Terry-Dawn Hewitt, Esq.
Chair
and
Wayne J. McKenna, Esq.

FISC Bulletin Board
IAAI Fire Investigation Standards Committee (FISC)

EXPERTS BEWARE: ARE YOUR FOUNDATIONS OPEN TO ATTACK?

1. Introduction

Part of the mission of the IAAI's Fire Investigation Standards Committee (FISC) is to keep abreast of information about standards and guides that apply to fire and explosion investigations. In addition, one of FISC's duties is educating the IAAI membership about such documents and related issues.[1] The purpose of this column is to share information about the vetting process for scientific literature, known as foundational literature, which provides the scientific foundation for each forensic discipline. If we were to create a list of scientific literature for the field of fire investigations that could qualify as foundational, industry standards such as those published by the National Fire Protection Association (NFPA)[2] and ASTM International[3] would feature prominently. So, too, would the reference materials they cite.

The 2009 report, *Strengthening Forensic Science in the United States: A Path Forward* (the *NRC/NAS Report*)[4] expressed concerns about the extent to which there may be gaps in the foundational research that provides the scientific basis of many forensic science disciplines. This article begins by summarizing these concerns and introducing the resulting Foundational Research Recommendation. Since this recommendation applies to forensic science disciplines, we explore whether fire investigations qualify as a forensic science discipline.

After concluding that fire investigations are, at least in some circles, considered to be among the forensic science disciplines affected by the *NRC/NAS Report*, we examine the activities undertaken by the following organizations that are relevant to the Foundational Research Recommendation and fire investigations:

- White House Interagency Working Group for Research, Development, Testing, and Evaluation (IWG RDT&E);
- The Technical and Scientific Working Group on Fires and Explosions (T/SWGFEX);
- The Organization of Scientific Area Committees (OSAC); and,
- The National Commission on Forensic Science (NCFS).

For the purposes of this article, the most important of these activities are certain work products of OSAC and the NCFS. Briefly, OSAC has added the 2014 editions of *NFPA 921 Guide for Fire and Explosion Investigations*[5] (*NFPA 921*) and *NFPA 1033 Standard for Professional Qualifications for Fire Investigator*[6] (*NFPA 1033*) to its Registries of Approved Standards and Guidelines. In the meantime, the NCFS has developed two sets of criteria for evaluating scientific literature. After examining these OSAC and NCFS projects, the authors raise two questions and discuss their implications. One is whether industry standards such as *NFPA 921* and *NFPA 1033* as well as the publications they mention, meet the NCFS' criteria. The second is the impact that the elevation of *NFPA 921* and *NFPA 1033* to the OSAC Registries will have on the influence of these documents in the fire investigation community and in court. We also clarify status of the 2017 edition of *NFPA 921*, which the NFPA issued in November 2016.

This article closes by touching on how attorneys could use the developments in OSAC or the NCFS to challenge or support the qualifications or opinions of fire investigation experts in criminal or civil litigation. We begin by tracing the roots of this issue. This background information is very important to understanding the significance of this topic to fire investigations and as a potential tool in court.

2. Background: The NRC/NAS Report

The 2009 report, *Strengthening Forensic Science in the United States: A Path Forward* (the *NRC/NAS Report*)[7] prompted the questions this article raises. The sea change this report is causing for the forensic sciences, including fire investigations, cannot be understated. Further, the issue under discussion, while at first glance is seemingly benign, goes to the heart of fire investigations. In the hands of the right lawyers

or experts, it could affect the outcome of cases. Therefore, to put matters into perspective, we begin with a brief look at the background of the *NRC/NAS Report*, its major findings respecting the foundational science for forensic disciplines, and the efforts underway to implement this aspect of the report.

It all started more than a decade ago. Realizing the need for an extensive investigation into the state of the forensic sciences in the United States, Congress passed legislation in 2005[8] authorizing the National Academy of Sciences (NAS) to conduct a broad ranging study. In the fall of 2006, the National Research Council (NRC), which is part of the NAS, formed an independent committee[9] to address the Congress' charge.[10] The committee consisted of professionals and experts from various fields of science and forensic science, from the law, and from engineering.[11]

The committee worked hard over a period of two years, meeting and deliberating, studying testimony from diverse experts and organizations in the public and private sectors from within and outside of the United States, reviewing published materials, and engaging in independent research.[12] In 2009, the NRC's committee completed its work and NAS published the resulting report: *Strengthening Forensic Science in the United States: A Path Forward*. Its recommendations reflect one underlying goal, consistent with the evidence the committee heard:

> The forensic science system, encompassing both research and practice, has serious problems that can only be addressed by *a national commitment to overhaul the current structure that supports the forensic science community in this country*.[13]

The report sets forth a blueprint for strengthening the forensic sciences, consisting of 13 recommendations. One of these, which we refer to as the "Foundational Research Recommendation," speaks to shoring up the scientific underpinnings for each forensic science discipline. Next, we introduce this recommendation, and then consider whether it applies to fire investigations.

3. *NRC/NAS Report* Foundational Research Recommendation

Woven through the 300-plus page *NRC/NAS Report* are repeated references about the need to identify and assess the foundational literature for forensic disciplines. This need results from "a notable dearth of peer-reviewed, published studies establishing the scientific bases and validity of many forensic methods."[14] Responding to this concern, the Foundational Research Recommendation deals with issues concerning scientific foundations and the necessity of research to fill the gaps:

> **Recommendation 3:**
>
> **Research is needed to address issues of accuracy, reliability, and validity in the forensic science disciplines.** . . .[15]

The support for this Foundational Research Recommendation is evident throughout the report, in which "[t]he term 'foundation' was used no less than thirty times to emphasize that each forensic discipline must have a scientifically robust and validated basis to its methods, its technologies, and its process of interpreting data."[16] However, in reading these numerous references in the *NRC/NAS Report* about the need to establish the scientific basis for each forensic discipline, one might reasonably question whether this recommendation applies to fire investigations. To answer this question, we begin by considering how the *NRC/NAS Report* defines forensic science disciplines and its reference to arson investigations and burn patterns.

4. *NRC/NAS Report* Characterizes "Forensic Science Disciplines"

Recognizing the breadth of its investigations, the committee[17] that wrote the *NRC/NAS Report* considered the question, "What is Forensic Science?"[18] This question is directly applicable to determining whether the report catches fire investigations in its net. They found that a useful approach was the categorization used by the National Institute of Justice,[19] which divides forensic science disciplines into 12 groups,[20] ranging from laboratory-based disciplines such as trace evidence, to disciplines based on expert interpretation such as blood pattern analysis. This categorization includes "fire debris/arson analysis," and "crime scene investigation," but does not specifically address "fire investigations."

In describing problems with the interpretation of forensic evidence, the report observes, "Often in criminal prosecutions and civil litigation, forensic evidence is offered to support conclusions about "individualization" (sometimes referred to as "matching" a specimen to a particular individual or other source) or about classification of the source of the specimen into one of several categories."[21] In this context, the report distinguishes analytically based disciplines, of which laboratory analysis of explosive evidence and fire debris analysis are examples, from those based on expert interpretations of observed patterns, such as fingerprint or bite mark analysis:

> The term "forensic science" encompasses a broad range of disciplines, each with its own distinct practices. The forensic science disciplines exhibit wide variability with regard to techniques, methodologies, reliability, level of error, research, general acceptability, and published material . . . . Some of the disciplines are laboratory based (e.g., nuclear and mitochondrial DNA analysis, toxicology, and drug analysis); others are based on expert interpretation of observed patterns (e.g., fingerprints, writing samples, toolmarks, bite marks). Some activities require the skills and analytical expertise of individuals trained as scientists (e.g., chemists or biologists); other activities are conducted by scientists as well as by individuals trained in law enforcement (e.g., crime scene investigators, blood spatter analysts, crime reconstruction specialists) . . . .[22]

Fire investigations include activities such as crime scene investigations and crime scene reconstruction mentioned above. *NFPA 1033,* the widely accepted standard that specifies the job performance requirements for fire investigators, supports this position. Chapter 4 defines the duties of fire investigators, which include inspecting and evaluating the fire scene for evidence,[23] and reconstructing the scene,[24] which fall within the scope of the above discussion.

Further reflections by the authors of the *NRC/NAS Report* on the meaning of forensic science, which defines the

report's scope, are also relevant to determining if the report's recommendations apply to fire investigations:

> Many of the processes used in the forensic science disciplines are largely empirical applications of science—that is, they are not based on a body of knowledge that recognizes the underlying limitations of the scientific principles and methodologies used for problem solving and discovery. It is therefore important to focus on ways to improve, systematize, and monitor the activities and practices in the forensic science disciplines and related areas of inquiry. *Thus, in this report, the term "forensic science" is used with regard to a broad array of activities, with the recognition that some of these activities might not have a well-developed research base, are not informed by scientific knowledge, or are not developed within the culture of science.*[25]

Relating the above discussion to fire investigations, fire investigations rely on scientific principles and the application of the scientific method to inquiries about fire origin and cause. They also utilize empirical applications of science, based on observation or experience. We conclude that the parameters set forth by the *NRC/NAS Report* to characterize disciplines that fall within the forensic sciences apply to a "broad array of activities" and are far reaching enough to include fire investigations. As we will see in the next section, lending support to this view are the report's references to burn pattern interpretation and the need for further research to put arson investigations on a more solid scientific footing.

