Guidelines for Classification and Construction

Part 1 Seagoing Ships

GUIDELINES FOR ELECTRIC VEHICLE CARRIER

Volume 14

2024 Edition

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Part 1 Seagoing Ships

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Volume 14

2024 Edition

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The following Guidelines come into force on 1st September 2024.

Foreword

This Guidelines is a 2024 edition of Guidelines for Electric Vehicle Carrier Part. 1 – Seagoing Ship, Volume 14.

This 2024 edition is a new publication developed by incorporates insights from the European Maritime Safety Agency (EMSA) document titled Guidance for the safe carriage of alternative fuel vehicles (AFV) in ro-ro spaces of cargo and passengers ships, dated 23 May 2022. Additionally, it draws upon research on Electric Vehicle (EV) carriers as well as internal advancement.

This Guidelines consist of three Sections and one Annex as follows:

Section 1 — General Requirements

Section 2 — Requirements for Fire Safety

Section 3 — Survey and Maintenance of Class

Annex A — Recommendation for determination of distance between EVs

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Further queries or comments concerning this Rules are welcomed through communication to BKI Head Office.

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Section 1 General Requirements

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A. General

1. Scope and application

1.1 This Guidelines for the Electric Vehicle carrier applies to new and existing ro-ro ships and pure car carrier (PCC) for the carriage of electric vehicles referred to as EV (both battery electric vehicle or hybrid electric vehicle) classed by BKI.

1.2 These Guidelines contain design recommendations as well as operational guidelines and procedures intended for owners/ operators and ship's personnel.

2. Definition and Abbreviation

For the purpose of these Guidelines the following definition and abbreviation are applied.

Table 1.1: Definition

Item	Description
Electric vehicle	Vehicle powered by motors whose source of energy is electricity. This includes not only Battery Electric Vehicle (BEV) (i.e. vehicles powered solely by rechargeable batteries), but also Hybrid Electric Vehicles (HEV) and plug-in Hybrid Electric Vehicles (PHEV)(i.e. vehicles powered by a combination of rechargeable batteries and gasoline).
Battery module	of battery cells that are connected together including electronic control
Battery pack	any sets of modules including complete BMS and can be used as a standalone unit
Battery system	complete battery installation including battery modules, battery management system, monitoring and sensing, electrical interconnections, and other safety features
Battery management system (BMS)	an electronic system associated with a battery pack which controls, monitors and manages the state of the battery by protecting the battery from operating outside its safe operating limits.
Electrolyte	A solution with electric conductivity properties created by dissolving ionic substances in polar solvents such as water

Item	Description
Fire fighting	Stopping combustion / Extinguishing visible fires
Fire suppression	Stopping combustion with no need for further fire fighting operations
Off-gas	gasses released from SEP cell(s) during an abnormal incident (vaporised electrolyte, thermal runaway exhaust gas)
Sealed battery	battery that remains closed and does not release either gas or liquid when operated within the limits specified by the manufacturer
Thermal runaway	accelerating self sustained temperature increase
Rechargeable battery	Battery that can be discharged and then re-charged for further use

Table 1.2: Abbreviation

BEV	Battery Electric Vehicle
BLEVE	Boiling Liquid Expanding Vapor Explosion
CCTV	Closed-Circuit Tele Vision
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicles
HEV	Hybrid Electric Vehicle
HF	Hydrogen Fluoride
ICE	Internal Combustion Engine
IMDG	International Maritime Dangerous Goods
IR	Infrared
ISM	International Safety Management (Code)
MED	Marine Equipment Directives
OEM	Original Equipment Manufacturer
PCC	Pure Car Carrier
PRV	Pressure Relief Valve
PRD	Pressure Relief Device
SoC	State of Charge
TPRV/TPRD	Temperature Pressure Relief Valve/Device
TR	Thermal Runaway

3. Basic principles

3.1 Risk assessment

3.1.1 A risk assessment should be conducted for each ship to ensure that risks arising from the carriage of the EV/HEV that might affect persons onboard, the environment, the safety of the ship are addressed. These risks should be managed within the framework of existing requirements in the ISM code. The result of the risk assessment should be a ship specific Risk Management Procedure to be carried onboard for the prevention and mitigation of fire incidents involving EV/HEV.

3.1.2 The risk assessment should be prepared taking into account the documents: "Risk assessment as required by the Guidance for Marine Industry (Pt.1, Vol.AC) Sec. 8 R-146 or other applicable documents accepted by the Administration of the ship's flag state.

3.1.3 When carrying out the risk assessment, the additional hazards associated with the transport of EV/HEV as defined in Section A.3.2 should be taken into account.

