Apex-Alpha/Beta Counting Productivity Software

7066293D V2.1

Technical Reference Manual

ISO 9001 SYSTEM CERTIFIED

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Notes

1. Introduction

This document provides technical information about the architecture and processing of data in the Apex-Alpha/Beta Software, along with a description of the algorithms and calculations used in Apex-Alpha/Beta.

Relevant Documents

1. Apex-Alpha/Beta Low Background Counting Software User's Manual.

2. Calculations

This appendix provides a description of the algorithms and calculations used in Apex-Alpha/Beta.

Alpha Plateau

The optimum operating voltage is determined from the plateau curve as the left-most point that satisfies the following two conditions:

1. The “slope” (in % per 100 volts - as defined below), %M, is less than 2.5% (per 100 volts).

2. The number of counts observed for this point is greater than 2500 (for 2% counting statistics).

For a set of N data points (x_i, y_i), the coefficients of the best fit straight line (y=mx+b) by the method of least squares are given by:

$$m = \frac{N \cdot \sum_{i=1}^{N} x_i \cdot y_i - \sum_{i=1}^{N} x_i \cdot \sum_{i=1}^{N} y_i}{N \cdot \sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i \right)^2}$$

$$b = \frac{\sum_{i=1}^{N} x_i^2 \cdot \sum_{i=1}^{N} y_i^2 - \sum_{i=1}^{N} x_i \cdot \sum_{i=1}^{N} x_i y_i}{N \cdot \sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i \right)^2}$$

In the case of the plateau determination, the data consists of a set of points (V_j, C_j), where C_j is the number of counts observed during a given counting interval when a voltage of V_j is applied to the detector. The slope (in counts per volt) at the i^{th} point, m_i, is defined as the slope of the straight line (C=mV+b) determined from the 5 points about the i^{th} point (i.e., from i-2 to i+2) by the method of least squares.

By analogy to the general case above, we write:

$$m_i = \frac{5 \cdot \sum_{j=i-2}^{i+2} V_j \cdot C_j - \sum_{j=i-2}^{i+2} V_j \cdot \sum_{j=i-2}^{i+2} C_j}{5 \cdot \sum_{j=i-2}^{i+2} V_j^2 - \left(\sum_{j=i-2}^{i+2} V_j \right)^2}$$

The "percent slope" at the i^{th} point, %mi, can be written as

$$\%m_i = \frac{m_i}{C_i} \cdot 100\%$$

and the "percent slope per 100 volts" at the i^{th} point, $\%M_i$, as

$$\%M_i = \%m_i \cdot 100(\text{volts}) = \frac{m_i}{C_i} \cdot 100\% \cdot 100 = \frac{m_i}{C_i} \cdot 10000\%$$

$$\%M_i = \frac{\left(\frac{5 \cdot \sum_{j=i-2}^{i+2} V_j \cdot C_j - \sum_{j=i-2}^{i+2} V_j \cdot \sum_{j=i-2}^{i+2} C_j}{5 \cdot \sum_{j=i-2}^{i+2} V_j^2 - \left(\sum_{j=i-2}^{i+2} V_j \right)^2} \right)}{C_i} \cdot 10000\%$$

In summary, the operating voltage is selected as the leftmost point (lowest i) for which

1. $\%M_i < 2.5\%$
2. $C_i > 2500$.

Beta Plateau

The optimum beta simultaneous operating voltage for the LB4100, LB5100, and Series 5 is determined in the same manner as described in the Alpha Plateau section.

The optimum beta simultaneous operating voltage for the IN20, MINI20, and PEGASE is determined from the plateau curve as the right-most point (highest voltage) the spillover (spill-up) from beta to alpha is less than 1% for all detectors that share a common high voltage supply.

For each point the plateau spillover is calculated is calculated using the following equation:

$$\chi_{1\_\beta\rightarrow\alpha} = \frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}}$$

Where,

$R_{1\_\alpha-calc'd} =$ the “calculated” alpha count rate for the one observation.

$R_{\_\beta\_calc'd}$ the “calculated” beta count rate for the one observation.

Each detector’s spillover result is evaluated individually, but the plateau voltage is determined by evaluating the beta to alpha spillovers together. The operating point is determined by finding the highest voltage where all detectors in a drawer have spillover values < 1.0 %.

Note: A detector drawer contains 4-8 detectors. All detectors must have beta to alpha spillover values of <1% concurrently for the operating voltage to be chosen by Apex-Alpha/Beta automatically.

Background

Backgrounds may be determined for each of the three count modes:

1. Alpha only
2. Simultaneous
3. Alpha then Beta

Backgrounds are always determined as a gross count, and may be determined from a single measurement or a set of measurements; e.g., 1 - 10 minute count or 10 - 1 minute counts.

Alpha Only Mode

Rates

For $N \geq 1$:

$$R_B = \frac{1}{N} \cdot \sum_{i=1}^{N} \left[\frac{C_i}{T} \right] = \frac{1}{N} \cdot \sum_{i=1}^{N} R_{B\_i}$$

$R_B =$ the BACKGROUND count rate.

$C_i =$ the number of counts obtained during the ith count.

T = the (common) count time of each of the N counts.

Uncertainties

For $N = 1$:

$$\sigma_{R_B} = \sqrt{\left(\frac{R_B}{T}\right)}$$

$\sigma_{R_B} =$ the **uncertainty** in the BACKGROUND count rate.

For $N > 1$:

$$\sigma^2_{R_B} = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} \left(R_{B\_i} - R_B\right)^2$$

or

$$\sigma_{R_B} = \sqrt{\frac{\sum_{i=1}^{N} \left(R_{B\_i} - R_B\right)^2}{(N-1)}}$$

Simultaneous Mode

Rates

For $N \geq 1$:

$$R_B = \frac{1}{N} \cdot \sum_{i=1}^{N} \left[\frac{C_i}{T}\right] = \frac{1}{N} \cdot \sum_{i=1}^{N} R_{B\_i}$$

$R_B =$ the BACKGROUND count rate.

$C_i =$ the number of counts obtained during the ith count.

T = the (common) count time of each of the N counts.

Uncertainties

For $N = 1$:

$$\sigma_{R_B} = \sqrt{\left(\frac{R_B}{T}\right)}$$

$\sigma_{R_B} =$ the **uncertainty** in the BACKGROUND count rate.

For $N > 1$:

$$\sigma_{R_B}^2 = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} \left(R_{B\_i} - R_B\right)^2$$

or

$$\sigma_{R_B} = \sqrt{\frac{\sum_{i=1}^{N} \left(R_{B\_i} - R_B\right)^2}{(N-1)}}$$

Alpha then Beta Mode

Since the ATB mode matches one α only count (i) to a corresponding [α + β] count (i), and the count times are the same, we may write:

$$T_{[\alpha+\beta]\_i} = T_{\alpha\_i} = T$$

Alpha Background in the ATB Mode

The Alpha Background Rate is given by

For $N \geq 1$:

$$R_{B\_\alpha} = \frac{1}{N} \cdot \sum_{i=1}^{N} \left[\frac{C_{\alpha\_i}}{T}\right] = \frac{1}{N} \cdot \sum_{i=1}^{N} R_{B\_\alpha\_i}$$

The corresponding uncertainty is then given by

For $N = 1$:

$$\sigma_{R_{B\_\alpha}} = \sqrt{\left(\frac{R_{B\_\alpha}}{T}\right)}$$

For $N > 1$:

$$\sigma^2_{R_{B\_\alpha}} = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} \left(R_{B\_\alpha\_i} - R_{B\_\alpha}\right)^2$$

or

$$\sigma_{R_{B\_\alpha}} = \sqrt{\frac{\sum_{i=1}^{N} \left(R_{B\_\alpha\_i} - R_{B\_\alpha}\right)^2}{(N-1)}}$$

where,

$R_{B\_\alpha} =$	the a background count rate for the a ONLY mode of the ATB count mode
$C_{\alpha\_i} =$	the number of a counts obtained during the ith count.
$T =$	the (common) count time of each of the N counts.
$R_{B\_\alpha\_i} =$	the a background count rate determined during the ith count.
$\sigma_{R_{B\_\alpha}} =$	the **uncertainty** in the a (system) BACKGROUND count rate for the a ONLY mode of the ATB count mode.

Beta Background in the ATB Mode

The Beta Background Rate is given by

For $N \geq 1$:

$$R_{B\_\beta} = \frac{1}{N} \cdot \sum_{i=1}^{N} \left[R_{B\_[\alpha+\beta]\_i} - R_{B\_\alpha\_i}\right] = R_{B\_[\alpha+\beta]} - R_{B\_\alpha}$$

The corresponding uncertainty is then given by

For N =1:

$$\sigma_{R_{B\_\beta}} = \sqrt{\frac{R_{B\_[\alpha+\beta]}}{T} + \frac{R_{B\_\alpha}}{T}}$$

For $N > 1$:

$$\sigma^2_{R_{B\_\beta}} = \frac{1}{(N-1)} \cdot \left(\sum_{i=1}^{N} \left[\left(R_{B\_[\alpha+\beta]\_i} - R_{B\_[\alpha+\beta]} \right)^2 + \left(R_{B\_\alpha\_\alpha} - R_{B\_\alpha} \right)^2 \right] \right)$$

or

$$\sigma_{R_{B\_\beta}} = \sqrt{\frac{\sum_{i=1}^{N} \left(R_{B\_[\alpha+\beta]\_i} - R_{B\_[\alpha+\beta]} \right)^2}{(N-1)} + \frac{\sum_{i=1}^{N} \left(R_{B\_\alpha\_i} - R_{B\_\alpha} \right)^2}{(N-1)}}$$

where,

R_{B_β} = the **derived** β BACKGROUND count rate for the ATB count mode

$R_{B\_[\alpha+\beta]\_i}$ = the GROSS (α+β) count rate obtained in the (α+β) mode during the i[th] count.

$R_{B\_\alpha\_i}$ the GROSS (α) count rate obtained in the α ONLY mode during the i[th] count.

$R_{B\_[\alpha+\beta]}$ = $\frac{1}{N} \cdot \sum_{i=1}^{N} R_{B\_[\alpha+\beta]\_i}$ = the (α+β) count rate for the (α+β) mode of the ATB count mode.

R_{B_α} = the α BACKGROUND count rate for the α ONLY mode of the ATB count mode.

Count Rates (Other than Background)

The remaining functions (Efficiency and Activity) depend on the corrected count rate of a standard (for efficiency) or a sample (for activity determinations). While the background count rate can be determined as an average from a set of N measurements, all other count rates are determined from a *single measurement*[1]. These count rates are determined as follows.

[1] The efficiency can also be determined as an average from a set of N measurements; however, this is an average of N efficiency measurements – each determined from a single measurement of the count rate of the calibration standard.

Alpha Only Mode

When Method Blank subtraction is implemented, the blank is counted as part of the batch, and the count times for the sample and blank are the same:

$$T_1 = T_{blank} = T$$

Rate

$$R = \frac{C_1}{T_1} - \delta_1 \cdot R_{B\_\alpha} - \delta_2 \cdot (\frac{C_{blank}}{T_1} - \delta_1 \cdot R_{B\_\alpha})$$

$$= R_1 - \delta_1 \cdot R_{B\_\alpha} - \delta_2 \cdot (R_{blank\_gross} - \delta_1 \cdot R_{B\_\alpha})$$

$$= R_1 - \delta_1 \cdot R_{B\_\alpha} - \delta_2 \cdot R_{blank\_gross} + \delta_1 \cdot \delta_2 \cdot R_{B\_\alpha}$$

$$= R_1 - \delta_2 \cdot R_{blank\_gross} - \delta_1 \cdot R_{B\_\alpha} + \delta_1 \cdot \delta_2 \cdot R_{B\_\alpha}$$

$$= R_1 - \delta_2 \cdot R_{blank\_gross} - \delta_1 \cdot [1 - \delta_2] \cdot R_{B\_\alpha}$$

where,

C_i = the number of counts obtained during this (one) measurement.

T_1 = the count time of this measurement.

$R_1 = \frac{C_1}{T_1}$ = the gross count rate of the sample (or standard in the case of efficiency).

R_{B_α} = the BACKGROUND count rate for the Alpha Only count mode.

C_{blank} = the number of counts obtained during this (one) measurement of the (one and only one) designated blank

R_{blank_gross} = $\frac{C_{blank}}{T_1}$ = the GROSS count rate of the (one and only one) designated blank

$\delta_1 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$

$\delta_2 = \begin{Bmatrix} 0\_if\_METHOD\_BLANK = NO \\ 1\_if\_METHOD\_BLANK = YES \end{Bmatrix}$

Note: $\delta_2 = 1$ is not currently allowed.

Uncertainties

$$\sigma_R = \sqrt{\left(\frac{R_1}{T_1}\right) + \delta_2^2 \cdot \sigma_{blank\_gross}^2 + \delta_1^2 \cdot [1-\delta_2]^2 \cdot \sigma_{R_{B\_\alpha}}^2}$$

$$\sigma_R = \sqrt{\left(\frac{R_1}{T}\right) + \delta_2^2 \cdot \left(\frac{R_{blank\_gross}}{T}\right) + \delta_1^2 \cdot [1-\delta_2]^2 \cdot \sigma_{R_{B\_\alpha}}^2}$$

$\sigma_{R_{B\_\alpha}} =$ the **uncertainty** in the Alpha Only (system) BACKGROUND count rate.

$$= \sqrt{\frac{R_{B\_\alpha}}{T_B}}$$

for the case in which the background was determined from a single measurement.

$$= \sqrt{\frac{\sum_{i=1}^{N}\left(R_{B\_\alpha\_i} - R_{B\_\alpha}\right)^2}{(N-1)}}$$

if the background was determined from a set of N measurements.

$$\delta_1 = \begin{Bmatrix} 0\_if\_METHOD\_BLANK = NO \\ 1\_if\_METHOD\_BLANK = YES \end{Bmatrix}$$

$$\delta_2 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$$

Note: $\delta_2 = 1$ is not currently allowed.

Simultaneous Mode

When Method Blank subtraction is implemented, the blank is counted as part of the batch, and the count times for the sample and blank are the same:

$$T_1 = T_{blank} = T$$

Without Spillover Corrrection

The equations for the count rate and corresponding uncertainty for the simultaneous mode without spillover correction are identical to those for alpha only, except that they are applied to each channel (of the simultaneous mode) individually:

Rate

$$R = \frac{C_1}{T_1} - \delta_1 \cdot R_B - \delta_2 \cdot (\frac{C_{blank}}{T_1} - \delta_1 \cdot R_B)$$

$$= R_1 - \delta_2 \cdot R_{blank\_gross} - \delta_1 \cdot [1 - \delta_2] \cdot R_B$$

where,

C_i = the number of counts obtained (in the channel of interest) during this (one) measurement

T_1 = the count time of this measurement.

$R_1 = \frac{C_1}{T_1}$ = the gross count rate of the sample.

R_B = the BACKGROUND count rate for the channel of interest for the Simultaneous count mode. (i.e., R_{B_α} for alpha and R_{B_β} for beta.)

R_{blank_gross} = the GROSS count rate for the channel of interest of the (one and only one) designated blank.

$\delta_1 = \left\{ \begin{matrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{matrix} \right\}$

$\delta_2 = \left\{ \begin{matrix} 0\_if\_BLANK\_SUBTRACTION = NO \\ 1\_if\_BLANK\_SUBTRACTION = YES \end{matrix} \right\}$

Note: $\delta_2 = 1$ is not currently allowed.

Uncertainties

$$\sigma_R = \sqrt{\left(\frac{R_1}{T_1}\right) + \delta_2^2 \cdot \sigma_{blank\_gross}^2 + \delta_1^2 \cdot [1 - \delta_2]^2 \cdot \sigma_{R_B}^2}$$

$$\sigma_R = \sqrt{\left(\frac{R_1}{T}\right) + \delta_2^2 \cdot \left(\frac{R_{blank\_gross}}{T}\right) + \delta_1^2 \cdot [1 - \delta_2]^2 \cdot \sigma_{R_B}^2}$$

σ_{R_B} = the **uncertainty** in the (system) BACKGROUND count rate for the channel of interest for the Simultaneous count mode.

$$= \sqrt{\frac{R_B}{T_B}}$$

for the case in which the background was determined from a single measurement

$$= \sqrt{\frac{\sum_{i=1}^{N} \left(R_{B\_i} - R_B\right)^2}{(N-1)}}$$

if the background was determined from a set of *N* measurements.

$R_{B\_i} = R_{B\_\alpha\_i}$ if the channel is the channel of interest

$= R_{B\_\beta\_i}$ if the channel is the channel of interest

$$\delta_1 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$$

$$\delta_2 = \begin{Bmatrix} 0\_if\_BLANK\_SUBTRACTION = NO \\ 1\_if\_BLANK\_SUBTRACTION = YES \end{Bmatrix}$$

Note: $\delta_2 = 1$ is not currently allowed.

With Spillover Correction

The equations for the count rate and corresponding uncertainty for the simultaneous mode with spillover correction are derived in *Derivation of the Activity and Count Rate Equation* on page 58. The results are presented below.

Rate

The spillover corrected count rates can be written as

$$R'_\beta = R_{\beta\_corrected} = \frac{\left\lfloor \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta (1-\delta_2)\right) - \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha \cdot (1-\delta_2)\right) \cdot \chi_{\alpha->\beta} \right\rfloor}{[1 - \chi_{\beta->\alpha} \cdot \chi_{\alpha->\beta}]}$$

$$R'_\alpha = R_{\alpha\_corrected} = \frac{\left\lfloor \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1-\delta_2)\right) - \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1-\delta_2)\right) \cdot \chi_{\beta->\alpha} \right\rfloor}{[1 - \chi_{\beta->\alpha} \cdot \chi_{\alpha->\beta}]}$$

Uncertainties

The uncertainty in the spillover corrected count rates can be written as

$$\sigma^2_{R'_\alpha} = \left[\frac{1}{[1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{R_\alpha} + (\delta_2)^2 \cdot \sigma^2_{M_{\alpha\_gross}} + (\delta_1)^2 \cdot (1-\delta_2)^2 \cdot \sigma^2_{B_\alpha}\right]$$

$$+\left[\frac{\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma_{\mathrm{R}_\beta}^2+(\delta_2)^2\cdot\sigma_{\mathrm{M}_{\beta\_gross}}^2+(\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma_{\mathrm{B}_\beta}^2\right]$$

$$+\left[\frac{-\mathrm{R}'_\beta\cdot\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta->\alpha}}}{\chi_{\beta->\alpha}}\right)^2$$

$$+\left[\frac{\mathrm{R}'_\alpha\cdot\chi_{\beta->\alpha}\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha->\beta}}}{\chi_{\alpha->\beta}}\right)^2$$

$$\sigma_{R'_\beta}^2=\left[\frac{1}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma_{R_\beta}^2+(\delta_2)^2\cdot\sigma_{M_{\beta\_gross}}^2+(\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma_{B_\beta}^2\right]$$

$$+\left[\frac{\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma_{\mathrm{R}_\alpha}^2+(\delta_2)^2\cdot\sigma_{\mathrm{M}_{\alpha\_gross}}^2+(\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma_{\mathrm{B}_\alpha}^2\right]$$

$$+\left[\frac{-\mathrm{R}'_\alpha\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha\to\beta}}}{\chi_{\alpha\to\beta}}\right)^2$$

$$+\left[\frac{\mathrm{R}'_\beta\cdot\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta\to\alpha}}}{\chi_{\beta\to\alpha}}\right)^2$$

Alpha then Beta Mode

Once again, since only one blank per batch is allowed, and the blank is counted as part of the batch, the count times for the sample and blank are the same:

$$T_1 = T_{blank} = T$$

Alpha Count Rate in ATB Mode

$$R_\alpha = R_{\alpha\_gross} - \delta_2 \cdot R_{\alpha\_blank\_gross} - \delta_1 \cdot [1-\delta_2] \cdot R_{B\_\alpha}$$

where,

$\mathrm{R}_{\alpha\_\mathrm{gross}}$ = the gross α count rate obtained during the α ONLY count of the ATB count.

$R_{\alpha\_blank\_gross}$ = the gross α count rate obtained during the α ONLY count of the ATB count of the (one and only one) designated blank.

R_{B_α} = the α (system) background count rate for the α ONLY mode of the ATB count mode.

$\delta_1 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$

$\delta_2 = \begin{Bmatrix} 0\_if\_BLANK\_SUBTRACTION = NO \\ 1\_if\_BLANK\_SUBTRACTION = YES \end{Bmatrix}$

Note: $\delta_2 = 1$ is not currently allowed.

Uncertainties

$$\sigma_{R_\alpha} = \sqrt{\left(\frac{R_{\alpha\_gross\_1}}{T_1}\right) + \delta_2^2 \cdot \sigma_{\alpha\_blank\_gross}^2 + \delta_1^2 \cdot [1-\delta_2]^2 \cdot \sigma_{R_{B\_\alpha}}^2}$$

$$\sigma_{R_\alpha} = \sqrt{\left(\frac{R_{\alpha\_gross\_1}}{T}\right) + \delta_2^2 \cdot \left(\frac{R_{\alpha\_blank\_gross}}{T}\right) + \delta_1^2 \cdot [1-\delta_2]^2 \cdot \sigma_{R_{B\_\alpha}}^2}$$

$\sigma_{R_{B\_\alpha}}$ = the **uncertainty** in the α (system) BACKGROUND count rate for the α ONLY mode.

$$= \sqrt{\frac{R_{B\_\alpha}}{T_B}}$$

for the case in which the background was determined from a single measurement

$$= \sqrt{\frac{\sum_{i=1}^{N}\left(R_{B\_\alpha\_i} - R_{B\_\alpha}\right)^2}{(N-1)}}$$

if the background was determined from a set of *N* measurements.

$\delta_1 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$

$\delta_2 = \begin{Bmatrix} 0\_if\_BLANK\_SUBTRACTION = NO \\ 1\_if\_BLANK\_SUBTRACTION = YES \end{Bmatrix}$

Note: $\delta_2 = 1$ is not currently allowed.

Beta Count Rate in ATB Mode

Since the ATB mode matches on α only count to a corresponding [α+β] count, and the one (and only) blank is counted during the same ATB count, then the count times are the same, and we may write:

$$T_{[\alpha+\beta]} = T_{\alpha} = T_{[\alpha+\beta]\_blank} = T_{\alpha\_blank} = T$$

$$R_{\beta} = (R_{[\alpha+\beta]} - \delta_2 \cdot R_{[\alpha+\beta]\_blank} - \delta_1 \cdot [1-\delta_2] \cdot R_{B\_[\alpha+\beta]}) - (R_{\alpha} - \delta_2 \cdot R_{\alpha\_blank} - \delta_1 \cdot [1-\delta_2] \cdot R_{B\_\alpha})$$

$$R_{\beta} = R_{[\alpha+\beta]} - \delta_2 \cdot R_{[\alpha+\beta]\_blank} - \delta_1 \cdot [1-\delta_2] \cdot R_{B\_[\alpha+\beta]} - R_{\alpha} + \delta_2 \cdot R_{\alpha\_blank} + \delta_1 \cdot [1-\delta_2] \cdot R_{B\_\alpha}$$

$$R_{\beta} = R_{[\alpha+\beta]} - R_{\alpha} - \delta_2 \cdot (R_{[\alpha+\beta]\_blank} - R_{\alpha\_blank}) - \delta_1 \cdot [1-\delta_2] \cdot (R_{B\_[\alpha+\beta]} - R_{B\_\alpha})$$

or

$$\mathrm{R}_{\beta} = \mathrm{R}_{[\alpha+\beta]} - \mathrm{R}_{\alpha} - \delta_2 \cdot (\mathrm{R}_{[\alpha+\beta]\_\mathrm{blank}} - \mathrm{R}_{\alpha\_\mathrm{blank}}) - \delta_1 \cdot [1-\delta_2] \cdot (\mathrm{R}_{\mathrm{B}\_\beta})$$

where,

$\mathrm{R}_{[\alpha+\beta]}$ = the gross (α+β) count rate obtained during the [α+β] mode of the ATB count

R_{α} = the gross (α) ONLY count rate obtained during [α] the ONLY mode of the ATB count

$\mathrm{R}_{[\alpha+\beta]\_\mathrm{blank}}$ = the gross (α+β) count rate of the (one and only one) designated blank obtained during the [α+β] count of the blank during the [α+β] mode of the ATB count.

$\mathrm{R}_{\alpha\_\mathrm{blank}}$ = the gross (α) ONLY count rate of the (one and only one) designated blank obtained during the α ONLY count of the blank during the α ONLY mode of the ATB count.

$\mathrm{R}_{\mathrm{B}\_[\alpha+\beta]}$ = the [α+β] (system) BACKGROUND count rate for the [α+β] mode of the ATB count mode.

$\mathrm{R}_{\mathrm{B}\_\alpha}$ = the α (system) BACKGROUND count rate for the α ONLY mode of the ATB count mode.

$\mathrm{R}_{\mathrm{B}\_\beta}$ = the **derived** β (system) BACKGROUND count rate for the ATB count mode.

δ_1 = $\begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION=NO \\ 1\_if\_BACKGROUND\_SUBTRACTION=YES \end{Bmatrix}$

δ_2 = $\begin{Bmatrix} 0\_if\_BLANK\_SUBTRACTION=NO \\ 1\_if\_BLANK\_SUBTRACTION=YES \end{Bmatrix}$

Note: $\delta_2 = 1$ is not currently allowed.

Uncertainties

Once again, noting that

$$T_{[\alpha+\beta]} = T_{\alpha} = T_{[\alpha+\beta]\_blank} = T_{\alpha\_blank} = T$$

we may write

$$\sigma_{R_{\beta}} = \sqrt{\left(\frac{R_{[\alpha+\beta]}}{T}\right) + \left(\frac{R_{\alpha}}{T}\right) + \delta_2^2 \cdot \left[\left(\frac{R_{[\alpha+\beta]\_blank}}{T}\right) + \left(\frac{R_{\alpha\_blank}}{T}\right)\right] + \delta_1^2 \cdot [1-\delta_2]^2 \cdot (\sigma^2_{B\_[\alpha+\beta]} + \sigma^2_{B\_\alpha})}$$

where,

$R_{[\alpha+\beta]}$ = the gross (α+β) count rate obtained during the [α+β] mode of the ATB count

R_{α} = the gross (α) ONLY count rate obtained during [α] the ONLY mode of the ATB count

$R_{[\alpha+\beta]\_\text{blank}}$ = the gross (α+β) count rate of the (one and only one) designated blank obtained during the [α+β] count of the blank during the [α+β] mode of the ATB count.

R_{α_blank} = the gross (α) ONLY count rate of the (one and only one) designated blank obtained during the α ONLY count of the blank during the α ONLY mode of the ATB count.

$R_{B\_[\alpha+\beta]}$ the [α+β] (system) BACKGROUND count rate for the [α+β] mode of the ATB count mode.

R_{B_α} = the α (system) BACKGROUND count rate for the α ONLY mode of the ATB count mode.

$\sigma_{B\_[\alpha+\beta]}$ = the **uncertainty** in the (α+β) (system) BACKGROUND count rate for the [α+β] mode of the ATB count mode.

$= \sqrt{\frac{R_{B\_[\alpha+\beta]}}{T_B}}$ for the case in which the background was determined from a single measurement

$= \frac{\sum_{i=1}^{N}\left(R_{B\_[\alpha+\beta]\_i} - R_{B\_[\alpha+\beta]}\right)^2}{(N-1)}$ if the background was determined from a set of *N* measurements.

σ_{B_α} = the **uncertainty** in the α (system) BACKGROUND count rate for the α ONLY mode of the ATB count mode.

$= \sqrt{\frac{R_{B\_\alpha}}{T_B}}$ for the case in which the background was determined from a single measurement

$$= \sqrt{\frac{\sum_{i=1}^{N}\left(R_{B\_\alpha\_i} - R_{B\_\alpha}\right)^2}{(N-1)}}$$

if the background was determined from a set of *N* measurements.

$$\delta_1 = \begin{Bmatrix} 0\_if\_BACKGROUND\_SUBTRACTION = NO \\ 1\_if\_BACKGROUND\_SUBTRACTION = YES \end{Bmatrix}$$

$$\delta_2 = \begin{Bmatrix} 0\_if\_BLANK\_SUBTRACTION = NO \\ 1\_if\_BLANK\_SUBTRACTION = YES \end{Bmatrix}$$

Note: $\delta_2 = 1$ is not currently allowed.

Note: Care should be taken in selecting background subtraction versus method blank subtraction during the alpha then beta mode. Unlike the method blank protocol (in modes other than ATB) in which the result of subtracting the gross blank from the gross sample produces the same result as subtracting the net blank from the net sample, in the ATB mode, subtracting the gross α only count from the gross (α+β) count does not produce the same result as subtracting the net α only count from the net (α+β) count. The difference is the derived β background. While the δ_1 parameter ensures that system background is consistently applied to the α only and (α+β) components of the above equations for the ATB mode, it needs to be noted that the system backgrounds for these modes are different. (The difference is the derived β background.) In fact, the δ_1 parameter multiplies what one could call the "derived beta background". Thus turning background subtraction ON versus OFF determines whether the "derived beta background" is subtracted or not - consistent with the definition of net count versus gross count. In other words, (derived gross β - β background) and (net [α+β] - net [α only]) produce the same net β only result (760 in the table below).

In a similar fashion, when one tries to take into account a method blank, consistent results will be obtained provided one is consistent in matching gross with gross and net with net measurements.

The following table helps to demonstrate these concepts. In the context of this table, the following definitions will apply:

TOTAL = sample contribution + blank contribution

GROSS = including system background

NET = the system background has been subtracted.

MODE:	(α ONLY)	($\alpha+\beta$)	DERIVED β: TOTAL GROSS β	β SYS BACK	BLANK GROSS β	BLANK NET β
Observed Backgrounds:	**10**	**50**				
Derived Background:				**40**		
Observed Blank:	**30**	**400**				
Derived Gross Blank:					**370**	
Derived Net Blank:	**20**	**350**				**330**
Observed Count:	**100**	**900**				
Derived Gross Count:			**800**	800	800	
Derived Total Net Beta Count:						**760**
$\delta_1 = 0, \delta_2 = 0$: **Gross Total SAMPLE:**	**100**	**900**	**800**[1]			
$\delta_1 = 1, \delta_2 = 0$: **Gross Total Samp - SYS BACK:**	**90**	**850**		**760**[2]		
$\delta_1 = 0, \delta_2 = 1$: **Gross Total Samp - Gross Blank:**	**70**	**500**			**430**[3]	
$\delta_1 = 1, \delta_2 = 1$: **Net Total Samp - Net Blank:**	**(90-20)**	**(850-350)**				**430**[4]

Note 1: The TOTAL gross beta counts. These are due to contributions from:
the system background = 40
The beta contribution from the method = 330
And the beta contribution from the sample itself = 430
800

Note 2: The TOTAL net beta counts. These are due to contributions from:
The beta contribution from the method = 330
And the beta contribution from the sample itself = 430
760

Note 3: The NET SAMPLE beta counts. These are due to contributions from:
the NET beta contribution from the sample itself = 430
430

While this is obtained by subtracting the GROSS blank count rate from the GROSS sample count rate, it still produces the NET beta count rate because the system background contribution is common to both the sample and blank, and is thus subtracted out:

The GROSS sample count rate = 800 (40+330+430) the GROSS blank count rate = 370 (40+330)

430

Note 4: The NET SAMPLE beta counts. These are due to contributions from:

the NET beta contribution from the sample itself = 430

430

This result is obtained by subtracting the NET blank count rate from the NET sample count rate. It produces the same NET beta count rate as demonstrated in Note 3:

The NET sample count rate = 760 (330+430)

the NET blank count rate = 330 (330)

430

These results follow from the associative property of addition and subtraction.

