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GUIDELINES FOR CONDUCTING PEER REVIEWS OF COMPLEX FIRE INVESTIGATIONS

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Abstract. The proper application of fire science and engineering principles and practice is paramount when conducting comprehensive and complex fire investigations. This is particularly true when these investigations determine the fire's origin and cause, ignition, growth, sequences of timeline events, potential code violations, and assignment of responsibility. In the right circumstances, the peer review process can be a valuable litigation tool.

However, there presently are no uniform guidelines for conducting peer reviews of fire investigations. These guidelines are needed when evaluating complex investigations, particularly when substantial loss of life and damage to property result in criminal prosecutions or extensive civil litigation. Furthermore, peer reviews by a team of disinterested parties avoid the alternative adversarial approach often seen in court litigation.

Peer reviews in both the academic and engineering communities have traditionally been used to ensure that practitioners upheld the standards of their discipline. Fire investigations should be peer reviewed in a professional manner that is consistent with accepted practice. This review should be well documented and follow consistent guidelines. Furthermore, this peer review should be conducted by at least a team consisting of subject matter experts in the fields of criminal/civil investigation, fire protection engineering, forensic science, and law.

The paper recommends a comprehensive set of uniform guidelines for the initiation, scope, conduct, and reporting of such a peer review in complex fire investigations. These recommended guidelines evaluate not only the conceptual and technical soundness of the approach, but also address the thoroughness of the overall investigative process. These guidelines also address when to conduct a peer review, choice of reviewers, scope, and proper documentation.

Key words: Fire investigation, peer review, scientific method, forensic science.

INTRODUCTION

Peer review is a process in which personal or institutional work products or ideas are subjected to the scrutiny of others who are also experts in the respective field. The traditional uses of peer reviews are to select articles or textbooks which are worthy for publication, or to determine fund awards based upon multiple submissions of proposals. An important reason for conducting peer reviews is that it helps identify and correct potential flaws in complicated cases.[1]

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Historically, probably one of the longest running examples of the application of peer review of a complex investigation involves a fire and explosion on board a U.S. Naval ship. Four reports[2] look at hypotheses for the cause of the February 15, 1898, fire and explosion on the battleship USS Maine (ACR-1) while it was docked in Havana, Cuba, causing the lives of 266 naval officers and sailors.[3]

An initial hurried investigation in 1898 conducted by Captain William Sampson, known as the *Sampson Court of Inquiry*, concluded that a mine had been placed under the ship, but could not place responsibility on the persons responsible for the act. Speculation that the Spanish were responsible quickly propelled the United States into war with Spain.[4]

The second look into the explosion took led by Admiral Charles E. Vreeland just after the USS Maine was raised in December 1910. The *Vreeland Court of Inquiry* in 1911 concluded an external blast caused explosions in the internal magazines. Physical examination, photographs, artifacts, and models were used in this inquiry before the wreckage was scuttled at sea and the dead were buried.[5]

Based upon new scientific and marine engineering knowledge acquired since the initial event, a third investigation by Admiral Hyman G. Rickover was launched and published in 1976.[6] The *Rickover Investigation* concluded that an external mine did not cause the explosion, but it was triggered by a coal bunker fire aboard the USS Maine that heated its magazines to their point of ignition. Building upon the information from previous inquiries and wartime examination of hulls, the Rickover Investigation leveraged experienced engineers from the U.S. Naval Research and Development Center who used computer modeling and correlated with eyewitness reports of the initial incident.

A fourth inquiry commissioned by the *National Geographic Magazine* coincided with the centennial anniversary of the USS Maine disaster. Their probe employed a firm who used newer computer modeling and arrived at a different conclusion than the Rickover Investigation. Historian Thomas B. Allen, the author of the 1998 *National Geographic* article, examined the cause of the magazine explosion from both the coal bunker fire and under-ship mine. His conclusions leaned towards the original hypothesis of the external mine theory.

These USS Maine disaster studies examine several hypotheses for determining whether an internal or external explosion occurred. Several of these analyses examined the underlying heat transfer problems, finite analysis of structural steel properties, the strength of welded and riveted connections, the impact of shock wave, and blast propagation. For example, the coal bunker fire analyses are examined by both heat transfer and the loss histories of similar fires aboard naval ships.

The USS Maine inquiries and hypotheses remind us that although peer reviewed science often forms the basis for conducting scientifically based fire investigations; much more is at stake than just examining the fire's development and growth. Treatises on the forensic reconstruction of a fire scene underscore the constant need to explore other factors when developing a hypothesis for the fire. These factors include, but are not limited to, fire dynamics, professional standards and guidelines, the analysis of fire patterns, human behavior, reported witness accounts, forensic evidence, environmental interactions, loss histories of similar fires, and fire testing data from similar incidents. Figure 1 summarizes many of these factors as cited in expert treatises in forensic fire scene reconstruction, several of which were taken into consideration during the many USS Maine inquiries.[7]

In dealing with the formation of a working hypothesis, the use of the scientific method ensures that the final working hypothesis, or expert opinion, is sound, reliable, and can bear scrutiny by others who are also experts. As in the USS Maine case, peer reviews of hypotheses subjected to the scrutiny of other experts can introduce new hypotheses, expand upon new computer modeling technologies, identify and correct analytical flaws. With any technical field, expert treatises, professional guidelines, and scientific standards come into play. In the fire and explosion field, the use of the scientific method is paramount in hypothesis development and testing.

SCIENTIFIC METHOD

Fire is commonly defined as "a rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities" as universally cited in the *NFPA 921*, the National Fire Protection Association's *Guide for Fire and Explosion Investigations*, 2004 Edition.[8] *NFPA 921* provides investigators with professional guidelines as to the methodology, protocols, and data for conducting origin and cause investigations. As indicated by *NFPA 921*, its role as a guide serves mainly as a "document that is advisory or informative in nature and that contains only nonmandatory provisions."

