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RECOMMENDATIONS FOR THE STORAGE OF LITHIUM-ION BATTERIES

28 August 2026 / Martin Mensch B.A.
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PREAMBLE

It is important to note that items containing lithium-ion batteries are considered dangerous goods when being transported or stored in warehouse buildings and must be treated as such. The relevant literature and the recognised best practices for dangerous goods are not superseded by this document. It goes without saying that legal requirements must also be observed. In addition, it is essential to adhere to occupational health and safety regulations. This document is intended solely for asset protection from the point of view of an owner or insurer of the goods in question and, where applicable, other goods stored in the same building. The document reflects the individual opinions of Battermann & Tillery Global Marine's Surveyors with experience in this field. It is important to note that these statements and recommendations are not intended to be legally binding, nor should they be interpreted as prejudicial to grounds for liability.

The document is intended to provide an overview. It should be noted that more complex issues have been simplified for the purposes of this document. This document should also be understood as a basis or guideline only and cannot possibly cover all types of warehouse storage and all goods. Individual assessments may deviate from the principles outlined in this document, sometimes significantly. For example, a storage location that complies exactly with the recommendations below may still pose a high risk, and conversely, in some cases, less stringent precautions than those outlined below may be entirely sufficient.

1. RISK ANALYSIS

BACKGROUND INFORMATION AND PRESUMPTIONS

The following principles must be understood and observed when storing goods containing lithium-ion batteries:

- This document and, in particular, the recommendations contained herein primarily relate to conventional batteries with a chemical composition based on a lithium cobalt dioxide. Alternative battery technologies are addressed separately below.
- In principle, viewed from the perspective of asset protection, there is no significant difference between lithium-ion batteries themselves as stored goods and items containing lithium-ion batteries.
- As with most other dangerous goods, the spread of fire to the storage areas being used for the storage of lithium-ion batteries or goods containing them should be prevented or at least significantly delayed. Lithium-ion batteries have a massive fire-accelerating effect and, once ignited by the spread of fire, cargo units and areas containing them are difficult to extinguish.

  In this respect, lithium-ion batteries are certainly comparable to flammable dangerous goods, even though items containing lithium-ion batteries may themselves not be readily flammable.
- Unlike almost all other stored goods and most other dangerous goods, lithium-ion batteries can themselves be a source of ignition and therefore a fire can start from the items themselves at any time and in any storage location. The likelihood of such a fire starting increases with the number of cells in a battery and depends on the stresses that are or have been applied to the battery. Accordingly, small lithium-ion batteries are less likely to be the source of fire than large lithium-ion batteries.

  A fire caused by lithium-ion batteries that are not or have not been exposed to particular stresses is very rare. Lithium-ion batteries that are or have been exposed to particular stresses must be considered as posing an increased risk. Manufacturing defects can also cause a fire. Although the state of charge affects the likelihood of a fire occurring, a low state of charge is no guarantee that a fire will not occur.
- When lithium-ion batteries burn, it must always be assumed that the stored energy will be discharged in a "thermal runaway". This is a self-sustaining and self-reinforcing chain reaction that is very difficult to extinguish because all the components required for combustion are present or are formed as part of the reaction. Individual cells in a battery heat up mutually until they, too, go into thermal runaway. Consequently, a fire will spread rapidly to neighbouring cargo units.

Again, the larger the battery and the more stored energy it contains, the faster the fire spreads and the more difficult it is to extinguish. Sometimes the only way to stop an advanced fire of this type is to prevent it from spreading further and to allow the cargo units already on fire to burn in a controlled manner. Therefore, when fighting a fire, the primary focus must be on fighting the fire in its early stages. The state of charge has a significant influence on the intensity of a fire and therefore on the speed at which it spreads and the success of extinguishing it

In summary, the following can be stated:

- Any individual battery can (seemingly) spontaneously start a fire, regardless of its capacity.
- The larger the battery, the greater the risk of such a fire starting.
- The larger the battery, the faster the fire will spread and the more difficult it will be to extinguish.
- The lower the state of charge, the lower the intensity of the fire and the lower the probability of thermal runaway, although this does not reduce the possibility of a fire starting.
- The spread of an (external) fire to items with lithium-ion batteries significantly increases the intensity of the fire.

