

Impact case study (REF3)

Institution: University of Dundee		
Unit of Assessment: UoA 12 Engineering		
Title of case study: Improving fire scene investigation for practitioners		
Period when the underpinning research was undertaken: 2014 onwards		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Niamh Nic Daeid	Professor of Forensic Science	2014 onwards
Period when the claimed impact occurred: 2014-2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Pioneering research in the area of fire scene investigation has underpinned the development of analytical techniques and has provided validation of these techniques for the fire investigation community. The research has led to impacts in the UK and beyond, including:

- The co-development (with professional bodies) of two major Codes of Practice that have been adopted and endorsed by all 43 Police forces and fire teams across the UK, and are used by operational fire investigators across Europe. Subsequent changes to the Criminal Procedure Rules and Practice Directions (2017) require expert witnesses in England and Wales to adhere to these standards of practice adopted by their professional bodies;
- The development of Best Practice Manuals, Codes of Practice and related training to Nordic countries, ensuring consistency of professional processes and scientific robustness in the investigation of fires.

2. Underpinning research

In the year 2019/2020, the national fire statistics recorded 180,683 fires attended by the fire and rescue services in the UK (including 26,726 in Scotland). Of these, approximately 46% were deliberately ignited. Fire investigation is carried out by practitioners from a range of different agencies and backgrounds, which can lead to a variability of training and experience as practitioners work to different operational and scientific standards. The importance of underpinning research for fire scene investigation has been widely accepted and is established in a range of documents including, but not limited to, reports from the National Academy of Science in the United States and the American Association for the Advancement of Science.

Nic Daeid has established research expertise in the area of fire scene investigation. Building on earlier work focusing on the investigation of electrical fires (conducted at the University of Strathclyde), her work at the University of Dundee (since 2014) has continued with a particular focus on fire engineering and the built environment in respect of the exposure of concrete to fire.

Understanding how the built environment responds to fire – for example, the failures in concrete structures and electrical systems as a result of thermal stresses and damage experienced under fire conditions – is critical to interpreting the resultant fire scene and the determination of the origin, cause and spread of the fire. Similarly, the chemical analysis of fire debris samples and the interpretation of the analytical results facilitated by ground-truth datasets of known

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provenance enable the confirmation (or otherwise) of the presence of ignitable liquids in samples recovered from fire scenes to be undertaken.

Nic Daeid's recent work has addressed how the built environment (concrete in particular) reacts to the stresses associated with real fire scenarios and what investigative approaches can be taken in regard to the analysis of fire-stressed concrete [R1, R2]. This research studied, for the first time, bespoke mixes of concrete rather than standard Portland cement which had previously been the default mix for such work. Her work has created a comprehensive ground-truth data set of a range of characterising measurements including the validation of handheld field-deployable instrumentation.

The chemical analysis of fire debris is an essential part of the fire scene to laboratory process where chemical analysis is used to explore the presence or absence of ignitable liquid residues in fire debris. In 2015, Nic Daeid was part of the team that secured EU commission funding (EU Add Fuel HOME/2013/ISEC/MO/ENFSI/4000005962) for the development of ignitable-liquid databases used in the interpretation of fire-debris analysis in collaboration with fire investigation practitioners in Europe, ultimately generating an online searchable dataset (<https://ncfs.ucf.edu/internationaldb/index.php?design=ILRC1>). Independently, she has published a set of ground-truth datasets of ignitable liquids and evaporated ignitable liquids for interpretation purpose.

These areas are specifically referenced in Section 5.2 of the Code of Practice for Investigators of Fires and Explosions for the justice systems in the UK, 2020 [E1], discussed further in section 4.

3. References to the research

[R1] Alqassim, MA, Jones, MR, Berlouis, LEA & Nic Daeid, N (2016), A thermoanalytical, X-ray diffraction and petrographic approach to the forensic assessment of fire affected concrete in the United Arab Emirates, *Forensic Science International*, vol. 264, pp. 82-88.

DOI: [10.1016/j.forsciint.2016.03.015](https://doi.org/10.1016/j.forsciint.2016.03.015)

[R2] Leung Tang, P, Alqassim, M, Nic Daeid, N, Berlouis, L & Seelenbinder, J (2016), Nondestructive Handheld Fourier Transform Infrared (FT-IR) Analysis of Spectroscopic Changes and Multivariate Modeling of Thermally Degraded Plain Portland Cement Concrete and its Slag and Fly Ash-Based Analogs, *Applied Spectroscopy*, vol. 70, no. 5, pp. 923-931.

DOI: [10.1177/0003702816638306](https://doi.org/10.1177/0003702816638306)

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4. Details of the impact

Nic Daeid's research has led to impact in terms of operational practice for fire investigators. The work has led to two major Codes of Practice that have been adopted and endorsed by professional bodies in the UK and by fire investigators across Europe, with further changes affecting the standards and requirements for fire scene investigators working within the criminal justice system of England and Wales.

Development and endorsement of the Code of Practice

The subjective nature of fire scene investigation is challenging within the justice process. The lack of consistency across operational and scientific standards, and across analytical techniques employed by fire investigators, has the potential to lead to haphazard implementation of practice and potential miscarriages of justice.

