



Lithium-ion Fire Suppression: Portable Fire Extinguishers

Explaining the increased risk of lithium-ion fires, the need to validate new fire suppression technology, and the key role of compliance certification.



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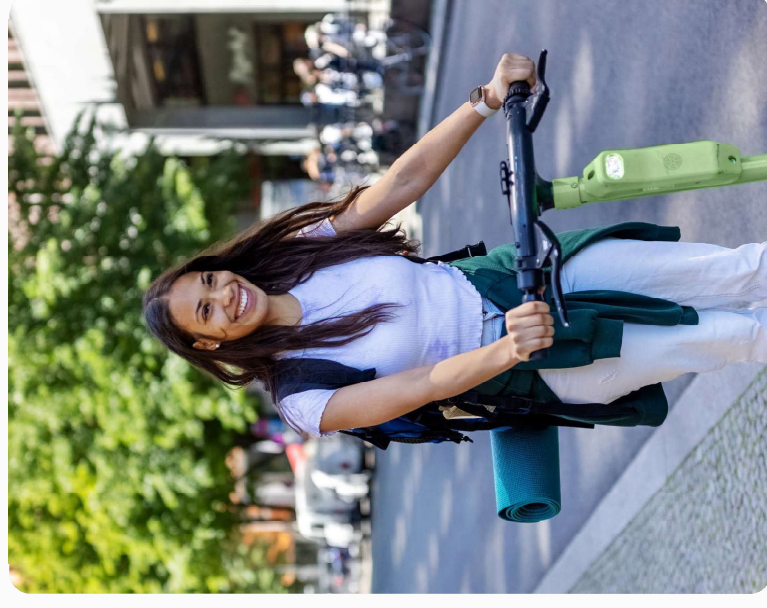


Executive Summary

As efforts to make our world more sustainable have increased, so has the use of lithium-ion (also known as 'Li-ion' or simply 'lithium') batteries, due to their energy efficiency and ability to power a range of portable devices. This alternative energy and storage source, however, presents an increasing concern in the form of Li-ion battery fires, which are a relatively new and rapidly growing risk across the world.

Our purpose in this white paper is to help the industry understand – and adopt – the latest best practice for Li-ion battery fire suppression products.

- Fires caused by rechargeable lithium-ion batteries, used in countless electronic products, are a major and increasing problem all around the world.
- There is growing demand for innovative fire suppression technology and equipment.
- However, manufacturers of such equipment – including new portable fire suppressors/extinguishers – face complexity and challenges.
- There are currently no standards available for fire suppression systems.
- NTA 8133 published by Dutch standards body NEN provides a solution for portable fire extinguishers¹.
- Compliance certification offers an interim solution.
- Compliance certification will give reassurance to fire industry stakeholders, including UK and overseas manufacturers, distributors and purchasers/users.
- BSI can provide compliance testing and certification, securing independent trust for product performance.
- Our progressive approach gives stakeholders safer options 'here and now', while national and European standards are developed.



The problem: lithium-ion fires

Li-ion batteries of one type or another are present in many rechargeable electronic devices, and their use is increasing. Millions of products are powered by them, from electric vehicles, laptops and smartphones to electric toothbrushes, cameras and vaping devices. With Li-ion battery proliferation has come a growing problem: Li-ion battery fires. As rechargeable Li-ion battery technology becomes more prevalent the incidence of fires increases.

Li-ion batteries contain a mix of flammable materials used to store a high energy potential. While they are safe in normal use, batteries can ignite when they are defective or misused, for example when an incompatible charger supplying the wrong voltage is used.



E-bikes and e-scooters

Electric car fires initially captured headlines and more recently electric scooters have come into focus. In 2021, for example, Transport for London (TfL) banned e-scooters and e-bikes on the city's trains, buses and stations following a number of fire incidents².

E-bikes and e-scooters use batteries that are around 50 times larger than those in smartphones, so there is heightened danger when they combust. The risk is compounded by bikes and scooters often being charged overnight in communal areas. This particularly affects young people and gig economy workers, who rely on them as an easy and cost-effective method of transportation for work.

For example, in 2022, the New York City Fire Department (NYCFD) responded to more than 200 e-scooter and e-bike fires, which resulted in six fatalities³. In March 2023, a defective e-scooter battery was believed to have ignited a fire in the Bronx area of New York City that took 200 firefighters to extinguish and injured at least seven people⁴.



One easy solution to this issue could be an increase in awareness and some regulation around e-scooter and e-bike safety. Electrical Safety First have launched a Battery Safety Campaign, in which they are proposing a Bill to address this issue⁵. The National Fire Chiefs Council (NFCC) has also responded, publishing e-bike and e-scooter fire safety advice⁶.