NFPA 921 states that the purpose of a *fire investigation* is to typically determine the area and point of origin, which is "the exact physical location where a heat source and fuel come in contact with each other and a fire begins." The primary goal of this probe is to first determine and establish the origin or origins of the fire, and then investigate the *cause*, which are "the circumstances, conditions, or agencies that brought about or resulted in the fire or explosion incident, damage to property resulting from the fire or explosion incident, or bodily injury or loss of life resulting from the fire or explosion incident." Clearly, many additional factors besides just the fire come into play such as human behavior, victim tenability, and hazardous environments.

The basic systematic approach to conducting a fire investigation (as outlined in *Kirk's Fire Investigation* by J.D. DeHaan,[9] *Forensic Fire Scene Reconstruction* by D.J. Icove and J.D. DeHaan,[10] and *NFPA 921*) uses the *scientific method*. The scientific method assists in forming a *working hypothesis* for the fire's origin and cause, using a systematic iterative process of formulating and eliminating opinions as to the cause of the fire, while taking into account the circumstances and conditions that brought about the incident. The culmination of this systematic iterative process is to form a final hypothesis or expert opinion as to the origin and cause of the fire. Figure 1 shows the generally accepted flowchart outlining the scientific method as it applies to forensic fire scene investigation and reconstruction.

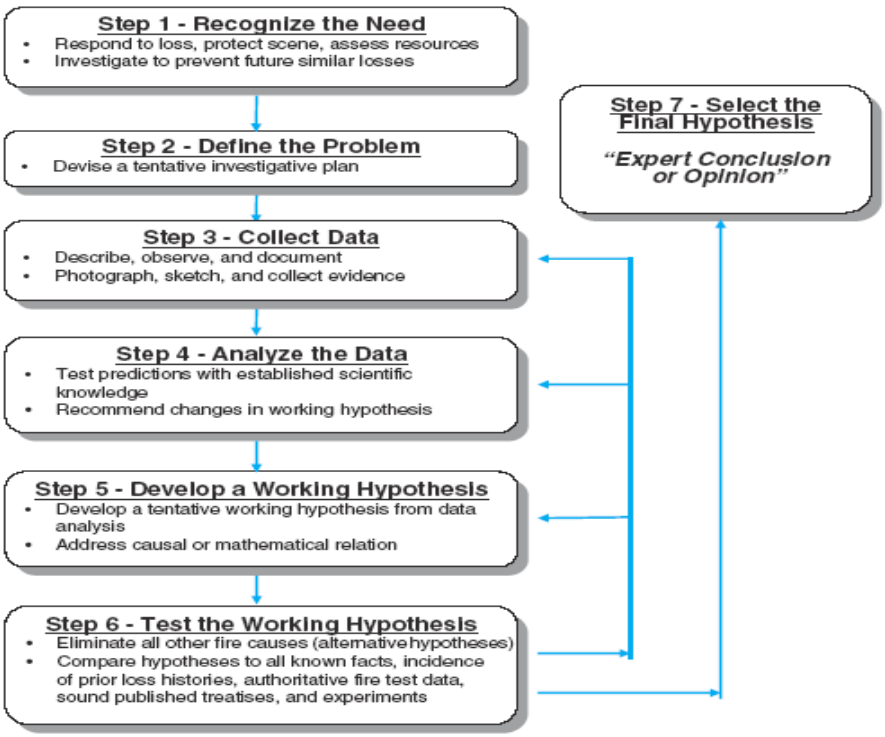

Figure 1. A flowchart outlining the scientific method as it applies to fire scene investigation and reconstruction, as derived from *NFPA 921*.
(Source: D.J. Icove and J.D. DeHaan, Forensic Fire Scene Reconstruction, Pearson-Prentice Hall, Upper Saddle River, New Jersey, 1st Edition, 2004.)

The concept of the ***working hypothesis*** is central within the framework of the scientific method. In the case of fire scene reconstruction, the working hypothesis is based upon how an investigator describes or explains the fire's origin, cause, and subsequent development. For example, research underscores the value of developing working hypotheses from fire toxicity exposure of fire victims, particularly if they are trapped in areas remote from the initial fire.[11]

As shown in Figure 2, the investigator molds a working hypothesis and then refines it by drawing upon and examining many sources of information, including past investigative experiences. The working hypothesis may include peer reviews of the fact sequences by other qualified investigators, who themselves bring institutional knowledge and experiences. Alternative hypotheses may be created and tested.

