Shipping battery energy storage systems - high energy, high risks?

In the past few months, Gard has received several queries on the safe carriage of battery energy storage systems (BESS) on ships. In this insight, we highlight some of the key risks, regulatory requirements, and recommendations for shipping such cargo.

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According to the International Energy Agency, *energy storage systems* (ESS) will play a key role in the transition to clean energy. Sometimes referred to as "energy storage cabinets" or "megapacks", ESS consist of groups of devices that are assembled together as one unit and that can store large amounts of energy.

Battery energy storage systems (BESS) are the most common type of ESS where batteries are pre-assembled into several modules. BESS come in various sizes depending on their application and their usage is expected to rise considerably in coming years. Although different kinds of batteries can be used in BESS, lithium-ion batteries seem to be the most popular. Our focus in this article is therefore on energy storage systems equipped with lithium-ion batteries.

Declaration of BESS

BESS with lithium-ion batteries is classed as a dangerous cargo, subject to the provisions of the IMDG Code. In the IMDG Code, there are multiple descriptions and shipping names for lithium cells and batteries, depending on their chemistry and whether they are stand-alone, within equipment, contained within vehicles or cargo transport units. This has caused some confusion among shippers about how to correctly declare this cargo. We have come across instances where a BESS is declared as either:

- UN 3480 (Lithium-ion batteries), or
- UN 3481 (Lithium-ion batteries contained in equipment or lithium-ion batteries packed with equipment), or
- UN 3536 (Lithium batteries installed in cargo transport unit).

Carriers should also be aware of the applicability of the different special provisions (SP) of the IMDG Code. SP 389 (which mentions the securing of batteries to the interior structure of the cargo transport unit) is applicable only to UN 3536. Similarly, a lot of other SPs which are applicable to UN 3480 and UN 3481 do not apply to UN 3536. There are some changes proposed to UN 3536. For more details on this, see below in the section 'stowage and securing'.

Fire and explosion risks

Potential fire and explosion hazards of Lithium-ion batteries have become a "hot topic" in the shipping industry, as detailed in this recent Gard article. As a precautionary measure, owners should therefore enquire about the state of charge (SoC) of the BESS before accepting shipment. The SoC has a direct influence on the likelihood of thermal runaway fire, and also on the growth and peak heat release rate. This has been highlighted by several industry bodies and regulators, such as EMSA's Guidance on the carriage of AFVs, and AMSA's guidance on risks associated with the carriage of battery electric vehicles. A minimal SoC is therefore recommended during transportation.

Although most BESS have an inbuilt battery management and cooling system, thermal runaway events can occur. Should such an event happen, most units are designed to vent from the top. If the BESS is stowed in a hold, the hold space may then be filled with a significant amount of toxic vapour, a build-up of which could lead to a vapour cloud explosion. Venting the space could be difficult, and given the volatility and toxicity of the gases, due regard needs to be given to avoid igniting the vapour cloud. Containment is recommended as far as possible and calling in an expert to advise. Certain units may be equipped with safety systems that could allow the crew or someone ashore to monitor the units and be alerted *before* a dangerous situation develops. Crew should be made aware of the toxicity of the vapours released and care should be taken to ensure that the gases do not enter areas where crew members are present.

There have been instances on shore where BESS have had a thermal runaway incident and subsequent explosion, like the 2019 incident in Arizona. In an attempt to deal with such fires, the container doors have been opened to gain access, which has resulted in explosions and in some cases significant injuries. Some BESS with inbuilt detection systems will activate an auto-release firefighting agent. However, a challenge with such systems is how they can be connected to the ship's system so that the crew will know which container is of concern.

A combination of measures may be required to contain or bring a lithium-ion battery fire under control. These include improved automatic fire detection alarm systems, CCTV and thermal imaging equipment for cargo spaces to enable earlier detection, appropriate and upgraded personal protective equipment (PPE), and provisions for the use of copious amounts of water.

Lithium-ion batteries may also continue to generate a lot of heat after the fire has been extinguished and are at risk of re-ignition. A decision to fight the fire manually should only be made when it is deemed safe for the crew. Owners are advised to assess the suitability of existing fire detection and firefighting equipment onboard their vessels for lithium-ion battery fires. Crew should also receive training in how to respond to lithium-ion battery fires.

Stowage and securing

For bulk carriers and general cargo vessels carrying BESS, consideration will have to be given to the following areas:

- *Securing arrangement and cargo spaces:* If the vessel does not have sufficient securing arrangements, they will need to be fabricated in the presence of expert supervision and all such modifications would require the Administration's approval.
- *Structural strength of the tank top and hatches:* The structural strength of the tank top, as well as the hatch covers needs to be verified.
- *Cargo securing manual (CSM):* It should be verified if the CSM incorporates carriage of such cargoes. Amendments may also be required in some cases covering the lashing arrangements and stowage of such units, which must be approved by the Administration.
- *Approvals:* Approvals from the vessel's Classification Society and Flag State may also be required. Owners are advised to contact their Classification Societies and Flag States early to better understand the various requirements and approval process.