3.2 Additional risks in relation to EV/HEV

The following information is simplified hazard identification on EV/HEV carriers.

- increase in fire size and propagation;
- small jet flames;
- toxic gases;
- gas explosion (if the released gas can be accumulated for a while before being ignited);
- long lasting re-ignition risk (can ignite or re-ignite weeks, or maybe months after the provoking incident);
- difficult to stop/extinguish.

It should be noted that the presented risks form a list of possible events without ranking their severity or probability of occurrence. It is expected that incidents related to new risks of EV/HEV will have a significantly low probability of occurrence due to the built-in safety barriers of these vehicles.

3.3 Reference to National and International standard/Code

The National and International standards related to the safety of carriage of electric vehicles should be considered.

3.3.1 IMDG Code

EV/HEV, while being transported on ships, are treated as dangerous goods, subject to the IMDG Code.

This section provides an overview of the currently applicable provisions from the IMDG Code in relation to EV/HEV.

According to the IMDG Code, section 2.9.2, EVs shall be classified as ”UN 3171 - BATTERY POWERED VEHICLE”.

Special provision SP 961 of Chapter 3.3 of the IMDG Code states that the Code shall not be generally applicable for EV/HEV carried in a special category, vehicle and ro-ro spaces or on the weather deck of a ro-ro ship as long as there are no signs of leakage from the battery, engine, fuel cell, compressed gas cylinder or accumulator, or fuel tank when applicable.

When the vehicle is stowed in a cargo transport unit (container), the exception does not apply to container cargo spaces of a ro-ro ship

.1 Electric vehicles (EV)

For EVs (both HEVs and BEVs), the lithium batteries shall meet the provisions of 2.9.4 of the IMDG Code.

Where a lithium battery installed in a vehicle is damaged or defective, the battery shall be removed. If the battery is not removed, the vehicle should not be accepted for transport. A removed damaged battery should be transported in accordance with the provisions of SP376 of Chapter 3.3 of the IMDG Code.

If an EV is found damaged but it is unclear if the battery is damaged, it is recommended to apply this provision and do not accept the vehicle it for transport.

.2 Small electric vehicles

According to the provisions of the IMDG code small EVs such as electric scooters, bicycles and kick bikes shall be classified as "UN 3171 BATTERY-POWERED VEHICLE or BATTERY-POWERED EQUIPMENT". Special provision SP 388 specifies that battery powered vehicles are self-propelled apparatus designed to carry one or more persons or goods, for example bicycles (pedal cycles with a motor) and self-balancing vehicles (such as segways).

Special provision SP 961 states that those vehicles are not subject to the provisions of the IMDG Code if they are stowed in the vehicle-, special category and ro-ro spaces or on the weather deck of a ro-ro ship or in a cargo space fulfilling the requirements of SOLAS, reg. II-2/20. If these conditions are not met, the vehicles shall be assigned to class 9 and fulfil the provisions of the IMDG Code.

4. Notations

The following 1.3 shows the list of additional class notations. This additional notations can be assigned to the ship provided with the relevant fire fighting measures in accordance with the requirements of this Guidelines.

Table 1.3: Class notations for EV/HEV carrier

Notations	Qualifier	Description
FFCEV	**DE**	This additional class notations is assigned to the ship when the fire detection system is provided
	DEP	This additional class notations is assigned to the ship when the fire detection and preventioan system are provided
	FE	This additional class notations is assigned to the ship when the fire extinguishing system is provided

4.1 Fire detection (FFCEV(DE))

Ships implementing effective measures for the early detection of electric vehicle anomalies and fires, and the prompt identification of vehicles on fire as stipulated in Section 2.B.5, may be assigned with this notation. However, the efficacy and practicality of these measures must be thoroughly assessed and validated beforehand.

4.2 Fire detection and prevention (FFCEV(DEP))

Ships implementing effective measures for the early detection of electric vehicle anomalies and fires, and the prompt identification of vehicles on fire, along with the prevention of fire spread upon initial fire detection, as stipulated in Section 2.B.5, may be assigned with this notation. However, the efficacy and practicality of these measures must be thoroughly assessed and validated beforehand.

4.3 Fire extinguishing (FFCEV(FE))

Ships implementing effective measures for the fire extinguishing of fires on electric vehicles, as stipulated in Section 2.B.6, may be assigned with this notation. However, the efficacy and practicality of these measures must be thoroughly assessed and validated beforehand.

B. Document to be submitted

1. The document listed in the Table 1.4 are to be submitted to BKI for ships intended to undergo an Initial Surveys in addition other plans and documents required by BKI Rules for Classification and Construction of ships.