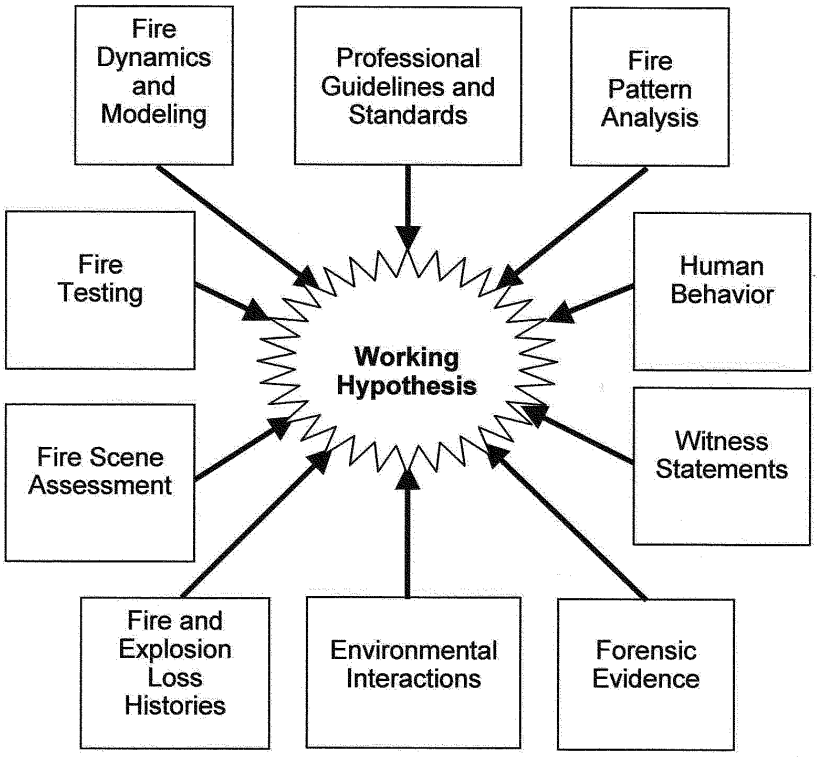

Figure 2. Many of the Factors used in forming a Working Hypothesis.
(Source: D.J. Icove and J.D. DeHaan, Forensic Fire Scene Reconstruction, Pearson-Prentice Hall, Upper Saddle River, New Jersey, 1st Edition, 2004.)

PEER REVIEW

Peer review is a process in which personal or institutional work products or ideas are subjected to the scrutiny of others who are also experts in the respective field. In the field of fire protection engineering, peer reviews of engineering designs form the pinnacle assessment tests for the true professional. In 2002, the Society of Fire Protection Engineers (SFPE) published a comprehensive "Guidelines for Peer Review in the Fire Protection Design Process."[12] These guidelines cover when to conduct a peer review, how to define its intended scope, selection of reviewers, confidentiality, and documentation of a final report. Furthermore, many of the SFPE publications and guidelines are applicable when conducting peer reviews.

Fire Investigation Review and Appraisals

The most frequent peer reviews of fire investigations typically occur during either in-house agency or company reviews, or during civil or criminal litigation. Criminal investigations may utilize solvability factors in making the determination to pursue or close a case. During agency or company reviews, supervisors and/or co-workers in the same area typically double check the hypotheses, documentation, and mathematical calculations.

A research sample shows exemplary programs in three states that use peer review of for fire investigators when determining job performance or challenges for certification. These reviews universally rely on *NFPA 1033 - Standard for Professional Qualifications for Fire Investigator*[13] in checklist protocol format. A review of these checklists show that in a majority of the cases they also test the understanding by the fire investigator of the proper application of the underlying concepts.

The Washington State Patrol's Fire Protection Bureau has by all means the most thorough of the peer review protocols, relying entirely upon job performance objective gleaned from the 2003 Edition of *NFPA 1033*. The 28-page protocol conducts an evaluation of a candidate listing the specific task, performance outcome, scene conditions, and pass/fail task steps. There is also a space reserved for evaluator and candidate comments. The protocol covers (1) scene examination, (2) documentation, (3) evidence collection/preservation, (4) interviewing/interrogation, (5) post-incident investigation, (6) preparation a written report, and (7) presentation of the investigative findings.

Similar to the Washington State Patrol, the State of Pennsylvania Voluntary Fire Service Certification Program uses the job performance requirements of *NFPA 1033*. The six-part "challenge skill exam" notes the objectives and mandatory requirements. The Office of the Illinois State Fire Marshal also uses *NPFA 1033* in its 11-page "Fire Investigator Equivalency Checklist." Their peer review protocol sequentially covers every section of *NFPA 1033* in a checklist format.

Criminal Prosecution Review

In criminal prosecutions of major felony cases, varying reviews are performed. Fire investigation unit supervisors typically review the reports for completeness, identify potential leads not addressed, and then forward the reports to the respective prosecutor's office for further review. Before formal criminal charges are filed, the case may get further intra-office scrutiny and possible additional investigation by the submitting agency.

Carefully reviewed cases that are presented to grand juries, which collectively also provide a further layer of review, typically return an indictment. The U.S. Federal system has possibly the most stringent peer review for determining when cases rise to the level of prosecution by the U.S. Department of Justice.[14]

In both criminal and civil litigation cases, both public and private fire investigative experts selected by opposing counsel review and assess the work performed by the respective sides. Some of these experts may be eventually called upon to testify in depositions and/or during trial.

DEFICIENCIES IN PEER REVIEW

With regard to peer review of complex fire investigations, there are many valid criticisms of the process—many of them related to the basic fact that no set of guidelines presently exist that will ensure that this process is comprehensive, uniform, unbiased, and valid. These criticisms were the primary basis for the development of this paper.

Deficiencies cited in the peer review process include the fact that the process is slow, biased, not generally open to public scrutiny, and may be cost-prohibitive. The complex nature of the underlying engineering and forensic sciences, coupled with the criminal and civil legal issues, requires that peer

reviews be conducted by multi-faceted teams of certified criminal and civil investigators, attorneys, forensic scientists, and engineers. Persons of this stature are sparsely distributed throughout the world.

Legal Perils and Concerns

There are ample legal concerns raised by attorneys who fear that peer review may undermine their legal process. For example, a written peer review prepared prior to or during the course of litigation is normally a discoverable instrument, not subject to any privileges per Rule 26(b)(I) of the Federal Rules of Civil Procedure. Although a peer review of an expert's opinion is important in preparing the case, the review may lead to the identification of the follow significant legal perils.[15]

An attorney is unlikely to approve a peer review when doing so unnecessarily places his client's confidential information in public view. This information might contain the client's trade/proprietary information that normally should not be shared with others.

Other concerns include if the peer review identifies significant fire or building code deficiencies, it may require notifying the adverse party as to potential theories of recovery not otherwise apparent to him. An example could be a violation of the National Electrical Code where negligent or improper wiring was discovered. Ethical considerations may lead to the reporting of these violations, which might result in the imposition of fines and other unforeseen adverse regulatory actions against the client.