5. The Thin Edge of The Wedge: *NRC/NAS Report* on Burn Patterns and Arson Investigations

As noted earlier, the *NRC/NAS Report* did not address fire investigations as among "some of the major forensic science disciplines" selected for specific review.[26] However, it included an explicit reference to determinations made from burn patterns in the section on the "Analysis of Explosives Evidence and Fire Debris." Below are the relevant excerpts from the "Summary Assessment" of that section.

Summary Assessment

> The scientific foundations exist to support the analysis of explosions, because such analysis is based primarily on well-established chemistry. As part of the laboratory work, an analyst often will try to reconstruct the bomb, which introduces procedural complications, but not scientific ones.
>
> *By contrast, much more research is needed on the natural variability of burn patterns and damage characteristics and how they are affected by the presence of various accelerants.* Despite the paucity of research, some arson investigators continue to make determinations about whether or not a particular fire was set. However, according to testimony presented to the committee,[27] many of the rules of thumb that are typically assumed to indicate that an accelerant was used (e.g., "alligatoring" of wood, specific char patterns) have been shown not to be true.[28] *Experiments should be designed to put arson investigations on a more solid scientific footing.*[29]

Though the references to arson investigations are brief, the report indicates that research is required into the scientific basis of burn pattern analysis, more precisely, "the natural variability of burn patterns and damage characteristics and how they are affected by the presence of various accelerants").[30]

Fire investigators refer to burn pattern analysis as fire pattern interpretation. Fire pattern interpretation is at the core of fire investigations, and is a mandatory duty required of fire investigators according to *NFPA 1033*.[31] *NFPA 921* also emphasizes the importance of fire pattern interpretation, discussing fire patterns at length,[32] and noting that "the analysis of effects and patterns left by the fire"[33] is one of only four types of information *NFPA 921* lists as necessary to determine a fire's origin.[34] In turn, "[g]enerally, a fire cause determination can be considered reliable only if the origin has been correctly determined."[35] Given the prominent role of fire pattern interpretation, even the report's limited reference to its scientific underpinnings merits attention by the fire investigation community. To appreciate fully the implications of the above Summary Assessment, we drilled down into the material cited by the *NRC/NAS Report* in its own footnotes (numbered 27 and 28 in the above quote).

First, the Summary Assessment speaks of "testimony presented to the committee," referring to a presentation cited in our endnote number 27. We reviewed the document supplied for this presentation, which provided numerous examples of errors made by fire investigators who misinterpreted burn patterns made by accidental fires as those caused by arson.[36] Noteworthy for our purposes, the presentation also referred to *NFPA 921*, stating that it is the "standard of care in fire investigation."[37]

The *NRC/NAS Report* likewise mentioned *NFPA 921* (at note 28 above), citing it as having shown that many "rules of thumb" used in arson investigation as not being true. However, even after acknowledging this value of *NFPA 921*, the *NRC/NAS Report* still concluded that, "[e]xperiments should be designed to put arson investigations on a more scientific footing."[38] One can infer that the testimony about *NFPA 921* as the standard of care for investigators was not sufficient to put to rest the concerns of report's authors about burn pattern interpretation in set fires. In a larger context, this statement is consistent with the concerns expressed elsewhere in the *NRC/NAS Report*, as summarized earlier in this article, about the need for further foundational research in the forensic sciences. Thus, it appears that the reference in the *NRC/NAS Report* to burn patterns in arson investigations may prove to have been the thin edge of the wedge, drawing fire investigations into the forensic science fold. The next section pursues the question of whether fire investigation is an emerging forensic science discipline.

6. Fire Investigations: A Forensic Science Discipline

The references to arson investigations and burn pattern interpretation in the *NRC/NAS Report* are brief. One might reasonably question whether fire investigations are among the forensic sciences targeted by that report and whether the Foundational Research Recommendation should apply. Though one can make arguments on either side of whether the report's

authors intended to include fire investigations as a forensic science discipline, later developments indicate that the field of fire investigations is one of the forensic science disciplines caught in its wake.

In this vein, in one of the developments flowing from the *NRC/NAS Report,* the National Institute of Standards and Technology (NIST) is working to strengthen forensic science through its Organization of Scientific Area Committees (OSAC). One way OSAC is strengthening the forensic sciences is, "by facilitating the development of *discipline-specific, science-based standards and guidelines for a broad array of forensic disciplines*."[39] NIST has formed 25 OSAC forensic science subcommittees to address these disciplines.[40] Some subcommittees were named after forensic disciplines expressly addressed in the *NRC/NAS Report*, such as the "Toxicology Subcommittee," the "Firearms and Toolmarks Subcommittee," and the "Fire Debris and Explosives Subcommittee." Others, such as the "Fire and Explosion Investigation Subcommittee" are among the forensic disciplines included in OSAC, but were not specifically labeled as forensic disciplines in the *NRC/NAS Report*. Therefore, OSAC is treating fire and explosion investigations as a forensic science discipline.

In analyzing whether fire investigations are included among the forensic sciences, one would be remiss not to inquire into their treatment by the American Academy of Forensic Sciences (AAFS), the largest forensic science organization in the world."[41] AAFS describes itself as "a multi-disciplinary professional organization that provides leadership to advance science and its application to the legal system."[42] Its objectives are "to promote professionalism, integrity, competency, education, foster research, improve practice, and encourage collaboration in the forensic sciences."[43] AAFS defines forensic as, "relating to, used in, or suitable to a court of law"[44]and forensic science as "[a]ny science used for the purposes of the law is a forensic science."[45]
AAFS does not exhaustively list the forensic science disciplines on its website. A web page for students, entitled "Types of Forensic Scientists: Disciplines of the AAFS" explains that AAFS members are divided into eleven sections, including "Criminalistics," "Engineering Sciences," and "Jurisprudence." These sections include members from the fire investigations field; however, "fire investigations" is not one of the eleven membership sections. Instructive is the epigraph at the beginning of the "General" section description, which says:

> *There is literally no end to the number of disciplines that become 'forensic' by definition. Nor is there an end in sight to the number of present or future specialties that may become forensic. The examples are many.*[46]

In therefore appears, then, that just as the *NRC/NAS Report* defined forensic sciences to include "a broad array of activities," so too does the AAFS. Looking to see if fire investigations feature among such "examples," we first consulted the AAFS' Reference Library. Even in the short period from 2014 to 2016, the library contains references to several papers on fire investigations presented by the Engineering Sciences and Jurisprudence sections, by such notable figures in fire investigations as Texas Fire Marshal Chris Connealy, former ATF Special Agent Steve W. Carman, and John Lentini. Further, the last two AAFS Annual Scientific Meetings included several presentations on fire investigations, including a full day workshop in 2015[47] and reports from the OSAC Fire and Explosion Investigation Subcommittee in both 2015 and 2016.

Insofar as the field of fire investigations is being included as one of many a forensic science disciplines, it is foreseeable that it will be influenced by relevant recommendations in the *NRC/NAS Report*. To the extent that the Foundational Research Recommendation, applies, it follows that "[r] esearch is needed to address issues of accuracy, reliability, and validity"[48] in the field of fire investigations as well as other forensic disciplines.

The next section of this article traces the steps that the federal government has taken to implement this Foundational Research Recommendation. Thereafter we shine the light on scientific literature forming the underpinnings of fire investigations, including *NFPA 921* and *NFPA 1033*.

7. Implementing the *NRC/NAS Report* Foundational Research Recommendation: White House Inter-agency Working Groups and T/SWGFEX

The federal government wasted no time in taking action on the *NRC/NAS Report's* recommendations. In 2009, the same year that the NAS published the *NRC/NAS Report*, the White House established the Subcommittee on Forensic Science. Its purpose is:

> [T]o advise and assist the [President's Committee on Science, National Science and Technology Council], and other coordination bodies of the Executive Office of the President on policies, procedures, and plans related to forensic science in the national security, criminal justice, and medical examiner/coroner systems at the local, state, and federal levels . . . ."[49]

To achieve its goals, the Subcommittee established five Inter-agency Working Groups (IWGs). The Foundational Research Recommendation came within the jurisdiction of the Inter-agency Working Group for Research, Development, Testing, and Evaluation (IWG RDT&E). Its Charter identified the work of this IWG.[50] Its job was to pursue, "the identification of foundational research that can be mapped to specific principles across the various disciplines of forensic science."[51]

The IWGs started their work in 2010. Fire investigations were on their radar, specifically with respect to fire pattern interpretation. The IWG RDT&E invited presentations from scientific working groups (SWGs) in a number of forensic disciplines. In July 2011, representatives of the Technical and Scientific Working Group for Fires and Explosions (T/SWGFEX)[52] met with the IWG RDT&E to address the scientific foundations of fire scene investigation and fire pattern interpretation. Presentations to the IWG RDT&E on behalf of T/SWGFEX included those made by fire investigators who were also IAAI and FISC members. The presenters were Steven J. Avato, who was at the time the Resident Agent in Charge at ATF in Falls Church, Virginia, and Rick Merck, P.E., who was at the time the Senior Fire Protection Engineer and Fire Marshal at Montgomery County Fire and Rescue Service, Maryland.[53]

Later, the IWG contacted T/SWGFEX again, posing a series of questions and requesting an annotated bibliography of materials dealing with what it called burn pattern analysis. T/SWGFEX provided a written response. Its *Annotated Bibliography on "Burn Pattern" Questions*[54] is available for free download from the National Institute of Standards and Technology (NIST) website at http://www.nist.gov/forensics/upload/Annotated-Bibliography-Burn-Pattern.pdf and we

encourage every professional in the fire investigation field to read it. This annotated bibliography provides a starting point for determining what scientific literature comprises the basis of fire investigations.

