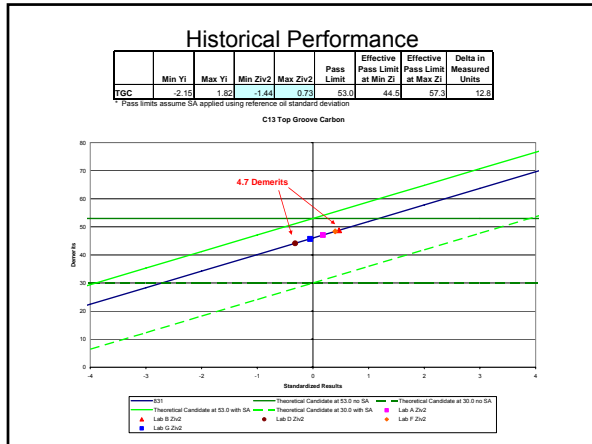
C13 Severity Adjustments

- Currently the C13 test does not have severity adjustments.
- A graphical review of current laboratory severity estimates as they relate to current pass limits follows and indicates severity adjustments may be appropriate.
- The low volume of reference testing in the C13 is a product of low non-reference test volume as the allowed non-reference tests per reference (12 valid tests) is similar to all other test types. This indicates the risk of inappropriate adjustments to non-reference oil tests in the C13 is similar to other test types.
- Having no severity adjustments may act as an encouragement to operate away from target.

Setting LTMSv2 Severity Limits

- LTMSv2 uses laboratory severity (Z_i) as opposed to individual test severity (Y_i) to determine when a lab is too far from target to continue to adequately correct non-reference oil results.
- Methods to assist in defining these limits
 - Data based
 - Review historical performance
 - Evaluate the relationship between test targets, standard deviations and pass limits in measured units
 - Experience and theoretical understanding of the test
 - Consider the mechanism that produces the test result and how it relates to the severity of oils tested. Ensure that this mechanism remains constant throughout the permitted Z_i range.
 - Understand the measurement technique and ensure bands are set well within the boundaries of the results obtainable



