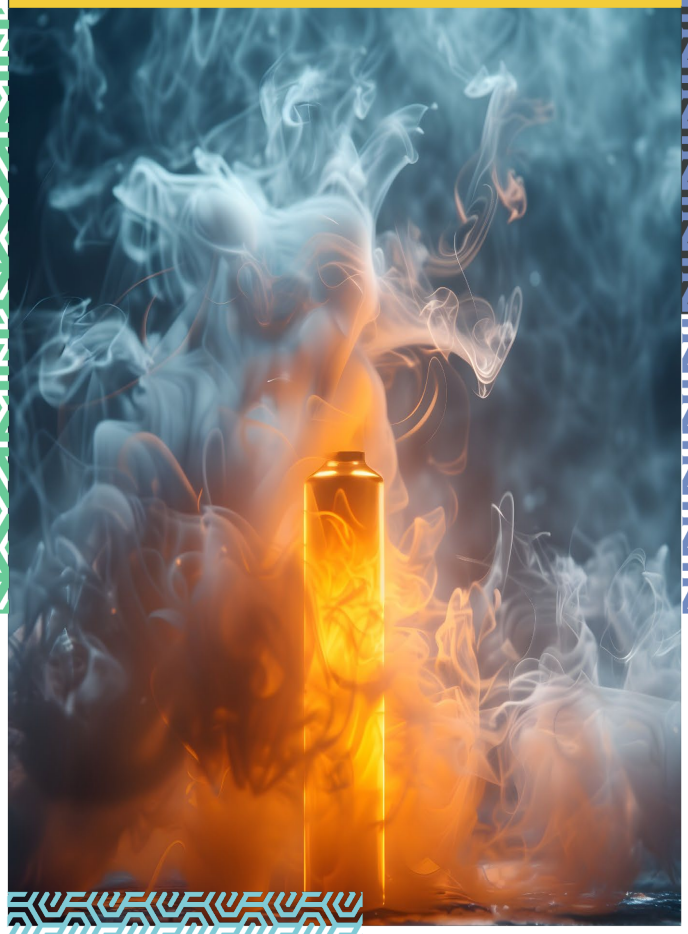
Risk control

Dangers of Cobalt from Lithium-ion Battery Fires



In partnership with

GALLAGHER BASSETT
GUIDE. GUARD. GO BEYOND.

Risk Management Partners
rmpartners.co.uk

Risk Control: Dangers of Cobalt from Lithium-ion Battery Fires

Introduction

Technological advances in the last decade have seen significant changes in the way that we power equipment and machinery. The Lithium-ion battery has a higher energy density compared to other types of batteries which makes them both lighter and more efficient at storing energy[1].

The gradual move away from hydrocarbon powered vehicles and other battery technologies to the more modern Lithium-ion battery-based power sources has led to the rise in popularity of electric vehicles such as electric cars, e-scooters and e-bikes. However, the new battery technology has created a new set of challenges to manage.

Traditional vehicle and equipment fires are extinguished by dousing or smothering. However, the change in battery composition to Lithium-ion poses new challenges to the traditional hazards and risks historically presented to blue light services responding to an emergency.

Causes of Ignition

There are a number of factors that can cause these batteries to ignite[3], however, two predominant causes are overheating and physical damage[4].

- **Overheating:** When a Lithium-ion battery is exposed to high temperatures an event known as thermal runaway can occur which results in the battery heating up uncontrollably. Some of the more common reasons for thermal runaway are exposure to heat sources, being left in direct sunlight or internal factors such as a short circuit or internal damage
- **Physical damage:** Damage to the battery through events such as punctures or crushing can cause internal short circuiting and lead to thermal runaway, resulting in ignition and potential fire
- **Manufacturing defects**: In low cost batteries with less stringent quality controls, manufacturing defects such as impurities in the electrode materials or the incorrect assembly of the battery itself can increase the risk of thermal runaway and potential fires
- **Overcharging or over-discharging**: Issues can occur when Lithium- ion batteries are charged beyond the manufacturers recommended voltage limits or when the batteries are discharged to extremely low levels. Operating the batteries at these extremes can lead to internal components failing and overheating
- **Incorrect usage**: The incorrect usage of Lithium-ion batteries can lead to the increased risk of fire. Incorrect usage includes things such DIY up-graded batteries fitted to e-bikes to increase range or adaptions to the batteries which increases power output.