The Preface to the T/SWGFEX annotated bibliography is very instructive in the context of the scientific basis and research underlying fire pattern interpretation, so we have reproduced key excerpts below. Note that while the discussion is about "burn pattern" analysis pursuant to the IWG's request, *NFPA 921* has replaced this expression by what is more accurately called "fire pattern" analysis or interpretation. *NFPA 921* defines fire patterns and the related phenomena, fire effects, as, "The visible or measurable physical changes, or identifiable shapes, formed by a fire effect or group of fire effects. Fire effects are the observable or measurable changes in or on a material as a result of exposure to the fire."[55]

Preface to the [T/SWGFEX] Annotated Bibliography on "Burn Pattern" Questions

> Before we can provide the annotated bibliography for the questions posed to us, T/SWGFEX would like to clarify its position on the use of burn patterns in the examination of a fire scene.
>
> At this time, "Burn Pattern Analysis" is a misnomer. The examination of the burn patterns following a fire is not a forensic examination and "burn pattern analysis" is not a forensic discipline. "Burn pattern analysis" has not risen to the level where it can be used exclusively as the only determinant of a fire investigation. . . .
>
> Due to the large number of variables and unknowns which have not yet been conclusively established by scientific research, "burn pattern analysis" cannot be considered as rising to the level where it is a recognized forensic discipline. *Existing and planned research is seeking to address and collect data on the many variables that affect the production and appearance of burn patterns within a scene. What has been determined so far is that many of the variables are interconnected and slight variations will change the resulting burn patterns. . . .*
>
> . . . .
>
> . . . Burn patterns provide data to the fire investigator in order to apply the scientific method to their investigation. The authoritative reference used by competent fire investigators is the National Fire Protection Association 921 "Guide for Fire and Explosion Investigations." . . . .[56]

The T/SWGFEX preface goes on to quote the disclaimer in *NFPA 921*, which acknowledges that "[t]he circumstances of every fire are different from every other fire"[57] because of the many variables that affect fire patterns. Accordingly, *NFPA 921* observes that while the chapter on Fire Patterns covers the basic principles it, "cannot cover every possible variation in fire patterns and how they come about."[58] T/SWGFEX further says:

> It is the goal of current research in burn patterns, fire dynamics, and fire modeling to better characterize the patterns that can be expected to develop under specific circumstances. *However duplication of all circumstances from the research setting to actual fire scenes is highly unlikely* and the investigator will be left with applying the best data they can obtain to test their hypothesis as to a fire's origin. Burn patterns provide only a portion of the data that must be identified and analyzed by the investigator and are not sufficient in and of themselves to conclude the origin or cause of the fire. After all parameters are considered and current understanding of their effects are applied, the investigator may be able to use them to build their hypothesis as to area of origin, the directionality of the fire, the time for fire development, and the heat generated during the fire. There may be other aspects of the fire suggested by the patterns that are not listed here.
>
> At this time the most commonly used "forensic" discipline intimately connected to fire investigations is the analysis of fire debris for the presence and identity of ignitable liquids. It is based on established scientific principles and is not under scrutiny as a result of the National Academy of Science's 2009 report, "Strengthening Forensic Science: A Path Forward."[59]

Note that this T/SWGFEX Preface and the quotes it adopts from the Fire Patterns Chapter in *NFPA 921* suggest that there are gaps in the scientific literature and research about fire patterns. It also points to the difficulty in duplicating the results of fire patterns created in research settings to those appearing in actual fire scenes. As we will see, the ability to reproduce results from research experiments is one criteria for measuring the scientific reliability of foundational research.[60]

The White House Subcommittee on Forensic Science has since issued a report containing "the first set of research findings and conclusions"[61] of its IWGs; however, it has not issued a report of the findings of the IWG RDT&E. Therefore, we do not know what further actions, if any, they recommend in response to T/SWGFEX's response to their questions and the submission of the *Annotated Bibliography on "Burn Pattern" Questions*. Nevertheless, T/SWGFEX's effort in creating this annotated bibliography is a great first step in identifying and evaluating the foundational scientific literature regarding fire pattern interpretation.

Even though we are not aware of the IWG RDT&E findings, the implementation of the *NRC/NAS Report's* Foundational Research Recommendation does not end here. This brings us to a review of the pertinent activities of the Organization of Scientific Area Committee (OSAC) and the National Commission on Forensic Science (NCFS).

8. Implementing the *NRC/NAS Report:* OSAC and NCFS

In a further effort to take action on the recommendations outlined in the *NRC/NAS Report*, the U.S. Department of Justice (DOJ) and NIST collaborated to launch two

organizations. The first was NCFS, a federal advisory committee established in 2013. Its purpose is to make policy recommendations to the U.S. Attorney General to improve the reliability of forensic sciences, particularly in the justice system. The NCFS consists of approximately 30 members selected to achieve a balance of representation and expertise from "scientific, legal, law enforcement, academic, and advocacy professions."[62] One can read more about the NCFS on its website at https://www.justice.gov/ncfs or by reading the FISC Bulletin Board article from April 2016.[63]

While the work of the NCFS is policy oriented, the second organization formed in 2014 under the leadership of NIST is OSAC, tasked with providing practice-based (as opposed to policy-based) scientific guidance to each forensic science discipline. A description of the work of each of these organizations that is relevant to foundational research follows. First is an overview of OSAC's role in tackling the scientific basis for fire investigations. Second, we introduce two documents published by the NCFS that provide guidance in evaluating any discipline's foundational research.

9. OSAC's Role in Foundational Research for Fire Investigations

Below is the statement of OSAC's purpose, centering on strengthening forensic science disciplines through standards and guidelines, which we will later see, include *NFPA 1033* and *NFPA 921*:

> The purpose of the OSAC is to strengthen the nation's use of forensic science by providing technical leadership necessary to *facilitate the development and promulgation of consensus-based documentary standards and guidelines* for forensic science, promoting standards and guidelines that are fit-for-purpose and *based on sound scientific principles*, promoting the use of OSAC standards and guidelines by accreditation and certification bodies, and establishing and maintaining working relationships with other similar organizations.[64]

OSAC's purpose as stated above relates to *NRC/NAS Report* recommendations, including one to develop standards and protocols for forensic practices that reflect best practices and serve as tools for accreditation of organization and certification of professionals.[65]

Standards and guidelines can provide a scientific basis for practice in a forensic discipline but they do not necessarily compose the foundational research that is the subject of this article. By way of review, foundational research includes "peer-reviewed, published studies establishing the scientific bases and validity"[66] of forensic methods that address "issues of accuracy, reliability, and validity in the forensic science disciplines."[67] In line with the Foundational Research Recommendation, one of OSAC's aims is to "provide insight on each forensic science discipline's research and development needs."[68]

OSAC has two subcommittees dedicated to improving the field of fire investigations:

> 1) The Fire and Explosion Investigation Subcommittee (focusing on "standards and guidelines related to the investigation, analyses and interpretation of crime scenes where arson or use of explosives is suspected.);" and,
>
> 2) The Fire Debris and Explosives Subcommittee (focusing on "standards and guidelines related to the scientific examination and analysis of materials associated with fire and explosion investigations.").

The first subcommittee concentrates on scene investigations, while the second deals with laboratory analyses. This article is concerned with two priority action objectives of the scene subcommittee that relate to the scientific foundations of fire investigations. The first objective affects standards and guidelines development. This objective is to "define a scientifically based investigation methodology for fire and explosions, and to establish qualifications required by investigators."[69] The scene subcommittee is achieving this objective by reviewing the scientific merit of NFPA and ASTM documents relevant to fire investigations and having them approved for posting to the OSAC Registry. The Registry "serves as a trusted repository of high-quality, science-based standards and guidelines for forensic practice."[70] At the date of writing[71] OSAC has approved the 2014 editions of both NFPA 921[72] and NFPA 1033[73] for inclusion in the registry. This is a major benchmark for fire investigations, and more is discussed about its significance later.

The second priority action objective of the scene subcommittee is to develop a research agenda for fire and explosion investigations by:

- Reviewing state-of-the-art of fire and explosion investigation science and related fire and explosion scientific literature; and,
- Developing a research agenda addressing needs in methodologies and processes for fire and explosion investigations.[74]

This objective speaks directly to the foundational research recommendation of the *NRC/NAS Report*. The OSAC scene subcommittee has assigned a task group to undertake work on this recommendation.

In the meantime, the NCFS has also been considering how to deal with scientific research, which brings us to one focal point of this article: the views of the NCFS on vetting foundational scientific literature using specific criteria.

10. Implementing the Foundational Research Recommendation: Notable Views of the NCFS

The important thing for our purposes is that because the NCFS is the policy-making organization charged with implementing the *NRC/NAS Report*, the views it takes are noteworthy. By definition, "Views" published by the NCFS "reflect the collective view of the Commissioners but do not request specific action by the Attorney General."[75] Views of the NCFS likely herald things to come, such as policy recommendations it may yet submit to the Attorney General or to OSAC for implementation. This article is concerned with two "Views documents" adopted by the NCFS respecting scientific and foundational literature.

