

Quality Assurance and Operations Manual

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Quality Assurance and Operations Manual

The Quality Assurance and Operations Manual (CHEM-100) supplements LAB-100 and LAB-200. Use CHEM-100 in conjunction with LAB-100 and LAB-200.

1 DOCUMENT CONTROL

1.1 Review of Controlled Documents

Each CU Level 2 controlled document will undergo a separate quality assurance and subject matter expert (SME) review prior to issuance. Each reviewer is typically assigned by the Unit Chief (UC) and/or Supervisors and will be included as document approvers via the FBI Laboratory Quality System – Document Control submission workflow process.

1.2 Document Distribution and Control

1.2.1 Instrument Operation and Systems Support (IOSS) Protocols

Chemistry Unit (CU) personnel will have access to controlled copies of IOSS Protocols on CHEMNET.

1.3 Annual Review of CU Controlled Documents

The below personnel will ensure an annual review of the listed documents is conducted and recorded. The annual review will be recorded in a memo issued to the UC by the end of each calendar year. Personnel responsible for more than one area may combine those areas into one memo. The memo will contain the following information:

- Any anticipated revisions, along with a timeline for submission of the revision(s)
- For any document that does not require revision, a statement indicating such
- For logs- any observed trends or the lack thereof

1.3.1 Technical Leader (TL)

Each TL will issue a memo for their applicable technical procedures, forms, IOSS instrument procedures, training manual content, Level 3 controlled documents, Level 4 controlled documents, and minor deviation logs (see section [3.8](#)).

1.3.2 CU Quality Assurance Program Manager (QAPM)

The CU QAPM will issue a memo for CHEM-100 and any associated forms.

1.3.3 CU Training Program Manager

The CU Training Program Manager will issue a memo for CHEM-940 and any associated forms.

2 EQUIPMENT

2.1 Reagents

2.1.1 Verification of Reagent Reliability

The reliability of a reagent will be verified prior to, or in concurrence with casework. This may be done in any of the following ways:

- When available, follow the reagent verification instructions given in the applicable technical procedure
- Perform the analysis using suitable reference materials, known materials, controls, and/or blanks and evaluate the outcome
- Measurement of a chemical property (e.g., pH)
- Apply to an item and evaluate a physical property (e.g., contrast of microstructural phases)

Reagent verification data will be kept in an appropriate location, such as within a reagent logbook, the CU Chemicals and Materials System (CAMS) database, an instrumentation binder, data archive, and/or examination records.

2.1.2 Reagent Preparation Records

For each CU prepared reagent, the following information will be recorded on the *CU Reagent Preparation Log* (CHEM-007) or in the CAMS database. Hard copy log sheets will be maintained in a reagent logbook maintained by each discipline/subdiscipline:

- Date of preparation
- Preparer
- Lot number (will contain initials of preparer and date of preparation)
- Components used to make the reagent and their source and lot information
- Verification result(s)
- Expiration date

2.1.3 Labeling of Reagent Containers

2.1.3.1 *Purchased Reagents*

Purchased reagents will have the following information recorded on the container:

- Date received
- Date opened

2.1.3.2 *CU Prepared Reagents*

CU prepared reagents will have the following information recorded on the container:

- Reagent name (using common name or SDS name)
- Lot number (will contain initials of preparer and date of preparation)
- Expiration date

2.1.4 Use of Reagents Beyond Their Expiration Date

A reagent may be used past its expiration date provided that the reagent reliability is verified with each use after the expiration date. The expiration date will not be altered or removed.

2.2 Reference Materials

2.2.1 Certificate of Analysis (COA)

CU's Chemical Inventory Manager (CIM) will ensure that a COA is requested/received from the manufacturer, if available. COAs will be retained by the CIM, with the exception of Metallurgy COAs that are retained on CHEMNET.

2.2.2 Reference Material Verification

A certified reference material (CRM) does not require verification. Additionally, Metallurgy maintains a collection of reference materials that do not require verification. These Metallurgy reference materials are accompanied by COAs that justify the scope of their use, however they do not meet the requirements to be classified as CRMs.

For all other reference materials, only one sample per manufacturer's lot number must be verified. Subsequent reference materials from the same lot will be considered as having the same verification as the original. The identity of the reference material will be verified prior to, or in concurrence with casework. Data supporting the verification of the reference material will be retained.

- From LAB-100, verification- provision of objective evidence that a given item fulfills specified requirements.
- For example, the identity of a reference material could be verified by orthogonal techniques, such as infrared spectroscopy and gas chromatography/mass spectrometry. The specific technical procedure(s) that the reference material will be used for may contain more information regarding the analytical techniques that would be applicable for verification purposes.

2.2.2.1 Discrepancies in Identity

Discrepancies in the identity of a reference material will be discussed with the supplier and the material returned, if applicable. If the material is retained, the container must be labeled with information indicating the discrepancy. Data supporting the new reference material identity will be retained.

2.2.3 Synthesis of a Reference Material

When a reference material is not available from a vendor, it may be necessary to synthesize it. The following information will be recorded and provided to the CIM:

- The procedure used to synthesize the material
- The date of synthesis
- The initials of the person who synthesized it
- Storage requirements

- Controlled substance schedule, if applicable

2.2.4 Use of Reference Materials Beyond Their Expiration Date

A reference material may be used past its expiration date provided that the reference material is verified with each use after the expiration date. The expiration date will not be altered or removed.

2.3 Reference Collections

Reference collections maintained in CU (e.g., paint panels, tape collections) will be handled according to the requirements in LAB-100.

2.4 Known Materials

A known material is an item acquired for method development, validation, and/or comparison with an evidentiary sample (e.g., commercial products, items received directly from manufacturers).

Known materials will undergo the same relevant analytical examinations that are performed on a questioned sample(s) during casework. The equipment, materials, reagents, and other relevant information may be found in the applicable technical procedure(s) being used. Sufficient information will be recorded in the examination records such that the nature of the known material is established.

2.5 Calibrated Equipment

See section [5.2](#).

2.6 Storage

Specialized storage conditions, as defined by the manufacturer, will be met when applicable. Additional information is provided below.

2.6.1 Controlled Substances

All controlled substances (with the exception of low concentration solutions, such as 1 mg/mL reference material solutions) will be stored in room 4297, which is an evidence storage room (ESR) secured for dual-person entry.

The initial product weight of a controlled substance will be recorded electronically in the CAMS database. Each time any amount of a controlled substance is removed from its container, the before and after weights of the container will be recorded in the CAMS database.

3 VALIDATION

3.1 Method Development (Pre-Validation)

Validation starts after a method is acquired and/or developed. If a method needs to be developed in CU (including the modification of an acquired method), the method development will be a planned activity which is recorded and approved on the *Method Development Plan* (CHEM-005) form prior to initiating the method development.

3.2 Validation Plan

A validation plan will be recorded and approved on the *Method Validation Plan* (CHEM-009) form prior to initiating the validation study.

3.2.1 Scope

The scope will declare the targeted matrix(ces) and analyte(s), specific equipment, and analytical method(s). The scope will generally fall into the following categories:

- Measurement of a physical property
- Screening for the presence or absence of a specified analyte or class of analytes
- Qualitative identification of a specified analyte or class of analytes
- Quantitation of a specified analyte or class of analytes

3.2.2 Performance Characteristics

The performance characteristics will vary depending on the scope. This decision requires professional judgment. For example, some performance characteristics are not relevant to particular sample types, but when applicable and appropriate, the following performance characteristics will be evaluated against pre-defined acceptable limits (where applicable).

