

Challenges in fire investigation

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ABSTRACT/WEB SUMMARY

This chapter introduces what fire investigation is and why it is necessary. It explores, through a case study and analysis of key issues the challenges that are faced by fire investigators and those that support them. It finishes with some of the general problems for fire investigation and then the more specific issues related to the chemistry of fire scenes.

X.1 Why do we investigate?

Fire scenes are generally regarded by Crime Scene Investigators (CSI) as forming a homogenous group of scene types and are frequently inferred as such in their treatment by the authors of standard works^{1,2}. The approach to such a broad range of scenes is limited and controlled by a requirement to work as closely as possible to a model of best forensic practice, and to address the legal requirements of exhibit continuity and integrity, ensuring that the CSI can account for the location of the exhibit from the scene of recovery to the courtroom³, as well as the scientific concerns of contamination of evidence⁴. Fire scenes entail an array of different scene types loosely joined as a heterogenous group by the effect of fire, heating or explosion. The nature of fire cause, development and resolution; the points required to be proven and the other factors present at the scene (human remains, electrical and chemical hazards or evidence of other criminality) all serve to make fire scenes of the most varied and challenging 'types' of forensic investigation. While the heart of criminal fire investigation is the science-based consideration of intentionality of cause, by conceiving of fire investigation purely in terms of 'arson or not', integration with the wider aspects of fire investigation frequently performed by other experts is challenged by an organisation and epistemological hiatus.

The reasons for investigating fires in the UK have been a strong influence on the questions generally asked by the fire investigator, and the team surrounding the investigator. The reasons reflect the concerns of the various interested agencies. A fire might result in fatalities, or have occurred under suspicious circumstances, in which case the police have a duty to investigate by coronial or criminal procedure, respectively. Likewise, the cause and spread of a fire might be of interest to the Health and Safety Executive (HSE), or to an involved insurance company. Lastly, the

Fire Service may take it upon itself to investigate for their own research or statistical purposes⁵.

In examining suspicious or fatal fires, the general responsibility of the fire investigator is most succinctly communicated in the USA National Fire Code National Fire Protection Association (NFPA) 921 (2017)⁶; which states that the investigator's responsibility is to determine origin, cause and responsibility. No comparative single piece of legislation exists in English and Welsh statute.

Why fires are investigated is an important point when considering who is doing the investigation. The range of professionals who can potentially form part of a fire investigation is broad (see Table 1), and in recent years seems to have grown more expansive.

Fire Investigator	Core forensic science investigation responsibilities.
Crime Scene Investigator (CSI)	Photography; seizure of exhibits; consideration of wider criminal activity.
Fire Scientist (usually a forensic chemist)	Fire cause and origin; sampling and analysis of accelerants; consideration of explosions/explosives.
Pathologist	Examination of burnt human remains.
Toxicologist	Analysis of fire-compromised body tissues for drugs/alcohol/carboxyhaemoglobin levels.
Forensic Archaeologist	Excavation of deep fire stratigraphy; Contextual excavation of human remains within a fire scene.

Forensic Anthropologist	Examination of fire-compromised human osseous material.
Forensic Engineer	Consideration of building systems failures.

Table 1: Specialists who participate in forensic fire scene investigations ('core' team members in blue).

X.2 Tripartite Service – What makes a fire investigator?

The 'core' team identified in Table 1 and detailed in Figure 1 have long been described as a tripartite arrangement of Fire Brigade Fire Investigator (FI), Police CSI and laboratory-based forensic scientist. This requirement is perhaps most comparable to post-mortem examinations, as both are effectively 'closed boxes' that begin without any necessary certainty as to whether a crime has been committed. Whereas other forensic scene examinations begin from the report of a crime, both suspicious fires and post-mortem examinations begin with a consideration of whether there is merit in the assertion that the event is suspicious.