Efficiency and Spillover Calibrations without Mass Attenuation

Efficiency

For $N \geq 1$:

$$\varepsilon = \frac{1}{N} \cdot \sum_{i=1}^{N} \varepsilon_i = \frac{1}{N} \cdot \sum_{i=1}^{N} \frac{R_{i\_calc'd}}{S}$$

where,

$\varepsilon_i = \frac{R_{i\_calc'd}}{S} =$ the efficiency determined from the i[th] observation.

$R_{i\_calc'd} =$ the “calculated” count rate (net or gross as determined by the analysis profile) for the particle (α or β)of interest during the i[th] observation.

$S =$ the emission rate of the calibration standard for the particle of interest.

$= S_0 \cdot e^{-\lambda \cdot \Delta T}$

$S_0 =$ the emission rate of the calibration standard as of the certificate date.

$\lambda = \frac{\ln(2)}{T_{1/2}}$

$\Delta T =$ Elapsed time between Calibration source certificate date/time and the Count Acquisition date/time.

Uncertainty

For $N = 1$:

$$\frac{\sigma_{\varepsilon_1}}{\varepsilon_1} = \sqrt{\left(\frac{\sigma_{R_{1\_calc'd}}}{R_{1\_calc'd}}\right)^2 + \left(\frac{\sigma_S}{S}\right)^2}$$

$\sigma_{R_1} =$ Uncertainty in the “calculated” count rate

From the count rate determination as stored in the database.

$\sigma_S =$ Uncertainty in the emission rate of the calibration standard.

For $N > 1$:

$$\sigma_{\bar{\varepsilon}}^2 = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} (\varepsilon_i - \varepsilon)^2$$

Spillover - Simultaneous Mode Only

Spilldown - Determined During Alpha Efficiency in Simultaneous Mode

For a single measurement:

$$\chi_{1\_\alpha->\beta} = \frac{R_{1\_\beta\_calc'd}}{R_{1\_\alpha\_calc'd}}$$

and

$$\frac{\sigma_{\chi_{1\_\alpha->\beta}}}{\chi_{1\_\alpha->\beta}} = \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

or restated as

$$\sigma_{\chi_{1\_\alpha->\beta}} = \chi_{1\_\alpha->\beta} \cdot \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

Which can be expanded as follows:

$$\sigma_{\chi_{1\_\alpha->\beta}} = \frac{R_{1\_\beta\_calc'd}}{R_{1\_\alpha\_calc'd}} \cdot \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

$$\sigma_{\chi_{1\_\alpha->\beta}} = \sqrt{\left(\frac{R_{1\_\beta\_calc'd}}{R_{1\_\alpha\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{R_{1\_\beta\_calc'd}}{R_{1\_\alpha\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

$$\sigma_{\chi_{1\_\alpha->\beta}} = \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2 + \left(\frac{R_{1\_\beta\_calc'd}}{R_{1\_\alpha\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

For the case when $R_{1\_\beta\_calc'd} = 0$, the second term inside the square root is zero and we can write:

$$\sigma_{\chi_{1\_\alpha->\beta}} = \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

where,

$R_{1\_\beta\_calc'd}$ =	the “calculated” beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.
$R_{1\_\alpha\_calc'd}$ =	the “calculated” alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.
$\sigma_{R_{1\_\alpha\_calc'd}}$ =	the uncertainty in the “calculated” alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.
$\sigma_{R_{1\_\beta\_calc'd}}$ =	the uncertainty in the “calculated” beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.

For a set of *N* measurements:

$$\chi_{\alpha->\beta} = \frac{1}{N} \cdot \sum_{i=1}^{N} \chi_{i\_\alpha->\beta}$$

where,

$$\chi_{i\_\alpha->\beta} = \frac{R_{i\_\beta\_calc'd}}{R_{i\_\alpha\_calc'd}}$$

$R_{i\_\beta\_calc'd}$ =	the “calculated” beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the ith observation.
$R_{i\_\alpha\_calc'd}$ =	the “calculated” alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the ith observation.

and

$$\sigma^2_{\chi_{\alpha\to\beta}} = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} \left(\chi_{i\_\alpha\to\beta} - \chi_{\alpha\to\beta}\right)^2$$

Spillup - Determined During Beta Efficiency in Simultaneous Mode

For a single measurement:

$$\chi_{1\_\beta->\alpha} = \frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}}$$

and

$$\frac{\sigma_{\chi_{1\_\beta->\alpha}}}{\chi_{1\_\beta->\alpha}} = \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

or restated as

$$\sigma_{\chi_{1\_\beta->\alpha}} = \chi_{1\_\beta->\alpha} \cdot \sqrt{\left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2}$$

Which can be expanded as follows:

$$\sigma_{\chi_{1\_\beta->\alpha}} = \frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}} \cdot \sqrt{\left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2 + \left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2}$$

$$\sigma_{\chi_{1\_\beta->\alpha}} = \sqrt{\left(\frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\alpha\_calc'd}}\right)^2 + \left(\frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2}$$

$$\sigma_{\chi_{1\_\beta->\alpha}} = \sqrt{\left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2 + \left(\frac{R_{1\_\alpha\_calc'd}}{R_{1\_\beta\_calc'd}}\right)^2 \cdot \left(\frac{\sigma_{R_{1\_\beta\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2}$$

For the case when $R_{1\_\alpha\_calc'd} = 0$, the second term inside the square root is zero and we can write:

$$\sigma_{\chi_{1\_\beta->\alpha}} = \sqrt{\left(\frac{\sigma_{R_{1\_\alpha\_calc'd}}}{R_{1\_\beta\_calc'd}}\right)^2}$$

where,

$R_{1\_\alpha\_calc'd}$ = the "calculated" alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.

$R_{1\_\beta\_calc'd}$ = the "calculated"beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.

$\sigma_{R_{1\_\alpha\_calc'd}}$ = the "calculated" alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.

$\sigma_{R_{1\_\beta\_calc'd}}$ = the uncertainty in the "calculated" beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the **one** observation.

For a set of *N* measurements:

$$\chi_{\beta->\alpha} = \frac{1}{N} \cdot \sum_{i=1}^{N} \chi_{i\_\beta->\alpha}$$

where,

$$\chi_{i\_\beta->\alpha} = \frac{R_{i\_\alpha\_calc'd}}{R_{i\_\beta\_calc'd}}$$

$R_{i\_\alpha\_calc'd}$ = the "calculated" beta count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the i[th] observation.

$R_{i\_\beta\_calc'd}$ = the "calculated" alpha count rate (net or gross as determined by the analysis profile) in the simultaneous count mode for the i[th] observation.

and

$$\sigma^2_{\chi_{\beta\to\alpha}} = \frac{1}{(N-1)} \cdot \sum_{i=1}^{N} \left(\chi_{i\_\beta\to\alpha} - \chi_{\beta\to\alpha}\right)^2$$

Efficiency and Spillover Calibrations with Mass Attenuation

Efficiency Calibrations with Mass Attenuation

The efficiency for samples of non-zero mass is modeled as a function of mass. Four models are available:

- Linear: $\varepsilon(m) = C_0 + C_1 \cdot m$
- Exponential: $\varepsilon(m) = C_0 \cdot e^{-C_1 \cdot m}$
- Inverse Linear: $\varepsilon(m) = \left[C_0 + C_1 \cdot m\right]^{-1}$
- Inverse Quadratic: $\varepsilon(m) = \left[C_0 + C_1 \cdot m^2 + C_2 \cdot m^2\right]^{-1}$

The coefficients of the equation (for the selected model) are determined from a **weighted** least squares fit to a set of paired mass-efficiency observations:
$[(m_1, \varepsilon_1);(m_2, \varepsilon_2);...;(m_N, \varepsilon_N)]$

. These coefficients, along with their uncertainties, are stored so that the efficiency, and its uncertainty, for a sample of any (attenuating) mass can be calculated and used for an activity determination.

Linear

The Fitted Efficiency

The coefficients of the linear solution:

$$\varepsilon(m) = C_0 + C_1 \cdot m$$

are determined by solving for the vector $\bar{b}$ in the following equations:

$$M \cdot \bar{b} = \bar{V}$$

where,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \varepsilon_i \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_{\varepsilon_i}^2}$$

The coefficients are then given by

$$\bar{b} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \bar{V}$$

and the uncertainties in the coefficients are given by

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

The reduced χ^2 of the final fit, Z, is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[\varepsilon_{i\,-}\,\varepsilon(m_i)\right]^2}{\sigma_{\varepsilon_i}^2}$$

For good fits, $Z \to 1$.

The Uncertainty in the Fitted Efficiency

The uncertainty in the calculated efficiency is determined as follows.

Given that the efficiency is calculated from the following equation:

$$\varepsilon(m) = C_0 + C_1 \cdot m$$

we can write

$$(d\varepsilon)^2 = \left[\frac{\partial \varepsilon}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial \varepsilon}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial \varepsilon}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$= [1]^2 \cdot \sigma_{C_0}^2 + [m]^2 \cdot \sigma_{C_1}^2 + [C_1]^2 \cdot \sigma_m$$

$$= \sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2$$

Substituting

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

we can write

$$d\varepsilon^2 = M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2$$

or

$$d\varepsilon = \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Exponential

The Fitted Efficiency

The coefficients of the exponential solution:

$$\varepsilon(m) = C_0 \cdot e^{-C_1 \cdot m}$$

are determined by first linearizing the equation:

$$y = \ln[\varepsilon(m)] = \ln(C_0) - C_1 \cdot m = A_0 + A_1 \cdot m$$

and then solving for A_0 and A_1 by solving for the vector $\bar{b}$ the equation

$$M \cdot \bar{b} = \bar{V}$$

In which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} A_0 \\ A_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \ln(\varepsilon_i) \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \ln(\varepsilon)$

and $(dy)^2 = \left(\frac{1}{\varepsilon}\right)^2 \cdot (d\varepsilon)^2$

the variance of y is given by

$$\sigma_y^2 = \left(\frac{1}{\varepsilon}\right)^2 \cdot \sigma_\varepsilon^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{\varepsilon^2}{\sigma_\varepsilon^2}$$

Then, noting that

$$A_0 = \ln(C_0)$$

$$A_1 = -C_1$$

we may now write:

$$C_0 = e^{A_0}$$

$$C_1 = -A_1$$

The coefficients, A_0 and A_1, are given by

$$\overline{b} = \begin{bmatrix} A_0 \\ A_1 \end{bmatrix} = M^{-1} \cdot M \cdot \overline{b} = M^{-1} \cdot \overline{V}$$

and, as before, the uncertainties in the coefficients A_0 and A_1, are given by

$$\sigma_{A_0}^2 = M_{11}^{-1}$$

$$\sigma_{A_1}^2 = M_{22}^{-1}$$

Noting the uncertainties in the coefficients C_0 and C_1, are given by

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0}$$

$$\sigma_{C_1} = \sigma_{A_1}$$

and substituting for σ_{A_0} and in σ_{A_1} the above equations, we obtain:

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0} = e^{A_0} \cdot \sqrt{M_{11}^{-1}} = C_0 \cdot \sqrt{M_{11}^{-1}}$$

$$\sigma_{C_1} = \sigma_{A_1} = \sqrt{M_{22}^{-1}}$$

As before, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[\varepsilon_{i-} \varepsilon(m_i)\right]^2}{\sigma_{\varepsilon_i}^2}$$

Once again, for good fits, . $Z \to 1$

The Uncertainty in the Fitted Efficiency

The uncertainty in the calculated efficiency is determined as follows.

Given that the efficiency is calculated from the following equation:

$$\varepsilon(m) = C_0 \cdot e^{-C_1 \cdot m}$$

we can write

$$(d\varepsilon)^2 = \left[\frac{\partial \varepsilon}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial \varepsilon}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial \varepsilon}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$\left[e^{-C_1 \cdot m}\right]^2 \cdot \sigma_{C_0}^2 + \left[C_0 \cdot e^{-C_1 \cdot m} \cdot (-m)\right]^2 \cdot \sigma_{C_1}^2 + \left[C_0 \cdot e^{-C_1 \cdot m} \cdot (-C_1)\right]^2 \cdot \sigma_m^2$$

$$\left[e^{-C_1 \cdot m}\right]^2 \bullet \left[\sigma_{C_0}^2 + C_0^2 \cdot m^2 \cdot \sigma_{C_1}^2 + C_0^2 \cdot C_1^2 \cdot \sigma_m^2\right]$$

$$\left[C_0 \cdot e^{-C_1 \cdot m}\right]^2 \bullet \left[\frac{\sigma_{C_0}^2}{C_0^2} + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2\right]$$

Substituting

$$\varepsilon(m) = C_0 \cdot e^{-C_1 \cdot m}$$

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0} = e^{A_0} \cdot \sqrt{M_{11}^{-1}} = C_0 \cdot \sqrt{M_{11}^{-1}}$$

$$\sigma_{C_1} = \sigma_{A_1} = \sqrt{M_{22}^{-1}}$$

we can write

$$(d\varepsilon)^2 = \varepsilon^2 \bullet \left[M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2\right]$$

or

$$d\varepsilon = \varepsilon \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

or

$$\frac{d\varepsilon}{\varepsilon} = \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Inverse Linear

The Fitted Efficiency

The coefficients of the inverse linear solution:

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m\right]^{-1}$$

are determined by first linearizing the equation:

$$y = \frac{1}{\varepsilon(m)} = C_0 + C_1 \cdot m$$

and then solving for C_0 and C_1 by solving for the vector $\overline{b}$ in the equation

$$M \cdot \overline{b} = \overline{V}$$

in which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \frac{1}{\varepsilon_i} \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \frac{1}{\varepsilon}$

and $(dy)^2 = \left(\frac{-1}{\varepsilon^2}\right)^2 \cdot (d\varepsilon)^2$

the variance of y is given by

$$\sigma_y^2 = \frac{1}{\varepsilon^4} \cdot \sigma_\varepsilon^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{\varepsilon^4}{\sigma_\varepsilon^2}$$

The coefficients, C_0 and C_1 , are given by

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \bar{V}$$

The uncertainties in the coefficients C_0 and C_1 are given by

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

As before, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[\varepsilon_{i\,-}\,\varepsilon(m_i)\right]^2}{\sigma_{\varepsilon_i}^2}$$

Once again, for good fits, $Z \to 1$.

The Uncertainty in the Fitted Efficiency

The uncertainty in the calculated efficiency is determined as follows.

Given that the efficiency is calculated from the following equation:

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m\right]^{-1}$$

we can write

$$(d\varepsilon)^2 = \left[\frac{\partial \varepsilon}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial \varepsilon}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial \varepsilon}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$= \left[\frac{-1}{\left[C_0 + C_1 \cdot m\right]^2}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{-1}{\left[C_0 + C_1 \cdot m\right]^2}\right]^2 \cdot \left[m\right]^2 \sigma_{C1}^2 + \left[\frac{-1}{\left[C_0 + C_1 \cdot m\right]^2}\right]^2 \cdot \left[C_1\right]^2 \cdot \sigma_{C_0}^2$$

$$= \left[\frac{-1}{\left[C_0 + C_1 \cdot m\right]^2}\right]^2 \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2\right]$$

Substituting

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m\right]^{-1}$$

We obtain

$$(d\varepsilon)^2 = \varepsilon^4 \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2\right]$$

Now substituting

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

We obtain

$$(d\varepsilon)^2 = \varepsilon^4 \bullet \left[M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2\right]$$

or

$$d\varepsilon = \varepsilon^2 \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

or

$$\frac{d\varepsilon}{\varepsilon} = \varepsilon \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Inverse Quadratic

The Fitted Equation

The coefficients of the inverse quadratic solution:

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^{-1}$$

are determined by first linearizing the equation:

$$y = \frac{1}{\varepsilon(m)} = C_0 + C_1 \cdot m + C_2 \cdot m^2$$

and then solving for C_0, C_1, and C_2 by solving for the vector in the equation

$$M \cdot \overline{b} = \overline{V}$$

in which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \\ C_2 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \frac{1}{\varepsilon_i} \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \dfrac{1}{\varepsilon}$

and $(dy)^2 = \left(\dfrac{-1}{\varepsilon^2}\right)^2 \cdot (d\varepsilon)^2$

the variance of y is given by

$$\sigma_y^2 = \frac{1}{\varepsilon^4} \cdot \sigma_\varepsilon^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{\varepsilon^4}{\sigma_\varepsilon^2}$$

The coefficients, C_0, C_1, and C_2 are given by

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \\ C_2 \end{bmatrix} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \bar{V}$$

The uncertainties in the coefficients C_0, C_1, and C_2 are given by

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

$$\sigma_{C_2}^2 = M_{33}^{-1}$$

With three coefficients, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-3}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[\varepsilon_{i\,-}\,\varepsilon(m_i)\right]^2}{\sigma_{\varepsilon_i}^2}$$

Once again, for good fits, $Z \to 1$.

The Uncertainty in the Fitted Efficiency

The uncertainty in the calculated efficiency is determined as follows.

Given that the efficiency is calculated from the following equation:

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^{-1}$$

we can write

$$(d\varepsilon)^2 = \left[\frac{\partial \varepsilon}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial \varepsilon}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial \varepsilon}{\partial C_2}\right]^2 \cdot \sigma_{C_2}^2 + \left[\frac{\partial \varepsilon}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$= \left[\frac{-1}{\left[C_0 + C_1 + \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot \sigma_{C_0}^2$$

$$+ \left[\frac{-1}{\left[\mathrm{C}_0 + \mathrm{C}_1 + \cdot \mathrm{m} + \mathrm{C}_2 \cdot \mathrm{m}^2\right]^2}\right]^2 \cdot (\mathrm{m})^2 \cdot \sigma_{\mathrm{C}_1}^2$$

$$+\left[\frac{-1}{\left[C_0 + C_1 + \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot \left(m^2\right)^2 \cdot \sigma_{C_2}^2$$

$$+\left[\frac{-1}{\left[C_0 + C_1 + \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot \left(2 \cdot C_2 \cdot m^2\right)^2 \cdot \sigma_m^2$$

$$(d\varepsilon)^2 = \left[\frac{-1}{\left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^2}\right] \bullet \left[\sigma_{C_0}^2 + (m)^2 \cdot \sigma_{C_1}^2 + \left(m^2\right)^2 \cdot \sigma_{C_2}^2 + \left(C_1 + 2 \cdot C_2 \cdot m\right)^2 \cdot \sigma_m^2\right]$$

$$= \left[\frac{-1}{\left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^2}\right] \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + m^4 \cdot \sigma_{C_2}^2 + \left(C_1 + 2 \cdot C_2 \cdot m\right)^2 \cdot \sigma_m^2\right]$$

Substituting

$$\varepsilon(m) = \left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^{-1}$$

We obtain

$$(d\varepsilon)^2 = \varepsilon^4 \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + m^4 \cdot \sigma_{C_2}^2 + (C_1 + 2 \cdot C_2 \cdot m)^2 \cdot \sigma_m^2\right]$$

Now substituting

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

$$\sigma_{C_2}^2 = M_{33}^{-1}$$

We obtain

$$(d\varepsilon)^2 = \varepsilon^4 \bullet \left[M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + m^4 \cdot M_{33}^{-1} + (C_1 + 2 \cdot C_2 \cdot m)^2 \cdot \sigma_m^2\right]$$

or

$$d\varepsilon = \varepsilon^2 \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + m^4 \cdot M_{33}^{-1} + (C_1 + 2 \cdot C_2 \cdot m)^2 \cdot \sigma_m^2}$$

or

$$\frac{d\varepsilon}{\varepsilon} = \varepsilon \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + m^4 \cdot M_{33}^{-1} + (C_1 + 2 \cdot C_2 \cdot m)^2 \cdot \sigma_m^2}$$

Spillover Calibrations (Simultaneous Mode Only) with Mass Attenuation

Note: Traditionally the symbol χ has been used to represent spillover; however, in this section we will also be working with the Chi-Squared (χ^2)value of the least squares fit. Therefore, to avoid confusion between the spillover and the Chi-Squared value of the fit, the symbol “S” will be used in this section to represent spillover.

The spillover for samples of non-zero mass is modeled as a function of mass. Four models are available:

- Linear: $S(m) = C_0 + C_1 \cdot m$
- Exponential: $S(m) = C_0 \cdot e^{-C_1 \cdot m}$
- Inverse Linear: $S(m) = [C_0 + C_1 \cdot m]^{-1}$
- Inverse Quadratic: $S(m) = [C_0 + C_1 \cdot m + C_2 \cdot m^2]^{-1}$

The coefficients of the equation (for the selected model) are determined from a weighted least squares fit to a set of paired mass-spillover observations: $[(m_1, S_1); (m_2, S_2); \ldots; (m_N, S_N)]$. These coefficients, along with their uncertainties, are stored so that the spillover, and its uncertainty, for a sample of any (attenuating) mass can be calculated and used for an activity determination.

Linear

The Fitted Spillover

The coefficients of the linear solution:

$$S(m) = C_0 + C_1 \cdot m$$

are determined by solving for the vector $\bar{b}$

in the following equations:

$$M \cdot \bar{b} = \bar{V}$$

where,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \chi_i \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_{\chi_i}^2}$$

The coefficients are then given by

$$\bar{b} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \bar{V}$$

and the uncertainties in the coefficients are given by

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

The reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[S_{i\_}S(m_i)\right]^2}{\sigma_{S_i}^2}$$

For good fits, $Z \to 1$.

The Uncertainty in the Fitted Spillover

The uncertainty in the calculated spillover is determined as follows.

Given that the spillover is calculated from the following equation:

$$S(m) = C_0 + C_1 \cdot m$$

we can write

$$(dS)^2 = \left[\frac{\partial S}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial S}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial S}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$= [1]^2 \cdot \sigma_{C_0}^2 + [m]^2 \cdot \sigma_{C_1}^2 + \left[C_1^2\right]^2 \cdot \sigma_m^2$$

$$= \sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2$$

Substituting

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

we can write

$$dS^2 = M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2$$

or

$$dS = \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Exponential

The Fitted Spillover

The coefficients of the exponential solution:

$$S(m) = C_0 \cdot e^{-C_1 \cdot m}$$

are determined by first linearizing the equation:

$$y = \ln[S(m)] = \ln(C_0) - C_1 \cdot m = A_0 + A_1 \cdot m$$

and then solving for A_0 and A_1 by solving for the vector $\bar{b}$ the equation

$$M \cdot \bar{b} = \bar{V}$$

in which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} A_0 \\ A_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \ln(S_i) \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \ln(S)$

and $(dy)^2 = \left(\frac{1}{S}\right)^2 \cdot (dS)^2$

the variance of y is given by

$$\sigma_y^2 = \left(\frac{1}{S}\right)^2 \cdot \sigma_S^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{S^2}{\sigma_S^2}$$

Then, noting that

$$A_0 = \ln(C_0)$$

$$A_1 = -C_1$$

we may now write:

$$C_0 = e^{A_0}$$

$$C_1 = -A_1$$

The coefficients, A_0 and A_1, are given by

$$\bar{b} = \begin{bmatrix} A_0 \\ A_1 \end{bmatrix} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \overline{V}$$

and, as before, the uncertainties in the coefficients A_0 and A_1 are given by

$$\sigma_{A_0}^2 = M_{11}^{-1}$$

$$\sigma_{A_1}^2 = M_{22}^{-1}$$

Noting the uncertainties in the coefficients C_0 and C_1 , are given by

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0}$$

$$\sigma_{C_1} = \sigma_{A_1}$$

and substituting for σ_{A_0} and σ_{A_1} in the above equations, we obtain:

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0} = e^{A_0} \cdot \sqrt{M_{11}^{-1}} = C_0 \cdot \sqrt{M_{11}^{-1}}$$

$$\sigma_{C_1} = \sigma_{A_1} = \sqrt{M_{22}^{-1}}$$

As before, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[S_{i\,-}\,S(m_i)\right]^2}{\sigma_{S_i}^2}$$

Once again, for good fits, $Z \rightarrow 1$.

The Uncertainty in the Fitted Spillover

The uncertainty in the calculated spillover is determined as follows.

Given that the spillover is calculated from the following equation:

$$S(m) = C_0 \cdot e^{-C_1 \cdot m}$$

we can write

$$(dS)^2 = \left[\frac{\partial S}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial S}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial S}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$\left[e^{-C_1 \cdot m}\right]^2 \cdot \sigma_{C_0}^2 + \left[C_0 \cdot e^{-C_1 \cdot m} \cdot (-m)\right]^2 \cdot \sigma_{C_1}^2 + \left[C_0 \cdot e^{-C_1 \cdot m} \cdot (-C_1)\right]^2 \cdot \sigma_m^2$$

$$\left[e^{-C_1 \cdot m}\right]^2 \bullet \left[\sigma_{C_0}^2 + C_0^2 \cdot m^2 \cdot \sigma_{C_{1,}}^2 + C_0^2 \cdot C_1^2 \cdot \sigma_m^2\right]$$

$$\left[C_0 \cdot e^{-C_1 \cdot m}\right]^2 \bullet \left[\frac{\sigma_{C_0}^2}{C_0^2} + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2\right]$$

Substituting

$$S(m) = C_0 \cdot e^{-C_1 \cdot m}$$

$$\sigma_{C_0} = e^{A_0} \cdot \sigma_{A_0} = e^{A_0} \cdot \sqrt{M_{11}^{-1}} = C_0 \cdot \sqrt{M_{11}^{-1}}$$

$$\sigma_{C_1} = \sigma_{A_1} = \sqrt{M_{22}^{-1}}$$

we can write

$$(dS)^2 = S^2 \bullet \left[M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2\right]$$

or

$$dS = S \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

or

$$\frac{dS}{S} = \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Inverse Linear

The Fitted Spillover

The coefficients of the inverse linear solution:

$$S(m) = \left[C_0 + C_1 \cdot m\right]^{-1}$$

are determined by first linearizing the equation:

$$y = \frac{1}{S(m)} = C_0 + C_1 \cdot m$$

and then solving for C_0 and C_1 by solving for the vector $\bar{b}$ in the equation

$$M \cdot \bar{b} = \bar{V}$$

in which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \frac{1}{S_i} \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \dfrac{1}{S}$

and $(dy)^2 = \left(\dfrac{-1}{S^2}\right)^2 \cdot (d\chi)^2$

the variance of y is given by

$$\sigma_y^2 = \frac{1}{S^4} \cdot \sigma_S^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{S^4}{\sigma_S^2}$$

The coefficients C_0 and C_1 , are given by

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \end{bmatrix} = M^{-1} \cdot M \cdot \bar{b} = M^{-1} \cdot \bar{V}$$

The uncertainties in the coefficients C_0 and C_1 are given by

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

As before, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-2}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[S_{i-} S(m_i)\right]^2}{\sigma_{S_i}^2}$$

Once again, for good fits, $Z \to 1$.

The Uncertainty in the Fitted Spillover

The uncertainty in the calculated spillover is determined as follows.

Given that the spillover is calculated from the following equation:

$$\mathrm{S(m)}=[\mathrm{C_0}+\mathrm{C_1}\cdot \mathrm{m}]^{-1}$$

we can write

$$(dS)^2 = \left[\frac{\partial S}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial S}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial S}{\partial m}\right]^2 \cdot \sigma_m^2$$

$$= \left[\frac{-1}{[C_0 + C_1 \cdot m]^2}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{-1}{[C_0 + C_1 \cdot m]^2}\right]^2 \cdot [m]^2 \cdot \sigma_{C_1}^2 + \left[\frac{-1}{[C_0 + C_1 \cdot m]^2}\right]^2 \cdot [C_1]^2 \cdot \sigma_m^2$$

$$= \left[\frac{-1}{[C_0 + C_1 \cdot m]^2}\right]^2 \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 \cdot \sigma_m^2\right]$$

Substituting

$$S(m)=[C_0 + C_1 \cdot m]^{-1}$$

We obtain

$$(dS)^2 = S^4 \bullet \left[\sigma_{C_0}^2 + m^2 \cdot \sigma_{C_1}^2 + C_1^2 \cdot \sigma_m^2\right]$$

Now substituting

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

We obtain

$$(dS)^2 = S^4 \bullet \left[M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2\right]$$

or

$$dS = S^2 \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

or

$$\frac{dS}{S} = S \bullet \sqrt{M_{11}^{-1} + m^2 \cdot M_{22}^{-1} + C_1^2 \cdot \sigma_m^2}$$

Inverse Quadratic

The Fitted Spillover

The coefficients of the inverse quadratic solution:

$$S(m) = \left[C_0 + C_1 \cdot m + C_2 \cdot m\right]^{-1}$$

are determined by first linearizing the equation:

$$y = \frac{1}{S(m)} = C_0 + C_1 \cdot m + C_2 \cdot m^2$$

and then solving for C_0, C_1, and C_2 by solving for the vector $\bar{b}$ in the equation

$$M \cdot \bar{b} = \bar{V}$$

in which,

$$M_{JK} = \sum_{i=1}^{N} w_i \cdot m_i^{J-1} \cdot m_i^{K-1}$$

$$\bar{b} = \begin{bmatrix} C_0 \\ C_1 \\ C_2 \end{bmatrix}$$

$$V_K = \sum_{i=1}^{N} w_i \cdot \frac{1}{S_i} \cdot m_i^{K-1}$$

and

$$w_i = \frac{1}{\sigma_y^2}$$

Since $y = \dfrac{1}{S}$

and $(dy)^2 = \left(\dfrac{-1}{S^2}\right)^2 \cdot (dS)^2$

the variance of y is given by

$$\sigma_y^2 = \frac{1}{S^4} \cdot \sigma_S^2$$

so that the weighting factor, w_i, is given by

$$w_i = \frac{S^4}{\sigma_S^2}$$

The coefficients, C_0, C_1, and C_2 are given by

$$\overline{b} = \begin{bmatrix} C_0 \\ C_1 \\ C_2 \end{bmatrix} = M^{-1} \cdot M \cdot \overline{b} = M^{-1} \cdot \overline{V}$$

The uncertainties in the coefficients C_0, C_1 and C_2 are given by

$$\sigma_{C_0}^2 = M_{11}^{-1}$$

$$\sigma_{C_1}^2 = M_{22}^{-1}$$

$$\sigma_{C_2}^2 = M_{33}^{-1}$$

With three coefficients, the reduced χ^2 of the final fit is given by:

$$Z = \frac{\chi^2}{N-3}$$

where,

$$\chi^2 = \sum_{i=1}^{N} \frac{\left[S_i - S(m_i)\right]^2}{\sigma_{S_i}^2}$$

Once again, for good fits, $Z \rightarrow 1$.

The Uncertainty in the Fitted Spillover

The uncertainty in the calculated spillover is determined as follows.