SUPPLEMENTARY INFORMATION ON POSSIBLE STRESSES

As previously stated, fires caused by lithium-ion batteries typically occur when the batteries themselves or the cargo units containing the batteries are or have been subjected to specific stresses. These may include:

- Mechanical stresses
    - Impacts
    - Compressive and tensile stress

- Thermal stresses
    - Exceeding or falling below the permissible temperatures (according to manufacturer's specifications, usually +10.0°C to +60.0°C)
    - Near-freezing temperatures (+2.0°C or below)
- Electrical and operational stresses
    - Overheating during charging
    - Overcharging and deep discharge
    - Continuous charging

In the event that one or more factors are found to have exerted an influence on the lithium-ion batteries, it is imperative that the battery is immediately classified as being high risk. An elevated risk of fire should be anticipated.

Conversely, if none of these factors are known to have occurred, modern lithium-ion batteries from tested and certified manufacturers will only present an acceptable residual risk of fire. It is imperative to recognise that, given the inherent challenges in ensuring absolute control of such risks, the implementation of extensive safety measures is strongly recommended. In particular, strains resulting from impacts and exposure to temperature extremes are to be expected during routine transport. These factors can and should be mitigated to some extent by measuring indicators, provided that this is considered a reasonable course of action in the context of commercial expediency.

Exposure to the full range of these stresses cannot be ruled out in the context of return transports. It is imperative to note that lithium-ion batteries that have been fully unpacked and operated are to be considered high risk, even in the absence of visible signs of stress.

SUPPLEMENTARY INFORMATION ON FIRES AND EXTINGUISHING AGENTS

A battery has the potential to start a fire in the event of a thermal runaway, and conversely, it can also enter a state of thermal runaway, i.e. ignite, as a consequence of thermal stress induced by the heat from other burning lithium-ion batteries or objects in the immediate vicinity. The process of thermal runaway is characterised by the generation of heat due to a short circuit within the electrolytes of the battery cells.

The initiation of combustion necessitates the presence of four fundamental elements. The absence of one of these will result in the termination of the combustion process.

1. The presence of combustible material within the battery itself (including its housing) and its packaging is a prerequisite for combustion.
2. Oxygen is produced by the chemical reaction of the thermal runaway itself.
3. Heat is generated as a consequence of the chemical reaction.
4. The precise proportion of these elements is typically naturally available.

The efficacy of extinguishing agents is dependent upon the disruption of at least one of these elements. It is very difficult for conventional extinguishing agents (powder, foam and water) to reach the seat of the fire, that is to say, the interior of the battery cells. The displacement of oxygen by carbon dioxide (CO_2) is only temporary, as the CO_2 itself is displaced by newly produced oxygen (O_2). The reaction can only be halted by implementing effective cooling methods or by the complete consumption of the combustible materials by the fire. It can thus be concluded that laypersons using simple extinguishing methods can only extinguish a lithium-ion battery fire in the incipient stage.

SUPPLEMENTARY INFORMATION ON STATE OF CHARGE

According to FM Global Data Sheet 7-112, October 2024, the consequences of a fire are significantly reduced when batteries are stored at a low state of charge. The fire-promoting effect during an external fire or a fire involving neighbouring cells is considerably lower. In addition, studies indicate that, at a state of charge of 30% or less, the likelihood of thermal runaway is substantially reduced, thereby also reducing the probability of a fire occurring.

For this reason, the state of charge is regarded as a key parameter when assessing risk and determining the necessary protective measures. Wherever reasonably possible, batteries should be stored at a state of charge of 30% or less. Where this is not feasible, enhanced safety precautions are recommended.

