



Design Appraisal Document

Lloyd's Register EMEA
Statutory Departments
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Date
11 November 2024

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RAMBSS for Storage and charging Li-Ion batteries on board of large Yachts
"RAclan Maritime Battery Safety System – RAMBSS" by FISACON
A verified container as part of an arrangement compliant to MGN 681 (M)

1. The Document(s) listed in paragraph 1 of the appendix have been examined for compliance with:
 - MGN 681 (M) fire safety and storage of small electric powered craft on yachts (red ensign flags)
 - 4.2 dedicated cabinet with resistance to fire or blast
 - 4.7.3 yacht below 500 GT: charging within 1m from boundary with Category A machinery spaces or spaces containing the main source of electrical power, associated transforming equipment (if any) or the main switchboard.
 - 4.9 Means for monitoring and alarming temperatures
 - 4.11.2 Using "A-0" instead of higher insulation because of sufficient heat absorbing by the cooling/extinguishing system
 - 4.12.1 ventilation sufficient to the lower explosion limit (LeL)
 - CYC 2020 (Malta commercial yacht code 11.2.1.4 Storage of battery-operated Water Sports' Equipment/Toys
 - MI 103 2021 (including amendments August 2023) Marshall islands yacht code Ch II (commercial Yachts) 13.5.4

And have been assigned an appraisal status as indicated in the appendix, subject to the satisfactory resolution of the comments listed in in section 3 below.

- 1.1. Design description: The RAMBSS is a stackable cabinet for storing and charging Li-Ion batteries for recreational vehicles, up to 5.25 kWh per RAMBSS, Available in 3 sizes.
The design of the RAMBSS fits in an arrangement compliant to MGN 681 (m) since:
 - it is designed to comply to a recognized standard regarding integrity (EN 14470-2)
 - stops charging in case of excessive temperatures
 - Provides sufficient waterspray to reduce A-60 requirement of the space to A-0The following design items that are not mandatory by MGN 681 (m) but do increase safety are also reviewed
 - the fixed fire detection connected to the ships alarm system and possibility to monitor via Wi-fi,
 - fixed automatic fire extinguishing and cooling system sufficient to absorb heat of a thermal runaway
 - Automatic fire extinguishing and cooling system sufficient to absorb heat of a delayed runaways,
 - exhaust filter to reduce toxicity of thermal runaway gas
 - exhaust filter to reduce flammability of thermal runaway gas
 - ventilation filter acting as a flame arrestor

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2. Conditions of approval, statements and assumptions:

- 2.1. When reviewing the design of the RAMBSS it is assumed that the RAMBSS is placed in a garage space compliant to the yacht code (see Ch. 14.1 of the Rede ensign yacht code Pt A) which requires independent ventilation, fire integrity, fire detection, fixed waterspray system and if there is petrol also proper hazardous zones. Reviewing that space is not part of that approval as required by MGN 681(m)
- 2.2. This design appraisal is limited to the design, this document is no approval or certification of the final product. The product is not LR type approved, there are no type approval standards for this product. The product may not show the LR logo.
The Product does not have an MCA product approval certification, there is currently no MCA agreed standard required for these types of products. The product may not show the MCA logo.
The product as designed can be part of an arrangement compliant to MGN 681(m).
- 2.3. The RAMBSS may contain up to 5.25 kWh of nominal battery capacity each, in order for the extinguishing/cooling system to work satisfactory, and the filter to work properly to minimize toxic and flammable gas and fumes in the room where the RAMBSS is located.
- 2.4. MGN 681(m) item 4.11.2 allows applying A-0 instead of A-60 (or A30 for commercial yacht under 500 GT) if there is sufficient cooling. The RAMBSS provides sufficient cooling to do so.
- 2.5. The RAMBSS shall be on the open deck or in a space compliant to either:
 - For large commercial yacht under the red ensign flag (no more than 12 passengers): The Red ensign yacht code part A Ch. 14.1 requiring items such as independent ventilation with 6 air changes/hour, fire detection and waterspray.
 - For Passenger yachts (13-36 passengers) under the red ensign flag The Red ensign yacht code part B Ch. 6.15 requiring items such as independent ventilation with 10 air changes/hour, fire detection and waterspray.
 - For commercial yacht under the Malta yacht code: 11.2.1.4 requiring items such as independent ventilation with 6 air changes/hour, fire detection and waterspray system
 - For Marshall Islands commercial Yacht: 13.5.4 requiring independent ventilation with 6 air changes/hour



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3. Issues that require resolution