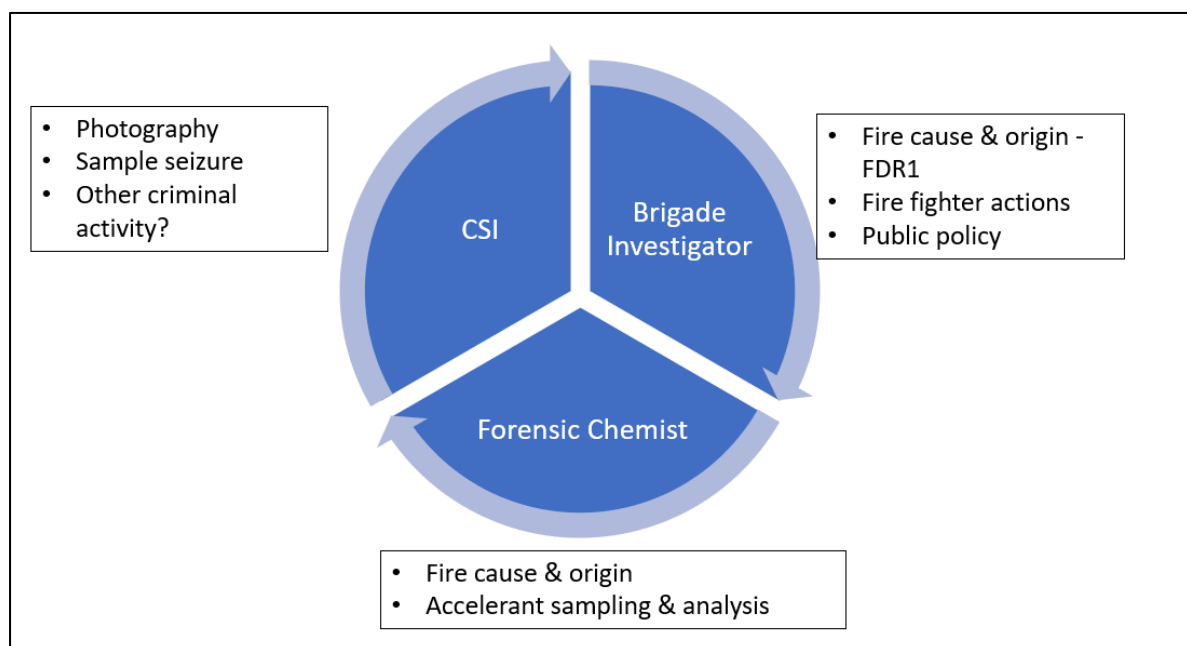


Figure 1: the tripartite arrangement of core fire investigation.

The critical importance in considering the breadth of potential response to different types of suspicious fire scenes is that it challenges the concept of what makes a fire investigator. While core training courses have long been offered by the Fire Service College and other private providers, these tend to only provide an awareness of the more specialist, 'non-core' aspects of fire scene investigation. Prior to the widespread adoption of International Organisation for Standardization (ISO) quality standards within forensic practice, those training in one of the core fire investigation disciplines would undergo a degree of informal 'apprenticeship' training, in which they would attend fire scenes with a mentor and be exposed to a variety of fire types. While this remains important, the ISO standards have played a role in formalising training models, which has perhaps had unintended consequences of distancing training away from exposure and a fluidity that would have made an acceptance of broader fire-related forensic disciplines an easier prospect.

X.3 Quality Accreditation vs Individual Certification

The concepts of 'best practice' and 'quality control' have become overwhelming concerns for the criminal justice system over the last decade. They have been set up to represent a means of conduct that sought to contrast directly with older 'charismatic' models of investigation that dominated police work prior to the Royal Commission on Criminal Justice, carried out throughout the early 1990s⁷. The Royal Commission sought to address concerns regarding the criminal justice system in the light of judicial reviews of the high profile cases of the 'Guildford Four' and

'Birmingham Six', and was more concerned with establishing an accepted, overt means of operation than with scientific issues.

More recently, quality accreditation has coalesced under the ISO system, utilising the ISO 17025 standard for laboratory examination (primarily laboratory-based accelerant analysis for fire investigation), and is beginning to utilise ISO 17020 for scene examination, although currently this is not being uniformly applied and its implementation is focused on CSI departments in police forces and Forensic Service Providers. By contrast, Fire Brigade-based FIs have not engaged with the standard in the same way. There is some ongoing debate regarding whether the ISO 17020 standard includes an assessment of a fire investigator's ability to determine cause and development of a fire, or if it is strictly limited to the act of inspecting a fire scene⁸. A further complication to this issue of quality standard accreditation is the onus of quality administration placed upon the body employing the FIs. Where Fire Brigades opt not to undertake the ISO 17020 standard it pushes the responsibility back to police forces, and the ISO system is not naturally given to recognising the balance of the tripartite structure of fire investigation.