A peer review which identifies the deficiencies of the investigation and subsequent hypothesis development might provide the adverse party now has a roadmap to attack the credibility of your and undermining the expert's determinations at trial. An attack such as this might render the expert's opinion inadmissible under *Daubert* and similar expert opinion standards.

Attorneys must carefully choose their peer reviewers and have confidence in their abilities because a review based on poor science or incorrect analysis will be difficult to overcome. Should an investigator decide to change their opinion in light of a peer review which identifies deficiencies, then the adverse party might use the expert's indecisiveness and his incorrect initial opinion to later detract from their credibility.

However, in the right circumstances, the peer review process is a valuable litigation tool if undertake early in the litigation process, particularly when it can correct or bolster your client's position well before the trial and can be of greatest value to the investigation. In order to counteract many of the these concerns identified above, a peer review must become be part of an iterative process by which the expert can refine their opinion by gathering additional information and exploring other hypotheses before finalizing their opinion in preparation for litigation.

***Daubert* Challenges**

The failures for the lack of a set of guidelines can be traced to the acceptance as truth of opinions and testimony offered by public fire investigators in trials over the years. Until recently with the advent of *Daubert*[16] challenges, attorneys often stipulated as to the opinion of the public fire official or private experts without questioning their background, training, certification, or education. These attorneys may not have cross-examined these experts on ruling out potential alternative hypotheses for the fire.

A *Daubert* challenge typically examines the reliability of an expert's proffered opinion testimony. This expert's opinion or hypothesis would be examined as to (1) whether it can or has been tested, (2) based on peer review and publication, (3) what is its known or potential rate of error, (4) whether standards controlling the technique's operation were maintained, and (5) whether it has gained general acceptance in the scientific community. If the basis for the opinion fails to meet one or more of these factors it may result in undermining the opinion or hypothesis and rendering the testimony unreliable.[17]

Hopefully, few experts will selectively choose a hypothesis to satisfy their own findings or the desired

opinion of their client. This approach is fraught with peril and ethical issues, and its conduct should be strongly discouraged.

Under *Rule 702* of the *Federal Rules of Evidence*, there is a three-part reliability test for an expert to express their opinion. First, the expert must be adequately qualified and demonstrate sufficient knowledge of the subject. Second, the expert must offer reliable testimony based upon the common Daubert challenges. Finally, the evidence must fit the facts of the case.

Recent studies by the *Innocence Project* revealed that for proffered scientific testimony in criminal cases, *Daubert* challenges still are rarely invoked. In contrast, *Daubert* challenges are more frequently used in civil cases. Conjecture is that court appointed advocates in criminal cases, while often underpaid, outskilled, and overworked, are not up to the challenge.[18] Another conjecture is that courts seldom exclude expert testimony in criminal cases.[19]

Interest Group Approaches

Another deficiency in the peer review process is that there is an on-going trend to circumvent the engineering and scientific community's collective judgment on the quality of individual studies. Recent research by the University of Texas, School of Law, cites the perils of relying on interested parties to evaluate scientific quality.[20] They caution that using adversarial, interest-group dominated approaches to peer review the scientific quality of these individual studies leads to undermining the science, and can blur distinctions made between policy and scientific judgments. These actions can result in poor decisions by courts, and they may lack the scientific competency to make independently sound decisions.

PROPOSED GUIDELINES

Based upon the underlying issues, the authors have reviewed several peer reviewed fire investigative procedures, standards, and guidelines in the field to propose a set of guidelines for conducting peer reviews of complex fire investigations. The term "complex" would include most obviously criminal and civil cases involving deaths, serious injuries, and major property damage. These guidelines build upon the previously referenced SFPE guidelines, yet expand into areas not previously addressed. In some cases, the proposed guidelines depart from those recommended by the SFPE in order to adequately address post-fire incident analysis.

Initiating a Peer Review

The decision to initiate a peer review may come from various sources or clients. Peer reviews may be commissioned, for example, by a judge, prosecutor, victim, plaintiff, or defendant. Furthermore, peer reviews of complex fire investigations may take place at various stages of an investigation and might be quite costly due to their resource intensive nature.

For example, a prosecutor may seek outside independent guidance to determine if they are on solid ground to pursue a criminal prosecution. An insurance company may require the review to determine if an errors and omissions claim against a private fire investigator is defendable. The defense attorney in a capital murder case may want to test the hypothesis that a fire was intentionally set that caused the death of a victim. Finally, a public defender's office may want to examine if reversible errors were made by a previous defense attorney's strategies not to challenge testimony, evidence, or investigate alternative hypotheses in a case.

When initiating a peer review, the members should be aware that their results may serve to further enhance an existing hypothesis. This may occur when further data becomes available, additional testing supports the original premise, or interviews lead to previously undisclosed information. The team should thoroughly document these findings in their final report.

Choice of Peer Review Team Members

In order to be balanced, peer review of complex fire investigations should be conducted by at least a team consisting of subject matter experts in the combined fields of criminal/civil investigation, fire protection engineering, forensic science, and law. The selection of these team members must be done carefully, particularly to ensure that each of the members has the appropriate credentials, experience, and ability, and is unbiased.

Upon being selected as a proposed peer reviewer, the team member should be vetted and enter into a signed agreement to ensure that no conflict of interest exists, notes and reports are retained, and that confidentiality is adhered to or observed. However, the team member should be aware that their testimony may be required at a later date, either in civil or criminal proceedings. Peer reviewers should be also cautioned as to whatever liability that they may assume in participating in such a team, particularly if it is later determined that they lacked the proper credentials or had a hidden bias.

The standard of care for the member of a peer review team should meet or exceed the care that would be expected by a person conducting the original investigation. Canons of ethics for that reviewer's particular field (investigative, legal, forensic, or engineering) should be reviewed prior to undertaking the task.

