Measuring fire damage

Fire damage in the 21st century has changed from the events of the 20th century.

1. Building and Content Materials

20th Century: Traditional building materials such as wood, brick, and concrete were prevalent. Furniture and interior items were often made from natural fibres and materials, which generally burn more slowly and might produce more visible smoke, giving occupants more time to react to a fire.

21st Century: The use of synthetic materials in construction and contents has increased dramatically. These materials, including plastics and foam insulation, can burn more rapidly and generate more heat, leading to faster fire spread. In this article we recognise how risks have changed and our fire residue may require a different approach.

The increased focus on health and safety today should require data to verify contamination is removed, diluted or neutralised

2. Presence of Lithium Batteries

20th Century: Lithium batteries were not widely used in consumer products.

21st Century: The proliferation of devices powered by lithium-ion batteries, such as smartphones, laptops, electric vehicles, and energy storage systems, has introduced new fire risks. These batteries can overheat and lead to thermal runaway, causing intense and difficult-to-extinguish fires.

3. Changes in Ventilation

20th Century: Buildings often had more natural ventilation, which could feed a fire with oxygen but also potentially slow its spread by dissipating heat and smoke.

21st Century: Modern buildings are designed to be more energy-efficient, with tighter seals and less natural ventilation. While this can limit the oxygen available to a fire, potentially leading to slower, smouldering fires, it can also cause fires to become more concentrated and generate toxic smoke. Once a fire gets enough oxygen (e.g., from a window breaking), the result can be a rapid and explosive spread due to the build-up of hot gases and unburned particles.

4. Slow, Low Oxygen Fires

The trend towards more airtight buildings can indeed make slow, low-oxygen fires more likely. These fires can smoulder undetected for longer periods, producing deadly gases like carbon monoxide. When they finally ignite with a sufficient oxygen source, the result can be a sudden and severe fire, a phenomenon known as a backdraft.

Residual Contamination likely form house or commercial premises fires

1. Carbon Monoxide (CO)

- **Description**: A colourless, odourless gas that is produced by the incomplete combustion of the battery's organic materials.
- **Dangers**: CO can bind to haemoglobin in the blood more effectively than oxygen, reducing the blood's ability to carry oxygen to organs and tissues. This can lead to symptoms such as headaches, dizziness, weakness, nausea, confusion, and even death in severe cases.

2. Hydrogen Cyanide (HCN)

- **Description**: Produced by the burning of nitrogen-containing materials such as plastics, wool, and certain synthetic textiles.
- **Dangers**: HCN is a potent poison that inhibits cellular respiration, leading to loss of consciousness, seizures, and even death at high concentrations.

3. Benzene (C6H6)

- **Description**: Emitted from the burning of plastics, foams, and synthetic fibres.
- **Dangers**: Benzene is a known carcinogen that can cause leukaemia and other blood disorders after long-term exposure.

4. Formaldehyde (CH2O)

- **Description**: Released from the combustion of wood products, upholstery, carpets, and other home building materials.
- **Dangers**: Exposure can cause irritation of the eyes, nose, and throat, and prolonged exposure is associated with cancer.

5. Acrolein (C_3H_4O)

- **Description**: Generated from the burning of wood, plastics, and other organic materials.
- **Dangers**: Highly irritating to the eyes, skin, and respiratory tract, and can cause lung injury with prolonged exposure.

6. Polycyclic Aromatic Hydrocarbons (PAHs)

- **Description**: Formed during the incomplete burning of organic materials.
- **Dangers**: Many PAHs are carcinogenic and can also cause eye and lung irritation upon exposure.

7. Dioxins and Furans

- **Description**: Produced by the burning of chlorine-containing substances like PVC plastics.
- **Dangers**: Highly toxic compounds that can cause reproductive and developmental problems, damage the immune system, interfere with hormones, and also cause cancer.

8. Volatile Organic Compounds (VOCs)

- **Description**: A broad category of chemicals released from burning materials, including solvents, paints, and cleaners.
- **Dangers**: Short-term exposure to VOCs can cause eye, nose, and throat irritation, headaches, and dizziness, while long-term exposure can lead to liver, kidney, and central nervous system damage.

9. Particulate Matter (PM)

- **Description**: Tiny particles or droplets in the air, produced by the burning of materials.
- **Dangers**: Can penetrate deep into the lungs and even enter the bloodstream, causing respiratory problems, cardiovascular disease, and aggravating existing lung conditions.

Some of the chemical hazards released from lithium batteries in a fire as used in lap tops power tools etc,

10. Hydrogen Fluoride (HF)

- **Description**: Produced when the lithium salts and other fluorine-containing materials in the battery are exposed to heat.
- **Dangers**: HF is a highly corrosive acid that can cause severe chemical burns on contact with skin and is toxic when inhaled. Exposure can lead to irritation of the eyes, skin, and respiratory tract, and significant exposure can cause systemic toxicity, affecting the heart and bones.

11. Phosphorus Pentafluoride (PF5)

- **Description**: Formed from the decomposition of lithium hexafluorophosphate (LiPF6), a common electrolyte in lithium-ion batteries.
- **Dangers**: PF5 hydrolyzes to form hydrofluoric acid (HF) upon contact with moisture, including humidity in the air. It poses similar risks as HF, including severe respiratory and skin irritation.

12. Other Toxic Compounds

- Fires can also release other harmful substances, including various organic compounds (VOCs) and particulate matter, depending on the specific materials in the battery and the conditions of the fire. These can include compounds like formaldehyde, acrolein, and other irritants or carcinogens.

13. Metal Particulates

- The burning process can aerosolize metals used in the batteries, such as cobalt, nickel, and manganese. These particulates can be inhaled, posing risks to the respiratory system and potentially leading to metal poisoning if exposure is high.

Environmental and Health Risks

- **Immediate Risks**: Include respiratory distress, chemical burns, and systemic toxicity from acute exposure.
- **Long-Term Risks**: Chronic exposure to low levels of some of these substances can lead to long-term health effects, including lung damage and neurological effects.

How Building Forensics can assist in assessing risks and hazards and determining scope of work

Some of the contamination issues identified in the article, may dissipate shortly after the fire has cooled. The significant issue is the content and composition of remaining soot's and the identification of chemical VOCs within any odours.

The fire restoration industry will invariably use camouflage odours to disguise mal odour and it is therefore essential that no fragrances are used in decontamination and fire restoration.

Building Forensics can provide detailed or overall VOC and sanitation assessments.

Conclusion

The transition from the 20th to the 21st century has seen both improvements and new challenges in fire safety. While modern building codes and advancements in fire detection and suppression technology have improved safety, the increased use of synthetic materials, lithium-ion batteries, and changes in building design have introduced new risks. These developments necessitate continued innovation in fire safety strategies, including improved materials, smarter building designs that account for fire behaviour, and better education for occupants on fire risks and safety practices.

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