In addition to the notion of organisational accreditation to a standard, or individual certification to a baseline level of competence, one of the key defining paradigms of forensic fire investigation has been a wholesale consideration of to what extent the determination of fire origin and development could be considered a science^{9,10}.

There has been a ten-year period of reflection on what aspects of fire investigation constitute reliable, dependable and evidence-based observations. It is interesting that much of this debate has been internalised within the 'core' group of fire investigators, rather than providing a catalyst for wider considerations across the community of forensic disciplines that work with fire scenes. The AAAS report notes

the problem caused by determining points of origin in a post-flashover fire scene, but its recommendations do not stretch to considering the contextual excavation and recording of debris on these scenes, which forensic archaeology would provide.

As a consequence, fire investigation can be seen as a set of related disciplines in a state of flux, characterised by a series of ongoing divides; between scene investigation and laboratory analysis; between 'core' investigators and peripheral specialists; between self-identifying fire 'investigators' and fire 'scientists'. These are necessary steps that see the discipline move forward in a paradigm shift of self-reflection and change¹¹, but they risk depriving fire scene investigation of wider forensic specialisms.

X.4 Breadth of capability requirement: Forensic Archaeology as an example

Structural fires of forensic interest present a range of complications and problems, which can cause them to be amongst the most complex of scene examinations routinely undertaken by Crime Scene Investigators (CSIs). Further to the institutional complications posed by arson investigation, fire scenes themselves form a complex working environment for CSIs. Concentrations of burned debris can form a monochromatic confusion of unrecognisable items, some of which might ultimately prove to be crucial to the understanding of the origin and development of the fire.

Locating, recording and recovering evidential material from layers of debris is problematic in its own right. These problems are then further compounded when the CSI attempts to communicate the exact location an exhibit was seized from, and why its position may be significant. These facts may be crucial to individuals or agencies

that do not have access to the crime scene, such as the Senior Investigating Officer (SIO), or the jury of a court. This problem of location of items within a semi-homogenous layer of debris is exactly the sort of challenge that the techniques of archaeology have adapted to solve.

Despite the difficulties posed by the examination of deep layers of fire-damaged wreckage, the excavation of this debris is an essential part of the investigation of structures subject to suspicious or serious fire^{5,12}. Not only does the sequence of deposition of the debris record the process of structural collapse throughout and after the fire, but it may also contain exhibits, which either through their presence or through associated patterns of fire damage reveal important information regarding the cause of the fire.

On the majority of structural fire scenes, it is generally recognised that far too much debris is deposited to allow a careful excavation and subsequent recovery of evidence from across the entire area. For that reason, potential seats of fire and other areas of interest are identified early in the examination, and their excavation and examination are prioritised accordingly¹³. The area surrounding a seat of fire to be considered for excavation has been assessed by means of a statistical exercise, by which the area of any structure subject to fire determines the size of excavation required to draw any meaningful conclusions⁵. The theory underpinning this mathematical relationship is not detailed further by Cooke and Ide, but it presumably relies upon a calculation of statistical confidence to be gained by sampling the selected area of a fire scene.

Within this area identified as being subject to excavation, there is a concept of qualitative change in the composition of the debris⁵. The authors state that the seat of fire should be excavated extremely carefully, and that the investigators should note any changes between layers of debris. Cooke and Ide do not, however, continue to make any practical suggestions regarding how such areas might be excavated, how changes in layers might be identified and recorded, and how this information might best be presented.

By no means would the approach to every structural fire investigated be improved by the addition of a forensic archaeologist, or the deployment of forensic archaeological method to the scene. But the fact that some scenes with deeply stratified debris would provide more locational information about items or human remains buried within it by the use of archaeology demonstrates the need for fire investigation to be capable of reaching out to other appropriate forensic specialisms.