3.2.2.1 *Measurement of a Physical Property*

- Accuracy

3.2.2.2 *Screening for the Presence or Absence of a Specified Analyte or Class of Analytes*

- Carryover
- Interferences
- Ionization Suppression/Enhancement
- Limit of Detection
- Processed Sample Stability

3.2.2.3 *Qualitative Identification of a Specified Analyte or Class of Analytes*

- Carryover
- Interferences
- Ionization Suppression/Enhancement
- Limit of Detection
- Processed Sample Stability

3.2.2.4 Quantitation of a Specified Analyte or Class of Analytes

- Accuracy
- Calibration Model
- Carryover
- Interferences
- Ionization Suppression/Enhancement
- Limit of Detection
- Limit of Quantitation
- Precision
- Processed Sample Stability
- Dilution Integrity

3.3 Conduct Validation Experiments

The following experiments are listed alphabetically and not necessarily in procedural order. Discipline/subdiscipline-specific documents and/or the validation plan will contain details with regards to the required number of replicates, number of runs, pre-defined acceptable limits, etc.

3.3.1 Accuracy

Accuracy (also referred to as bias) is the closeness of a measured value to the known, or “true” value and is typically reported as a percent difference. The accuracy of an analytical method can be estimated by measuring materials of known concentration or amount and comparing the result(s) with the known value(s). Matrix-matched reference materials are preferred for estimating accuracy. When practicable, these samples are obtained from an independent source rather than produced by the same person performing the validation.

$$Accuracy = \left[\frac{Measured\ Value - Known\ Value}{Known\ Value} \right] \cdot 100$$

3.3.2 Calibration Model

The calibration model is the mathematical model used to describe the relationship between signal response and analyte concentration. When possible, matrix-matched, spiked calibrator samples are analyzed to establish the calibration model.

The most often used calibration model is the least squares model for linear regression, although it should be noted that this model is only applicable when there is constant variance over the concentration range. When there is a significant difference between variances at the lowest and highest concentration levels, an appropriate non-linear model (e.g., weighted least squares) should be applied. Ultimately, the simplest calibration model that adequately describes the concentration-response relationship should be used.

Once established, the calibration model will not be changed unless additional validation studies have been conducted to evaluate and justify the change.

3.3.3 Carryover

Carryover is the appearance of an analyte signal in samples after the analysis of a positive sample. Carryover will be evaluated during method development or validation and its source investigated. This can be accomplished by running matrix blank samples immediately after a high concentration sample or calibration standard. If possible, the analytical procedure will be modified to remove any carryover. In cases when it is not possible to eliminate the carryover, the technical procedure and/or a guidelines document must address how carryover will be assessed (e.g., the signal in a case sample must be ten times greater than the signal in a blank sample immediately preceding the case sample).

3.3.4 Dilution Integrity

Dilution integrity becomes relevant when a sample has to be diluted. For example, if the analyte concentration is found to be above the validated concentration range, then the sample may have to be diluted and reanalyzed. Similarly, low sample volume may necessitate dilution prior to analysis for sample preservation and/or to allow for exams to be conducted.

Dilution integrity will be included as a performance characteristic when validating a quantitative method that will allow for sample dilution. The effect of dilution on the method's accuracy and precision for at least one concentration pool will be evaluated. This will be accomplished by establishing accuracy and within-run precision studies at a common dilution ratio utilized by the method to determine if performance criteria are still met.

3.3.5 Ionization Suppression/Ionization Enhancement

The enhancement or suppression of analyte ionization resulting from the presence of co-eluting matrix components is a phenomenon commonly encountered in liquid chromatography/mass spectrometry (LC/MS). Ionization suppression/enhancement experiments may be performed during the method development phase to ensure extraction and instrumental conditions are optimized. It can be further evaluated during the validation phase using either of the following approaches.

3.3.5.1 Post-Column Infusion

Post-column infusion provides information on retention times where ionization suppression/enhancement occurs. A solution of the analyte is constantly infused with a syringe pump into the mobile phase from the column via a post-column tee-connection and a constant, baseline signal for the analyte of interest is collected. Extracted matrix blanks are injected into the LC/MS. If there is any considerable suppression or enhancement (>25%) of the infused analyte signal at the retention time of the analyte, then modification of the chromatographic system or the sample preparation may be required to minimize the ionization suppression/enhancement.

3.3.5.2 Post-Extraction Addition

Post-extraction addition yields a quantitative estimation of ionization suppression/enhancement. Two different sets of samples are prepared, and the analyte peak

areas are compared between sets to evaluate the ionization suppression/enhancement. The first set consists of the neat standards at both low and high concentrations.

Set two consists of samples extracted from different matrix sources. The extracts are then fortified with the neat standard at either the low or high concentrations.

The average area of each set (\bar{X}) is used to estimate the ionization suppression/enhancement effect at each concentration as follows:

$$Effect = \left[\frac{\bar{X}(extracted)}{\bar{X}(neat)} - 1 \right] \cdot 100$$

A negative value is indicative of ionization suppression [i.e., $\bar{X}(extracted) < \bar{X}(neat)$], while a positive value is indicative of ionization enhancement [i.e., $\bar{X}(extracted) > \bar{X}(neat)$]. In instances where the ionization suppression/enhancement is outside of the limits defined in the validation plan, the method development phase would start over in an attempt to minimize the ionization suppression/enhancement.

3.3.6 Limit of Detection (LOD)

The LOD is an estimate of the lowest concentration (or amount) of an analyte that can be reliably differentiated from the analyte-free matrix and/or the background noise. In some instances, it may not be necessary to establish the absolute LOD provided it is shown to be less than the lowest concentration required by the method. Because a method's LOD incorporates the instrumental performance as well as the sample matrix and inherent procedural limitations, it may be important to assess LOD over multiple days. The LOD may be estimated by one or more of the following approaches.

3.3.6.1 *Estimating LOD for Screening Methods*

This approach is used for non-instrumental screening methods (e.g., chemical color tests). Blank matrix sources are fortified with decreasing concentrations of the specified analyte. The matrix-matched samples are then analyzed. Multiple analysts should be involved in assessing the results if there is subjectivity involved in the screening method. The lowest concentration of analyte that yields a positive result on all runs and confirmed by all participating analysts is considered the LOD.

3.3.6.2 *Estimating LOD Using Background Noise*

The following approaches may be used for determining the LOD of methods that demonstrate equipment-related background noise.

3.3.6.2.1 *Estimating LOD Using Reference Materials*

Matrix-matched reference materials at known concentrations are analyzed. The LOD is defined as the lowest concentration (or amount) of an analyte that reproducibly yields a signal greater than or equal to 3.3 times the noise level of the background signal.

3.3.6.2.2 *Estimating LOD Using Statistics*

The LOD may also be determined by statistically comparing results obtained from blank matrix samples and matrix-matched reference materials at known concentrations. The average and

standard deviation for the signal of the blank samples are calculated. Likewise, matrix-matched reference materials at decreasing concentrations are analyzed, however the signals are evaluated independently (not averaged). The LOD is considered as the lowest concentration of a reference material that consistently yields a signal greater than the average signal of the blank matrix samples plus 3.3 times the standard deviation of the blank matrix samples.

3.3.6.3 *Estimating LOD Using Calibration Curves*

3.3.6.3.1 Concentration of Lowest Non-Zero Calibrator

In some instances, it may be sufficient to define the LOD as the value of the lowest acceptable non-zero calibrator. It is acceptable to use the replicates generated to establish the calibration model (see section [3.3.2](#)).