Other uses of Li-ion batteries

There are various other uses of Li-ion batteries, which may not have attracted the same media attention as e-scooters and e-bikes, but also pose a great, if not even greater, fire risk. Intense fires have stemmed from large batteries such as Battery Energy Storage Sites (BESS). Electric vehicle fires can be lengthy and there is often uncertainty over whether the fire risk has truly ended; for example, the flames may have subsided, but the remaining cells are likely to have been compromised by the fire so may be liable to go into thermal runaway, seemingly spontaneously.

Phones and small electrical items also pose a fire risk, particularly when they are charged for long periods unmonitored, typically overnight. As long ago as 2016 Samsung recalled its Galaxy Note 7 globally⁷ – an initial recall of around 2.5 million phones, before ceasing production of the model entirely. In the same year, around 41,000 HP⁸ and 1,700 Sony⁹ computer batteries were also recalled due to the risk of Li-ion battery fires.

London Fire Brigade have shared vital information on how to purchase and use items with Li-ion batteries safely, including a Home Fire Safety Checker (HFSC), which allows users to complete a questionnaire to establish where risks might appear around the home and how these can be mitigated¹⁰.

Lithium-ion batteries have also caused great concern to the waste management industry in recent years, where a surge of fire incidents in bin lorries and waste disposal and recycling centres have all been at least partially attributed to improper disposal of devices containing Li-ion batteries. In the last year, over 1.1bn electricals containing hidden lithium-ion batteries were disposed of in the UK, and there were over 1,200 battery fires in bin lorries and at waste sites – an increase of 71% from 700 in 2022. According to the NFCC, “fires involving lithium-ion batteries are a disaster waiting to happen”¹¹.

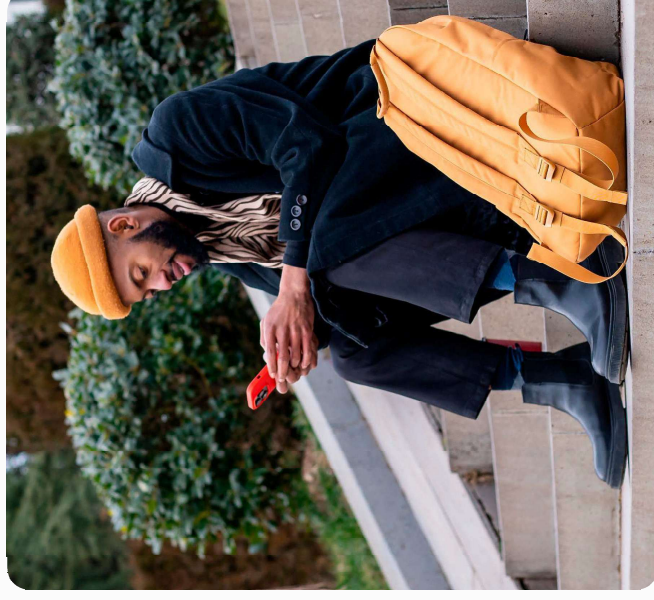
71%

And this is a global problem. Experts agree that we will inevitably see a rise in such incidents alongside the exponential increase in the use of rechargeable batteries all over the world.

Why Li-ion fires are so dangerous

What makes Li-ion battery fires so hazardous is a 'thermal runaway' within cells leading to thermal cascading from one cell to the next. This occurs when heat builds up in the battery faster than can be dissipated, causing the battery to give off gas or even explode. Thermal runaway occurs when the battery is overcharged, overheated or suffers damage such as a puncture.

Fires from these batteries are different to those we are familiar with for wood, plastic and heptane. When they reach thermal runaway, it can be very difficult to stop Li-ion battery fires, and they can burn for hours or even days. Faulty batteries that have potential to go into thermal runaway can be identified from indicators such as swelling, voltage drop and off-gassing, although the exact trajectory of the fire will depend on whether the batteries are in a



“There is a significant risk posed by e-bikes purchased from online marketplaces and batteries sourced on the internet, which may not meet the correct safety standards.

“When these batteries and chargers fail, they do so with ferocity and because the fires develop so rapidly, the situation can quickly become incredibly serious. These items are often stored in communal areas and corridors and can block people’s only means of escape¹².”

Charlie Pugsley
Assistant Commissioner for Fire Safety,
London Fire Brigade

“In lithium fires, it is not a slow burn, it literally explodes. It’s a tremendous volume of fire as soon as it happens, and it’s very difficult to extinguish, so it’s particularly dangerous”¹³.

Laura Kavanagh
Commissioner, New York City Fire Department
(NYCFD)



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cell, pack or battery installation. The construction of larger batteries is for multiple cells in a pack, and it may be very difficult to detect a single cell going into thermal runaway in such a pack.