X.5 Integrating testing in an investigation

As with all forensic examination, it is essential that fire investigation follows a systematic sequence that ensures optimal recording and recovery of exhibits. The sequence presented below in Table 2 was initially suggested by Ide¹³ (1998). Whilst alternative sequences have been laid out by other authors¹⁴, Ide's would still seem to hold some relevance in the context of UK fire investigation, despite its age:

1. Establish objectives
2. Investigate background
3. Consider safety
4. Locate seat

5. Consider possible ignition sources
6. Excavate seat
7. Take samples
8. Formulate hypothesis
9. Report conclusion

Table 2: The Sequential Process of Forensic Fire Investigation (after Ide¹³).

While the point seems facile, Ide's sequence of forensic fire investigation makes it clear that concepts of 'investigation' and 'scientific testing' cannot sit separately from one another, as they are not only embedded within a single continuum of examination, which usually takes place during a single instance of investigation; but also that they are frequently invested in a single individual. The laboratory-based fire scientist is both a field investigator and an analytical tester of questioned samples. The interweaving between fire development investigation and sample testing is yet more convoluted when that testing is integral to the scene approach via the use of portable hydrocarbon testing apparatus. While such testing would be routinely supported by second-line laboratory-based confirmatory tests, the preliminary findings of portable field-based detectors will clearly form a chief intelligence input that dictates the direction of the rest of the scene investigation. The main text of the article should appear here with headings as appropriate. Standard IUPAC nomenclature must be used.

X.6 Case study: Fatal fire investigation

X.6.1 Background

The primary aim of a FI is to ascertain the origin and cause of a fire, put simply, where and how the fire started. There are numerous organisations and publications

that provide guidance on how to conduct an effective, detailed and robust fire investigation; these include NFPA 921 - Guide for Fire and Explosion Investigations, Institution of Fire Engineers - A Guide to Fire Investigation and Kirks - Fire Investigation, all of which highlight the importance of a joint services approach.

Fire investigation is explicit in stressing the use of the 'Scientific Method' to structure the investigation and allow the FI to gather information and data in order to reach a final tested hypothesis.

If the information you require is readily available and reliable then the process can be relatively straight forward, if not then you have limited options. As discussed earlier in the chapter it can require significant investigation in order to determine if the scene really is suspicious and in need of a full investigation. This is a vicious circle and it needs the FI to be resilient and robust with partner agencies. In a resource constrained environment FIs already face the same problem as CSIs: the value of investigation is weighted against the scale of the crime. Volume incidents are often overlooked with the focus only on fatalities. Even with fatalities there can be a risk of rushing to conclusions, as the following case study demonstrates.

X.6.2 The Incident

On a damp Saturday evening in the spring of 2016, a fire occurred at a flat in a local suburb of Birmingham and one of the authors (Jason Dean) was despatched after being informed by Fire Control of the casualties. The two occupants of the flat, one adult male and one adult female had sustained life threatening injuries. As part of the mobilising protocol within the brigade, a duty FI must be requested to attend such an incident. In this instance there was an initial failure of the first attending Incident Commander (IC), who knowing that the casualties were in a life-threatening

condition failed to request the attendance of the duty FI. The FI hearing the call self-mobilised.

X.6.2.1 Information Gathering

On arrival, the FI immediately attempted to gather information from first responders and from any available witnesses. The IC had been informed by the first responder, a Police Constable (PC), that the male occupant of the affected property had informed him that his wife was smoking and was leant over a container of white spirit which subsequently ignited. The second failure of the IC was that he accepted this information as being correct. This led to a lower level of scrutiny of the scene.

Unquestioned, the PC was content that he had relayed the information to the IC and due to no contradiction from the IC, he stood his team down and left the scene, leaving the fire service with the responsibility of closing the incident. In short order a potential crime scene was left without police supervision.

It is important to highlight that white spirit is not a particularly volatile substance and only produces a flammable vapour when it reaches a certain temperature, in this instance approximately 38°C. The resultant vapour then mixes with air and it is then susceptible to ignition only when a competent ignition source i.e. a naked flame is introduced. This is basic knowledge for a FI but an IC may not be as comfortable with the chemistry. Even if an IC doesn't have this knowledge there are advice lines that can be called – e.g. West Midlands as an advice line. So checking the details of the story from a chemistry perspective would have been easy and quite fast.