Scope of the Peer Review

The scope of the peer review should be established from the beginning. It should not be limited, for example, to just a review of the investigative report or expert disclosure and trial testimonies. In a complex criminal or civil trial, many materials exist that may not have been presented in court, yet may have significant bearing on the case.

In examining a hypothesis for a fire, the panel should consider the technical approach used by the expert, the factual basis, data sources, methods, and models. The panel should also take into consideration the training, education, certification, and past experience of the expert in determining if they correctly arrived at a sound conclusion.

Many documents consisting of statements, reports, opinions, and filings may not have been introduced at trial, yet may contain significant information not taken into consideration by the expert or simply not known to exist. For example in criminal cases, a proffer may have existed but was not introduced at the trial. This document may be used to offer an affirmative defense for the crime, preserving evidence for later possible appeals.

Typical reports not introduced at trial might be the results of a various examinations or investigations such as admissions during polygraph examinations, background revealed during probation/parole investigations, admissions made during psychological/psychiatric examinations, or results of drug testing. These documents may contain information of interest for the peer review panel.

In some cases, the peer reviewers may decide to conduct additional research into the case through scholarly searches of additional data, testing of alternative hypotheses, or interviews of available witnesses. The team may decide to use one or more fire models to test these hypotheses or even conduct actual physical tests of their own.

Finally, re-interviews of witnesses, suspects, prosecutors, and defense attorneys should not be out of the question. Appropriate waivers for disclosure should be obtained, allowing these individuals to speak candidly and honestly. For example, witness in a case may have revealed information to their counsel that adds or detracts from judging their credibility.

Peer Review Report

A final report should be issued containing the conclusions reached by the peer review panel. It should document the original scope of work, the selection and background of the peer reviewers, methods used in hypothesis testing, and any additional findings. Appendices should include any additional data used in the analysis, listing of computer modeling codes, references, reports of significant forensic findings, documentation of additional interviews, and the panels' vitae.

The peer review report appendix should also include checklists that inventory the factors considered by the team. Figure 3 lists a summary of factors to consider when conducting a peer review of a complex fire investigation. This list is not all inclusive, but it should serve only as a guide. Note that a comprehensive report of a peer review should include a discussion of the findings correlated with the information the team reviewed.

An example of a specific checklist from a more detailed and comprehensive collection (Figure 4) is used for determining whether evidence was properly labelled and sufficiently documented.

These checklist protocols address applicable standards and treatises in the fire investigation field. Although not totally comprehensive, the use of checklists while conducting a peer review often streamlines the rationale, and addresses technical issues and hypothesis areas documented. In some cases, these checklist protocols may even enhance an already sound hypothesis.

APPLICABLE STANDARDS AND TREATISES

The crucial issue surrounding a report of investigation is that it contains sufficient information that would allow an independent reviewer to arrive at a similar, if not the same conclusion. Protocols for this information already exist and are cited in *NFPA 921* and in other references. In addition, other guides and standards exist that knowledgeable investigators are encouraged to follow. Note that this section serves as only a synopsis of these applicable standards and suggested treatises, and it should not replace their careful review.

U.S. Department of Justice

Since the l990s, the U.S. Department of Justice has developed and disseminated a series of investigative guides and protocols covering the handling of various aspects of fire, arson, and related matters. These guides have now become standards of care for investigators. The following investigative guide documents should become part of a peer review of a complex fire investigation:

- *Crime Scene Investigation: A Guide for Law Enforcement*, NIJ Guide, January 2000. See also: *Crime Scene Investigation: A Reference for Law Enforcement*, NIJ Special Report, June 2004 (designed to accompany Crime Scene Investigation: A Guide for Law Enforcement)
- *Death Investigation: A Guide for the Scene Investigator*, NIJ Guide, November 1999
- *Electronic Crime Scene Investigation: A Guide for First Responders*, NIJ Guide, June 2001
- *Eyewitness Evidence: A Guide for Law Enforcement*, NIJ Guide, October 1999. See also: *Eyewitness Evidence: A Trainer's Manual for Law Enforcement*, NIJ Special Report, September 2003 (designed to accompany Eyewitness Evidence: A Guide for Law Enforcement)
- *Fire and Arson Scene Evidence: A Guide for Public Safety Personnel*, NIJ Guide, June 2000
- *Forensic Examination of Digital Evidence: A Guide for Law Enforcement*, NIJ Special Report, April 2004
- *A Guide for Explosion and Bombing Scene Investigation*, NIJ Guide, June 2000
- *Postconviction DNA Testing: Recommendations for Handling Requests, Issues and Practices*, September 1999
- *Using DNA to Solve Cold Cases*, NIJ Special Report, October 2002
- *What Every Law Enforcement Officer Should Know About DNA Evidence*, Brochure, September 1999

In addition to the NIJ investigative guides, the Federal Bureau of Investigation has working committees that provide specific guidance on the use of digital evidence. With the increased use of digital cameras, it is important for photographs taken by investigators that are used, enhanced, and stored to be maintained with integrity, since they may later come under close scrutiny. The following documents serve as a guide:

- FBI. 1999. *Definitions and Guidelines for the Use of Imaging Technologies in the Criminal Justice System.* Forensic Science Communications 1 (October): No. 3.
- FBI. 2004. *Scientific Working Group on Imaging Technology* (SWGIT) References/Resources, Forensic Science Communications (March).

These NIJ and FBI publications can be obtained off the Internet websites, nij.ncjrs.gov and www.fbi.gov, respectively.

National Fire Protection Association

Like the U.S. Department of Justice investigative guides, the following NFPA documents have become standards of care for fire investigators. The following documents should become part of a peer review of a complex fire investigation:

- *NFPA Fire Protection Handbook*, 2003 Edition.
- *NFPA 555 - Guide on Methods for Evaluating Potential for Room Flashover*. 2000
- *NFPA 906 - Guide for Fire Incident Field Notes*. 1998
- *NFPA 921 - Guide for Fire and Explosion Investigations*. 2004
- *NFPA 1033 - Standard for Professional Qualifications for Fire Investigator*. 2003

The contact information for obtaining additional information can be website www.nfpa.org or NFPA, 1 Batterymarch Park, Quincy, Massachusetts, USA 02169-7471, telephone number (617) 770-3000.