SUPPLEMENTARY INFORMATION ON LITHIUM PHOSPHATE BATTERIES AND OTHER ALTERNATIVE BATTERIES

For alternative battery technologies, particularly lithium iron phosphate batteries and sodium-ion batteries, it should be assumed that spontaneous ignition turning into a fire remains possible at any time, although the likelihood of such an event is generally lower than for conventional batteries. However, any resulting fire is generally expected to be less intense, and the occurrence of thermal runaway is considered unlikely or, in some cases, nearly impossible. Accordingly, the recommendations set out in this document are generally applicable to the storage of alternative battery technologies as well. Nevertheless, a greater degree of flexibility may be permitted when considering deviations from, or alternatives to, the recommendations provided.

2. RISK GROUPS

Every battery can act as an independent ignition source and may also significantly accelerate fire development. However, as outlined above, the associated risk depends not only on battery size and energy content, but also on state of charge and possible prior damage.

In the following, the general categorisation as defined in the VdS (VdS Schadenverhütung GmbH) data sheet 3103:2019-06 (03) is applied and expanded by additional risk groups to account for the state of charge and batteries with suspected damage.

Group	Description	Performance data
1	New lithium-ion batteries of low power and without any presumption of damage and with a low state of charge, as used in small electronic devices such as smartphones	≤100 Wh per battery, ≤30% state of charge

2	New lithium-ion batteries of low power and without any presumption of damage and with a high state of charge, as used in small electronic devices such as smartphones	≤100 Wh per battery, >30% state of charge
3	New lithium-ion batteries of medium power and without any presumption of damage and with a low state of charge, as used in battery-powered garden tools, e-bikes or larger power banks.	>100 Wh per battery but ≤12.00 kg per battery, ≤30% state of charge
4	New lithium-ion batteries of medium power and without any presumption of damage and with a high state of charge, as used in battery-powered garden tools, e-bikes or larger power banks.	>100 Wh per battery but ≤12.00 kg per battery, >30% state of charge
5	New lithium-ion batteries of high power and without any presumption of damage and with a low state of charge, as used in large appliances	>100 Wh and >12.00 kg per battery, ≤30% state of charge
6	New lithium-ion batteries of high power and without any presumption of damage and with a high state of charge, as used in large appliances	>100 Wh and >12.00 kg per battery, >30% state of charge
7	Lithium-ion batteries of any size with suspected damage resulting from transport-related incidents or from return transports following unpacking and (possible) use by end customers until inspection by a qualified person.	Size and state of charge irrelevant

Below is a summary of the above table:

Group	Brief description	Criteria
1	Low power, low charge	≤100 Wh, ≤30%
2	Low power, high charge	≤100 Wh, >30%
3	Medium power, low charge	>100 Wh, ≤12 kg, ≤30%
4	Medium power, high charge	>100 Wh, ≤12 kg, >30%
5	High power, low charge	>100 Wh, >12 kg, ≤30%
6	High power, high charge	>100 Wh, >12 kg, >30%
7	Damaged / suspected to be damaged	Any size

3. RECOMMENDATIONS

The following recommendations are applicable to warehouse operating companies which store lithium-ion batteries in their buildings, irrespective of their risk group. The recommendations are divided into two categories: basic recommendations, which should be observed as a minimum requirement, and extended recommendations, which have been shown to significantly reduce the risk, in particular that of a total loss of entire warehouses or buildings.

It is imperative to note that adherence to the minimum requirements does not absolve entities from their obligation to give due consideration to the extended recommendations. Extended recommendations are to be assessed on an individual basis, considering the specific risks present in each location. In general, particularly in the context of mixed storage of lithium-ion batteries and other goods within the same building, the objective should be to minimise the risk.

It is imperative to consider that owners of goods other than lithium-ion batteries should be afforded special protection, as their goods are already exposed to an elevated risk due to the presence of lithium-ion batteries, for which they are not responsible. Comprehensive, extended measures have been shown to help mitigate this risk and improve acceptance among owners of other goods at increased risk. In principle, it is therefore advisable to use separate rooms or peripheral areas of a warehouse section for the storage of lithium-ion batteries in cases of mixed storage.