Given that the spillover is calculated from the following equation:

$$S(m) = \left[C_0 + C_1 \cdot m + C_2 \cdot m\right]^{-1}$$

we can write

$$(dS)^2 = \left[\frac{\partial S}{\partial C_0}\right]^2 \cdot \sigma_{C_0}^2 + \left[\frac{\partial S}{\partial C_1}\right]^2 \cdot \sigma_{C_1}^2 + \left[\frac{\partial S}{\partial C_2}\right]^2 \cdot \sigma_{C_2}^2 + \left[\frac{\partial S}{\partial C_m}\right]^2 \cdot \sigma_m^2$$

$$= \left[\frac{-1}{\left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot \sigma_{C_0}^2$$

$$+ \left[\frac{-1}{\left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot (m)^2 \cdot \sigma_{C_1}^2$$

$$+ \left[\frac{-1}{\left[C_0 + C_1 \cdot m + C_2 \cdot m^2\right]^2}\right]^2 \cdot (m^2)^2 \cdot \sigma_{C_2}^2$$

$$+\left[\frac{-1}{\left[C_0+C_1\cdot m+C_2\cdot m^2\right]^2}\right]^2\cdot(2\cdot C_2\cdot m)^2\cdot\sigma_m^2$$

$$(dS)^2=\left[\frac{-1}{\left[C_0+C_1\cdot m+C_2\cdot m^2\right]^2}\right]^2\bullet\left[\sigma_{C_0}^2+(m)^2\cdot\sigma_{C_1}^2+(m^2)^2\cdot\sigma_{C_2}^2+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2\right]$$

$$=\left[\frac{-1}{\left[C_0+C_1\cdot m+C_2\cdot m^2\right]^2}\right]^2\bullet\left[\sigma_{C_0}^2+m^2\cdot\sigma_{C_1}^2+m^4\cdot\sigma_{C_2}^2+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2\right]$$

Substituting

$$S(m)=\left[C_0+C_1\cdot m+C_2\cdot m\right]^{-1}$$

We obtain

$$(dS)^2=S^4\bullet\left[\sigma_{C_0}^2+m^2\cdot\sigma_{C_1}^2+m^4\cdot\sigma_{C_2}^2+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2\right]$$

Now substituting

$$\sigma_{C_0}^2=M_{11}^{-1}$$

$$\sigma_{C_1}^2=M_{22}^{-1}$$

$$\sigma_{C_2}^2=M_{33}^{-1}$$

We obtain

$$(dS)^2=S^4\bullet\left[M_{11}^{-1}+m^2\cdot M_{22}^{-1}+m^4\cdot M_{33}^{-1}+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2\right]$$

or

$$dS=S^2\bullet\sqrt{M_{11}^{-1}+m^2\cdot M_{22}^{-1}+m^4\cdot M_{33}^{-1}+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2}$$

or

$$\frac{dS}{S}=S\bullet\sqrt{M_{11}^{-1}+m^2\cdot M_{22}^{-1}+m^4\cdot M_{33}^{-1}+(C_1+2\cdot C_2\cdot m)^2\cdot\sigma_m^2}$$

Sample Activity

The activity is reported in units of activity per unit size (mass, volume, etc.). For certain sample types (e.g., smears), the size is pre-defined as 1 and the size units are none, causing the reported activity to simply be the total activity of the sample. The activity is calculated from the “corrected” count rate of the sample and the efficiency for the geometry of the sample. If the activity is to be reported in units other than dpm, an appropriate conversion factor is applied:

$A_s =$

$$A_s = \frac{R_{corr'd}}{\varepsilon \cdot S} \cdot F_{AC}$$

where,

$A_s =$ the Activity of the sample (in units of activity per unit size).

$R_{corr'd} =$ the “corrected” count rate (net or gross or even Spillover corrected as determined by the analysis profile).

$\varepsilon =$ the efficiency (either simple or mass attenuated) as appropriate to the sample geometry

$S =$ the Size of the sample in the selected units. For certain sample types (e.g., smears), $S = 1$.

$F_{AC} =$ Activity Conversion Factor for the desired Activity units.

The uncertainty in the sample activity is given by

$$\sigma_{AS} = A_S \cdot \sqrt{\frac{\sigma_R^2}{R^2} + \frac{\sigma_\varepsilon^2}{\varepsilon^2} + \frac{\sigma_S^2}{S^2}} \bullet F_{AC}$$

where,

$\sigma_\varepsilon =$ the uncertainty in the “corrected” count rate.

$\sigma_\varepsilon =$ the uncertainty in the efficiency.

$\sigma_S =$ the uncertainty in the sample size.

MDA

In most situations MDA is given by the following. The lone exception to this is in the Simultaneous count mode with the spillover correction enabled. That equation is shown after the standard version.

The MDA is given by

$$MDA = \frac{L_{D\_RATE}}{\varepsilon \cdot S} \bullet F_{AC}$$

where,

F_{AC} = Activity Conversion Factor for the desired Activity units.

S = the Size of the sample in the selected units. For certain sample types (e.g., smears),

ε = the efficiency (either simple or mass attenuated) as appropriate to the sample geometry.

L_{D_RATE} = the "Detection Limit" (in units of rate; e.g., cpm), which is given by

$$L_{D\_RATE} = \frac{k^2}{T_S} + 2 \cdot L_{C\_RATE}$$

in which L_{C_RATE} is given by

$$L_{C\_RATE} = k \cdot \sigma_{0\_RATE} = k \cdot \sqrt{\frac{R_B}{T_S} + \sigma_{R_B}^2}$$

where

T_S = the sample count time

and,

σ_{R_B} = the **uncertainty** in the (system) BACKGROUND count rate.

$= \sqrt{\frac{R_B}{T_B}}$ for the case in which the background was determined from a single measurement.

$$= \sqrt{\frac{\sum_{i=1}^{N}\left(R_{B-} R_B\right)^2}{(N-1)}}$$

if the background was determined from a set of *N* measurements.

This "empirical uncertainty" IS NOT YET IMPLEMENTED!

Thus,

$$L_{D\_RATE} = \frac{k^2}{T_S} + 2 \cdot k \cdot \sqrt{\frac{R_B}{T_S} + \sigma_{R_B}^2}$$

For the case in which the background was determined from a single measurement, this becomes

$$L_{D\_RATE} = \frac{k^2}{T_S} + 2 \cdot k \cdot \sqrt{\frac{R_B}{T_S} + \frac{R_B}{T_B}}$$

Substituting

$$k_\alpha = k_\beta = k = 1.645$$

we obtain

$$L_{D\_RATE} = \frac{1.645^2}{T_S} + 2 \cdot 1.645 \cdot \sqrt{\frac{R_B}{T_S} + \frac{R_B}{T_B}} = \frac{2.706}{T_S} + 3.29 \cdot \sqrt{\frac{R_B}{T_S} + \frac{R_B}{T_B}}$$

and

$$MDA = \frac{\left[\frac{2.706}{T_S} + 3.29 \cdot \sqrt{\frac{R_B}{T_S} + \frac{R_B}{T_B}}\right]}{\varepsilon \cdot S} \bullet F_{AC}$$

For the case in which the background was determined from a set of *N* measurements, the MDA is given by

$$MDA = \frac{\left[\frac{2.706}{T_S} + 3.29 \cdot \sqrt{\frac{R_B}{T_S} + \sigma_{R_B}^2}\right]}{\varepsilon \cdot S} \bullet F_{AC}$$

in which

$\sigma_{R_B} =$

the **uncertainty** in the (system) BACKGROUND count rate.

For the Simultaneous count mode with spillover correction enabled the MDA for the alpha channel is given by

$$MDA_{\alpha} = \frac{L_{D\_RATE\_\alpha}}{\varepsilon_{\alpha \cdot S}} \bullet F_{AC}$$

where $L_{D\_RATE\_\alpha}$ is given by

$L_{D\_RATE\_\alpha} = 1.645^2 / T_S + 2 \cdot L_{C\_RATE\_\alpha}$ in which $L_{C\_RATE\_\alpha}$

is given by

$$L_{C\_RATE\_\alpha} = 1.645 \cdot \sqrt{\frac{R_{B\_\alpha}}{T_S} + \frac{R_{\beta} \cdot \chi_{\beta\to\alpha}}{T_S} + S^2_{R_{B\_\alpha}} + \frac{R_{\beta} \cdot \chi^2_{\beta\to\alpha}}{T_S} + \frac{R_{B\_\alpha} \cdot \chi^2_{\beta\to\alpha}}{T_S} + \chi^2_{\beta\to\alpha} \cdot S^2_{R_{B\_\beta}} + R^2_{\beta} \cdot S^2_{\chi_{\beta\to\alpha}}}$$

And R_{β} is given by the following:

if C_{β_net} is greater than $C_{\alpha\_net} \bullet \chi_{\alpha\to\beta}$ then

$$R_{\beta} = \frac{C_{\beta\_net} - C_{\alpha\_net} \cdot \chi_{\alpha\to\beta}}{T_S \cdot (1 - \chi_{\alpha\to\beta} \cdot \chi_{\beta\to\alpha})} = \frac{R_{\beta\_net} - R_{\alpha\_net} \cdot \chi_{\alpha\to\beta}}{(1 - \chi_{\alpha\to\beta} \cdot \chi_{\beta\to\alpha})}$$

otherwise if C_{β_net} is less than $C_{\alpha\_net} \bullet \chi_{\alpha\to\beta}$ or equal to

$R_{\beta} = 0$

where

$C_{\alpha\_net} = \quad C_{\alpha\_Gross} - C_{\beta\_\alpha}$

C_{α_Gross} = the **observed** gross alpha counts.

C_{β_α} = the **observed** alpha background.

C_{β_net} $C_{\beta\_Gross} - C_{B\_\beta}$

C_{β_Gross} = the **observed** gross beta counts.

C_{B_β} = the **observed** beta background.

$R_{\alpha\_net} = \dfrac{C_{\alpha\_Gross}}{T_S} - \dfrac{C_{B\_\alpha}}{T_B} = R_{\alpha\_Gross} - R_{B\_\alpha}$

R_{α_Gross} = the **observed** gross alpha count rate.

R_{B_α} = the **observed** alpha background rate.

$S^2_{R_{B\_\alpha}}$ = the experimental variance of R_{B_α} =

$R_{\beta\_net} = R_{\beta\_Gross} - R_{B\_\beta}$

R_{β_Gross} = the **observed** gross beta count rate.

R_{B_β} = the **observed** beta background rate

$S^2_{R_{B\_\beta}}$ = the experimental variance of R_{B_β} =

$\chi_{\alpha\rightarrow\beta}$ = the alpha to beta crosstalk

$S^2_{\chi_{\alpha\rightarrow\beta}}$ = the experimental variance of $\chi_{\alpha\rightarrow\beta}$

$\chi_{\beta\rightarrow\alpha}$ = the beta to alpha crosstalk

$S^2_{\chi_{\beta\rightarrow\alpha}}$ the experimental variance of $\chi_{\beta\rightarrow\alpha}$

Note: The equations for beta channel are effectively the just transpose the alpha and beta channels in the equations.

ISO 11929

The ISO 11929 MDA is an optional MDA variant that the user may select, instead of the standard Currie MDA. The quantities calculated using ISO 11929 are the Decision Threshold (or Critical Level, L_C), and the MDA (or Detection Limit L_D).

Decision Threshold or Critical Level LC

The decision threshold DT is calculated, in units of activity:

$$DT = k_{1-a}\, w\sigma_0$$

Where,

$k_{1-\alpha}$ User Settable – Default 5%

Error probability α = False Positive = Type I Error

Error probability β = False Positive = Type I Error

$k_{1-\alpha}$ is the parameter expressing the confidence limit in positive results.

$k_{1-\beta}$ is the parameter expressing the confidence limit in negative results.

And, *w* is the counts-to-activity conversion factor is given by:

$$w = \frac{F_{AC}}{\varepsilon \cdot S}$$

Note: If the activity calculation is not performed, and the user is reporting results in units of *count rate*, then $w = 1/S$.

If spillover correction is not performed, then σ_0 zero net-count rate uncertainty is given by:

$$\sigma_0 = \sqrt{\frac{R_B}{T_S} + \sigma^2{}_{R_B}}$$

In case where spillover correction is performed, then σ_0 is given by:

$$\sigma_0 = \sqrt{\frac{R_{B\_\alpha}}{T_s} + \frac{R_\beta \cdot \chi_{\beta\to\alpha}}{T_S} + S^2{}_{R_{B\_\alpha}} + \frac{R_\beta \cdot \chi^2{}_{\beta\to\alpha}}{T_S} + \frac{R_{B\_\alpha} \cdot \chi^2{}_{\beta\to\alpha}}{T_S} + \chi^2{}_{\beta\to\alpha} \cdot S^2{}_{R_{B\_\alpha}} + R^2{}_\beta \cdot S^2{}_{\chi_{\beta\to\alpha}}}$$

MDA or Detection Limit

The ISO 11929 MDA is calculated by solving the formula:

$$MDA = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

where the coefficients have the following forms:

$$a = \left\{1 - k_{1-\beta}^2 \frac{\sigma_w^2}{w^2}\right\}$$

$$b = -\left\{2k_{1-\alpha}\sigma_0 + \frac{k_{1-\beta}^2}{T_S}\right\}w$$

$$c = \left\{k_{1-\alpha}^2 - k_{1-\beta}^2\right\}\sigma_0^2 w^2$$

where σ_w Count-Rate-to-Activity uncertainty and is given as: k^l

$$\sigma_w = w\sqrt{\frac{\sigma_\varepsilon^2}{\varepsilon^2} + \frac{\sigma_S^2}{S^2}}$$

If the activity calculation is not performed, and the user is reporting results in units of count rate per unit sample amount.

MDA Validity Test

No physically meaningful MDA is obtained by this method if the quadratic coefficient $a \leq 0$. This is a consequence of calculating the detection limit directly in activity. In this case, the ISO 11929 MDA calculation returns “Not Applied”. The traditional Currie Detection MDA may still be calculated even in these cases.

Furthermore, as the coefficient *a* approaches zero, the ISO 11929 MDA will tend toward infinity, even though the Currie MDA is still well behaved at the same input values. A test against the 95% confidence level of the Currie MDA is applied in order to ensure that the ISO MDA value is reasonable. A warning is then issued if the two values are found to be inconsistent at the 95% confidence level; the user may then want to re-evaluate the measurement method to determine if systematic uncertainties in factors related to the conversion factor *w* can be reduced, or simply use the Currie MDA.

The 95% confidence limit of the Currie MDA, C_{max} can be calculated as:

(1) $$C_{\max} = \left(1 + 1.6448536\frac{\sigma_w}{w}\right)\frac{-b+\sqrt{b^2-4c}}{2}$$

If the ISO 11929 MDA exceeds this value, the algorithm does not return a numeric value for the MDA. The variable C_{max} does not need to be reported or stored in the database.

If $K_{1-\alpha} = k_{1-\beta}$ then,

$$C_{\max} = b \cdot \left(1 + 1.6448536\frac{\sigma_w}{w}\right)$$

Only LARGER of the two possible quadratic roots is used.

Bayesian Confidence Interval Calculations

The Bayesian Confidence limits and Best Estimate of Activity are calculated using the final Activity result *A*, and its uncertainty σ_A, from the existing analysis. Note that if the activity is not calculated, the final Rate result R (and σ_R) will be used instead. This calculation also uses the user-specified Bayesian confidence parameter γ.

The Upper and Lower Quantiles

The quantiles k_p and k_q are given by the inverse of cumulative normal distributions $\Phi(k_x) = x$, using the lower probability

$$p = \omega(1 - \gamma / 2)$$

and upper probability

$$q = 1 - \omega\gamma / 2$$

respectively.

The Confidence Interval Limits

The lower limit of the confidence interval is given by

$$A <= A - k_p * \sigma_A$$

and the upper limit is given by

$$A >= A + k_q * \sigma_A$$

The Best Estimate

The best estimate of the true activity (or count rate, if no activity is calculated) is given by

$$\langle A \rangle = A + \frac{\sigma_A}{\omega\sqrt{2\pi}} \exp(-A^2 / 2\sigma_A^2)$$

The uncertainty in the best estimate is

$$\sigma_{\langle A \rangle} = \sqrt{\sigma_A^2 - \langle A \rangle (\langle A \rangle - A)}$$

Derivation of the Activity and Count Rate Equations

This section includes the derivation of the activity and count rate equations for the case in which Spillover Correction is applied in the Simultaneous Mode.

Without Consideration for Method Blank Subtraction

Definitions

$A_\beta =$ the beta activity in dpm.

$A_\alpha =$ the alpha activity in dpm.

$R_\beta =$ the GROSS beta count rate in cpm.

$R_\alpha =$ the GROSS alpha count rate in cpm.

$\varepsilon_\beta =$ the beta efficiency (either simple or mass attenuated) as appropriate to the sample geometry.

$\varepsilon_\alpha =$ the alpha efficiency (either simple or mass attenuated) as appropriate to the sample geometry.

$B_\beta =$ the beta (system) background count rate in cpm.

$B_\alpha =$ the alpha (system) background count rate in cpm.

$\chi_{\alpha->\beta} =$ the fractional spillover (spilldown) from alpha to beta.

$\chi_{\beta->\alpha} =$ the fractional spillover (spillup) from beta to alpha.

Spilldown

$$\chi_{\alpha->\beta} \equiv \frac{R_{\beta\_net}}{R_{\alpha\_net}}$$

and

$$\sigma_{\chi_{\alpha->\beta}} = \chi_{\alpha->\beta} \cdot \sqrt{\left(\frac{\sigma_{R_{\beta\_net}}}{R_{\beta\_net}}\right)^2 + \left(\frac{\sigma_{R_{\alpha\_net}}}{R_{\alpha\_net}}\right)^2}$$

when determined from a *single measurement*[2].

Spillup

$$\chi_{\beta->\alpha} \equiv \frac{R_{\alpha\_net}}{R_{\beta\_net}}$$

and

$$\sigma_{\chi_{\beta->\alpha}} = \chi_{\beta->\alpha} \cdot \sqrt{\left(\frac{\sigma_{R_{\beta\_net}}}{R_{\beta\_net}}\right)^2 + \left(\frac{\sigma_{R_{\alpha\_net}}}{R_{\alpha\_net}}\right)^2}$$

when determined from a *single measurement*[3].

Derivation

Rates

The gross beta count rate includes contributions from the

[2] When the spillover is determined from a set of N measurements, the uncertainty assigned to the spillover in Apex-Alpha/Beta is determined from the empirical variance as described in Efficiency and Spillover calibration without Mass Attenuation.

[3] When the spillover is determined from a set of N measurements, the uncertainty assigned to the spillover in Apex-Alpha/Beta is determined from the empirical variance as described in Efficiency and Spillover calibration without Mass Attenuation.

- beta activity in the sample
- alpha to beta spillover
- beta background

as follows:

$$R_\beta = A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} + B_\beta$$

Similarly, the gross alpha count rate can be written as

$$R_\alpha = A_\alpha \cdot \varepsilon_\alpha + A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} + B_\alpha$$

We now have two equations in two unknowns (A_α and A_β), which can be rearranged as follows:

$$A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} = R_\beta - B_\beta$$

$$A_\alpha \cdot \varepsilon_\alpha + A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} = R_\alpha - B_\alpha$$

Or further rearranged as follows:

$$A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} = R_\beta - B_\beta$$

$$A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} + A_\alpha \cdot \varepsilon_\alpha = R_\alpha - B_\alpha$$

Solving these equations simultaneously yields:

$$A_\beta = \frac{\left[(R_\beta - B_\beta) - (R_\alpha - B_\alpha) \cdot \chi_{\alpha\to\beta}\right]}{\varepsilon_\beta \cdot \left[1 - \chi_{\alpha\to\beta} \cdot \chi_{\beta\to\alpha}\right]}$$

$$A_\alpha = \frac{\left[(R_\alpha - B_\alpha) - (R_\beta - B_\beta) \cdot \chi_{\beta\to\alpha}\right]}{\varepsilon_\alpha \cdot \left[1 - \chi_{\beta\to\alpha} \cdot \chi_{\alpha\to\beta}\right]}$$

By analogy to the general equation for total activity, namely, the count rate divided by the efficiency:

$$A = \frac{R}{\varepsilon}$$

we may write the beta and alpha activities as follows:

$$A_\beta = \frac{R_{\beta\_corrected}}{\varepsilon_\beta}$$

$$A_\alpha = \frac{R_{\alpha\_corrected}}{\varepsilon_\alpha}$$

in which

$$R_{\beta\_corrected} = \frac{\left[(R_\beta - B_\beta) - (R_\alpha - B_\alpha) \cdot \chi_{\alpha->\beta}\right]}{[1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}]}$$

and

$$R_{\alpha\_corrected} = \frac{\left[(R_\alpha - B_\alpha) - (R_\beta - B_\beta) \cdot \chi_{\beta->\alpha}\right]}{[1 - \chi_{\beta->\alpha} \cdot \chi_{\alpha->\beta}]}$$

Uncertainties

Defining:

$$R'_\alpha = R_{\alpha\_corrected}$$

and

$$R'_\beta = R_{\beta\_corrected}$$

we can write the uncertainties in the sample activities as

$$\sigma_{A_\alpha} = A_\alpha \cdot \sqrt{\frac{\sigma^2_{R'_\alpha}}{R'^2_\alpha} + \frac{\sigma^2_{\varepsilon_\alpha}}{\varepsilon^2_\alpha}}$$

$$\sigma_{A_\beta} = A_\beta \cdot \sqrt{\frac{\sigma^2_{R'_\beta}}{R'^2_\beta} + \frac{\sigma^2_{\varepsilon_\beta}}{\varepsilon^2_\beta}}$$

where,

$\varepsilon_\alpha =$ the alpha counting efficiency

$\varepsilon_\beta =$ the beta counting efficiency

$\sigma_{\varepsilon_\alpha} =$ the uncertainty in the alpha counting efficiency defined previously

$\sigma_{\varepsilon_\beta} =$ the uncertainty in the beta counting efficiency defined previously

$\sigma_{R'_\alpha} =$ the uncertainty in the corrected alpha count rate defined below

$\sigma_{R'_\beta} =$ the uncertainty in the corrected beta count rate defined below

in which the uncertainties in the corrected count rates are given by (see derivation [including Method Blank subtraction] in the section *With System Background and Method Blank Subtraction* on page 63):

$$+\left[\frac{\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{\mathrm{R}_\beta}+\sigma^2_{\mathrm{B}_\beta}\right]$$

$$+\left[\frac{-\mathrm{R}'_\beta\cdot\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta->\alpha}}}{\chi_{\beta->\alpha}}\right)^2$$

$$+\left[\frac{\mathrm{R}'_\alpha\cdot\chi_{\beta->\alpha}\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha->\beta}}}{\chi_{\alpha->\beta}}\right)^2$$

$$\sigma^2_{R'_\beta}=\left[\frac{1}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{R_\beta}+\sigma^2_{B_\beta}\right]$$

$$+\left[\frac{\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{\mathrm{R}_\alpha}+\sigma^2_{\mathrm{B}_\alpha}\right]$$

$$+\left[\frac{-\mathrm{R}'_\alpha\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha->\beta}}}{\chi_{\alpha->\beta}}\right)^2$$

$$+\left[\frac{\mathrm{R'}_{\beta}\cdot\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}}{\left[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}\right]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta->\alpha}}}{\chi_{\beta->\alpha}}\right)^2$$

With System Background and Method Blank Subtraction

Definitions

$A_\beta =$ the beta activity in dpm.

$A_\alpha =$ the alpha activity in dpm.

$R_\beta =$ the GROSS beta count rate in cpm.

$R_\alpha =$ the GROSS alpha count rate in cpm.

$\varepsilon_\beta =$ the beta efficiency (either simple or mass attenuated) as appropriate to the sample geometry.

$\varepsilon_\alpha =$ the alpha efficiency (either simple or mass attenuated) as appropriate to the sample geometry.

$B_\beta =$ the beta (system) background count rate in cpm.

$B_\alpha =$ the alpha (system) background count rate in cpm.

$M_{\beta\_gross} =$ the gross beta count rate of the Method Blank in cpm.

$M_{\alpha\_gross} =$ the gross alpha count rate of the Method Blank in cpm.

$\chi_{\beta->\alpha} =$ the fractional spillover (spilldown) from alpha to beta.

$\chi_{\beta->\alpha} =$ the fractional spillover (spillup) from beta to alpha.

Spilldown

$$\chi_{\alpha->\beta} \equiv \frac{R_{\beta\_net}}{R_{\alpha\_net}}$$

and

$$\sigma_{\chi_{\alpha->\beta}} = \chi_{\alpha->\beta}\cdot\sqrt{\left(\frac{\sigma_{R_{\beta\_net}}}{R_{\beta\_net}}\right)^2+\left(\frac{\sigma_{R_{\alpha\_net}}}{R_{\alpha\_net}}\right)^2}$$

when determined from a *single measurement*[4].

[4] See section Differentiation, Rearrangement, and Simplification of Partial Derivative for details.

Spillup

$$\chi_{\beta->\alpha} \equiv \frac{R_{\alpha\_net}}{R_{\beta\_net}}$$

and

$$\sigma_{\chi_{\beta->\alpha}} = \chi_{\beta->\alpha} \cdot \sqrt{\left(\frac{\sigma_{R_{\beta\_net}}}{R_{\beta\_net}}\right)^2 + \left(\frac{\sigma_{R_{\alpha\_net}}}{R_{\alpha\_net}}\right)^2}$$

when determined from a *single measurement*[5].

Derivation

Rates

The gross beta count rate includes contributions from the

- beta activity in the sample
- beta activity from the Method
- beta background
- alpha to beta spillover

as follows:

$$R_\beta = A_\beta \cdot \varepsilon_\beta + M_{\beta\_net} + B_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta}$$

which can be re-written as

$$R_\beta = A_\beta \cdot \varepsilon_\beta + \delta_2 \cdot [M_{\beta\_gross} - \delta_1 \cdot B_\beta] + \delta_1 \cdot B_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta}$$

where δ_1 and δ_2 can be interpreted as follows:

$\delta_1 = 0$ means the system background may be neglected

$\delta_1 = 1$ means the system background is to be taken into account

$\delta_2 = 0$ means the Method Blank contribution may be neglected

5 See section Differentiation, Rearrangement, and Simplification of Partial Derivative for details.

$\delta_2 = 1$ means the Method Blank contribution is to be taken into account

Similarly, the gross alpha count rate can be written as

$$R_\alpha = A_\alpha \cdot \varepsilon_\alpha + M_{\alpha\_net} + B_\alpha + A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha}$$

which can be re-written as

$$R_\alpha = A_\alpha \cdot \varepsilon_\alpha + \delta_2 \cdot [M_{\alpha\_gross} - \delta_1 \cdot B_\alpha] + \delta_1 \cdot B_\alpha + A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha}$$

We now have two equations in two unknowns (A_α and A_β), which can be rearranged as follows:

$$A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} = R_\beta - \delta_2 \cdot [M_{\beta\_gross} - \delta_1 \cdot B_\beta] - \delta_1 \cdot B_\beta$$

$$A_\alpha \cdot \varepsilon_\alpha + A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} = R_\alpha - \delta_2 \cdot [M_{\alpha\_gross} - \delta_1 \cdot B_\alpha] - \delta_1 \cdot B_\alpha$$

Or further rearranged as follows:

$$A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} = R_\beta - \delta_2 \cdot M_{\beta\_gross} + \delta_2 \cdot \delta_1 \cdot B_\beta - \delta_1 \cdot B_\beta$$

$$A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} + A_\alpha \cdot \varepsilon_\alpha = R_\alpha - \delta_2 \cdot M_{\alpha\_gross} + \delta_2 \cdot \delta_1 \cdot B_\alpha - \delta_1 \cdot B_\alpha$$

and finally stated as

$$A_\beta \cdot \varepsilon_\beta + A_\alpha \cdot \varepsilon_\alpha \cdot \chi_{\alpha->\beta} = R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1 - \delta_2)$$

$$A_\beta \cdot \varepsilon_\beta \cdot \chi_{\beta->\alpha} + A_\alpha \cdot \varepsilon_\alpha = R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1 - \delta_2)$$

Solving these equations simultaneously yields:

$$A_\beta = \frac{\left\lfloor \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1 - \delta_2)\right) - \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1 - \delta_2)\right) \cdot \chi_{\alpha->\beta} \right\rfloor}{\varepsilon_\beta \cdot [1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}]}$$

$$A_\alpha = \frac{\left\lfloor \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1 - \delta_2)\right) - \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1 - \delta_2)\right) \cdot \chi_{\beta->\alpha} \right\rfloor}{\varepsilon_\alpha \cdot [1 - \chi_{\beta->\alpha} \cdot \chi_{\alpha->\beta}]}$$

Since the total activity is given by the count rate divided by the efficiency:

$$A = \frac{R}{\varepsilon}$$

we recognize that the spillover corrected count rates can be written as

$$R_{\beta\_corrected} = \frac{\left\lfloor \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1-\delta_2)\right) - \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1-\delta_2)\right) \cdot \chi_{\alpha->\beta} \right\rfloor}{[1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}]}$$

$$R_{\alpha\_corrected} = \frac{\left\lfloor \left(R_\alpha - \delta_2 \cdot M_{\alpha\_gross} - \delta_1 \cdot B_\alpha (1-\delta_2)\right) - \left(R_\beta - \delta_2 \cdot M_{\beta\_gross} - \delta_1 \cdot B_\beta \cdot (1-\delta_2)\right) \cdot \chi_{\beta->\alpha} \right\rfloor}{[1 - \chi_{\beta->\alpha} \cdot \chi_{\alpha->\beta}]}$$

so that the alpha and beta activities, and , are given by

$$A_\alpha = \frac{R_{\alpha\_corrected}}{\varepsilon_\alpha}$$

$$A_\beta = \frac{R_{\beta\_corrected}}{\varepsilon_\beta}$$

Uncertainties

Uncertainties

Defining:

$$\mathrm{R'}_\alpha = \mathrm{R}_{\alpha\_\text{corrrected}}$$

and

$$\mathrm{R'}_\beta = \mathrm{R}_{\beta\_\text{corrected}}$$

we can write the uncertainties in the sample activities as

$$\sigma_{A_\alpha} = A_\alpha \cdot \sqrt{\frac{\sigma^2_{R'_\alpha}}{R'^2_\alpha} + \frac{\sigma^2_{\varepsilon_\alpha}}{\varepsilon^2_\alpha}}$$

$$\sigma_{A_\beta} = A_\beta \cdot \sqrt{\frac{\sigma^2_{R'_\beta}}{R'^2_\beta} + \frac{\sigma^2_{\varepsilon_\beta}}{\varepsilon^2_\beta}}$$

where,

$\varepsilon_\alpha =$ the alpha counting efficiency

$\varepsilon_\beta =$ the beta counting efficiency

$\sigma_{\varepsilon_\alpha} =$ the uncertainty in the alpha counting efficiency defined previously

$\sigma_{\varepsilon_\beta} =$ the uncertainty in the beta counting efficiency defined previously

$\sigma_{R'_\alpha} =$ the uncertainty in the corrected alpha count rate defined below

$\sigma_{R'_\beta} =$ the uncertainty in the corrected beta count rate defined below

in which the uncertainties in the corrected count rates are given by

$$\sigma^2_{R'_\alpha} = \left[\frac{1}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{R_\alpha} + (\delta_2)^2\cdot\sigma^2_{M_{\alpha\_gross}} + (\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma^2_{B_\alpha}\right]$$

$$+\left[\frac{\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{\mathrm{R}_\beta} + (\delta_2)^2\cdot\sigma^2_{\mathrm{M}_{\beta\_\mathrm{gross}}} + (\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma^2_{\mathrm{B}_\beta}\right]$$

$$+\left[\frac{-\mathrm{R}'_\beta\cdot\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta->\alpha}}}{\chi_{\beta->\alpha}}\right)^2$$

$$+\left[\frac{-\mathrm{R}'_\alpha\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha->\beta}}}{\chi_{\alpha->\beta}}\right)^2$$

$$\sigma^2_{R'_\beta} = \left[\frac{1}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2 \bullet \left[\sigma^2_{R_\beta} + (\delta_2)^2\cdot\sigma^2_{M_{\beta\_gross}} + (\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma^2_{B_\beta}\right]$$

$$+\left[\frac{\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2\bullet\left[\sigma^2_{\mathrm{R}_\alpha}+(\delta_2)^2\cdot\sigma^2_{\mathrm{M}_{\alpha\_\mathrm{gross}}}+(\delta_1)^2\cdot(1-\delta_2)^2\cdot\sigma^2_{\mathrm{B}_\alpha}\right]$$

$$\left[\frac{-\mathrm{R}'_\alpha\cdot\chi_{\alpha->\beta}}{[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\alpha->\beta}}}{\chi_{\alpha->\beta}}\right)^2$$

$$+\left[\frac{\mathrm{R}'_\beta\cdot\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}}{[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]}\right]^2\cdot\left(\frac{\sigma_{\chi_{\beta->\alpha}}}{\chi_{\beta->\alpha}}\right)^2$$

