

# Quality Assurance Guide for the Forensic Analysis of Ignitable Liquids

## Scientific Working Group for Fire and Explosions

### Laboratory Fire Standards and Protocols Committee

*Version 2.0*

#### 1. Scope

- 1.1. The goal of a laboratory's fire debris analysis program is to provide quality analytical service for fire investigations. It is the goal of these guidelines to provide a framework of quality management in the processing of fire debris evidence including evidence handling, management practices, qualitative analysis, and reporting.
- 1.2. It is recognized that other types of evidence may be encountered at a fire scene, however, the scope of this document is limited to the analysis of ignitable liquids and ignitable liquid residues.

#### 2. Significance and Use

- 2.1. This document pertains to the analysis of samples suspected to contain ignitable liquids or their residues. It is intended to serve as a framework for the development and assessment of a quality assurance program.

#### 3. Terminology

- 3.1. *Administrative review*: A review of a report for compliance with laboratory policy and for editorial correctness.
- 3.2. *Audit*: A review conducted to compare various aspects of a laboratory's performance with established criteria.
- 3.3. *Blank*: A quality control tool needed to establish an analytical baseline for interpretation. A quality control check used to detect potential contamination.
- 3.4. *Calibration*: The process of assigning a known value within specified limits to an instrument's scale reading.
- 3.5. *Certified Reference Material (CRM)*: A reference material that has one or more of its property values certified by a technical procedure and accompanied by or traceable to a certificate or other documentation that has been issued by a certifying body.
- 3.6. *Chain of custody*: Procedures and documents that account for the integrity of an item of evidence by tracking its handling and storage from its point of collection to its final disposition.

- 3.7. *Competency test*: An assessment of a person's knowledge, skills and ability to perform his assigned duties.
- 3.8. *Deficiency of analysis*: An erroneous analytical result or interpretation, or an unacceptable deviation from an established policy or procedure in an analysis.
- 3.9. *Examiner*: A person who receives and examines evidence, interprets results, writes reports, and testifies to casework findings.
- 3.10. *Ignitable Liquid*: A liquid capable of burning.
- 3.11. *Official methods*: Validated analytical methods that have been accepted and published by an appropriate standardization organization.,
- 3.12. *Proficiency Test*: An evaluation of personnel and laboratory procedures through the examination and interpretation of a prepared sample.
- 3.13. *Quality Assurance*: Planned and systematic actions to provide confidence that a service will meet established requirements.
- 3.14. *Quality Control*: Operational procedures designed to ensure quality results or indicate system failure.
- 3.15. *Reference Collection*: A collection of materials, substances, and/or objects of known properties and/or origin, that may be used to aid in the identification or classification of unknown items.
- 3.16. *Reference Ignitable Liquid*: An ignitable liquid that has had its composition verified, and that is used to aid in the identification and classification of unknown ignitable liquids and their extracted residues.
- 3.17. *Systematic Error*: Any discrepancy due to an inherent problem in the design of the analytical process.
- 3.18. *Technical Peer*: An examiner technically competent in fire debris analysis and related interpretation.
- 3.19. *Technical Review*: Review by a technical peer for technical accuracy and use of appropriate methodology and documentation.
- 3.20. *Validation*: The acquisition of information needed to assess the reliability of a procedure and to determine the conditions under which acceptable test results can be obtained.
- 3.21. *Verification*: Confirmation that a validated method works as intended in a given environment.

#### **4. Physical Plant**

- 4.1. The laboratory shall contain adequate space to perform required analytical functions and prevent contamination.
- 4.2. Chemical fume hoods shall be provided and maintained.
- 4.3. Adequate measures shall be taken to ensure good housekeeping in the laboratory.
  - 4.3.1. Housekeeping products that may be exposed to evidence and sampling devices shall be free of potential contaminants.
- 4.4. Adequate facilities must be provided to ensure the proper safekeeping of physical evidence, reference materials, and records.
  - 4.4.1. Refrigerators/freezers shall be available for the storage of samples prone to degradation (e.g. soil, biological samples).

