Ignitable Liquids, Explosives, & Gunshot Residue

Fire Debris Admissibility

Disclaimer: The following are general legal guidelines. Specific state rules and/or case law may apply depending on the venue of the hearing.

Admissibility hearing: An evidence admissibility hearing is a proceeding or test before the court to determine the admissibility of evidence/testimony for a trial. The *judge* ultimately determines what evidence is admitted. The judge uses certain criteria or standards to aid in making that determination.

Three most common general admissibility criteria or standards in the US come from:

- Frye v. United States (1923)
- Rule 702 (1975, Revised 2017)
- Daubert v. Merrell Dow Pharmaceuticals, Inc. (1993)

Frye: "…The thing from which the deduction is made must be sufficiently established to have gained *general acceptance* in the field in which it belongs."

- Evidence is admissible if it's based on principles that are "generally accepted" by the field

Rule 702: A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if:

- **(a)** the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- **(b)** the testimony is based on sufficient facts or data;
- **(c)** the testimony is the product of reliable principles and methods; and
- **(d)** the expert has reliably applied the principles and methods to the facts of the case.

Rule 702 grants wide judicial discretion in determining admissibility and serves as the basis of expert evidence admissibility in many jurisdictions. It establishes that exclusion of expert testimony is the exception rather than the rule.

Daubert: "…whether the theory or technique in question can be (and has been) *tested*, whether it has been subjected to *peer review and publication*, its known or *potential error rate* and the existence and maintenance of *standards* controlling its operation, and whether it has attracted *widespread acceptance* within a relevant scientific community."

Per Daubert, scientific evidence has four criteria or prongs that can be considered:

1) Testability
2) Peer Review
3) Error Rate
    a) Standards and controls
4) General acceptance by the scientific community

Prongs of Daubert

1. Testability

Have the theories, techniques, methods been tested? Is there a procedure for critical evaluation of the methods?

Fire debris methods mainly involve GC-MS and extraction methods, both of which have been extensively tested.

- GC-MS:
    - The concept of GC first emerged in 1941, coupled to MS in 1959
    - GC-MS is one of the most widely used instruments in a variety of scientific fields including: Environmental, forensic science, food and beverage industry, pharmacology, etc.
    - First publications on the use of GC-MS for fire debris analysis
        - Mach MH (1977) Gas chromatography-mass spectrometry of simulated arson residues using gasoline as an accelerant, *JFS* 22(2)
        - Smith MR (1982) Arson analysis by mass chromatography, *Analytical Chemistry* 54(13)
    - First version of ASTM E1387 (GC) dates back to 1990
    - First version of ASTM E1618 (GC-MS) dates back to 1994
- Extraction methods
    - Long history of extraction procedures for fire debris in the literature (summarized in Fire Debris Analysis)
        - 1940: Vacuum distillation
        - 1957: Dynamic headspace (very early version)
        - 1963: Solvent extraction
        - 1968: Direct headspace
        - 1977: Passive headspace concentration
        - 1979: Dynamic headspace concentration
        - 1981: First use of Tenax
        - 1995: Solid phase micro extraction (SPME)
    - Long history of adsorption media for fire debris in the literature (summarized in Fire Debris Analysis)
        - 1977: Wire coated with activated charcoal
        - 1979: Activated coconut charcoal in disposable pipet with glass wool plugs
        - 1981: First use of Tenax

        - 1982: Plexiglas beads coated with activated charcoal particles
        - 1991: C-bags and c-strips
        - 1994: DFLEX
        - 1995: SPME
- Forensic Science Assessments: A Quality and GAP Analysis, by American Association for the Advancement of Science: *"The basic science is sufficiently developed and mature, and there is no reason for operational laboratories not to use these methods. Hence, all fire debris analysis laboratories and forensic practitioners should be made aware of these methods, should have access to them, and should be expected to follow them."*
- Personal testability- successfully complete a fire debris analysis proficiency test per year
- Results testability- casework undergoes both a technical and administrative review (and can be reviewed again in internal/external audits or reviews)

2. Peer Review

Has the technique or theory been subjected to peer review and publication?

- Numerous books, scientific articles, and consensus-based standards (ASTM) have been published concerning all aspects of fire debris analysis including extraction procedures and GC-MS:
    - Fire Debris Analysis, Kirk's Fire Investigation, ASTM standards, scientific articles (Journal of Forensic Sciences, Forensic Science International, Forensic Chemistry, Fire and Arson Investigator, etc.)
    - See the Fire Debris References List compiled by the OSAC for a list of applicable literature [OSAC Analyis of Fire Debris Reference List]
- Casework peer review
    - Technical review, administrative review, internal/external review or audit

3. Error Rate

Is there a known or potential rate of error?