Differentiation, Rearrangement, and Simplification of Partial Derivatives

Noting that R'_α and R'_β are given by

$$\mathrm{R}'_\alpha=\left[\left(\mathrm{R}_\alpha-\delta_2\cdot\mathrm{M}_{\alpha\_\mathrm{gross}}-\delta_1\cdot\mathrm{B}_\alpha\cdot(1-\delta_2)\right)-\left(\mathrm{R}_\beta-\delta_2\cdot\mathrm{M}_{\beta\_\mathrm{gross}}-\delta_1\cdot\mathrm{B}_\beta(1-\delta_2)\right)\cdot\chi_{\beta->\alpha}\right]\bullet[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]^{-1}$$

$$R'_\beta=\left[\left(R_\beta-\delta_2\cdot M_{\beta\_gross}-\delta_1\cdot B_\beta\cdot(1-\delta_2)\right)-\left(R_\alpha-\delta_2\cdot M_{\alpha\_gross}-\delta_1\cdot B_\alpha(1-\delta_2)\right)\cdot\chi_{\alpha->\beta}\right]\bullet[1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}]^{-1}$$

we can simplify the notation with the following definitions:

$$f=\left(R_\beta-\delta_2\cdot M_{\beta\_gross}-\delta_1\cdot B_\beta\cdot(1-\delta_2)\right)$$

$$g=\left(R_\alpha-\delta_2\cdot M_{\alpha\_gross}-\delta_1\cdot B_\alpha(1-\delta_2)\right)$$

so that we may write

$$R'_\alpha=\frac{\left(g-f\cdot\chi_{\beta->\alpha}\right)}{\left(1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}\right)}=\left(g-f\cdot\chi_{\beta->\alpha}\right)\bullet\left(1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}\right)^{-1}=w\bullet v$$

and

$$R'_\beta=\frac{\left(f-g\cdot\chi_{\alpha->\beta}\right)}{\left(1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}\right)}=\left(f-g\cdot\chi_{\alpha->\beta}\right)\bullet\left(1-\chi_{\alpha->\beta}\cdot\chi_{\beta->\alpha}\right)^{-1}=u\bullet v$$

in which

$$w = \left(g - f \cdot \chi_{\beta->\alpha}\right)$$

$$u = \left(f - g \cdot \chi_{\alpha->\beta}\right)$$

$$v = \left(1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}\right)^{-1}$$

which simplify the required differentiations. Since the derivation of the uncertainty in the corrected count rate is being carried out for the beta case, we proceed as follows:

$$u = \left(f - g \cdot \chi_{\alpha->\beta}\right)$$

$$\frac{\partial u}{\partial \chi_{\alpha->\beta}} = \left(-g\right)$$

$$\frac{\partial u}{\partial \chi_{\beta->\alpha}} = 0$$

$$v = \left(1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}\right)^{-1}$$

$$\frac{\partial v}{\partial \chi_{\alpha->\beta}} = (-1) \cdot \left[1 - \chi_{\alpha->\beta} \bullet \chi_{\beta->\alpha}\right]^{-2} \cdot \left(-\chi_{\beta->\alpha}\right)$$

$$= \frac{\chi_{\beta->\alpha}}{\left[1 - \chi_{\alpha->\beta} \bullet \chi_{\beta->\alpha}\right]^{2}}$$

$$\frac{\partial v}{\partial \chi_{\beta->\alpha}} = (-1) \cdot \left[1 - \chi_{\alpha->\beta} \bullet \chi_{\beta->\alpha}\right]^{-2} \cdot \left(-\chi_{\alpha->\beta}\right)$$

$$= \frac{\chi_{\alpha->\beta}}{\left[1 - \chi_{\alpha->\beta} \bullet \chi_{\beta->\alpha}\right]^{2}}$$

We may now write:

$$\frac{\partial R'_{\beta}}{\partial \chi_{\alpha->\beta}} = u \cdot \frac{\partial v}{\partial \chi_{\alpha->\beta}} + v \cdot \frac{\partial u}{\partial \chi_{\alpha->\beta}}$$

$$=\left(f-g\cdot\chi_{\alpha\to\beta}\right)\frac{\cdot\chi_{\beta\to\alpha}}{\left[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}\right]^{2}}+\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]^{-1}\cdot\left(-g\right)$$

$$=\frac{\left(f-g\cdot\chi_{\alpha\to\beta}\right)\cdot\chi_{\beta\to\alpha}}{\left[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}\right]^{2}}+\frac{\left(-g\right)}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]}$$

$$=\frac{\left(f-g\cdot\chi_{\alpha\to\beta}\right)\cdot\chi_{\beta\to\alpha}}{\left[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}\right]^{2}}+\frac{\left(-g\right)\cdot\left[1-\chi_{\alpha\to\beta}\bullet\cdot\chi_{\beta\to\alpha}\right]}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]^{2}}$$

$$=\frac{f\cdot\chi_{\beta\to\alpha}-g\cdot\chi_{\alpha\to\beta}\cdot\chi_{\beta\to\alpha}}{\left[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}\right]^{2}}+\frac{\left(-g\right)+g\cdot\chi_{\alpha\to\beta}\cdot\chi_{\beta\to\alpha}}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]^{2}}$$

$$=\frac{f\cdot\chi_{\beta\to\alpha}-g}{\left[1-\chi_{\alpha->\beta}\bullet\chi_{\beta->\alpha}\right]^{2}}$$

$$=\frac{-R'_{\alpha}}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]}$$

6

and

$$\frac{\partial R'_{\beta}}{\partial\chi_{\beta->\alpha}}=u\cdot\frac{\partial v}{\partial\chi_{\beta->\alpha}}+v\cdot\frac{\partial u}{\partial\chi_{\beta->\alpha}}$$

$$=\left(f-g\cdot\chi_{\alpha\to\beta}\right)\cdot\chi_{\alpha\to\beta}\cdot\frac{\chi_{\alpha\to\beta}}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]^{2}}+\left(1-\chi_{\alpha\to\beta}\cdot\chi_{\beta\to\alpha}\right)^{-1}\cdot 0$$

$$=\frac{\left(f-g\cdot\chi_{\alpha\to\beta}\right)\cdot\chi_{\alpha\to\beta}}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]^{2}}$$

$$=\frac{R'_{\beta}\cdot\chi_{\alpha\to\beta}}{\left[1-\chi_{\alpha\to\beta}\bullet\chi_{\beta\to\alpha}\right]}$$

[6]By substituting $$R'_{\alpha} = \frac{\left(g - f \cdot \chi_{\beta->\alpha}\right)}{\left(1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}\right)}$$

or more specifically $$-R'_{\alpha} = \frac{\left(f \cdot \chi_{\beta->\alpha} - g\right)}{\left(1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}\right)}$$

[7]By substituting $$R'_{\beta} = \frac{\left(f - g \cdot \chi_{\alpha->\beta}\right)}{\left(1 - \chi_{\alpha->\beta} \cdot \chi_{\beta->\alpha}\right)}$$

3. Database Schema

This appendix provides an overview of the Apex-Alpha/Beta data model.

Introduction and Standards

The Apex-Alpha/Beta product development uses the CANBERRA general engineering SQL development coding standards. These guidelines help to maintain good design strategies as well as consistency across our products. In addition to these, Apex-Alpha/Beta has it's own product specific standards and naming conventions for this schema. The standards and guidelines which this schema follows are defined below.

Legend and Abbreviations

The following notation is used within this schema document to describe the details for tables and columns.

Notation	Meaning
Key	**Primary Key Indicator** - If this symbol appears to the left of a column, it signifies that it is part of the primary key of the table.
FK	**Foreign Key** - Columns that contain data that reference rows in other tables will be indicated as being a foreign key. In the table details section of the schema report, this value will be set to “Yes” for foreign key columns.
Reqd.	**Required Field** - A required field is one that must be filled in. It can not be NULL. The table details section of the schema report will display a value of “Yes” for nonull columns.
Def.	**Default Value** - If a column has a default value, then this value will be displayed in the table details section of the schema report. Default values only exist for certain required fields. When creating a new row in a table, if you do not specify a value for a column that has a default, the database will automatically fill in this value.

Standards and Naming Conventions

Singular Table Names: We will use singular names as described in the CANBERRA generic standards. This means that table names will not end with an "S" to indicate plurality. For example a table which holds data for Standards, would be called CI_LBS_STANDARD rather than CI_LBS_STANDARDS. For Apex-Alpha/Beta, an additional reason to use singular table names is to remain consistent with the Apex product family which uses singular names.

Unique Column Names: Wherever possible, all physical column names should be unique throughout the schema (with the exception of foreign key references which should generally keep the column name the same as the column being referred to). This is an additional convention for this product. This was done to make the use of Views easier. Thus when two tables are joined in a view, we do not have to rename columns and remember what the new names are. Use of views becomes easier to map columns back to their original table columns, especially in a multi-tier environment where recordsets are detached and later used to try and update the original tables. Since every column name is unique, we will be able to take the data originally retrieved with a view and use it to update a physical table. This is because we will know exactly what column goes with what table. It makes application logic much simpler since there is no field mapping logic in the software. The downside however is that the column names could get a little longer because we usually add a prefix to the column name to make it unique. Also, it takes more up front planning and checking to ensure there are no duplicates (you need a special tool to help verify that no column names are duplicated).

Table and View Naming Convention: We will use the following table naming convention as described in the CANBERRA generic standards document mentioned above:

CC_PPT_DESCRIPTION

For Apex-Alpha, the first two identifiers (CC) will be as follows:

Code	Meaning	Identifier	Description
CC	Company Identifier	CI	Standards for Mirion Technologies (Canberra), Inc.
PP	Product Identifier	AA	for Apex-Alpha/Beta
T	Table Type Identifier	SH	for tables shared with other Apex applications
		D	Data tables - these tables hold the main application data generated through common activities such as defining and counting batches and samples.
		I	Internal data - these tables contain data that has strings that are in the language of the application (English, German, ect.)
		J	Junction tables - these tables contain data that defines a many-to-many relationship between to other tables.
		M	Application data - these tables contain data used by internal systems of the application.
		S	Setup tables - these are tables that hold setup data. This data is generally configured from the setup screens and is not changed often. It contains things like procedures and detector settings, as well as security, calibration, and QA settings.
		L	Lookup tables - these are tables that have fairly static information or tables that are shared with other Apex products.
		V	All views defined in the system will be denoted with this identifier.

Index and Key Naming Convention: We will use the naming conventions as described in the generic standards document listed above. Indexes and alternate keys will be created using the following convention (CC_PPT_TABLEDESCRIPTION_TT). So the name will be identical to the table name to which it applies, but it will be appended with the type identifier "TT" which has the following values.

Type (TT)	Identifier	Examples(s)
Primary Key Constraint	PK	CI_LBS_STANDARD_PK
Foreign Key Constraint	F[n] where 'n' is the constraint number	CI_LBS_STANDARD_F1 CI_LBS_STANDARD_F2
Alternate Key/Column Index	X[n] where 'n' is the index number	CI_LBS_STANDARD_X1 CI_LBS_STANDARD_X2

Primary Key Column Names and ID columns: We will use the naming convention as described in the generic standards document listed above.

Unique Names: Primary key columns must be unique throughout the schema to avoid naming conflicts when they are used as Foreign Keys.

ID columns: If a table is to have an ID column which is a unique value automatically generated by the database, the column name should follow this naming convention:

<TableDescription>ID

The *TableDescription* is the part of the table name which comes after the "CI_LBx_" part of the tablename. Here are some examples of a table and it's ID column:

Table Name	ID Column Name
CI_LBS_STANDARD	STANDARDID
CI_LBS_DEVICE	DEVICEID
CI_LBS_DETECTOR	DETECTORID

Data Types: We will use the following SQL Server and Oracle data types for logical types:

Coding Type	Oracle Datatype	SQL Server Datatype
Booean	number(1)	decimal(1)
Short	number(n)	decimal(5)
Long & Identity IDs	number(10)	decimal(10)
ID columns	number(10)	decimal(10) Only Shared tables are Identity columns to remain compatible with other Apex applications. Alpex-Alpha/Beta ID columns use CI_LBD_IDENTITY table to generate unique IDs.
Enumerations	number(10)	decimal(10)
File/Path Strings	varchar(260)	nvarchar(260)
User Defined Names (such as SampleName, Detector Name, Display Group name, ect)	varchar(64)	nvarchar(64)
Real/Float Numbers	number	float This has less precision than Oracle but it is the most similar to our Oracle type. Floats must be used to match the floating point aspect of how Oracle treats a number field with no precision.
Short Character Data	char	char, nchar
Character/Text	varchar(n)	varchar,nvarchar
Date/Time	date	datetime
Binary Data	blob	varbinary,image
Large Character Data	clob	text

