What You Don't Know Can Hurt You:
How Do You Know Your Lab Has It Right?

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(Presented in the original manuscript version for easier reading)

There is an old saying: "the more you learn the less you know." This is true in many fields, but especially in fire investigation. As more test fires are run and the results recorded, the difficulty in making an identification of a "flammable liquid pour pattern" becomes more apparent. As is reflected in the 2001 version of *NFPA 921*, in *Kirk's* Fifth Edition, and in a recent study of flammable liquid burn patterns by Anthony Putorti of NIST[1], things are not always what they seem. Patterns that all of us were likely to attribute to flammable liquids a decade or two ago are now known to be produced, or capable of being produced, by non-accelerated fires.

Thus, when a fire investigator forms a hypothesis that an ignitable liquid caused a particular pattern, accurate laboratory analysis of samples from that pattern becomes critical. No longer can the laboratory analysis be accurately called the "icing on the cake" that merely serves to inform the investigator *which* ignitable liquid was used. A negative finding on a sample from a "suspicious" burn pattern, while not conclusive proof that no ignitable liquid was present, usually means the difference between a hypothesis being supported and not being supported. With the courts looking more closely at fire investigations, and demanding more "scientific" evidence, an improper call by a laboratory can be devastating to a case, a career, or a company.

As chair of ASTM Committee E30 on Forensic Sciences, the author has a chance to review more than his fair share of chemical analysis reports and data from other laboratories. Review work such as this is usually not called for unless someone has a doubt about the accuracy of the laboratory report, so the number of errors in this limited universe can hardly be characterized as an "error rate". What can be stated, however, is that there is a significant amount of bad laboratory work going on in our field today. Some of this improper analytical work has resulted in litigation against insurance carriers, against fire investigators, and against the laboratories themselves.

How can someone with limited scientific training evaluate the work product of a particular laboratory? Despite the fact that the chemist you hire has (hopefully)

much more knowledge of chemistry than you do, it is possible to probe the laboratory and make some inferences about the quality of its work. Documentation of your efforts to check on the quality of the work provided to you by this important subcontractor can go a long way in providing you with a defense, if your laboratory makes a critical error.

In cases where litigation surrounding an alleged arson occurs, and the jury finds that the fire was not arson but an accident, it is a typical response of the insurance company to state, "we relied on our expert fire investigator." In turn, the fire investigator will frequently say, "I relied on my expert laboratory analyst." The question for the consumers of the laboratory product thus becomes "how do I know I am getting good work out of this particular laboratory?"

In 1994, the IAAI Forensic Science Committee printed a useful article entitled "Is Your Lab Giving You Proper Results?"[2] This article is worth reviewing for the basics of what the scientific community expects from its members. The following is a non-exclusive list of steps that an individual fire investigator or an insurance company may take to ensure that they are getting quality work from their laboratory.

1. **Ask**. Ask the chemists if they follow ASTM standards in their analyses. If you look through the pages of this magazine you will note that almost all of the laboratories advertising herein make mention somewhere of the fact that they follow ASTM standards. Be advised that just stating that one follows ASTM standards does not mean that it actually happens, but it is a starting point.

   Ask your laboratory chemist to explain to you the difference between the old ASTM classification system and the new ASTM classification system. (John DeHaan gave an excellent description of the new system in this magazine in April of 2002)[3]. If your chemist is unable to explain the difference in the revised classification scheme, you should probably be talking to a different chemist.

   Ask for references of other fire investigators who utilize the laboratory services. You do not want to be the first or only customer of this laboratory that requests this kind of work.

2. **Insurance.** Most private fire investigators carry errors and omissions insurance because their clients require it. Some laboratories are insured, some are not. If your clients will not hire someone who is not insured, why should you?

3. **Certification.** Many of the consumers of private fire investigative services require that the fire investigators they hire be certified. Certification is also available for laboratory analysts through the American Board of Criminalistics. Just as in fire investigation, certification does not guarantee that the work product will be accurate, but it sure doesn't hurt.

4. **Accreditation.** Most public sector crime laboratories are accredited by the American Society for Crime Laboratory Directors-Laboratory Accreditation Board (ASCLD-LAB). Accreditation is also available to private sector laboratories working with quality programs that meet International Standards Organization (ISO) standards. ISO has a set of requirements for testing and calibration laboratories, including forensic science laboratories, called *Guide 17025*. A laboratory that has been accredited to this standard has been independently reviewed by a knowledgeable third party to make sure that the laboratory's quality standards and written protocols meet the requirements generally accepted as necessary to do a quality job.

5. **Publication.** If your chemist follows the accepted procedures for doing laboratory analysis of fire debris, and has helped move the field forward by doing independent research and publication, you can be reasonably certain that the type of work that takes place in that laboratory is within acceptable limits. By publishing an article in a peer-reviewed journal, the chemist is in effect saying "here's how I do things" and, giving the entire scientific community the opportunity to shoot him or her down. Laboratories that do not follow accepted procedures are unlikely to have published.