Where individual basic recommendations cannot be implemented, or can only be implemented with disproportionate effort, alternative measures may be adopted in consultation with suitably qualified specialists. Such alternatives may, for example, be selected from the extended recommendations contained within this document.

The authors of this document have based their recommendations on VdS data sheet 3103:2019-06 (03) and FM Global data sheet 7-112, published in October 2024, but have modified and extended them to reflect their own experience.

3.1 BASIC RECOMMENDATIONS

Recommendation by risk group (Power & state of charge)	Low		Medium		High		Return
	<30%	>30%	<30%	>30%	<30%	>30%	
	1	2	3	4	5	6	7
G01: Manufacturer's testing in accordance with UN 38.3	X	X	X	X	X	X	(X)
G02: Distance / "fire breaks"	X	X	X	X	X	X	(X)
G03: Incoming goods inspection	X	X	X	X	X	X	(X)
G04: Automatic fire detection using heat or smoke detectors	X	X	X	X	(X)	(X)	(X)
G05: Automatic fire extinguishing systems (min.		(X)	(X)	X	X	X	-

Recommendation by risk group (Power & state of charge)	Low		Medium		High		Return
	<30%	>30%	<30%	>30%	<30%	>30%	
	1	2	3	4	5	6	7
ESFR ceiling sprinkler)							
G06: Concept regarding removal from storage			X	X	X	X	-
G07a: In-rack sprinklers OR separate storage area			X	(X)	-	-	-
G07b: In-rack sprinklers AND separate storage area			-	X	-	-	
G08: Enhanced incoming goods inspection				(X)	X	X	-
G09: Separate block storage only					X	X	-
G10: Automatic fire detection by smoke detectors					X	X	(X)
G11: Fire service access routes					X	X	-
G12: Further consultation, tailor-made solutions						X	
G13: Storage outside the building at a distance from the building							X

G01: Manufacturer's testing in accordance with UN 38.3

Both the manufacturer and the battery model stored should be certified according to UN 38.3. The corresponding test certificate should be made available.

G02: Distance / "fire breaks"

As all lithium-ion batteries have a significant fire-accelerating effect, measures should be implemented to prevent the spread of an external fire to storage areas or shelves with stored lithium-ion batteries, either by preventing such a spread entirely or by delaying it for as long as possible. Outside of the immediate working hours, sufficient distances from all potential sources of ignition should always be maintained. Potential sources of ignition may include electrical distribution boxes, motors, heating and ventilation systems, and workstations with electrical appliances, unless the workstation has been disconnected from the power supply. The placement of cargo units or other fire loads that form a temporary or even a permanent "bridge" between sources of ignition and storage areas should be avoided.

During working hours, and under the direct supervision of employees, these measures may be relaxed if this is necessary to allow normal business operations.

G03: Incoming goods inspection

It is imperative that all cargo units containing either lithium-ion batteries or items with lithium-ion batteries undergo a detailed inspection to ascertain the presence of any externally visible damage. The standard incoming goods inspections, which take place while warehouse personnel are operating a warehouse handling truck, do not constitute the thorough inspection of the packing units required in this context. In particular, signs of heat or smoke, wetting and any indicators of the package having been dropped or subjected to significant impact should be recognised reliably.

In the event of such anomalies or indications of serious transport-related incidents, the cargo unit must be removed immediately from the building and from the vicinity of the building and delivery vehicles. Until further notice, such cargo units must be assigned to risk group 7. They can then be unpacked and, if necessary, sorted in a safe environment.
The following table can be used as a guideline for action:

DAMAGE LEVEL	COURSE OF ACTION
Level I damage - minor damage to master packaging - torn cardboard, damage to poly film (no tangible signs of fire: no fire, no sparks, no smoke or specific odour, no increase in temperature detected by the employee, no sooty packaging).	No change of the risk group A report will be issued to the customer, and the goods will be monitored and held in the warehouse for the time being.
Level II damage - crushed cartons, bulging cartons (change in the shape of the load on the pallet), loss of pallet stability, damage resulting from mechanical impacts both during transport and in the storage facility (no tangible signs of fire: no fire, no sparks, no smoke or specific odour, no increase in temperature detected by the employee, no sooty packaging).	Change to risk group 7 Storage inside the warehouse is refused, and the goods are stored in a container or shed outside the warehouse at a safe distance. If, upon closer inspection, there is no evidence of particular stress on the battery cells, the battery can be returned to its original group for storage.
Level III damage - pallet fire (any of the following signs of fire observed: fire, smoke, sudden increase in temperature, smoke and specific odour, traces of sooty packaging)	The fire service must be informed immediately. The driver of the carrying truck/trailer will then be instructed to remove the vehicle from the building. The burning package must be removed from the building as quickly as possible, if possible using a special sheet that can be placed over the package in order to contain the incident. Firefighting operations should only be carried out in parallel with these measures and must not delay them.

G04: Automatic fire detection using heat or smoke detectors

The warehouse must be equipped with a fire detection system that reports a fire directly to a permanently staffed alarm receiving centre. Fire detection can be provided by smoke detectors, heat detectors or the alarm valve stations of a sprinkler system. Faster detection methods are available, and their implementation is suggested as an extended recommendation. It is vital to ensure that the arrival of the fire service is guaranteed within 15 minutes of the first alarm, and measures must be taken to reduce the alarm and response time as much as possible. Relaying the alarms directly to the fire service is clearly preferable. Under no circumstances should internal processes delay notifying the fire service by more than 3 minutes. If a response time of 15 minutes is not deemed sufficiently reliable, the use of ESFR ceiling sprinklers is necessary. Even if ESFR ceiling sprinklers are already installed, this recommendation should still be followed as far as possible, as only a rapid response by the fire service can reliably limit damage to goods and ultimately extinguish the fire. If a fire has not been extinguished after well over 20 minutes or has only been prevented from spreading by a sprinkler system, it is questionable whether it can be extinguished within the following few hours.

G05: Automatic extinguishing system (min. ESFR ceiling sprinklers)

In light of the potential for rapid fire spread and challenging extinguishing conditions, particularly in scenarios involving a substantial number of medium or high-capacity lithium-ion batteries, the installation of an automatic fire-fighting system, such as an ESFR sprinkler system, is strongly recommended. This system is able to prevent or at least delay the spread of the fire and assist the fire service's extinguishing efforts. Other types of extinguishing systems are also conceivable. In any case, the relevant specifications for extinguishing systems, in particular installing the right size for the calculated fire load, must be observed.

For batteries of low power, and for batteries of medium power with a state of charge of 30% or less, automatic extinguishing systems may, particularly where only limited quantities are stored, be replaced by other suitable protective measures (for example from the extended recommendations) in consultation with qualified specialists.

G06: Concepts for removal from storage

A concept should be drawn up for removing the lithium-ion batteries from storage in the event of early detection of a developing fire or thermal runaway. These units should be moved to a safe area outside the building as quickly as possible, if this is still feasible without risk. All necessary measures must be taken to ensure this, both in terms of availability of materials and staff training. Ideally, a warehouse handling truck with an enclosed cabin, which can still be operated even if the cargo unit is smouldering slightly, should be available for this purpose. Additionally, cargo units can be covered with fire-retardant blankets. In the event of a battery fire, immediate removal of the cargo unit from the building is preferable to extinguishing the fire with hand-held extinguishers, unless both can be effected at the same time. In all cases, it is imperative that the access routes are kept clear and unobstructed. The storage position on the racking should also be easily accessible. If a cargo unit is left in the building, major damage to the stored goods will almost certainly be caused by fire smoke. Similarly, if a cargo unit is left on a pallet rack, there is a risk of loss of the respective row of racks or even the total loss of the fire compartment or building.