2. Submission of additional plans and documents may be required when deemed necessary by BKI.

Table 1.4: Documents to be submitted

Notations	Qualifier	Plans and documents
FFCEV	**DE, DEP**	— Risk assessment of EV as specified in A.3.2 — Fire safety plan — Fire detection system — Stability calculation [1] — Stowage arrangement [2] — Other document deemed necessary by BKI
FFCEV	**FE**	— Risk assessment of EV as specified in A.3.2 — Fixed fire fighting system diagram and relevant system — Fire safety plan — Stability calculation [1] — Stowage arrangement [2] — Other document deemed necessary by BKI
[1] For existing ship stability calculation shall be resubmitted for evaluation due to change of stowage arrangement [2] For existing ship revised of stowage arrangement shall be submitted for evaluation		

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Section 2 Requirements for Fire Safety

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A. General

1. Stability Assessment and Load Restrictions

Due to the inherent design of electric vehicles (EVs), they are typically 25% heavier than conventionally powered vehicles of comparable dimensions. Additionally, EVs possess a lower center of gravity compared to their internal combustion counterparts. These factors must be considered during cargo load calculations to ensure vessel stability during transportation.

2. Detection

2.1 Fixed fire detection

Ro-ro spaces or special category spaces intended for the carriage of EVs should have appropriate detectors installed.

2.2 Video monitoring

It is assumed that effective television surveillance systems are provided as described in 2.2.2 of the Annex of Circ.1615. EVs should be stowed in a position where the images from such systems are not obstructed from other vehicles or ship's structures.

2.3 Fire patrol routines

2.3.1 Crew members on fire patrol duties should be familiarised in the basic characteristics and safety aspects of EVs. Fire patrol to be skilled in routines for emergency disconnection of charging EVs.

2.3.2 Fire patrol routes should be arranged in such way that cargo spaces with a high content of EVs, such as, but not limited to, spaces designated to EV charging, are well covered.

2.3.3 A portable IR camera should be carried at all times and should be used regularly.

2.3.4 In addition to general signs of fire or elevated risk of ignition, Fire patrols should be especially alert to EV related signs of instability such as:

- Smoke/heat emitted from parts of vehicle where a battery is normally located
- Popping sounds from battery cells caused by a thermal runaway
- Gas smell
- Suspected unauthorized connection to ship electric system for charging of batteries (if any)

2.3.5 On suspicion of unstable behaviour of an EV, in terms of fire safety, the fire patrol should take safety precautions such as keeping a safe distance and avoidance of potentially hazardous gases.

3. Fire suppression and extinguishment

3.1 EVs emergency response procedure

3.1.1 Emergency response procedures and contingency plan

In general, the activation of the fixed fire-extinguishing system should be the preferred response for a fully developed fire. However, under specific circumstances, a first response through manual means may be effective.

The procedure determined in Section 1.A.3 should also include an emergency response part which should be incorporated in the Decision Support System required by SOLAS Reg.III/29.

The response procedures should include, but not be limited to, the following:

1) mitigation actions for all specific foreseeable hazards caused by a fire involving EVs;
2) the number, the type and capacity of fixed and portable equipment (local water cooling etc) of the fire-fighting team;
3) the appropriate smoke strategy to ensure the operation of the fire-fighting team and avoiding a fire growth, also taking into account the type of ro-ro space;
4) a strategy to contain the fire;
5) fire-fighting team strategy, taking into consideration the possibility of entering a space with toxic gases (e.g. HF in the case of EVs), procedures for decontamination of firefighters and handling of contaminated clothes and equipment after the operation;
6) post fire routine, to prevent reignition;
7) the activation and operation of fixed fire-fighting system, in combination with appropriate ventilation system operation.

3.1.2 Drills (specific for EVs)

A fire drill using a scenario involving EVs should be carried out at least every two months. Such a fire drill should follow the requirements under SOLAS Reg.III/19.3 and III/30.

3.2 Fire suits and specifications

Compared to conventional vehicles, EVs do not, to today's knowledge, introduce any additional specifications of the fire suits. The suit should be certified according to EN 469:2020 and fulfil level 2 for heat protection, water penetration and water vapor resistance (indicated with X2, Y2 and Z2). Note that MED also allows level 1, which has a lower level of protection and should not be used. Furthermore, the firefighter should wear a hood (balaclava), to protect exposed areas of the head and neck. Such hoods are not (yet) included in MED and can instead be approved according to EN 13911:2017. Full-coverage clothing should be worn under the suit, and it is recommended that the fire station is equipped with undergarments for any firefighter arriving without wearing long sleeves.