3.3.6.3.2 Linear Calibration Curve

A linear calibration model is useful for estimating the LOD for quantitative procedures. The LOD is estimated from the standard deviation of the y-intercept (s_y) and the average slope of the best-fit lines (m_{avg}) as:

$$LOD = \frac{3.3 \cdot s_y}{m_{avg}}$$

3.3.7 Limit of Quantitation

The limit of quantitation (LOQ) is an estimate of the lowest concentration or smallest amount of an analyte that can be reliably differentiated and quantitated from an analyte-free matrix. In some instances, it may not be necessary to establish the absolute LOQ, provided it is shown to be at least that of the lowest non-zero calibrator. Because a method's LOQ incorporates the instrumental performance as well as the sample matrix and inherent procedural limitations it may be important to assess LOQ over multiple days. The LOQ may be estimated by one or more of the following approaches.

3.3.7.1 *Estimating LOQ Using Concentration of Lowest Non-Zero Calibrator*

In some instances, it may be sufficient to define the LOQ as the value of the lowest acceptable non-zero calibrator. It is acceptable to use the same replicates that were analyzed to establish the calibration model (see section [3.3.2](#)).

3.3.7.2 *Estimating LOQ Using Reference Materials*

Matrix-matched reference materials are analyzed, and the concentrations are calculated from a calibration curve constructed over the entire working range. The lowest concentration that is capable of achieving an acceptable accuracy (see section [3.3.1](#)) and precision (see section [3.3.8](#)) is considered the LOQ.

3.3.8 Precision

Precision is a measure of the repeatability of a series of measurements of the same sample. It is expressed as the coefficient of variation (%CV) and two different types of precision studies will be assessed during method validation: within-run precision and intermediate precision.

Matrix-matched reference materials are preferred for estimating precision. When practicable, these samples are obtained from an independent source rather than produced by the same person performing the validation.

3.3.8.1 Within-Run Precision Calculations

Within-run precision may be calculated at each concentration level using the average and standard deviation of the replicates within a sequence:

$$\text{Within Run CV}(\%) = \frac{\text{standard deviation (single run of samples)}}{\bar{X} \text{ (single run of samples)}} \cdot 100$$

3.3.8.2 Intermediate Precision Calculations

Intermediate precision may be calculated at each concentration level using the combined data from all replicates as:

$$\text{Intermediate CV}(\%) = \frac{\text{standard deviation (all samples)}}{\bar{X} \text{ (all samples)}} \cdot 100$$

3.3.8.3 One-way ANOVA Approach to Calculating Within-Run and Intermediate Precision

Both within-run precision and intermediate precision may be calculated using the one-way ANOVA approach with the varied factor (run number) as the grouping variable. Using this approach, within-run precisions may be calculated at each concentration level as:

$$\text{Within Run CV}(\%) = \left[\frac{\sqrt{MS_{wg}}}{\bar{X} \text{ (all samples)}} \right] \cdot 100$$

where MS_{wg} is the mean square within groups obtained from the ANOVA table.

Likewise, intermediate precisions may be calculated as:

$$\text{Intermediate CV}(\%) = \left[\frac{\sqrt{\frac{MS_{bg} + (n - 1) \cdot MS_{wg}}{n}}}{\bar{X} \text{ (all samples)}} \right] \cdot 100$$

where MS_{bg} is the mean square between groups obtained from the ANOVA table and n is the number of observations in each group (e.g., $n=3$ when doing triplicate analyses).

3.3.9 Processed Sample Stability

Circumstances may arise in which samples that have undergone routine preparation cannot be immediately analyzed. In these instances, it is important to evaluate the length of time a prepared sample can be maintained before it undergoes changes, which may prevent reliable detection and/or quantitation.

Matrix-matched reference materials are processed and used for stability determinations. It is important to ensure that sufficient quantity is prepared to complete this evaluation, keeping in mind that it may be necessary to split the sample into multiple portions. For example, samples in different autosampler vials may be analyzed every 8 hours up to 72 hours. The average

responses for analytes of interest and any internal standards are used to evaluate any significant changes over the duration of the study.

3.3.10 Interference Studies

Interference studies are used to assess the selectivity of a method. Selectivity is the extent to which an analytical procedure is free from interferences arising from material other than the target analyte(s), including matrix components which may be expected to be present. Selectivity can often be improved by modifying sample preparation or instrumental parameters (e.g., using a different column in chromatography).

The use of an alternate analytical procedure for verification of analytical findings is an additional assessment of selectivity. Whenever possible, orthogonal analytical techniques will be employed to respond to different properties of a particular analyte. For example, Fourier Transform Infrared Spectroscopy (FTIR) and mass spectrometry are orthogonal to each other, while FTIR and Raman spectroscopy are complementary, but non-orthogonal.

3.3.10.1 Matrix Interferences

Matrix interferences are usually sample specific and will be addressed on a matrix-by-matrix basis. When applicable, analyze matrix blanks from different sources to demonstrate the absence of interferences in the matrix.

3.3.10.2 Other Interferences

In certain instances, it is necessary to check for possible interferences from other analytes which may be expected to be present in a sample. For example, a method for analyzing samples for cocaine must be evaluated for interferences caused by the matrix, but also evaluated for common drugs of abuse (e.g., opiates, cannabinoids, amphetamines). This is accomplished by analyzing a negative matrix spiked with the potential interference(s) at appropriate concentration(s). Alternatively, neat standards of potentially interfering compounds can be analyzed for this evaluation.

3.3.10.3 Stable-Isotope Internal Standard Interferences

In methods using stable-isotope labeled analogs, the isotopically labeled compounds may contain the non-labeled compound as an impurity. Additionally, the mass spectra of the labeled analogs may contain fragment ions with the same mass-to-charge ratios as the significant ions of the target analyte. In both instances, the peak area(s) of the analyte could be overestimated.

Internal standard interferences are assessed by analyzing a blank sample spiked with the internal standard and monitoring the signal(s) of the analyte(s) of interest. Likewise, a blank sample spiked with the analyte(s) at the upper limit of the calibration range is analyzed without internal standard, to evaluate if the unlabeled analyte ions appear as isotopically labeled compound fragments.

3.4 Review and Approval of Validation Records

Finalized validation records will be reviewed and approved using the applicable *Method Validation Review* form (CHEM-013a, CHEM-013b, or CHEM-013c).

3.5 Validation Summary

A *Validation Summary* (CHEM-012) form will be completed for each CU validation study that results in a new technical procedure. The individual that led the validation study will complete the form and provide it to the applicable TL. If the TL is the “Lead Scientist” for the study, then another SME will review and approve the validation summary. The summary will briefly describe the performance characteristics that were evaluated to include the values that were obtained for the performance characteristics, if applicable. Other details may be included in the summary. An abstract for a scientific article is a basic model that may be considered when composing the summary.

3.6 Modifications of Validated Procedures

Modifications to a validated procedure require verification that the changes do not have an adverse effect. The decision regarding which performance characteristics require additional validation will be based on logical consideration of the specific parameters likely to be affected by the change(s). These changes may include, but are not limited to:

- Analytical conditions
- Equipment
- Sample processing
- Data software

For example, changes of extraction solvent or a buffer may affect linearity, selectivity, LOQ, precision, and accuracy. A change of the analytical column or mobile phase may affect linearity and selectivity. Parallel studies with known samples utilizing both the previously validated procedure and the modified procedure should be conducted to evaluate the effects of the changes.