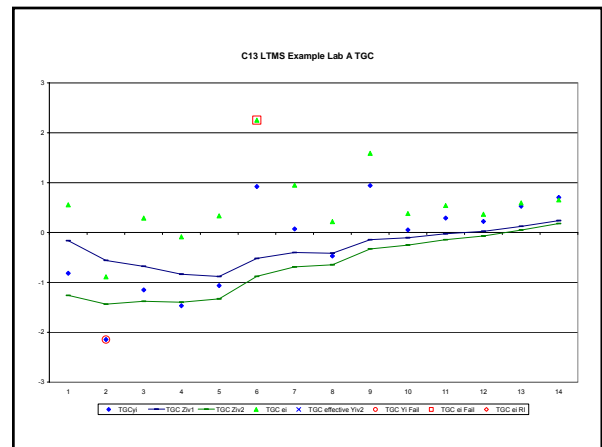


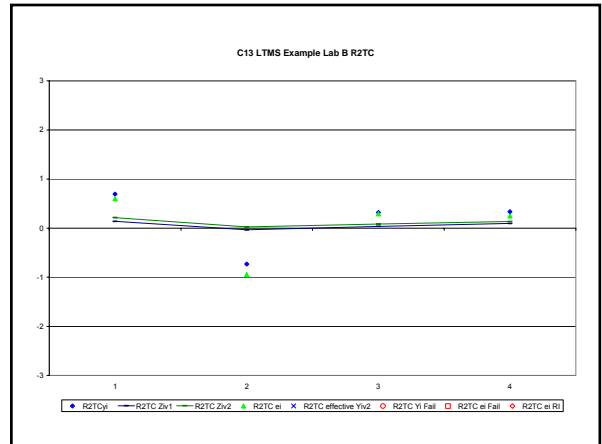
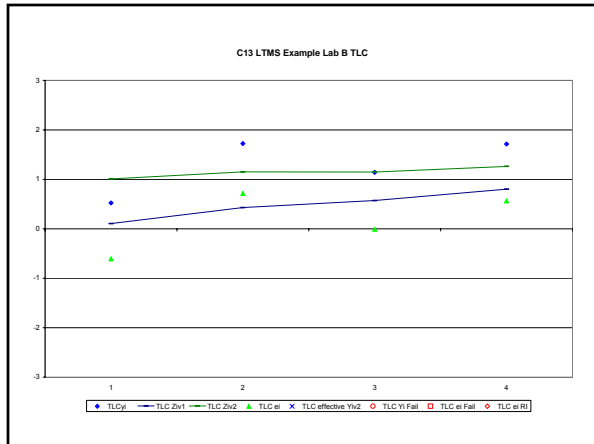
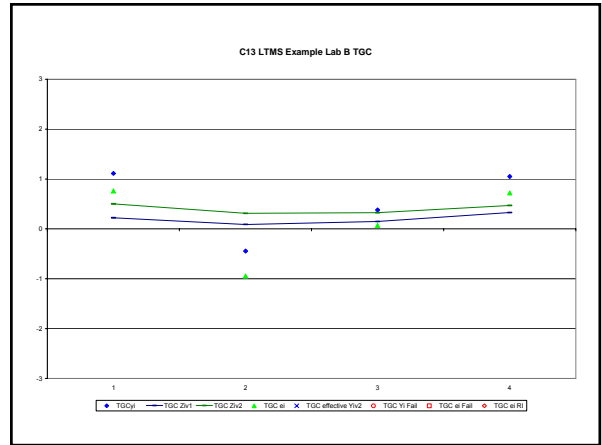
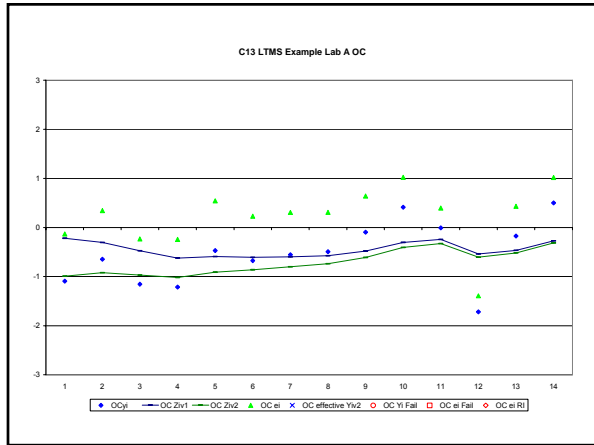
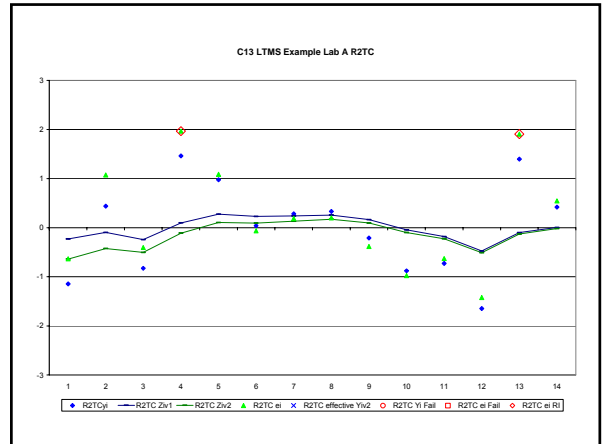
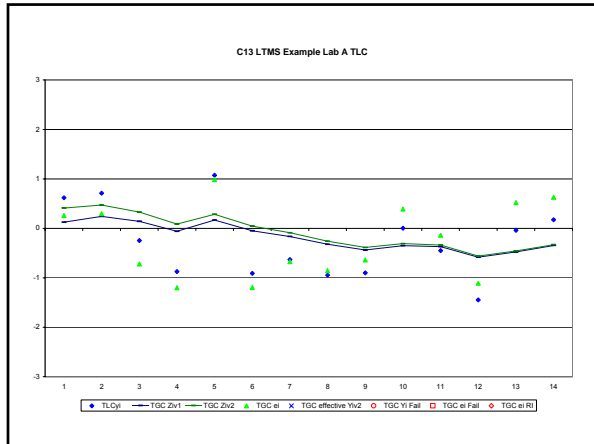
SP Considerations

