IOSH Fire Risk Management Group
Back-to-Basics Webinar 4: FRMG Principal 4: Fire Investigation.
1230-1330. 13 January 2022.
Questions received from Zoom participants and suggested answers offered.

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1	Not all insurers investigate fires in order to reduce their own losses. Insurance investigations, usually carried out by loss adjusters, are often used to learn from the incident and prevent recurrence and offering guidance for that particular client or more widely. Thank you for your observation.
2	It will be good to make sprinklers a legal requirement in English schools. Can the FRM Group influence the UK Gov? Yes. In line with all aspects of IOSH's work in promoting, influencing and aligning safety policy internationally it is hoped that this initiative will float to the top of the pile. Provision of sprinklers is a loss prevention, property protection and business continuity function, second to life safety. In schools the emphasis is still on structured and disciplined building evacuation to a safe place where this is necessary. However, where the FRMG gets the opportunity, it will promote the installation of sprinkler systems.
3	Has anyone been prosecuted as the result of this criminal neglect? If so what breaches of legislation were there? Thank you for this follow-up question. Details around this case are not available, simply due to the age of the young person involved and the known personal circumstances. The Criminal Damage Act 1971 (CDA 1971) is the primary source of offences involving damage to property. The Act created a statutory offence of arson and abolished the common law offence (s.11 CDA 1971). In Section 1(1) CDA 1971, a person who without lawful excuse destroys or damages any property belonging to another, intending to destroy or damage any such property, or being reckless as to whether any such property would be destroyed or damaged, shall be guilty of an offence. Damage can be temporary as well as permanent 'Recklessness' for the purposes of the CDA 1971 is defined within the House of Lords decision in *R v G* [2004] 1 A.C. 1034. "A person acts recklessly within the meaning of s.1 Criminal Damage Act 1971 with respect to: • A circumstance when they are aware of a risk that it exists or will exist. • A result when they are aware of a risk that it will occur; and • It is, in the circumstances known to them, unreasonable to take the risk." So, in the circumstances the bar is set quite high in proving intent and often young persons will receive a police caution.
4	I am experienced fire investigator and accept sharing real events is a way of bringing the session alive. However, there are some very basic principles in fire investigation that should be

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	explained in this basic session. I am unclear what is being explained and how it underpins the basic principles or where the session is going. Happy to discuss, explain if required. Thank you for your helpful feedback which we shall take on board in restructuring any sequels to this programme. Constructive comments are always welcome.
5	As a UK based Fire Safety Advisor within a large organisation and, having recently completed an Apparent and Root Cause Investigation course, what additional training would you advise undertaking specific to basic and intermediate level investigations please? There are many excellent training courses available in the UK and around the world, provided by experienced trainers and professional bodies. Without bias, one would recommend courses run by the Fire Service College: Fire Service College Or the Institution of Fire Engineers have an established international presence. Training & Development Directory (ife.org.uk)
6	Is there a good example of an appropriate hot work permit, for various types of locations (education, offices, manufacturing)? For example, the Fry Building at Bristol University appeared to not have appropriate measures. Yes, it is true. No Hot Works Permit (a type of Permit-to-Work) was in place. Examples of suitable HWP are on the portal with the Webinar and the Presenter's Notes.
7	Regarding the Cutty Sark ship fire, in addition to PAT testing, we should be making sure that the cleaning staff are emptying the 'bags' on a regular basis? Yes. This is a simple process safety issue. Responsibility for the safe use of the industrial vacuum cleaners was not expressly down to any cleaning staff as such. The shipwrights who were working on the restoration should have taken action to leave their work in a safe condition at the end of each shift, and even more importantly overnight or at weekends. It is all part of good housekeeping in the workplace.
8	What are the major causes of fire involved in cold stores operating at -15°C and above, especially in products having flour as their ingredients? Factors which contribute to fire in cold stores include electrical installations, wiring and power supplies and electrically powered machinery, including machines for mechanical movement, ventilation equipment and transport such as Fork-lift trucks and charging systems. While some forms of plastic or polymer packaging may be flammable, or at least combustible, the cold temperature means that generating enough vapour than can ignite may be difficult. Finally, of course, people are a significant cause of fires in what they do or do not do and in bringing-in to the cold store extrinsic hazards such as portable electrical equipment and charging systems.

