



SAFETY INVESTIGATION REPORT

201809/007

REPORT NO.: 16/2019

September 2019

The Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011 prescribe that the sole objective of marine safety investigations carried out in accordance with the regulations, including analysis, conclusions, and recommendations, which either result from them or are part of the process thereof, shall be the prevention of future marine accidents and incidents through the ascertainment of causes, contributing factors and circumstances.

Moreover, it is not the purpose of marine safety investigations carried out in accordance with these regulations to apportion blame or determine civil and criminal liabilities.

NOTE

This report is not written with litigation in mind and pursuant to Regulation 13(7) of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011, shall be inadmissible in any judicial proceedings whose purpose or one of whose purposes is to attribute or apportion liability or blame, unless, under prescribed conditions, a Court determines otherwise.

The report may therefore be misleading if used for purposes other than the promulgation of safety lessons.

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MY KANGA

Fire in the garage of yacht, in position 42° 46.1' N, 017° 45.9' E 07 September 2018

SUMMARY

MY Kanga was at anchor in the coastal area of Dubrovnik, Croatia, on the morning of 07 September 2018.

While the first officer was on the bridge, the fire panel gave off an alarm, indicating a fire in the garage. He immediately went down to inspect and was overwhelmed by the presence of heat and smoke in the garage.

The main fire alarm was triggered and the first officer called all crew and passengers to muster at the bow. An attempt was made to fight the fire; however, it was unsuccessful. The fire rose towards the upper

decks and subsequently grew out of control. The yacht was abandoned on orders given by the master. No injuries were reported.

The safety investigation concluded that in all probability, the seat of the fire was the Lithium-ion batteries.

The MSIU has issued two recommendations to the Company, designed to ensure adequate fire detection measures; and four recommendations to the flag State Administration, with the aim of enhancing fire safety on board commercial yachts.



FACTUAL INFORMATION

Vessel

Kanga was a luxury commercial yacht, built in Italy and delivered to her owners, early in 2018. She was owned by Lady Luck Ltd., managed by Floating Life International S.A. of Switzerland, and classed with RINA.

The vessel had a length overall of 40.80 m, a moulded breadth of 9.28 m, and a moulded depth of 3.25 m. The vessel had a summer draft of 2.60 m and a gross tonnage of 497.

Propulsive power was provided by two Caterpillar, 12-cylinder marine engines, C32 Acert Ditta, producing a total of 2,162 kW at 2,300 RPM. These engines drove two fixed pitch propellers, enabling *Kanga* to reach a speed of 15 knots.

Certification of *Kanga*

Kanga was surveyed and certified in accordance with the Commercial Yacht Code, 2015 and as per her Certificate of Compliance to trade as a Commercial Yacht, the vessel was certified for an unrestricted range of operation. The Cargo Ship Safety Radio Certificate, issued by RINA, certified the vessel to operate within GMDSS Sea Area A3.

The trading area specified on her Minimum Safe Manning Certificate, however, restricted the yacht to a range of 150 nautical miles from a safe haven; thus identifying the range of *Kanga* as an extended short range of operation, within the meaning of Commercial Yacht Code, 2015.

Crew

Kanga's Minimum Safe Manning Certificate stipulated a crew of six. At the time of the accident, the vessel had nine crew members *i.e.*, the master, a first officer, a chief engineer, a bosun, one deckhand, three stewardesses, and a chef. The crew included

nationals from New Zealand, Australia, and the United Kingdom.

Passengers

At the time of the occurrence, there were a total of four passengers on board, including a child. All passengers were evacuated safely.

Environment

On the day of the accident, the weather was clear with calm seas. The winds present at that time have been reported to be light airs.

Garage space

The garage space was the main housing area for a 6.4 m tender rigid inflatable boat (RIB), and two electric surfboards. In addition, the garage space also contained a number of items:

- two electric chest freezers;
- two Lithium-ion accumulator-powered underwater scooters;
- three Lithium-ion battery packs for electric surfboards¹;
- a hydraulic power pack and associated controls;
- galley fridge compressors;
- the electrical system of the tender;
- fixed mains, wiring and accessories, including lighting and socket outlets, within the garage;
- a garage extraction fan; and
- the exhaust ducting for each of the two propulsion engines.

Views of the garage space are reproduced in Figures 1 and 2.

¹ During the course of the safety investigation, RINA advised that Lithium-ion batteries had neither been included / indicated in the list of batteries provided by the shipyard, nor reported by the Class surveyor.