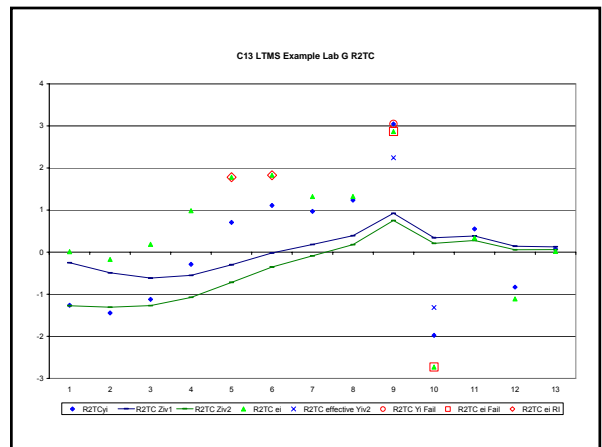
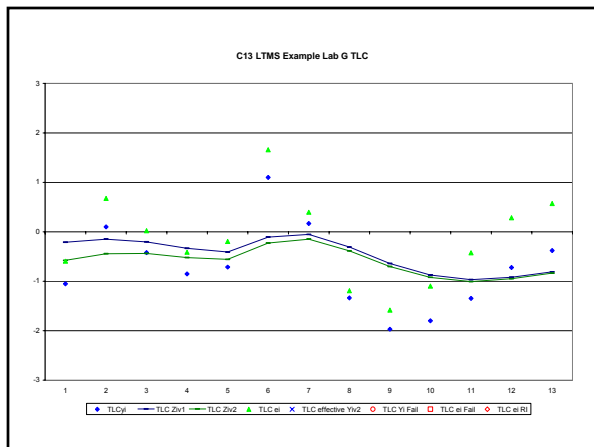
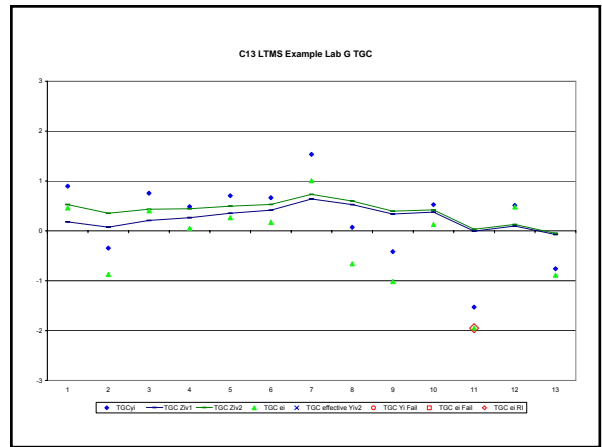
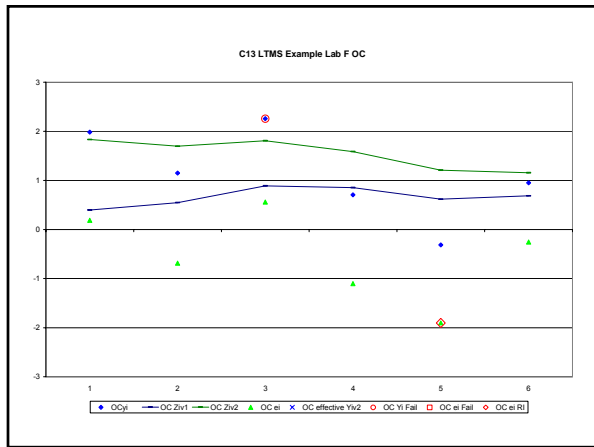
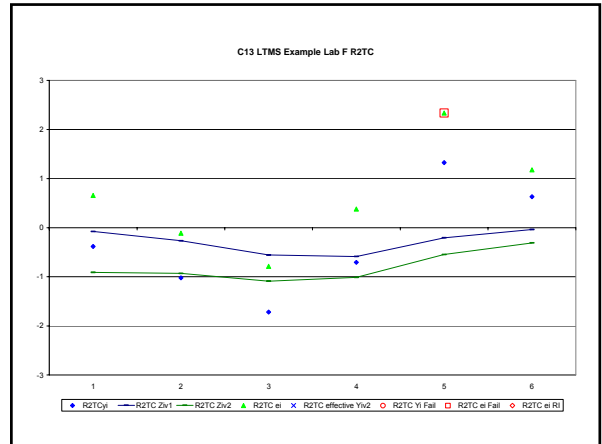
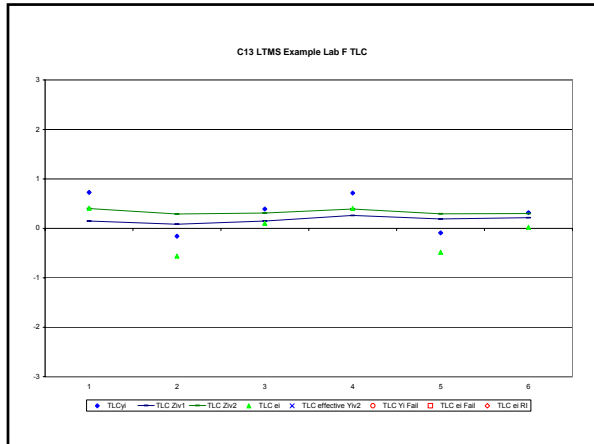
- Prior to adopting LTMSv2 the SP has a number of decisions to make.
 - Required decisions
 - Establish upper and lower severity limits
 - Items for consideration
 - Which parameters should be considered when determining reference interval reductions and extensions?
 - Are e_i limits appropriate for all parameters?
 - Is there evidence that a different lambda is appropriate?
 - Is there evidence that a severity adjustment dead band is appropriate for any or all parameters?
 - Should current reference intervals be revised in light of any LTMS changes adopted?

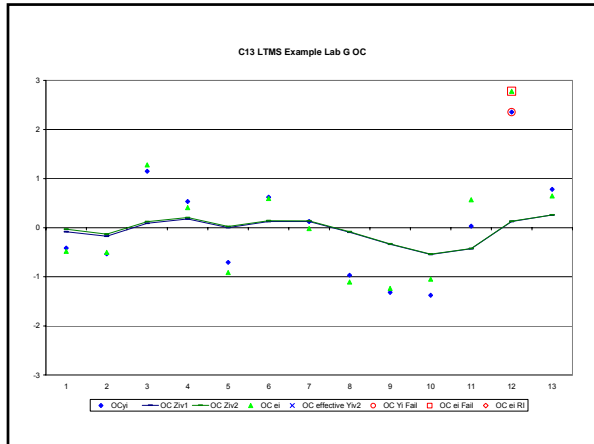
Current Lab Charts

- Example charts for each lab from the TMC database through 05/21/2010 are included for information only. These charts assume a lambda of 0.2 and the default LTMSv2 for all C13 test parameters.









Questions?