B. Roro Passenger Ships

1. Vehicle Identification

The ship's crew shall maintain awareness of the location and type of Electric Vehicles (EVs) onboard, according to the designated stowage plan. This information is crucial for proper handling and emergency response procedures.

2. Carriage Requirements for EVs

EVs shall only be permitted onboard if they comply with the regulations outlined in the International Maritime Dangerous Goods (IMDG) Code, as referenced in Section 1.A.3.3. Particular attention shall be paid to the following:

— Damaged Vehicles or Defective Batteries: If there is suspicion of damage to the EV or a malfunctioning battery, transport shall only be allowed on a trailer with the battery physically removed.

— Leakage Prevention: All EVs must be free from any leaks of hazardous gases.

3. Stowage of EVs on Board

The stowage of EVs must ensure direct access for fire patrols to all vehicles.

Within ro-ro (roll-on/roll-off) or special category spaces, it is recommended to separate the EVs parking area from conventional vehicle parking with a clear and sufficient space/distance. The space should be provided with a special mark for EV parking area. Annex A Table A.1 may be used as reference to determine the minimum distance of EVs.

The EV may be located above machinery space fitted with A60 structural fire protection. Otherwise, EV shall be located at least 3 meters from machinery space

4. Fire hazards from electric batteries

4.1 EVs account for an increasing proportion of the means of transport used and are increasingly carried on board ro-ro passenger ferries. Fires in these vehicles do not release significantly more energy than fires of traditionally fueled vehicles and are not at greater risk of fire although such fires may last longer (thus being more dangerous) and be more liable to reignite following fire-extinction. There are significant differences in EV fire detection and suppression practices compared to conventional vehicles.

4.2 Timely response to the first signs of a fire is vital in reducing the risk of a vehicle fire developing and to extinguish it effectively.

4.3 EVs are most commonly powered by high voltage Lithium-Ion (Li-Ion) batteries. Li-ion battery fires can be ”self-sufficient” and continue to burn without access to additional oxygen, they may also continue to generate high amounts of heat following fire-extinction. In hybrid vehicles the risks from both battery and hydrocarbon fires exist simultaneously.

4.4 The common high-voltage battery consists of lithium-ion cells. These cells are considered dry cells. If damaged, usually only a small amount of clear liquid will leak. The highvoltage battery and drive-unit are liquid-cooled with a typical glycol-based automotive coolant. If this blue coolant is found to leak, the high voltage battery casing may be damaged. Either a blue or clear fluid leak may indicate that the battery is damaged, and such symptoms should prompt the crew to take appropriate preventive action.

4.5 Thermal-runaway (TR) is the event most associated with catastrophic EVs fires and occurs when the heat generated within a battery exceeds the amount of heat that is dissipated to its surroundings. Internal battery temperature will continue to rise which will cause the battery current to rise; without intervention (such as cooling) this feedback loop continues causing further heat rises and potential fire spread or explosion. The likelihood of this is reduced by modern Li-Ion battery design which allows the battery to vent instead of exploding.

4.6 Immediately preceding and during TR, gas-freeing occurs – this is a release of various gases from the battery, including carbon dioxide, carbon monoxide, hydrogen, and volatile organic compounds. During the early phase of their generation the off-gases can be heavier than air and accumulate at deck-level or be lighter than air and dissipate, or accumulate at deck-head level.

The use of appropriate gas detectors can be helpful in detecting hazards from such dangerous and toxic gases.

4.7 As well as the above listed gases produced when a Li-Ion battery burns, the following can be released as vapours or particulates in the gases: hydrogen chloride, hydrogen cyanide, soot, oxides of nickel, aluminum, lithium, copper, cobalt, and hydrogen fluoride. It should be noted that most of these gases are also present in traditional vehicle fires, and the same protective measures are required during the firefighting operation. These vapor clouds can be toxic or create an explosion hazard.

4.8 damaged high-voltage battery can create rapid heating of the battery cells. If you notice hissing, whistling, or popping, a possible sweet chemical smell, then black “smoke” (nanoparticles of heavy metals, not smoke), then white vapour coming from the high-voltage battery or the vehicle generally, assume that this is battery overheating and appropriate firefighting measures should be taken.

5. Detection and prevention of EVs fire

5.1 Prompt identification of a burning vehicle is crucial for enabling the timely implementation of fire mitigation measures and preventing fire propagation. To address this challenge, the following measures are recommended for consideration:

1) Gas Detection Systems

   Lithium-ion battery electric vehicles (EVBs) typically generate gaseous emissions consisting primarily of hydrocarbon gases (methane, ethane, propane), along with hydrogen gas and carbon monoxide. Consequently, the installation of gas detection systems for these specific gases within vehicle spaces, ventilation ducts, and other relevant areas is a viable approach for early fire detection.

