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Firefighters are Heroes of Modern Age

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Abstract

Fire is an uncontrolled combustion that causes material damage and endangers human lives. Combustion is a chemical process that causes the oxidation of the fuel constituents of a some kind fuel. It is a process between fuel and oxidants in which heat is generated due to changes in chemical constituents. By releasing heat, it may occur light in the form of annealing or flame. There are accidental and arson fires. This work is dedicated to all firefighters in the world who very often find themselves in situations where they save the lives of others while neglecting their own safety. Firefighters are the heroes of modern times.

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Introduction

Fire is a rapid oxidation process with the evolution of heat and light in various intensities (NFPA 921) [1]. Fire is different from combustion in that fire is usually expected to have an uncontrolled factor to it.

In the simplest terms, fire can be defined as a rapid chemical reaction where a fuel and oxygen combine to produce heat and light. Of course, in practice nothing is simple.

An understanding of the basic physics of fire phenomena can help the fire investigator to interpret the fire scene. It is important to remember that fires are transient phenomena. Fires grow, shrink, and move, and the fire scene is a record of every phase of the fire. The clues and indicators left after a fire are directly related to how long the fire burned. Fires start small and then grow until the fire size is limited by available fuel or available oxygen.

In a fire situation, the heat from the fire acts as the fundamental mechanism that drives the rest of the fire phenomena. Near the fire, it produces heat, light and products of combustion. The heat from the fire is the primary mechanism that makes smoke move. Through buoyant forces the fire acts as a pump that sucks in air from low regions and, by heating the gases, reduces their density and emits the gases as the products of combustion above the fire. The products of combustion leaving the fire have an initial momentum that acts to create airflow above the fire and throughout structures.

All of these mechanisms can be related to the fire power, also known as the heat release rate. In most scenarios, the dominant factors are all a function of the fire power. The airflows leaving the fire start with a quantifiable amount of momentum introduced by the fire. As the air and smoke flow moves further from the fire, the momentum of the flow is decreased by the solid surfaces that the flow moves past. Therefore, one way to look at smoke flow is that smoke only travels as far as the initial momentum added by the fire can carry it. This is the fundamental reason why the smoke from large fires extends to the farthest recesses of a building and smoke from small fires does not propagate long distances.

Arson

Arson often presents complex and difficult circumstances to investigate [2]. Normally, these incidents are committed at the convenience of a perpetrator who has thoroughly planned the criminal act and has left the crime scene long before any official investigation is launched. Furthermore, proving commission of the offense is more difficult because of the extensive destruction that frequently dominates the crime scene. The contribution of the criminalist is only one aspect of a comprehensive and difficult investigative process that must establish a motive, the modus operandi, and a suspect.

The criminalist's function is limited; usually he or she is expected only to detect and identify relevant chemical materials collected at the scene and to reconstruct and identify igniters. Although a chemist can identify trace amounts of gasoline or kerosene in debris, no scientific test can determine whether an arsonist has used a pile of rubbish or paper to start a fire. Furthermore, a fire can have many accidental causes, including faulty wiring, overheated electric motors, improperly cleaned and regulated heating systems, and cigarette smoking—which usually leave no chemical traces. Thus, the final determination of the cause of a fire must consider numerous factors and requires an extensive on-site investigation. The ultimate determination must be made by an investigator whose training and knowledge have been augmented by the practical experiences of fire investigation.

Fire Department

It is the role of the municipal fire department to respond to reports of hostile fires and take appropriate action [3]. Members of the local fire department are typically the first officials to arrive at the scene of a fire. Depending on the severity of the fire, numerous firefighting assets may arrive and participate in the operations. It is at this point that the fire investigation really begins. While not formally trained as fire investigators, firefighters can make note of the time of the fire, the fire conditions, the weather conditions, and the point of entry to suppress the fire. In addition, any suspicious or unusual activity surrounding the fire should be noted, including burn patterns, open doors or windows, alarms, unusual odors, deep-seated fire, and

overall behavior and conditions.

The actions of a fire department at the scene can be separated into three distinct phases: (1) suppression, (2) overhaul, and (3) investigation. During the fire suppression phase, the first goal is to save lives; the second goal is the suppression of fire and the protection of property. In their mission, firefighters typically utilize hoses that are 1-1/2 to 2-1/2 in. in diameter to control and suppress the fire. After the fire has been extinguished, firefighters will search for hidden fire in walls, ceiling spaces, or other areas that are not easily accessible. This phase is termed "overhaul," and includes opening walls, pulling down ceiling materials, removing flooring, etc., to ensure that the fire has been completely extinguished. During overhaul, firefighters can unwittingly alter the fire scene by removing furnishings, devices, wiring, walls, and ceiling or framing materials. Unfortunately, this alteration of the fire scene can create difficulties for the fire investigator. Depending on the jurisdiction involved, the fire scene investigation can occur in conjunction with overhaul, where the investigators are on the scene to direct the overhaul activities and to ensure the preservation of evidence. The final phase of fire scene activities involves the investigation of the fire with the intent of determining its origin and cause. Although this is identified as the final phase, the investigation of the fire scene can actually begin during the suppression or overhaul phase. The commencement of the investigation depends largely on the time of arrival of the fire investigator or the abilities and responsibilities of the fire suppression personnel. Fire investigators will attempt to determine whether the fire was accidental or intentionally set (incendiary). Upon completion of the fire scene investigation, the property is typically released to the property owner or insurance company for further action.