Figure 1: Internal view of the garage – facing the door through which the Tender RIB is launched

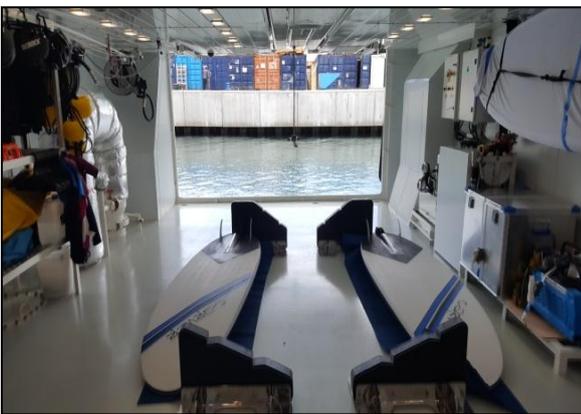


Figure 2: Internal view of the garage – with electric surfboards in their stowed position

The garage had a total of six 220V power sockets and one 400V power socket. Two of the 220V sockets were used to recharge the battery packs of the electric surfboards, while three of these sockets were used to recharge the underwater scooters, shown in Figure 3.

According to the crew, none of the equipment / batteries were being recharged at the time of the occurrence, and the garage extraction fan was running. The only fuel stored in the garage was diesel, located in the tender's fuel tank. There were also empty jerry cans, which had previously contained diesel.

The ventilation grid of the garage had a removable shutter, in lieu of a permanent one required by section 4.2.8 of the Commercial Yacht Code, 2015. This section of the Code dealt with the watertight integrity of the yacht.

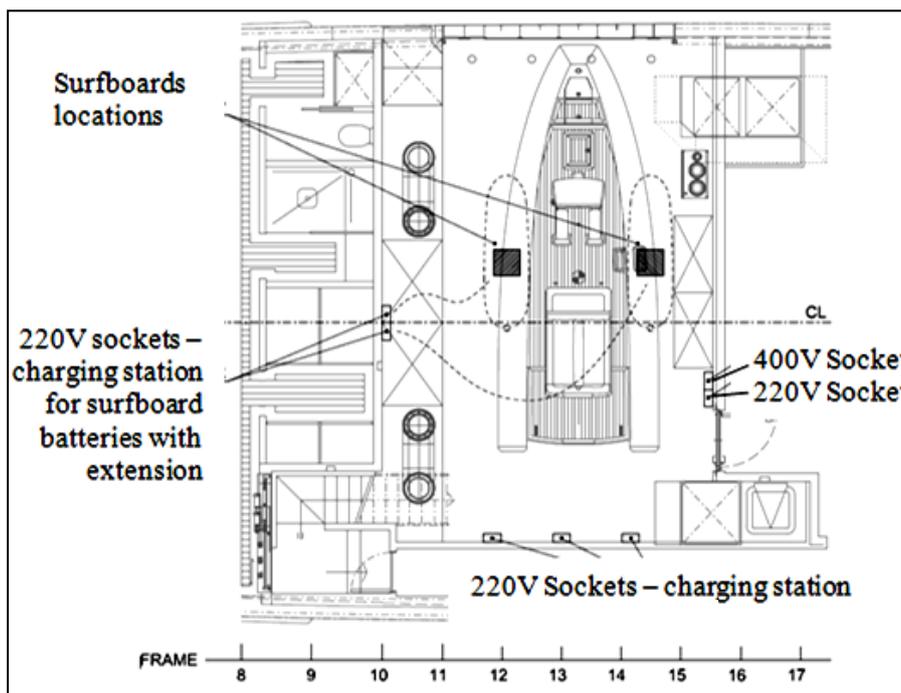


Figure 3: Plan of the garage showing the power outlets

Taking into account that this was considered as a normal standard on yachts, and that an external grid and a droplet separator² were also installed, the Administration had found this deviation as acceptable.

Other water craft on board

In addition to the water craft located in the garage of *Kanga*, the vessel had a 4.2-metre tender RIB and a jet ski positioned on the deck – at the forward end. The lifesaving appliances included four inflatable life rafts – two on each side of the vessel. Each of these life rafts could hold 12 persons.

Fire protection of the garage

As per the initial survey report of the vessel, the garage was not deemed to fall into any of the two categories of service spaces, as defined in the Commercial Yacht Code, 2015 and therefore, it did not require any specific structural fire protection.

However, as the forward bulkhead of the garage separated it from the galley, this bulkhead was a B-15 Class division³, as can be seen in Figure 4.