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9	What are the basic principles of fire investigation? There are traditionally three levels of fire investigation: Basic fire investigations; Intermediate fire and explosion investigations; and Advanced level fire and explosion investigation, where there is a terrorist involvement. https://www.ukfrs.com/guidance/search/investigation-fires-and-firefighting When undertaking fire investigation, it is the responsibility of the fire investigator to ensure that the investigative process follows a logical, structured and demonstrable framework, and that all fire investigations are approached without presumption of the origin, cause or responsibility for the incident until the scientific method has yielded a provable hypothesis. This is achieved by following a sequence of logical activities: 1 Secure the scene to prevent unwanted interference. 2 Gather basic facts and information, principally from interviewing eyewitnesses and interrogating electronic technology such as recordable CCTV, security camera 'footage' from vehicles and doorbell cameras etc. data from fire alarm and power systems and any equipment or machinery that may contain programmable electronic systems. 3 Working from the outer peripheries of the fire into the heart of the building or structure, locate the seat(s) of the fire and excavate the remains and debris to establish a timeline and position-line for development of the fire. 4 Account for any inventories of combustible and flammable materials and any known potential means of ignition to determine what is expected and what is not expected to be present in the building. 5 Examine the scene and record facts and observations. This will require collecting data and gathering information from witnesses. 6 Analyse the data, based on the knowledge, training and experience of the investigator, using additional skills and assistance if necessary. This leads to being able to identify the cause of the fire or explosion. 7 Produce likely hypotheses based on an analysis of the data. 8 Test the hypothesis to ensure it can withstand examination, possibly in a court of law. 9 Select a final hypothesis, review and report on the findings.
10	What are the HFACS and HFIX models? There are many root cause analysis methods available to a fire investigator. But one that can be adapted to fire investigation and works very well where people are involved is HFACS. The Human Factors Accident Classification Scheme was developed for the US Department of Transportation Federal Aviation Administration by Dr Scott A. Shappell, FAA Civil Aeromedical Institute Oklahoma City, OK 73125 and Dr Douglas A. Wiegmann, University of Illinois at Urbana-Champaign, Institute of Aviation, Savoy, IL 61874, in February 2000. HFACS is heavily based upon James Reason's Swiss cheese model (Reason 1990). The HFACS framework provides a tool to assist in the investigation process and target training and prevention efforts.

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	Investigators are able to systematically identify active and latent failures within an organisation that culminated in an accident. The goal of HFACS is not to attribute blame; it is to understand the underlying causal factors that lead to an unintentional event. The framework is based on underlying unsafe acts and conditions, unsafe management and supervision and essentially unsafe organisational influences. The Scheme uses a series of nanocodes to identify and address each of the consequences of actions and conditions etc to identify through root cause analysis the likely causation of the event. The system lends itself ideally to RCA of complex fire scenes. HFIX (Human Factors Intervention Matrix) is a downstream method of working out if fire prevention and fire precautions were addressed at the right level as a consequence of the outbreak and development of the fire.
11	From the investigation perspective, are there deeper examples where the investigator will look e.g., how to find seat of the fire, is there a technique? Yes. There are many techniques that can be used and in the presentation the analogy with archaeology was suggested where the seat of a fire can be found by excavation of areas of deep burning which could indicate where the fire has been burning for the longest time. However, some of the signs that you should look out for are patterns and directions of burning, smoke damage, heat damage, charring of wooden objects and timber used in the construction of the building, particularly with walls adjacent to the seat of the fire and ceiling damage above the seat of the fire, if the ceiling remains. A simple example is to look at the pattern of 'fuel' or combustible material and where it is located in the building or room and also if it piled up or scattered around. The principles of fire investigation work – Gulf Fire (mdmpublishing.com) Two particularly well-recommended sources of more detailed reading on fire investigation are: Fire and Explosion Investigations: National Fire Protection Association (NFPA) 921. Principles of Fire Investigation: R.A. Cooke & R.H. Ide, The Institution of Fire Engineers.
12	Will you comment about the rise in domestic fires? Thankfully we have had recently a decrease of 4% in the number of domestic fires in the UK. Annually there are approximately 250 fire-related deaths. The majority of these occur within the home between 2200 and 0600 when people are asleep. There are about 37,000 house fires a per annum in the UK, out of a total of 149,779 fire incidents in the year ending June 2021 (latest statistics published). The majority of these domestic fires were caused by electrical equipment misuse, mainly cooking appliances. Fire safety statistics can be found at: https://www.gov.uk/government/collections/fire-statistics-monitor.

