SUMMARY OF THE
TNI ENVIRONMENTAL MEASUREMENT METHODS EXPERT COMMITTEE MEETING

NOVEMBER 4, 2011

The Committee held a conference call on Friday, November 4, 2011, at 2:00 pm EDT.

1 – Roll call

Richard Burrows, Test America (Lab)	Present
Brooke Connor, USGS (Other)	Present
Dan Dickinson, NYSDOH (Accreditation Body)	Present
Tim Fitzpatrick, Florida DEP (Lab)	Present
Nancy Grams, Advanced Earth Technologists, Inc. (Other)	Present
Anand Mudambi, USEPA (Other)	Present
John Phillips, Ford Motor Co., (Other)	Present
Lee Wolf, Columbia Analytical Services (Lab)	Present
Ken Jackson, TNI administrative support staff	Present

The following Associate Committee member was also present: Francoise Chauvin (NYC DOH)

2 – Minutes from October 7, 2011

It was moved by John and seconded by Lee to approve the minutes. All were in favor.

3 – Discussion of the Guidance Document

The Committee had previously decided to insert new standard language on calibration into the existing Quality Systems (QS) module 4 (Chemistry). Therefore, it was decided the standard sections already under discussion would now be part of the guidance document. When complete the guidance document will then be used as a basis for editing QS module 4.

Procedural Calibration.

Nancy had circulated this to the committee (see attachment). Brooke addressed the sentence in the middle of the second paragraph ("Standard deviations should be evaluated…."), asking how many standards should be used. Nancy said it is just a recommendation, but replicates of the same concentration are needed. Brooke asked if a section should be included to say **how** to do a procedural calibration. Nancy clarified the next sentence ("Where %RSD is greater than 30% for a calibrant…"); because 34% RSD is at the detection limit, quantitation is not possible at this level. John suggested this will tell us how low the concentration of the first standard will be, and Tim said this might be

included in a sentence stating how to pick calibration points. Brooke suggested a list of advantages and disadvantages.

Multipoint Calibration.

Nancy had also circulated this to the committee (see attachment).

In discussing the calibration range, Tim cautioned that the range may be specified in the method, and in older methods the range may not be right anymore; e.g, with more sensitive instrumentation, the calibration may no longer be linear over the range. There was general consensus that this may be moot, since it is not often that a method requires calibration over a specified range.

It was suggested the number of calibrants specified would be too many if 9 standards were required over 2 orders of magnitude. Also, for technologies such as ICPAES and ICPMS known to be linear over a long dynamic range, it should be possible to have fewer calibrants. John cautioned that putting the number of calibrants in the standard would cause auditors to require it. Richard said it makes sense to establish instrument linearity and then decide how many points will be needed. Lee suggested requiring a demonstration of linearity. Perhaps TNI auditors could collect information on linearity from a number of laboratories. Francoise said you would then need to say how to establish linearity.

There was agreement that weighting belongs in the guidance document.

4 – Next Steps

Nancy will revise the procedural and multipoint calibration documents from the above discussion.

The next call will be December at 2:00 pm EDT. The meeting adjourned at 3:30 pm

Attachment

Procedural Calibration

While most calibrations in the environmental field are limited to the calibration of instrumental system (i.e., the detection device and the system needed to properly introduce the samples to the detection device), there are many circumstances where processing the calibration standards through one or more procedural steps of the method, may be necessary or beneficial to data quality. This is particularly the case for methods where the recovery of analytes through sample preparation procedure/s is not quantitative (e.g., the esterification of phenoxy acid herbicides). Procedural calibration is a requirement in methods where the procedure is integral to the instrumental system, such as in certain volatile organic analysis, where the concentration procedure (purge and trap) is the means by which sample is introduced into the instrument. Encompassing the bias error of the procedure or procedures may be the primary reason for using procedural calibration where it is not a requirement (i.e. is optional).

The additional processing of the calibration standards in procedural calibration introduces additional potential sources of random error and is therefore likely to increase calibration imprecision (above levels of instrument-only calibration). Where procedural calibration is used, initial studies of the calibration model should be carefully examined for curvature and other non-linear behavior (e.g., stair steps). Standard deviations should be evaluated and where standard deviations are high (above 20%RSD, except at trace levels) replication of calibrants in routine, on-going, initial calibrations should be considered (as well as improvements to the procedure/s) to reduce uncertainty. Where %RSD is greater than 30% for a calibrant in the initial assessment, a level of imprecision equivalent to the detection limit (aka Critical Level) is being reached as are the potential lowest levels for appropriate calibration.