American Society for Testing and Materials

American Society for Testing and Materials (ASTM) standards for years have provided guidance in fire testing and forensics. The following documents should become part of a peer review of a complex fire investigation:

- *ASTM E 620-04 Standard Practice for Reporting Opinions of Technical Reports*. Committee E30.11 on Interdisciplinary Forensic Science Standards.
- *ASTM E 678-98 Standard Practice for Evaluation of Technical Data*. Committee E30.05 on Forensic Engineering Sciences.
- *ASTM E 860-97 Standard Practice for Examining and Testing Items That Are or May Become Involved in Products Liability Litigation.* Committee E-30.05 on Forensic Engineering Sciences.
- *ASTM E 1020-96 Standard Practice for Reporting Incidents.* Committee E30.05 on Forensic Engineering Sciences.
- *ASTM E 1188-95 Standard Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator*. Committee E 30.05 on Forensic Engineering Sciences.
- *ASTM E 1355-05 Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models.* Committee E 05.33 on Fire Safety Engineering.
- *ASTM. E 1138-89 Terminology of Technical Aspects of Products Liability Litigation*. Committee E 30.40 on Technical Aspects of Products Liability Litigation (Withdrawn 1995).
- *ASTM E 1459-92 (Re-approved 1998) Standard Guide for Physical Evidence Labeling and Related Documentation.* Committee E 30.01 on Criminalistics.

- *ASTM E 1472-03 Standard Guide for Documenting Computer Software for Fire Models.* Committee E 05.33 on Fire Safety Engineering.
- *ASTM E 1492-92 (Re-approved 1999) Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory.* Committee E 30.01 on Criminalistics.
- *ASTM E 1546-00 Standard Guide for Development of Fire-Hazard-Assessment Standards.* Committee E 05.33 on Fire Safety Engineering.
- *ASTM E 1591-00 Standard Guide for Obtaining Data for Deterministic Fire Models.* Committee E 05.33 on Fire Safety Engineering.
- *ASTM E 1895-04 Standard Guide for Determining Uses and Limitation of Deterministic Fire Models.* Committee E 05.33 on Fire Safety Engineering.

The contact information for obtaining additional information can be obtained off the Internet website www.astm.org or at ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959, USA, telephone number: (610) 832-9585.

Society of Fire Protection Engineers.

The Society of Fire Protection Engineers (SFPE) has issued a series of engineering practice guides for use by fire protection professionals. Several of these guides can be referenced in complex fire investigations. The following documents should become part of a peer review of a complex fire investigation:

- *The SFPE Handbook of Fire Protection Engineering*. 3rd ed. 2002,
- *Engineering Guide for Assessing Flame Radiation to External Targets from Pool Fires*. 1999.
- *Engineering Guide to Predicting 1st and 2nd Degree Skin Burns*. 2000,
- *SFPE Engineering Guide to Piloted Ignition of Solid Materials under Radiant Exposure*.2002.
- *SFPE Engineering Guide—The Evaluation of the Computer Model DETECT-QS*. 2002.
- *Guidelines for Peer Review in the Fire Protection Design Process*. 2002.
- *Engineering Guide: Human Behavior in Fire*. 2003,

The contact information for obtaining additional information can be obtained off the Internet website www.sfpe.org or at 7315 Wisconsin Avenue, Suite 620E, Bethesda, MD 20814, USA, telephone number: (301) 718-2910.

Expert Treatises

There are several peer reviewed textbooks and references that are recommended for inclusion in both conducting and assessing complex fire investigations. These texts are written by prominent credentialed fire scientists and engineers, are widely cited in scholarly publications, used and distributed in the fire investigation community, included in association publication lists, cited in court cases, and often have been reviewed by forensic journals.

Based upon one of more of these actions, these texts have become or have the potential of becoming expert or learned treatises in the field of fire investigation. Learned treatises are those texts that further rise to the level of authoritative acceptance that they can be admitted as evidence in court to support or rebut the testimony given by an expert witness.

Although not totally inclusive, the following reference documents, many of which are considered expert treatises, should be available to team members during a peer review of a complex fire investigation:

- Babrauskas, V. 2003. *Ignition Handbook*. Fire Science Publishers, Issaquah, WA, and the Society of Fire Protection Engineers, Bethesda, MD. ISBN 0-9728111-3-3.
- Babrauskas, V. 1992. *Heat Release in Fires*, Taylor and Francis, Publisher, ISBN 0419161007.

- Beveridge, A.D., Editor, 1998. *Forensic Investigation of Explosions*, ISBN 0-7484-0565-8, Taylor & Francis Ltd. Publishers, Basingstoke, UK.
- Brannigan, F.L. 1992. *Building Construction for the Fire Service,* 3rd Ed. ISBN 0-87765-381, National Fire Protection Association, Quincy, MA.
- Cole, L.S. 2001. *Investigation of Motor Vehicle Fires,* 4th Ed., ISBN 0-939818-29-9, Lee Books, San Anselmo, CA.
- Cooke, R.A., and R.H. Ide. 1985. *Principles of Fire Investigation*, Institution of Fire Engineers Gloucestershire, UK.
- DeHaan, J.D. 2007. *Kirk's Fire Investigation*, 6th Ed. Upper Saddle River, N.J.: Prentice Hall. ISBN 0-13-171922-X.
- Drysdale, D. 1999. *An Introduction to Fire Dynamics*, 2nd Ed. New York: John Wiley and Sons. ISBN 0-471-97290-8.
- Icove, D.J., V.B. Wherry, and J.D. Schroeder, 1998. *Combating Arson-for-Profit: Advanced Techniques for Investigators*, 2nd Edition, Battelle Press, Columbus, Ohio.
- Icove, D.J., and DeHaan, J.D. 2004. *Forensic Fire Scene Reconstruction*, Pearson-Prentice Hall, Upper Saddle River, New Jersey, 1st Ed.
- Iqbal, N., and M. H. Salley, 2004. *Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program*, Washington, D.C.
- Janssens, M. 2000. *Introduction to Mathematical Fire Modeling*, 2nd Ed., Technomic, Lancaster, PA.
- Karlsson, B., and J. G. Quintiere. 1999. *Enclosure Fire Dynamics*, Boca Raton, Fla.: CRC Press. ISBN 0-8493-1300-7.
- Quintiere, J. G. 1997. *Principles of Fire Behavior*. Albany, N.Y.: Delmar.
- Quintiere, J. G. 2006. *Fundamentals of Fire Phenomena*. England: Wiley.