3.7 Records

The data generated during method validation studies must be retained. Validation records must include a summary of the studies conducted, who conducted the studies, and the results. The records may include the following:

- *Method Development Plan* (CHEM-005)
- *Method Validation Plan* (CHEM-009)
- Description of performance characteristics that were evaluated. If any of the required performance characteristics were not evaluated, then the reason will be stated.
- Sample preparation steps to include concentrations and matrices
- Data printouts or reference to where the raw data may be found
- Results and calculations

- Conclusions
- References
- *Method Validation Review* (CHEM-013a, CHEM-013b, or CHEM-013c)
- *Validation Summary* (CHEM-012)
- Records of modifications to validated procedures

3.8 Minor Deviations to Previously Validated Procedures

All minor deviations to technical procedures will be recorded by the applicable TL in a centralized location. The format of the records is left to the discretion of the TL. In addition to the required information in LAB-100, the records will include the FBI Laboratory number(s) or batch code(s) [linked to the FBI Laboratory number(s)] associated with the minor deviation.

4 MEASUREMENT UNCERTAINTY

4.1 Scope

These requirements apply to CU personnel recording and/or reporting measurement results that require an estimation of measurement uncertainty. Measurement uncertainty will be estimated for all reported quantitative results and when the measurement uncertainty is relevant to the validity and/or interpretation of qualitative examination results.

4.2 Estimating Measurement Uncertainty

The eight steps listed below are used to estimate measurement uncertainty:

- Step 1: Specify the measurement process
- Step 2: Identify uncertainty components
- Step 3: Quantify uncertainty components
- Step 4: Convert quantities to standard uncertainties
- Step 5: Calculate combined standard uncertainty
- Step 6: Expand the combined standard uncertainty by coverage factor (k)
- Step 7: Evaluate the expanded uncertainty
- Step 8: Report the uncertainty

The CU utilizes uncertainty budgets for performing estimation of measurement uncertainty calculations.

4.2.1 Step 1: Specify the Measurement Process

In the first step, the measurand is defined. The measurand is the quantity intended to be measured. It is important to be as specific as possible when defining the measurand. The measurand will likely be determined by a combination of measurement processes. If necessary, include a reference to a specific technical procedure, instrument, etc., in the statement defining the measurand to distinguish one measurement process from another.

4.2.2 Step 2: Identify Uncertainty Components

Possible uncertainty components associated with the measurement process should be assembled into a reasonably comprehensive list. This list must include all uncertainty components considered, and which uncertainty components were deemed to be significant. An uncertainty component is considered significant if a change in the uncertainty component corresponds to a change in the significant figures of the stated value or uncertainty of the measurement result. Several uncertainty components that may be considered in this process are provided below. The specific measuring device or instrument used will be evaluated in the estimation of measurement uncertainty for the associated technical procedure.

- Sampling (homogeneity, physical state, environment, etc.)
- Sample preparation (homogenizing, dissolving, extracting, diluting, concentrating, derivatizing, etc.)
- Reference materials (purity, ability to matrix match, etc.)
- Uncertainty of a calibration (pipettes, volumetric glassware, balances, etc.)
- Calibration curves (uncertainty of calibrators, matrix matching of calibrators, etc.)
- Analysis (systematic errors, random errors, environment, matrix interferences, run-to-run precision, etc.)

4.2.2.1 *Reconciliation of Uncertainty Components*

Reconciliation simplifies the uncertainty budget. In this step, a review is conducted to determine whether a listed uncertainty component is adequately accounted for by existing data (usually repeatability data) or small experiments are planned to account for the uncertainty component. The basis for this step lies in the fundamental assumption that if an uncertainty component is representatively varied during the course of a series of observations, then the uncertainty associated with that component is adequately accounted for in the repeatability of those observations. Of course, it is important that those uncertainty components that are reconciled in this step are truly represented through the existing data or planned experiments.

4.2.3 Step 3: Quantify Uncertainty Components

Once the uncertainty components have been identified and reconciled, the standard deviation of each will be determined. The approach to calculating the standard deviation is dependent on whether the uncertainty component is classified as a *Type A* or *Type B*.

4.2.3.1 *Type A Uncertainty*

Type A uncertainty is evaluated by the statistical analysis of data from a series of measurements. The CU relies on the use of “historical” data (e.g., method validation data, positive control data) to establish a historical standard deviation for the measurement process. The historical standard deviation is the value assigned to the *Type A* uncertainty associated with the measurement process and the equation for calculating the historical standard deviation (s_{hist}) is shown below:

$$s_{hist} = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}},$$

where $\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$ (i.e., \bar{x} is the mean of the historical data),
and n = the number of measurements

There may be instances where the standard deviation for a measurement process is calculated to be extremely small or even zero due to the standard deviation being less than the resolution of the measuring device. In these instances, the standard deviation (s_p) will be calculated from the below equation, where d = the measuring device resolution. The calculated standard deviation will be compared to the historical standard deviation and the larger value will be used.

$$s_p = \frac{d}{\sqrt{3}}$$

4.2.3.1.1 Measurement Assurance and Updating the Historical Standard Deviation

At least one positive control sample is analyzed when a procedure is used to make a significant measurement (i.e., a measurement that requires an estimation of measurement uncertainty). A range of acceptable values for positive control samples is defined in the associated technical procedure. If a value that does not fall within the acceptable range is observed, then the result will be investigated. If the value cannot be explained (e.g., human error, instrument malfunction) then an appropriate statistical analysis will be performed to determine if the value is an outlier. An outlier value will be rejected and not used to update the historical standard deviation. Otherwise, the value will be included in the updated standard deviation calculation.

The schedule to review and update the repeatability component (i.e., historical standard deviation) used in uncertainty calculations will be defined within the applicable technical procedure.

4.2.3.1.2 Adjustments to the Historical Standard Deviation when Reporting the Average of Multiple Measurements of a Case Specimen (Standard Deviation of the Mean)

It is common for multiple measurements of a case specimen to be made and the average of the multiple measurements to be reported. For historical data that is approximately normally distributed (or for any historical data distribution and $n \geq 30$ measurements on the case specimen), the Central Limit Theorem dictates that the sample mean will be normally distributed with a standard error [i.e., standard deviation of the mean (s_{mean})] calculated as follows, where s_{hist} = the historical standard deviation, and n = the number of measurements used to calculate the average value of the case specimen:

$$s_{mean} = \frac{s_{hist}}{\sqrt{n}}$$

The standard deviation of the mean is then used as the *Type A* uncertainty value. (Note- if applicable, s_{hist} is replaced by s_p in the above equation for s_{mean}).

As an example, if a historical standard deviation for an applicable procedure was equal to 4.38% and a case specimen measurement result was based on an average of 5 measurements, then

the standard deviation of the mean would be calculated as $[(4.3\%) / \sqrt{5}] = 1.9_6\%$. This value of 1.9₆% would then be used as the *Type A* uncertainty value in the estimation of measurement uncertainty calculations (note- in this example three significant figures are carried forward as indicated by the subscript in the hundredths place, with the intention of rounding up to two significant figures at the conclusion of the uncertainty calculations).

4.2.3.2 *Type B Uncertainty*

Type B uncertainty is evaluated by means other than the statistical analysis of data from a series of observations. No single approach is applicable for evaluating and quantifying these uncertainty components. Examples of *Type B* uncertainty components include uncertainty of a calibration (i.e., external calibration services), uncertainty of a reference material concentration, and uncertainty of volumetric glassware.