If feasible, the involvement of the fire services in the development of the concept is recommended. As the fire services may only be able to prevent a fire from spreading and contain it, but not extinguish it completely, it would be advisable to proactively instruct the fire services in the use of available equipment such as warehouse handling trucks. It is important to note that a (naturally) delayed reaction by the fire services does not replace the (immediate) reaction of the company's own employees, when a reaction by the employees themselves is still possible without risk.

G07a: In-rack sprinklers OR separate storage area

In instances where items with medium-capacity lithium-ion batteries with a state of charge of 30% or less are stored in pallet racks or comparable storage configurations, it is imperative that these storage areas, in the form of the respective double row of racks, are used exclusively for such items. Other items should be separated by a distance of at least the width of a regular aisle (not a narrow aisle) over the entire height of the warehouse.

A minimum distance of 3.00 m can be used as a guideline. If the storage of a mixture of different goods is desired (mixed storage), in-rack sprinklers should be used in addition to ESFR ceiling sprinklers, or equivalent measures.

To avoid mixed storage, a distance of 3.00 m can also be applied within a row of racks by leaving rack compartments empty. These compartments would then have to be blocked off on all rack levels to make it permanently impossible to store any goods there.

G07b: In-rack sprinklers AND separate storage area

In instances where items with medium-power lithium-ion batteries with a state of charge of more than 30% are stored in pallet racks or comparable storage configurations, both in-rack sprinklers AND distance in accordance with Recommendation G07a are recommended.

G08: Enhanced incoming goods inspection

While it is recommended that items containing small and medium-capacity lithium-ion batteries be unpacked, this is not a feasible option in practice. However, it is highly recommended for high-capacity lithium-ion batteries. Each cell must be meticulously inspected for damage and other abnormalities. The use of a checklist can be helpful in these instances. In addition, it is recommended that the previous transport history and the stresses that have occurred be monitored using sensors (shock indicators, temperature indicators) per transport unit (truck/trailer, container) and that the measured results be evaluated before the goods are brought into the storage area. If it is not possible to check the battery cells, for example because unpacking the goods is not permitted, the use of suitable sensors (impact indicators, temperature indicators) per packing unit (crate, pallet, load carrier) is recommended.

For medium-power batteries with a state of charge exceeding 30%, monitoring of the transport route prior to storage is likewise recommended on a per transport unit basis (e.g. truck, trailer or container). Appropriate monitoring devices, such as shock indicators and temperature recorders, should accompany the shipment.

G09: Separate block storage only

Pallet racks are not an appropriate storage location for high-capacity lithium-ion batteries. It is recommended that separate block storage areas be created for items containing such lithium-ion batteries. The block storage area must be separated from all other fire loads – including other goods – by a distance of 5.00 m.

It is imperative that an external fire cannot spread to these areas and that the spread of a fire from these storage areas to other areas is significantly delayed. Each cargo unit must be positioned so that it can be easily reached by a warehouse handling truck without first having to remove other cargo units. For this reason, stacking of cargo units is only permissible if and to the extent that the warehouse handling trucks are able to move entire stacks at once.

G10: Automatic fire detection using smoke detectors

In light of how quickly a fire can start and spread, conventional fire detection methods based on heat detectors or sprinkler system alarm valve stations are no longer adequate. It is therefore recommended that faster fire detection be achieved through the use of smoke detectors in order to speed up all response options and to increase the likelihood of removing the affected goods from the warehouse building.

G11: Fire service access routes

A clearly defined, marked and unobstructed access route for the fire service must be provided for all floor block storage areas from a marked building entrance to the storage area. Ideally, the access route should be 5.00 m wide, but at the very least 3.00 m. Ideally, ground-level access gates to warehouse sections should be used as building entrances, as these can also be used to remove goods from the building. The access routes should have as few bends and restrictions as structurally possible.

To facilitate orientation in the presence of smoke, it is advisable to mark access routes with floor markings. It is essential that all floor block storage areas, access routes and defined building entry points are clearly indicated/marked on fire service site layout plans and similar documentation.