The NCFS accomplishes its work through its subcommittees, formed by NCFS members together with experts who are members of the public. The mandate of the Scientific Inquiry and Research Subcommittee[76] encompasses the *NRC/NAS Report's* Foundational Research Recommendation. Its scope is as follows:

> There is considerable debate regarding the strength of the foundational science

> underpinning some forensic science disciplines. Additionally, fragmentation of research efforts hinders the development and deployment of advanced technologies for forensic science. The Subcommittee on Scientific Inquiry and Research will consider ways to examine existing foundational research and recommend research priorities for technological investments that can improve the quality and timeliness of forensic analyses.[77]

This subcommittee has issued several work products.[78] Our focus is on two documents expressing formal views taken by the commission:

> 1) *Scientific Literature in Support of Forensic Science and Practice*[79] (hereafter called *NCFS Views on Features of Scientific Literature*); and,
>
> 2) *Views of the Commission Regarding Identifying and Evaluating Literature that Supports the Basic Principles of a Forensic Science Method or Forensic Science Discipline*[80] (hereafter called *NCFS Views on Identifying and Evaluating Scientific Literature*).

Below we address the portions of these documents that are relevant for our purposes.

Each document represents views of the NCFS and does not necessarily represent the views of the DOJ or NIST.[81] Neither of these documents formally recommends action by a government entity.[82] It is still open to the NCFS to adopt later documents requiring action by the government or OSAC. However, as we will discuss later in this article, these two "Views documents"[83] provide immediate ammunition for challenging experts in litigation, regardless of whether the NCFS takes further action on these views.

10.1. *NCFS Views on Features of Scientific Literature*

In early 2015, the NCFS voted unanimously to adopt a Views document issued by the Scientific Inquiry and Research Subcommittee. Below is the Statement of the Issue this document addresses, encompassing the definition of "scientific literature:"

> It is the view of the National Commission on Forensic Science (NCFS) that each forensic discipline must have an underlying foundation that is the result of a rigorous vetting process and that is ultimately captured in the peer-reviewed scientific literature. *Scientific literature comprises manuscripts that report empirical data and have been independently peer-reviewed for quality, originality, and relevance to the discipline.* To strengthen confidence in results obtained in forensic examinations, each forensic discipline must identify resources that are scientifically credible, valid and with a clear scientific foundation. Such foundational literature in forensic practice should conform to norms across all scientific disciplines. Accordingly, the National Commission on Forensic Science (NCFS) proposes criteria by which scientific literature can be assessed for its consistency with principles of scientific validity.[84]

By way of background, this Views document references the work of the IWG RDT&E, which asked discipline-specific questions and compiled annotated bibliographies from several SWGs. (Highlights of the *Annotated Bibliography on "Burn Pattern" Questions* submitted by T/SWGFEX on behalf of the fire investigations discipline are found in section 7 above.) A "cursory review"[85] of these annotated bibliographies raised two concerns within the NCFS:

> 1. In some cases, it was unclear which literature citations are crucial to support the foundation of a particular forensic science discipline.
>
> 2. Some of the cited literature had not undergone a rigorous peer-review process.[86]

In addressing these concerns, the NCFS went on to say that:

> [A] comprehensive evaluation of the scientific literature is critical for the advancement of forensic science policy and practice in the United States. While other forms of dissemination of research and practice (e.g., oral and poster presentations at meetings, workshops, personal communications, editorials, dissertations, theses, and letters to editors) play an important role in science, the open, peer-reviewed literature is what endures and forms a foundation for further advancements. . . .[87]

Further, the NCFS addressed the importance of addressing conflicts of interest in peer review and publication practices. The Views document concludes by stating the NCFS's position is "that foundational, scientific literature supportive of forensic practice should meet criteria such as the following:"[88]

- Peer-reviewed in the form of original research, substantive reviews of the original research, clinical trial reports, or reports of consensus development conferences.
- Published in a journal or book that has an International Standard Number (ISSN for journals; ISBN for books) and recognized expert(s) as authors (for books) or on its Editorial Board (for journals).
- Published in a journal that maintains a clear and publicly available statement of purpose that encourages ethical conduct such as disclosure of potential conflicts of interest integral to the peer review process.
- Published in a journal that utilizes rigorous peer review with independent external reviewers to validate the accuracy in its publications and their overall consistency with scientific norms of practice.

- Published in a journal that is searchable using free, publicly available search engines (e.g. PubMed, Google Scholar, National Criminal Justice Reference Service) that search major databases of scientific literature (e.g. Medline, National Criminal Justice Reference Service Abstracts Database, and Xplore).
- Published in a journal that is indexed in databases that are available through academic libraries and other services (e.g. JSTOR, Web of Science, Academic Search Complete, and SciFinder Scholar).[89]

Note that only the first of these criterion concerns reports resulting from "consensus development" conferences, which would presumably apply to the NFPA and ASTM. While these criteria are not earth shattering, the NCFS later clarified that these criteria are only intended to delineate "features" of scientific literature.[90] The Views document adopted by the NCFS a year later has much greater significance because it addresses what is required for scientific literature to rise to the level of "foundational."

10.2. *NCFS Views on Identifying and Evaluating Scientific Literature*

In February 2016, the NCFS adopted another Views document prepared by the Scientific Inquiry and Research Subcommittee, stating:

> It is the view of the National Commission on Forensic Science (NCFS) that scientific literature must be evaluated and be vetted through an objective and critical review process using tenets based on general scientific principles and practice. These tenets must be satisfied before any form of scientific literature is included in, and considered part of, a forensic discipline's scientific foundation.

In reconciling this document with the earlier one (above), the NCFS commented that the earlier Views document offered measures for assessing scientific literature "for consistency with principles of scientific validity."[91] It clarified that this is only the first step in compiling the "core scientific literature within a field."[92]

Therefore, it appears that "scientific literature" includes publications that meet the criteria in the *NCFS Views on Features of Scientific Literature* (above.) Foundational literature meets a higher standard and "is intended to refer to that upon which a discipline has derived, developed, or defined practices and procedures examined and validated by a given discipline and applied within a legal, medicolegal, or judicial setting."[93]

Below are the criteria the NCFS has suggested be used to evaluate individual publications to determine which ones qualify as foundational literature. Before reading these criteria, we invite those readers who are fire investigators to have in mind publications that are critical to one's qualifications as an expert and to one's expert opinions. While reading, consider if these publications pass muster.

Recommended Implementation Strategy

> The purpose of this Views document is to provide guidance relevant to evaluating [the] status of scientific literature for specific forensic science discipline[s]. *The following tenets of literature review should be considered in a critical review process that evaluates the merit of an individual article:*
>
> - Does the publication adhere to the guidelines stated in the Views Document "*Scientific Literature in Support of Forensic Science and Practice*"?
> - Is the problem or hypothesis clearly stated?
> - Is the scope of the article clearly stated as appropriate (article, case study, review, technical note, etc.)?
> - Is the literature review current, thorough, and relevant to the problem being studied?
> - Does this work fill a clear gap in the literature or is it confirmatory and/or incremental?
> - Are the experimental procedures clear and complete such that the work could be easily reproduced?
> - Are the experimental methods appropriate to the problem?
> - Are the methods fully validated to the necessary level of rigor (fit for purpose)?
> - Are the data analysis and statistical methodology appropriate for the problem, and explained clearly so it can be reproduced?
> - Are the experimental results clearly and completely presented and discussed?
> - Are omissions and limitations to the study discussed and explained?
> - Are the results and conclusions reasonable and defensible based on the work and the supporting literature?
> - Are the citations and references complete and accurate?
> - Are the references original (primary) and not secondary? [Primary sources are documents that contain a full description of original research by the person conducting or witnessing that research. Examples of primary sources are conference papers or reports of original research, surveys, or dissertations. Secondary sources review or comment on the results of original research. Examples of secondary sources are journal articles, review articles, or books compiling or analyzing original research.]
> - Are funding sources and other potential sources of conflict of interest clearly stated?[94]

These two Views documents issued by the NCFS are not policy recommendations. Nevertheless, when one takes them together with the *NRC/NAS Report* and the IWG RDT&E inquires, they point unwaveringly to the growing importance of the identification of scientific literature and the need for a "rigorous vetting process."[95] It would not be a surprising next step for the NCFS to make a policy recommendation, perhaps to the DOJ to be passed on to OSAC, that each discipline

including fire investigations, undertake a rigorous evaluation of their foundational literature using the stated criteria.

In the meantime, experts, lawyers, and judges do not have to wait. Given the background as we have summarized it here, these issues are ripe for use in evaluating the admissibility and weight of expert testimony in civil and criminal litigation.

11. Applying NCFS Criteria to Scientific Literature Forming the Underpinnings of Fire Investigations

In the fire investigation field, reliability issues would seem to have been put to rest by the consensus-based nature of industry standards on which that the fire investigation community has come to rely, particularly *NFPA 1033* and *NFPA 921*. *NFPA 1033*[96] delineates the extent of the knowledge base required for anyone wanting to be qualified as a fire investigator. *NFPA 1033* defines this knowledge base first with its list of 16 topics about which investigators are required to maintain a basic knowledge,[97] and later with the "requisite knowledge"[98] component specified for each of the job performance requirements for fire investigators.

NFPA 1033 identifies the knowledge required, but does not contain the knowledge base itself. Instead, the investigator must turn to other publications. Most notable is *NFPA 921*,[99] which summarizes aspects of the knowledge investigators require.[100] It also cites volumes of reference materials in Chapter 2 and the annexes.