When these batteries catch fire the release of energy can be sudden and violent. The adjacent cells are likely compromised, and the cycle starts again, thus causing large batteries to burn for long periods. Further issues emerge when efforts to extinguish a fire involve dousing it in water – fire brigades use copious amounts of water to tackle large BESS, carrying chemicals that are damaging to the environment into the water table. In 2020, it took firefighters 59 hours to extinguish a fire at a BESS site in Liverpool, which had been caused by thermal runaway following a lithium battery failure¹⁴.

Thermal cascading, where the thermal event on one battery then compromises the separating layers on adjacent batteries, leads to short circuits, spots where there is high resistance as current surges from the anode to the cathode, and spot heating. As each cell affects the next, there is a domino-style series of explosions. Violent explosions from cells can mechanically compromise other cells leading to the same effect.

There are lots of different battery compositions, which will affect the ferocity of the explosion, and different electrolytes will also contribute. The sudden release of energy can create projectiles which, dangerous in themselves, can also create secondary fires. Batteries once extinguished can reignite, and any remaining cells in the battery packs may still hold energy, compromising the separating layer of the cathode and anode.

Failing batteries also produce an array of nasty chemicals even before they go into full explosion, such as hydrogen fluoride which forms hydrofluoric acid when it meets water such as moisture in the eyes. The failure of the battery can be slow, and the warning signs can vary.

Suppression where the extinguishant can be applied to the battery is the most effective way to stop this type of fire. However, the packaging of these batteries can obscure the application of the extinguishant. An electric vehicle battery, for example, has a whole car surrounding it, and eScooter batteries are sealed to be protected from water.

329

The number of battery fires associated specifically with e-bikes and e-scooters attended by UK Fire and Rescue Services from the beginning of 2022 to May 2023.

(Source: metroSTOR)



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The response: manufacturer innovation

It is clear there is a major new risk facing the fire industry and growing demand for effective countermeasures in the form of new Li-ion fire suppression technology and equipment. As is the case with all fires, prevention is better than suppression; but while technology develops to improve the overall safety of Li-ion batteries so they are less liable to catch fire, it is important to ensure that effective methods are also in place to extinguish these fires as quickly as possible when they do occur.

Manufacturers of fire suppression equipment have responded by developing and launching innovative products, such as new portable fire extinguishers, that will prevent or inhibit thermal runaway and thermal propagation. These emerging devices contain high-performance agents that produce significant cooling or blocking action to interrupt the unstable and potentially hazardous chemical process affecting the battery cells.

National and European standards are in development for this emerging equipment – but manufacturers still need to have their products certified and performance claims validated in the meantime.



BSI compliance certification

As technology in this area has been rapidly developing, BSI has been investigating best practice within the industry. Bolstered by a wealth of experience in fire suppression product testing and certification, we have been gathering information and opinions from experts, both within our electrical laboratory and in the wider industry, and this knowledge has been fed into standard committees to develop much needed test and validation methods.

As a first step to the solution of the issue of Li-ion battery safety, we are offering a Compliance Certificate for the Li-ion fire suppression for portable fire extinguishers.

An interim solution

BSI compliance certification provides independent trust for fire extinguishers. While national and European standards are in development, compliance certification allows manufacturers to validate their product performance claims through independent testing of their devices conducted by an established certified body that specializes in fire suppression products.

Specifically, it provides assurance:

- **To manufacturers** that their claims for new and developing fire suppression technology and equipment are backed up by verified testing.
- **To distributors** of such equipment that they can rely on the manufacturer's claims and therefore that they are stocking safe and effective products.
- **To large purchasers** of fire suppression equipment – from public sector bodies such as fire brigades and local authorities to private sector organizations such as transport and air travel companies – that they are buying safe and effective products.
- **To consumers and end-users** of portable Li-ion fire extinguishers that they can be relied upon and will meet expectations based on their stated claims.



BSI compliance certification demonstrates that specific items meet relevant and repeatable performance requirements, as detailed in the applicant's technical file, in accordance with BSI protocol.

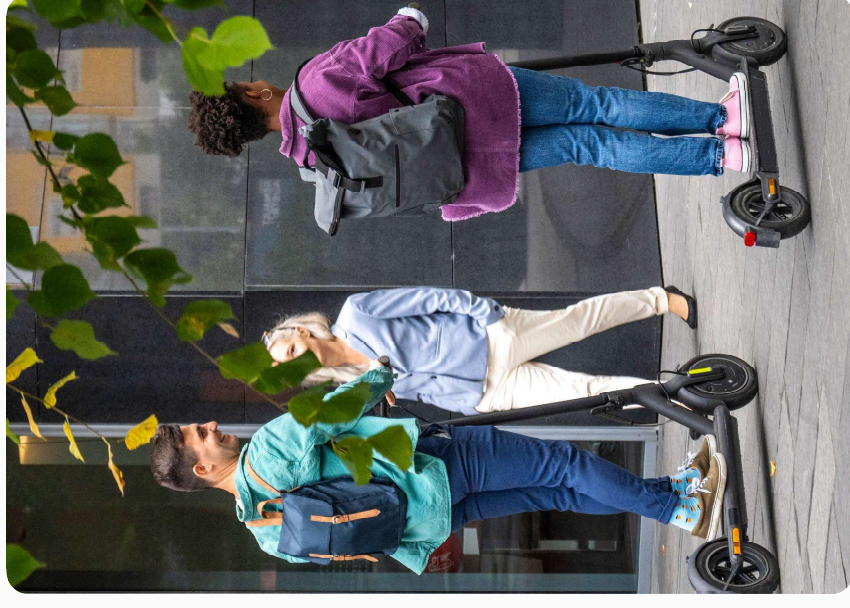
While a BSI Compliance Certificate only verifies the exact product under test, it also offers a useful indication of the validity of claims made for closely related products using the same technology.