G12: Further consultation, tailor-made solutions

For high-power batteries with a state of charge exceeding 30 %, further consultation with insurers and/or the authorities is mandatory. Individual solutions may be necessary that go beyond the scope of this document. The extended recommendations may provide initial impetus for enhanced risk management in this regard.

G13: Storage outside the building at a distance from the building

Conventional warehouse buildings are not considered suitable storage locations for batteries assigned to Risk Group 7, namely returned batteries, batteries with actual or suspected damage, and batteries that have probably or demonstrably been subjected to elevated stresses during transport or use.

Regardless of their capacity and state of charge, they pose an increased risk of fire. It is therefore recommended that a separate storage location outside the warehouse be provided at a safe distance from the building. This location can be used to store lithium-ion batteries returned, as well as lithium-ion batteries damaged in storage. It is important to consider the possibility of large-scale returns of lithium-ion batteries following the occurrence of a road traffic incident. The storage location must be capable of accommodating all items containing lithium-ion batteries from such deliveries.

3.2 EXTENDED RECOMMENDATIONS

E01: Separation into fire compartments or buildings

Particularly due to the risk of significant damage to goods from smoke even in the case of small fires, it is recommended that as many fire compartments as possible be created in the building. It is also advisable to store items with lithium-ion batteries in their own fire compartments or, at the very least, to opt for smaller fire compartments, thus ensuring that as few items as possible are present in the affected area in the event of a fire. If feasible, high-value or particularly sensitive goods should, as a rule, not be stored in the same fire compartment as hazardous goods.

These considerations ought to be addressed in the design of all new buildings. This recommendation is defined as an extended recommendation because implementing it in existing buildings is unrealistic.

E02: Special containers with self-contained fire detection systems

Storage in special storage units made of fire-resistant material can significantly delay the spread of a fire. However, it is essential to ensure that these storage units have their own fire detection systems, as otherwise both the spread of the fire and its detection will be delayed.

E03: Measures for faster fire detection

As outlined in other recommendations, the most effective approach to avoid significant damage is to detect fires promptly, ideally in their incipient stage. The installation of enhanced detection options such as aspirating smoke detectors in the warehouse sections, optical heat detection directly on the cargo unit or additional smoke detectors in the immediate vicinity is therefore deemed highly advantageous.

E04: Measures to support the fire service

Any measures that make the fire service's response faster and more effective are particularly important when storing items with lithium-ion batteries, since the transition from an incipient fire to a full-blown fire entails drastic differences in risk and the expected extent of damage. Measures that improve the response include the following: detailed and clear layout plans posted in numerous locations, quick access to the premises, buildings and any equipment available, a logical and clear layout of buildings and racks, clearly marked access routes and storage spaces, and efficient concepts and (if necessary, active) systems for smoke extraction.

E05: Proactive use of fire-retardant blankets

Fire-retardant blankets are advertised on the market and intended to be placed over affected packages in the event of a fire. Their use can facilitate the removal of affected goods from storage areas and is already addressed in the basic recommendations. However, proactive use of such blankets on stored packages may also help significantly delay the spread of fire and thereby support additional protective measures.

E06: Oxygen reduction or CO_2 extinguishing systems

Reducing the oxygen concentration available to a fire by suitable means can help delay or even prevent the spread of fire. Although such measures are unlikely to extinguish a fire completely, they can considerably simplify other response measures, including cooling operations and the removal of affected goods from storage areas.

E07: Redundant measures

To reduce the individual risk, it is possible to implement redundant systems. Specifically, the use of multiple automatic fire detection methods is strongly advised.

E08: Individual basic recommendations for items in a high-risk group

To reduce the risk in specific cases, the implementation of a number of the above measures can be considered for items in a higher-risk group.

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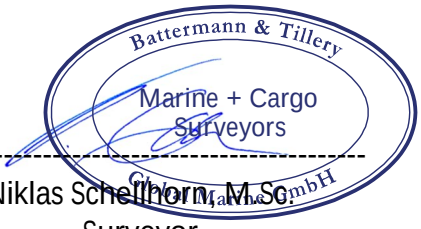

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