On arrival the FI decided that this incident was suspicious, particularly due to the nature of explanation not being feasible. The re-attendance of the police was requested, and the IC was informed that the information shared by the PC was likely

to be inaccurate. It became apparent that the police would not return as they had already deemed this to be an accidental fire.

It is important to establish early on in an investigation who the available witnesses are and what information they can provide. In this instance, the witnesses comprised the IC and his two Breathing Apparatus (BA) wearers; two individuals who were in a neighbouring property and the PC, who had left the scene. The information provided by the available witnesses confirmed to the FI that this fire was suspicious.

It is protocol within the brigade area that if a person or persons has sustained life-threatening injuries or has died then a Police Forensic Scene Investigator (FSI) attends the scene in order to assist in the investigation.

Initially, the FSI would not attend due to the lack of involvement from the police and the police would not re-attend or sanction the attendance of the FSI as they had deemed the incident to be accidental.

Within the West Midlands the relationship between the fire service fire investigation team and the police forensics team is exemplary. Fortunately, this relationship enabled the FI to personally contact the FSI team and explain my concerns in order to secure their attendance.

X.6.2.2 The Scene Examination

Approximately 3 hours into the scene an FSI arrived to support the investigation, however, there was still no interest from the police. Up to this point the FI had gathered witness testimony, examined the external scene and carried out a preliminary examination of the internal scene, noting the overpowering odour of white spirit. He then secured the scene until the arrival of the FSI.

The joint examination of the scene by the FI and the FSI enabled the collection of physical evidence which supported the hypothesis of a deliberate fire. The scene provided evidence that indicated the movement of the occupants prior to and during the fire, including the male occupant's escape and the female occupant's rescue by the neighbours.

A Police Inspector arrived at the scene approximately 6 hours later. It was apparent that their interest in the scene was low, due to the previous reports of the fire being accidental and only attended to establish why their FSI was committed to the investigation. The FI provided details of the investigation, a final hypothesis that this fire had been deliberately set following the application of white spirit to one of the occupants and that the hypothesis was supported by physical and testimonial evidence. The FI asked if there had been any police enquiries, to which the Inspector replied no. The FI highlighted that the affected property was located opposite a service station and there may be closed circuit television (CCTV) cameras on the service station forecourt that may assist with the investigation; the inspector decided not to act on this.

This concluded the scene examination and the FI left with the available information and evidence to support the hypothesis.

X.6.3 On-going Investigation and Conclusion

The following weeks led to numerous meetings and telephone calls with the police. The FI informed them that in their opinion, following an argument between the two occupants who were married, the husband poured white spirit over his wife and ignited the vapour with a naked flame ignition source, ultimately setting fire to himself

in the process. At this point the police still took little interest as both casualties were in induced comas.

Three months after the incident the female came out of her coma and requested to speak to the police. She confirmed the hypothesis in a statement but unfortunately succumbed to her injuries shortly after. The husband came out of his coma and gave a different version of events, not only to that of his wife's but different to the version he had given the PC on the night of the incident. It was at this point the police finally decided they needed to commence their investigation.

The on-going investigation included further site visits and test burns on clothing and white spirit. CCTV that was eventually retrieved from the service station, which confirmed the hypothesis of the movement of the casualties and the subsequent fire, which supported the final hypothesis.

Approximately 18 months after the incident, the case went to trial and the FI was the key witness for the prosecution. Following a lengthy period giving evidence in Crown Court and being cross examined by the defence the husband was found guilty of murdering his wife and sentenced to a minimum of 25 years in prison.

X.6.4 Discussion

It is important to note that the case detailed above is not typical in the way incidents of this type are dealt with and in general police and fire service cooperation is excellent. Crime scenes involving fire in the UK are still investigated predominantly by the fire service, however primacy belongs to the police, therefore police participation is essential.

The lack of police support can lead to poorly managed scenes, spoliation of evidence, poor scene recording and poor or negligible evidence retrieval.