- 4.4.2. Storage areas must be adequately ventilated to prevent incidental contamination.
- 4.4.3. Separate areas should be available for storing fire debris evidence and bulk ignitable liquid submissions.
- 4.5. Appropriate storage must be available for the storage of chemicals, reagents, and supplies. This storage area shall be separate from the evidence storage area.
- 4.6. Separate areas should be available for processing suspected ignitable liquid residues (debris samples) from other ignitable liquids (reference ignitable liquids and bulk liquid evidence submissions) or other controls must be in place to avoid incidental contamination.

## 5. Personnel

### 5.1. Job Descriptions

#### 5.1.1. Quality Assurance Manager

- 5.1.1.1. A person who is responsible for maintaining and monitoring the quality management system.

#### 5.1.2. Technician/Laboratory Aide

- 5.1.2.1. A person who performs basic laboratory duties but does not examine or handle evidence.

#### 5.1.3. Support Analyst

- 5.1.3.1. A person who processes evidence, but does not issue reports for court purposes.

#### 5.1.4. Analyst

- 5.1.4.1. A person who examines and analyzes evidence for the presence of ignitable liquids and ignitable liquid residues or directs such analyses.
- 5.1.4.2. A person who interprets ignitable liquid analysis results, writes reports based upon those results, and testifies as an expert to those findings.

### 5.2. Qualifications/Education

#### 5.2.1. Quality Manager

- 5.2.1.1. Education, skill, and abilities commensurate with responsibilities.

#### 5.2.2. Laboratory Technician

- 5.2.2.1. Education, skills, and abilities commensurate with responsibilities.
- 5.2.2.2. On-the-job training specific to duties

#### 5.2.3. Support Analyst

- 5.2.3.1. Have documented on-the-job training specific to responsibilities,

AND

- 5.2.3.2. Have demonstrated competency in the specific areas of responsibility through successful completion of a competency assessment,

AND

- 5.2.3.3. Meet the requirements of at least one of the following:
  - 5.2.3.3.1. Have a minimum of a bachelor's degree in a natural science or equivalent which shall include lecture and associated laboratory classes in general, organic, and analytical chemistry,

OR

- 5.2.3.3.2. Have a minimum of one (1) year practical experience in the area of fire debris analysis.

#### 5.2.4. Analyst

- 5.2.4.1. Have documented on-the-job training specific to responsibilities,  
AND
- 5.2.4.2. Have demonstrated competency in the specific areas of responsibility  
AND
- 5.2.4.3. Have a minimum of a bachelor's degree in a natural science or equivalent, which shall include lecture and associated laboratory classes in general, organic, and analytical chemistry.

#### 5.3. Training

- 5.3.1. The laboratory must establish a written training program for new analysts and for analysts in need of remedial training.
- 5.3.2. The new analyst training program should include elements as described in "Training Guidelines for the Fire Debris Analyst: Basic Training Requirements Set Forth by SWGFEX Lab Fire Debris Training and Education Committee" ([www.ncfs.org\twgfex\training](http://www.ncfs.org/twgfex/training)) for analysts in need of remedial training should be customized to ensure that deficiencies are resolved.
- 5.3.3. Training programs shall include documented standards of performance and assessment.
- 5.3.4. Training shall include a period of supervised casework representative of the types of analyses the employee may perform.
- 5.3.5. Upon the completion of the training program, documentation demonstrating that the trainee has achieved the required level of competence shall be generated and maintained.