  The use of incompatible chargers or exposure to extreme vibrations or shock can also increase the risks.

Health Risks

Lithium-ion battery fires release a number of compounds which can pose various risks when individuals are exposed to them[4]. These include carbon monoxide, hydrogen, cyanide, hydrogen fluoride and cobalt. Lithium-ion batteries in a thermal runaway event generate oxygen ensuring that associated fires burn extremely hot and have a tendency to reignite after being initially extinguished. Fires can escalate with subsequent explosions which can the spread the fire further. As such, the time and resources that blue light services expend to fight these fires is significantly higher than that of a traditional fire.

The toxic compounds released by these fires are of significant concern to firefighters and other first responders as derivatives can be inhaled and absorbed through the skin. Normal clothing does not protect individuals from potential exposure through dermal absorption, but turnout kit for firefighters does provide a level of protection due to its waterproof nature[5].

Cobalt, which is commonly used in Lithium-ion batteries, can contribute to these risks. In the event of a battery fire, cobalt compounds can release hazardous fumes such as Cobalt Oxide and Cobalt Hydroxide. These fumes can be harmful if inhaled or come into contact with the skin or eyes. Additionally, Cobalt can increase the intensity and duration of a fire, making it more challenging to extinguish and increasing the potential exposure time for blue light service people on site.

Blue light services have to be mindful of not only the safety of their staff, but also to the safety of the general public. In certain circumstances instructions to the general public downwind of fires involving Lithium-ion batteries to close windows and remain indoors or to evacuate maybe necessary. The dispersal of bystanders maybe also be required to protect them from particulate fall out and exposure to toxic gasses.

Equipment and Decontamination

Although designed for use, firefighters' equipment can become contaminated with combustion products as well as cobalt and cobalt salts. Procedures need to be in place to allow equipment and personnel to decontaminate on the site of the fire in order to remove the bulk of contamination off and minimise the risk of cross contamination of vehicles and other equipment. These procedures need to take into consideration how equipment is transported and decontaminated back at the station. As well as considering the provision of additional equipment to prevent contaminated gear being used before it has been laundered or decontaminated.

In addition to standard equipment maintenance and decontamination, the frequency and attention to detail regarding deep cleaning and decontamination of vehicle cabs after attending a lithium fire should be increased in order to remove any potential residual carcinogenic dust particles.

Health and Safety Regulations

The Management of Health and Safety at Work Regulations 1999[6] requires employers to make suitable and sufficient assessments of the risks posed to their staff and others affected by them carrying out their tasks.

Therefore, suitable procedures and mitigation measures must be included to reduce the risks so far as reasonably practicable for employees, other emergency responders, bystanders and the wider communities.

Symptoms

EH 40[7] gives a work place long term exposure limit for Cobalt and cobalt derivatives of (8-hr TWA) of 0.1mg.m3

As with most exposures, the effect of cobalt can vary from person to person and the effects can vary depending on the duration and concentration of the exposure.

Depending on the size of the fire and number of batteries involved, fires involving lithium and lithium- ion batteries can result in potentially high exposures to cobalt and cobalt derivatives. Due to the increased use of these batteries, the number of fires involving lithium and lithium-ion batteries increases, so does the level of long-term exposure and potential risks to ill health of those responding.

The health hazards associated with exposure to cobalt drops into two areas, acute and chronic. Depending on the concentration of the length of exposure, acute health effects can have several symptoms include abdominal pain and vomiting if ingested. Whereas, chronic effects can include allergic reactions, dermatitis, asthma, inflammation and fibrosis of the lung, occasional instances of heart disease and thyroid issues.