Apex-Alpha/Beta Data Model

Batch/Sample

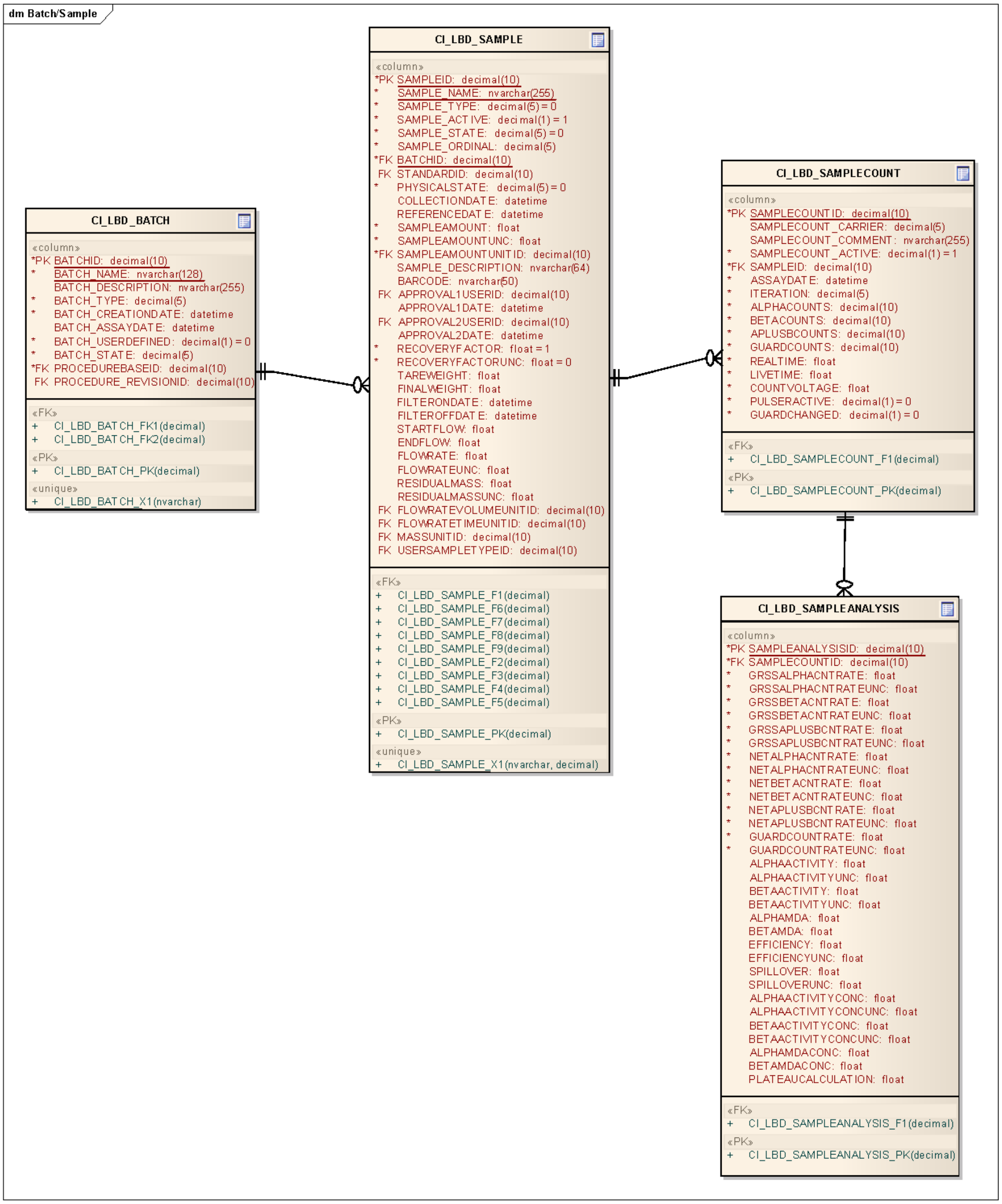

Figure 1 Batch/Sample Data Model

Execution Context

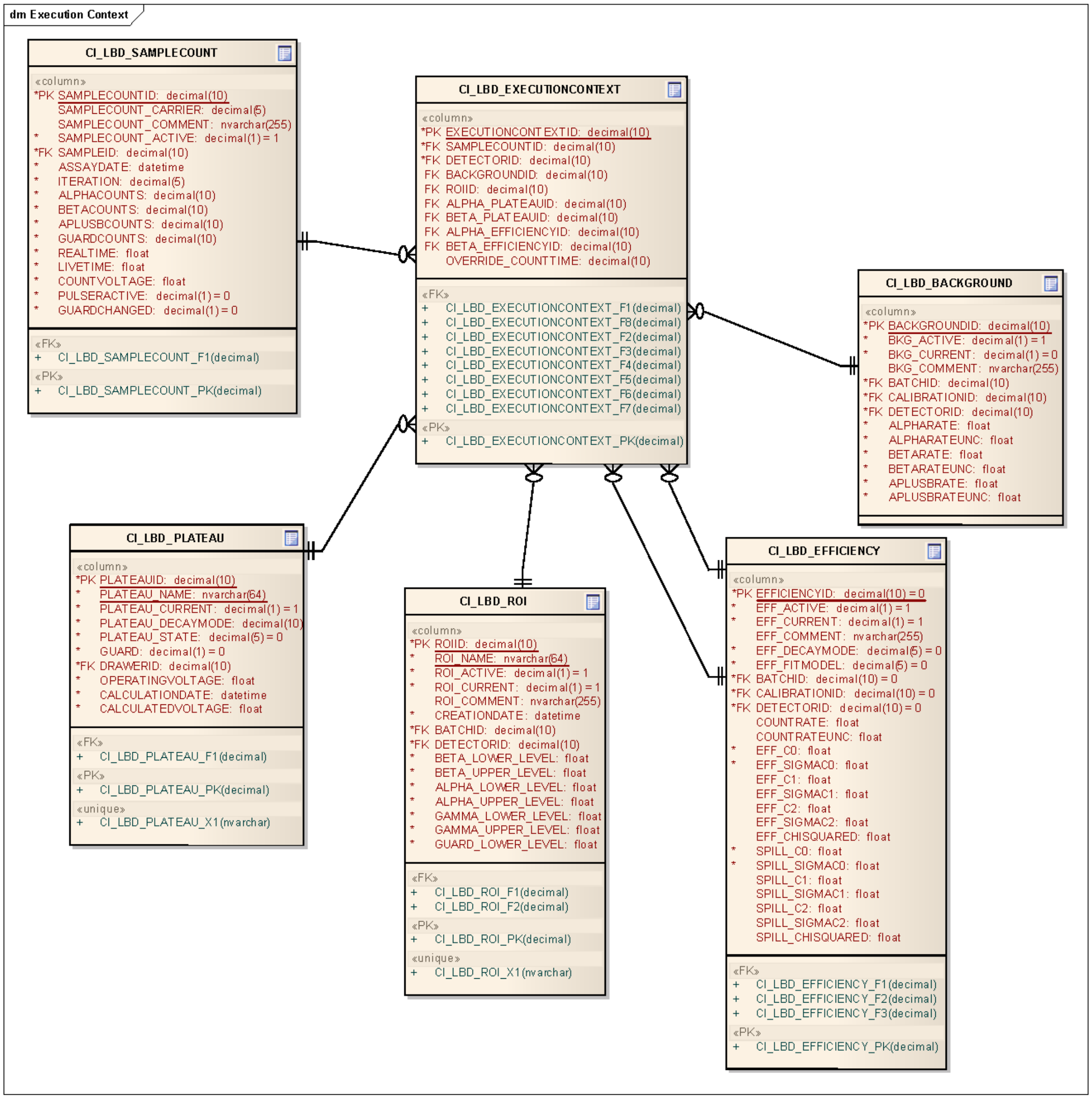

Figure 2 Execution Content Data Model

Efficiency/Background - Detector

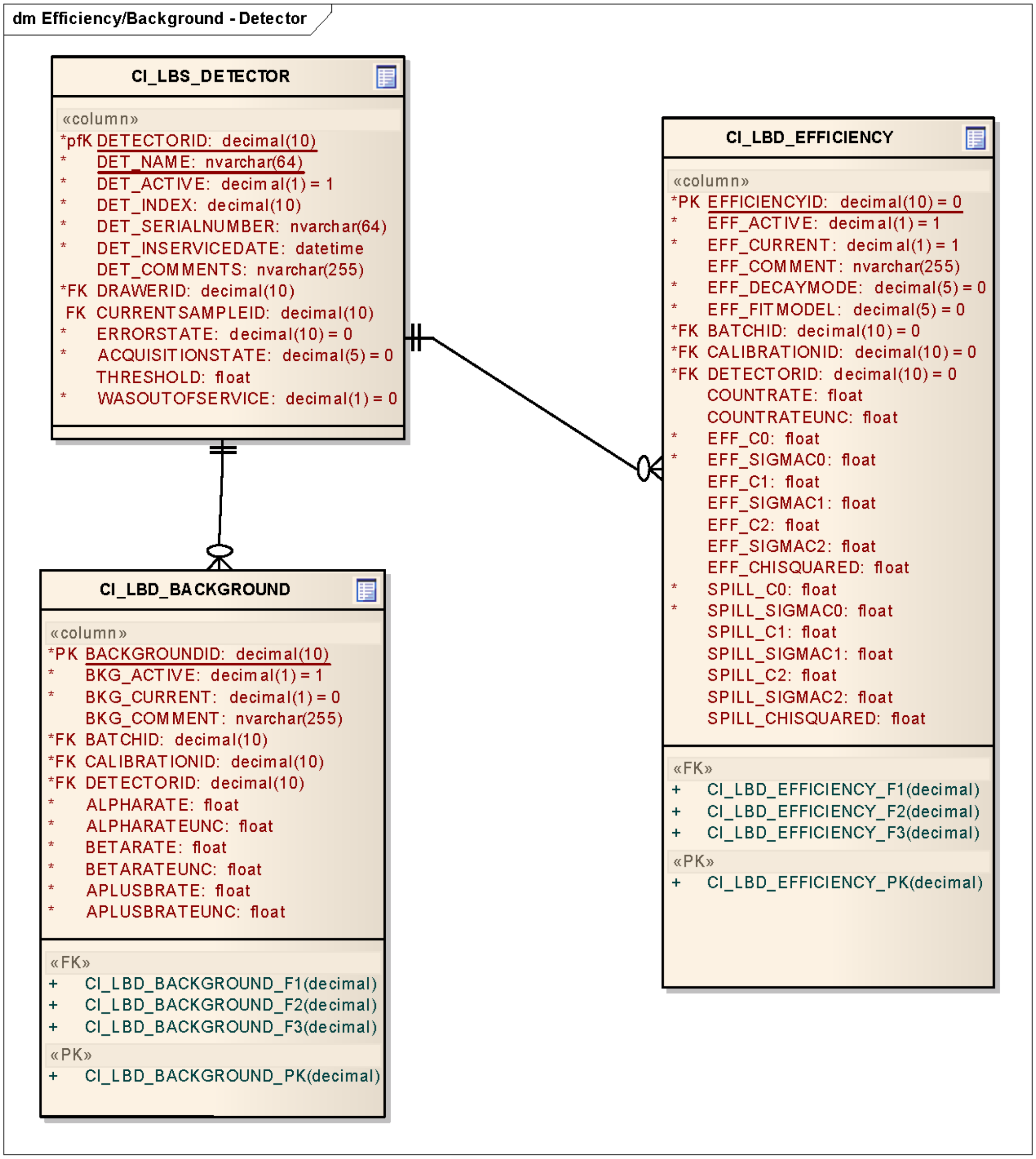

Figure 3 Efficiency/Background - Detector Data Model

Display Groups

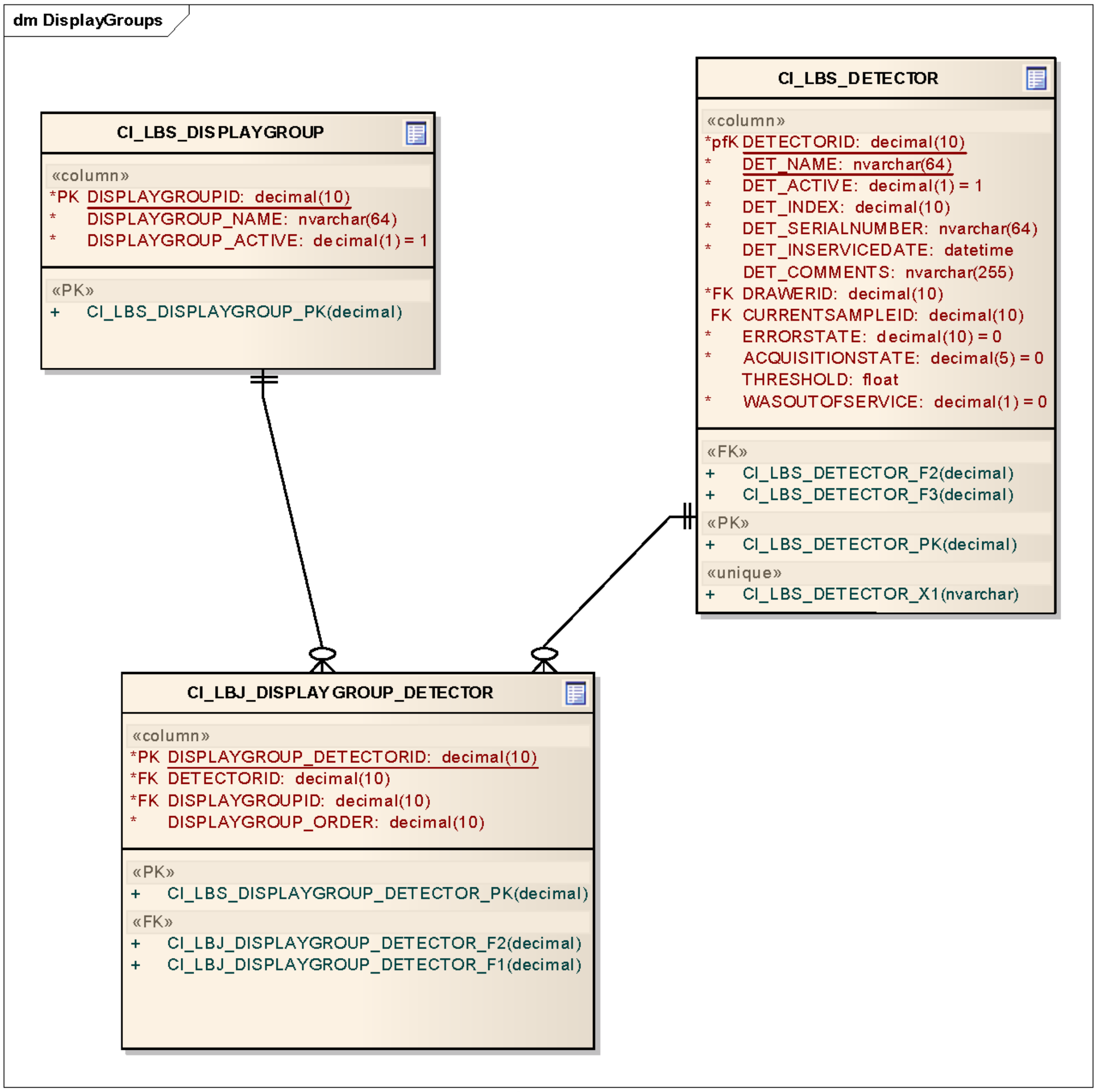

Figure 4 Display Groups Data Model

Efficiency Data Relationships

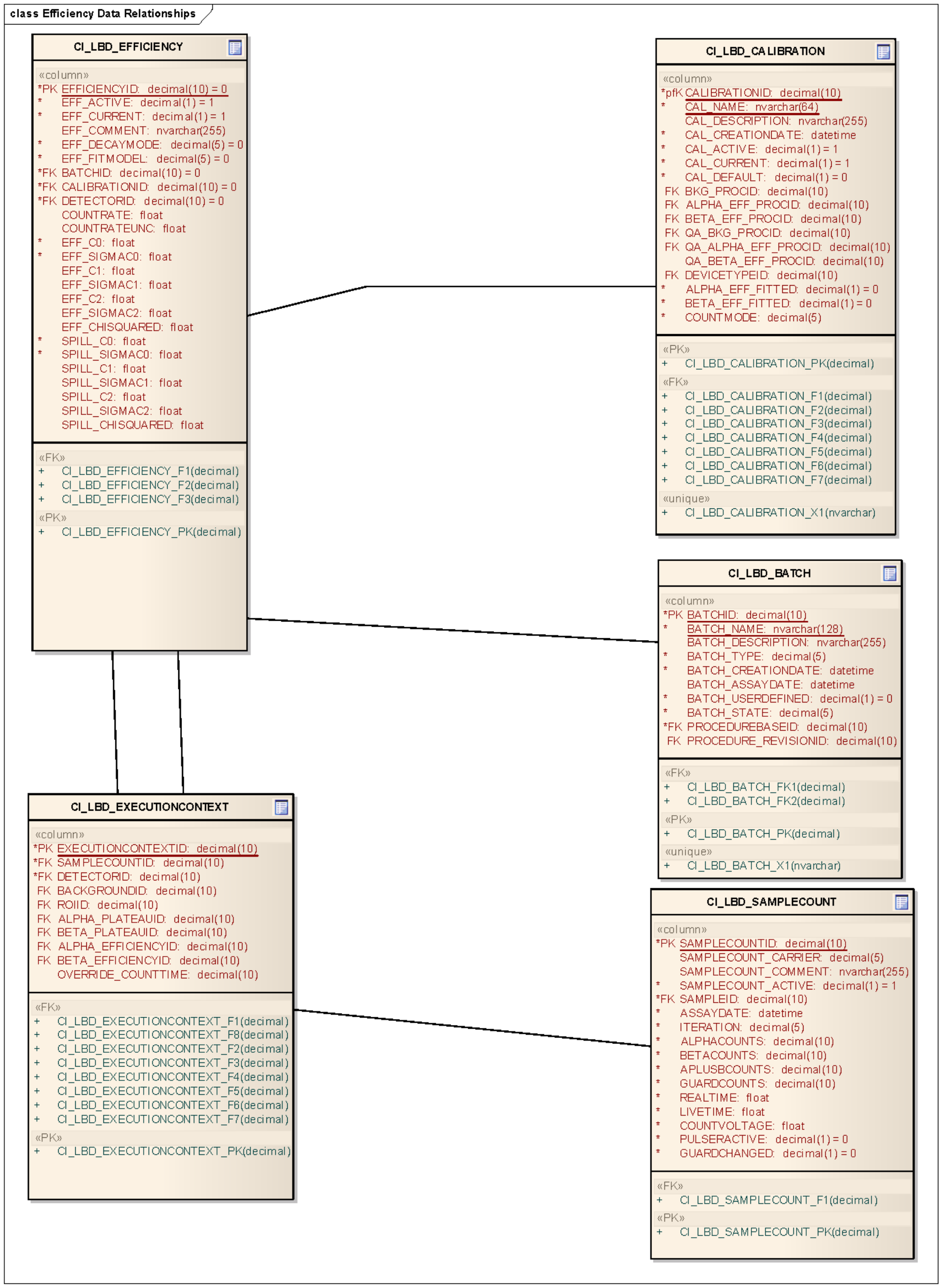

Figure 5 Efficiency Data Relationships Data Model

Procedure

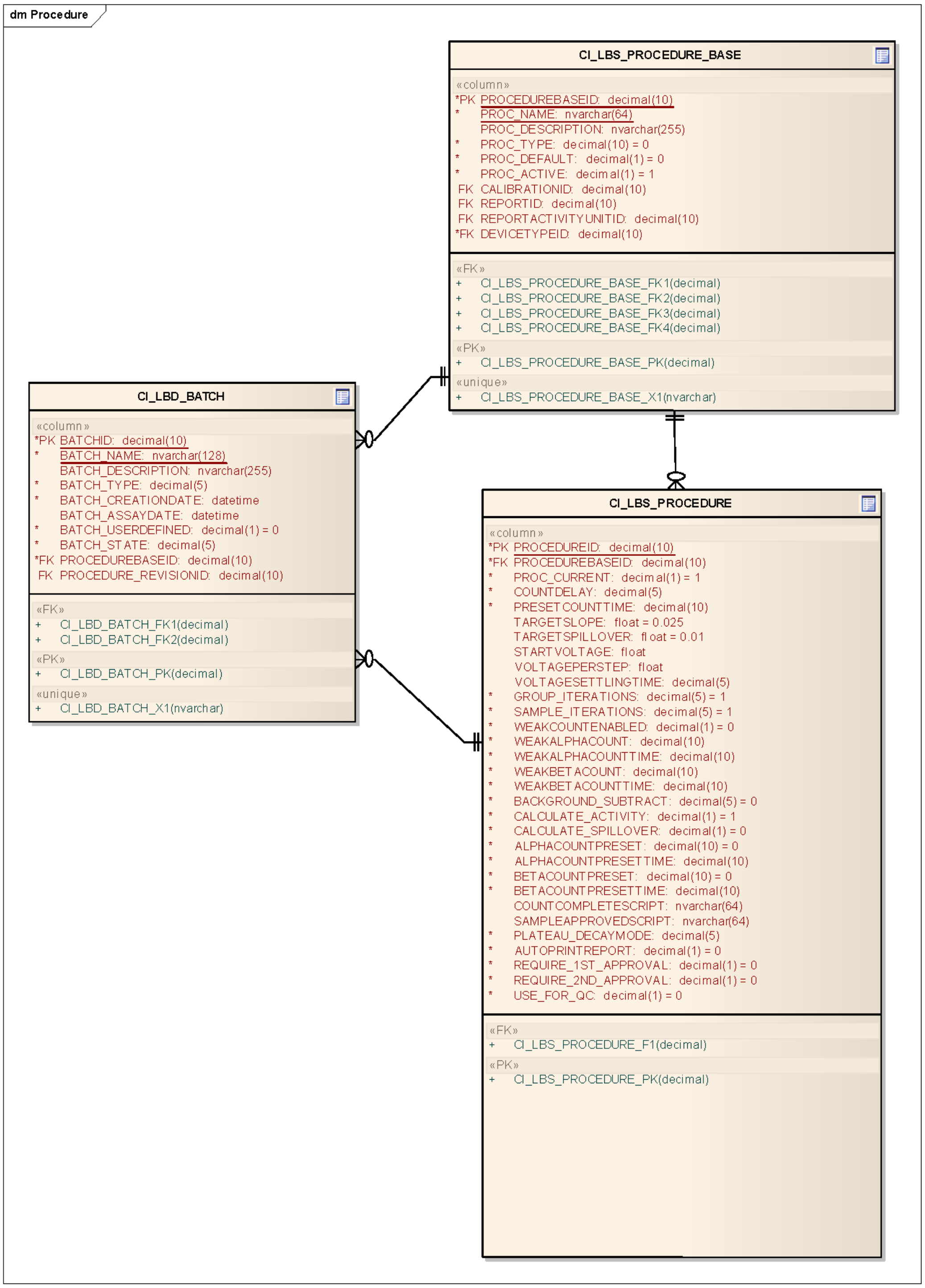

Figure 6 Procedure Data Model

Shared Table

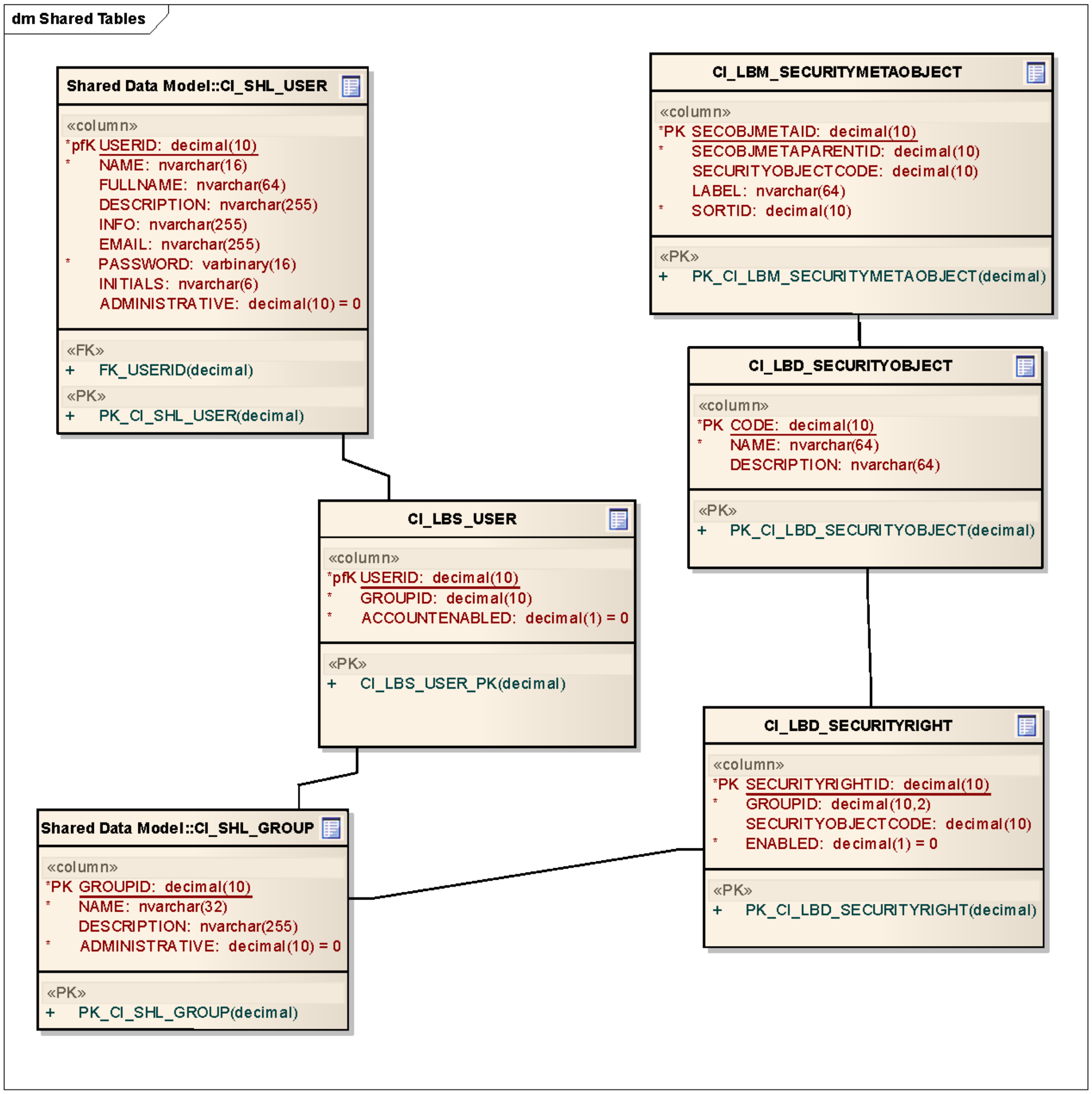

Figure 7 Shared Tables Data Model

Tables for Data Review

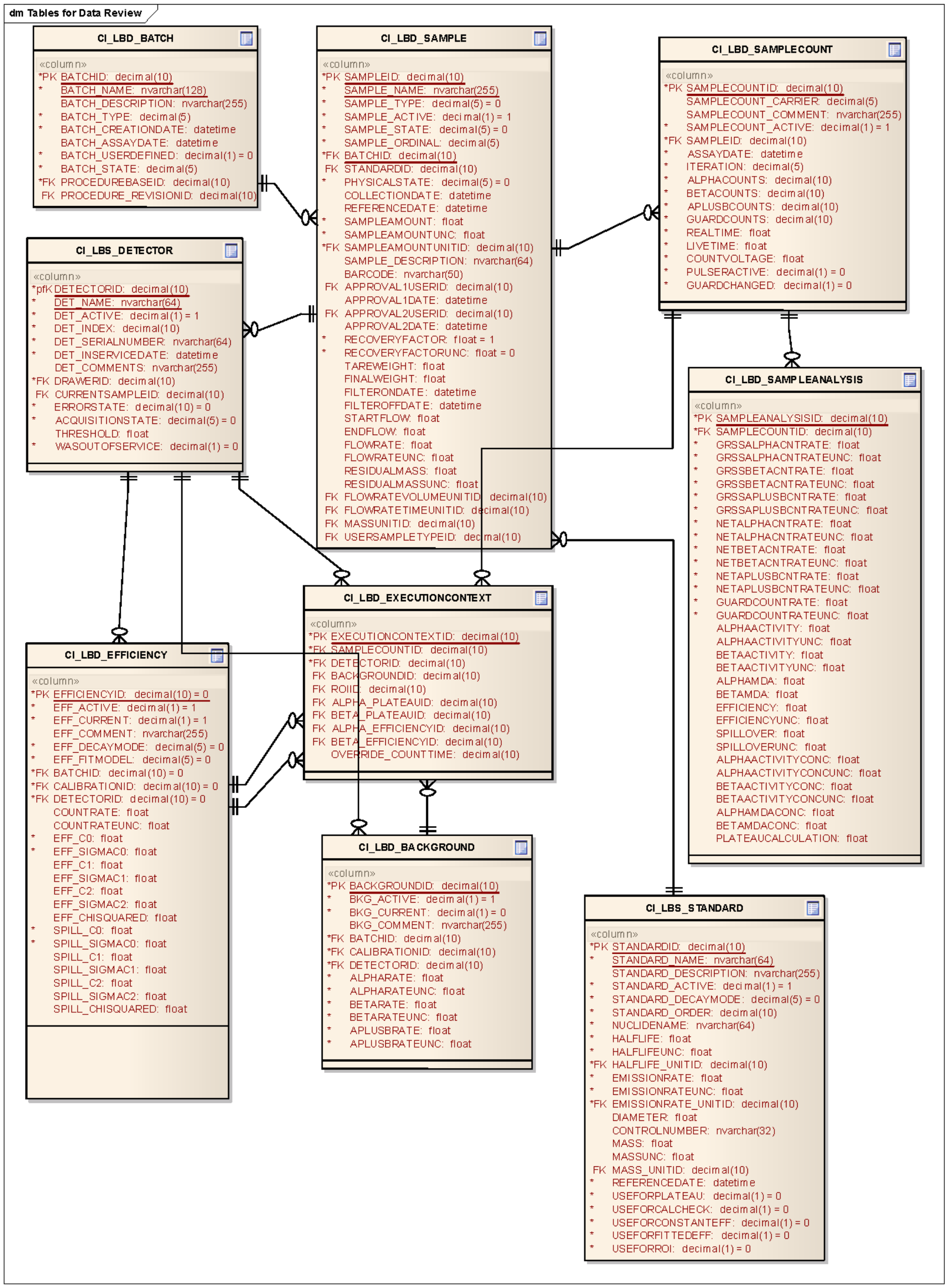

Figure 8 Tables for Data Review Data Model

TestData

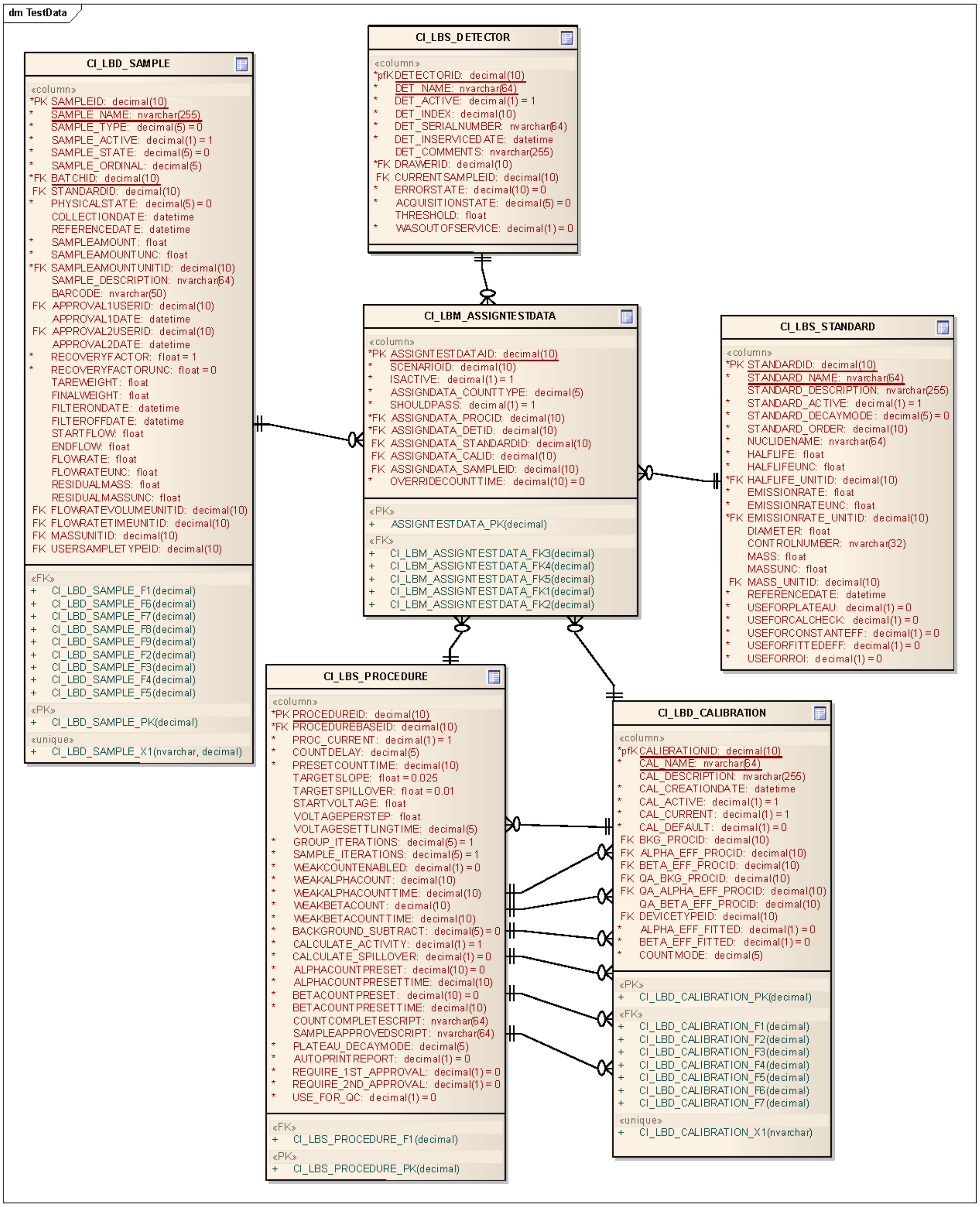

Figure 9 TestData Data Model

Customer/Sample Type

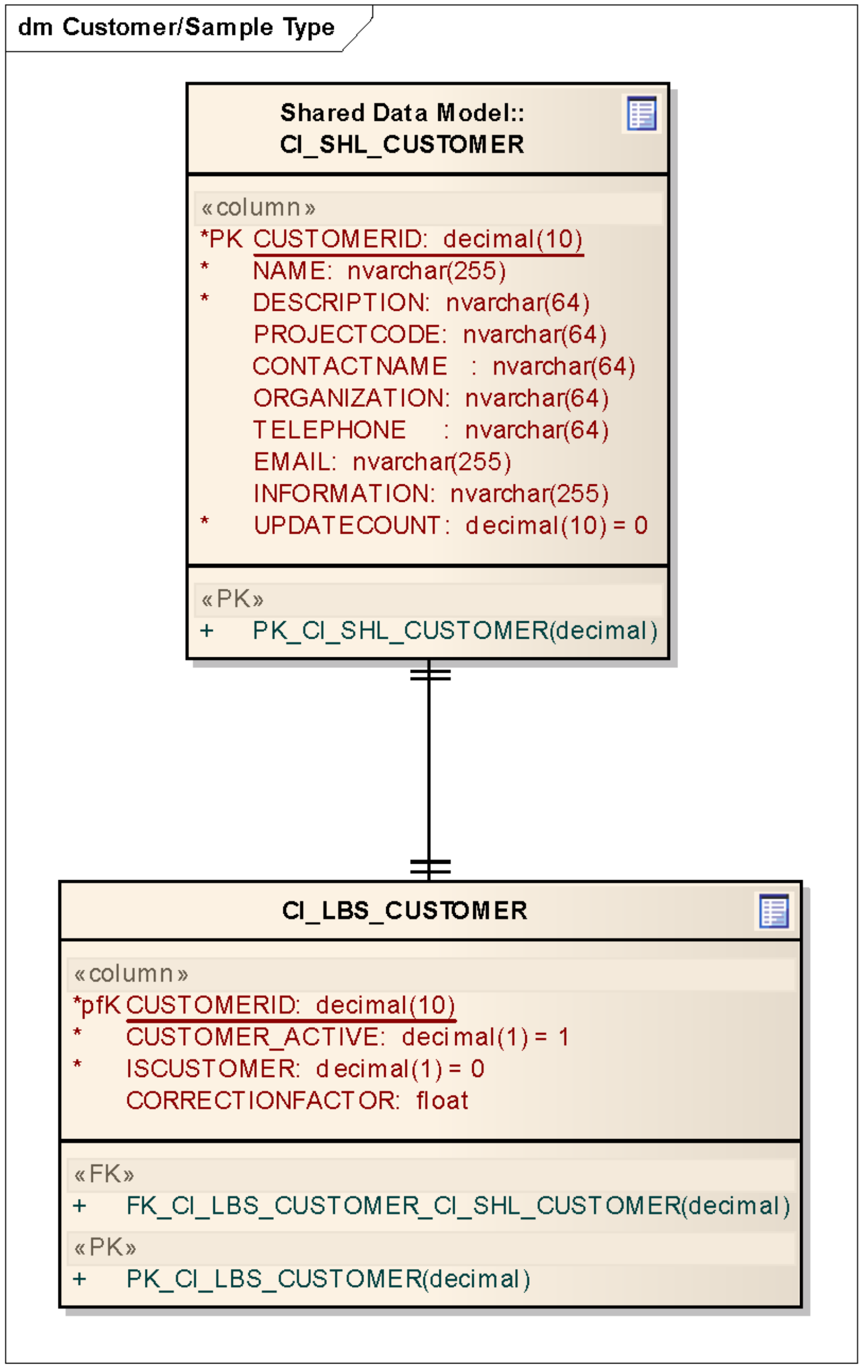

Figure 10 Customer/Sample Type Data Model

Tables for Sequences

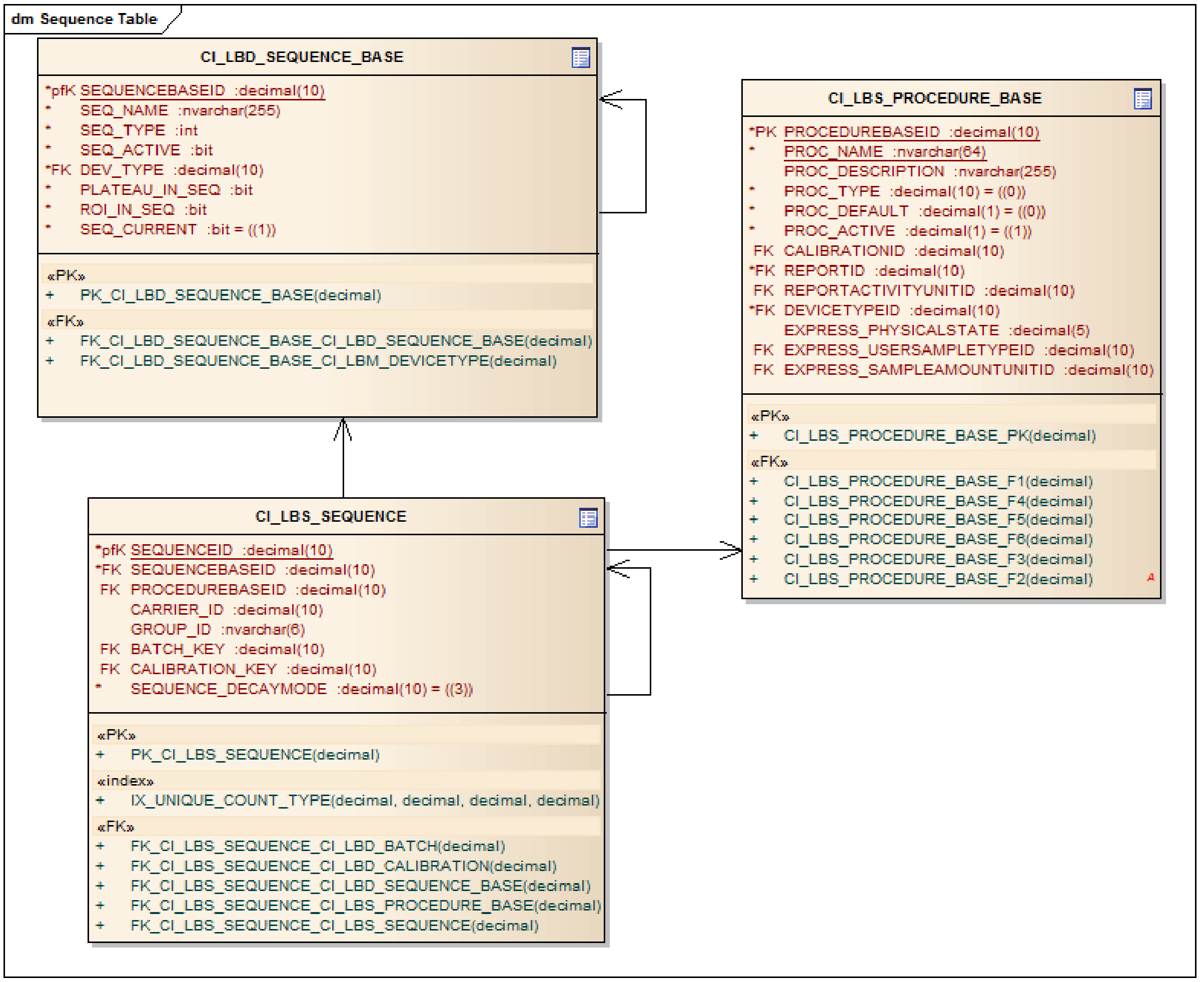

Figure 11 Sequences

CI_LBD_APPLICATIONDATA

Notes: Application Data Table. This holds settings that apply to the application as a whole such as the install path, version information and any needed runtime settings.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	FIELDID	decimal	True	True		10	0		
	NAME	nvarchar	True	True	255				Internal name for the application setting. This is not editable and is used internaly by the system.
	FIELDTYPE	varchar	True	True	1				Field Type Identifier. This code identifies a category for the setting.
	STRINGVAL1	nvarchar	False	False	255				If the setting contains a text value such as a file path or some name, this field is used to store that data
	LONGVAL1	decimal	False	False		10	0		If the setting contains a numeric value, this field is used to store that data.
	DOUBLEVAL1	float	False	False		53			If the setting contains a double value, this field is used to store that data.
	DATETIMEVAL	datetime	False	False					If the setting contains a date value, this field is used to store that data
	STRINGVAL2	nvarchar	False	False	255				If the setting needs to store some additional text value, this field is used to store that data.
	LONGVAL2	decimal	False	False		10	0		If the setting needs to store some additional numeric value, this field is used to store that data.
	DOUBLEVAL2	float	False	False		53			If the setting needs to store some additional double value, this field is used to store that data.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_APPLICATIONDATA_PK	Primary Key	FIELDID	
CI_LBD_APPLICATIONDATA_X1	Unique	NAME,FIELDTYPE	

CI_LBD_APPLICATIONLOG

Notes: Application Event Data. This holds the data for events that are audited.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EVENTID	decimal	True	True		10	0		Event ID. This is a unique identifier created by the system. This is automatically generated by the system and is not editable.
	CREATIONDATE	datetime	True	False				getdata()	Date the event occurred.
	EVENT_META_ID	decimal	True	False		10	0		Event Meta ID. A reference to the specific event that occurred.
	COMPUTERNAME	nvarchar	True	False	32				The Windows Network name of the computer on which the event occurred, or for server based events dealing with detectors, it would be the remote computer name on which the detector is defined.
	DETECTOR_NAME	nvarchar	False	False	64				The name of the detector being used when the event occurred. This is only filled in for applicable events.
	USER_NAME	nvarchar	False	False	16				The name of the user associated with the event. Not every event has an associated user.
	LPARAM1	decimal	False	False		10	0		Event-specific numeric data.
	LPARAM2	decimal	False	False		10	0		Event-specific numeric data.
	TEXTPARAM1	nvarchar	False	False	255				Event-specific text data. In general, this is used to specify the DLL or module which generated the event.
	TEXTPARAM2	nvarchar	False	False	1024				Event-specific text data. In general, this is a description of the event.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EVENT_TYPE	varchar	True	False	1			'A'	An event code particular to the event being raised. For example E might indicate an error type. But generally the event type is determined by looking up the type in the Application Event Type table (CI_LBM_APPLICATIONEVENTTYPE).
	ERROR_CODE	decimal	False	False		10	0		Error Code. For error events, this is the internal system error code. It is used for product support purposes to help further identify the exact error that occurred.
	SAMPLE_NAME	nvarchar	False	False	255				If an event occurs during sample processing, the sample name is recorded in this field.
	PROCEDURE_NAME	nvarchar	False	False	64				The name of the procedure associated with the event.
	CALIBRATION_NAME	nvarchar	False	False	64				The name of the calibration associated with the event.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(EVENT_META_ID = EVENT_META_ID)	CI_LBD_APPLICATIONLOG.CI_LBD_APPLICATIONLOG_F1 CI_LBM_APPLICATIONEVENT.CI_LBM_APPLICATIONEVENT_PK	CI_LBM_APPLICATIONEVENT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_APPLICATIONLOG_PK	Primary Key	EVENTID	
CI_LBD_APPLICATIONLOG_X1	Non Unique	EVENT_META_ID	

CI_LBD_BACKGROUND

Notes: Holds a record of Background and Background Checks the have performed for a detector and calibration.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BACKGROUNDID	decimal	True	True		10	0		
	BKG_ACTIVE	decimal	True	False		1	0	(1)	
	BKG_CURRENT	decimal	True	False		1	0	(0)	Indicates whether this is current background or not
	BKG_COMMENT	nvarchar	False	False	255				
	BATCHID	decimal	True	False		10	10		
	CALIBRATIONID	decimal	True	False		10	0		
	DETECTORID	decimal	True	False		10	0		FK to the detector this efficiency applies to
	ALPHARATE	float	True	False		53			
	ALPHARATEUNC	float	True	False		53			
	BETARATE	float	True	False		53			
	BETARATEUNC	float	True	False		53			
	APLUSBRATE	float	True	False		53			
	APLUSBRATEUNC	float	True	False		53			
	GAMMARATE	float	False	False		53			
	GAMMARATEUNC	float	False	False		53			
	CHILD_BACKGROUNDID	decimal				10	0		not used originally planned for use with the gamma option
	MANUAL_REFERENCE_DATE	date/time	False	False		10	0		not used originally planned for use with the gamma option

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	MANUAL_BACKGROUNDID	decimal	False	False		10	0		This is a reference to the actual counted background(if any),when using manual backgrounds

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(BATCHID = BATCHID)	CI_LBD_BACKGROUND_F1 CI_LBD_BATCH_PK	CI_LBD_BATCH	
(CALIBRATIONID = CALIBRATIONID)	CI_LBD_BACKGROUND_F2 CI_LBD_CALIBRATION_PK	CI_LBD_CALIBRATION	
(DETECTORID = DETECTORID)	CI_LBD_BACKGROUND_F3 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(CHILD_BACKGROUNDID = BACKGROUNDID)	CI_LBD_BACKGROUND_F4 CI_LBD_BACKGROUND_PK	CI_LBD_BACKGROUND	
(MANUAL_BACKGROUNDID = MANUAL_BACKGROUNDID)	CI_LBD_BACKGROUND_F5 CI_LBD_MANUAL_BACKGROUND_PK	CI_LBD_MANUAL_BACKGROUND	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_BACKGROUND_PK	Primary Key	BACKGROUNDID	
CI_LBD_BACKGROUND_X1	Non Unique	BATCHID	
CI_LBD_BACKGROUND_X2	Non Unique	CALIBRATIONID	
CI_LBD_BACKGROUND_X3	Non Unique	DETECTORID	

CI_LBD_BATCH

Notes: The Batch Table holds the the information about each batch of samples to be counted. All samples must belong to a batch and each batch must have a procedure which specifies how the batch should be counted, analyzed, reviewed, etc.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BATCHID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	BATCH_NAME	nvarchar	False	False	255				Name of the batch
	BATCH_DESCRIPTION	nvarchar	False	False	255				General description or detail information about the batch.
	BATCH_TYPE	decimal	True	False		5	0		Mapped to enumeration CountType
	BATCH_CREATIONDATE	datetime	True	False					The date/time the batch was created in the system.
	BATCH_ASSAYDATE	datetime	False	False					The date/time the first sample in the batch started counting.
	BATCH_USERDEFINED	decimal	True	False		1	0	(0)	If true, indicates that the batch was defined by a user, rather than automatically through a calibration procedure.
	BATCH_STATE	decimal	True	False		5	0		One of {Defined, Queued, Assigned, Counting, Counted, Analyzing, Completed}
	PROCEDUREBASEID	decimal	False	False		10	0		The ID of the base procedure that is used to count a batch.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PROCEDURE_REVISIONID	decimal	False	False		10	0		The key to procedure revision used for the batch. To identify the procedure completely we need to know what revision of a procedure was used when the batch was counted. All samples in a batch must use the same procedure revision. The procedure revision is left as null when the batch is created, however it will be set when the first sample is assigned to a chamber (the most recent revision of the procedure is taken).
	DETECTORID	decimal	False	False		10	0		Foreign key to Detector table. This is only used for Fitted Efficiency batches. It indicates the target detector for the Batch.
	SEQUENCEBASEID	decimal	False	False		10	0		Foreign key to the sequence name used for this batch, null if not part of a sequence.
	SEQUENCEREVISIONID	decimal	False	False		10	0		Foreign key to the sequence elements used by this batch.
	TEMPLATEBATCH	bit	True	False				(0)	Originally designed for use with super sequences, currently not used.
	GROUP_ID	nvarchar	False	False	6				For sample changers, this is the sample changer group the batch will be counted on.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	ASSIGNMENT_ID	decimal	False	False		10	0		This is a unique id for sample changers that binds an assignment together to a particular detector group. If the assignment is part of a sequence, all batches in the sequence will have the same assignment id. If not part of sequence, this batch alone will have the assignment id.
	BATCH_REVISION	decimal				10	0	(1)	The current batch revision number which is displayed in data review.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(PROCEDUREBASEID = PROCEDUREBASEID)	CI_LBD_BATCH_F1 CI_LBS_PROCEDURE_BASE_PK	CI_LBS_PROCEDURE_BASE	
(PROCEDURE_REVISIONID = PROCEDUREID)	CI_LBD_BATCH_F2 CI_LBS_PROCEDURE_F2	CI_LBS_PROCEDURE	
(PROCEDUREBASEID = PROCEDUREBASEID)	CI_LBD_BATCH_F2 CI_LBS_PROCEDURE_F2	CI_LBS_PROCEDURE	
(DETECTORID = DETECTORID)	CI_LBD_BATCH_F3 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_BATCH_PK	Primary Key	BATCHID	
CI_LBD_BATCH_X4	Non Unique	ASSIGNMENT_ID	([ASSIGNMENT_ID] IS NOT NULL)
CI_LBD_BATCH_X2	Non Unique	PROCEDUREBASEID	
CI_LBD_BATCH_X3	Non Unique	PROCEDURE_REVISIONID	
CI_LBD_BATCH_X5	Non Unique	DETECTORID	([DETECTOR_ID] IS NOT NULL)