Owners will need to take a risk-based approach in deciding where to stow the units. Some of the factors to consider are:

- The level of protection to withstand the weather, when stowed on deck.
- Other types of cargoes stowed in the vicinity, which could act as a potential source of fire or could be reactive as a result of an unstable BESS and further complicate emergency response.
- Availability of fire detection and firefighting equipment.
- The need to vent the space (see more details below in 'Fire and explosion risks' section).
- Proximity to areas such as crew accommodation, working areas, machinery space, lifesaving appliances, and fuel tanks.

In July 2023, one of the member states made a submission to the IMO sharing the results of its simulation of an explosion of a BESS unit onboard, and recommended amendments to the IMDG Code. Suggested amendments primarily cover three areas: improved stowage, increasing ventilation capacity of holds, and assessment of vessel's stability due to free surface effect in the

holds if a large amount of water is used for firefighting. Since then, certain amendments to UN 3536 have been agreed and these have been included in the draft 42-24 amendment of the IMDG Code which is likely to be adopted at MSC 108 (Maritime Safety Committee) in 2024. The relevant amendments are:

- Stowage category changed from 'A' (on deck or under deck) to 'D' (on deck).
- Stowage codes 'SW1' (Protected from sources of heat) and 'SW2' (Clear of living quarters) will be applicable to such shipments.

Owners can consider adopting these proposed amendments as part of their risk-based stowage approach.

For more details on safe carriage of containers on bulk carriers, please refer to this article.

Tilting and vibrations

BESS units may also have a limitation on how much they can be tilted from the vertical during loading/unloading and transportation. The safety of its components may be compromised if the units are tilted beyond the limits. These limits will be defined by the manufacturer. If no information is supplied to the carrier at the time of shipment, the shipper should provide clarification on this. The vessel's movement at sea should also be factored in when accepting cargo units where the tilting angle limitations are marginal.

Heavy vibrations and rough handling of the BESS units can cause damage to the batteries and various other associated fittings. If the crew notice that the cargo is not handled properly during loading or if it makes heavy contact with the cargo hold structure, further checks should be carried out before accepting a BESS unit for carriage onboard. Carrying a damaged unit could potentially increase the risk of thermal runaway.

Owners should also keep in mind that when smaller BESS units are being carried inside containers, they should request the shipper to provide evidence showing that the BESS units are suitably lashed.

Varying quality of information in safety data sheets

Information contained in the safety data sheets (SDS) and additional guidance by shippers and manufacturers are vital to better understand the overall risks associated with transporting BESS at sea. In our experience, the quality and depth of information can vary depending on the manufacturer and the shipper.

As an example, for one of the shipments the owner was provided with detailed documentation on various aspects of BESS, including lifting, securing, and firefighting, whereas for another shipment a very generic SDS was provided with no cargo-specific guidance. Where owners feel that sufficient details have not been provided by the shipper, they should request for such to be made available.

Another point to note is that since BESS units are primarily built to function on land, the guidance contained in SDS, and other documents provided, may not be applicable to sea transportation. As such, owners are advised to seek additional guidance from shippers on this.

Recommendations

- Ensure cargo is loaded in accordance with IMO statutory requirements, the vessel's CSM, CSS Code, and IMDG Code.

- Vessel's Classification Society and/or the Flag State should be contacted for necessary approvals.
- Owners are advised to request the charterers and shippers to provide information on special handling instructions, state of charge, type of batteries, in-built safeties, and clear guidance on emergency response.
- It is recommended to adopt a risk-based approach when deciding on the stowage location of BESS, wherein consideration can also be given to the draft amendments to the IMDG Code (42-24).
- The vessel may need to be equipped with additional fire safety equipment to detect and respond to fire and explosion. Owners and Managers are also advised to provide the crew with cargo-specific guidance and training on emergency response.

Readers are advised that there is currently limited knowledge on maritime transportation risks associated with the carriage of BESS. Once more information becomes known, we will seek to update this insight. Finally, we should also add that the market for lithium-ion batteries is continuously expanding and the way in which they are used is evolving at the same time. As a result, the risk landscape for such products is also changing, and at a faster rate than regulatory controls can be put in place in the IMDG Code, thereby requiring a greater degree of due diligence from owners and managers of vessels carrying such cargoes.

Useful links

- Lithium-ion battery fires – industry guidance and conference address risks
- Carriage of containers on bulk carriers
- The risk of EV battery fires should not be downplayed
- CINS guidelines for Lithium-ion batteries in containers

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