#### 5.4. Professional Development/Maintaining Qualifications

- 5.4.1. In order to maintain qualifications analysts should:
  - 5.4.1.1. Successfully complete competency/proficiency testing in fire debris analysis on an annual basis.
  - 5.4.1.2. Actively participate in casework examinations.
  - 5.4.1.3. Attain a minimum requirement of 20 hours per year of continuing education of a chemical/technical nature relevant to the analyst's

duties. This can be achieved in a number of ways, including one or more of the following:

- 5.4.1.3.1. Attendance at a relevant professional forensic association meeting or workshop
- 5.4.1.3.2. Attendance in a relevant technical training course
- 5.4.1.3.3. Completion of relevant college-level courses
- 5.4.1.3.4. Participation and/or presentation in relevant research or method development

## 6. Quality Manual Documentation

6.1. In addition to case documentation the laboratory must maintain the following:

- 6.1.1. Test methods/procedures for ignitable liquid and ignitable liquid residue analysis for each technique utilized.
- 6.1.2. Policies and procedures for and documentation of maintenance and use of reference ignitable liquids including acquisition, testing, and classification.
- 6.1.3. Policies and procedures for and documentation of preparation and testing of prepared reagents used in ignitable liquid analysis.
- 6.1.4. Evidence handling protocols and documentation of chain of custody.
- 6.1.5. Policies and procedures for and documentation of equipment calibration and maintenance.
- 6.1.6. Policies and procedures for and documentation of proficiency and competency testing.
- 6.1.7. Policies for personnel training and qualifications.
- 6.1.8. Documentation of professional development.
- 6.1.9. Quality assurance protocols and documentation of audits.
- 6.1.10. Security protocols.
- 6.1.11. Health and safety policies.
- 6.1.12. Procedures for and documentation of method validations and/or verifications.

## 7. Evidence Control

- 7.1. The laboratory shall maintain written policies for evidence control to ensure the integrity of the evidence while in the laboratory's custody.
- 7.2. Access to the operational areas of the laboratory and areas in which evidence is stored must be controlled and limited.
- 7.3. Sample storage must prevent loss, deterioration, and contamination.

- 7.4. Procedures should be in place to ensure that samples are properly labeled throughout the analytical process.
- 7.5. Procedures must be established to document and preserve the chain of custody for each item of evidence.
- 7.6. Evidence must be properly packaged, secured and sealed.
  - 7.6.1. Containers should be vapor-tight and free of ignitable liquid contaminants.
    - 7.6.1.1. It is recommended that a representative sample from batches of fire debris evidence containers be analyzed for incidental contamination prior to use.
- 7.7. The laboratory must maintain records of requests for analysis to include:
  - 7.7.1. A unique identifier assigned to each case or record.
  - 7.7.2. Submission documents.
  - 7.7.3. Identifying information of the submitting parties.
  - 7.7.4. A description of the items submitted.
  - 7.7.5. A record of the chain of custody.
- 7.8. A description of the evidence shall be compared to the documentation prior to analysis. Significant discrepancies shall be documented and resolved prior to completion of analysis.
  - 7.8.1. Any alteration of the evidence must be documented in writing.

## 8. Analytical Procedures

- 8.1. Analytical Procedures for Ignitable Liquid Analysis
  - 8.1.1. The laboratory shall have and shall follow written analytical procedures.
  - 8.1.2. Work practices shall be established to prevent contamination of evidence during processing, analysis and storage.
  - 8.1.3. The analysis of various substrates for the presence of ignitable liquids or ignitable liquid residues can be accomplished by a variety of methods.
    - 8.1.3.1. Preference should be given to using non-destructive techniques. When multiple techniques are used, non-destructive techniques should be performed first.
  - 8.1.4. Sample handling after analysis
    - 8.1.4.1. Laboratory extracts should be preserved for potential re-analysis.
  - 8.1.5. All analytical procedures used must be validated and verified. The use of official methods is recommended.
    - 8.1.5.1. All new or unofficial methods must be validated prior to use in casework.
    - 8.1.5.2. Official methods must be verified prior to use in casework.
  - 8.1.6. Blanks representing each extraction technique should be run with each case to demonstrate that sampling devices, chemicals, and processes do not result in contamination of evidence.
- 8.2. Reference Ignitable Liquids

- 8.2.1. Reference ignitable liquids shall be maintained by the laboratory; however, certified reference materials are not required
- 8.2.2. The classification of reference materials must be authenticated prior to use by the use of gas chromatography-mass spectrometry and/or by pattern recognition comparison to appropriate reference documentation.