CI_LBD_BATCH_REVISIONS

Notes: The Batch Revision Table contains a history of the revisions for the batch from data review. If no entries for the batch are contained in this table, then the batch has not been revised.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BATCHID	decimal	True	True		10	0		Foreign Key to CI_LBD_BATCH table
	BATCH_REVISION	decimal	True	True		10	0		The revision number of the batch (1,2,3) etc.
	CREATIONDATE	datetime	True	False				getdate()	The creation date of the batch revision.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete

Indexes

Name	Type	Columns	Filter Definition

CI_LBD_CALIBRATION

Notes: Contains a record for each calibartion defined for the system. This describes the count mode, efficiency type and procedures used for the calibration.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CALIBRATIONID	decimal	True	True			10	0	
	CAL_NAME	nvarchar	True	True	64				
	CAL_DESCRIPTION	nvarchar	False	False	255				
	CAL_CREATIONDATE	datetime	True	False					
	CAL_ACTIVE	decimal	True	False		1	0	(1)	
	CAL_CURRENT	decimal	True	False		1	0	(1)	
	CAL_DEFAULT	decimal	True	False		1	0	(0)	
	BKG_PROCID	decimal	False	False		10	0		
	ALPHA_EFF_PROCID	decimal	False	False		10	0		
	BETA_EFF_PROCID	decimal	False	False		10	0		
	QA_BKG_PROCID	decimal	False	False		10	0		
	QA_ALPHA_EFF_PROCID	decimal	False	False		10	0		
	QA_BETA_EFF_PROCID	decimal	False	False		10	0		
	DEVICETYPEID	decimal	Fals	False		10	0		
	ALPHA_EFF_FITTED	decimal	True	False		1	0	(0)	If true, indicates that the alpha efficiency associated with a calibration is fitted rather than constant.
	BETA_EFF_FITTED	decimal	True	False		1	0	(0)	If true, indicates that the beta efficiency associated with a calibration is fitted rather than constant.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	COUNTMODE	decimal	True	False		5	0		The count mode for this calibration. Possible values are AlphaOnly, Simultaneous, or AlphaThenBeta.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DEVICETYPEID = DEVICETYPEID)	CI_LBD_CALIBRATION_F1 CI_LBM_DEVICETYPE_PK	CI_LBM_DEVICETYPE	
(BKG_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F2 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(ALPHA_EFF_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F3 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(BETA_EFF_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F4 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(QA_BKG_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F5 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(QA_ALPHA_EFF_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F6 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(QA_BETA_EFF_PROCID = PROCEDUREID)	CI_LBD_CALIBRATION_F7 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_CALIBRATION_PK	Primary Key	CALIBRATIONID	
CI_LBD_CALIBRATION_X1	Unique	CAL_NAME	
CI_LBD_CALIBRATION_X2	Non Unique	BKG_PROCID	
CI_LBD_CALIBRATION_X3	Non Unique	ALPHA_EFF_PROCID	
CI_LBD_CALIBRATION_X4	Non Unique	QA_BETA_EFF_PROCID	
CI_LBD_CALIBRATION_X5	Non Unique	QA_BKG_PROCID	
CI_LBD_CALIBRATION_X6	Non Unique	QA_ALPHA_EFF_PROCID	
CI_LBD_CALIBRATION_X7	Non Unique	QA_BETA_EFF_PROCID	
CI_LBD_CALIBRATION_X8	Non Unique	DEVICETYPEID	

CI_LBD_EFFICIENCY

Notes: Holds a record of Efficiency and Calibration Checks the have performed for a detector and calibration.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EFFICIENCYID	decimal	True	True		10	0	0	
	EFF_ACTIVE	decimal	True	False		1	0	(1)	
	EFF_CURRENT	decimal	True	False		1	0	(1)	
	EFF_COMMENT	nvarchar	False	False	255				
	EFF_DECAYMODE	decimal	True	False		5	0	(0)	The decay mode for an efficiency. Possible values are Alpha, Beta, and Gamma.
	EFF_FITMODEL	decimal	True	False		5	0		The fit model for an efficiency. Possible values are Constant, InverseLinear, Linear, Exponential, InverseQuadratic.
	BATCHID	decimal	True	False		10	0		
	CALIBRATIONID	decimal	True	False		10	0		
	DETECTORID	decimal	True	False		10	0		FK to the detector this efficiency applies to
	EFF_C0	float	True	False		53			Coefficient 0 (for constant efficiency this is the efficiency)
	EFF_SIGMAC0	float	True	False		53			
	EFF_C1	float	False	False		53			
	EFF_SIGMAC1	float	False	False		53			
	EFF_C2	float	False	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EFF_SIGMAC2	float	False	False		53			
	EFF_CHISQUARED	float	False	False		53			
	SPILL_C0	float	True	False		53			C0 term for fitted spillover, for constant efficiency this is the spillover value.
	SPILL_SIGMAC0	float	True	False		53			
	SPILL_C1	float	False	False		53			
	SPILL_SIGMAC1	float	False	False		53			
	SPILL_C2	float	False	False		53			
	SPILL_SIGMAC2	float	False	False		53			
	SPILL_CHISQUARED	float	False	False		53			
	COUNTRATE	float	True	False		53			Average count rate for all iterations of sample count. Will be null for fitted efficiencies.
	COUNTRATEUNC	float	False	False		53			Average count rate uncertainty based on all iterations of sample count. Will be null for fitted efficiencies.
	CHILD_EFFICIENCYID	decimal				10	0		
	MANUAL_EFFICIENCYID	decimal				10	0		This is a reference to the actual counted efficiency(if any), when using manual calibration.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(BATCHID = BATCHID)	CI_LBD_EFFICIENCY_F1 CI_LBD_BATCH_PK	CI_LBD_BATCH	
(CALIBRATIONID = CALIBRATIONID)	CI_LBD_EFFICIENCY_F2 CI_LBD_CALIBRATION_PK	CI_LBD_CALIBRATION	
(DETECTORID = DETECTORID)	CI_LBD_EFFICIENCY_F3 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(CHILD_EFFICIENCYID = EFFICIENCYID)	CI_LBD_EFFICIENCY_F4 CI_LBD_EFFICIENCY_PK	CI_LBD_EFFICIENCY	
(MANUAL_EFFICIENCYID = MANUAL_EFFICIENCYID)	CI_LBD_EFFICIENCY_F5 CI_LBD_MANUAL_EFFICIENCY_PK	CI_LBD_MANUAL_EFFICIENCY	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_EFFICIENCY_PK	Primary Key	EFFICIENCYID	
CI_LBD_EFFICIENCY_X1	Non Unique	BATCHID	
CI_LBD_EFFICIENCY_X2	Non Unique	CALIBRATIONID	
CI_LBD_EFFICIENCY_X3	Non Unique	DETECTORID	

CI_LBD_EXECUTIONCONTEXT

Notes: Stores a snapshot of the system when count started. Will be populated on when a count is started with current calibration and hardware setup for detector sample is being counted on.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EXECUTIONCONTEXTID	decimal	True	True		10	0		
	SAMPLECOUNTID	decimal	True	False		10	0		
	DETECTORID	decimal	True	False		10	0		
	BACKGROUNDID	decimal	False	False		10	0		
	ROIID	decimal	False	False		10	0		
	ALPHA_PLATEAUID	decimal	False	False		10	0		
	BETA_PLATEAUID	decimal	False	False		10	0		
	ALPHA_EFFICIENCYID	decimal	False	False		10	0		
	BETA_EFFICIENCYID	decimal	False	False		10	0		
	OVERRIDE_COUNTTIME	decimal	False	False		10	0		
	GAMMA_PLATEAUID	decimal	False	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	CI_LBD_EXECUTIONCONEXT_F8 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(SAMPLECOUNTID = SAMPLECOUNTID)	CI_LBD_EXECUTIONCONTEXT_F1 CI_LBD_SAMPLECOUNT_PK	CI_LBD_SAMPLECOUNT	✓
(BACKGROUNDID = BACKGROUNDID)	CI_LBD_EXECUTIONCONTEXT_F2 CI_LBD_BACKGROUND_PK	CI_LBD_BACKGROUND	
(ROIID = ROIID)	CI_LBD_EXECUTIONCONTEXT_F3 CI_LBD_ROI_PK	CI_LBD_ROI	
(ALPHA_PLATEAUID = PLATEAUID)	CI_LBD_EXECUTIONCONTEXT_F4 CI_LBD_PLATEAU_PK	CI_LBD_PLATEAU	
(BETA_PLATEAUID = PLATEAUID)	CI_LBD_EXECUTIONCONTEXT_F5 CI_LBD_PLATEAU_PK	CI_LBD_PLATEAU	
(ALPHA_EFFICIENCYID = EFFICIENCYID)	CI_LBD_EXECUTIONCONTEXT_F6 CI_LBD_EFFICIENCY_PK	CI_LBD_EFFICIENCY	
(BETA_EFFICIENCYID = EFFICIENCYID)	CI_LBD_EXECUTIONCONTEXT_F7 CI_LBD_EFFICIENCY_PK	CI_LBD_EFFICIENCY	
(GAMMA_PLATEAUID = PLATEAUID)	CI_LBD_EXECUTIONCONTEXT_F8 CI_LBD_PLATEAU_PK	CI_LBD_PLATEAU	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_EXECUTIONCONTEXT_PK	Primary Key	EXECUTIONCONTEXTID	
CI_LBD_EXECUTIONCONTEXT_X1	Non Unique	BACKGROUNDID	
CI_LBD_EXECUTIONCONTEXT_X2	Non Unique	SAMPLECOUNTID	
CI_LBD_EXECUTIONCONTEXT_X3	Non Unique	ALPHA_EFFICIENCYID	
CI_LBD_EXECUTIONCONTEXT_X4	Non Unique	BETA_EFFICIENCYID	
CI_LBD_EXECUTIONCONTEXT_X5	Non Unique	DETECTORID	
CI_LBD_EXECUTIONCONTEXT_X6	Non Unique	ALPHA_PLATEAUID	
CI_LBD_EXECUTIONCONTEXT_X7	Non Unique	BETA_PLATEAUID	
CI_LBD_EXECUTIONCONTEXT_X8	Non Unique	ROIID	
CI_LBD_EXECUTIONCONTEXT_X9	Non Unique	OVERRIDE_COUNTTIME	

CI_LBD_GAMMAROI

Notes: This sample contains gamma discriminators for the series 5 with gamma option, for a plateau it should bound the peak..

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	GAMMAROIID	decimal	True	True		10	0	(1)	Primary Key
	ROI_ACTIVE	decimal	True	False		1	0	(1)	Boolean 1 if active zero if inactive
	ROI_CURRENT	decimal	True	False		1	0		Boolean 1 if current zero if not current (only one value can be current per detector)
	ROI_COMMENT	nvarchar	False	False	255				
	CREATIONDATE	datetime	True	False		1			
	DETECTORID	decimal	True	False		10	0		Detector for which this region of interest is associated.
	GAMMA_LOWER_LEVEL	float	True	False		53			Gamma lower level discriminator
	GAMMA_UPPER_LEVEL	float	True	False		53			Gamma upper level discriminator

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	CI_LBD_GAMMAROI_F1 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_GAMMAROI_PK	Primary Key	GAMMAROIID	

CI_LBD_IDENITY

Notes: Identity Table. This table is used by database components to generate unique identifiers for tables with an ID column. The use of this table provides a common approach for all supported database platforms. It keeps track of the next ID value for each table that needs one.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	TABLENAME	varchar	True	True	32				Table this record is associated with
	IDENTITYVALUE	decimal	True	False		10	0	(0)	Current identity value for this table

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_AAD_IDENTITY_PK	Primary Key	TABLENAME	

CI_LBD_MANUAL_BACKGROUND

Notes: This table contains manual calibration information for the manual calibration screen.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	MANUAL_BACKGROUNDID	decimal	True	True		10	0		Primary key for manual background table.
	ALPHARATE	float	False	False		53			
	ALPHARATEUNC	float	False	False		53			
	BETARATE	float	False	False		53			
	BETARATEUNC	float	False	False		53			
	GAMMARATE	float	False	False		53			
	GAMMARATEUNC	float	False	False		53			

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_MANUAL_BACKGROUND_PK	Primary Key	MANUAL_BACKGROUNDID	

CI_LBD_MANUAL_Efficiency

Notes: This table contains manual efficiency information for the manual calibration screen.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	MANUAL_EFFICIENCYID	decimal	True	True		10	0		
	EFF_C0	float	False	False		53			
	EFF_SIGMAC0	float	False	False		53			
	EFF_C1	float	False	False		53			
	EFF_SIGMAC1	float	False	False		53			
	EFF_C2	float	False	False		53			
	EFF_SIGMAC2	float	False	False		53			
	SPILL_C0	float	False	False		53			
	SPILL_SIGMAC0	float	False	False		53			
	SPILL_C1	float	False	False		53			
	SPILL_SIGMAC1	float	False	False		53			
	SPILL_C2	float	False	False		53			
	SPILL_SIGMAC2	float	False	False		53			
	SPILL_CHISQUARED	float	False	False		53			
	EFF_FITMODEL	decimal	False	False		5	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_MANUAL_EFFICIENCY_PK	Primary Key	MANUAL_EFFICIENCYID	

CI_LBD_PLATEAU

Notes: Holds a record of plateaus defined for each drawer in the system.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PLATEAUID	decimal	True	True		10	0		Primary key
	PLATEAU_NAME	nvarchar	True	True	64				
	PLATEAU_CURRENT	decimal	True	False		1	0	(1)	Indicates whether or not this is the current plateau for a specified drawer
	PLATEAU_DECAYMODE	decimal	True	False		10	0		Alpha, Beta, Gamma
	PLATEAU_STATE	decimal	True	False		5	0	(0)	
	GUARD	decimal	True	False		1	0	(0)	The type of plateau (Sample Detector or Guard)
	DRAWERID	decimal	True	False		10	0		
	OPERATINGVOLTAGE	float	True	False		53			The operating voltage for this plateau
	CALCULATIONDATE	datetime	True	False					The date this plateau was created
	CALCULATEDVOLTAGE	float	True	False		53			The operating voltage calculated by the system for this plateau.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DRAWERID = DRAWERID)	CI_LBD_PLATEAU_F1 CI_LBS_DRAWER_PK	CI_LBS_DRAWER	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_PLATEAU_PK	Primary Key	PLATEAUID	
CI_LBD_PLATEAU_X1	Unique	PLATEAU_NAME	
CI_LBD_PLATEAU_X2	Non Unique	DRAWERID	

CI_LBD_ROI

Notes: Stores descriminator settings used to define regions when counting in Simultaneous count mode.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	ROIID	decimal	True	True		10	0		
	ROI_NAME	nvarchar	True	False	64				
	ROI_ACTIVE	decimal	True	False		1	0	(1)	
	ROI_CURRENT	decimal	True	False		1	0	(1)	
	ROI_COMMENT	nvarchar	False	False	225				
	CREATIONDATE	datetime	True	False					The date this ROI record was created. Should be initailized to current date time when ROI created.
	BATCHID	decimal	True	False		10	0		
	DETECTORID	decimal	True	False		10	0		
	BETA_LOWER_LEVEL	float	True	False		53			
	BETA_UPPER_LEVEL	float	True	False		53			
	ALPHA_LOWER_LEVEL	float	True	False		53			
	ALPHA_UPPER_LEVEL	float	True	False		53			
	GUARD_LOWER_LEVEL	float	True	False		53			
	BETA_LOSS	float	False	False		53			
	BETA_LOSS_ACCURACY	float	False	False		53			
	BA_SPILLOVER	float	False	False		53			
	BA_ACCURACY	float	False	False		53			

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	CI_LBD_ROI_F1 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(BATCHID = BATCHID)	CI_LBD_ROI_F2 CI_LBD_BATCH_PK	CI_LBD_BATCH	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_ROI_PK	Primary Key	ROIID	
CI_LBD_ROI_X2	Non Unique	BATCHID	
CI_LBD_ROI_X3	Non Unique	DETECTORID	

CI_LBD_SAMPLE

Notes: This is the main sample view to which all sample information corresponds. It contains the current revision of a sample for each physical sample. A sample record is defined for each physical sample that needs to be counted. This table retains references to things like the detector the sample was counted in, the batch to which it belongs and the execution context.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SAMPLEID	decimal	False	False		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	SAMPLE_NAME	nvarchar	True	True	255				Descriptive Name of the sample. If this is a shared sample, then the description shown on forms and reports will come from the CI_SHL_SAMPLESHARE table, so when the user is ompleting the definition of a shared sample, they should not be able to edit this field.
	SAMPLE_TYPE	decimal	True	False		5	5		This specifies if the sample is a QA sample type or anunknown sample. Values are: Unknown, Spike, Duplicate, LaboratoryControl, MethodBlank, EfficiencyCal, SystemBackground, BackgroundCheck, CalibratinoCheck, ...
	SAMPLE_ACTIVE	decimal	True	False		1	0		If not true, this field indicates the results from this sample should be ignored in reports and calculations.
	SAMPLE_STATE	decimal	True	False		5	0		The current sample state.
	SAMPLE_ORDINAL	decimal	True	False		5	0		For autoBatch : the index of the sample in the batch For other batches: is User defined

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BATCHID	decimal	True	True		10	0		The ID of the batch to which a sample belongs.
	STANDARDID	decimal	False	False		10	0		For calibration samples, this is the ID of the standard on which the sample is based.
	PHYSICALSTATE	decimal	True	False		5	0	(0)	One of (Swipe/Smear, Filter, Solid, Liquid)
	COLLECTIONDATE	datetime	False	False					The date/time that the sample was collected.
	REFERENCEDATE	datetime	False	False					Reference date for decay correction.
	SAMPLEAMOUNT	float	True	False		53			Sample amount specified in SampleAmountUnits
	SAMPLEAMOUNTUNC	float	True	False		53			Sample Amount uncertainty
	SAMPLEAMOUNTUNITID	decimal	True	False		10	0		FK to sample amount units (see XLS for possible values)
	SAMPLE_DESCRIPTION	nvarchar	False	False	64				If this is a shared sample, then the description shown on forms and reports will come from the CI_SHL_SAMPLESHARE table, so when the user is completing the definition of a shared sample, they should not be able to edit this field.
	BARCODE	nvarchar	False	False	50				Barcode assigned to the sample
	APPROVAL1USERID	decimal	False	False		10	0		The user who provided the 1st approval for the sample in data review.
	APPROVAL1DATE	datetime	False	False					The date of the first approval
	APPROVAL2USERID	decimal	False	False		10	0		The user who provided the 2nd approval for the sample in data review.
	APPROVAL2DATE	datetime	False	False					The date of the second approval.
	RECOVERYFACTOR	float	True	False		53			External recovery factor, used to specify chemical yield.
	RECOVERYFACTORUNC	float	True	False		53			Error in recovery factor uncertainty.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	TAREWEIGHT	float	False	False		53			Weight/Mass of an empty planchet prior to adding sample (Solid/Liquid) Only
	FINALWEIGHT	float	False	False		53			Weight/Mass of a planchet after adding sample and any chemical processing. (solid/liquid only)
	FILTERONDATE	datetime	False	False					Date and time at the beginning of the sampling period.
	FILTEROFFDATE	datetime	False	False					Date and time at the end of the sampling period.
	STARTFLOW	float	False	False		53			Flow rate at the beginning of the sampling period.
	ENDFLOW	float	False	False		53			Flow rate at the end of the sampling period.
	FLOWRATE	float	False	False		53			For Filter samples. Specifies the total amount of the sample. calculated automatically.
	FLOWRATEUNC	float	False	False		53			For Filter samples. Specifies the total uncertainty of the sample. calculated automatically.
	RESIDUALMASS	float	False	False		53			The actual mass/weight of the sample to be analyzed.
	RESIDUALMASSUNC	float	False	False		53			The actual mass/weight uncertainty of the sample to be analyzed.
	FLOWRATEVOLUMNEUNITID	decimal	False	False		10	0		The volume unit associated with the Tare and Final Weight
	FLOWRATETIMEUNITID	decimal	False	False		10	0		
	MASSUNITID	decimal	False	False		10	0		
	USERSAMPLETYPEID	decimal	False	False		10	0		If true this sample was created by user through the batch screen, false it was auto created

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PRESETCOUNTTIME	decimal	False	False		10	0		This value is used in the sample assigner to override the procedure preset
	STANDARDID_EXCLUDE	bit	False	False					If this value is 1, then this sample is excluded from the normal database check that prevents samples in the assigned or counting state from having the same standard. This can occur during database upgrades or sample changer counting.
	SAMPLE_REVISION	decimal	True	False		10	0		
	PARENT_SAMPLE	decimal	False	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(BATCHID = BATCHID)	CI_LBD_SAMPLE_F1 CI_LBD_BATCH_PK	CI_LBD_BATCH	✓
(SAMPLEAMOUNTUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F2 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(STANDARDID = STANDARDID)	CI_LBD_SAMPLE_F3 CI_LBS_STANDARD_PK	CI_LBS_STANDARD	
(APPROVAL1USERID = USERID)	CI_LBD_SAMPLE_F4 CI_LBS_USER_PK	CI_LBS_USER	
(APPROVAL2USERID = USERID)	CI_LBD_SAMPLE_F5 CI_LBS_USER_PK	CI_LBS_USER	
(USERSAMPLETYPEID = CUSTOMERID)	CI_LBD_SAMPLE_F6 PK_CI_LBS_CUSTOMER_PK	CI_LBS_CUSTOMER	
(FLOWRATEVOLUMEUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F7 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	

(FLOWRATETIMEUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F8 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(MASSUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F9 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SAMPLE_PK	Primary Key	SAMPLEID	
CI_LBD_SAMPLE_X1	Unique	SAMPLE_NAME,BATCHID	
CI_LBD_SAMPLE_X2	Non Unique	BATCHID	
CI_LBD_SAMPLE_X3	Non Unique	STANDARDID	
IX_LBD_SAMPLE_X4_STANDARD	Unique	STANDARDID	(([SAMPLE_STATE] IN ((1), (2))) AND [STANDARDID] IS NOT NULL)

CI_LBD_SAMPLEANALYSIS

Notes: This is A VIEW for CI_LBD_SAMPLEANALYSIS_REVISIONS It contains the current analysis for a given sample.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SAMPLEANALYSISID	decimal	True	True		10	0		
	SAMPLECOUNTID	decimal	True	False		10	0		
	GRSSALPHACNTRATE	float	True	False		53			
	GRSSALPHACNTRATEUNC	float	True	False		53			
	GRSSBETACNTRATE	float	True	False		53			
	GRSSBETACNTRATEUNC	float	True	False		53			
	GRSSAPLUSBCNTRATE	float	True	False		53			
	GRSSAPLUSBCNTRATEUNC	float	True	False		53			
	NETALPHACNTRATE	float	True	False		53			
	NETALPHACNTRATEUNC	float	True	False		53			
	NETBETACNTRATE	float	True	False		53			
	NETBETACNTRATEUNC	float	True	False		53			
	NETAPLUSBCNTRATE	float	True	False		53			
	NETAPLUSBCNTRATEUNC	float	True	False		53			
	GUARDCOUNTRATE	float	True	False		53			
	GUARDCOUNTRATEUNC	float	True	False		53			
	ALPHAACTIVITY	float	False	False		53			
	ALPHAACTIVITYUNC	float	False	False		53			
	BETAACTIVITY	float	False	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BETAACTIVITYUNC	float	False	False		53			
	ALPHAMDA	float	False	False		53			
	BETAMDA	float	False	False		53			
	EFFICIENCY	float	False	False		53			
	EFFICIENCYUNC	float	False	False		53			
	SPILLOVER	float	False	False		53			
	SPILLOVERUNC	float	False	False		53			
	ALPHAACTIVITYCONC	float	False	False		53			
	ALPHAACTIVITYCONCUNC	float	False	False		53			
	BETAACTIVITYCONC	float	False	False		53			
	BETAACTIVITYCONCUNC	float	False	False		53			
	ALPHAMDACONC	float	False	False		53			
	BETAMDACONC	float	False	False		53			
	PLATEAUCALCULATION	float	False	False		53			
	ALPHADECISIONTHRESHOLD	float	False	False		53			
	ALPHABAYESIANBESTEST	float	False	False		53			
	ALPHABAYESIANBESTESTUNC	float	False	False		53			
	ALPHABAYESIANUPCONFLIM	float	False	False		53			
	ALPHABAYESIANLOWCONFLIM	float	False	False		53			
	ALPHACMAXWARNING	decimal	True	False		1	0		
	BETADECISIONTHRESHOLD	float	False	False		53			
	BETABAYESIANBESTEST	float	False	False		53			
	BETABAYESIANBESTESTUNC	float	False	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BETABAYESIANUPCONFLIM	float	False	False		53			
	BETABAYESIANLOWCONFLIM	float	False	False		53			
	BETACMAXWARNING	decimal	True	False		1	0		
	GRSSGAMMACNTRATE	float	False	False		53			
	GRSSGAMMACNTRATEUNC	float	False	False		53			
	NETGAMMACNTRATE	float	False	False		53			
	NETGAMMACNTRATEUNC	float	False	False		53			
	ISACTIVE	bit	True	False					
	ALPHAWARNING	bit	False	False		53			
	BETAWARNING	bit	False	False		53			
	REVISION_NUMBER	decimal	True	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete

CI_LBD_SAMPLEANALYSIS_REVISIONS

Notes: This table contains a record for an individual analysis performed on a given sample count.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SAMPLEANALYSISID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	SAMPLECOUNTID	decimal	True	False		10	0		The ID of the sample count to which an analysis belongs.
	GRSSALPHACNTRATE	float	True	False		53			Gross Alpha Count Rate in CPS
	GRSSALPHACNTRATEUNC	float	True	False		53			Gross Alpha Count Rate Uncertainty
	GRSSBETACNTRATE	float	True	False		53			Gross Beta Count Rate in CPS
	GRSSBETACNTRATEUNC	float	True	False		53			Gross Beta Count Rate Uncertainty
	GRSSAPLUSBCNTRATE	float	True	False		53			Gross Alpha Plus Beta Count Rate in CPS
	GRSSAPLUSBCNTRATEUNC	float	True	False		53			Gross Alpha Plus Beta Count Rate Uncertainty
	NETALPHACNTRATE	float	True	False		53			Net Alpha Count Rate in CPS
	NETALPHACNTRATEUNC	float	True	False		53			Net Alpha Count Rate Uncertainty
	NETBETACNTRATE	float	True	False		53			Net Beta Count Rate in CPS
	NETBETACNTRATEUNC	float	True	False		53			Net Beta Count Rate Uncertainty
	NETAPLUSBCNTRATE	float	True	False		53			Net Alpha Plus Beta Count Rate in CPS
	NETAPLUSBCNTRATEUNC	float	True	False		53			Net Alpha Plus Beta Count Rate Uncertainty
	GUARDCOUNTRATE	float	True	False		53			
	GUARDCOUNTRATEUNC	float	True	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	ALPHAACTIVITY	float	False	False		53			Alpha Activity in DPM
	ALPHAACTIVITYUNC	float	False	False		53			Alpha Activity Uncertainty
	BETAACTIVITY	float	False	False		53			Beta Activity in DPM
	BETAACTIVITYUNC	float	False	False		53			Beta Activity Uncertainty
	ALPHAMDA	float	False	False		53			Alpha MDA in DPM
	BETAMDA	float	False	False		53			Beta MDA in DPM
	EFFICIENCY	float	False	False		53			For samples analyzed as part of an efficiency procedure, this is the decimal representation of the efficiency.
	EFFICIENCYUNC	float	False	False		53			For samples analyzed as part of an efficiency procedure, this is the efficiency uncertainty.
	SPILLOVER	float	False	False		53			For samples analyzed as part of an efficiency procedure on a gasflow proportional counter, this is the decimal representation of the spillover into the opposite channel.
	SPILLOVERUNC	float	False	False		53			For samples analyzed as part of an efficiency procedure on a gasflow proportional counter, this is the spillover uncertainty.
	ALPHAACTIVITYCONC	float	False	False		53			
	ALPHAACTIVITYCONCUNC	float	False	False		53			
	BETAACTIVITYCONC	float	False	False		53			
	BETAACTIVITYCONCUNC	float	False	False		53			
	ALPHAMDACONC	float	False	False		53			
	BETAMDACONC	float	False	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PLATEAUCALCULATION	float	False	False		53			
	ALPHADECISIONTHRESHOLD	float	False	False		53			The decision threshold for Alpha, only calculated when MDA type = ISO 11929
	ALPHABAYESIANBESTEST	float	False	False		53			The best estimate of sample alpha activity based on Bayesian statistics
	ALPHABAYESIANBESTESTUNC	float	False	False		53			The uncertainty in ALPHABAYESIANBESTESTIMATE
	ALPHABAYESIANUPCONFLIM	float	False	False		53			The upper Bayesian Confidence Interval Limit for alpha
	ALPHABAYESIANLOWCONFLIM	float	False	False		53			The lower Bayesian Confidence Interval Limit
	ALPHACMAXWARNING	decimal	True	False		1	0	(0)	If performing ISO 11929 MDA this flag will be set if Alpha MDA > Cmax, this indicates the MDA value is diverging.
	BETADECISIONTHRESHOLD	float	False	False		53			The decision threshold for Beta, only calculated when MDA type = ISO 11929
	BETABAYESIANBESTEST	float	False	False		53			The best estimate of sample beta activity based on Bayesian statistics
	BETABAYESIANBESTESTUNC	float	False	False		53			The uncertainty in BETABAYESIANBESTESTIMATE
	BETABAYESIANUPCONFLIM	float	False	False		53			The upper Bayesian Confidence Interval Limit for beta
	BETABAYESIANLOWCONFLIM	float	False	False		53			The lower Bayesian Confidence Interval Limit for beta
	BETACMAXWARNING	decimal	True	False		1	0	(0)	If performing ISO 11929 MDA this flag will be set if Beta MDA > Cmax, this indicates the MDA value is diverging.
	GRSSGAMMACNTRATE	float	False	False		53			
	GRSSGAMMACNTRATEUNC	float	False	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	NETGAMMACNTRATE	float	False	False		53			
	NETGAMMACNTRATEUNC	float	False	False		53			
	ISACTIVE	bit	True	False				(1)	
	ALPHAWARNING	bit	False	False		53			If true the iso11929 engine has exceed its warning value
	BETAWARNING	bit	False	False		53			If true the iso11929 engine has exceed its warning value
	REVISION_NUMBER	decimal	True	False		10	0	(1)	Corresponds to the current batch revision in the CI_LBD_BATC_TABLE

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(SAMPLECOUNTID = SAMPLECOUNTID)	CI_LBD_SAMPLEANALYSIS_F1 CI_LBD_SAMPLECOUNT_PK	CI_LBD_SAMPLECOUNT	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SAMPLEANALYSIS_PK	Primary Key	SAMPLEANALYSISID	
CI_LBD_SAMPLEANALYSIS_X1	Non Unique	SAMPLECOUNTID	
CI_LBD_SAMPLEANALYSIS_X2	Unique	SAMPLECOUNTID,REVISION_NUMBER	