- | | |
|--|-----------------------|
| <p>3.1. Potential free contact of the Alarm connection from the RAMBSS to the ships alarm system to be connected and tested.</p> | <p>recommendation</p> |
| <p>3.2. Freshwater supply from the ship to the RAMBSS to be connected and tested.</p> | <p>recommendation</p> |
| <p>3.3. RAMBSS to be proper attached/ stowed to the ship for seagoing conditions.</p> | <p>recommendation</p> |
| <p>3.4. The filter of the RAMBSS filter to be marked with "Next filter replacement on: "with the date of not more than a year after filter replacement.
 Filter replacement due date to be noted in the ships maintenance book/system.</p> | <p>recommendation</p> |
| <p>3.5. Hazardous zones: if there are petrol vehicle(s) or petrol stores in the same space as the RAMBSS:
 The RAMBSS electrical supply shall be cut off by a switch on all poles in case of gas detection.
 Noted is that the lower 450mm is reasonable gastight when closed, so that part is acceptable and no ATEX rating is required.
 Power to the charging equipment inside the RAMBSS can also be switched off at control panel at the RAMBBS, as may be done when only used for storage.</p> | <p>recommendation</p> |
| <p>3.6. For commercial yacht under red ensign flag: A certificate showing compliance with EN 14470-2 (or equivalent) to be provided once available.
 If not available yet (only preliminary test were available when issuing this document) then the current design may be specially considered to be equivalent up to 31 December 2025
 Considerations for that is that the design providing an equivalent or better level of safety because:</p> <ul style="list-style-type: none"> • its sturdy construction with steel corners, steel strengthening, • blast resistant plating with flame retardant properties, • the use of insulating non-combustible material on the inside, • the fixed firefighting/cooling system inside the RAMBSS, independent from the space, • early warning system with 3 heat detectors inside the RAMBSS, • filters reducing toxic and flammable gas in case of thermal runaway, • thermal runaway prevention by means of shutdown when overheated. • hazards, and the prevention, detection and mitigations have been reviewed and no unacceptable risk remains, see chapter 4 "risk assessment" of this document. | <p>recommendation</p> |
| <p>3.7. For commercial yacht under red ensign flag above 500 GT the storage and charging of batteries shall be at least 1m away from boundaries: Category A machinery spaces or spaces containing the main source of electrical power, associated transforming equipment (if any) or the main switchboard. (See MGN 681(m) item 4.7.3.</p> | <p>recommendation</p> |

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- 3.8. For commercial yacht under red ensign flag below 500 GT: the storage and charging of batteries shall be at least 1m away from boundaries: Category A machinery spaces or spaces containing the main source of electrical power, associated transforming equipment (if any) or the main switchboard. recommendation
Where not practicable, there a risk assessment should consider the associated risks and how these are mitigated, with reference to MGN 681(m) item 4.7.3.
See item 4.15 of this DAD for this risk assessment when applicable.
- 3.9. The RAMBSS is to be placed in a garage space with independent ventilation, fire detection and waterspray as required by the applicable Yacht code. recommendation



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4. Risk assessment: Identification of hazards, their prevention, detection and mitigations that reduce consequences

The following hazards of Li-Ion batteries are identified:

Thermal runaway resulting in: explosion, fire/ heat, toxic gas, combustible gas, explosive gas, damage to nearby cells resulting in a delayed thermal runaway

The product has the following preventions:

- 4.1. Cooling fan to prevent overheating while charging and storing.
- 4.2. Automatic stop of charging at high temperature.
- 4.3. Cooling spray system activated if high temperatures inside the RAMBSS are reached.
(high temperatures might force Li-Ion batteries in a thermal runaway)
- 4.4. Insulation (solid non-combustible plate) inside the RAMBSS limiting the heat throughput
- 4.5. Lower part of the RAMBSS is reasonable gastight and air inlet is above 450 mm, so that petrol fumes from outside the RAMBSS- that are more likely in the lower 450mm- are not reaching the chargers that may act as an ignition source. Where there is petrol inside the space of the RAMBSS, the installer is responsible for installing a switch (on all poles) outside the space to shut down the charging upon detection of petrol fumes by the ships gas detection system.
- 4.6. Monitoring/warning system that displays the temperature from outside the RAMBSS on a display, and possibility to monitor this remote via wi-fi.

As detection, the design of the product has the following:

- 4.7. Heat detectors inside the RAMBSS resulting in a normally closed potential free contact opening at dangerous temperatures. This alarm to be connected to the ships alarm system.
The detection systems has 3 Heat detectors, 2 independent Printed Control board (PCB), 2 power sources: external power and a battery for 3 weeks, so designed as a system with high redundancy. On top of that the space in which the RAMBSS is placed has as an approved fire detection system as required by flag rules.