Firefighters

Describing firefighters without using the word "hero" would be tough [4]. After all, their ultimate goal is to prevent or relieve human suffering and loss. They regularly put their own lives on the line to save other lives and protect property. Much of their work is physically exhausting, mentally demanding, and highly dangerous. When a fire or other emergency strikes, they are on the scene battling flames, smoke, collapsing walls, chemical explosions, and numerous other threats. Unlike civilians, they can't evacuate the premises. They are working hard until the crisis has passed.

Behind every heroic moment, of course, are countless hours of preparation. Career firefighters are highly trained professionals. Their services are essential to every community and every stretch of land across this country.

Today, the fire service is an all-hazards response agency. Firefighters might find themselves at a trash fire and, before returning to quarters, have to render medical aid to a child who fell from her bike. If a problem or emergency is not clearly assigned to other agencies, the fire service is sent. In the twenty-first century, firefighters are on the front line of community protection. Hazardous materials require knowledge of chemistry. Terrorism, both homegrown and domestic, requires cross-training with law enforcement. Natural threats, such as floods, storms, and earthquakes, require knowledge of emergency management.

A career in the fire service is no longer a part-time career that provides benefits and the ability to run a side business, but rather requires a full-time commitment to lifelong learning. As a group, firefighters are seen by the community as heroes who are able to treat injuries like a combat medic; mitigate spilled chemicals as a professional chemist would; defeat terrorism alongside homeland defense responders; plan for emergencies at the level of a military planner; fight every fire, and rescue all who are in danger. For all ofthese reasons, communities are very careful whom they hire for fire department openings. All applicants must go through a rigorous testing and selection process that may last a few months to a year or more, so as to select only those who are qualified and prepared for the commitment. Although physical strength is still required, firefighters today must also have the academic skills to apply mathematics and sciences. Municipalities seek candidates with all the necessary skills, but they also seek potential firefighters who are trustworthy. When all is said and done, a firefighter occupies a position in which people must trust him or her with their lives and property.

Modern firefighters are trained in the assessment and treatment of life-threatening conditions

sustained by the public they serve [5]. They are responsible for stabilizing the scene of an accident or emergency situation and performing basic first aid procedures, as well as assisting pre-hospital providers. Patient assessment and basic medical treatment is essential to the role of the firefighter. Upon the arrival of the ambulance, firefighters will transmit valuable information to emergency medical technicians (EMTs) and paramedics concerning the patient's condition, chief complaints, and any medical assistance that was administered prior to their arrival. Today's firefighter is truly a multifaceted, life-saving professional.

Investigation

Fire investigation can occur in two different stages [6]. The first involves examination of the fire scene to determine the cause, origin and development/ spread of fire. The second involves laboratory analysis of samples recovered from a fire scene normally when arson is suspected. While both of these may be linked together, they may be activities carried out by different personnel with different backgrounds and experience.

In a fire investigation, investigators seek to determine the cause and origin of a fire [7]. The cause of the fire may be classified as accidental, natural, incendiary, or undetermined. Fire investigators use a systematic approach to investigate the fire and use their training and experience to evaluate fire patterns, potential ignition sources, fuel loads, fire progression, and other factors to determine what may have happened. As the fire investigator evaluates the fire scene, they may collect evidence to support their hypothesis of how and where the fire started. This is where the fire debris examiner fits in: typically, examiners analyze evidence recovered from or related to fire scenes to determine if any ignitable liquids are present. Common fire debris evidence includes debris from the scene, suspect or victim clothing, and liquids found at the scene or during the execution of a search warrant. Though closely linked to fire investigation, a fire debris examiner should avoid terms that are commonly used during investigations such as "arson" and "accelerant," both of which imply intent. The fire debris examiner should be unbiased and report the objective results of their analyses.

When it comes to the possible causes of a fire, it actually means the causes of a fire, and the causes may be different [8]. Detecting the cause of fire is the ultimate goal of criminal investigation because it determines the type of event that caused the fire, that is, the normative side of the event, which is characterized by fire (according to statistical indicators the most common causes: negligence-inattention, technical causes: failure of electrical installations and devices, children's play , construction flaws, self-ignition, and more, while about 10% of the fires are intentionally caused). A cause of fire is a criterion that distinguishes fire as an event from incrimination whose modus operandi contains fire as its determination.