CI_LBD_SAMPLECOUNT

Notes: This table contains a record for an individual count that is performed on a given sample. When the user initiates an acquisition for a sample, a row is created in this table. If multiple counts iterations are performed for a given sample, then there would be multiple rows in this table for that sample.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SAMPLECOUNTID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	SAMPLECOUNT_CARRIER	decimal	False	False		5	0		For sample changer systems, this will be populated with the Carrier ID.
	SAMPLECOUNT_COMMENT	nvarchar	False	False	255				Field for user comment
	SAMPLECOUNT_ACTIVE	decimal	True	False		1	0	(1)	If not true, this field indicates the results from this sample count should be ignored in reports and calculations.
	SAMPLEID	decimal	True	False		10	0		The ID of the sample to which a sample count belongs.
	ASSAYDATE	Date/time	True	False					Date the sample sample counted occurred.
	ITERATION	decimal	True	False		5	0		For counts with multiple sample iterations, this column indicates the iteration number.
	ALPHACOUNTS	decimal	True	False		10	0		Raw alpha counts reported by the instrument.
	BETACOUNTS	decimal	True	False		10	0		Raw beta counts reported by the instrument.
	APLUSBCOUNTS	decimal	True	False		10	0		All counts (sum of alpha & beta) reported by the instrument.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	GUARDCOUNTS	decimal	True	False		10	0		Guard counts reported by the instrument.
	REALTIME	float	True	False		53			Elapsed real time for the sample count.
	LIVETIME	float	True	False		53			Elapsed instrument time for the sample count.
	COUNTVOLTAGE	float	True	False		53		(0)	The operating voltage used for this count.
	PULSERACTIVE	decimal	True	False		1	0	(0)	A value of 1 indicates that the test pulser was active during this sample count.
	GUARDCHANGED	decimal	True	False		1	0	(0)	A value of 1 indicates that the guard state was changed during this sample count.
	GAMMACOUNTS	decimal	False	False		10	0	(0)	
	AUXCOUNTVOLTAGE	float	False	False		53			
	IS_REJECTED	decimal	True	False		1	0	(0)	
	GAMMA_LOWER_LEVEL	float	False	False		53			
	GAMMA_UPPER_LEVEL	float	False	False		53			

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(SAMPLEID = SAMPLEID)	CI_LBD_SAMPLECOUNT_F1 CI_LBD_SAMPLE_PK	CI_LBD_SAMPLE_REVISIONS	✓

Column Constraint Information

Columns	Constraint Name	Rule
IS_REJECTED	CHK_REJECTED	([IS_REJECTED]=(1) OR [IS_REJECTED]=(0))

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SAMPLECOUNT_PK	Primary Key	SAMPLECOUNTID	
CI_LBD_SAMPLECOUNT_X1	Non Unique	SAMPLEID	
CI_LBD_SAMPLECOUNT_X2	Non Unique	COUNTVOLTAGE,SAMPLECOUNTID,SAMPLEID	

CI_LBD_SAMPLE_REVISIONS

Notes: This is the main sample table to which all sample information corresponds. It contains all revisions of a sample for each physical sample. A sample record is defined for each physical sample that needs to be counted. This table retains references to things like the detector the sample was counted in, the batch to which it belongs and the execution context.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SAMPLEID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	SAMPLE_NAME	nvarchar	True	True	255				Descriptive Name of the sample. If this is a shared sample, then the description shown on forms and reports will come from the CI_SHL_SAMPLESHARE table, so when the user is ompleting the definition of a shared sample, they should not be able to edit this field.
	SAMPLE_TYPE	decimal	True	False		5	5	(0)	This specifies if the sample is a QA sample type or anunknown sample. Values are: Unknown, Spike, Duplicate, LaboratoryControl, MethodBlank, EfficiencyCal, SystemBackground, BackgroundCheck, CalibratinoCheck, ...
	SAMPLE_ACTIVE	decimal	True	False		1	0	(1)	If not true, this field indicates the results from this sample should be ignored in reports and calculations.
	SAMPLE_STATE	decimal	True	False		5	0	(0)	The current sample state.
	SAMPLE_ORDINAL	decimal	True	False		5	0		For autoBatch : the index of the sample in the batch For other batches: is User defined

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	BATCHID	decimal	True	True		10	0		The ID of the batch to which a sample belongs.
	STANDARDID	decimal	False	False		10	0		For calibration samples, this is the ID of the standard on which the sample is based.
	PHYSICALSTATE	decimal	True	False		5	0	(0)	One of (Swipe/Smear, Filter, Solid, Liquid)
	COLLECTIONDATE	datetime	False	False					The date/time that the sample was collected.
	REFERENCEDATE	datetime	False	False					Reference date for decay correction.
	SAMPLEAMOUNT	float	True	False		53			Sample amount specified in SampleAmountUnits
	SAMPLEAMOUNTUNC	float	True	False		53			Sample Amount uncertainty
	SAMPLEAMOUNTUNITID	decimal	True	False		10	0		FK to sample amount units (see XLS for possible values)
	SAMPLE_DESCRIPTION	nvarchar	False	False	64				If this is a shared sample, then the description shown on forms and reports will come from the CI_SHL_SAMPLESHARE table, so when the user is completing the definition of a shared sample, they should not be able to edit this field.
	BARCODE	nvarchar	False	False	50				Barcode assigned to the sample
	APPROVAL1USERID	decimal	False	False		10	0		The user who provided the 1st approval for the sample in data review.
	APPROVAL1DATE	datetime	False	False					The date of the first approval
	APPROVAL2USERID	decimal	False	False		10	0		The user who provided the 2nd approval for the sample in data review.
	APPROVAL2DATE	datetime	False	False					The date of the second approval.
	RECOVERYFACTOR	float	True	False		53			External recovery factor, used to specify chemical yield.
	RECOVERYFACTORUNC	float	True	False		53			Error in recovery factor uncertainty.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	TAREWEIGHT	float	False	False		53			Weight/Mass of an empty planchet prior to adding sample (Solid/Liquid) Only
	FINALWEIGHT	float	False	False		53			Weight/Mass of a planchet after adding sample and any chemical processing. (solid/liquid only)
	FILTERONDATE	datetime	False	False					Date and time at the beginning of the sampling period.
	FILTEROFFDATE	datetime	False	False					Date and time at the end of the sampling period.
	STARTFLOW	float	False	False		53			Flow rate at the beginning of the sampling period.
	ENDFLOW	float	False	False		53			Flow rate at the end of the sampling period.
	FLOWRATE	float	False	False		53			For Filter samples. Specifies the total amount of the sample. calculated automatically.
	FLOWRATEUNC	float	False	False		53			For Filter samples. Specifies the total uncertainty of the sample. calculated automatically.
	RESIDUALMASS	float	False	False		53			The actual mass/weight of the sample to be analyzed.
	RESIDUALMASSUNC	float	False	False		53			The actual mass/weight uncertainty of the sample to be analyzed.
	FLOWRATEVOLUMNEUNITID	decimal	False	False		10	0		The volume unit associated with the Tare and Final Weight
	FLOWRATETIMEUNITID	decimal	False	False		10	0		
	MASSUNITID	decimal	False	False		10	0		
	USERSAMPLETYPEID	decimal	False	False		10	0		If true this sample was created by user through the batch screen, false it was auto created

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PRESETCOUNTTIME	decimal	False	False		10	0	(0)	This value is used in the sample assigner to override the procedure preset
	STANDARDID_EXCLUDE	bit	False	False					If this value is 1, then this sample is excluded from the normal database check that prevents samples in the assigned or counting state from having the same standard. This can occur during database upgrades or sample changer counting.
	SAMPLE_REVISION	decimal	True	False		10	0	(0)	
	PARENT_SAMPLE	decimal	False	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(BATCHID = BATCHID)	CI_LBD_SAMPLE_F1 CI_LBD_BATCH_PK	CI_LBD_BATCH	✓
(PARENT_SAMPLE = SAMPLEID)	CI_LBD_SAMPLE_F10 CI_LBD_SAMPLE_PK	CI_LBD_SAMPLE_REVISIONS	
(SAMPLEAMOUNTUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F2 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(STANDARDID = STANDARDID)	CI_LBD_SAMPLE_F3 CI_LBS_STANDARD_PK	CI_LBS_STANDARD	
(APPROVAL1USERID = USERID)	CI_LBD_SAMPLE_F4 CI_LBS_USER_PK	CI_LBS_USER	
(APPROVAL2USERID = USERID)	CI_LBD_SAMPLE_F5 CI_LBS_USER_PK	CI_LBS_USER	
(USERSAMPLETYPEID = CUSTOMERID)	CI_LBD_SAMPLE_F6 PK_CI_LBS_CUSTOMER_PK	CI_LBS_CUSTOMER	

(FLOWRATEVOLUMEUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F7 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(FLOWRATETIMEUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F8 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(MASSUNITID = MEASUREMENTUNITID)	CI_LBD_SAMPLE_F9 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SAMPLE_PK	Primary Key	SAMPLEID	
CI_LBD_SAMPLE_X1	Unique	SAMPLE_NAME,BATCHID	
CI_LBD_SAMPLE_X2	Non Unique	BATCHID	
CI_LBD_SAMPLE_X3	Non Unique	STANDARDID	
IX_LBD_SAMPLE_X5	Non Unique	STANDARDID	PARENT_SAMPLE,SAMPLE_REVISION,BATCHID

CI_LBD_SECURITYOBJECT

Notes: This holds the list of security rights which the system understands. This data is populated when the database is created or updated. These security rights can be assigned to User Groups. If a group is assigned a particular security object, then all users in that group have that right (i.e. they have the permission to perform that task). A security right might be permission to edit procedures, or perform an energy calibration on a chamber. Through a separate table, these security rights/objects are grouped into logical categoires such as Calibration, Data Review, Sample Counting, etc.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CODE	decimal	True	True		10	0		
	NAME	nvarchar	True	False	64				
	DESCRIPTION	nvarchar	False	False	255				

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SECURITYOBJECT_PK	Primary Key	CODE	

CI_LBD_SECURITYRIGHT

Notes: This holds all the assigments of security rights to user groups. As an administrator assigns different rights to a group, that assignment is recorded in this table and used by the system to authenticate users before they attempt to perform a certain task.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SECURITYRIGHTID	decimal	True	True		10	0		
	GROUPID	decimal	True	False		10	0		
	SECURITYOBJECTCODE	decimal	True	False		10	0		
	ENABLED	decimal	True	False		1	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(GROUPID = GROUPID)	CI_LBD_SECURITYRIGHT_F1 PK_GROUP_SHARE	CI_SHL_GROUP	✓
(SECURITYOBJECTCODE = CODE)	CI_LBD_SECURITYRIGHT_F2 CI_LBD_SECURITYOBJECT_PK	CI_LBD_SECURITYOBJECT	

Column Constraint Information

Columns	Constraint Name	Rule
ENABLED	CI_RUL_BOOLEAN136	([ENABLED]>=(0) AND [ENABLED]<=(1))

Indexes

Name	Type	Columns	Filter Definition
CI_LBD_SECURITYRIGHT_PK	Primary Key	SECURITYRIGHTID	
CI_LBD_SECURITYRIGHT_X1	Non Unique	GROUPID	
CI_LBD_SECURITYRIGHT_X2	Non Unique	SECURITYOBJECTCODE	

CI_LBD_SEQUENCE_BASE

Notes: This table contains the name and some of the base properties associated with a sample changer sequence, it does not contain the details. Every time a sequence is modified (name etc) a new entry is created.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SEQUENCEBASEID	decimal	True	True		10	0		
	SEQ_NAME	nvarchar	True	False	255				
	SEQ_TYPE	int	True	False		10	0		1 = qc 2 = autocal 3 = super sequence
	SEQ_ACTIVE	bit	True	False					If true the sequence appears as active, false not active
	DEV_TYPE	decimal	True	False		10	0		Device Type foreign key to device table
	PLATEAU_IN_SEQ	bit	True	False					Not Used
	ROI_IN_SEQ	bit	True	False					Not Used
	SEQ_CURRENT	bit	True	False				(1)	If true, ths sequence is currently in use and can be seen on the sample assigner, by setting this sequence to non current and not adding a new sequence equates to deleting the sequence

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(SEQUENCEBASEID = SEQUENCEBASEID)	FK_CI_LBD_SEQUENCE_BASE_CI_LBD_SEQUENCE_BASE PK_CI_LBD_SEQUENCE_BASE	CI_LBD_SEQUENCE_BASE	
(DEV_TYPE = DEVICETYPEID)	FK_CI_LBD_SEQUENCE_BASE_CI_LBM_DEVICETYPE CI_LBM_DEVICETYPE_PK	CI_LBM_DEVICETYPE	

Indexes

Name	Type	Columns	Filter Definition
PK_CI_LBD_SEQUENCE_BASE	Primary Key	SEQUENCEBASEID	

CI_LBD_SPECTRALDATA

Notes: Stores sparse array of spectral data. That is only non-zero values are stored along with channel number and whether or not this is compensated or uncompensated data.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SPECTRALDATAID	decimal	True	True		10	0		
	SAMPLECOUNTID	decimal	True	False		10	0		Foreign key to SAMPLECOUNT record this data is associated with
	SPECTRUMTYPE	decimal	True	False		5	0		Indicates what type of spectrum. Currently compensated and uncompensated are the available types
	CHANNEL	decimal	True	False		10	0		Zero based index of channel number
	VALUE	float	True	False		53			The value for the specified channel. Don't store values = 0.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(SAMPLECOUNTID = SAMPLECOUNTID)	CI_LBD_SPECTRALDATA_F1 CI_LBD_SAMPLECOUNT_PK	CI_LBD_SAMPLECOUNT	✓

Indexes

Name	Type	Columns	Filter Definition
PK_CI_LBD_SPECTRUM	Primary Key	SPECTRALDATAID	
CI_LBD_SPECTRALDATA_X1	Non Unique	SAMPLECOUNTID	

CI_LBJ_DISPLAYGROUP_DETECTOR

Notes: Join table that maps detectors to a display group and provides the order the detectors should be displayed in.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DISPLAYGROUP_DETECTORID	decimal	True	True		10	0		Primary key
	DETECTORID	decimal	True	False		10	0		FK to detector table
	DISPLAYGROUPID	decimal	True	False		10	0		FK to the display group
	DISPLAYGROUP_ORDER	decimal	True	False		10	0		Within a display group the detectors will all have an order. Each will start at 1 and ascend.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	CI_LBJ_DISPLAYGROUP_DETECTOR_F1 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(DISPLAYGROUPID = DISPLAYGROUPID)	CI_LBJ_DISPLAYGROUP_DETECTOR_F2 CI_LBS_DISPLAYGROUP_PK	CI_LBS_DISPLAYGROUP	

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_DISPLAYGROUP_DETECTOR_PK	Primary Key	DISPLAYGROUP_DETECTORID	
CI_LBJ_DISPLAYGROUP_DETECTOR_X1	Non Unique	DISPLAYGROUPID	
CI_LBJ_DISPLAYGROUP_DETECTOR_X2	Non Unique	DETECTORID	

CI_LBJ_PLATEAU_SAMPLE

Notes: Maps a plateau to the samples which are its constituent parts.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PLATEAU_SAMPLEID	decimal	True	True		10	0		
	PLATEAUID	decimal	True	False		10	0		
	SAMPLEID	decimal	True	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(PLATEAUID = PLATEAUID)	CI_LBJ_PLATEAU_SAMPLE_F1 CI_LBD_PLATEAU_PK	CI_LBD_PLATEAU	
(SAMPLEID = SAMPLEID)	CI_LBJ_PLATEAU_SAMPLE_F2 CI_LBD_SAMPLE_PK	CI_LBD_SAMPLE	

Indexes

Name	Type	Columns	Filter Definition
CI_LBJ_PLATEAU_SAMPLE_PK	Primary Key	PLATEAU_SAMPLEID	
CI_LBJ_PLATEAU_SAMPLE_X1	Non Unique	PLATEAUID	
CI_LBJ_PLATEAU_SAMPLE_X2	Non Unique	SAMPLEID	

CI_LBL_CONVERTIBLE_VAL_NAME

Notes: For internal use only.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CONVERTIBLE_VAL_NAMEID	decimal	True	True		10	0		
	CODE	nvarchar	True	True	64				
	DISPLAY_NAME	nvarchar	True	False	64				
	LASTUPDATED	datetime	False	False					
	UPDATECOUNT	datetime	True	False		10	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBL_CONVERTIBLE_VAL_NAME_PK	Primary Key	CONVERTIBLE_VAL_NAMEID	
CI_LBL_CONVERTIBLE_VAL_NAME_X1	Unique	CODE	

CI_LBM_APPLICATIONEVENT

Notes: This holds a list individual events that can occur and be audited. Each event is associated with an event type. Each event that is recorded in the application event data table (CI_LBD_APPLICATIONEVENT) is associated with one of the events defined in this table. The data in this table is populated at install time and is not editable by the user. Examples of an event might be the start of a calibration count, or the approval of sample from data review.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EVENT_META_ID	decimal	True	True		10	0		
	EVENT_TYPE_ID	decimal	True	False		10	0		
	EVENT_NAME	nvarchar	True	False	64				
	DESCRIPTION	nvarchar	False	False	255				

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(EVENT_TYPE_ID = EVENT_TYPE_ID)	CI_LBM_APPLICATIONEVENT_F1 CI_LBM_APPLICATIONEVENTTYPE_PK	CI_LBM_APPLICATIONEVENTTYPE	

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_APPLICATIONEVENT_PK	Primary Key	EVENT_META_ID	
CI_LBM_APPLICATIONEVENT_X1	Non Unique	EVENT_TYPE_ID	

CI_LBM_APPLICATIONEVENTTYPE

Notes: This holds a list of groups or classes to which application events can be assigned. As events occur they are logged in the application event table. This provides a way to enable or disable a group of events. The data in this table is populated at install time and is not editable by the user. Examples of some types would be either general system events such as Errors or Security items, or application specific events such as Sample Counting, Data Review, etc.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EVENT_TYPE_ID	decimal	True	True			10	0	
	EVENT_TYPE_CODE	nvarchar	True	True	32				
	LONG_NAME	nvarchar	True	False	64				
	DESCRIPTION	nvarchar	False	False	255				
	ENABLED	decimal	False	False		5	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_APPLICATIONEVENTTYPE_PK	Primary Key	EVENT_TYPE_ID	
CI_LBM_APPLICATIONEVENTTYPE_X1	Unique	EVENT_TYPE_CODE	

CI_LBM_ASSIGNTESTDATA

Notes: For internal use only.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	ASSIGNTESTDATAID	decimal	True	True		10	0		Primary Key
	SCENARIOID	decimal	True	False		10	0		Unique ID for this scenario.
	ISACTIVE	decimal	True	False		1	0	(1)	Indicates whether or not this test is active.
	ASSIGNDATA_COUNTTYPE	decimal	True	False		5	0		Maps to count type enumeration.
	SHOULDPASS	decimal	True	False		1	0	(1)	Indicates whether or not this specific test should pass or fail.
	ASSIGNDATA_PROCID	decimal	True	False		10	0		FK to procecure table, indicates what procedure the sample assigned to this batch will use to count.
	ASSIGNDATA_DETID	decimal	True	False		10	0		Maps to detector used for this assignment.
	ASSIGNDATA_STANDARDID	decimal	False	False		10	0		If the CountType requires a standard, indicates the standard to be used for this assignment.
	ASSIGNDATA_CALID	decimal	False	False		10	0		If the procedure requires a calibration, indicates the correct calibration to use.
	ASSIGNDATA_SAMPLEID	decimal	False	False		10	0		If a pre-defined sample is required, such as for Unknown and Fitted Efficiency count types, this field specifies the sample ID.
	OVERRIDECOUNTTIME	decimal	True	False		10	0	(0)	Specifies preset override if desired

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(ASSIGNDATA_PROCID = PROCEDUREID)	CI_LBM_ASSIGNTESTDATA_FK1 CI_LBS_PROCEDURE_PK	CI_LBS_PROCEDURE	
(ASSIGNDATA_STANDARDID = STANDARDID)	CI_LBM_ASSIGNTESTDATA_FK2 CI_LBS_STANDARD_PK	CI_LBS_STANDARD	
(ASSIGNDATA_DETID = DETECTORID)	CI_LBM_ASSIGNTESTDATA_FK3 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	
(ASSIGNDATA_CALID = CALIBRATIONID)	CI_LBM_ASSIGNTESTDATA_FK4 CI_LBD_CALIBRATION_PK	CI_LBD_CALIBRATION	
(ASSIGNDATA_SAMPLEID = SAMPLEID)	CI_LBM_ASSIGNTESTDATA_FK5 CI_LBD_SAMPLE_PK	CI_LBD_SAMPLE_REVISIONS	

Indexes

Name	Type	Columns	Filter Definition
ASSIGNTESTDATA_PK	Primary Key	ASSIGNTESTDATAID	

CI_LBM_DEVICETYPE

Notes: This contains unique identifiers for each Device supported by Apex-Alpha/Beta along with various characteristics of the device.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DEVICETYPEID	decimal	True	True		10	0		
	DEVTYPE_NAME	nvarchar	True	True	64				
	DEVTYPE_ACTIVE	decimal	True	False		1	0	(0)	
	DEVTYPE_MANUFACTURER	nvarchar	True	False	64				
	DEVTYPE_COMMENT	nvarchar	False	False	255				
	MAX_DRAWERS	decimal	True	False		5	0		
	DETECTORS_PER_DRAWER	decimal	True	False		5	0		Not sure if this will be meaningful, since it can vary...e.g. LB4100 can have 1, 2, 4 or 8 detectors per drawer
	DISCRIMINATOR_COUNT	decimal	True	False		5	0		
	GASFLOW_DEVICE	decimal	True	False		1	0	(0)	
	SOFTWARE_CONTROLLED	decimal	True	False		1	0	(0)	
	SAMPLE_CHANGER	decimal	True	False		1	0	(0)	
	SPECTRAL_DATA	decimal	True	False		1	0	(0)	
	USER_CANDEFINEBATCH	decimal	True	False		1	0	(0)	
	USER_MUSTDEFINEBATCH	decimal	True	False		1	0	(0)	
	SW_CAN_START_COUNT	decimal	True	False		1	0	(0)	
	VOLTAGE_MIN	float	True	False		53			
	VOLTAGE_MAX	float	True	False		53			

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	VOLTAGE_PER_STEP	float	True	False		53			
	SPECTRALSIZE	decimal	True	False		10	0	(0)	Indicates size of spectral data, it will be 0 if spectral data is not supported.
	ISSIMULATOR	decimal	True	False		1	0	(0)	Indicates whether this device type is a simulator or real device.
	THRESHOLD	float	False	False		53			
	ROI_BLL	float	False	False		53			Decimal reprsentation of Beta Lower Limit value used for plateaus (.001 = .1 % full-scale)
	ROI_BUL	float	False	False		53			Decimal reprsentation of Beta Upper Limit value used for plateaus (.001 = .1 % full-scale)
	ROI_ALL	float	False	False		53			Decimal reprsentation of Alpha Lower Limit value used for plateaus (.001 = .1 % full-scale)
	ROI_AUL	float	False	False		53			Decimal reprsentation of Alpha Upper Limit value used for plateaus (.001 = .1 % full-scale)
	ALT_THRESHOLD	float	False	False		53			
	ALT_ROI_BLL	float	False	False		53			
	ALT_ROI_BUL	float	False	False		53			
	ALT_ROI_ALL	float	False	False		53			
	ALT_ROI_AUL	float	False	False		53			
	INDEPENDENT_START_STOP	decimal	True	False		1	0	(0)	If 1 each detector in a drawer can start and stop independently, if 0 all detectors start and stop at same time.
	SUPPORT_WEAKCOUNTREJECT	decimal	True	False		1	0	(0)	If 1 this device type supports weak sample reject feature, if 0 it doesn't

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	THRESHOLD_SET_ECHELON	decimal	True	False		5	0	(0)	Indicates at what level the discriminators are set at (Detector = 0, Device = 1)
	SUPPORT_AB_AC	decimal	True	False		1	0		Boolean value indicating whether or not this type of device supports Alpha/Beta anticoincidence.
	SUPPORT_PULSER_DEST	decimal	True	False		1	0		Boolean value indicating whether or not this type of device supports changing the pulser destination.
	MIN_FW_REQ	nvarchar	True	False	64				This field should contain the minimum required firmware version necessary to operate a given type of device with Apex-Alpha/Beta, though the exact contents may vary by device type.
	USESPILLOVERFORBETAPLATEAU	decimal	True	False		1	0	(0)	A value of 1 indicates that this type of device uses Eurisys methodology for beta plateaus, while a value of 0 indicates that this type of device uses Canberra methodology.
	USEFIXEDROIS	decimal	True	False		1	0	(0)	A value of 1 indicates that this type of device uses fixed ROIs, while a value of 0 indicates user-defined ROIs.
	MAXCOUNTTIME	decimal	True	False		10	0		The maximum count time in seconds allowed for this type of device.
	MAXITERATIONS	decimal	True	False		5	0		The maximum number of sample iterations allowed for this type of device.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DETECTORLAYOUT	nvarchar	True	False	64				Describes the detector layout in a drawer. [starts a drawer definition followed by the number of detectors in the drawer. The next character is a { which starts a row followed by a comma delimited list for the detector numbers in the row. A } finishes the row and a] finishes a drawer. The default layout for an LB4100 is: [1{1}][2{1,2}][4{1,3}{2,4}][8{1,3,5,7}{2,4,6,8}] The row layout is always from back to front.
	INDEPENDENT_GUARDVOLTAGE	decimal	True	False		1	0		Indicates whether or not this device type requires setting a guard voltage independent from the sample detector voltage.
	GUARDVOLTAGE_DEFAULT	float	False	False		53			The default guard voltage assigned to each drawer upon inital detection of this type of device. Must be set if INDEPENDENT_GUARDVOLTAGE = 1.
	GUARDVOLTAGE_MAX	float	False	False		53			The maximum guard voltage supported by this type of device. Must be set if INDEPENDENT_GUARDVOLTAGE = 1.
	FIELD_UPDATABLE	decimal	True	False		1	0	(0)	Indicates that devices of this type are field updatable.
	REPORTS_SYSTEM_HEALTH	decimal	True	False		1	0	(0)	Indicates that devices of this type report system health information.
	HVSETTLINGTIME_DEFAULT	decimal	True	False		5	0	(0)	Default high voltage settling time for this device type.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	HVSETTLINGTIME_MIN	decimal	True	False		5	0	(0)	Minimum high voltage settling time for this device type.
	HVSETTLINGTIME_MAX	decimal	True	False		5	0	(0)	Maximum high voltage settling time for this device type.
	GASCON_DEVICE	decimal	True	False		1	0	(0)	Indicates whether this device type supports gas conservation.
	INACTIVITYTIME_DEFAULT	decimal	False	False		5	0		Default inactivity time for this device type.
	INACTIVITYTIME_MIN	decimal	False	False		5	0		Minimum inactivity time for this device type.
	INACTIVITYTIME_MAX	decimal	False	False		5	0		Maximum inactivity time for this device type.
	PURGETIME_DEFAULT	decimal	False	False		5	0		Default purge time for this device type.
	PURGETIME_MIN	decimal	False	False		5	0		Minimum purge time for this device type.
	PURGETIME_MAX	decimal	False	False		5	0		Maximum purge time for this device type.
	USEGUARDTHRESHOLD	decimal	True	False		1	0	(0)	Indicates whether this device type supports setting of the guard threshold.
	GUARD_THRESHOLD_DEFAULT	float	False	False		53			Default guard threshold for this device type.
	VOLTAGE_PER_STEP_MAX	float	True	False		53		(0)	Maximum allowed step voltage for this device type.
	VOLTAGE_PER_STEP_DEFAULT	float	True	False		53		(0)	Default step voltage for this device type.
	IS_GUARD_SUPPORTED	decimal	True	False		1	0	(0)	If true, guard operations are supported on the main screen.
	IS_PULSER_SUPPORTED	decimal	True	False		1	0	(0)	If true Pulser operations are supported on the main screen.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SUPPORTS_ATB_BETA_PRESET	bit						(0)	
	GASFLOW_INPUT_MIN_TOLERANCE	float				53			
	GASFLOW_INPUT_MAX_TOLERANCE	float				53			
	GASFLOW_OUTPUT_TOLERANCE	float				53			
	GASFLOW_STDBY_OUTPUT_CONV_FACTOR	float				53			
	GASFLOW_OPERATE_OUTPUT_CONV_FACTOR	float				53			

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Column Constraint Information

Columns	Constraint Name	Rule
IS_GUARD_SUPPORTED	CI_RUL_BOOLEAN	([IS_GUARD_SUPPORTED]>=(0) AND [IS_GUARD_SUPPORTED]<=(1))
IS_PULSER_SUPPORTED	CI_RUL_BOOLEAN1	([IS_PULSER_SUPPORTED]>=(0) AND [IS_PULSER_SUPPORTED]<=(1))

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_DEVICETYPE_PK	Primary Key	DEVICETYPEID	
CI_LBM_DEVICETYPE_X1	Unique	DEVTYPE_NAME	

CI_LBM_METADATA

Notes: For internal use only.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	METADATAID	decimal	True	True		10	0		
	NAME	nvarchar	True	True	64				
	LABEL	nvarchar	True	False	64				
	DATA_TYPE	decimal	True	False		10	0	(0)	
	REQUIRED	decimal	True	False		1	0	(0)	
	READ_ONLY	decimal	True	False		1	0	(0)	
	FIELD_SIZE	decimal	False	False		5	0		
	DEFAULT_VALUE	float	False	False		53			
	MIN_VALUE	float	False	False		53			
	MAX_VALUE	float	False	False		53			
	FORMAT	nvarchar	False	False	64				
	CONVERTIBLE_VAL_NAMEID	decimal	False	False		10	0		
	METADATA_ENUMID	decimal	False	False	0	10	0		
	DESCRIPTION	nvarchar	False	False	64				
	TOOL_TIP	nvarchar	False	False	64				
	LASTUPDATED	datetime	False	False					
	UPDATECOUNT	decimal	True	False		10	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(CONVERTIBLE_VAL_NAMEID = CONVERTIBLE_VAL_NAMEID)	CI_LBM_METADATA_F1 CI_LBL_CONVERTIBLE_VAL_NAME_PK	CI_LBL_CONVERTIBLE_VAL_NAME	
(METADATA_ENUMID = METADATA_ENUMID)	CI_LBM_METADATA_F2 CI_LBM_METADATA_ENUM_PK	CI_LBM_METADATA_ENUM	

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_METADATA_PK	Primary Key	METADATAID	
CI_LBM_METADATA_X1	Unique	NAME	
CI_LBM_METADATA_X2	Non Unique	CONVERTIBLE_VAL_NAMEID	
CI_LBM_METADATA_X3	Non Unique	METADATA_ENUMID	

CI_LBM_METADATA_ENUM

Notes: For internal use only.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	METADATA_ENUMID	decimal	True	True		10	0		
	ENUM_NAME	nvarchar	True	False	64				
	ENUM_DESCR	nvarchar	False	False	64				
	LASTUPDATED	datetime	False	False					
	UPDATECOUNT	decimal	True	False		10	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_METADATA_ENUM_PK	Primary Key	METADATA_ENUMID	

CI_LBM_METADATA_ENUM_VAL

Notes: For internal use only.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	METADATA_ENUM_VALID	decimal	True	True		10	0		
	METADATA_ENUMID	decimal	False	False		10	0		
	ENUM_VALUE	decimal	True	False		10	0		
	ENUM_LABEL	nvarchar	True	False	64				
	ENUM_DESCRIPTION	nvarchar	False	False	64				
	LASTUPDATED	datetime	False	False					
	UPDATECOUNT	decimal	True	False		10	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(METADATA_ENUMID = METADATA_ENUMID)	CI_LBM_METADATA_ENUM_VAL_F1 CI_LBM_METADATA_ENUM_PK	CI_LBM_METADATA_ENUM	

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_METADATA_ENUM_VAL_PK	Primary Key	METADATA_ENUM_VALID	
CI_LBM_METADATA_ENUM_VAL_x1	Non Unique	METADATA_ENUMID	