CONCLUSIONS

The proper application of fire science and engineering principles and practice is paramount when conducting comprehensive and complex fire investigations. The purpose of this paper is to form the basis for a set of consensus guidelines for conducting peer reviews of fire investigations. These guidelines are needed when evaluating complex investigations, particularly when substantial loss of life and damage to property results in criminal prosecutions or extensive civil litigation. Furthermore, peer reviews by a team of disinterested parties avoid the alternative adversarial approach often seen in court litigation.

Fire investigations should be peer reviewed in a professional manner that is consistent with accepted practice. This review should be well documented and follow consistent guidelines. Furthermore, this peer review should be conducted by at least a team consisting of subject matter experts in the fields of criminal/civil investigation, fire protection engineering, forensic science, and law.

The paper recommends a comprehensive set of uniform guidelines for the initiation, scope, conduct, and reporting of such a peer review in complex fire investigations. These recommended guidelines evaluate not only the conceptual and technical soundness of the approach, but also address the thoroughness of the overall investigative process.

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Figure 3. Summary of Suggested Areas to be Addressed in a Peer Review of a Complex Fire Investigation

Instructions: Check the appropriate block to indicate the presence or absence of the following information.

YES	NO	
☐	☐	Scene secured (*NFPA 1033, 4.2.1*)
☐	☐	Scene safety assessment conducted (*OSHA, 29 CFR Section 1910*)
☐	☐	Exterior survey conducted (*NFPA 1033, 4.2.2; NFPA 906-2*)
☐	☐	Interior survey conducted (*NFPA 1033, 4.2.3; NFPA 906-2*)
☐	☐	Burn patterns interpreted (*NFPA 1033, 4.2.4; NFPA 906-2*)
☐	☐	Burn patterns correlated (*NFPA 1033, 4.2.5; NFPA 906-2*)
☐	☐	Fire debris examined and removed (*NFPA 1033, 4.2.6, ASTM 1188, ASTM E 1459*)
☐	☐	Area(s) of origin reconstructed (*NFPA 1033, 4.2.7*)
☐	☐	Building performance inspected (*NFPA 1033, 4.2.8*)
☐	☐	Effects of explosions discriminated from other damage (*NFPA 1033, 4.2.9*)
☐	☐	Scene diagrammed (*NFPA 1033, 4.3.1; NFPA 906-9*)
☐	☐	Scene photographed (*NFPA 1033, 4.3.2; NFPA 906-8, ASTM E 1188*)
☐	☐	Investigative notes taken and preserved (*NFPA 1033, 4.3.3; NFPA 906*)
☐	☐	Eyewitness evidence identified, preserved, collected, packaged (*NIJ Eyewitness Evidence Guide*)
☐	☐	Evidence (physical, electronic, digital) identified, preserved, collected, packaged (*NFPA 1033, 4.4.1, 4.4.2; NFPA 906-7; ASTM E 620; ASTM E 860; ASTM E 1188, ASTM E 1459; NIJ Electronic Crime Scene Investigation Guide; FBI Guidelines for Imaging Technologies*)
☐	☐	Evidence properly selected for analysis (*NFPA 1033, 4.4.3; NFPA 906-7; ASTM E 620, ASTM E 1492*)
☐	☐	Chain of custody documented (*NFPA 1033, 4.4.4; NFPA 906-7*)
☐	☐	Evidence properly disposed (*NFPA 1033, 4.4.5*)
☐	☐	Interview plan developed (*NFPA 1033, 4.5.1*)
☐	☐	Interviews/interrogations properly conducted (*NFPA 1033, 4.5.2, NFPA 906-6*)
☐	☐	Investigative information properly inventoried (*NFPA 906-0*)
☐	☐	Investigative information properly analyzed/correlated (*NFPA 1033, 4.5.3; ASTM E 620*)
☐	☐	Investigative information properly obtained/documented (*NFPA 1033, 4.6.1; NFPA 906-1, 906-10, 906-11*)
☐	☐	Investigative information in file is interpreted/corroborated (*NFPA 1033, 4.6.2*)
☐	☐	Investigative information on victims/casualties documented (*NFPA 906-5, NIJ Death Investigation Guide*)
☐	☐	Investigative information need for fire modeling documented (*NFPA 921, ASTM E 1355, ASTM E 1472, ASTM E 1591, ASTM E 1895*)
☐	☐	Investigative information need for determining occurrence of room flashover documented (*NFPA 555*)
☐	☐	Expert resources matched to needs, causation (*NFPA 1033, 4.6.3*)
☐	☐	Motive/opportunity evidence established (*NFPA 1033, 4.6.4*)
☐	☐	Person(s)/product(s) identified for responsibility (*NFPA 1033, 4.6.5*)
☐	☐	Concise written report prepared (*NFPA 1033, 4.7.1; ASTM E 620, ASTM E 678, ASTM E 1020. ASTM E 1188, ASTM E 1492, ASTM E 1459, ASTM E 1546*)
☐	☐	Investigative findings verbally presented (*NFPA 1033, 4.7.2*)
☐	☐	Testimony clearly presented at legal proceedings (*NFPA 1033, 4.7.3*)
☐	☐	Public informational presentations are accurate (*NFPA 1033, 4.7.4*)

Figure 4. Peer Review Checklist for Physical Evidence Labeling

Purpose of Review: To confirm that the physical evidence collected during the investigation and in the forensic laboratory is uniquely identified and labeled.