2) Smoke Detectors

   Conventional smoke detectors trigger alarms upon smoke particles reaching their sensors. However, obstructions such as beams and girders on the deck, or smoke stratification rising towards upper decks via lashing holes, can impede smoke flow and significantly delay alarm activation. Therefore, smoke detector placement strategies must consider smoke flow characteristics and vessel structures to ensure the most rapid and effective smoke detection possible.

3) Heat Detectors and Flame Detectors

   Heat detectors initiate alarms when surrounding temperatures exceed their preset thresholds, while flame detectors react to the infrared radiation emitted by flames. As these detection methods rely solely on the presence of flames for activation, they offer a means for swiftly identifying the location of a burning vehicle, thereby facilitating the prompt commencement of firefighting efforts during the initial stages of a fire event.

4) CCTV (Surveillance cameras)

   It is recommended that the closed-circuit television (CCTV) system, mentioned in A.2.2 be capable of recognizing the flame and rise of temperature.

   Note:

   The placement of gas detection systems, heat detectors, and smoke detectors on ro-ro passenger and pure car carrier vessels with open decks must be carefully arranged to ensure optimal detection effectiveness.

5.2 Fire patrols should be trained in the utilization of thermal imaging cameras. These cameras are particularly valuable when permitting Electric Vehicle (EV) charging onboard. They enable crews to inspect EV floor pans for signs of overheating, both prior to embarkation and throughout the voyage.

It’s crucial to consider the expected rise in battery temperature during charging when establishing alarm thresholds. According to manufacturers, the minimum battery temperature at which thermal runaway becomes a potential risk lies between 60 °C and 70 °C.

5.3 To effectively prevent the escalation of the EV's battery temperature or propagation of fires to adjacent vehicles within the vessel's hold, the following measures shall be implemented:

1) Water Spray Systems:

   Water spray systems employ water as the primary fire extinguishing agent due to its exceptional cooling properties. Additionally, water's specific heat, which represents its capacity to absorb heat while maintaining a relatively stable temperature, further enhances its fire extinguishing capabilities. Notably, vessels have the inherent advantage of being surrounded by water during voyages, facilitating the onboard storage of sufficient water supplies for fire suppression efforts. These factors collectively position water as the most effective, if not the ideal, fire extinguishing medium readily available.

   Beyond directly extinguishing a burning vehicle, water spray systems also provide a crucial secondary function. The water spray effectively coats surrounding vehicles with a protective water film. This film acts as a barrier, significantly attenuating the radiant heat transfer that could otherwise ignite nearby vehicles. Consequently, water spray systems offer exceptional fire spread prevention within the vessel's hold.

2) Water Curtains:

   Similar to water spray systems, water curtains utilize strategically positioned nozzles to create a protective water film. These curtains isolate the radiant heat produced by a vehicle fire, preventing its propagation to adjacent vehicles. There are two primary types of water curtains, fixed and portable.:

   Fixed Water Curtains offer the advantage of permanent installation at designated locations within the hold. This eliminates the need for manual positioning during a fire event, potentially saving valuable time in critical situations.

   Portable water curtain hoses provide greater operational flexibility. Unlike fixed systems, they are not permanently affixed to a specific location, allowing for deployment based on the specific fire scenario. This adaptability is particularly advantageous when dealing with various vehicle configurations within the hold. However, the effectiveness of portable water curtains can be hindered by the arrangement of loaded vehicles. Therefore, it is imperative to strategically determine the designated installation locations for portable water curtain hoses to ensure their optimal use during fire emergencies.

6. Principles concerning fire extinguishing in EVs

6.1 In the case of an electric vehicle (EV) fire, activating a fixed water spray system is generally considered the most effective initial response. This is because it provides boundary cooling to the vehicle, thereby reducing the risk of the fire spreading to nearby vehicles.

6.2 In the event of a fire involving lithium-ion (Li-Ion) batteries, large volumes of water are the most effective method for cooling the batteries. It is recommended for manual firefighting using hoses supplied by the ship's main fire water system. Fixed water drenching systems may not be sufficient due to their limited water discharge, but they can still be helpful in containing the fire's spread.

6.3 Since electric vehicle (EV) fires are often most severe in the underbody-mounted battery pack, directly cooling the underside of the vehicle should be a key firefighting consideration. An upward-spraying nozzle connected to a fire hose, positioned underneath the vehicle, could be an effective method for delivering this cooling water. Additionally, fixed water monitors could be used to provide perimeter cooling, enabling firefighters to perform other tasks. While traditional vehicle fires typically require around 4,000 liters of water for suppression, EVs may necessitate up to 10,000 liters depending on battery size and extinguishing methods.