CI_LBM_SECURITYMETAOBJECT

Notes: This contains a list of categories into which security objects are place. It also contains the actual mapping of these categories to security objects. The categories represent general application functions such as Calibration, Data Review QA, etc. All security objects are assigned to a category and they are displayed in these groups on the security setup screens.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	SECOBJMETAID	decimal	True	True		10	0		
	SECOBJMETAPARENTID	decimal	True	False		10	0		For rows that define a category for security objects, this column is set to 0. For rows that define what category a security object belongs to, this column points back to another row in this table that represents one of those parent categories.
	SECURITYOBJECTCODE	decimal	False	False		10	0		FK to security objects.
	LABEL	nvarchar	False	False	64				This is only filled in for parent category definitions. It is a short description of the category such as Calibration, or Detectors. This text is displayed on the security setup screens.
	SORTID	decimal	True	False		10	0	(1)	A sort value for the categories.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(SECURITYOBJECTCODE = CODE)	CI_LBM_SECURITYMETAOBJECT_F1 CI_LBD_SECURITYOBJECT_PK	CI_LBD_SECURITYOBJECT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBM_SECURITYMETAOBJECT_PK	Primary Key	SECOBJMETAID	
CI_LBM_SECURITYMETAOBJECT_X1	Non Unique	SECURITYOBJECTCODE	

CI_LBM_SERIES6_TOLERANCES

Notes: This table contains the tolerance values for the series 6 that control the range of acceptable values. This will provide for customization if the default values are not correct for your system.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	FRONT_END_INDEX	int	True	True		10	0		This value is used internally by the series 6 and should not be changed.
	LOW_TOLERANCE	float	True	False		53			This value is the minimum value considered to be in range.
	HIGH_TOLERANCE	float	True	False		53			This value is the maximum value considered to be in range
	DESCRIPTION	nvarchar	False	False	25				Parameter description, similar to value on the System Health screen.
	CONVERSION_FACTOR	float	False	False		53			This describes the conversion to raw(DAC) value for the parameter and should not be changed.
	COMMENTS	nvarchar	False	False	100				
	LOW_TOLERANCE_DAC	int	False	False		10	0		This a computed value that describes the actual low tolerance DAC value used by the series 6.
	HIGH_TOLERANCE_DAC	int	False	False		10	0		This a computed value that describes the actual high tolerance DAC value used by the series 6.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
PK_CI_LBM_SERIES6_TOLERANCES	Primary Key	FRONT_END_INDEX	

CI_LBS_CUSTOMER

Notes: This table links to the CI_SHL_CUSTOMER table defined for use by all Apex applications. It is used to capture both customer and/or sample type information.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CUSTOMERID	decimal	True	True		10	0		This primary key is the same as CI_SHL_CUSTOMER.CUSTOMERID
	CUSTOMER_ACTIVE	decimal	True	False		1	0	(1)	Indicates whether this customer/sample type is active
	ISCUSTOMER	decimal	True	False		1	0	(0)	If 1this is a customer and ProjectCode, Organization, ContactName may have data. If zero, this is a SampleType and only Name and Description are valid data.
	CORRECTIONFACTOR	float	False	False		53			If ISCUSTOMER = 0, it will be possible to specifiy a correction factor for the sample type.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(CUSTOMERID = CUSTOMERID)	FK_CI_LBS_CUSTOMER_F1 PK_CUSTOMER	CI_SHL_CUSTOMER	

Indexes

Name	Type	Columns	Filter Definition
PK_CI_LBS_CUSTOMER_PK	Primary Key	CUSTOMERID	

CI_LBS_DETECTOR

Notes: Stores a record for each chamber defined in the system and keeps track of various state information.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DETECTORID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	DET_NAME	nvarchar	False	True	70				
	DET_ACTIVE	decimal	True	False		1	0	(1)	A value of 1 indicates that this detector is active, and a value of 0 indicates that it is not active.
	DET_INDEX	decimal	True	False		10	0		Must uniquely identify the detector IN THE DEVICE.
	DET_SERIALNUMBER	nvarchar	True	False	64				The detector serial number.
	DET_INSERVICEDATE	datetime	True	False					Date the detector was put in service.
	DET_COMMENTS	nvarchar	False	False	255				Detector specific comments.
	DRAWERID	decimal	True	False		10	0		The ID of the drawer to which a detector belongs.
	CURRENTSAMPLEID	decimal	False	False		10	0		If counting, this field contains the ID of the current sample. Otherwise this field is NULL.
	ERRORSTATE	decimal	True	False		10	0	(0)	Indicates if detector is in an error state {NoError, HWError}
	ACQUISITIONSTATE	decimal	True	False		5	0	(0)	The current state of the detector.
	THRESHOLD	float	False	False		53			Lower level Discriminator for noise discrimination.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	WASOUTOFSERVICE	decimal	True	False		1	0	0	Indicates whether or not detector was out of service prior to current assignment/counting, this should be set to 1 anytime the detector is in Assigned, Counting, or CountDone where it had previously been in OutOfService state, otherwise it should be set to zero. If detector OutOfService, Available or Offline this value should be zero.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DRAWERID = DRAWERID)	CI_LBS_DETECTOR_F2 CI_LBS_DRAWER_PK	CI_LBS_DRAWER	✓
(CURRENTSAMPLEID = SAMPLEID)	CI__LBS_DETECTOR_F3 CI_LBD_SAMPLE_PK	CI_LBD_SAMPLE_REVISIONS	

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_DETECTOR_PK	Primary Key	DETECTORID	
CI_LBS_DETECTOR_X1	Unique	DET_NAME	
CI_LBS_DETECTOR_X2	Non Unique	DRAWERID	
CI_LBS_DETECTOR_X4	Non Unique	CURRENTSAMPLEID	

CI_LBS_DETECTOR_GROUP

Notes: This .table tracks assignments to a detector group within a sample changer

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	GROUPID	decimal	True	True		10	0		artificial primary key, not really used.
	GROUPNAME	nvarchar	True	True	6				Detector Group name A through J or CAL or QC
	DETECTORID	decimal	True	True		10	0		foreign key to detector table, combined with groupname is the unique key for this table
	ASSIGNMENT_ID	decimal	False	False		10	0		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	FK_CI_LBS_DETECTOR_GROUP_CI_LBS_DETECTOR CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	

Indexes

Name	Type	Columns	Filter Definition
PK_CI_LBS_DETECTOR_GROUP	Primary Key	GROUPID	
IX_LBS_DETECTOR_GROUP	Unique	DETECTORID,GROUPNAME	

CI_LBS_DEVICE

Notes: This table contains all devices recognized within the system.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DEVICEID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	DEV_NAME	nvarchar	True	True	64				The device name
	DEV_ACTIVE	decimal	True	False		1	0	(1)	0 = InActive, 1 = Active
	DEV_STATE	decimal	True	False		5	0	(0)	This field indicates the state of the device. Possible values are Connected = 0, Offline = 1, OutOfService = 2.
	DEV_SERIALNUMBER	nvarchar	True	False	64				The device serial number.
	DEV_CREATEDATE	datetime	True	False					Date this device was added to the system.
	DEV_COMMENTS	nvarchar	False	False	255				User comments
	DEVICETYPEID	decimal	False	False		10	0		The ID of the device type to which a device belongs.
	NUMBEROFDRAWERS	decimal	True	False		10	0	(1)	Between 1 and 4. Sample changer systems will have 1 drawer by default.
	ADDRESS	decimal	True	False		20	0		EEEE Address, COM Port number or SUID (system unique ID) for the device.
	PROTOCOL	decimal	True	False		5	0	(-1)	Type of communication protocol used {IEEE, RS232-Tennelec, RS2332 - Eurisys, USB}

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	LASTSERVICEDATE	datetime	False	False					Date/time for the last service call on this device.
	WINDOWLESSDECTORS	decimal	True	False		1	0	(0)	If 1 system uses windowless dectors, if 0 detectors have windows.
	ALPHABETA_AC_ENABLED	decimal	True	False		1	0	(1)	
	CONFIGMISMATCH	decimal	True	False		1	0	(0)	
	INACTIVITYTIME	decimal	False	False		5	0		Value indicating whether or not Alpha/Beta anticoincidence is enabled on this device. Only applies to Eurisys instruments (IN20/MINI20/PEGASE).
	PURGETIME	decimal	False	False		5	0		A value of 1 indicates that the last unsuccessful connection attempt was due to a device configuration mismatch.
	GUARD_THRESHOLD	float	True	False		53			Time the device is inactive before it enters standby mode.
	DEVICE_INDEX	decimal	True	False		10	0	(0)	Time the device will purge when leaving standby mode.
	GASSTATE	decimal	True	False		5	0	(0)	Threshold on the guard detector for devices that use this value. Value is the decimal representation of percent full scale.
	OPSTATE	decimal	True	False		5	0	(0)	The order in which drawers for active devices will be displayed in the Main View.
	AUTORESTACK	bit	True	False				(0)	Describes the current gas state (OK = 0, PressureBad = 1, FlowBad = 2).

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	GAMMAENABLED	bit	True	False				(0)	Describes the current operational state (Normal = 0, Standby = 1, Purge = 2, InitBias = 3).
	USE_GAMMA_OPTION	bit						(0)	If true, perform restack at the end of a count. Only valid for sample changers.
	CHANGERSTATE	decimal				5	0	(0)	
	GASFLOW_INPUT_MIN_TOLERANCE	float				53			
	GASFLOW_INPUT_MAX_TOLERANCE	float				53			
	GASFLOW_OUTPUT_TOLERANCE	float				53			
	GASFLOW_STDBY_OUTPUT_CONV_FACTOR	float				53			
	GASFLOW_OPERATE_OUTPUT_CONV_FACTOR	float				53			
	HAS_CAMERA_SUPPORT	decimal			1	0	(0)		

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DEVICETYPEID = DEVICETYPEID)	CI_LBS_DEVICE_F1 CI_LBM_DEVICETYPE_PK	CI_LBM_DEVICETYPE	

Indexes

Name	Type	Columns	Filter Definition
CI__LBS_DEVICE_PK	Primary Key	DEVICEID	
CI__LBS_DEVICE_X1	Unique	DEV_NAME	
CI__LBS_DEVICE_X2	Non Unique	DEVICETYPEID	

CI_LBS_DISPLAYGROUP

Notes: This will hold logical definitions of detector groupings. This allows the user to group multiple devices together or group detectors from different devices together that are have a similar use. Because of differences in the different device hardware, all detectors in a display groups must have the same device type.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DISPLAYGROUPID	decimal	True	True		10	0		
	DISPLAYGROUP_NAME	nvarchar	True	False	64				
	DISPLAYGROUP_ACTIVE	nvarchar	True	False		1	0	(1)	bool

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_DISPLAYGROUP_PK	Primary Key	DISPLAYGROUPID	

CI_LBS_DRAWER

Notes: Contains a record for each drawer defined in the system.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	DRAWERID	decimal	True	True		10	0		Unique identifier created by the system. This is automatically generated by the system and is not editable.
	DRAWER_NAME	nvarchar	False	True	67				Must uniquely identify the drawer IN THE DEVICE.
	DRAWER_ACTIVE	decimal	True	False		1	0	(1)	A value of 1 indicates that this drawer is active, and a value of 0 indicates that it is not active.
	DRAWER_INDEX	decimal	True	False		10	0		
	DRAWER_SERIALNUMBER	nvarchar	True	True	64				Drawer serial number
	DRAWER_STATE	decimal	True	False		5	0		The current state of the drawer.
	DRAWER_GUARDED	decimal	True	False		1	0	(0)	Indicates whether or not this drawer has a guard detector.
	DRAWER_COMMENT	nvarchar	False	False	255				User comment
	DEVICEID	decimal	True	False		10	0		The ID of the device to which a drawer belongs.
	CURRENTVOLTAGE	float	True	False		53			Current operating voltage used by a drawer.
	GUARDVOLTAGE	float	True	False		53			
	GUARDENABLED	decimal	True	False		1	0	(1)	Boolean value indicating whether or not the guard is enabled for this drawer.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PULSERENABLED	decimal	True	False		1	0	(0)	Boolean value indicating whether or not the pulser is currently enabled for this drawer.
	PULSERAMPLITUDE	decimal	True	False		5	0	(0)	Value indicating the current pulser amplitude (0 = Beta, 1 = Alpha and Beta).
	PULSERDESTINATION	decimal	True	False		5	0	(0)	Value indicating the current pulser destination (0 = Main Amplifier, 1 = Preamplifier).
	DRAWEROPEN	decimal	True	False		1	0	(0)	Boolean indicating whether the drawer is open or not.
	HVSETTLINGTIME	decimal	True	True		5	0	(0)	Time to wait for stabilization of sample detector voltage after a voltage change.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DEVICEID = DEVICEID)	CI_LBS_DRAWER_F1 CI_LBS_DEVICE_PK	CI_LBS_DEVICE	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_DRAWER_PK	Primary Key	DRAWERID	
CI_LBS_DRAWER_X2	Unique	DRAWER_NAME	
CI_LBS_DRAWER_X1	Unique	DRAWER_SERIALNUMBER	
CI_LBS_DRAWER_X3	Non Unique	DEVICEID	

CI_LBS_MEASUREMENTUNIT

Notes: Contains the information needed to define a measurement unit and the conversion factor needed to translate from the internal system units used to the user defined unit. The conversion factors are used to display values on reports and on screens in units of the users choice. Once a new measurement unit is defined, it can no longer be deleted from the system since it could be referenced by some samples.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	MEASUREMENTUNITID	decimal	True	True		10	0		
	MMNT_TYPE	decimal	True	False		10	0		
	MMNT_NAME	nvarchar	True	True	64				
	MMNT_CONV_FACTOR	float	True	False		53	0	(0)	
	MMNT_SYSTEM	decimal	True	False		1	0		
	MMNT_SORT_ORDER	decimal	True	False		10	0		
	MMNT_REF_UNIT	decimal	True	False		1	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_MEASUREMENTUNIT_PK	Primary Key	MEASUREMENTUNITID	
CI_LBS_MEASUREMENTUNIT_X1	Unique	MMNT_NAME	

CI_LBS_PROCEDURE

Notes: This table contains information for all counting procedures. The procedure defines how samples in a batch are to be counted, analyzed, reviewed, etc. When a procedure is created a record is created in the Procedure Base table and in this table. Whenever a procedure is modified, a new record is stored inthis table with the new settings and a new revision number. This allows the system to retain the original procedure settings used for any given batch (the batch table retains the procedure revision that was used).

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PROCEDUREID	decimal	True	True			10	0	
	PROCEDUREBASEID	decimal	True	False		10	0		
	PROC_CURRENT	decimal	True	False		0	1	(1)	Used to indicate whether or not this is the "current" version of this procedure. For a given base procedure only one procedure can be marked current. The "current" version will be used when starting all sample counts and will be the version displayed in Setup - Procedures. Each time a given base procedure is edited it will generate a new record in the Procedures table and mark it as current. The PROC_CURRENT flag on the previous version will be set to zero.
	COUNTDELAY	decimal	True	False		5	0		0-9999, min. amount of time to wait after sample in position, and before counting.
	PRESETCOUNTTIME	decimal	True	False		10	0		Stored in DB in "seconds" Send to the device in minutes: plateau: (0.1 - 9999.0 if in minutes) = preset Time

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	TARGETSLOPE	float	False	False		53	(0.025)		Slope to calculate plateau (defaults to 2.5%). Only applicable to procedures of plateau type.
	TARGETSPILLOVER	float	False	False		53	(0.010)		Spillover to calculate beta plateau (defaults to 1%). Only applicable to procedures of plateau type where PLATEAU_DECAYMODE is beta.
	STARTVOLTAGE	float	False	False		53			Initial voltage for starting a plateau. Only applicable for plateau procedures.
	VOLTAGEPERSTEP	float	False	False		53			The amount by which the voltage is incremented for each iteration of a plateau count.
	VOLTAGESETTLINGTIME	decimal	False	False		5	0		Where applicable: (Tennelec) delay to allow the High Voltage to settle.
	GROUP_ITERATIONS	decimal	True	False		5	0	(1)	Number of times group is to be counted (1-9). Only applicable on XLB.
	SAMPLE_ITERATIONS	decimal	True	False		5	0	(1)	Number of times each sample in group/batch is to be counted (1 - 99).
	WEAKCOUNTENABLED	decimal	True	False		1	0	(0)	Indicates whether or not the Weak Count reject test is enabled.
	WEAKALPHACOUNT	decimal	False	False		10	0		
	WEAKALPHACOUNTTIME	decimal	False	False		10	0		
	WEAKBETACOUNT	decimal	False	False		10	0		
	WEAKBETACOUNTTIME	decimal	False	False		10	0		
	BACKGROUND_SUBTRACT	decimal	True	False		5	0	(0)	Flag to indicate what type of background subtraction, if any, will be done.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CALCULATE_ACTIVITY	decimal	True	False		1	0	(1)	Flag to indicate whether or not activity calculation will be performed in analysis.
	CALCULATE_SPILLOVER	decimal	True	False		1	0	(0)	Indicates whether or not spillover correction will be performed. On/Off (only available if Activity enabled and in A+B count mode)
	ALPHACOUNTPRESET	decimal	True	False		10	0	(0)	Represents the Preset Counts for the Alpha channel
	ALPHACOUNTPRESETTIME	decimal	True	False		10	0	(0)	The time in seconds at which to check the specified ALPHACOUNTPRESET value.
	BETACOUNTPRESET	decimal	True	False		10	0	(0)	Count preset for the beta channel
	BETACOUNTPRESETTIME	decimal	True	False		10	0	(0)	The time in seconds at which to check the specified BETACOUNTPRESET value.
	COUNTCOMPLETESCRIPT	nvarchar	False	False	64				Script to run on count done
	SAMPLEAPPROVEDSCRIPT	nvarchar	False	False	64				Script to run when sample is approved.
	PLATEAU_DECAYMODE	decimal	True	False		5	0		For plateau procedures, indicates the decay mode. Possible values are Alpha, Beta, and Gamma.
	AUTOPRINTREPORT	decimal	True	False		1	0	(0)	If 1 autoprint report, of 0 don't.
	REQUIRE_1ST_APPROVAL	decimal	True	False		1	0	(0)	

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	REQUIRE_2ND_APPROVAL	decimal	True	False		1	0	(0)	If REQUIRE_1ST_APPROVAL = false then REQUIRE_2ND_APPROVAL must be false. If REQUIRE_1ST_APPROVAL = true then REQUIRE_2ND_APPROVAL can be true of false.
	USE_FOR_QC	decimal	True	False		1	0	(0)	
	ALPHACONFFACTOR	float	False	False		53			The alpha confidence factor in percent
	BETACONFFACTOR	float	False	False		53			The beta confidence factor in percent
	BAYESIANCONFFACTOR	float	False	False		53			The Bayesian confidence factor in percent
	MDATYPE	decimal	False	False		5	0		Determines which MDA is used Currie or ISO 11929
	GAMMACOUNTPRESET	decimal	True	False		10	0	(0)	
	GAMMACOUNTPRESETTIME	decimal	True	False		10	0		
	PRESELECTEDGROUP	decimal	True	False	6				
	SAVESPECTRALDATA	decimal	True	False				(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(PROCEDUREBASEID = PROCEDUREBASEID)	CI_LBS_PROCEDURE_F1 CI_LBS_PROCEDURE_BASE_PK	CI_LBS_PROCEDURE_BASE	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_PROCEDURE_PK	Primary Key	PROCEDUREID	
CI_LBS_PROCEDURE_X1	Non Unique	PROCEDUREBASEID	
CI_LBS_PROCEDURE_F2	Unique	PROCEDUREID,PROCEDUREBASEID	

CI_LBS_PROCEDURE_BASE

Notes: This table contains a sigle record for each procedure. Each procedure may have multiple revisions which are stored in CI_LBS_PROCEDURE.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	PROCEDUREBASEID	decimal	True	True		10	0		
	PROC_NAME	nvarchar	True	True	64				
	PROC_DESCRIPTION	nvarchar	False	False	255				Description for the procedure
	PROC_TYPE	decimal	True	False		10	0	(0)	AEff, BEff, Plateau, ROI, Bkgd, Unknown: see XLS for the possible values
	PROC_DEFAULT	decimal	True	False		1	0	(0)	Boolean: for a procedure type. Only one proc can be default for a given procedure type
	PROC_ACTIVE	decimal	True	False		1	0	(1)	Boolean : if inactive, do not show in UI
	CALIBRATIONID	decimal	False	False		10	0		FK to the calibration that this procedure uses when count. This identifies the Background and Efficiency records to use.
	REPORTID	decimal	True	False		10	0		FK to the report used for this procedure.
	REPORTACTIVITYUNITID	decimal	False	False		10	0		Foriegn key to counting units, indicates what activity units to use on report.
	DEVICETYPEID	decimal	True	False		10	0		
	EXPRESS_PHYSICALSTATE	decimal	False	False		5	0		For Unknown procedures, this is the default physical state to use for a new Express Count batch.

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	EXPRESS_USERSAMPLETYPEID	decimal	False	False		10	0		For Unknown procedures, this is the default User Sample ID to use for a new Express Count batch.
	EXPRESS_SAMPLEAMOUNTUNITID	decimal	False	False		10	0		For Unknown procedures, this is the default sample amount unit to use for a new Express Count batch.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(CALIBRATIONID = CALIBRATIONID)	CI_LBS_PROCEDURE_BASE_F1 CI_LBD_CALIBRATION_PK	CI_LBD_CALIBRATION	
(REPORTID = REPORTID)	CI_LBS_PROCEDURE_BASE_F2 CI_LBS_REPORT_PK	CI_LBS_REPORT	
(REPORTACTIVITYUNITID = MEASUREMENTUNITID)	CI_LBS_PROCEDURE_BASE_F3 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(DEVICETYPEID = DEVICETYPEID)	CI_LBS_PROCEDURE_BASE_F4 CI_LBM_DEVICETYPE_PK	CI_LBM_DEVICETYPE	
(EXPRESS_USERSAMPLETYPEID = CUSTOMERID)	CI_LBS_PROCEDURE_BASE_F5 PK_CI_LBS_CUSTOMER_PK	CI_LBS_CUSTOMER	
(EXPRESS_SAMPLEAMOUNTUNITID = MEASUREMENTUNITID)	CI_LBS_PROCEDURE_BASE_F6 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_PROCEDURE_BASE_PK	Primary Key	PROCEDUREBASEID	
CI_LBS_PROCEDURE_BASE_X1	Unique	PROC_NAME	
CI_LBS_PROCEDURE_BASE_X2	Non Unique	CALIBRATIONID	
CI_LBS_PROCEDURE_BASE_X3	Non Unique	DEVICETYPEID	

CI_LBS_QA_DETECTOR_PARAM

Notes: Stores definitions for parameters to be used for QA.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	QADETPARAMID	decimal	True	True		10	0		
	DETECTORID	decimal	True	False		10	0		
	MEANTYPE	decimal	True	False		5	0	(0)	
	MANUALVALUE	float	False	False		53			
	MANUALVALUEUNC	float	False	False		53			
	PARAMETER	decimal	True	False		5	0	(0)	
	DEFAULTDATERANGE	decimal	True	False		10	0	(30)	
	ISENABLED	bit	True	False				(1)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(DETECTORID = DETECTORID)	CI_LBS_QA_DETECTOR_PARAM_F1 CI_LBS_DETECTOR_PK	CI_LBS_DETECTOR	✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_QA_DETECTOR_PARAM_PK	Primary Key	QADETPARAMID	
CI_LBS_QA_DETECTOR_PARAM_X1	Non Unique	DETECTORID	

CI_LBS_REPORT

Notes: Mechanism to register reports templates in the database.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	REPORTID	decimal	True	True		10	0		
	REPORT_NAME	nvarchar	True	True	64				User defined name for report.
	REPORT_TYPE	decimal	True	False		5	0	(0)	Indicates the type of a report. Possible values are Unknown, Plateau, Background, Efficiency, and Other.
	REPORT_PATH	nvarchar	True	False	260				Fully qualified path to report template.
	ISACTIVE	decimal	True	False		1	0	(1)	Indicates whether report is active or not.
	ISDEFAULT	decima	True	False		1	0	(0)	Indicates whether or not this is the default report.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_REPORT_PK	Primary Key	REPORTID	
CI_LBS_REPORT_X1	Unique	REPORT_NAME	

CI_LBS_STANDARD

Notes: Holds definitions for all standards defined in the system.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	STANDARDID	decimal	True	True		10	0		
	STANDARD_NAME	nvarchar	True	True	64				Name for the standard
	STANDARD_DESCRIPTION	nvarchar	False	False	255				Description of the standard.
	STANDARD_ACTIVE	decimal	True	False		1	0	(1)	Flag to indicate whether or not the standard is active.
	STANDARD_DECAYMODE	decimal	True	False		5	0	(0)	The decay mode for a standard. Possible values are Alpha, Beta, and Gamma
	STANDARD_ORDER	decimal	True	False		10	0		
	NUCLIDENAME	nvarchar	True	False	64				Name for the nuclide that is in the standard.
	HALFLIFE	float	True	False		53			Half-life of the nuclide in the standard (in seconds)
	HALFLIFEUNC	float	True	False		53			UNCERTAINTY IN THE HALFLIFE
	HALFLIFE_UNITID	decimal	True	False		10	0		Foriegn key to measurement units table, the type of the unit must be Time.
	EMISSIONRATE	float	True	False		53			4 Pi Emission rate of the nuclide in Bq.
	EMISSIONRATEUNC	float	True	False		53			Uncertaity in emission rate (in Bq).
	EMISSIONRATE_UNITID	decimal	True	False		10	0		FK to measurement unit table, needs to be an activity unit.
	DIAMETER	float	False	False		53			Source diameter - iSeries only
	CONTROLNUMBER	nvarchar	False	False	32				Control number assigned to the standard.

	MASS	float	False	False		53			Requied for standards that are used in attenuations (in grams).
	MASSUNC	float	False	False		53			Uncertainty in mass (in grams), required for attentuation standards.
	MASS_UNITID	decimal	False	False		10	0		Display units for sample mass
	REFERENCEDATE	datetime	True	False					The reference date for the standard, this is the date the standard activity was measured.
	USEFORPLATEAU	decimal	True	False		1	0	(0)	Indicates whether or not this standard can be used for plateaus.
	USEFORCALCHECK	decimal	True	False		1	0	(0)	Indicates whether or not this standard can be used for calibration checks
	USEFORCONSTANTEFF	decimal	True	False		1	0	(0)	Indicates whether or not this standard can be used for constant efficiencies.
	USEFORFITTEDEFF	decimal	True	False		1	0	(0)	Indicates whether or not this standard can be used for fitted efficiencies
	USEFORROI	decimal	True	False		1	0	(0)	Indicates whether or not this standard can be used for ROI Setup

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(HALFLIFE_UNITID = MEASUREMENTUNITID)	CI_LBS_STANDARD_F1 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(EMISSIONRATE_UNITID = MEASUREMENTUNITID)	CI_LBS_STANDARD_F2 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	
(MASS_UNITID = MEASUREMENTUNITID	CI_LBS_STANDARD_F3 CI_LBS_MEASUREMENTUNIT_PK	CI_LBS_MEASUREMENTUNIT	

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_STANDARD_PK	Primary Key	STANDARDID	
CI_LBS_STANDARD_X1	Unique	STANDARD_NAME	
CI_LBS_STANDARD_X2	Non Unique	HALFLIFE_UNITID	
CI_LBS_STANDARD_X3	Non Unique	EMISSIONRATE_UNITID	
CI_LBS_STANDARD_X4	Non Unique	MASS_UNITID	

CI_LBS_USER

Notes: This holds a list of users that can log into the system and the group they are assigned. A user can only be assigned to a single user group. The users permissiosn come from the group to which they are assigned. Information about the user and group are stored in the shared Apex tables CI_SHL_USER and CI_SHL_GROUP.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	USERID	decimal	True	True		10	0		
	GROUPID	decimal	True	False		10	0		
	ACCOUNTENABLED	decimal	True	False		1	0	(0)	

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
(USERID = USERID)	CI_LBS_USER_F1 PK_USER_SHARE	CI_SHL_USER	
(GROUPID = GROUPID)	CI_LBS_USER_F2 PK_GROUP_SHARE	CI_SHL_GROUP	

Indexes

Name	Type	Columns	Filter Definition
CI_LBS_USER_PK	Primary Key		USERID

CI_LBV_SIMILAR_BACKGROUND

Notes: This view provides a link between that will display calibrations that are considered similar The current background can be shared among both calibrations.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CHILDID	decimal	True	False		10	0		Calibration ID of the actual calibration.
	CHILD_NAME	nvarchar	True	False	64				Description of the actual calibration.
	MASTERID	decimal	False	False		10	0		Calibration ID of the shared calibration.
	MASTER_NAME	nvarchar	False	False	64				Description of the shared calibration.
	PROCEDUREBASEID	decimal	False	False		10	0		Foreign reference to the procedure, must be the same for both calibrations.

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

CI_LBV_SIMILAR_EFF

Notes:

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
	CALIBRATIONID	decimal			10	0			Child calibration foreign key FOR CI_LBD_CALIBATION^
	CAL_NAME	nvarchar		64					Calibration Description
	ALPHA_MASTERID	decimal			10	0			shared calibration id for alpha efficiency correction
	ALPHA_MASTER_NAME	nvarchar		64					shared calibration description for alpha efficiency correction
	BETA_MASTERID	decimal			10	0			shared calibration id for beta efficiency correction
	BETA_MASTER_NAME	nvarchar		64					shared calibration description for beta efficiency correction
	ALPHA_PROCEDUREBASEID	decimal			10	0			procedure id (foreign key into CI_LBS_PROCEDUREBASE) for the shared alpha efficiency
	BETA_PROCEDUREID	decimal			10	0			

Relationships

Columns	Foreign/Primary Key Name	Referencing Table	Do Cascade Delete
			✓

Shared Data Model

CI_SHL_CUSTOMER

Notes: The definition for this table is set by Apex-Gamma et al and cannot be changed in Apex-AB.

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
True	CUSTOMERID	decimal	True	True		10	0		
False	NAME	nvarchar	True	False	255				
False	DESCRIPTION	nvarchar	True	False	64				
False	PROJECTCODE	nvarchar	False	False	64				
False	CONTACTNAME	nvarchar	False	False	64				
False	ORGANIZATION	nvarchar	False	False	64				
False	TELEPHONE	nvarchar	False	False	64				
False	EMAIL	nvarchar	False	False	255				
False	INFORMATION	nvarchar	False	False	255				
False	UPDATECOUNT	nvarchar	False	False		10	0	0	

Constraints

Name	Type	Columns	Initial Code	Notes
PK_CI_SHL_CUSTOMER	Public	CUSTOMERID		

Relationships

Columns	Association	Notes
(CUSTOMERID = CUSTOMERID)	**0..*** CI_LBD_CUSTOMER.FK_CI_LBS_CUSTOMER_CI_SHL_CUSTOMER **1** CI_LBS_CUSTOMER.PK_CI_SHL_CUSTOMER	

CI_SHL_GROUP

Notes:

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
True	GROUPRID	decimal	True	True		10	0		
False	NAME	nvarchar	True	False	32				
False	DESCRIPTION	nvarchar	False	False	255				
False	ADMINISTRATIVE	decimal	True	False		10	0	0	

Constraints

Name	Type	Columns	Initial Code	Notes
PK_CI_SHL_GROUP	Public	GROUPID		

Relationships

Columns	Association	Notes
	CI_LBD_SECURITYRIGHT CI_SHL_GROUP.	
	CI_LBS_USER. CI_SHL_GROUP.	

CI_SHL_USER

Notes:

Columns

PK	Name	Type	Not Null	Unique	Len	Prec	Scale	Init	Notes
True	USERID	decimal	True	True		10	0		
False	NAME	nvarchar	True	False	16				
False	FULLNAME	nvarchar	False	False	64				
False	DESCRIPTION	nvarchar	False	False	255				
False	INFO	nvarchar	False	False	255				
False	EMAIL	nvarchar	False	False	255				
False	PASSWORD	varbinary	True	False	16				
False	UPDATECOUNT	nvarchar	False	False	6				
False	ADMINISTRATIVE	decimal	False	False		10	0	0	

Constraints

Name	Type	Columns	Initial Code	Notes
PK_USERID	Public	USERID		Foreign key constraint
PK_CI_SHL_USER	Public	USERID		

Relationships

Columns	Association	Notes
	CI_LBS_USER.USERID CI_SHL_USER.PK_CI_SHL_USER	

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