Some *Type B* uncertainty values can be derived from sources of information that are readily available. These sources include:

- Calibration certificates
- Manufacturer's specifications
- Reference data

When information sources such as those listed above are not available for deriving *Type B* uncertainty values, but the upper and lower limits of the equipment are known, then the uncertainty value will be estimated using the Rectangular Distribution or Triangular Distribution approaches described below. When in doubt, use the Rectangular Distribution approach as it is the more conservative approach.

4.2.3.2.1 *Type B Uncertainty- Rectangular Distribution*

A Rectangular Distribution approach can be used to estimate a *Type B* uncertainty component if the following criteria are met: the upper and lower limits of the equipment are known, the probability that a value lies outside of these limits is zero, and one value is just as likely as another value between the limits (equal probability). For a Rectangular Distribution, the upper limit = +a, the lower limit = -a, and the possible range of values = 2a. The calculation to estimate the equivalent of one standard deviation is defined as:

$$s = \frac{a}{\sqrt{3}}$$

For example, if a 100 mL volumetric flask has a tolerance of ± 0.2 mL, then the upper limit = +0.2 mL, the lower limit = -0.2 mL, and the range of the outer limits = 0.4 mL. The estimated standard deviation is calculated as:

$$s = \frac{0.2 \text{ mL}}{\sqrt{3}} = 0.1_2 \text{ mL}$$

4.2.3.2.2 *Type B Uncertainty- Triangular Distribution*

A Triangular Distribution approach can be used to estimate a *Type B* uncertainty component if the following criteria are met: the upper and lower limits of the equipment are known and a

value near the center is more likely than one at the upper or lower limit. For a Triangular Distribution, the upper limit is still equal to +a, and the lower limit is still equal to -a. The calculation to estimate the equivalent of one standard deviation is defined as:

$$s = \frac{a}{\sqrt{6}}$$

4.2.4 Step 4: Convert Quantities to Standard Uncertainties

Standard uncertainty is simply the measurement uncertainty expressed as a standard deviation. All statistically calculated uncertainty components (*Type A*, *Type B*- Rectangular Distribution, and *Type B*- Triangular Distribution) should already be expressed as one standard deviation.

The information source (e.g., calibration certificate) for any other *Type B* component must be carefully reviewed in order to arrive at the standard uncertainty. For example, calibration certificates generated by NIST are typically calculated assuming a normal distribution and reported at a ~95.45% confidence level ($k = 2$). In this case, the reported uncertainty on the certificate will be divided by the coverage factor, 2, to arrive at the standard uncertainty.

In preparation for the next step, all standard uncertainties must be expressed in the same measurement unit. If the same measurement unit is not associated with each standard uncertainty, then convert each standard uncertainty into a percentage (i.e., relative standard uncertainty).

4.2.5 Step 5: Calculate Combined Standard Uncertainty

In this step, all of the individual standard uncertainties are combined to calculate a standard uncertainty of the measurement process, which is an estimated standard deviation. This combined standard uncertainty [$u_c(y)$] is calculated as the square root of the sum of the variance of each of the combined uncertainty components:

$$u_c(y) = \sqrt{s_{hist}^2 + s_p^2 + u_0^2 + u_1^2 + u_2^2 + \dots + u_i^2},$$

where s_{hist} and/or s_p are the *Type A* calculated standard uncertainties for the measurement process and u_i are the *Type B* calculated standard uncertainties.

4.2.6 Step 6: Expand the Combined Standard Uncertainty by Coverage Factor (k)

The combined standard uncertainty calculated in the previous step is an estimated standard deviation with a confidence level of ~68.27% ($k = 1$). The combined standard uncertainty will be expanded by an appropriate coverage factor (k) to yield a confidence level of $\geq 95.45\%$. The specific value for the coverage factor is based on the amount of data that is available for the measurement process (i.e., *Type A* data). For example, Table 1 provides the coverage factor (k) to apply for a confidence level of 99.73% (two-tailed) based on a Student's t-distribution with degrees of freedom = $(n-1)$, where n is equal to the number of *Type A* data points. Coverage factors other than those shown in Table 1 can be calculated using the T.INV.2T function in

Excel®. The combined standard uncertainty [$u_c(y)$] is simply multiplied by the coverage factor to yield the expanded uncertainty (U) as shown below:

$$U = k * u_c(y)$$

Table 1: Coverage factor, k , for Student's t-distribution at a 99.73% confidence level
[from Excel® "T.INV.2T" function, probability = 0.0027, reported as "99.7% confidence level"]

Degrees of Freedom	k-value (99.73% CL)
10	3.957
11	3.850
12	3.765
13	3.695
14	3.636
15	3.587
16	3.545
17	3.508
18	3.476
19	3.448
20	3.423
25	3.330
30	3.271
35	3.230
40	3.199
60	3.130
80	3.097
100	3.077
500	3.016
10000	3.001

4.2.7 Step 7: Evaluate the Expanded Uncertainty

In this step the expanded uncertainty (U) is evaluated to determine if it makes sense and is reasonable. This evaluation may identify calculation errors that can be corrected. Additionally, if pre-determined acceptable limits were defined for measurement uncertainty, then the expanded uncertainty will be evaluated against the acceptable limits. If the measurement uncertainty is deemed to be unacceptable, areas of method improvement can be identified and evaluated for their impact on the estimation of measurement uncertainty using the information available from Steps 3 and 4.

4.2.8 Step 8: Report the Uncertainty

Expanded uncertainty will be rounded up and reported with two or less significant figures. This rounding up should only be done at the end of the measurement uncertainty calculation, to

prevent cumulative effects from rounding up each standard uncertainty value. The reported measurement result will be truncated to the same level of significance that the rounded expanded uncertainty is reported. For example, if the measurement uncertainty of an analyte concentration is 29 ng/mL (99.7% confidence level), and the measurement result for the case specimen is 498.23 ng/mL, then the measurement result will be truncated and reported as 498 ng/mL.

When reporting quantitative values in a *Laboratory Report*, the CU will adhere to the requirements described in LAB-200. For example,

"Item 1 weighed 506.5 milligrams \pm 1.2 milligrams (99.7% confidence level)."

4.3 Records

Supporting records related to the estimation of measurement uncertainty may be maintained in multiple locations to include technical procedures, validation binders, measurement uncertainty records [to include electronic files (e.g., Excel® spreadsheets)], and case files. Refer to LAB-100 for the specific information that needs to be recorded.

5 MEASUREMENT TRACEABILITY

Measurement traceability is required for all measurements where measurement uncertainty is estimated. Measurement traceability can be characterized by the following essential elements:

- Documented unbroken chain of calibrations
- Documented measurement uncertainty (including specification of the measurand and evaluation of each step in the traceability chain)
- Documented measurement procedure
- Technical competence
- Realization of the International System of Units (SI Units)
- Documented calibration intervals
- Measurement assurance

5.1 Establishing Measurement Traceability

5.1.1 Establishing Measurement Traceability Via Calibration of Equipment Used

5.1.1.1 Equipment List

The following CU equipment requires calibration when the measurement accuracy or measurement uncertainty of the equipment affects the validity of the examination and/or the calibration is required to establish metrological traceability of the examination. However, equipment of the type listed below that is used in CU for qualitative purposes only is not required to be calibrated. The specific equipment requiring calibration is recorded in the LIMS.