6.4 Water mist lances are specialized firefighting tools that can deliver a fine mist of water directly into the battery compartment by puncturing the casing. This provides immediate cooling to the battery cells. However, improper use of these lances can cause further damage to the battery and even lead to reignition. Due to the risks involved in penetrating the battery enclosure, the use of water mist lances should be carefully evaluated and reserved for trained firefighters.

6.5 In order to effectively control and extinguish fires involving electric vehicles (EVs), specialized firefighting equipment may be required. This equipment could include foam fire extinguishers, car fire blankets, water mist lances, or water monitors specifically designed for open decks. It's crucial to ensure this equipment is readily accessible and strategically positioned near EV access points.

6.6 Alternative methods for controlling flame spread and heat, such as specialized car fire blankets or other designated textile barriers, might be considered until sufficient water becomes available. However, the deployment of fire blankets and similar textile barriers should be weighed against the limitations of access around vehicles on the car deck and potential crew safety risks. These fire blankets/textile boundaries may be most effective as a preventative measure when a vehicle is identified with a heightened fire risk. It's important to remember that while these blankets can contain flames, the Thermal Runaway (TR) event will likely continue, potentially generating vapor clouds with explosive gas mixtures.

6.7 Firefighters responding to electric vehicle (EV) fires should be able to distinguish between white pre-ignition vapor clouds and grey/black post-ignition smoke. This distinction helps determine if the battery is undergoing thermal runaway (pre-ignition) or if a developed fire is already present.

Due to the risk of battery venting, which can lead to explosions, firefighters must maintain a safe distance from the vehicle while deploying fire suppression measures.

6.8 Firefighters responding to EV fires aboard ships must be aware of the high-voltage electrical systems in these vehicles. A critical step in EV fire response procedures is to ensure the power supply from the ship's electrical system to the involved vehicle, whether charging or not, is de-energized or isolated before attempting fire suppression. When the EV is successfully isolated from the ship's electrical supply, the risk of electric shock during firefighting is significantly reduced.

6.9 Once the EV fire has been extinguished, there is a risk of the vehicle reigniting. The vehicle should be monitored by the crew, ready to undertake additional firefighting measures until it is removed from the ship.

6.10 During a fire involving an electric vehicle (EV) battery, firefighters must always wear full personal protective equipment (PPE), including a self-contained breathing apparatus (SCBA). This is crucial to avoid smoke inhalation hazards. When responding to a shipboard fire, prioritize crew and passenger safety. Utilize the ship's position downwind from the fire to minimize smoke exposure. Whenever possible, direct passengers and crew to muster stations unaffected by smoke.

6.11 Fire departments should establish procedures for decontaminating firefighters and handling contaminated clothing and equipment after responding to electric vehicle (EV) fires. Smoke from burning EVs can contain hydrogen fluoride, a dangerous substance that can seep through protective gear. This highly corrosive and toxic gas can cause chemical burns if it penetrates clothing and reaches the skin. Therefore, decontamination procedures for EV fires may be more rigorous than those for traditional vehicle fires.

6.12 Specialized fire response protocols for electric vehicle (EV) fires should be incorporated into existing ship fire drills.

7. Delivering of water from fire hoses

7.1 Regarding Electric Vehicle (EV) transportation, it's crucial to consider the significant water volume needed to extinguish fires and cool down electric batteries. Since fixed water drencher systems typically provide insufficient water flow (usually 5 to 15 l/min/m² and cover the entire area), it's recommended to have two fire hydrants near the EV parking area, as mandated by SOLAS regulation II-2/10. These hydrants would allow for the application of two water jets directly onto a burning electric vehicle. An alternative and potentially effective approach could involve feeding water from hoses positioned underneath the car to target the battery pack directly.

7.2 During vehicle transport, unrestricted access to fire hydrants must be maintained. This will allow firefighters to connect hoses and extinguish fires on any Electric Vehicle (EV) or nearby vehicles for cooling purposes. If flat hoses are used on board the ship, ensure a straight path to the hydrants for unrestricted deployment. Otherwise, consider using semi-rigid hoses pre-connected to the hydrants and stored on reels.

C. Roro Cargo Ships and Pure Car Carrier

1. Precautions Against Ignition

1.1 Vehicle Identification

The ship's crew shall maintain awareness of the location and type of Electric Vehicles (EVs) onboard, according to the designated stowage plan. This information is crucial for proper handling and emergency response procedures.

