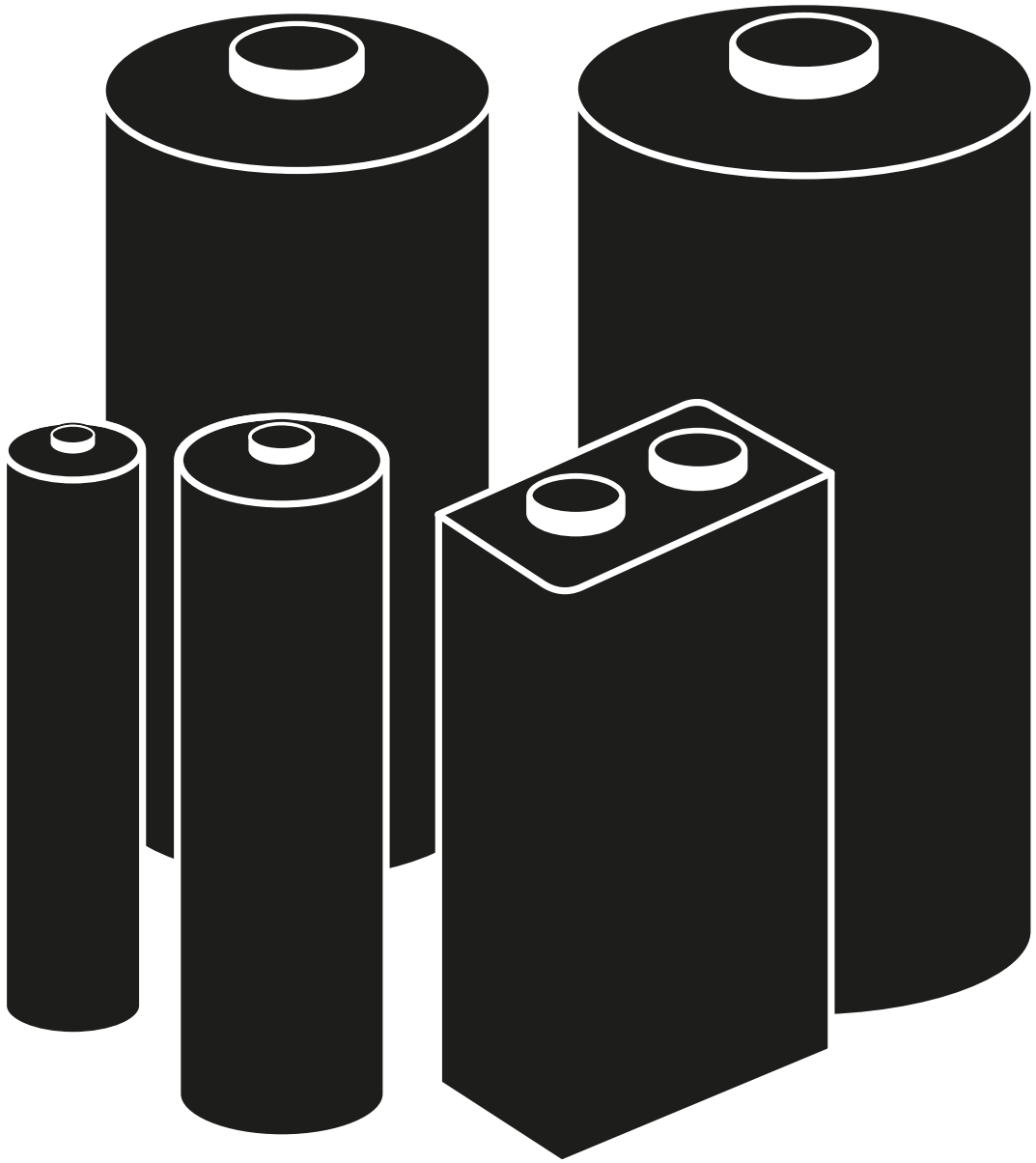
Publication by the German Insurers (GDV e.V.)
on the issue of loss prevention

Lithium Batteries



Summary

To date, we have not got any regulations under public law regarding the storage and provision of lithium batteries.

The present publication informs on how to prevent damage when making lithium batteries available in production and storage areas. Here, we classify the batteries into three categories depending on their lithium content, weight, and power.

You will find the main findings from fire tests regarding storage and provision.

This document does not apply to the collection of used batteries or the recycling of batteries.