As escalation prevention or limiting consequences the design of the product has the following:

- 4.8. Explosion: its sturdy construction with steel corners, metal reinforcements, impact resistant plating are factory tested to with withstand explosions. Official tests and certification to EN 14470-2 by a recognized laboratory are expected soon.
- 4.9. Fire/heat: High temperatures inside the RAMBSS are detected by electronic sensors that will activate the fixed firefighting and cooling system, using concentrated trident and fresh water from the ship. The system will stop once the temperature is within safe limits, if the trident concentrate is depleted the system will continue with fresh water from the ship.
The initial activation of trident liquids also works without the freshwater connection.
Detection: Activation of the firefighting system will trigger the alarm connected to the ships alarm system via a potential free contact and Wi-fi to authorized person (in example the safety officer)
detection 2: The space in which the RAMBS is fitted with a fixed fire detection alarms as required by flag rules
Firefighting 2: The space in which the RAMBSS is fitted with a fixed firefighting system as required by flag rules.

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- 4.10. Toxic gas from thermal runaway:
- The RAMBSS has Filters on its exhaust system effective against toxic gas such as HF for at least 99.5 %.
 - The space in which the RAMBSS is fitted has reasonable ventilation for further dilution.
 - persons will be alarmed by the audible alarm of the RAMBSS.
 - unfiltered toxic HF gas as a strong smell that will alarm persons inside the space.
 - The RAMBSS acts without crew needing to be present. Thereby limiting the exposure of persons.
- 4.11. Combustible gas:
- The RAMBSS has Filters on its exhaust system minimizing many combustible gasses such as H₂, hydrocarbons, and combustible aerosols, so minimizing the outflow of combustible gas.
 - The space in which the RAMBSS is placed has independent ventilation to dilute remaining combustible gas.
- 4.12. Flame propagation:
- the filters of the RAMBSS contain a fine mesh that will cool the flames and thereby act as a flame arrestor and prevent ignition outside the RAMBSS.
- 4.13. Explosive gas: A thermal runaway may result in gas that may form an explosive mixture. This mixture can be ignited by the thermal runaway. This is less common in a thermal runaway, but it cannot be excluded. The RAMBSS is blast proof tested.
- Explosive gas outside the RAMBSS is minimized by the filter and further dilution by ventilation of the space.
- The other reason for explosive gas would be electrolysis of highly conductive water such as seawater
- Note the RAMBSS has no seawater extinguishing system for this reason.
- If however a battery is wetted by highly conductive water that is electrolyzed, then the explosive gas would be ventilated and diluted and absorbed by the RAMBSS ventilation system, and further diluted by the independent ventilation system of the space where the RAMBSS is placed
- 4.14. Damage to battery cells from an adjacent thermal runaway resulting in a delayed thermal runaway(s):
- The temperature detectors remain active and will re-deploy the firefighting/cooling spray system.
- The temperature sensors stop the extinguishing /cooling system once a safe temperature is reached.
- The fresh water from the ships connection provides sufficient cooling even if the trident concentrate is depleted.



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- 4.15. MGN 681 (m) does not allow charger location located closer than 1m to any boundary with Category A machinery spaces or spaces containing the main source of electrical power, associated transforming equipment (if any) or the main switchboard. (further called essential space):
For vessels under 500GT this requirement should be met where practicable, but where not, a risk assessment should consider the associated risks and how these are mitigated. This is as follows;
- hazard: batteries in a spontaneous thermal runaway, resulting in fire in the adjacent essential space, resulting in loss of power.
 - Hazard Batteries forced into a thermal runaway because of heat from the engineroom, resulting in fire.
- There are 2 independent mitigation
- 1 The RAMBSS will contain the thermal runaway without further escalation and will alarm
 - 2 The space in which the RAMBSS is fitted has fire detection and waterspray to contain the thermal runaway to the space where the RAMBSS is in. (as required by MGN 681 referring the chapter 14.1 of the yacht code).
- Recommendation: to have sufficient time for manual activation there shall be proper insulation towards the essential space (in example A-30 insulation)

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Appendix

1. The documents listed below have been examined

Document No.	Rev.	Title	Status	Date
		RAMBSS_technical short description_30.10.2024	AQ	11-Nov-2024

2. The documents listed below have been considered together with the submitted documents in the appraisal

Document No.	Rev.	Title
		Movie clip of preliminary blast test to EN14470-2
		multiple certificates of non-combustibility and low flame spread
		Multiple construction details
		Notes from the telephone call "RAMBSS risk assessment" with Fisacon (as presented in chapter 4 of this DAD)

Appraisal Status Key

AQ Approved subject to the matters raised that require resolution – and provided the arrangements are to the surveyor's satisfaction

"All statuses that aren't applicable should be removed from the table above".



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