1.2 Carriage Conditions

EVs shall only be permitted onboard if they comply with the regulations outlined in the International Maritime Dangerous Goods (IMDG) Code, as referenced in Section 1.A.3.3 Particular attention shall be paid to the following:

— Damaged Vehicles or Defective Batteries: If there is suspicion of damage to the EV or a malfunctioning battery, transport shall only be allowed on a trailer with the battery physically removed.

— Leakage Prevention: All EVs must be free from any leaks of hazardous gases.

For Battery Electric Vehicles (BEVs), onboard admission shall be denied if the battery State of Charge (SoC) falls below the minimum level required for self-propelled entry and exit from the vessel, as specified in C.1.3.

1.3 State of Charge (SoC) for EV Batteries

1.3.1 Thermal Considerations

While the total energy released during a battery fire is not directly affected by the initial SoC, the rate of heat release is significantly impacted. Batteries with a higher charge level will tend to experience a faster and more intense heat peak compared to those with a lower SoC.

1.3.2 Thermal Runaway (TR) Mitigation

The SoC also influences the likelihood of Thermal Runaway (TR), a catastrophic event where battery temperatures rapidly escalate. Lower SoC values significantly reduce the risk of TR. It's important to note that the displayed SoC on the vehicle may not accurately reflect the actual battery state.

1.3.3 Manufacturer Recommendations

Considering these factors, particular attention should be paid to the maximum recommended battery charge levels specified by vehicle manufacturers for EV transportation. These recommendations may vary depending on the specific car model, manufacturer, and intended travel distance.

1.3.4 General SoC Guidelines

As a general rule, EVs should ideally display battery charge levels within the 20% to 50% range during transport. Vehicles equipped with a ”transport mode” that allows them to remain in an ”off” state throughout the logistical chain must have sufficient battery power to safely operate basic functions. Additionally, all Internal Combustion Engine (ICE) hybrid vehicles should have their electric drive mode disabled during transport.

1.3.5 BEV SoC Recommendations

For BEVs, a minimum SoC of approximately 20% is recommended to ensure sufficient driving range for basic operations, including port time, loading/unloading activities, and travel to the first designated destination. However, for vehicles with a smaller battery capacity, a higher limit of around 50% SoC may be necessary to guarantee uninterrupted travel from the factory distribution line to the final unloading port.

1.4 Low Ground Clearance Considerations

1.4.1 EV batteries are typically located beneath the vehicle, positioned between the axles. Manufacturers of low ground clearance EVs should clearly mark such vehicles to raise awareness of potential limitations during transport on ship ramps and internal pathways with varying inclines.

1.4.2 Ship operators may request advanced notification regarding low-clearance vehicles, including information on their gradeability and maximum angle of approach for loading and unloading procedures. As a preventative measure, vehicle manufacturers may consider implementing spring blocks or other suspension control methods to minimize the risk of damage to low ground clearance vehicles, particularly those with under-battery plate covers.

1.4.3 Ship operators are also responsible for taking all necessary precautions to prevent ground contact and potential damage to EV batteries during transport.

2. Fire detection and extinguishing

When transporting different types of EVs, the rules and procedures set out in 2.B apply accordingly.

Section 3 Survey and Maintenance of Class

A. General . . . 3-1
B. Survey of EV notations . . . 3-1
C. Initial Surveys . . . 3-2
D. Periodical Surveys . . . 3-2
E. Occasional Surveys . . . 3-2

A. General

This Section provides the requirement for Class Survey due to additional class notation of ships carrying electrical vehicle. These surveys are generally harmonized with survey for maintenance of class.

B. Survey of EV notations

1. Type of surveys

The types of survey covered in this Guidelines are as follows.

1) Initial survey/ class entry survey

2) Periodical survey

3) Occasional survey

2. Survey shedule

The surveys time window is defined in .B.1. is as follows.

1) Initial Surveys are to be carried out at the time the application for the survey is made.

2) Periodical Surveys Performed during Annual Surveys, Intermediate Surveys, and Special Surveys for ship classification (as per Rules for Classification and Survey (Pt.1, Vol.I) Sec. 3.B.1.1.1, 1.2.1, 1.3.1).

3) Occasional Surveys: Conducted outside of Initial or Periodical Surveys in the following situations:

   — Changes or replacements to fire-fighting or related shipboard equipment.
   — Conversions affecting fire-fighting or related equipment.
   — Shipowner requests a survey.
   — Other situations deemed necessary.

3. Periodical Surveys Carried Out in Postponement

Requirements for conducting Periodical Surveys in postponement follow the relevant regulations for ship classification surveys (as per Rules for Classification and Survey (Pt.1, Vol.I) Sec. 3.B.1.3.7).

4. Ships Laid-up

Ships designated as laid-up are exempt from the Periodical Surveys outlined in B.1.2).