Where an internal standard calibration procedure is used in conjunction with procedural calibration, the internal standard may be added before or after the procedural processing, but would generally be added after the procedures to allow for any necessary or optional steps such as concentration or dilution and to minimize the variables affecting the internal standard to that of instrumental processing. Internal standard may be added prior to processing where: reprocessing due to need to dilute or concentration after processing is less time consuming than that of

adding the internal standard to each prepared sample and standard after the processing; where variability due to the processing of the internal standard is found to be insignificant relative to total variability in the internal standard response; or where adding the internal standard after the fact creates greater variability than adding it before processing.

In any event, the manner in which the procedural processing of calibration standard is conducted should be identical to the manner for samples and the manner in which procedural calibrations are evaluated and validated should be the same as for non-procedural (instrument-only)calibration types.

Multipoint Calibration

The selection of the range of the calibration, the number of calibrants (different concentrations of the calibration standards), spacing of the calibrants and replication of the calibrants is required. This section provides the minimum requirements, the procedure for these selections and the requirements for documentation. NOTE: A requirement for initial demonstration of linearity is also required where the assumption of linearity is used by the laboratory in these determinations.

Calibration Range

1. Where specified, use the range required by the method.
2. Where not specified by the method, select the range based on the laboratory's use and taking into account the requirements for number of calibrants (section ###,below). Note: where, for example, a method specifies the concentration of quality control samples, though not the specific range of the calibration, assume that these quality control concentrations are required to be within the range of the calibration.

Number of Calibrants

1. Where the method specifies the minimum number of calibrants, use this number or a larger number based on the criteria of this section.
2. Special cases for one-point and two-point calibrations are addressed in sections #### (John's Sections).
3. Where linearity has been established in accordance with the ???????? Initial Linearity Evaluation Procedure, the minimum number of required calibrants is three when the range of the calibration does not exceed one order of magnitude. Note: Three calibrants are the minimum number necessary to assess (e.g., confirm continued) linearity and five the minimum to model curvature.
4. Where linearily has not been established a minimum of five calibrants are requirement for one order of magnitude.
5. The highest and lowest positive concentration calibrants (i.e., not a calibration blank or zero concentration calibrant) define the range of the calibration.

6. All sample results reported from raw data outside the range of the highest and lowest positive-concentration calibrants must be qualified as estimated or extrapolated.
7. A minimum of two additional calibrants are required for each order of magnitude where linearity has been demonstrated.
8. A minimum of four additional calibrants must be added for each added order of magnitude covered where linearity has not been demonstated.

For purposes of this section, the number of orders of magnitude are calculated starting from the lowest positive concentration calibrant(X) incremented 10X for each one order of magnitude until the highest concentration calibrant is within the final order (i.e. partial orders of magnitude are counted as a full order).

Spacing of Calibrants

1. Where the concentrations or spacing of the calibrants is specified by the method, use the required concentrations.
2. Where not specified by the method, the highest and lowest positive true-concentration calibrants are established as in Section ### (above) as the maximum and minimum concentrations of the calibration.
3. Where a zero concentration calibrant (calibration blank) is used in calibration, its spacing is also predefined.
4. The spacing of remaining calibrant concentrations is to be determined as follows, in the order listed, until the minimum number of calibrants are defined.
    a. In each area of curvature (single arc) place a minimum of three calibrants within this arc. The recommended spacing is one concentration at the center and one concentration at approximately one quarter and three quarters of the length of the arc.
    b. Where there are two or more areas of curvature, at least one calibrant concentration should be selected approximately equidistant between the two arcs.
    c. If it is known that a large proportion (greater than 50%) the test results for an analyte are known to be used for the purposes of comparison to a single regulatory concentration at least one calibrant at, or near-but-below, the regulatory value shall be included. It is recommended that the calibrant be within 10% of the regulatory value. It is required that it be within 20% of the regulatory value. Where a laboratory knows of one or more regulatory standards for which its testing data are likely to be used it is recommended that concentrations at or near-but-below these standards be included as calibrant concentrations.
    d. Where no other criteria for choice of calibrant criteria apply and where additional calibrants have not been assigned above, the laboratory may choose either an equidistant spacing or geometric spacing as follows:
        i. Geometric spacing shall be used for those methods where it is known or expected that the majority of results will be reported as censored data (below reporting limits). Geometric spacing should

also be used where it is known or expected that the majority of results will be in the lowest order of magnitude of the calibration range (for calibrations of more than one order of magnitude). What geometric design should we specify?????

ii. Equidistant spacing shall be used for those applications of the methods in which for the majority of the analytes the majority of the time the expected test results are reported values (above the reporting limits used) and generally distributed randomly or evenly throughout the calibration range.