These publications are authoritative because a reputable standards-development process regulates *NFPA 1033* and *NFPA 921*.[101] This process has the following key features that add credibility to NFPA Codes and Standards (of which *NFPA 1033* and *NFPA 921* are a part): (a) openness, (b) balance of affected interests, (c) due process (d) an appeals process; and, (e) oversight by experts and consensus.[102]

The NCFS criteria for evaluating literature as scientific or foundational are different from those required of a standards-development process. *NFPA 1033* and *NFPA 921* are clearly authoritative. However, do they comprise part of the foundational research envisioned by the *NRC/NAS Report* and the NCFS Views documents? This question is probably immaterial when evaluating *NFPA 1033*. It does not purport to be scientific literature containing data from research in the fire investigations field. It is a standard—a list of mandatory requirements for a person to qualify as a fire investigator. While *NFPA 1033* is based on scientific principles, it does not purport to relay the underlying scientific research. Therefore, the challenge for the fire investigation community is not to justify *NFPA 1033* in the context of the NCFS criteria. The challenge is to identify or develop the foundational scientific research that provides the information *NFPA 1033* sets forth as required to be qualified as a fire investigator.

The next question is whether *NFPA 921* meets the NCFS criteria. *NFPA 921* states that it is a "peer-reviewed document."[103] From a technical viewpoint, NFPA's standards-development requirements require consensus rather than peer-review.[104] The NFPA regulations[105] define what is required to achieve consensus in the creation of NFPA standards:

> Consensus has been achieved when, in the judgment of the Standards Council of the NFPA, substantial agreement has been reached by materially affected interest categories. Substantial agreement means much more than a simple majority but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made toward their resolution. . . .[106]

On the other hand, as a technical committee of experts prepares *NFPA 921*, one can make a convincing argument that it is a peer-reviewed guideline. Further, *NFPA 921* has a strong scientific base as evidenced by the rigorous reviews made necessary by NFPA's standards-development process. Its addition to the OSAC registry is additional evidence of its scientific foundations. This point is discussed in the next section of this article. While *NFPA 921* by its nature cannot meet all of the NCFS criteria—reproducibility of experimental methods, reproducibility of data analysis and statistical methodology, references to primary, not secondary sources, etc.—it is probably one of the best examples of foundational scientific literature in the fire investigation field.

NFPA 921's biggest limitation comes not from applying NCFS criteria, but from its own stated disclaimer:

> 1.3.5 This document is not intended as a comprehensive scientific or engineering text. Although many scientific and engineering concepts are presented within the text, the user is cautioned that these *concepts are presented at an elementary level and additional technical resources, training, and education may often need to be utilized in an investigation*.[107]

This disclaimer may drive fire investigators to other foundational research, particularly in difficult or complex investigations. In any event, the fire investigation community does not confine itself to *NFPA 921*. There are textbooks, handbooks, journal articles, web articles, research studies, manuscripts, proceedings of meetings, and other literature on which investigators, experts, or lawyers may rely. Such literature may be consulted during the course of an investigation, referred to in investigative or expert reports, or used in testimony, examination, or cross-examination.

Take, for example, the references cited in *NFPA 921* (Chapter 2 and the Annexes) or in the T/SWGFEX *Annotated Bibliography on "Burn Pattern" Questions*. They were cited because well-reputed experts reached a consensus that these references are authoritative. However, one might ask if each of these references comply with the NCFS's other criteria. To what extent can the studies described in these publications be replicated or reproduced? Are the citations in these references complete (every factual statement supported)? Are citations to primary and not secondary sources (*i.e.* are citations to original research and not to secondary materials such as textbooks, handbooks, or the like)? Have they undergone the type of rigorous peer-review vetting process described by the NCFS?

The fire investigation community will not be able to definitively point to its body of foundational research until a critical review of fire investigation literature is undertaken, applying the NCFS criteria. However, these criteria can assist a fire investigator to assess the scientific reliability of individual publications that one may rely on in a given case. A similar

assessment can be conducted to determine the reliability of publications an investigator relies on to establish his or her qualifications. Putting it in another way an investigator may consider:

a) How strong are the foundations of your qualifications? (*E.g.,* Do the publications you rely on in support of your knowledge of the *NFPA 1033* "list of 16," and the knowledge requirements of *NFPA 1033's* Chapter 4 measure up to these criteria?).

b) How strong are the foundations to your opinions with respect to a given fire? (*I.e.,* which of the publications that you rely on meet the NCFS criteria?).

Likewise, lawyers or judges can apply these criteria to evaluate individual publications relied on by experts as a method of assessing reliability.

The NCFS has raised this issue of the critical evaluation required to determine a discipline's foundational underpinnings and provided a glimpse of what is required by way of critical evaluation. Since together the NCFS and OSAC are providing the major impetus towards implementing the *NRC/NAS Report*, we next look at the implications of the approval of *NFPA 1033* and *NFPA 921* for posting to the OSAC Registry.

12. Effect of NFPA 921 and NFPA 1033 Approval for the OSAC Registry

The authors concluded above that *NFPA 921* and *NFPA 1033* do not meet all of the criteria for scientific or foundational literature set forth in the two NCFS Views documents introduced earlier. However, the decisions by OSAC in the last quarter of 2016 to approve *NFPA 921*, 2014 edition for inclusion in the OSAC Registry of Approved Guidelines, and to approve *NFPA 1033*, 2014 edition for inclusion in the OSAC Registry of Approved Standards will lend great weight to these documents. At the time of writing this article, the formal announcement of the approval of NFPA 1033 for posting to the OSAC Registry is still pending. Nonetheless, the following excerpts from the announcement respecting *NFPA 921* reflect how the OSAC approval process provides assurance respecting the scientific underpinnings for both of these documents. OSAC's approval should therefore elevate them in the eyes of the fire investigation community and the courts:

> Craig Beyler, the chair of OSAC's Fire & Explosion Investigation Subcommittee, shepherded the [*NFPA 921*] guide through the OSAC approval process. "NFPA 921 is regarded as the standard of care in the fire and explosion investigation community and in the courts," Beyler said. "It sets a high bar for science-based investigation and analysis of fire and explosion incidents."
>
> NFPA 921 addresses all aspects of fire and explosion investigation, including methodology, evidence collection and failure analysis. The document is used in the field, in training and in court, and it serves as a guide for rendering accurate opinions on origin, cause, responsibility and prevention. Fire investigators who work for public agencies, insurance companies and litigation firms all rely on this document in their daily work.
>
> . . . .
>
> Mark Stolorow, director of OSAC affairs at NIST, explained that OSAC scrutinizes existing standards and guidelines from a range of standards developing organizations for their technical merit and due process.
>
> "Elevating NFPA 921 to the official OSAC Registry is an endorsement of the high quality of this document and encourages its adoption by all agencies and practitioners who investigate scenes of fires and explosions," Stolorow said.
>
> OSAC does not have authority to enforce standards. However, by endorsing standards, OSAC promotes their adoption by forensic science service providers and by accrediting bodies that audit participating agencies for compliance.[108]

Information from the OSAC Registries web page clarifies one difference between an "OSAC Standard" such as *NFPA 1033* and an "OSAC Guideline" such as *NFPA 921*. Implementation of OSAC Standards will be required, whereas implementation of OSAC Guidelines will be recommended, not required.[109] Nevertheless, because of the relationship between the two documents explained in the last section, many will turn to *NFPA 921* when trying to prove that they are satisfying the mandatory requirements of the *NFPA 1033* standard.

In terms of the effect of the elevation of these NFPA documents to the OSAC Registries, one could posit that the OSAC scrutiny required as a prerequisite is another level of peer review, lending further credence to the position that they rest on solid scientific foundations.

Looking ahead, the NFPA issued the 2017 edition of *NFPA 921* in November 2016 and it will be available in January 2017.[110] Like *NFPA 921* 2014 edition, the 2017 edition will also have to go through the OSAC Registry approval process. Members of the fire investigation community can either monitor the OSAC News page or subscribe to OSAC forensic science updates[111] to stay informed of developments concerning *NFPA 921's* 2017 edition and ASTM documents going through the approval process.

13. A Litigation Perspective

Lawyers and seasoned experts know that there are many ways to attack the admissibility and the weight of expert evidence. This is particularly true when there is any doubt about the reliability of the body of knowledge upon which the expert bases his or her qualifications and opinions. The *NRC/NAS Report* commented on this, seemingly speaking to lawyers and judges:

> The law's greatest dilemma in its heavy reliance on forensic evidence, however, concerns the question of whether—and to what extent—there is *science* in any given forensic science discipline.
>
> Two very important questions should underlie the law's admission of and reliance

> upon forensic evidence in criminal trials: (1) the extent to which a particular forensic discipline is founded on a reliable scientific methodology that gives it the capacity to accurately analyze evidence and report findings and (2) the extent to which practitioners in a particular forensic discipline rely on human interpretation that could be tainted by error, the threat of bias, or the absence of sound operational procedures and robust performance standards. These questions are significant.[112]

With this in mind, it is not surprising that the NCFS has tackled the thorny question of the scientific reliability of publications that the practitioners in any forensic discipline rely on. It is clear that NCFS intended that members of each discipline use the criteria set forth in its two Views documents to create a compilation of their foundational literature. One might question whether the NCFS also intended the justice system to use the criteria to make a critical evaluation of publications used by experts in litigation. This question is explicitly answered in the affirmative by the NCFS in its observation that, "Such compilations are vital to the forensic discipline *as well as to the judicial system where it should be integral to admissibility and gatekeeping practices.*"[113]

Another reminder of the importance of ensuring fire investigators' expert opinions rest on a solid foundation are two recommendations of the Texas Forensic Science Commission (TFSC) in its final report on its investigation into two allegedly wrongful arson murder convictions.[114] Space does not permit reviewing the background or details of this report. However, it is sufficient to note that this report, while intended to apply to fire investigators statewide in Texas, is being used across America as a model for how the *NRC/NAS Report* recommendations translate to the field of fire investigations.