Lithium Batteries

Content

1 Introduction

In every field of everyday life we use lithium batteries. Rechargeable lithium-ion storage batteries for mobiles, notebooks, power tools, power garden tools, electric lawnmowers, and e-bikes are quite normal in everyday life and, eventually, the progressing e-mobility in the automotive industry also benefits from this development.

The energy content compared to conventional battery technologies is much higher; this, however can increase the extent of damage in case of fire.

Specific hazards of the lithium battery technology are for instance the auto-ignition and severe fire events accompanied by very rapid fire spread. The risks involved here make especially high demands on fire protection.

Lithium batteries always are hazardous goods as defined in the shipping law. Transportation of them is subject to the applicable regulations for hazardous material.

For the time being, we have not got any regulations under public law regarding the storage and provision of lithium batteries.

It shall be clarified on an individual basis whether an existing extinguishing system is suitable to control a fire of the different battery types or whether the existing fire protection concepts are still suitable in this context.

Fire and extinguishing tests have proven that it is generally possible to use water to control both, a fire of batteries and a fire of equipment holding batteries.

A GDV project group of representatives of the insurance industry, the electrical goods industry, the automotive industry, the logistics and recycling services, as well as the extinguishing systems engineering has worked out and updated this leaflet on loss prevention.

2 Field of application

Storage and provision of lithium batteries in production and storage areas.

Note: The collection of used batteries and the recycling of batteries require separate consideration. These should be agreed with the property insurer on an individual basis:

3 Principles

Lithium batteries are chemical energy stores, which use an electrochemical reaction to supply the stored charge as electric energy. We basically distinguish between two types of batteries:

- primary batteries
  (non-rechargeable batteries)
- secondary batteries
  (rechargeable batteries, accumulators)

The term "lithium battery" is a collective term for the variety of battery systems, which use pure or bound lithium. The following electrochemical performance characteristics make the advantages of lithium batteries (e.g. lithium-ion storage batteries) compared to conventional chemical energy stores (e.g. nickel metal hydride storage batteries):

- high efficiency
- little self-discharge
- no memory effect for the most secondary batteries
- large temperature range
- high cell voltage

4 Potential dangers of lithium batteries

Taking today's manufacturing standards into account, we can assume that lithium batteries can be considered to be relatively safe unless handled improperly.

However, if technical defects or improper handling cause an uncontrolled and accelerated release of the chemically stored energy, this energy is normally of the thermal type and can be the root cause of a fire.

Generally applies: Operation or storage of lithium batteries beyond their specifications can be dangerous. Here, the hazards are especially due to an improper handling. Examples thereof are:

- mechanical damage
  (short circuits inside)
- thermal load
  (short circuits inside, external heating)
- overcharge (heavy increase in temperature caused by the exothermic reaction)

In addition to improper handling, there are hazard sources inherent to the battery cells and systems:

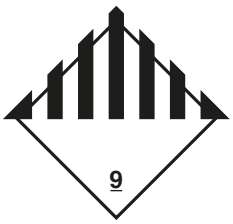
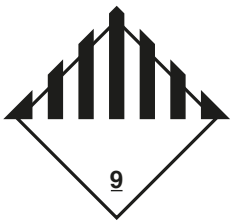
- potential high electric energy (increase in temperature due to electric arcs, short circuits, etc.)
- potential release of toxic and/or combustible or explosive substances during a fire, which can evolve an explosive mixture
- the materials and components used provide for a high fire load
- when subject to heating / thermal runaway, the batteries and battery cells burst suddenly as the safety valve fails

The German Occupational Safety and Health Act (ArbSchG) lays down that a risk assessment shall assess and evaluate the hazards of batteries and technical equipment and devices containing batteries.

5 Actions to prevent loss

The information on loss prevention apply to both, new and used batteries.

The hazard potential of lithium batteries is not only due to the product design but also - to a considerable degree - to the capacity of the modules and the system itself. For the types known so far, a categorisation as follows is obvious:

Capacity	Lithium-metal battery (UN 3090)	Lithium-ion battery (UN 3480)
low	⩽2 g Li per battery  *)	⩽100 Wh per battery  *)
medium	>2g Li per battery and ⩽12 kg gross per battery 	>100 Wh per battery and ⩽12 kg gross per battery 
high	>2g Li per battery and >12 kg gross per battery 	>100 Wh per battery and/or >12 kg gross per battery 

**) Note: Exemplary marking; this is the marking required in air traffic. This is often used in road transport, too; but other markings are possible.*

Lithium batteries of low capacity

These include all one-cell batteries and small batteries, mainly used in computers, multimedia, small electric appliances, and small tools, etc.