BSI Compliance Certificates include witness testing on specific battery configuration, chemistry and capacities, which are then documented on the certificate itself.

A pre-requisite of this compliance certificate is BSI Kitemark™ certification in accordance with EN 3-7, SANS 1910 or AS/NZ 1841. Where the Li-ion performance test is completed before Kitemark certification has been achieved, an acknowledgement of the test outcome may be provided in the interim, until the Kitemark has been awarded and the test report can be issued.

To achieve compliance certification, manufacturers need to:

- Create a technical file detailing the product and demonstrating it meets performance and quality requirements
- Undertake performance testing to defined test requirements in accordance with battery suppression claims (NTA 8133)
- Meet the requirement of regulatory (e.g. PED CE) and performance requirements for the extinguisher (e.g. EN3 Kitemark).

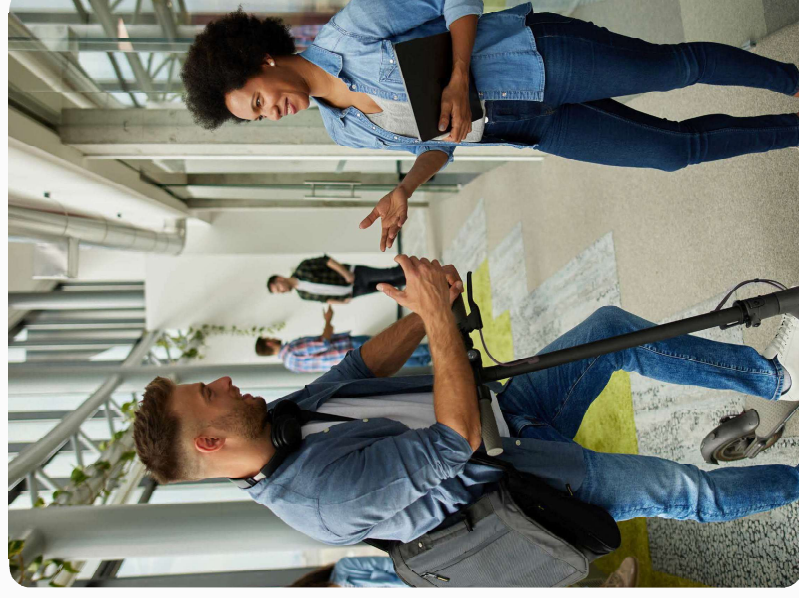


Conclusion

BSI compliance certification offers a robust interim certification option while national and European standards are in development. By providing independent trust for product performance, we are taking a progressive position to enable stakeholders to make safer choices.

Fire industry organizations can achieve a competitive edge by demonstrating compliance with the best practice available today.

For the fire industry, BSI compliance certification for fire extinguishers is just the start of a longer journey. Such devices can demonstrate the effectiveness of innovative fire suppression technology, showing its potential to be developed for other, possibly larger, applications. At BSI, we are determined to continue to support the industry with best practice in terms of product performance assurance for a range of fire suppression products.



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The BSI Kitemark™

Differentiate your fire suppression products with the BSI Kitemark. It demonstrates that your products comply with legislative and regulatory requirements and provides assurance that you have followed due diligence relating to product safety.

- The BSI brand is known, trusted and respected across the global fire sector.

81%

- 81% of Consumers more likely to buy from an organization with the Kitemark.*

78%

- 78% of Senior Business Leaders have more confidence in Kitemarked products and services.*
- The value of independent certification commands confidence globally.

*YouGov, 2024. Sample of 2065 UK Adults.

About BSI

We have been developing world-leading standards for over 100 years and we continue to break new ground.

We work closely with leading manufacturers to ensure their products meet the latest regulations to gain market access. We focus on delivering a testing and certification partnership underpinned by quality, safety, reliability and accuracy aligned to your requirements.

BSI's blend of heritage, expertise, innovation and international reach makes us unique – we are the only organization that can offer such a powerful combination.



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