In the context of our article, two recommendations in the TFSC final report are noteworthy. In making recommendations for "Standards for Testimony in Arson Cases" and "Enhanced Admissibility Hearings in Arson Cases," the TFSC urges that investigators be required to follow *NFPA 1033* in testimony.[115] Further, that *Daubert/Kelly*[116] admissibility hearings be conducted in arson cases, *and be aggressively pursued by prosecutors and defense counsel, to help ensure the scientific testimony is both relevant and reliable.*[117] One excellent way to "aggressively pursue" admissibility hearings is to ensure the reliability of scientific testimony by fire investigators by assessing the publications that support their qualifications and opinions using the NCFS criteria.

For those preparing to defend an admissibility hearing or to prepare for examination and cross-examination at trial, when dealing with *NFPA 1033* and *NFPA 921*, the significance of their approval for the OSAC Registry should not be understated. This development can help support the opinions of investigators who rely on these documents in their qualifications, in the conduct of their investigations, and in court. Experts should be prepared to explain the role of OSAC in the betterment of fire investigations so that they may be effective in relaying this information in a litigation setting.

14. Conclusion

This article summarized in some detail efforts to strengthen forensic sciences by identifying and assessing the foundational research that establishes the scientific basis of each discipline. The *NRC/NAS Report* sparked these efforts. The umbrella issue we wrestled is the extent to which fire investigators may be affected. The answer may turn on whether or not fire investigations are characterized as a forensic science discipline. Each organization implementing the *NRC/NAS Report* may answer this question differently. Time will tell. In the meanwhile, we have endeavored to project how these efforts may influence fire investigations. Below is a summary of the major issues addressed in this article and conclusions we reached:

- The *NRC/NAS Report* expressed general concerns about foundational research that applies to many forensic science disciplines. It may no longer matter whether its authors intended to include fire investigations as one of the forensic science disciplines the report encompasses. The report's brief remarks about burn pattern interpretation in the context of set fires were probably sufficient to raise questions about the scientific underpinnings of arson investigations. This conclusion is supported by inquires made by one of the White House IWGs and by OSAC into foundational research for fire investigations.
- In addressing the foundational research recommendation of the *NRC/NAS Report*, one of the White House IWGs approached T/SWGFEX about the scientific foundations of fire scene investigation and fire pattern interpretation. At the IWG's request, T/SWGFEX prepared an *Annotated Bibliography on "Burn Pattern" Questions*. Although most of the activities of T/SWGFEX has been suspended pending the completion of the work of OSAC and NCFS, this annotated bibliography is available and may prove valuable to anyone exploring the scientific foundations of fire pattern interpretation.
- OSAC includes fire investigations as one of the forensic science disciplines it is seeking to strengthen. OSAC's Fire and Explosion Investigation Subcommittee has successfully steered *NFPA 921* and *NFPA 1033* through OSAC's approval process and OSAC has added these two documents to the OSAC Registry. This bolsters the perception that these two documents rest on a solid scientific basis. Also relevant to the issue of foundational research, this OSAC subcommittee is also creating a research agenda for the fire and explosion investigation field. It is beginning with a review of the up-to-date fire and explosion investigation science and related scientific literature.
- The NCFS has published criteria for evaluating foundational and scientific literature. These criteria may prove useful to OSAC's scientific literature review. These criteria are also instructive for anyone wanting to assess the reliability of particular publications in the fire investigation field. While it is

clear that OSAC considers fire investigations to be a forensic discipline, the position of the NCFS on this issue is not settled. It probably does not matter whether a formal interpretation of the NCFS Views documents discussed in this article would hold that fire investigation is a forensic discipline. It is not a sustainable argument to say that fire investigation does not need to be on a solid scientific footing, given the high stakes in many fire investigations and subsequent civil or criminal litigation. Therefore, the criteria listed by the NCFS opens the door for litigation challenges, especially when investigators rely on literature that cannot pass muster.

- Finally, as always when dealing with literature that an expert might use to support or contest an opinion, there are potential litigation implications of the work of both OSAC and the NCFS. This article raised matters that may stimulate some thought among fire investigators, attorneys, and judges. Is it reasonable to apply tenets of scientific literature review and apply the NCFS criteria in evaluating publications forming the basis of fire investigations? We believe the answer is "yes." Consider the respect that courts are giving to the *NRC/NAS Report*,[118] together with the impact of the background information supplied in this article. When taken together, it is reasonable to expect lawyers will begin to use these criteria in selecting and challenging experts, and that judges will listen.

As a final observation, we began this article by pointing to the issue raised in the *NRC/NAS Report* of the reliability of burn pattern interpretation in determining whether a fire was intentionally set. It was probably this small part of the report that caused fire investigations to be drawn into the overhaul of the forensic sciences. While this article focuses on the sufficiency of foundational research, including the proof of the scientific validity of the knowledge base about fire patterns, one must not lose sight of the bigger picture. Assuming, for example, that all of the scientific data summarized in *NFPA 921* concerning fire patterns and fire effects is valid and reliable. The real Achilles heel of fire investigations is probably not in the scientific underpinnings of fire patterns. Rather, it is the challenge to interpret them correctly, particularly in major fires or in the absence of other sufficient reliable data. However, it is still necessary to ensure the scientific foundations are sound before tackling problems of human interpretation.

In closing, we welcome your feedback and would like to thank those that contributed to this rather lengthy article.[119]

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Endnotes

1 Int'l Ass'n of Arson Investigators, Fire Investigation Standards Committee Standard Operating Procedures, § 2.2 (Sept. 7, 2013).

2 *About NFPA*, Nat'l Fire Prot. Ass'n (2016), http://www.nfpa.org/about-nfpa.

3 *About ASTM International – Detailed Overview*, ASTM Int'l (2016), http://www.astm.org/ABOUT/full_overview.html. The ASTM standards and guides relevant to fire investigations are cited in NFPA 921, *infra* note 5 and NFPA 1033, *infra* note 6.

4 Comm. on Identifying the Needs of the Forensic Sci. Cmty. *et al.*, Nat'l Research Council of the Nat'l Acads., Strengthening Forensic Science in the United States: A Path Forward (2009), *available at* https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf [hereinafter NRC/NAS Report].

5 Nat'l Fire Prot. Ass'n Technical Comm. on Fire Investigations, NFPA 921 Guide for Fire and Explosion Investigations (2014 ed.) [hereinafter NFPA 921].

6 Nat'l Fire Prot. Ass'n Technical Comm. on Fire Investigator Professional Qualifications, NFPA 1033 Standard for Professional Qualifications for Fire Investigator (2014 ed.) [hereinafter NFPA 1033].

7 Comm. on Identifying the Needs of the Forensic Sci. Cmty. *et al.*, Nat'l Research Council of the Nat'l Acads., Strengthening Forensic Science in the United States: A Path Forward (2009), *available at* https://www.ncjrs.gov/pdffiles1/nij/grants/228091.pdf [hereinafter NRC/NAS Report].

8 Science, State, Justice, Commerce, and Related Agencies Appropriations Act, 2006 (2005 - H.R. 2862), GovTrack.us, https://www.govtrack.us/congress/bills/109/hr2862 (last visited May 30, 2016). On November 22, 2005 this Act became law, authorizing the National Academy of Sciences to conduct the study, which was ultimately published in 2009: Strengthening Forensic Science in the United States: A Path Forward.

9 The Committee was called the "Committee on Identifying the Needs of the Forensic Science Community" and was charge formed under the auspices of the National Academies' Committee on Science, Technology, and Law and Committee on Applied and Theoretical Statistics.

10 NRC/NAS Report, *supra* note 7, at 2.

11 NRC/NAS Report, *supra* note 7, at xx.

12 NRC/NAS Report, *supra* note 7, at 2.

13 NRC/NAS Report, *supra* note 7, at xx (emphasis added).

14 NRC/NAS Report, *supra* note 7, at 8.

15 NRC/NAS Report, *supra* note 7, at 23.

16 Scientific Inquiry and Research Subcomm. of the Nat'l Comm. on Forensic Sci., *Scientific Literature in Support of Forensic Science and Practice* (2015), *available at:* https://www.justice.gov/ncfs/file/786591/download [hereinafter NCFS Views on Features of Scientific Literature].

17 The NRC/NAS Report was written by the "Committee on Identifying the Needs of the Forensic Science Community," consisting of members of the forensic science community, the legal community, and a diverse group of scientists and engineers (NRC/NAS Report, *supra* note 7, at *v*). The committee heard testimony from experts including "federal agency officials; academics and research scholars; private consultants; federal, state, and local law enforcement officials; scientists; medical examiners; a coroner; crime laboratory officials from the public and private sectors; independent investigators; defense attorneys; forensic science practitioners; and leadership of professional and standard setting organizations." (NRC/NAS Report, *supra* note 7, at *xx*. *Also see* NRC/NAS Report, *supra* note 7, at *xi-xii* for a list of the presenters.)