Lithium batteries of medium capacity

Batteries of this category are used e.g. for bicycles featuring an accessory electric drive (pedelec, e-bike), e-scooters, Light Electric Vehicles (LEVs), larger garden tools, a variety of light vehicles and so on, but also as cells in batteries of high capacity.

Lithium batteries of high capacity

Batteries of this category are identified by a particular high capacity resulting from the combination and connection of cells of medium capacity to become a system.

Known fields of use are at the moment: e-mobility (automotive industry) and off-grid large-size equipment.

5.1 General safety rules

The following safety rules shall be observed at any time:

- adherence to the specifications of the respective manufacturer and technical product data sheets
- prevention of external short circuits (protection against short circuit of the battery terminals, e.g. by means of caps)
- prevention of internal short circuits (protection against mechanical damage)
- do not expose directly and permanently to high temperatures or heat sources (e.g. direct solar irradiation)
- in any area not protected by an automatic extinguishing system, a structural or spatial separation of min. 2.5 m from other combustible materials shall be provided for
- immediately remove any damaged or defective lithium battery from the storage and production area and store this temporarily with safe distance or in an area separated with fire protection technology until its disposal

Only those cells and batteries shall be stored, for which evidence of the tests acc. to UN38.3 has been furnished (in exceptional cases it is allowed to store prototypes provided that a risk assessment exists).

Among other things the tests cover impact, external short circuit, overcharge, and discharge.

Charging of batteries is subject to the information delivered by the manufacturers and insurers.

5.2 Specific safety rules

Depending on the battery category, the special safety rules below shall be observed:

Lithium batteries of low capacity

To batteries of this category apply the general safety rules (see 5.1); there are no specific safety rules to be observed. To larger storage quantities in one area (volume exceeding 7 m^3 or more than six Euro-pallets) apply the information on lithium batteries of medium capacity.

Lithium batteries of medium capacity

Areas with batteries of medium capacity shall be separated from other areas spatially (min. 5 m) or structurally in a fire-resistant manner. Mixed storage together with other products capable to act as an accelerant should be avoided. The storage area shall be subject to monitoring by an appropriate fire detection and fire alarm system connected to a permanently manned location. If fire extinguishing systems exist, take the information as to suitable extinguishing agents given in the corresponding technical product data sheet into consideration. To larger storage quantities in one area (occupied area > 60 m^2 and/or storage height > 3 m) apply the information on lithium batteries of high capacity.

Lithium batteries of high capacity

At the moment, we do not have any reliable information about adequate safeguards for batteries of high capacity. Therefore, the safeguards shall be agreed upon with the property insurer on an individual basis.

Possible measures are e.g.:

- separation and limitation of quantity
- storage in areas separated in a fire-resistant manner or with safe distances (spatial separation of 5 m)
- automatic extinguishing systems

5.3 Provision in production areas

If lithium batteries are required in the production area, the following requirements shall be met:

- number to be limited to the required minimum (daily requirement)
- appropriate fire extinguishing equipment (e.g. fire extinguishers, wall hydrants) to be provided for in short range

6 Findings from fire tests

Tests carried out by insurers, manufacturers, and fire services showed that rapid and targeted fire-fighting with water can contribute to control the effects of fires under participation of lithium batteries.

The different fire tests revealed that not only the batteries themselves but also their packaging and the equipment design are a fire load with significant influence on the fire development.

If efficient fighting of an initial fire succeeds in the first minutes, there is great chance to get control of the fire. Therefore, sprinkler and water spray systems designed adequately to fit the risk can be effective protection, which is often necessary.

At the moment, we have got reliable test results for special conditions, only; they confirm the effectiveness of sprinkler systems. No proof has been established whether one can do without an automatic extinguishing system in cases where a factory fire service is on the premises. Consequently, this requires separate consideration.

Generally, lithium batteries shall be treated as hazardous material. Effective protection always requires a comprehensive fire protection concept. Thus, in addition to automatic extinguishing systems the marginal conditions regarding structure and organisation shall be considered.

As their is a multitude of different battery types and there is rapid development in this field, it is impossible for the time being to make general statements regarding appropriate concepts.

These are the reasons why an effective protection concept always requires the analysis of the particular case and an agreement with the insurer.

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