Calibrant Replication

1. The minimum number of replicates at each calibrant is one.
2. Where standard deviation is required to be calculated the minimum number of replicates is 3.
3. Increasing the number of replicates at one or more calibrants, especially where increased certainty in the response at that concentration is likely to improve the quality of the calibration (e.g. at the quantiation limit), may provide value to the laboratory. See the calibration guide for more information on selection of calibrant replicates.

Multi-Analyte Method Considerations

1. Use the process in ###### to ##### to identify the optimal calibration design for individual analytes, then normalize the concentrations to allow for the use of spiking concentrations following the steps of ### (e.g., first model curvature, then include regulatory concentrations and for any remaining calibrants use either a geometic or equidistance spacing).
2. For large analyte lists (e.g., 20 or more analytes) where there are analytes with very different calibration behaviors, group the analytes into two or more spiking solutions based on behavior, and establish different calibrant spacing for the different groups. Alternatively a laboratory may choose to run separate sets of calibration standards for analytes requiring different numbers of calibrants or different spacing of calibrants.

Documentation

1. Document the decision process for the selection of the range of the calibration, the number of calibrants (different concentrations of the calibration standards), spacing of the calibrants, replication of the calibrants and normalization of the concentrations of calibrants in multi-analyte methods.
2. The laboratory, where it chooses to reduce the number of calibrants based on the assumptions of linearity, must document and maintain in an auditable manner, the initial evaluation of linearity.

3. Demonstration of linearity must be repeated when the laboratory expands the working range beyond the limits of the existing demonstration, but not when reducing the range of the calibration.
4. Use of calibration models other than average response factor or linear regression in multicalibrant calibrations is demonstration of non- linearity regardless of any initial demonstration of linearity.
5. A series of routine calibrations meeting the requirements of the Initial Linearity Evaluation Procedure may be used to meet the requirements for this evaluation.

NOTE: This initial demonstration could also be a way to determine the need for and to specify the weighting should be applied in on-going initial calibrations.

PROCEDURE FOR INITIAL DEMONSTRATION OF LINEARITY (DRAFT)

{NG: I would suggest a 5 replicate equidistant 5 calibrant design with 4 additional equally spaced calibrations for each added order of magnitude. We would have to specify a test or tests of the linearity (r2). We would have to specify the temporal variance.}

{NG: through this process we could potentially unify into a total quality cycle an approach that would allow methods to move to the single point or two point circumstance or to higher or lower multicalibrant values based on performance. IF WE GO THIS WAY, WHAT I WROTE ABOVE WOULD NEED TO BE MODIFIED. DOIN THIS PROCEDURE WOULD ALSO ALLOW THE DETERMINATION OF THE NEED FOR WEIGHTING AND POTENTIALLY THE WEIGHTS TO BE USED.}

Scheme such as:

% RSD	# Calibration Points Per Order of Magnitude*
0 - < 2	1
2 - <5	2
5-<10	3
10 -<15	4
15- <20	5
20-<25	6
25-<30	7
>30	7 + a minimum of three replicates at each concentration for all concentrations where the %RSD is 25% or greater.

1. Determine the standard deviation and percentage relative standard deviation (%RSD) at each calibrant concentration using all replicates.
2. Prepare a table for of %RSD vs. concentration. For each entry in the table add the value of the calibration points per order of magnitude number.
3. Evaluate each individual concentration and each order of magnitude.

4. Based on the laboratory's use of the method and performance of the instrument in calibration determine the range and the number of orders of magnitude included in that range.
5. For each order (or part of an order of magnitude) identify the highest calibration points per order of magnitude value and add these values together to determine the total minimum number of calibrants required for the chosen range.
6. Use the procedure ####### (top of this section) to determine the spacing of replicates.

A lab could then decide to move the lowest calibrant up or have the range go over fewer orders of magnitude if it wants to limit the number of calibration runs. This approach would also allow labs to get down to two and one-point calibrations if that were more efficient for them (less calibration runs vs. potentially having to dilute samples to get into the range. 30%RSD is getting very close to the detection limit, and as such there should be a total quality means of pressuring the range upward (thus the replication requirement) or if the lab wants/needs to calibrate there allowing it (with penalty). The point is to drive appropriate behavior while allowing flexibility.