- Balances
- Weight sets
- Pipettes
- Rockwell Hardness tester (HRB and HRC scales)

- Microhardness tester (Knoop and Vickers scales)
- Micrometers
- Calipers
- Gauge blocks
- Load cells
- Extensometers
- SmartScope
- Volumetric glassware

5.1.1.2 Specifications for Suppliers of External Calibration Services

See LAB-100.

5.1.1.3 Specified Requirements for Calibrations

Suppliers of external calibration services will be considered to meet CU requirements when the supplier meets the specifications in LAB-100 and a calibration certificate is supplied that provides the calibration status, the specified property, its associated measurement uncertainty, and a statement of metrological traceability. Reviews of calibration certificates for accuracy and conformance are recorded in the LIMS.

5.1.1.4 Interval of Calibration

The calibration due date for CU equipment that requires calibration is maintained in the LIMS and is indicated on (or near) the equipment where practicable.

5.1.2 Establishing Measurement Traceability Via CRMs

5.1.2.1 Calibrators and Controls

CRMs with valid measurement traceability will be used as the source of calibrators and controls when calibrators and/or controls are used in conjunction with a measuring system to establish measurement traceability. If the CRM is changed in a way that alters the traceable measurement value (e.g., dilution) then calibrated equipment (e.g., pipette, volumetric glassware) will be used to alter the CRM and will be considered part of the traceability chain.

Specific information related to preparation of calibrators and controls can be found in the applicable CU technical procedures.

5.1.2.2 Specified Requirements for CRM Providers

Suppliers of CRMs used to establish measurement traceability will be considered to meet CU requirements when the supplier meets the specifications in LAB-100 and a certificate of analysis is supplied that provides the specified property, its associated measurement uncertainty, and a statement of metrological traceability. Reviews of calibration certificates for accuracy and conformance are maintained by the applicable TL.

5.2 Measurement Assurance (Calibration Checks)

Calibration checks are utilized to maintain confidence in the calibration status of equipment used for significant measurements (i.e., a measurement that requires an estimation of

measurement uncertainty). If calibration checks are utilized for equipment not addressed below, the details can be found in the applicable CU technical procedures.

5.2.1 Balances and Weight Sets

All balances are clearly marked as 'traceable' or 'not traceable' to indicate whether or not they can be used for a significant measurement. The following procedure will be performed on 'traceable' balances prior to the first use of the balance to make a significant measurement on a given day. Checking a value recorded on a 7-248 or FD-723 drug label is not considered a significant measurement. The calibration check will be waived during the time period when the weight sets are out for external calibration.

- A. Verify the balance is clean.
- B. Run the internal 'autocalibration' feature (if available).
- C. Verify the balance is properly zeroed.
- D. Use forceps and gloves when handling weights.
- E. Refer to Table 2 or the applicable log sheet and measure each of the indicated weights, ensuring the balance is properly zeroed between measurements. Allow the balance to stabilize before recording the observed weight.
- F. Record the measurements on the log sheet.
- G. Refer to Table 2 or the applicable log sheet for the tolerances. Record the appropriate information on the log sheet. If a measured weight is outside of its tolerance, provide the data to the CU QAPM for assessment of the calibration status of the balance.
- H. If a balance calibration is found to be out of specification, the IOSS Instrument Manager or appropriate instrument support personnel will determine the corrective action to be taken.

Table 2- Calibration Check: Weights and Tolerances

Balance Resolution	Calibration Check Weights	Tolerance
0.1 mg	100 mg, 1 g, 10 g	± 0.3 mg
0.001 g/ 0.01 g	2 g, 20 g	± 0.002 g
	100 g	± 0.02 g
0.1 g	5 g, 500 g, 2 kg	± 0.2 g

5.2.1.1 *Measurement Uncertainty*

Measurement uncertainty information for CU balances is maintained by the CU QAPM. The Type A repeatability uncertainty component of the balances will be updated annually using the calibration check data.

Measurement uncertainty worksheets are available on CHEMNET. The expanded uncertainty is provided at a 99.73% confidence level on the worksheets (reported as "99.7%"). If a weight is

determined by the difference of more than one weighing (i.e., weight by difference) then the expanded uncertainty for the measurement will be calculated as the root-sum-square (RSS) of the expanded uncertainty of each weighing.

5.3 Records

Measurement traceability relies upon a variety of records. Applicable TLs will ensure the necessary records are compiled into a measurement traceability file, which may consist of paper and/or electronic records. The CU QAPM will compile the necessary records for the balances and weight sets. At a minimum, this measurement traceability file will contain:

- A list of uncertainty components deemed to be significant to the measurement and how traceability of each of the uncertainty components is established (i.e., through calibration of equipment and/or through CRMs)
- List of approved providers of calibration services and/or CRMs
- Supporting documentation that demonstrates a supplier of external calibration services meets requirements (see LAB-100 for requirements)
- Equipment calibration certificates (maintained on the UNET Equipment Calibration and Service site)
- Reviews of equipment calibration certificates for accuracy and conformance (recorded in the LIMS)
- Supporting documentation that demonstrates a CRM provider meets requirements (see LAB-100 for requirements)
- CRM certificates of analysis
- Reviews of CRM certificates of analysis for accuracy and conformance
- Supporting data and/or calculations that demonstrate calibration of particular equipment is not significant to the measurement result and associated measurement uncertainty (where applicable)

6 PROFICIENCY TESTING/INTRALABORATORY COMPARISON

Each CU examiner and analyst must complete one annual open proficiency test in each “Test Description” listed in Table 3 in which they routinely perform casework. Note- the “Metallurgy (Trace Metal Comparison)” test is an intralaboratory comparison.

Table 3- CU Proficiency Test/Intralaboratory Comparison Summary

Discipline/Subdiscipline	Test Description	Frequency
Seized Drugs	Drug Analysis	1/year/individual
Fire Debris	Ignitable Liquid Identification	1/year/individual
Materials (Trace)	Chemical Unknown	1/year/individual
	Paint	1/year/individual
	Tape	1/year/individual
	Metallurgy (Trace Metal Comparison)	1/year/individual
	Metallurgy (Steel Quantitation)	1/year/individual

6.1 Approved Proficiency Test Suppliers

The CU proficiency test representative (CU PTR) will maintain the following records for proficiency test providers.

- List of proficiency test providers that have been evaluated and approved for use
- Supporting documentation that demonstrates a proficiency test provider meets requirements (see LAB-100 for requirements)

6.2 Distribution

Prior to distribution of any proficiency test, the “Participant & Test Info” and “Test Preparation” sections of the *CU Performance Monitoring Preparation and Evaluation Form* (CHEM-006) will be completed by the CU PTR. The CU PTR will ensure the proficiency test and associated paperwork are delivered to the test participant. The test participant will sign and date the applicable memo as an acknowledgment of receipt of the proficiency test and due date. This memo will be retained in the proficiency test file.

6.3 Metallurgy Intralaboratory Comparison (Trace Metal Comparison)

6.3.1 Preparation

The Trace Metal Comparison test will be prepared as needed by the CU PTR and/or an examiner/analyst that is authorized in the applicable discipline/subdiscipline. Any other personnel participating in sample preparation will need prior approval from the applicable TL. This approval will be recorded on the CHEM-006 form or attached records. Sample and test preparation records will be retained permanently in the intralaboratory comparison file.

