
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**
- **Range Overlap method in Refractive Index (RI) Determination** – The range of refractive indices for a known standard is defined as the values between the minimum and maximum n_D RI measurements. If the known glass RI measurements produce an average that falls outside of the accepted ± 0.0001 RI units, this overlap method shall be used. For the refractive indices to be considered indistinguishable, the ranges for the known and questioned glass must overlap or fall within each other. This method is mostly used for tempered glass which is known to have a wider range of refractive index within one manufactured pane.
- 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 Review the request for analysis. A request for physical match examination shall be transferred to an analyst trained in physical match 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.
- 5.1.2 Perform screening, searching, and retrieval of glass evidence from items using the Trace Unit [Technical Procedure for the Collection and Preservation of Evidence](#)
- 5.1.3 Using a stereomicroscope, isolate any potential glass fragments from the item of evidence or in the debris resulting from the collection and preservation process.
- 5.1.4 Determine if the fragments are glass using one or more of the methods described under 5.2. If glass fragments are not found, the examination shall conclude.
- 5.1.5 Record the number, or approximate number, of glass fragments and, if applicable, the condition of the glass.
- 5.1.6 If a physical match may be possible after viewing the fragments, the evidence shall be transferred to an analyst trained in physical match. The glass examination may continue after the conclusion of the physical match examination.
- 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.
 - 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 (5.3) and refractive index analysis (5.4) 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 5.5 as a guide.

5.2 Glass Determination Methods

- 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 Unit [Technical Procedure for X-ray Fluorescence Spectrometer](#). If the sample is too small, the Forensic Scientist shall document this and move on to 5.4. In general, the XRF analysis for glass requires a sample size of at least 5 mm in width.
- 5.3.1.1 Effort shall be made to compare known and questioned samples of the approximate same size 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 Compare the spectra for the known and questioned samples to determine if there are any elemental differences.
- 5.3.1.4 Export the report results into Excel which has the capability to calculate both the calcium to iron intensity ratio (Ca/Fe) and the strontium to zirconium intensity ratio (Sr/Zr).

5.4 Glass Refractive Index Determination

- 5.4.1 If sample size permits, measure the refractive index of the glass sample using the Glass Refractive Index Measurement System. See the Trace Unit [Technical Procedure for Glass Refractive Index Measurement](#).
- 5.4.2 If possible, obtain a minimum of five (5) refractive index measurements from different fragments within each sample. With small samples, fewer than 5 readings may be made and noted in the FA worksheet.

- 5.4.3** The refractive index should fall within the range of +/- 0.0001 RI units. However, if the known glass produces a wider range of refractive index measurements than +/- 0.0001 RI units, the range overlap method may be used when comparing questioned and known glass refractive measurements.

5.5 Guidelines for Glass Examination Result Statements

5.5.1 Item Searched

5.5.1.1 Glass was found.

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

5.5.1.2 Glass was not found.

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

5.5.2 Positive (association between items).

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

- 5.5.2.2** 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 shared a common origin.

5.5.3 Negative (no association between items).

- 5.5.3.1** 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.

- 5.5.3.2** 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.

5.5.4 No known glass standard was submitted.

- 5.5.4.1** In order 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 Forensic Scientist Manager of the Physical Evidence Section.

- 5.5.4.2** Example: Due to the fact that 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.

5.5.5 Limited Sample

- 5.5.5.1** 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.

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

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

- 5.5.5.2** A recommendation to outsource the evidence for further analysis (e.g., μ XRF) shall be added to the report in cases where the known and questioned samples are consistent in refractive index, but limited sample size does not allow for elemental analysis offered at this laboratory.

5.5.5.2.1 Example: Due to the limited size of the glass fragments in Item A, elemental analysis could not be performed by this laboratory. It is recommended that the evidence be submitted to a laboratory that can perform elemental analysis of this sample size.

5.5.6 No Analysis

- 5.5.6.1 No analysis performed.**

5.5.6.1.1 Example: Item A was not analyzed.

- 5.5.6.2 No analysis performed due to the results of DNA analysis.**

5.5.6.2.1 Example: Based on the results of nuclear 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

- 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.

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 Forensic Scientist Manager of the Physical Evidence Section.

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.

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 while the x-rays are on.

8.0 References

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ASTM Standard C162-05, 2010, “Standard Terminology of Glass and Glass Products.” ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/C0162-05R10, <http://www.astm.org>.

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Saferstein, Richard. *Criminalistics: An Introduction to Forensic Science*. 6th ed. Upper Saddle River, NJ: Prentice-Hall, Inc., 1998.

Zadora, G. “Classification of Glass Fragments Based on Elemental Composition and Refractive Index.” *Journal of Forensic Sciences* 54.1 (2008): 49-59.

9.0 Records – N/A

10.0 Attachments – N/A

Revision History		
Effective Date	Version Number	Reason
09/17/2012	1	Original ISO Document
09/30/2013	2	Removed examples of result statements 5.1.5.1.3.1 and 5.1.5.2.2.1; Reworded 5.1.5.2.1.2 and 5.1.5.1.2.2
10/18/2013	3	Added issuing authority to header
09/05/2014	4	Updated header to Physical Evidence Section – Trace Unit, issuing authority to Physical Evidence Section Forensic Scientist Manager Updated all references in procedure from Trace Evidence Section to Trace Unit Removed “comparison and/or glass fracture” from 2.0 Changed 5.1 title to “Analytical Approach” Removed 5.1.1 and 5.1.4 Added physical match, direction of force and type of break statement to 5.1.1 Reworded 5.1.1.3, 5.1.1.4, 5.1.1.5, 5.1.1.8.4, 5.1.1.8.5 and 5.1.2.1.2 Moved 5.1.1.4.1, 5.1.1.4.2 and 5.1.1.4.3 to the new section titled Glass Determination Methods (new 5.2) and reworded Added water option to 5.1.1.6 Reworded 5.1.1.7 and moved above 5.1.1.6 Combined and reworded 5.1.1.9, 5.1.1.9.1 and 5.1.1.9.2 Added new 5.1.10 regarding issuing report

		Pulled out sentence beginning “Effort shall be made...” into a bullet point under Elemental Analysis Removed parenthetical note in 5.1.2.1.1 Replaced “possible” with “made” in 5.1.3.2 Reorganized 5.1.5 by combining Item Searched statements and renamed “Glass Examination Result Statements” Moved RI notes in 5.1.5.1.2.1 to Glass Refractive Index Determination section. Reorganized into new 5.4 Removed caveat statement in 5.1.5.3.1 Removed “is” from 5.1.5.5.1 Removed “is” and “the” from 5.1.5.5.2 Reworded 5.1.5.5.2.1 and 5.1.6.4 Replaced “unworked” with “without examination” in 5.1.6.3 Moved wording from 5.2.4 and 5.2.5 to 5.1.8 and 5.1.9, respectively Removed entire section 5.2 5.5.4.1 edited wording for required standards 5.8 edited calibration requirements 5.9 edited maintenance requirements Added “in some cases” to 6.1 Reworded 6.2 Removed 6.3 Added “broken glass” to 7.1
03/20/2015	5	Replaced “unknown” with “questioned” for consistency throughout procedure Added sentence regarding no glass found to 5.1.4 Removed “color” from 5.1.8.4 Added “the” and changed “shall conclude” in 5.1.9 Replaced “unworked” with “without examination” in 5.5.4.2 Removed 5.6.3 and 6.1 because redundant with 5.7
12/11/2015	6	Removed option of forwarding evidence in 5.1.1 Added 5.5.5.2 and 5.5.5.2.1
07/01/2016	7	Removed first sentence of 5.1.6