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SUBJECT	**BATTERY FIRES**

INTRODUCTION

This paper present background information on the potential fire risks associated with li-ion batteries.

The BPE team are seeking feedback from BCTRAG on whether the Building Code adequately manages these risks given the increasing use of li-ion batteries.

WHAT RISKS ARE WE TRYING TO MANAGE

Injuries and death due to li-ion batteries causing fire

LITHIUM- ION BATTERIES

'Lithium–ion batteries' is a collective term used to describe a family of different kinds of batteries with different chemistries. There is no one standard for the chemistry and composition of Li-ion battery packs. Li-ion batteries are rechargeable. They are found everywhere, in a variety of applications:

- *Consumer electronics*: Such as laptops, cell phones, power tools, toys. These can be found as individual items in a household or workplace, or stored in large quantities in warehouses.
- *Larger applications:* Such as electric scooters, bicycles, vehicles, commercial aircraft auxiliary power units, satellites, military applications.
- *Electrical energy storage (ESS) and grid stabilization applications*: In New Zealand, power companies are installing these as back-up systems, as are large institutions such as hospitals and shopping malls (Auckland mall has a solar system in place).

FIRE RISKS ASSOCIATED WITH LI ION BATTERIES

The fires caused by li-ion batteries are intense but burn out quickly. If there are no combustibles nearby, the fire will self-extinguish. In many cases however, the battery will be charging near combustibles causing the fire to spread.

When li-ion battery cell temperature reaches about 150-200°C, thermal runway can occur. The temperature increase causes the pressure inside the cell to build which often results in one or more of the following: heat generation, gas smoke formation, cell breach/cell explosion, fire or gas explosion. The battery can also explode due to high-pressure build-up (caused by poor design), or gas explosion (caused by the release of battery gases in the air, accumulating and igniting). Battery gases contain toxic substances.

There are several ways li-ion batteries can malfunction and create a fire risk:

- *Charging issues:* Repeated over-discharge, charging above 4.2 V, or charging significantly above the manufacturer's high voltage specification (overcharge) can lead to failure of the battery and potential thermal runway reactions.
- *Manufacturer's fault*: The current standards on designing li-ion batteries are conceptual, and not all countries or manufacturers have adopted them. Low cost batteries can fail. There is also a large counterfeit market.
- *Mechanical damage:* When a li-ion battery suffers mechanical damage, it can start a fire. The fire may not occur straight away, and it is impossible to know the history of the li-ion battery, nor is there necessarily any visual indicator that the battery is damaged.

INTERNATIONAL REGULATIONS

The number of international li-ion battery fire incidents is growing as the use li-ion batteries is becoming more widespread. Incidents have occurred involving cell phones, laptops, vaping devices, waste and recycling plants, electric vehicles, ESS, etc.

Lithium-ion batteries are classified as Hazardous Materials by transportation codes, which for most countries, including New Zealand, are harmonized by the United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations.

Performance standards: a few key organizations (UL, IEC, and IEEE) have developed "consensus" standards. UL have developed design standards for storage systems, and various standards for electrical storage system components. Some fire and life safety NFPA standards as well as the International Fire Code have been amended to include sections on energy storage systems.

Lithium-ion battery development in the automotive industry is in a formative stage. There are no standard batteries or approaches for this industry use. There are various performance and test Standards recently issued or in development.

With regards to fire protection for ESS, NFPA has recently issued NFPA 855: *Standard for the Installation of Stationary Energy Storage Systems*.

NEW ZEALAND

The number reported incidents relating to li-ion batteries in New Zealand is increasing annually at a steady rate. This is in line with the increase in global incidents, as the use of li-ion batteries is becoming more prevalent in a wide variety of applications.

At present, Fire and Emergency New Zealand (FENZ) is notified about 2 to 3 incidents per week. Incidents which are either not reported, or possibly not captured appropriately in incident reports are not included in these figures. The incidents occur across the gamut of li-ion battery applications.

FENZ have encountered incidents such as:

- Li-ion batteries being discarded with the regular waste or recycling. When the waste is compacted, it causes mechanical damage and a fire starts. This is also applicable to electrical vehicles being wrecked.
- E-scooters or e-bikes being charged either in warehouse or, as part of a customer incentive, at a residence. There is an issue when too many scooters/bikes are plugged into one outlet.
- E-scooters being charged overnight in a common area in a rest home.
- Home owners wiring with li-ion battery supplied energy as the main energy source for their residences
- Charge from an electrical vehicle being used as the main energy supply to a home.
- Large ESS buildings not equipped with an adequate fire safety system
- Li-ion batteries used to store the energy captured from solar panels. The panels keep charging the battery system and there is no way to isolate the system. Responding firefighters are faced dealing with a live system.

The New Zealand Building Code compliance documents do not provide for the use and application of li-ion batteries:

- Code clause C2 *Prevention of fire occurring* contains performance requirements for fixed appliances which, when operating at design level, must not exceed 90°C. Li-ion batteries do not reach that temperature during normal operations.
- Code clause G9 *Electricity* contains clearer objectives to “ensure the electrical installation has safeguards against outbreak of fire and personal injury”. G9 compliance documents reference the Electrical (Safety) Regulations 2010, where further electrical safety requirements are captured although at present not on li-ion battery safety.

Australia has published joint standard AS/NZS: 5139:2019 *Electrical installations – Safety of battery systems for use with power conversion equipment.* This standard, developed for use by manufacturers and system designers and installers, only applies to the safety and installation of battery systems connected to power conversion equipment for the supply of AC and DC power. This standard is not referenced in the building code compliance documents.

FENZ have commissioned BRANZ to research the risk of lithium-ion batteries "*Lithium Batteries – What's the Problem*", which can be found here:

https://www.fireandemergency.nz/assets/Documents/Files/Report_174_Lithium_Batteries_Whats_the_problem.pdf

The report contains recommendations on how to mitigate the risks:

1. Labeling the li-ion battery cells, including safety information
2. Educating the consumer
3. Requiring building consents for the installation of electrical vehicle charging stations
4. Advising the insurance industry on the risks associated with electrical vehicles being charged in residential garages, and the risk of 'juicing' operations

For discussion:

- **Is there any concern in industry that the risks associated with li-ion batteries are not being regulated adequately?**
- **If there is a view that better regulation is required, what risks/applications should be considered for regulation via the Building Code?**