5. Survey Preparation and Responsibilities

5.1 Shipowners must notify surveyors of the desired survey location with a reasonable lead time to facilitate proper execution.

5.2 Shipowners or their representatives are responsible for all preparations for registration, periodical, and other surveys specified within these guidelines, including any additional preparations requested by surveyors.

5.3 Survey Supervision:

- Applicants must appoint a qualified supervisor familiar with all required survey items.
- The supervisor is responsible for providing necessary assistance to surveyors throughout the survey.

5.4 Surveys may be suspended when necessary preparations are incomplete, a qualified supervisor is not present, safe execution of the survey is compromised,

5.5 Surveyors will notify applicants of any repairs deemed necessary following a survey. Applicants must obtain surveyor verification upon completion of repairs.

C. Initial Surveys

1. General

To verify compliance with these guidelines by examining relevant measures, systems, etc.

2. Survey Items

The following items are to be confirmed during Initial Surveys.

1) Verification of proper installation of fire-fighting measures.
2) Confirmation of proper operation of fire-fighting measures.
3) Verification of the presence of all required documents, manuals, and record books on board.
4) Confirmation of proper onboard maintenance procedures for all relevant equipment, documents, manuals, and record books, particularly when Initial Surveys are conducted outside of Classification Surveys during construction. Additionally, proper record-keeping practices must be demonstrated.

D. Periodical Surveys

1. General

To confirm continued compliance with these guidelines by evaluating fire detection and fire-fighting measures.

2. Survey Items

The following items are to be confirmed during Periodical Surveys.

1) Verification of proper maintenance of fire-fighting measures.
2) Confirmation of proper onboard maintenance of all relevant documents and procedures.
3) Verification of proper record-keeping and recording of necessary information.

E. Occasional Surveys

1. General

Conducted when relevant fire-fighting measures are changed or replaced, to ensure compliance with these guidelines

Annex A Recommendation for determination of distance between EVs

A. General A-1
B. Recommendation for determination of distance between EVs A-1

A. General

The main purpose of this Annex is to determine the minimum parking distance between each EVs on board as well as the optimum flow rate and position of sprinkler.

B. Recommendation for determination of distance between EVs

Preference should be made in in accordance with Table A.1, otherwise other combination may be proposed with equivalent level of safety

Recommended distance between top of the car and sprinkler is more than 1 m

The simulation results for the open and closed deck did not show any significant temperature differences.

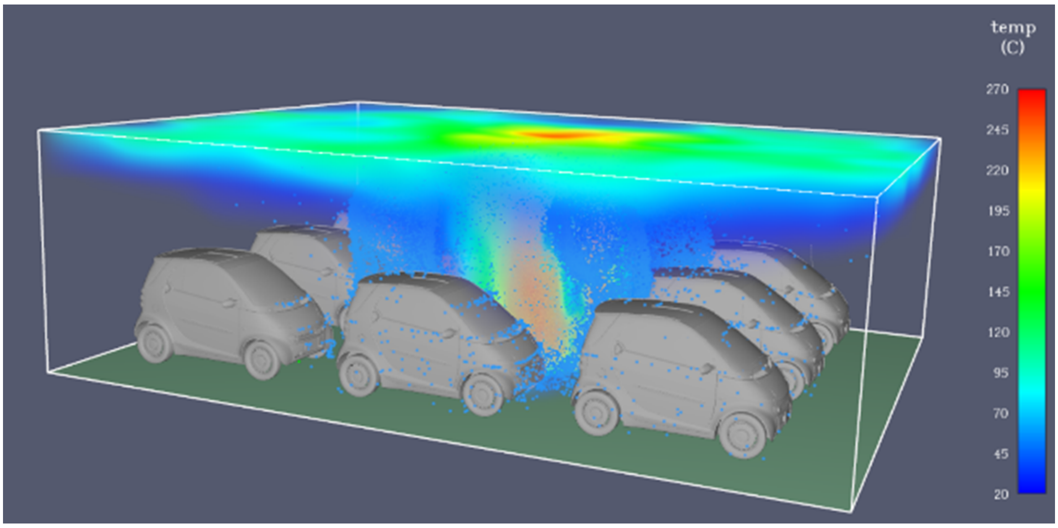

Figure A.3: Simulation post processing

Table A.1: Recommendation distance (D) between EVs

D[m]	Required Flow rate [L/min/m ^{2}] for each sprinkler in position of	
	Topside only	Top and underside
0,6	32	14
0,7	26	12
0,8	20	9
0,9	14	7
1	8	5
1,1 and over	5	5
Note: the recommended minimum distance between EVs is 0,6 m.		