6.3.2 Test Design

The intralaboratory comparison will consist of either a positive or negative association based on the composition of the material. All samples provided to the participant will come from a source that has an established composition. The sources include NIST-traceable reference materials or other metal samples of known provenance. The samples should be chosen to be homogeneous for the purposes of analysis and should be of sufficient size to allow all necessary analyses to be performed. The individual samples will be placed in appropriate, separate packaging and given unique identifiers. The sample(s) and test preparation information will be provided to the CU PTR. The CU PTR will distribute the test sample(s) to the participant.

6.3.2.1 Positive Test

The positive test will consist of a minimum of three splits of samples provided to each participant. At least two of the splits will be from the same source.

6.3.2.2 Negative Test

The negative test will consist of a minimum of three splits of samples provided to each participant. All of the splits will be from different sources.

6.4 Proficiency Tests

The CU PTR will ensure proficiency tests are procured for CU. Proficiency tests are administered as directed by the provider. Additional information is provided below.

6.4.1 Tape Analysis

In the event that the test sample(s) received consist of a type of tape not routinely analyzed by CU (e.g., office tape, masking tape), the CU PTR will coordinate the preparation of an intralaboratory comparison using retained proficiency tests. The sample(s) and test numbers will be changed so they cannot be correlated to published test results.

6.4.2 Metallurgy (Steel Quantitation)

Measurement uncertainty will not be estimated nor reported for this test since it does not influence the interpretation of the results of examinations and the test provider (ASTM) does not allow it to be reported.

6.5 Analysis Approach

Each analyst and examiner will complete their portion of a proficiency test or intralaboratory comparison independently.

6.6 Reporting and Evaluation

Proficiency test and intralaboratory comparison results will be reported and reviewed similar to casework. The requirements for marking case records are the same as for casework, with the exception that the CU Test ID # (analogous to the FBI Laboratory number in casework) only needs to be on the first page of bound examination records.

6.6.1 Division of Labor

For a proficiency test/intralaboratory comparison assigned to an analyst, the analyst will provide all notes and analytical data to an examiner authorized in the applicable discipline/subdiscipline. For an intralaboratory comparison, the analyst and examiner will complete their respective portions of the *CU Intralaboratory/Interlaboratory Comparison Results Form* (CHEM-004). For proficiency tests, the examiner will complete the provider's data sheet(s).

6.7 Verifications, Technical Reviews, and Administrative Reviews

Verifications, technical reviews, and administrative reviews will be conducted and recorded as would be done for a typical case. See LAB-100 for additional details.

6.8 Completed Intralaboratory Comparison/Proficiency Test Samples

Upon completion of a proficiency test/intralaboratory comparison, all remaining samples will be returned to the CU PTR.

6.9 Evaluation

The "Evaluation" section of the CHEM-006 form will be completed by a SME in the task being evaluated. The Evaluator, UC, and Participant will then sign and date the form after reviewing the proficiency test/intralaboratory comparison and summary report(s).

6.10 Records

The CU PTR will ensure that the relevant records associated with a completed proficiency test/intralaboratory comparison are maintained permanently. The following records will be maintained in CU, electronically, and/or in the LIMS:

- *CU Performance Monitoring Preparation and Evaluation Form* (CHEM-006)
- Examination records
- Results of test and sample validations (for intralaboratory comparisons)
- Memo from the CU PTR to the test participant that accompanies the proficiency test/intralaboratory comparison
- *CU Intralaboratory/Interlaboratory Comparison Results Form* (CHEM-004)
- Results and evaluation notices from proficiency test providers
- All notices to and from the Laboratory Division Proficiency Test Program Manager (PTPM) concerning a particular test
- Completed provider data sheets

7 EVIDENCE HANDLING AND EXAMINATION PROCESS

Appendix A contains a list of abbreviations that are specific to CU. Any other CU-specific abbreviations will be defined upon first use within each case file.

7.1 Evidence Handling

7.1.1 Evidence Storage

Other than the below exceptions, evidence will be stored in an ESR Redacted at the end of each day. When evidence is stored in a location other than an individually assigned locker within an ESR, each transfer to-and-from the storage location (e.g., cage, refrigerator, shelf) will be recorded.

Evidence that is not transferred to an ESR at the end of the day will be secured by placing an “Evidence Do Not Disturb” sign (or similar) on top or in front of the evidence and locking the door to the room (where possible). This practice is limited to evidence that is too large and/or bulky to transfer, or evidence that is being processed in a manner that prohibits transfer. Transfer of the evidence to the non-ESR storage location will be recorded at the end of each day it was examined.

7.1.2 Evidence Seal- Boxes with Zip Tie Closures

Boxes with zip tie closures (also referred to as “blue bins”) will be considered properly sealed when zip ties are applied to both ends of the box and each zip tie is initialed by the individual sealing the box.

7.1.3 Repackaging Drug or Valuable Evidence Following CU Exams

Where practicable, any item(s) that require additional examinations (e.g., latent prints) will be separated from bulk drug evidence and repackaged. An *FBI Laboratory Drug Evidence* label (7-248) is not required if the item(s) can be handled as general evidence within the FBI Laboratory.

Note- it is the responsibility of the last discipline/subdiscipline on the *Examination Plan* to properly seal drug or valuable evidence that was handled as general evidence using the applicable *FBI Laboratory Drug Evidence* label (7-248) or *FBI Laboratory Valuable Evidence* label (7-287). Refer to the *Handling Drug/Valuable Evidence* flow chart in LAB-200.

7.2 Acknowledgement

For Single Unit Submissions (SUS), the submission manager will ensure the customer is contacted to acknowledge receipt of the request and/or item(s) within 14 calendar days of the request and/or item(s) being received in CU, to include requests for storage only. See LAB-200 for additional requirements.

7.3 Evidence Inventory

After a submission is assigned and the evidence is delivered to the CU, the evidence container(s) and/or packaging will be opened and the contents inventoried. The *CU Evidence*

Check-In Sheet (CHEM-003) form or the *FBI Laboratory Evidence Check-In Notes* (generated in the LIMS) will be used for recording the inventory.

The CHEM-003 form is not required when the evidence management personnel's *FBI Laboratory Evidence Check-In Notes* adequately describe the details of the received evidence, so long as the applicable examiner or analyst records this review.

7.4 Examination Process

7.4.1 Secondary Evidence

Secondary evidence is material derived from an examination process on an item of evidence (e.g., prepared microscope slides, pill boxes containing debris, vials containing extracts, homogenates). If sufficient original evidence remains after the examination process such that the process could readily be repeated, then the material is not required to be retained as secondary evidence.

Secondary evidence is recorded on the *CU Secondary Evidence Log* (CHEM-008). The item description will include "Secondary Evidence" along with the unit, FA discipline, number, and type of evidence. For example:

- Item 2 Secondary Evidence, Chemistry-General (2 vials)

7.4.2 Autosampler Verification

When an autosampler is used, a sequence log containing the file name, autosampler position, and sample identification will be printed, or otherwise retained. For instruments that do not have the ability to print a sequence log, or in other situations when a sequence log cannot be obtained, the *CU Autosampler Verification Log* (CHEM-000) will be completed and retained. The sequence log or CHEM-000 form will be completed by the instrument operator and will be acknowledged by the operator (e.g., initialed, electronic entry, communication log entry) to indicate that the sequence was checked against the sample position(s) to ensure the two are in agreement.

8 CASE RECORD AND REVIEWS

The phrase "examination records" is used in CU to apply to case notes, data printouts, sequence logs, method parameters, etc. that are part of the technical content of a case 1A.

8.1 Initialing of Examination Records

The preparer of physical examination records will initial each page by hand.