18 NRC/NAS Report, *supra* note 7, at 38.

19 *About NIJ*, Nat'l Inst. of Justice (2016), http://www.nij.gov/about/Pages/welcome.aspx ("NIJ — the research, development and evaluation

agency of the U.S. Department of Justice — is dedicated to improving knowledge and understanding of crime and justice issues through science. NIJ provides objective and independent knowledge and tools to reduce crime and promote justice, particularly at the state and local levels.")

20 NRC/NAS Report, *supra* note 7, at 38, *citing* "National Institute of Justice. 2006. *Status and Needs of Forensic Science Service Providers: A Report to Congress.* Available at www.ojp.usdoj.gov/nij/pubs-sum/213420.htm," which divides forensic science into these categories:
1. general toxicology;
2. firearms/toolmarks;
3. questioned documents;
4. trace evidence;
5. controlled substances;
6. biological/serology screening (including DNA analysis);
7. fire debris/arson analysis;
8. impression evidence;
9. blood pattern analysis;
10. crime scene investigation;
11. medicolegal death investigation; and
12. digital evidence.

21 NRC/NAS Report, *supra* note 7, at 8.
22 NRC/NAS Report, *supra* note 7, at 38.
23 *Id.* § 4.2.
24 *Id.* § 4.2.7.
25 NRC/NAS Report, *supra* note 7, at 38-39.
26 NRC/NAS Report, *supra* note 7, at ch. 5. The forensic disciplines reviewed in the report are: Biological Evidence, Analysis of Controlled Substances, Friction Ridge Analysis, Other Pattern/Impression Evidence: Shoeprints and Tire Tracks, Toolmark and Firearms Identification, Analysis of Hair Evidence, Analysis of Fiber Evidence, Questioned Document Examination, Analysis of Paint and Coatings Evidence, Analysis of Explosives Evidence and Fire Debris, Forensic Odontology, Bloodstain Pattern Analysis, Digital and Multimedia Analysis.
27 NRC/NAS Report, *supra* note 7, at 173 *citing* John J. Lentini, The State of The Art in Fire Investigation, Presentation to Comm. on Identifying the Needs of the Forensic Sci. Cmty, Nat'l Research Council (Apr. 23, 2007) (on file with the author) (hereinafter called "The Lentini Presentation").
28 NRC/NAS Report, *supra* note 7, at 173 *citing* Nat'l Fire Prot. Ass'n Technical Comm. on Fire Investigations, NFPA 921 Guide for Fire and Explosion Investigations (2008 ed.).
29 NRC/NAS Report, *supra* note 7, at 172-173 (emphasis added).
30 NRC/NAS Report, *supra* note 7, at 173.
31 NFPA 1033, *supra* note 6, at §§ 4.2.4, 4.2.5.
32 *See* NFPA 921, 2014 ed., *supra* note 5, ch. 6 *Fire Patterns* and ch. 18 *Origin Determination*. There are also references to fire patterns in chapters 5, 7, 16, 17, 18, 19, 24, 25, 26, 27, and 30.
33 NFPA 921, 2014 ed., *supra* note 5, § 18.2.1 (2).
34 NFPA 921, 2014 ed., *supra* note 5, § 18.2.1 "Determination of the origin of the fire involves the coordination of information derived from one or more of the following," listing "(1) Witness Information," "(2) Fire Patterns," "(3) Arc Mapping," and "(4) Fire Dynamics."
35 NFPA 921, 2014 ed., *supra* note 5, § 19.1.
36 NRC/NAS Report, *supra* note 7, at 173, fn. 118 *citing* The Lentini Presentation, *supra* at n. 27. Mr. Lentini's presentation was obtained through the URL cited in footnote 118 on page 173 of the NRC/NAS Report, although this URL no longer links to the presentation.
37 The Lentini Presentation, *supra* note 27, at 115 (showing the 2004 edition of NFPA 921, and stating "This document represents the standard of care in fire investigation." The 2004 edition of NFPA 921 was the current edition at the time of Mr. Lentini's presentation. In referring to the rules of thumb shown not to be true, the *NRC/NAS Report* cites the 2008 edition of NFPA 921, which was the current edition at the time the *NRC/NAS Report* was published in 2009.
38 NRC/NAS Report, *supra* note 7, at 173.
39 Nat'l Institute of Standards and Technology, News, *Fire and Explosion Guideline Approved for OSAC Resigtry,* https://www.nist.gov/news-events/news/2016/09/fire-and-explosion-investigation-guideline-approved-osac-registry (Sept. 20, 2016) (emphasis added).
40 When OSAC was originally launched in 2014, it was composed of "23 forensic science subcommittees." (https://www.nist.gov/topics/forensic-science/osac-subcommittees). Its most recent OSAC Subcommittee page lists 25 subcommittees, including the Fire and Explosion Investigation sub. In announcing NFPA 921 as the first guideline to be posted to the OSAC Registry, the accompanying press release stated in part: "The goal of OSAC and its 550-plus members is to facilitate the development of science-based standards for each of 25 distinct forensic science disciplines and to promote their widespread adoption." Thus, it seems clear that NIST and its OSAC considers fire and explosion investigations to be one of the "distinct forensic science disciplines" under its charge.
41 American Academy of Forensic Sciences, https://www.aafs.org/students/choosing-a-career/types-of-forensic-scientists-disciplines-of-aafs (last visited Nov. 27, 2016).
42 American Academy of Forensic Sciences, https://www.aafs.org/ (last visited Nov. 27, 2016).
43 *Id.*
44 Merriam Webster Dictionary, www.merriam-webster.com.
45 American Academy of Forensic Sciences, https://www.aafs.org/students/choosing-a-career/types-of-forensic-scientists-disciplines-of-aafs (last visited Nov. 27, 2016).
46 *Quoting* Anthony Longhetti, BA, Past-President, AAFS, Editorial, Journal of Forensic Sciences 1983; 28:3-5 (emphasis in original).
47 From Fire Dynamics to Legal Dynamics: Shifted Science and the Criminal Justice System's Response, AAFS Annual Scientific Meeting, Orlando Fl. (Feb. 16, 2015)
48 NRC/NAS Report, *supra* note 7, at 23.
49 Nat'l Sci. and Tech. Council, Charter of the Subcomm. on Forensic Sci. Comm. on Sci. § B, *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/forensic-science-subcommittee-charter.pdf (last visited Nov. 27, 2016) (emphasis added).
50 Nat'l Sci. and Tech. Council, Comm. on Sci., Subcomm. on Forensic Sci., Charter Inter-agency Working Group Research, Development, Testing and Evaluation, 1, *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/forensic-science-rdte.pdf.
51 Nat'l Sci. and Technology Council, Comm. on Sci, & Subcomm. on Forensic Sci., Strengthening the Forensic Sciences (2014), at 2, *available at* https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/forensic_science___may_2014.pdf (last visited Nov. 27, 2016).
52 The Technical Working Group for Fire and Explosions and the Scientific Working Group for Fire and Explosions, together known as T/SWGFEX, were founded in 1999 by the National Center for Forensic Science at the University of Central Florida and work together to improve fire and explosion laboratory analyses and scene investigations. The mission of TWGFEX is to establish and maintain nationally accepted programs for the forensic investigation of fire, arson and explosion scenes and devices. The mission of SWGFEX is to establish and maintain nationally accepted guidelines for fire, arson and explosive laboratory analysts. When it was active, there were approximately 100 members of SWGFEX and TWGFEX at any one time. The membership was broad-ranging, including fire investigators, fire debris analysts and explosive examiners. Members were from the public sector (federal, state, and local representatives) and from the private sector. As of June, 2016, the Executive Committee acted to suspended the activities of T/SWGFEX, with the exception of some ongoing work, until OSAC and the National Commission on Forensic Science have concluded their work. (*See* Email from T/SWGFEX Chair Dennis Hilliard to T/SWGFEX Members (Jun. 27, 2016). More information is about T/SWGFEX and its publications is available at the archived TWGFEX website (on file with authors).
53 As a TWGFEX member, Terry-Dawn Hewitt (one of the authors of this article), was one of the TWGFEX representatives who participated in the Inter-agency Working Group (IWG) on Research, Development, Testing, and Evaluation (RDT&E) meeting.
54 Tech. & Scientific Working Group for Fire and Explosions, Annotated Bibliography on "Burn Pattern" Questions (Dec. 12, 2011) *available at* http://www.nist.gov/forensics/upload/Annotated-Bibliography-Burn-Pattern.pdf.
55 NFPA 921, 2014 ed., *supra* note 5, at § 6.1.1.
56 Tech. & Scientific Working Group for Fire and Explosions, Annotated Bibliography on "Burn Pattern" Questions (Dec. 12, 2011) *available at* http://www.nist.gov/forensics/upload/Annotated-Bibliography-Burn-Pattern.pdf [hereinafter T/SWGFEX Annotated Bibliography on "Burn Pattern" Questions] (emphasis added).