6. **Peer Review**. Look at your laboratory report. Does it indicate that anyone besides the chemist who analyzed the samples has looked at the report and the data? Peer review is a fundamental underpinning of science. We all make mistakes. If we have someone who is knowledgeable about what we are doing reviewing our work, those mistakes can be caught before they get out of the laboratory.

7. **Audit**. Even though you may not have the science degree, you can still conduct a reasonable audit of your laboratory. Schedule a meeting with your chemist to spend an hour or two to go over their methodology and documentation. Ask to see how a sample is handled from start to finish. Ask to see a copy of the laboratory's quality assurance manual. Ask to see a copy of the lab's in-house protocols. ASTM standards only generally describe the analytical procedures. Each lab should have its own written adaptation of those standards.

Ask to see a copy of the laboratory's proficiency testing records. Proficiency testing is a quality assurance procedure wherein the laboratory subscribes to a program that supplies them with unknown samples, which they must identify. A typical proficiency test will have a description of the samples, an answer sheet provided by the laboratory that is submitted to the proficiency test provider, and a response from the proficiency test provider stating whether the laboratories answer agreed or disagreed with the provider's analysis.

During an audit, you can also ask to see some typical files. A proper file, if an ignitable liquid residue has been identified, will include at least a gas chromatogram of the sample, and a gas chromatogram of the standard or reference material to which that sample was compared. Every file that contains a laboratory report identifying gasoline should include a copy of a reference chromatogram made from known gasoline. The chemist should be able to show you on a light box exactly how your sample compares to the standard gasoline. If there is no standard in the file, or if the chemist is unable to show you that the pattern matched to your satisfaction, you need to be going someplace else. If you cannot see the pattern match, neither will an adverse expert, or a jury. The file should also include a copy of the chain of custody document.

8. **Blind Proficiency Testing**. Blind proficiency testing is the "holy grail" of forensic quality assurance. Because the person being tested doesn't know it is a test, you are likely to see a more representative sample of everyday casework than on an open proficiency test. Fire debris analysis lends itself to this type of proficiency testing more than many other types of forensic analyses, because fire debris samples look pretty much alike. You can collect three samples from a fire scene, and for the price of one additional analysis, slip in another sample that is either a known positive or a known negative, and see how your laboratory responds. Do not put more than a drop of ignitable liquid residue in the known positives, and make sure that you have clean samples that you burned with a propane torch for the known negatives. The sample can be easily labeled to indicate that it came from the same fire scene, even if it didn't. When challenged, you can tell the judge or opposing counsel that you were using this sample for quality control purposes. If your negative comes back positive for gasoline, or your gasoline sample comes back negative, you will know it is time to look for another laboratory.

Fire debris analysis is a difficult branch of forensic science, in that it is frequently complicated by background substances and pyrolysis products. **It is not like environmental chemistry**, where the analyst usually presumes the

presence of a substance and goes about quantifying it. **It is not like drug analysis** where the analyst is trying to identify a few compounds rather than analyzing the pattern produced by a mixture of up to two hundred different compounds. Fire debris analysis requires judgment and practice, just as fire investigation does. None of the steps listed above will guarantee that your laboratory will be 100% correct 100% of the time, but taking these steps will help you to avoid hiring a really bad laboratory, and documentation of these steps will at least prove that you have spent the time and energy necessary (due diligence) to ensure that this important subcontractor knows what they are doing.

References

1. Putorti, A. D., *Flammable and Combustible Liquid Spill/Burn Patterns*, NIJ Report 604-00. NCJ 186634, National Institute of Standards and Technology, Gaithersburg, MD, National Institute of Justice, Washington, DC, March 2001.

2. IAAI Forensic Science Committee, "Is Your Lab Giving You Proper Results?" *Fire and Arson Investigator*, Vol. 45, No. 2, December 1994, page 39.

3. DeHaan, John, "Our Changing World, Part 2:Ignitable Liquids: Petroleum Distillates, Petroleum Products and Other Stuff," *Fire and Arson Investigator*, Vol. 52, No. 3, April 2002, page 46.

About the Author:

John Lentini is one of two persons on the planet certified to do both fire scene investigations and laboratory analysis of fire debris. Since 1974, he has personally investigated over 2,000 fire scenes and analyzed more than 20,000 samples of fire debris.

John currently serves as Chairman of ASTM Committee E30 on Forensic Sciences and was Chairman of the IAAI Forensic Science Committee from 1988 to 1991. He was the principal author of the IAAI Guidelines for Laboratories Performing Chemical and Instrumental Analysis of Fire Debris Samples, and ASTM E-1387, Standard Test Method for Flammable or Combustible Liquid Residues in Extracts from Samples of Fire Debris by Gas Chromatography.

An IAAI member since 1978, he is also a member of NFPA and serves on the 921 Technical Committee. He works for Applied Technical Services of Marietta, GA, where he manages the company's Fire Investigation division. He analyzes artifacts from fire scenes, and serves as a consultant on the standard of care in fire investigation and the standard of care in chemical analysis of fire debris.