## 9. Instrumentation

- 9.1. Instruments must be routinely monitored to ensure proper performance.
  - 9.1.1. Written procedures for monitoring instrument performance and maintenance shall be established.
  - 9.1.2. Documentation of instrument performance and maintenance shall be maintained.
- 9.2. Equipment
  - 9.2.1. Only suitable and properly operating equipment shall be used.

## 10. Technical and Administrative Review

- 10.1. All casework shall be subjected to technical and administrative review.
- 10.2. The laboratory must have a written policy establishing the protocols for technical and administrative case review.
- 10.3. The laboratory must have written policy to determine the course of action should an analyst and reviewer disagree.
- 10.4. Technical review shall be documented and maintained
  - 10.4.1. A standard technical review should cover the following points:
    - 10.4.1.1. Is there adequate documentation relating to all the materials examined?
    - 10.4.1.2. Have all the appropriate analyses been carried out?
    - 10.4.1.3. Have all the relevant QA procedures been followed?
    - 10.4.1.4. Are the conclusions reached justified and appropriate?
    - 10.4.1.5. Is the statement/report accurate?
- 10.5. Administrative review should ensure editorial correctness and adherence to laboratory policies.

## 11. Chemicals, Reagents, and Supplies

- 11.1. Chemicals and reagents used in ignitable liquid/ignitable liquid residue analysis must be of sufficient purity.
- 11.2. Documentation for reagents prepared within the laboratory must include identity, concentration (where appropriate), date of preparation, identity of the individual preparing the reagents, and the expiration date (if appropriate).

- 11.3. Each container of extraction solvents must be tested for interfering contaminants prior to use and the resulting documentation maintained.
- 11.4. Chemical and reagent containers shall be dated and initialed when received and when first opened.

## **12. Proficiency and Competency Testing**

- 12.1. Each laboratory shall have written protocols for testing the competency of its laboratory analysts.
- 12.2. Each laboratory should participate in at least one external proficiency test annually.
- 12.3. Laboratories shall perform proficiency testing in order to evaluate the laboratory's performance.
  - 12.3.1. Proficiency tests should be representative of the laboratory's normal casework.
  - 12.3.2. Standard laboratory procedures shall be used for all proficiency test analyses.
- 12.4. Each analyst should be competency tested in fire debris analysis at least once per year.
  - 12.4.1. Competency testing samples should be representative of the laboratory's normal casework.
  - 12.4.2. Standard laboratory procedures shall be used for all competency test analyses.
  - 12.4.3. A single test may serve as both a competency test and a proficiency test.

## **13. Verification and Validation**

- 13.1. The laboratory shall use validated techniques and procedures. Official methods are considered valid.
- 13.2. All methods, including official methods, shall be verified to ascertain proper performance in the individual laboratory.
- 13.3. Validation and verification procedures shall be documented.
  - 13.3.1. Validation should include specificity, limits of detection, reproducibility, advantages and limitations of technique.
- 13.4. New techniques developed for the characterization, identification, and comparison of ignitable liquids and their residues should be based on accepted scientific principles. Validation studies to establish the technique's reliability must be performed prior to use in casework.

## **14. Laboratory Audits**

- 14.1. Audits of laboratory operations should be conducted at least once per year.



- 14.2. Records of each audit must be maintained and should include the date of the audit and its scope, auditor's name(s), findings, and corrective actions taken.

## **15. Deficiency of Analysis**

- 15.1. In the course of examining ignitable liquids and their residues, laboratories may expect to encounter some operations or results that are deficient in some manner. Each laboratory must have a written policy to deal with such deficiencies. This policy must include a definition of a deficiency and a protocol for addressing and correcting such deficiencies.

## **16. Health and Safety**

- 16.1. The laboratory must have a documented health and safety program in place to meet the needs of the laboratory.