57 Quoting Nat'l Fire Prot. Ass'n Technical Comm. on Fire Investigations, NFPA 921 Guide for Fire and Explosion Investigations § 6.3.1. (2011 ed.). This subsection remains the same in NFPA 921, 2014 ed., *supra* note 5.
58 Id.
59 T/SWGFEX Annotated Bibliography on "Burn Pattern" Questions, *supra* note 56, *citing* the NRC/NAS Report, *supra* note 7 (emphasis added) (citation omitted).
60 Scientific Inquiry and Research Subcomm. of the Nat'l Comm. on Forensic Sci., Views of the Commission Regarding Identifying and Evaluating Literature that Supports the Basic Principles of a Forensic Science Method or Forensic Science Discipline 3 (2016) , *available at:* https://www.justice.gov/ncfs/file/839716/download [hereinafter NCFS Views on Identifying and Evaluating Scientific Literature].
61 Nat'l Sci. and Technology Council, Comm. on Sci, & Subcomm. on Forensic Sci., Strengthening the Forensic Sciences ii, 2 (2014), *available at* https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/forensic_science___may_2014.pdf (last visited Nov. 27, 2016).
62 U.S. Dept. of Justice, Charter Nat'l Comm'n on Forensic Sci., (Renewed Apr. 23, 2015) para. 12, *available at* http://www.justice.gov/ncfs/file/624216/download (last visited Nov. 27, 2016).
63 Terry-Dawn Hewitt & Wayne J. McKenna, *Implementing the* NRC/NAS Report*: Introducing the National Commission on Forensic Science and The Organization of Scientific Area Committees*, 66 Issue 4 Int'l Assoc. of Arson Investigators, Fire & Arson Investigator J. 40 (Apr. 2016).
64 Nat'l Institute of Standards and Technology, Forensic Science, *About OSAC* https://www.nist.gov/topics/forensic-science/about-osac (last visited Nov. 27, 2016) (emphasis added).
65 *See* Recommendation 6 of the NRC/NAS Report, *supra* note 7, at 24-25.
66 NRC/NAS Report, *supra* note 7, at 8.
67 NRC/NAS Report, *supra* note 7, at 23.
68 Nat'l Institute of Standards and Technology, Forensic Science, *About OSAC* https://www.nist.gov/topics/forensic-science/about-osac (last visited Nov. 27, 2016).
69 Craig Beyler, Chair, Priority Action Report of the Fire and Explosion Investigation Subcommittee of the Crime Scene and Death Investigation Scientific Area Committee, (Jan. 30, 2016), presented to the American Academy of Forensic Sciences Annual Scientific Meeting, Las Vegas, Nevada (Feb. 22, 2016). [Hereinafter "Beyler 2016 Priority Action Report"]
70 Nat'l Institute of Standards and Technology, News, *Fire and Explosion Guideline Approved for OSAC Resigtry,* https://www.nist.gov/news-events/news/2016/09/fire-and-explosion-investigation-guideline-approved-osac-registry (Sept. 20, 2016).
71 November 27, 2016.
72 Fire and Explosion Guideline Approved for OSAC Resigtry, supra note 70.
73 Email from Craig Beyler, Chair of the OSAC Fire and Explosion Investigation Subcommittee to Terry-Dawn Hewitt, Chair of IAAI Fire Investigation Standards Committee (Nov. 16, 2016) (on file with authors.)
74 Beyler 2016 Priority Action Report, *supra* note 69
75 Nat'l Comm. on Forensic Sci., Work Produce Development Process 1 (Mar. 21, 2016), *available at:* https://www.justice.gov/ncfs/file/788191/download.
76 The membership of this subcommittee is available at https://www.justice.gov/ncfs/scientific-inquiry-and-research-subcommittee.
77 U.S. Dept. of Justice, Nat'l Commission on Forensic Sci., Scientific Inquiry and Research Subcomm., https://www.justice.gov/ncfs/scientific-inquiry-and-research (last visited Nov. 27, 2016).
78 Its draft work products are available at https://www.justice.gov/ncfs/scientific-inquiry-and-research (last visited Nov. 27, 2016), and its final work products that have been adopted by the NCFS are available at https://www.justice.gov/ncfs/work-products-adopted-commission (last visited Nov. 27, 2016).
79 NCFS Views on Features of Scientific Literature, *supra* note 16.
80 Scientific Inquiry and Research Subcomm. of the Nat'l Comm. on Forensic Sci., Views of the Commission Regarding Identifying and Evaluating Literature that Supports the Basic Principles of a Forensic Science Method or Forensic Science Discipline (2016), *available at:* https://www.justice.gov/ncfs/file/839716/download [hereinafter NCFS Views on Identifying and Evaluating Scientific Literature].
81 *See* the explicit disclaimer to this effect in NCFS Views on Identifying and Evaluating Scientific Literature, *id.* at 1.
82 Id.
83 Nat'l Comm. on Forensic Sci., Work Produce Development Process 1 (Mar. 21, 2016), *available at:* https://www.justice.gov/ncfs/file/788191/download, ("The [NCFS] Vice-Chairs will designate or establish a Subcommittee to research the issue and develop a work product. Potential work products include: (a) "Recommendations to the Attorney General," which propose specific acts that the Attorney General should take to further the goals of the Commission; or (b) "Views of the Commission," which reflect the collective view of the Commissioners but do not request specific action by the Attorney General.") In this article, we refer to the latter as "Views documents."
84 NCFS Views on Features of Scientific Literature, *supra* note 16 at 1 (emphasis added).
85 NCFS Views on Features of Scientific Literature, *supra* note 16 at 2.
86 NCFS Views on Features of Scientific Literature, *supra* note 16 at 2.
87 NCFS Views on Features of Scientific Literature, *supra* note 16 at 2.
88 NCFS Views on Features of Scientific Literature, *supra* note 16 at 2-3.
89 NCFS Views on Features of Scientific Literature, *supra* note 16 at 2-3 (citations omitted).
90 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 1.
91 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 1.
92 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 1.
93 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 2.
94 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 2-3 (emphasis added) (explanatory information about primary vs. secondary sources in square brackets added by the authors).
95 NCFS Views on Features of Scientific Literature, *supra* note 16 at 1.
96 NFPA 1033, *supra* note 6.
97 NFPA 1033, *supra* note 6, at § 1.3.7.
98 S*ee, e.g.* NFPA 1033, *supra* note 6, at §§ 4.2.2* (A), 4.2.4 (A), & 4.2.8* (A).
99 NFPA 921, *supra* note 5.
100 *See, e.g.* NFPA 1033*, supra* note 6, at § A.1.3.7, "Basic up-to-date information on these topics [the list of 16 in § 1.3.7] can be found in the current edition of NFPA 921."
101 Nat'l Fire Prot. Ass'n, Regulations Governing Committee Projects, (2014) available at http://www.nfpa.org/codes-and-standards/standards-development-process/regulations-directory-and-forms (last visited Nov. 27, 2016) [hereafter NFPA Committee Project Regs.]. This document sets forth the NFPA standards development process.
102 Nat'l Fire Prot. Ass'n, Regulations Governing Committee Projects, (2014) available at http://www.nfpa.org/codes-and-standards/standards-development-process/regulations-directory-and-forms (last visited Nov. 27, 2016) [hereafter NFPA Committee Project Regs.]. This document sets forth the NFPA standards development process and describes in detail each of the five key features listed.
103 NFPA 921, 2014 ed., *supra,* at note 5, at § 4.6.3.1.
104 NFPA Committee Project Regs., *supra* note 101. A search of these regulations shows that the NFPA does not even use the term "peer review" in stating the steps to comply with its process.
105 NFPA Committee Project Regs., *supra* note 101.
106 NFPA Committee Project Regs., *supra* note 101, at 19, (definition of "Consensus").
107 NFPA 921, 2014 ed., *supra,* at note 5, at § 1.3.5 (emphasis added).
108 Nat'l Institute of Standards and Technology, News, *Fire and Explosion Guideline Approved for OSAC Resigtry,* https://www.nist.gov/news-events/news/2016/09/fire-and-explosion-investigation-guideline-approved-osac-registry (Sept. 20, 2016).
109 Nat'l Institute of Standards and Technology, OSAC Registries, https://www.nist.gov/topics/forensic-science/osac-registries (last visited Nov. 27, 2016).
110 Email from Michael Wixted, MIFireE, NFPA Emergency Services Specialist and *NFPA 921* Staff Liaison, to Terry-Dawn Hewitt, Chair IAAI FISC committee, November 25, 2016 (on file with authors).
111 Sign up for email updates at https://www.nist.gov/sign-e-mail-updates (last visited Nov. 27, 2016).
112 NRC/NAS Report, *supra* note 7, at 9.
113 NCFS Views on Identifying and Evaluating Scientific Literature, *supra* note 80 at 1 (emphasis added).
114 Tex. Forensic Sci. Comm'n, Final Report Willingham/Willis Investigation 8-9 (April 15, 2011), *available at* http://www.fsc.state.tx.us/documents/FINAL.pdf (in

2008, "the Innocence Project filed a formal complaint with the FSC alleging professional negligence and/or misconduct in the course of the arson investigations and testimony given" in the Willingham and Willis cases dealing largely with fire pattern interpretation).

115 *Id*, at 48–49.

116 This reference is to the unanimous decision of the California Supreme Court in *People v. Kelly* 549 P.2d 1240 (Cal. 1976), which explored the admissibility of expert witness testimony based on novel scientific evidence, setting forth the tests to be used in determining the reliability and confirming the general acceptance test proffered in *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923). In 1994, the California Supreme Court rendered its decision in *People v. Leahy* 882 P.2d 321 (Cal. 1994), considering but declining to adopt the approach set forth in *Daubert*, and reaffirming the *Kelly/Frye* rule. Texas follows a modified version of the *Daubert* decision.

117 *Supra* note 114, at 48–49 (emphasis added).

118 *See, e.g.,* the U.S. Supreme Court decision in Melendez-Diaz v. Massachusetts, 557 U.S. 305 (2009).

119 If you have questions or wish to provide feedback, we invite you to contact the FISC Chair, Terry-Dawn Hewitt at TDHewitt@McKennaHewitt.com.