Routes of Entry

When lithium and lithium-ion batteries are involved in a fire, the gases, fumes, and dust particles released can contain Cobalt and Cobalt derivatives. The nature of these derivatives varies as do the potential routes into the body.

There are three main pathways for Cobalt to enter the human body[8]. All are possible when emergency services and members of the public are exposed to compounds and derivatives given off by fires involving Lithium-ion batteries.

Inhalation: Cobalt dust inhalation can lead to breathing difficulties similar to asthma or pulmonary fibrosis. These symptoms can result in individuals suffering shortness of breath and decreased tolerance to exercise. Due to the nature of Cobalt Oxide particles, depending on the size of the partials, a small proportion of these can remain in the lung for several months or years after inhalation. As Cobalt compounds are classified as "possibly" carcinogenic, dust inhalation should be avoided.

Dermal absorption: Cobalt dermal absorption is possible during exposure to smoke, soot, ash and particulate fallout from fires containing Lithium-ion batteries. Cobalt salts and compounds containing Cobalt can be given off and contaminate clothing and equipment being worn or used by blue light services. Although dermal absorption rates for Cobalt are relatively low, it is possible for it to enter the body through direct contact with the skin. This is made more possible due to the length of time these types of fires can take to put out.

Ingestion: Ingestion of cobalt normally occurs through the consumption of foods that have been grown in contaminated soils or contaminated water is drunk, however ingestion can occur if blue light responders do not follow good hand hygiene protocol and hands are not washed before consuming food.

Mitigation

Risk assessments and mitigation measures need to consider the risks posed to blue light services and members of the public when dealing with Lithium-ion battery fires. UK fire fighters already have at their disposal several mitigation measures capable of

controlling exposure to gasses and compounds given off by fires which can and will be suitable for controlling the exposure to Cobalt and Cobalt derivatives.

Firefighting breathing apparatus operates on open loop circuit. This provides firefighters with clean air preventing gas, vapour or fume inhalation. Firefighting turnout clothing is suitable so long as the clothing does not become saturated with contaminates contained Cobalt salts and derivatives and that decontamination procedures are followed during clean up.

Key Points

- Due to Lithium-ion batteries giving off oxygen during thermal runaway events, exposure times for blue light services to potential carcinogens is greater than when responding to traditional fires
- There are a number of reasons why Lithium-ion batteries can ignite but most are due to excessive heat or damage
- There are three main pathways for Cobalt to enter the body: Inhalation; dermal absorption; and ingestion
- Risk assessments need to consider mitigation measures to cover both staff and members of the public. Suitable equipment, training and procedures are required to keep both staff and members of the public safe

References

1. Lithium-Ion vs Lead-Acid Batteries - Battery Skills
2. Lithium vs. Lithium Ion Batteries | Sciencing
3. Explained: The Reason Behind Lithium Batteries Catching Fire (slashgear.com)
4. Toxic fluoride gas emissions from lithium-ion battery fires | Scientific Reports (nature.com)
5. 9479_GRA 5.3_Text.indd (publishing.service.gov.uk)
6. The Management of Health and Safety at Work Regulations 1999 (legislation.gov.uk)
7. EH40/2005 Workplace exposure limits (hse.gov.uk)
8. Cobalt and you. Working with cobalt - are you at risk? INDG442 (hse.gov.uk)

Further information

For access to further RMP Resources you may find helpful in reducing your organisation's cost of risk, please access the RMP Resources or RMP Articles pages on our website. To join the debate follow us on our LinkedIn page.

Get in touch

For more information, please contact your broker, RMP risk control consultant or account director.

contact@rmpartners.co.uk

Risk Management Partners

The Walbrook Building
25 Walbrook
London EC4N 8AW

020 7204 1800
rmpartners.co.uk

FP960-2024