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13	As we know, significant fires cause substantial damage and in destroying buildings or structures this restricts evidence available which can be used for investigation. Is there any way or techniques to establish root causes of fire in these above-mentioned situations? Yes. Techniques such as photography are very useful if archive images can be found to compare with plans and drawings of the structure and the post-fire state that you find it in. However, the best techniques available are now electronic and data and information that can be available through the 'Internet of Things' if buildings are ICT enabled with data logging systems for power and machinery condition monitoring etc. Finally, always look at the 'mass balance' that you would expect to find in terms of fuels and combustibles and sources of ignition that you would expect to find in the building with process safety and inventory records.
14	Would it be useful in some cases to use the Event Tree Analysis to support the Fire Risk Assessment Process? Yes indeed. We used the concept of fire investigation being a de-construction of FRA and reverting to the way in which Event Trees are popularly used it would be ideal to use an ETA for working out the consequences of fire in an FRA. In fact, this would make that huge leap of faith that is needed in some instances in translating a FRA from a basic fire hazard spotting exercise to a true risk assessment by working out what the consequences are, how likely they are to occur, what to do about it and who to tell.
15	I am interested in how you reconcile a structured approach to investigation, by for example following a fishbone process, with what would appear to be, a biased outcome. e.g., an investigation by loss adjusters resulting specifically in their favour. Thank you for your question. I feel there is a mixed message here. In the fishbone type of diagram, the principal critical factors which would be considered include: - Equipment - Processes - People - Materials - Environment and - Management which essentially is an extension of the familiar three focal points around occupational, environmental and human factors. And from each of these factors spins out a series of causes that lead to the head of the fish which is the outcome or the defect itself. So, listing all the consequences or causes of these six principal critical factors will give rise to a series of root causes. From experience, while a loss adjuster may produce the same list of principal critical factors and he agrees of the value or quantum of the damage that has been caused, it is the proportion of the loss that should be borne by the employer or business owner or investor as against his

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	client or employer, the Insurance Company that he may disagree with. Its not about the factors or the outcomes, it is about the responsibility for the bill.
16	What relationship is there between asbestos and fire? Quite simply it is that in the UK pre-2000 asbestos was used widely in industry and industrial and commercial buildings, and often in domestic homes too, to provide a robust and popular construction material with fire protection properties. Consequently, in fires, asbestos would lose its structural integrity, become friable and be disbursed throughout the atmosphere. This presents an environmental, occupational health and safety related risk to firefighters, employees and the public.
17	Some references such as NFPA 921 (scientific method) rely on gathering evidence from the scene in cooperation with forensic specialists. This will help to identify if the fire is accidental or deliberate and using simulation, rebuilding and reconstructing the scene or both sometimes, can present investigation techniques which can be counted as an acceptable level of evidence beyond reasonable doubt. Yes, re-enactment of a timeline of actions above a reconstruction of conditions can be a powerful process in establishing the probable cause of a fire.
18	An excellent presentation. Thank you, Gary. What is your opinion on recognising and categorising electrofusion welding as hot works? Yes, technically you would have to consider electrofusion welding of HDPE pipework for example as Hot Work, in the context of being a source of energy which could transfer heat in an unpredictable way to surroundings which may be combustible. Having said that, the most significant aspect of the process would be in minimisation of 'stray' heat and in ensuring that joints are revisited after a period of time to see that everything has cooled down safely.
19	What formal courses/qualifications are recommended to take in Fire Investigation that are recognised by industry? There are many suitable courses that can be followed. Examples include those run by the Fire Service College and the Institution of Fire Engineers.
20	Can we please have some custodial premises examples in future presentations? Yes. Thank you for this comment. The FRMG will try to include this area of fire safety.
21	Is fire RA assessment mandatory for shops? They may have only 2-3 staff and from time to time have volunteers working there as well. Yes. Under article 9 (1) of the Regulatory Reform (Fire Safety) Order 2005 the responsible person must make a suitable and sufficient assessment of the risks to which relevant persons