Recognising this challenge, Nic Daeid led an interdisciplinary and multiagency team of practitioners from the public and private sector in the UK to develop a UK Code of Practice, setting out best practice for those involved in fire investigation. Participants included fire

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investigators from the private sector (Hawkins & Associates Ltd, Fire Investigations (UK) LLP, Prometheus Forensic Services, BRE Group), the public sector (Forensic Science Northern Ireland, Fire and Rescue Service Northern Ireland, Hertfordshire Constabulary, Scottish Police Authority Forensic Services, Scottish Fire and Rescue Service, Chief Fire Officers Association) and professional bodies (Institution of Fire Engineers and the UK Association of Fire Investigators). The resultant Code of Practice underwent a national consultation involving UK Police forces and Fire and Rescue Services, private-sector organisations and professional bodies. It was subsequently endorsed by the Chief Fire Officers Association (CFOA) – now the National Fire Chief’s Committee (NFCC) – the Institute of Fire Engineers (IFE) and the UK Association of Fire Investigators (UKAFI), the latter being the two professional bodies for fire engineers and fire scene investigators, respectively.

Following its endorsement, the Code of Practice was published in 2017 [E1] and has subsequently been revised (2020) to cover all fire investigations in both criminal and civil courts.

The Code of Practice is used by fire investigators across the UK and for the first time sets out, in a single UK document, industry-led best practice for the fire investigation community. The content of this document is fundamental to the development and implementation of quality standards for fire investigation.” [E2]

It is described as:

“...a critical document as experts are bound to adhering to it through their responsibilities to the courts as laid out in the Criminal Procedures Rules Practice directions... The Code of Practice is used by fire investigators across the UK.” [E3]

The Code of Practice and the methodology laid out within were referred to in the popular crime scene drama TRACES, based on the University of Dundee team. TRACES debuted on the TV channel Alibi in December 2019, exposing the methodological approach to an audience of 140,000 viewers, and was subsequently shown on BBC 1 in January 2021.

The significance of the code is underpinned by related changes to the Criminal Procedure Rules and Practice Directions (CPR, 2017, as amended) issued by the Lord Chief Justice of England and Wales [E4]. The CPR now states that expert witnesses must adhere to the individual Codes of Practice of their professional bodies, thus making compliance mandatory across the practitioner communities working within the criminal justice system of England and Wales.

These changes have implications for access to justice by ensuring systematic and consistent approaches to the investigation of fire scenes and for making sure that *“the needs of the UK judiciary are properly met” [E3]*.

Establishing and extending best practice

The European Network of Forensic Science Institutes Fire and Explosion Investigation Working Group (ENFSI FEIWG) is made up of representation from 70 forensic science institutes across Europe. Nic Daeid chaired the fire and explosion investigation working group (2011-2015) and, with Hackman (Dundee) and other European colleagues, led the development of the ENFSI FEIWG best practice manual in fire and explosion investigation [E5]. This document amalgamates previous European guidance documents developed collectively by the ENFSI FEIWG into a single document, providing guidance in the domain at a European level.

The ENFSI FEIWG best practice manual [E5] has been adopted and published by the ENFSI community; it forms the basis of a new online training course created in 2020 by Nic Daeid and ENFSI colleagues for 50 participants from 22 European countries. The ENFSI manual has also been used to underpin the development of new systems of training and operational practice in the Nordic countries (Norway, Sweden, Finland and Denmark) across their forensic science services and fire investigation provision [E6].

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The Code of Practice for Investigators of Fires and Explosions for the justice systems in the UK [E1] and the Nordic manual [E6] are two of the reference guides listed by the Office of the Forensic Science Regulator in the recent tender document [E7] for the amendment to the FSR Code of Practice and Conduct for forensic practitioners, with which all fire science investigators in England and Wales must comply.

5. Sources to corroborate the impact

[E1] NicDaeid, N. et al (2017). *Code of Practice for Investigators of Fires and Explosions for the Criminal Justice Systems in the UK*. Chief Fire Officers Association, The Institution of Fire Engineers, United Kingdom Association of Fire Investigators. Available at: [https://www.ife.org.uk/write/MediaUploads/Documents/Fire Investigation Code of Practice.pdf](https://www.ife.org.uk/write/MediaUploads/Documents/Fire%20Investigation%20Code%20of%20Practice.pdf) [Accessed 26 March 2021]

[E2] Statement from the UKAFI.

[E3] Statement from DCCH, independent fire investigation consultants.

[E4] The Criminal Procedure Rules and Practice directions (2017 as amended) issued by the Lord Chief Justice of England and Wales [PDF available].

[E5] European Network of Forensic Science Institutes. (2019) *Best practice manual for the investigation of fires and explosions*. (ENFSI-BPM-FEI-01 v3). [PDF available].

[E6] Nordic Fire Manual (2018) Available at: <https://brandogsikring.dk/files/Pdf/Brandunders%C3%B8gelse/Nordic%20Fire%20Manual%20v.2.0%20-%20First%20Edition.pdf> [Accessed 19 March 2021].

[E7] Fire Appendix for the Forensic Science Regulator Request for Proposal - Statement of Requirements (2020) [PDF available].