- Entire discipline
    - An error rate of the entire discipline is not currently known. Proficiency testing is a poor indicator of the error rate of the entire discipline. Due to known design problems with current proficiency testing and a lack of required rigor in reporting, a wide range of answers have been considered acceptable by test providers.
        - Test participants are not limited to practitioners.

        - Fire debris analysis involves qualitative examinations. Qualitative examinations are subject to uncertainty based on random error which is monitored through the use of positive and negative controls, instrument performance checks, technical and administrative reviews, and proficiency testing.

- Instrumentation: GC-MS
    - Ensure the instrument is functioning properly and free of contamination
        - MS tune
        - QC
        - Solvent blanks
- Extraction method
    - Ensure that no contamination is being introduced during extraction and extraction materials are as expected
        - Materials control/system blank/control
        - Charcoal strip checks (positive and negative controls)
        - Solvent screening
- Examiner
    - In the field of forensic fire debris analysis, a statistically-derived or verified measurement of the accuracy and reliability of an examiner's results, or error rate, is currently undetermined. Factors that can affect the accuracy and reliability of a forensic fire debris examiner's results include, but are not limited to, the following:
        - Quantity and quality of education, training, and experience in fire debris analysis
        - Complexity of the fire debris sample
        - Quality of data obtained from the fire debris sample
        - Human factors such as cognitive bias and other human tendencies
        - Peer review
    - Until such time that a statistically-derived or verified measurement of the accuracy and reliability of an examiner's results, or error rate, is determined, the trier of fact may find the following factors helpful when attempting to establish confidence in an examiner's results:

- Fire debris examiners should have completed a formalized training program to establish competency in performing independent casework, writing reports, and testifying in court (ASTM E2917).
- Fire debris examiners should demonstrate continued proficiency through successful participation in a monitoring program that includes practical testing.
- Fire debris examiners should remain current in the field of forensic fire debris analysis through continuing education and professional development activities (ASTM E2917).
- Fire debris examiners should evaluate and document the relative complexity of the fire debris sample, the relative quality of the data obtained from the fire debris sample, and any limitations that may arise in their overall analysis as a consequence of sample complexity, sampling method, and data quality.
- Fire debris examiners should implement appropriate quality assurance practices for the methods and instrumentation utilized during their analysis.
- Fire debris examiners should have an awareness of the potential for human factors to influence the accuracy and reliability of their results, and, to the extent possible and practicable, take measures to minimize this influence.
- Fire debris examiners should disclose any limitations of their reported results.
- The fire debris examiner's work should be reviewed for technical accuracy by at least one other individual who has established competency in peer review of forensic fire debris casework.

3a) Standards and controls

Is the technique or theory subject to standards governing its application?

- Organizations devoted to ensuring quality, consistency, and scientific rigor
    - ASTM International - subcommittee E30, numerous standards outlining fire debris practices
    - OSAC Ignitable Liquids, Explosives, & Gunshot Residue Subcommittee

4. General Acceptance

Is the technique or theory generally accepted by the relevant scientific community?

- Consensus-based standards developed and adopted by practitioners around the world
- GC-MS related analyses and testimonies have been accepted in thousands of court cases in the areas of fire debris, drug, explosive, and toxicology analysis
- Fire debris analysis is taught as part of forensic science/criminology courses

Case Examples

United States *v.* Aman, 748 F. Supp. 2d 531 (E.D. Va. 2010)

- See III. C. Testimony of Andrew Hawkins (https://www.courtlistener.com/opinion/2468941/united-states-v-aman/)

United States v Rayborn, 495 F.3d 328 (6th Cir. 2007)

- See II. B. Testimony of Wolgang Bertsch and Darlene Loprete (https://www.courtlistener.com/opinion/1394726/united-states-v-rayborn/)

Re: admissibility of the witness to testify based on qualifications

Ohio *v*. Powell, 132 Ohio St. 3D233 (OH, 2012)

- See Paragraph 141. Testimony of Crista Rajendram (https://www.courtlistener.com/opinion/2690788/state-v-powell/)

Arizona *v*. Davolt, 84 P.3d 456 207 Ariz. 191 (AZ, 2004)

- See F. 3. Testimony of John Hoang (https://www.courtlistener.com/opinion/867501/state-v-davolt/)