Technical Procedure for the Examination of Glass Evidence

1.0 Purpose – This technical procedure shall be followed for the examination of glass evidence.

2.0 Scope – This document shall be used as a guideline for the forensic examination of glass. These guidelines are used by Forensic Scientists in the evaluation, selection and application of tests regarding glass examination.

3.0 Definitions

4.0 Equipment, Materials, and Reagents

4.1 Equipment

- Polarized light microscope
- Stereomicroscope
- Calipers
- Ultra-sonic cleaner
- Ultraviolet Viewing Cabinet with 254 nm (short) and 365 nm (long) wavelengths
- Glass Refractive Index Measurement System (GRIM)
- X-Ray Fluorescence System (XRF)

4.2 Materials

- Clean paper (brown and/or white)
- Metal tin
- Gelatin capsules
- Tweezers
- Kimwipes

4.3 Reagents

- Acetone - Reagent A.C.S. grade
- Diluted nitric acid solution (5-10 %)
- Mild detergent

5.0 Procedure

5.1 Analytical Approach

5.1.1 Most Trace Evidence cases involve some degree of evidence screening, either visually/microscopically or in combination with instrumental techniques. Preliminary evaluation of the known's characteristics is warranted when screening is performed in order that those questioned units suitable for further comparison can be selected. When proceeding to further comparison of known and questioned samples, beginning with the questioned items is required unless case constraints dictate otherwise.

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5.1.2 Review the request for analysis. A request for physical fit examination shall be transferred to an analyst trained in physical fit prior to a glass examination. A request for direction of force or type of break examination shall be returned to the agency with a statement indicating those examinations are not performed at this laboratory.

5.1.3 Perform screening, searching, and retrieval of glass evidence from items using the Trace Evidence Section Technical Procedure for the Collection and Preservation of Evidence

5.1.4 Using a stereomicroscope, isolate any potential glass fragments from the item of evidence or in the debris resulting from the collection and preservation process.

5.1.5 Determine if the fragments are glass using one or more of the methods described under **Glass Determination Methods**. If glass fragments are not found, the examination shall conclude.

5.1.6 Record the number, or approximate number, of glass fragments and, if applicable, the condition of the glass.

5.1.7 Clean glass fragments as necessary. This can be done using water, a solvent such as acetone, or a diluted acid, such as 5 % to 10 % nitric acid. Some fragments may require the use of detergent and/or an ultra-sonic cleaner to remove debris.

5.1.8 If sample size permits, determine and record the physical characteristics of the glass.

5.1.8.1 Color.

5.1.8.2 Type (e.g., flat, container, curved, tempered, laminate, etc.).

5.1.8.3 Thickness using calipers; measured sides must be parallel. Thickness measurements are not required on non-flat glass such as container glass.

5.1.8.4 UV Fluorescence: Observe the glass fragment under short wave and long wave UV light. If the glass fluoresces, note the wavelength and location of fluorescence.

5.1.8.5 Additional notes, if applicable, include recording surface features such as additional coatings, manufacturing or non-manufacturing features (scratches, etc.).

5.1.9 If there are differences between the physical properties of the questioned and known samples, the examination shall conclude. If the physical properties are consistent between the questioned and known samples, the examination shall continue to **Elemental Analysis** and **Glass Refractive Index Determination** as sample size permits.

5.1.10 At the completion of the examination, the Forensic Scientist shall issue a report stating his or her findings using the **Guidelines for Glass Examination Result Statements** as a guide.

5.2 Glass Determination Methods

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5.2.1 Use a polarized light microscope to determine if the fragments are isotropic or anisotropic. Anisotropic particles are not glass. If the particle is glass, the particle will remain extinct (no interference colors or rainbows) under crossed polars. There will be no interference colors during rotation of the stage.

5.2.2 Place the particle into an organic solvent such as acetone. If the particle exhibits soluble characteristics, it is not glass.

5.2.3 Glass fragments can be differentiated from plastics by their hardness. If the pressure of a needle/probe causes deformation, the particle is not glass.

5.3 Elemental Analysis

5.3.1 If sample size permits, measure the elemental composition of the glass samples. See the Trace Evidence Section Technical Procedure for Micro X-Ray Fluorescence (µ-XRF) Spectrometry. If the sample is too small, the Forensic Scientist shall document this and move on to **Glass Refractive Index Determination**.

5.3.1.1 Effort shall be made to compare known and questioned samples of similar size, shape and thickness to ensure the best results.

5.3.1.2 If the sample is float glass, the non-float side shall be placed toward the x-ray detector.

5.3.1.3 Analyze a minimum of three replicates per questioned sample and a minimum of nine replicates per known sample.

5.3.1.4 Compare the spectra for the known and questioned samples to determine if there are any elemental differences. Reproducible differences, such as spectral shape and relative peak height, may indicate the samples have different sources which can be confirmed by calculating peak intensity ratios.

5.3.1.5 Export the instrument results into an Excel template which has the capability to calculate the peak intensity ratios for Ca/Mg, Ca/Ti, Ca/Fe, Sr/Zr, Fe/Zr, and Ca/K. Additional ratios may be used depending on the elements present in the sample.

5.3.1.5.1 When the area of a characteristic energy peak for an element has a signal-to-noise ratio of ten or more, that element may be used for peak intensity ratio comparisons.

5.3.1.6 Compare the peak intensity ratios for the questioned and known samples. If the ranges for one or more elements do not overlap, the samples are distinguishable.