Undoubtedly, these errors lead to the perpetrator not being held to account, the collapse of a criminal case and a lack of justice for the victims.

There is currently no standardised training for responding fire service ICs regarding flammable liquids, fire development and simple ignition sources and can result in the investigation being compromised.

There are many reasons why the support required during an investigation is not always available. In this case, the PC based his reasoning on his personal experience, assuming a flammable liquid would ignite in the presence of a lit cigarette. However, he was also let down by the IC who failed to question his explanation, therefore, giving credence to the PC's opinion.

The incident occurred on a Saturday night, always a busy period for the police, close to the change of a shift and with other police incidents requiring attention. Deeming the incident to be accidental makes it a low priority. The protocols within the police for mobilising FSIs prevented a rapid response and it took a robust personal discussion by the FI to get support. As FSIs are the route to submission for evidential testing it is critical that they are deployed to support the FI.

This was a relatively simple scene and investigation with fairly little effort made by the suspect to deceive. If the FI had not had the experience, knowledge and understanding to secure the scene, secure evidence, gather testimonial information and initiate a crime scene investigation then a murder could have gone undetected and unsolved. This case study is used by the author during teaching on the Fire Service College Fire Investigation course to demonstrate the need for FIs and ICs to have the confidence to robustly challenge their Police Colleagues. Challenge is fundamental to the scientific methods, so it should be nothing to fear.

X.7. General challenges and issues

The chapter has so far set the context of fire investigation, with the case study succinctly laying out a real-life example of the challenges in a successful investigation. In this section some of the key challenges are described in more detail. These should assist researchers in understanding the needs of the user community.

X.7.1 Powers

The case study highlighted some of the legal challenges faced in fire investigation. An employee of a fire and rescue authority has relatively limited powers under the Fire and Rescue Services Act 2004, when they are carrying out an investigation. These section 45 powers must be specifically granted to the investigator, and are not a default power to all firefighters (who are usually granted section 44 powers for entry to property under emergency conditions).

While the section 45 powers allow entry to a property, to a designated fire investigator, they do not allow for entry by force or for admission as of right if the premises are occupied. Note:

“An authorised officer may not enter as of right premises in which there has been a fire if the premises are unoccupied, and the premises were occupied as a private dwelling immediately before the fire, unless 24 hours' notice in writing has first been given to the person who was the occupier of the dwelling immediately before the fire”¹⁵

He can apply for access from a justice of the peace to access without notice and with force. But this specifically hinders an investigation where criminality is suspected. Additionally, fire investigators have no powers to detain, arrest or interview. This can be mitigated by the police supporting the investigation, because their powers for

entry without warrant¹⁶ are higher as long as the offence is indictable. Arson is an either way offence, so it does allow for those powers to be used under PACE. It does leave the fire investigator challenged if there isn't a good working relationship with the police, and in situations where the police may not initially believe it is arson the investigation is almost impossible.

X.7.2 Training

The UK still lags behind the USA in the breadth and quality of its training interventions for fire investigation. There is no centralised system of training and fire services are welcome to run their own training or attend private courses often run by private fire investigation companies or private training colleges. The training tends to be based around relatively simple compartment fires, perhaps due to the constraints of a mixed training audience and the cost of realistic fire investigation.

Specialist areas, e.g. car, explosion, maritime and wildfire have no established training courses in the UK and training tends to be ad-hoc and organised at local levels. As is often the case with forensic training, the scenarios used in training are often the least likely to cause problems and be complex or important enough to require investigation.

X.7.3 Governance

There are efforts to try to improve governance by organisations such as the UK association of Fire Investigators. But it is extremely difficult to build consensus on ways forward without supporting governance. The shortcomings of the legal powers have been highlighted, and earlier the impact of the ISO standards. There is a real risk that in order to achieve a quick and simple solution to ISO accreditation fire investigators stop taking evidence and use CSIs to carry out all the recovery. CSI

training has itself been going through challenges since the College of Policing withdrew from providing training and forces were left to create their own solutions. Without specialist training, a CSI is simply not safe on a fire scene and unlikely to understand how to process the scene. So in almost all cases a CSI would need to be accompanied by a fire investigator. If that is the case then one must ask how are they judged competent to process the scene under ISO, if they require a non-ISO audited fire investigator and take direction from them on what to sample.