Fires happen for a number of reasons, but regardless of the cause, they destroy property and families and cost taxpayers billions of dollars annually [9]. Whether the fire was started accidently or deliberately, it must be put out and its cause and origin identified. Certainly, fire scene investigations are also among the most complicated and dangerous. The most comprehensive manual of fire investigation has been published by the NFPA (National Fire Protection Association), which is an essential guide for all fire scene investigators. In addition to determining the agency responsible for the fire investigation (fire services and/or law enforcement), there are fundamental reasons why fire investigations are complex.

The origin of the fire is not necessarily obvious. Thus, determining the cause and origin of the fire requires considerable time, extensive data collection, and rigorous application of the scientific method. It is an effort requiring experience, technology, science, and knowledge.

The fire can compromise evidence because it can consume evidence, which means that sufficient data to establish the origin and cause might not survive.

Such destruction of evidence can be exacerbated by normal rescue, suppression, and salvage tasks.

There is the threat a major fire presents to the health and safety of the community, the public, and the investigators.

There is always the threat that a fire can spread to adjoining structures.

It can be difficult to find the origin of a fire [10]. Because fire moves upward, the origin is most often found at a low point marked by very intense burning. It is best to sample a larger area than one might initially think. Drafts, fuel sources, techniques used to extinguish the fire, and other factors may obscure the origin. Once detected, the area around the origin should be photographed and protected from foot traffic until searching for evidence of accelerants, ignition devices, and indications of arson is done. Suspicious circumstances to be mindful of near the origin include a number of small fires in several areas, the use of devices to spread fire ("streamers") such as paper or clothing, and ignition in unusual places. Containers found near the origin, even when empty, should be collected, as should anything that could have been used as a fuse. Signs of accidental ignition should also be noted.

Human Remains

By definition, mass fatality incidents (MFIs) result in numerous deaths occurring over a relatively narrow time frame [11]. These events produce complex multidisciplinary investigative challenges. From a medicolegal perspective, investigators seek to recover and examine decedents in a dignified and respectful manner, accurately determine cause and manner of death, perform accurate and efficient identification of victims, provide for the rapid return of victims' remains to their legal next of kin, and exchange factual and timely information with families in a compassionate manner. Oftentimes, severe fragmentation and commingling of human remains are the byproducts of the causative forces and pose significant challenges to investigators. In a mass fatality context, the overarching tenet regarding commingling is that human remains with no anatomical/physical connection must be considered to be commingled. This principle also applies to remains that are spatially associated but present no valid anatomical connection. From the perspective of the forensic investigator, resolving commingling, and ultimately decedent identification, requires careful management of both the human remains and the data generated during recovery and postmortem examination.

Photography

Fire photography and videography are critically important [9]. Ideally, the forensic photographer will be at the scene as soon as possible after its discovery. These scenes are difficult, tedious, dangerous, and complex. There may be dead bodies as an accidental consequence or the direct result of a murder. The forensic photographer's role begins while the fire is burning and continues long after it is out, as the fire marshal sifts through the fire debris to uncover the fire burn patterns.

Fire scenes must be considered and treated like any crime scene, and all crime scene investigations are scientific endeavors.

DNA

DNA may be obtained also from some personal effects bearing biological material [12]. For that reason, a DNA specialist should be consulted before personal belongings are cleaned for photographing, cataloging, and returning to families.

Comprehensive X-rays documentation is made of appropriate cases to identify commingled remains, artifacts (jewelry, evidence, etc.) imbedded in human tissue, and evidence of antemortem skeletal injury, surgeries, or anomalies. Such features may aid in identification by correlation with antemortem medical records.

Human remains that lack typical identifying features (tissues without fingerprint, dental, or anthropological material) can often be identified through DNA. For this reason, morgue processing should include a station to obtain and preserve a specimen for DNA testing from each case processed.

Following a mass fatality, the entity or organization responsible for identifying the human remains will use DNA profiling to supplement traditional methods of human identification, which include anthropology, pathology, fingerprint, and dental records [13]. While DNA is a powerful identification tool, DNA results are only part of an overall identification effort, which, depending on the condition of the human remains, also takes into account non-DNA evidence. In certain circumstances, where there is extensive fragmentation and/or decomposition of the bodies, DNA analysis may be the only method of identification. DNA analysis is often the only tool available that can be used

to identify and reunite fragmented human remains.