Case Number: _____
Date of review: _____
Peer Reviewers: _____

Applicable Standards/Guidelines:

- *ASTM E 1459*-92 (Re-approved 1998) *Standard Guide of Physical Evidence Labeling and Related Documentation*, ASTM E 30 Committee on Forensic Sciences, Subcommittee E30.01 on Criminalistics.
- *Fire and Arson Scene Evidence: A Guide for Public Safety Personnel*, NIJ Guide, June 2000
- *NFPA 906 - Guide for Fire Incident Field Notes*. 1998
- *NFPA 921 - Guide for Fire and Explosion Investigations*. 2004
- *NFPA 1033 - Standard for Professional Qualifications for Fire Investigator*. 2003

Instructions: Check the appropriate block to indicate the presence or absence of the following information on the labeled evidence.

Items collected during the investigation

YES	NO	
☐	☐	Item number
☐	☐	Case or incident number
☐	☐	Identification of where the evidence was found
☐	☐	Identification of person who collected item
☐	☐	Initials of investigator
☐	☐	Date item collected
☐	☐	Brief description of item
☐	☐	Identification of additional persons, dates, and disposition transferring this item of evidence (chain of custody)

Items produced during examination in the forensic laboratory

YES	NO	
☐	☐	Item number
☐	☐	Case or incident number
☐	☐	Laboratory case number
☐	☐	Identification of person who collected item
☐	☐	Initials of examiner
☐	☐	Date item prepared
☐	☐	Brief description of item
☐	☐	Identification of additional persons, dates, and disposition transferring this item of evidence (chain of custody)

REFERENCES

[1]Wikipedia. 2006, "Peer Review," URL: http://en.wikipedia.org/wiki/Peer_review.
[2] Wikipedia. 2006, "USS Maine (ACR-1)," URL: http://en.wikipedia.org/wiki/USS_Maine.
[3] Allen, T.B. 1998. "What Really Sank the Maine?" *Naval History Magazine*, U.S. Naval Institute, Annapolis, MD, www.usni.org/navalhistory/articles98/nhallen.htm.
[4] Glazier, P. 2004. *Yellow Journalism and the USS Maine Explosion*, Thesis, University of North Carolina, Ashville.
[5] Miller, T. 1998. "Remember the Maine," *Smithsonian*, February 1998, Vol. 28, No. 11, pp. 46-57.
[6] Rickover, H.G. 1976. *How the Battleship Maine was Destroyed*, Naval Institute Press, Annapolis, MD.
[7] Icove, D.J. and J.D. DeHaan, 2004.*Forensic Fire Scene Reconstruction*, Pearson-Prentice Hall, Upper Saddle River, New Jersey, 1st Edition,
[8] *NFPA 921—Guide For Fire and Explosion Investigations*. Quincy, Mass.: National Fire Protection Association. 2004 Edition.
[9] DeHaan, J.D. 2007. *Kirk's Fire Investigation*, 6th Ed. Upper Saddle River, N.J.: Prentice Hall. ISBN 0-13-171922-X.
[10] Icove, D.J. and J.D. DeHaan, 2004.*Forensic Fire Scene Reconstruction*, Pearson-Prentice Hall, Upper Saddle River, New Jersey, 1st Edition,
[11] Carpenter, D. R. Roby, and J. Torero, "The Use of Toxicity Data in the Reconstruction and Analysis of Fires" ISFI. *International Symposium on Fire Investigation Science and Technology,* Cincinnati, Ohio, June 26-28, 2006.
[12] Guidelines for Peer Review in the Fire Protection Design Process, Society of Fire Protection Engineers, Bethesda, Maryland, Oct. 8, 2002, URL: www.sfpe.org/upload/peer_review_guidelines.pdf.
[13] *NFPA 1033 - Standard for Professional Qualifications for Fire Investigator*. Quincy, Mass.: National Fire Protection Association. 2003 Edition.
[14] U.S. Department of Justice, *Principles of Federal Prosecution*, U.S. Government Printing Office, 1980-341-235/1721 (See also: U.S. Department of Justice, *Criminal Resource Manual*, Title 9, http://www.justice.gov/usao/eousa/foia_reading_room/usam/title9/27mcrm.htm).
[15] Carrigan, T.J. 2007. Personal correspondence, January 3, 2007.
[16] *Daubert v Merrell Dow Pharmaceuticals, Inc.* (1993), 509 U.S. 579, 113 S. Ct. 2756, 215 L.Ed.2d 469; and *Daubert v Merrell Dow Pharmaceuticals, Inc.* (Daubert II), 43 F.3d 1311, 1317 (9th Cir. 1995).
[17] Cwik, C. 2006. Scientific Evidence Review: Current Issues at the Crossroads of Science, Technology, and the Law, Monograph No. 7, American Bar Association, pp. 1-5.
[18] Neufeld, P.J. 2005. *The Near Irrelevance of Daubert to Criminal Justice and Some Suggestions for Reform*, American Journal of Public Health; 2005 Supplement 1, Vol. 95, pp. 107-113.
[19] Lentini, J. 2007. Personal correspondence, February 19, 2007.
[20] Wagner, W. 2005. *The Perils of Relying on Interested Parties to Evaluate Scientific Quality*, American Journal of Public Health, 2005 Supplement 1, Vol. 95, pp. 99-106.