X.7.4 Terrorism

The interface between terrorist attacks and arson is well established. The use of fire is one of the most popular attack methods used by terrorist organisations. However, the investigation of such an attack divides the expertise in the fire investigator from the investigation leads in the police. Fire Investigators are unlikely to hold high security clearances, as they are unnecessary for their work. So sharing information as scenes are processed becomes difficult beyond using the fire investigator for very specific tasks. Bomb scene investigators have reasonable understanding of incendiary devices, but it isn't their stock in trade. An ideal solution would be cross training or allowing fire investigators to be trained and vetted such that they could support terrorist investigations where appropriate.

X.7.5 Fire modelling

Fire modelling has become something of a forgotten art outside of engineering companies today. NIST have an excellent set of codes for computational fluid dynamics modelling (The Fire Dynamics Simulation). But it takes time to understand how to set up and run the software. More significantly understanding the right way to

apply the simulation to your work can be even harder. It does not seem to be taught outside of academic programs nowadays.

X.8 Chemical challenges on scene

An excellent review of the chemical and engineering research in fire investigation between 2016 and 2019 was conducted by Interpol¹⁷. It demonstrates that there is healthy research activity in fire investigation. But the uptake of that research into investigation training is questionable. Just keeping current across the research would be a full-time job and challenging for an engineer or chemist. For a fire investigator, whose training may range from a few days up to a PhD (rare while serving) it is nigh on impossible. As with policing the science needs to be distilled so in to accepted tenets. The need for that authoritative distillation explains the popularity of single volume guides such as Kirk's Fire Investigation.

The situation for forensic chemistry is even more challenging. As the rest of the chapter will have laid out, it is but one small part of an investigation. It begins with trying to find the evidence of ignitable liquid residues at the scene. Due to the cost of private forensic labs running chemical analysis the investigators want to be sure they are getting good samples, so there is a temptation to bring detection to the scene.

The most obvious form of this is the arson or accelerant dog. They can, when working well, provide an excellent qualitative indication that there are ignitable residues present. Sadly, they can't tell you what they are or the quantity, which may make a significant difference in interpreting the data.

Electronic options explored at scene range from the simple, but useful, approach of ultraviolet light (365nm source) which can help visualise the residue pattern. But it still needs a cue that the substance is ignitable. If this isn't provided by a dog then

other options can include the use of some portable GC-MS technologies. While these can give excellent data they come with a high training burden and cost and can be easily damaged by poor operation.

The recovery of the samples themselves has its challenges. The desire to use CSI to recover samples comes with risks, the swabs they use for DNA recovery tend to have desiccants which can prevent recovery of key compounds of interest. The cleanliness of sample equipment is extremely important and appropriate control samples. The UK still tends to recover using nylon bags, which have reasonable retention of accelerants as long as they are well sealed and not subject to high temperatures. But the process for filling and sealing them can be tricky and gives plenty of opportunity for mistakes compared to the use of paint pots, which are favoured by many in the US for their simplicity.

The challenge on the lab side of fire investigation is twofold. Excellent research increased the body of work on recovery and analysis of various ignitable from different substrates under varying weathering conditions. There is always room for more work in this area, and particularly where it looks at the recovery media used and the packaging effectiveness. However, one of the greater challenges is that the science has progress really well and has a need to perhaps, in a simple and understandable way, describe to the investigator what it can achieve and what is currently not possible. This speaks to the need to distil the research, because otherwise an investigator will rely on the same set of tools they are used to unless a lab offers up options and suggestions.

X.8 Conclusion

This chapter has explored why fire investigation takes place. The focus has been on criminal fire investigation, but the challenges are similar in insurance, Health and Safety Executive and engineering failure analysis. The challenges that can be seen throughout fire investigation speak to a greater need for stronger governance and training and better resources of curated research to support both training and operations. Set in that context the chemist has a far greater challenge than the forensic analysis of residues, but of communicating a complex body of knowledge in a way which supports and doesn't overwhelm either the investigator or the court.

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