



Digital Radiography in Forensic Investigations of Fire-Damaged Electrical Equipment

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Executive Summary

- Electrical equipment is the **primary cause of accidental fires** in domestic and commercial buildings and ranks third for vehicle fires, for a total estimated cost of £12 billion in England in 2020.
- Fire investigators **cannot ascertain the cause of ignition** with certainty, due to external damage to the relevant equipment or component, and therefore cannot prove manufacturer/economic operator non-compliance with 'Electrical Equipment (Safety) Regulations (2016)', leading to **hazardous items remaining in circulation**.
- **Digital radiography** (x-ray and CT) are **non-destructive, rapid, and cost-effective** techniques that should be **integrated into fire investigation Standards of Procedure (SOP)** to improve the identification of structural defects, which can be used in insurance (liability), Health and Safety Executive (HSE), civil and criminal casework.

Policy recommendations

The economic and social cost of fire in England in 2020 was est.£12 billion, of which £3.2 billion was classified as marginal cost that was 'reclaimable' should fire incidents be reduced (Pickering et al., 2023). The Association of British Insurers also recognises the significant financial burden of fires, paying £1.3 billion in fire insurance claims in 2021 (ABI 2023). Thus, there is cross-sector backing for the development of strategies that enhance the quality and effectiveness of fire investigations which can contribute to fire prevention. To achieve this, local and national authorities should:

- Support Fire and Rescue Services to identify digital radiography facilities in their region.
- Encourage collaboration between digital radiography facilities and Fire and Rescue Services to explore the pros and cons of using digital radiography in fire investigations caused by electrical equipment.
- Establish minimum standards for the use of digital radiography in fire investigations (e.g., industry wide professional standards developed in conjunction with the HSE, insurance and legal sectors).
- Develop and provide training for fire service personnel in the analysis and interpretation of radiographic data.



Background

Statistical analysis of data collected between 2010–2023 (880,639 fires) demonstrates that electrical equipment was the cause of 51% of all accidental dwelling fires, 22% of all road vehicle fires, and 36% of accidental non-dwelling structure fires in England (Home Office 2023).

- Faulty appliances and lead fires: 16% dwelling; 21% road vehicles; 23% other buildings.
- Misuse of equipment or appliances fires: 35% dwelling; 1% road vehicles; 13% other buildings.

Interviews conducted with Fire and Rescue Service personnel (January 2024) revealed that external heat damage to appliances/equipment makes it hard to identify and recover relevant components for examination. If recovered, they are disassembled to perform electrical and arc surveys to confirm ignition source and fire causation. However, these assessments are only undertaken in “significant” cases (criminal; fatalities) in line with regional force policies.

This results in:

- Lack of datasets to prove manufacturer/economic-operator non-compliance with Electrical Equipment (Safety) Regulations (2016). Therefore, regulatory authorities cannot enforce the withdrawal, prohibition, or restriction in the supply of dangerous/non-compliant products.
- Unresolved casework leading to dissatisfaction amongst victims, investigators, and insurers.
- Destruction of evidence, preventing re-examination and archiving.

Solution

The **integration of non-destructive digital radiography, as standard, into fire investigation protocols** permits responders to rapidly identify objects of interest. Visualisation capabilities allow hidden defects, such as internal wiring damage, insulation degradation, and component failure, which are often undetectable through surface inspection, to be examined. It can provide critical evidence for the determination of the origin and progression of a fire, aiding in the identification of ignition source(s) and contributing risk factors (Svare, 2023). It also produces 2D and 3D models that facilitate evidence presentation, preservation, re-examination, and archiving. Integration could be encouraged by adopting the following strategy:

- **Interviews** with fire investigators, ABI and HSE representatives to identify the limitations of current SOPs.
- **Surveys** to establish the **current use of radiography** in fire-related investigations (international; national).
- **Cost-benefit analysis** considering the societal, economic, environmental, technological, and legislative impact.
- A **cross-sector working group** to develop and implement new SOPs including representatives from:
 - Association of British Insurers.
 - Home Office; HSE; Office for Product Safety and Standards.
 - HM Chief Inspector of Fire and Rescue Services; Fire and Rescue Service; Chief Fire Officers Association; The Institution of Fire Engineers; Association of Fire Investigators; International Association of Arson Investigators.
 - Institutions with suitable radiographic facilities and expertise.



Further information

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