5.4 Glass Refractive Index Determination

5.4.1 If sample size permits, measure the refractive index of the questioned and known glass

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sample using the Glass Refractive Index Measurement System. See the Trace Evidence Section Technical Procedure for Glass Refractive Index Measurement.

5.4.2 Collect a minimum of three (3) refractive index measurements for the questioned sample and note the average of the measurements.

Establish the range of the known sample by obtaining a minimum of ten (10) refractive index measurements for a known non-tempered sample and a minimum of twenty (20) refractive index measurements for a known tempered sample.

5.4.3 If the average refractive index of the questioned sample falls within the range of refractive index measurements for the known sample, the refractive index of the two glass samples is considered indistinguishable.

5.5 Guidelines for Glass Examination Result Statements

5.5.1 A methodology statement shall be added to all reports in which analysis was performed.

5.5.1.1 Example: The following methodologies were used in the examination of this case: visual examination, physical examination, microscopy, digital calipers, UV fluorescence, XRF and GRIM3.

5.5.2 Item Searched

5.5.2.1 Glass was found.

5.5.2.1.1 Example: Examination of Item A revealed the presence of (a) broken glass fragment(s).

5.5.2.2 Glass was not found.

5.5.2.2.1 Example: Examination of Item A did not reveal the presence of any broken glass fragment(s).

5.5.3 Positive (association between items).

5.5.3.1 The samples (questioned and known) could have originated from the same source or another source of broken glass with the same physical properties, refractive index and/or elemental composition. This opinion would occur when the samples are consistent in comparison of physical properties, refractive index, and/or elemental composition.

5.5.3.2 Example: Examination showed the glass in Item A is consistent in physical properties, refractive index, and elemental composition with the glass in Item B. These fragments could have originated from the same source or another source of broken glass with the same physical properties, refractive index and/or elemental composition. **.**

5.5.4 Negative (no association between items).

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5.5.4.1 This opinion would come from evidence where analysis showed a difference between questioned and known samples in one or more of its properties (physical, optical, or elemental). The samples (questioned and known) could not have come from a common source.

5.5.4.2 Example: Item A and Item B were not consistent in physical properties, optical properties, and/or elemental composition. These items could not have shared a common origin.

5.5.5 No known glass standard was submitted.

5.5.5.1 To perform a glass analysis, a glass standard must be submitted. If a standard is not available, the evidence will only be analyzed with written pre-approval by the Technical Leader, Forensic Scientist Supervisor or Forensic Scientist Manager.

5.5.5.2 Example: Because no known glass standard was submitted for comparison purposes, the evidence is being returned without examination. Should a known glass standard become available, please resubmit this item along with the known standard. If you have any questions, please contact the Forensic Scientist who issued this report.

5.5.6 Limited Sample

5.5.6.1 Sometimes the limited questioned sample does not allow for the performance of all/any methods of analysis for comparison. In this case, the Forensic Scientist must note that there is insufficient sample for comparison purposes.

5.5.6.1.1 Example: The fragment(s) recovered from Item A were too small for analysis.

5.5.6.1.2 Example: Due to the limited size of the glass fragments in Item A, only refractive index measurement could be performed.

5.5.7 No Analysis

5.5.7.1 No analysis performed.

5.5.7.1.1 Example: Item A was not analyzed.

5.5.7.2 No analysis performed due to the results of DNA analysis.

5.5.7.2.1 Example: Based on the results of DNA analysis, the above listed evidence is being returned without analysis. If you have any questions, please contact the Forensic Scientist who issued this report.

5.6 Sampling and Sample Selection

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5.6.1 No sampling is performed. When sample selection occurs, it shall be based on the Forensic Scientist's training and experience.

5.6.2 If, at any point during the course of examination, the items are found to be inconsistent with one another, analysis may be halted and a lab report shall be issued stating a negative finding.

5.6.3 The glass evidence may be returned without analysis based on the results of the DNA analysis or physical fit examination.

5.7 Standards and Controls – There shall be at least one known glass standard submitted in each case for comparison purposes, unless otherwise approved for analysis by the Technical Leader, Forensic Scientist Supervisor or Forensic Scientist Manager.

5.8 Calibrations – This procedure uses instruments that require performance checks. See the individual technical procedures for the operations of those instruments.

5.9 Maintenance – This procedure uses instruments that require maintenance. See the individual technical procedures for the operations of those instruments.

5.10 Uncertainty of Measurement – N/A

6.0 Limitations

6.1 The size of the known and questioned samples may limit the type of analyses performed on each sample. It must be documented in the notes which tests were and were not performed.

6.2 Glass is a manufactured material. It shall not be possible to identify a glass fragment as having come from a particular source to the exclusion of all others unless there is a physical fit association.

7.0 Safety

7.1 Broken glass and glass slides have sharp edges.

7.2 High temperatures may be produced by the hot stage using the GRIM.

7.3 The X-ray Fluorescence (XRF) emits x-rays. Become familiar with the safety section of the XRF manual. NEVER open the lid or door while the x-rays are on.

8.0 References

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9.0 Records – N/A

10.0 Attachments – N/A

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11.0

Revision History		
Effective Date	Version Number	Reason
03/25/2025	10	Remove definition of range overlap. Change “physical match” to “physical fit” throughout. Updated section 5.3 (elemental analysis). Updated section 5.4 (refractive index). Added qualifier to positive association wording 5.5.3. Added limitation 6.2. Added ASTM 1967-19 and ASTM 2926-17 to References list 8.0. Removed hyperlinks from References list 8.0.

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