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	are exposed for the purpose of identifying the general fire precautions he needs to take to comply with the requirements and prohibitions imposed on him by or under this Order. The 'employment' in the shop of 'volunteers' and only 2-3 people may be 'red-herrings' here. I suspect the implications of article 9 (6) (a) may be weighing on the mind of the person citing these factors in this question as there is a requirement to record the information (such as the findings of the FRA) where he employs five or more employees. This article does not say that if there are <5 employees there is an exemption and you **DO NOT** need to record the findings: it is just that with >5 employees you **DO** have to record the information. Excellent GOV.UK advice of FRA for shops is available at: 9449 DCLG Fire Risk Offices and Shops Insides.indd (publishing.service.gov.uk)
22	I have a fire retardant approved by the fire institute for work platforms used on scaffolding for work at height. But the client requires steel platforms to be used. Can you please explain. Kindly elaborate? Thank you for your question. I am presuming that the fire retardant has been applied to wooden scaffolding boards which are used to make-up the safe working platform, and that the client has rejected this idea in favour of using metal scaffold boards. When the retardant is freshly applied to new boards, the level of protection will be high, and the fire resisting properties will be expected to perform as anticipated. However, as boards wear and are subject to weathering, especially rainfall, the fire resisting performance will deteriorate. Consequently using metal boards, and those manufactured from heavier steel as opposed to aluminium will be more reliable.
23	Thank you sir our speaker for the insightful presentation. How would you differentiate between fires caused by accident and deliberate or naturally occurring? Characteristic factors of deliberate fires (or arson where a fire is deliberately set to endanger life) are that there will typically be: - An element of planning, which is to say the fire will break out during quiet hours or when the building is unoccupied. - A fire accelerant may be used. - Additional fuel may be brought in or stacked to give a bonfire effect. - Multiple seats of fire may be found. - There may be signs of forced entry. - Valuable items may be claimed to be in the building, but none can be found. Naturally occurring fires include 'Acts of God' and are generally unpredictable including the effects of lightning, focussed sun's rays, microbiological activity and spontaneous ignition. Petrol and oil-soaked rags and clothing, sawdust, piles of vegetation, including hay, and compost heaps have all been known to spontaneously combust.

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	Accidental ignition or fires with no known causes probably comprise the rest of the fires that occur occupationally. They include: - Discarded smoking materials. - Chemical reactions. - Thermal runaway reactions. - Self heating cooking equipment. - Vapour cloud explosions / deflagrations. - Static electrical ignition. Fire Investigation – The Forensics Library (aboutforensics.co.uk)
24	Who should do Fire Investigation? Any competent person appointed by an employer with suitable knowledge, approach, training and experience and an interest in fire, industrial and process and occupational safety should be ideally suited to undertaking fire investigation.
25	What qualifications are required for fire investigation? There are many suitable courses that can be followed. Examples include those run by the Fire Service College and the Institution of Fire Engineers. To have an education and training in occupational safety and health, a science, technology or engineering subject will be useful also.
26	Question is basically in small scale company they skip the fire and its investigation. Ah! That is not the right approach as one day there may be a fire in the workplace which has terrible consequences which causes the business, the owner and investors and the employees their livelihoods when all along with proper investigation of earlier incidents, the fire could have been prevented.
27	Is there any standard or legal framework on fire safety related guidance on buses (diesel or electric)? A very interesting question. It is understood that this is not an insignificant problem area, historically in Scandinavia at least where it is thought that 1% of buses on the road may be involved in albeit small fires annually. Regarding 'standards' there will be requirements for manufacturers to use materials which have an element of fire resistance after testing etc. and regarding guidance there will be requirements for integrity of mechanical components and systems to be regularly inspected by VOSA (Vehicle and Operator Services Agency) in the UK and for vehicles to have certain Type Approvals, under the provisions of The Road Vehicles (Approval) Regulations 2020. A127 Essex school bus fire: Pupils safely evacuated - BBC News PowerPoint Presentation (iru.org)

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	However, it is not exactly clear that while most of the requirements relate to a disparate selection of road safety and motor vehicle safety issues how many of these requirements relate specifically to fire safety issues. It is noted however that there are requirements which relate to the integrity of fuel tanks and electrical systems. This area is one where research is clearly required.
28	Updated list of fire equipment for the building please? We addressed this is the webinar No. 3 on Fire Precautions, and the statutory requirements under articles of the RRO apply also in terms of fire extinguishers, fire safety signs, fire alarm systems, smoke fand fire detectors and AFD.
29	Great presentation this afternoon, many thanks Gary. Thank you.
30	This is a very useful event. Well done. Thank you for your comments. See you at the next Webinar.

Keywords:
Arson
Asbestos
Bus fires
Cold stores
Criminal damage
Domestic fires
Electrofusion welding
Event Tree Analysis
Fire Investigation training
Fishbone diagrams
Forensic skills
FRA in shops and retail
HFACS
Hot Work Permits
Permit-to-Work
Root cause analysis
Sprinklers