Electronic examination records will be 'initialed' by the preparer using a secure electronic signature (e.g., using the "Approve" feature in the LIMS) or by acknowledging the specific records via a Communication Log entry.

8.2 Review of Examination Records Not Prepared by the Issuing Examiner

The issuing examiner will record their review of the examination records by initialing each page, or by recording a statement indicating the data and results have been reviewed for each applicable laboratory activity (e.g., handwriting a statement on the first page of a data packet, creation of a Communication Log entry addressing each activity).

8.3 Contemporaneous Changes to Physical Records

If a handwritten change is made contemporaneously to a physical record, this will be indicated with an asterisk (*) along with an initialed single strike-out and the change entered alongside.

8.4 Verifications

8.4.1 Identification

Within the context of verifications, an identification comparison result is defined as follows:

- Identification- a determination that two or more items or materials were once part of the same object (i.e., physical fit).

The verification of an identification comparison result will be documented in an examination record, or within the Comments field of the LIMS technical review by the individual conducting the verification. The verification details will include the independent conclusion(s) reached and the date(s) the activity(ies) occurred.

Note- the identification of a specific chemical or component as part of an item of evidence is not considered an identification *comparison result*. For example, the identification of a specific chemical, alloy, or commercial product is not an identification comparison result that requires a verification.

8.4.2 Association

Within the context of verifications, an association comparison result is defined as follows:

- Association- a determination that a relationship exists between two or more items of evidence or between an item of evidence and a known material (see section [2.3](#)). Discipline/subdiscipline technical procedures may contain additional details.

The verification of an association comparison result is conducted as part of the technical review of the examination records. The record of the technical review within the LIMS will serve as the record of the verification of an association comparison result.

Note- associations resulting from fiber examinations conducted by a Paints and Polymers examiner may be verified by a Trace Evidence Unit (TEU) examiner. In these instances, the verification will be recorded in an examination record or within the LIMS.

8.5 Technical Reviews

8.5.1 Examinations Conducted by CU Personnel

CU conducts a technical review of all *Laboratory Reports* and technical records that communicate results of examinations performed within CU. In addition to the requirements in LAB-200, a CU technical review will include a check of manual calculations, data transcriptions, and data reductions relevant to the examinations.

8.5.1.1 Packets

An examiner may perform a technical review of a *Laboratory Report* and technical records that contain a “packet(s)” of examination records they authored/co-authored, provided that the packet(s) has been technically reviewed by another authorized individual in the discipline/subdiscipline that did not author/co-author the packet(s) in question. The technical review of the packet(s) will be recorded on the first page of the packet(s) with the reviewing examiner’s initials and/or signature (handwritten or secure electronic equivalent), the date, and a statement indicating that the packet(s) has been technically reviewed.

8.5.2 Outsourced Examinations

Laboratory Reports and technical records that communicate results of examinations that were completely outsourced will be technically reviewed at a frequency of 20% or more.

8.6 Administrative Reviews

CU conducts an administrative review on all *Laboratory Reports* and associated records.

8.6.1 Reviewers

Authorized CU administrative reviewers are documented in an Electronic Communication (EC) uploaded to Sentinel.

8.6.2 Packets

A reviewer may perform an administrative review on a case record that contains a “packet(s)” of examination records they authored/co-authored, provided that the packet(s) has been administratively reviewed by another reviewer that did not author/co-author the packet(s) in question. The administrative review of the packet(s) will be recorded on the first page of the packet(s) with the reviewer’s initials and/or signature (handwritten or secure electronic equivalent), the date, and a statement indicating that the packet(s) has been administratively reviewed.

8.7 Expedited Results

Expedited or partial results of an examination(s) will be technically reviewed and verified (if applicable, see section [8.4.1](#)) prior to dissemination. The technical review and verification will be recorded in an examination record.

8.8 Recording Nonconformities

Nonconformities will be recorded within the log maintained on the CU O365 SharePoint site.

8.9 Performance Monitoring Records

Required performance monitoring records for applicable laboratory tasks performed by personnel that do not participate in a proficiency test, interlaboratory comparison, or intralaboratory comparison will consist of one or more of the following:

- Annual performance feedback (e.g., check-in, wrap-up) specific to the laboratory task
- A record describing the direct observation of the laboratory task [see LAB-100, *Performance Monitoring Other Than Proficiency Testing* (7-290a-c) form].
 - Note- refer to ANAB GD 3152 for applicable laboratory tasks
 - Note- direct observation will occur once an accreditation cycle

9 REVISION HISTORY

Revision	Issued	Changes
04	11/15/2024	<ul style="list-style-type: none"> Added Section 2.3 to differentiate 'reference collections' from 'known items' Sections 3.4, 3.7- clarified that CHEM-013 has an a, b, or c version Section 5.2.1- added note addressing the checking of drug label weights as not being a "significant" measurement. Removed Toxicology from Table 3 Sections 6.2, 6.10- corrected title of CHEM-006 form Moved previous Section 6.3 to new Section 6.5 Deleted previous Section 6.5.1 (Toxicology Survey AL1) Sections 6.6.1, 6.10- revised title of CHEM-004 form (revised form will also be issued) Section 6.9- edited to require a SME be the evaluator Deleted previous Section 7.1.2.2- Exception for Toxicology racks (storage of tubes/containers without a proper seal) Section 7.2- clarified requirement for acknowledgements being sent within 14 days Section 8- defined "examination records" and used the term throughout the document (previously was "case notes", which could be interpreted as narrower in scope) Deleted previous Section 8.1 (annotations to case notes) Added Sections 8.1 and 8.2 (initials/reviews of examination records) Section 8.4.1- removed "fracture fit" as a phrase Section 8.5.2- removed "approximately" from 20% or more Edited Section 8.7 for clarity (expedited results) Section 8.9- edited for clarity- removed "CU personnel" as may apply to non-CU employees, removed Sentinel as location of records (performance monitoring records) Removed several abbreviations from Appendix A, added "Neg. Ctrl."

Appendix A - CU Abbreviations

ABS	acrylonitrilebutadiene-styrene co-polymer	TWt	tare weight
BC	basecoat	VCF	vacuum collection filter
BOPP	biaxially-oriented polypropylene	w/f	warp/fill
bpt	black plastic tape	ZPB, ZLB, ZPLB	ziplock/zippered plastic bag
cap	capsule		
CC	clear coat		
CD, c.d.	cross direction		
CT	culture tube		
gms	glass microscope slide		
GSV	gray stoppered vial		
gws	glass well slide		
GWt	gross weight		
HDPE	high-density polyethylene		
HS	heat-sealed		
HSB	heat-sealed bag		
HSE	heat-sealed envelope		
HSEE	heat-sealed evidence envelope		
IS, ISTD	internal standard		
LDPE	low-density polyethylene		
LSV	lavender stoppered vial		
MD, m.d.	machine direction		
MMA	methyl methacrylate		
MMY	make/model/year		
MOPP	monoaxially-oriented polypropylene		
NC, neg. con., Neg. Ctrl.	negative control		
ND, n.d.	not detected		
N/R	no reaction		
NR, n.r.	not reporting		
PB	plastic bag		
PBX	pill box		
PC	positive control		
PE	polyethylene		
PP	polypropylene		
PS	polystyrene		
RSV	red stoppered vial		
SBR	styrene butadiene rubber		
SIS	styrene-isoprene co-polymer		
Tab	tablet		
TM	testmix		
tt	test tube		