As with other identification technologies (anthropology, fingerprints, odontology), human identification through DNA analysis is, at its most basic, a biometric technique. Like these other technologies, DNA analysis uses a characteristic specific to the unknown sample (remains) to compare to a known sample from the deceased (reference). In order to identify human remains, a DNA profile from the human remains must be "matched" to one or more DNA profiles from biological samples of known origin (reference sample). However, unlike these other comparison techniques, DNA analysis offers the additional flexibility of allowing the comparison of a profile from the unknown sample to immediate and extended family members.

DNA is a comparison science that requires one or more valid reference samples to identify remains [14]. DNA samples should be collected from the remains, appropriate family references, and direct references, such as personal items or biological specimens. Personal items may include used toothbrushes, shavers/razors, personal hygiene items, unwashed undergarments, and other suitable clothing. Biological specimens may be obtained from blood stored for elective surgery, biopsy samples, PAP smears, extracted teeth, or hair samples.

Obtaining, storing, and analyzing biological samples from both the remains and potential relatives requires special expertise and should always be undertaken by a scientific or medical expert. If the DNA samples need to be transported, the Medical Examiner should seek expert advice on the most appropriate method of preservation and transport to ensure that the security and integrity of the samples are maintained.

Forensics

Forensic analysis to assist fire investigators is becoming more and more common [3] This analysis typically involves the traditional laboratory analysis of fire debris, but can also involve other forensic disciplines such as tool-mark, fingerprint, trace evidence, DNA, pathology, and engineering. A dialogue or link between the fire investigator and the forensic chemist or engineer is extremely important to the successful evaluation and analysis of evidence. The fire investigation is always better served as the fire investigator, forensic chemist, and forensic engineer understand and learn more about each other's roles, methods, and techniques. This increased level of awareness can be accomplished through an ongoing dialogue between the parties regarding a specific investigation as well as joint training sessions and meetings. Fire investigators have often benefited from presentations provided by forensic chemists during annual training sessions that relate to the collection and preservation of evidence and subsequent laboratory examination. Forensic chemists and engineers often benefit from participating in actual fire scene investigations and working side by side with fire investigators. Through this partnership all the parties are able to provide a better level of service, as well as to develop a better understanding of the other's duties and responsibilities.

Commingled human skeletal remains present complex challenges for medicolegal investigations [15]. In cases of commingling, it is important to accurately segregate the remains of each individual represented and then make a determination of the number of individuals present. Forensic anthropologists are uniquely qualified to make assessments regarding commingling because they routinely employ laboratory methods such as identifying duplicated skeletal elements, visual and osteometric pair-matching of bilateral elements, evaluation of joint congruity between articular surfaces, skeletal age comparisons, and assessment of corresponding pathological changes and taphonomic modifications between different skeletal elements. Other methods for resolving commingled remains, such as nuclear and mitochondrial DNA testing, involve destructive, costly, and time-consuming techniques. Although these methods are highly accurate for identification, time and resource limitations, as well as cultural beliefs by a decedent's family, may negate the use of destructive analytical methods in some contexts.

Public Health

It doesn't matter what kind of event provokes the catastrophe, all catastrophes lead to significant health impacts [16]. Catastrophes provoke a significant increase in demand for healthcare services, while at the same time many of those that provide such services and

the facilities in which they deliver this care are themselves affected directly by the event and unable to provide even the normal level of preventive and curative care services. This imbalance can constitute a major challenge for the public and, thus, also for public health and emergency managers, one that will be made infinitely more complicated if emergency managers and public health personnel do not understand each other's skills and needs.

The health effects from a catastrophe can be termed primary or secondary. Primary health effects are those that are caused directly by the event's causal agents (e.g., winds or flooding in a hurricane), or as a result of the direct effects of the event (e.g., the shaking in an earthquake causes buildings and objects within buildings to fall, causing injury. Note that some event types can cause multiple health effects. For example, hurricanes can lead to trauma injury from flying debris, injury from falling structures or trees, and drowning.

Secondary effects are those that are indirectly caused by the catastrophic event. For example, hurricanes may not directly carry microbial infection, but they can promote disease transmission if humans densely crowd together to seek shelter, or if fresh water supplies are contaminated and ingested without filtration or boiling. Another example would be in chemical or biological agent accidental or intentional release. In this case, there are secondary effects that not only affect victims but also affect public health responders, such as decontamination, contamination, hospital lockdown, positive pressure equipped isolation wards in hospitals, working in personal protective equipment, etc., not to mention having to deal with the worried relatives. In some catastrophes, the human response to the event may provoke more damage to health than the event itself.

Conclusion

Fire occurs and develops under different circumstances. In order to reduce the risk of fire, automatic fire alarm and self-extinguishing systems are installed. Fire protection includes a set of activities aimed at reducing the risk of fire, that is, rapid and high-quality fire extinguishing if it occurs. The proper functioning of the fire detection and fire alarm and fire extinguishing systems must be ensured.

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