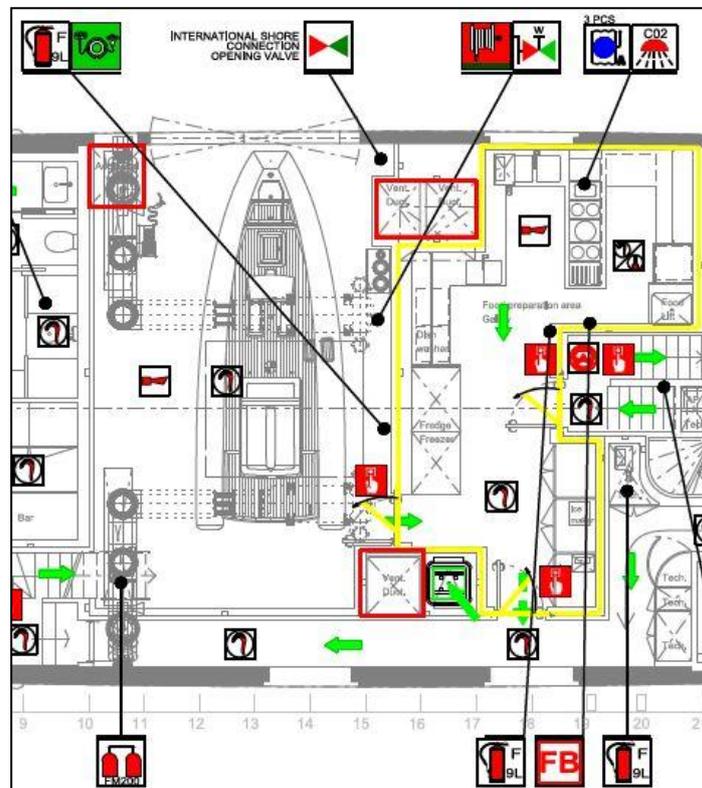


Figure 4: Extract of fire and safety plan depicting the garage and galley

² A droplet separator consists of a series of vertically arranged, curved baffle vanes, designed to deflect the flow of water droplets contained in an air stream. When these droplets are deflected and come in contact with the surface of the separator, they flow down by gravity and are then drained out, thus, allowing a drier air stream to pass through.

³ A B-15 Class division is formed by bulkheads, decks, ceiling or linings and are so constructed to prevent the passage of flame to the ends of the first half hour of the standard fire test. They also have an insulation value such that the average temperature of the unexposed side will not rise more than 140 °C above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225 °C above the original temperature, within 15 minutes. 'B' class divisions are constructed of approved non-combustible materials.

For fire extinction and fire detection, the Code required the garage – of a yacht with a length of 24 metres and above – to be fitted with a manual water spray system and a fixed smoke, heat and gas detection system.

Section 11.2.1.3 of the Code listed additional fire protection fittings for garages wherein vehicles or craft containing fuel having a flash point below 60°C were stowed. Although *Kanga* was not known to have been carrying such fuel, her garage still met most of these requirements.

Narrative⁴

On 07 September 2018, at around 0820, while *Kanga* was lying at anchor off Dubrovnik, Croatia, the first officer, who was carrying out routine GMDSS checks, heard a fire alarm on the bridge. The fire panel indicated a fire in the garage. He immediately went down with a portable two-way radio to the door of the garage, which was located in the galley. Around the same time, the bosun, who was working on the aft deck, noticed smoke coming up the port side of the yacht.

The first officer, who had now reached the garage door, noticed that the door was warm. When he opened the door slightly, he was overwhelmed by heat and smoke. He shut the door and made his way to the bridge.

At approximately 0830, the main fire alarm was heard throughout the yacht. The master, on hearing the alarms, arrived on the bridge, where he met the first officer. The master visually noticed black smoke billowing out of the garage space, and he immediately ordered all crew and passengers to muster on the forward deck. He closed all fire doors and dampers from the bridge and started the fire pump, following, which he sent out a distress call by VHF Channel. 16. Dubrovnik Radio immediately responded to

the call, and confirmed that assistance would be provided.

The first officer carried out a head count, confirmed all crew and passengers were accounted for, and then ordered for boundary cooling to be commenced from the main deck, port side, and around the garage area.

The first officer and the bosun donned fire suits and BA sets and proceeded to the garage door with charged fire hoses. At this point, it was noticed that the fire had reached the main deck and by the time the first officer and the bosun reached the door, the fire had reached the owner's deck. The first officer decided to call off the fire fighting, and together with the bosun, headed back to the forward deck. In order to protect the persons mustered on the forward deck, the boundary cooling was continued.

The fire had now reached the sun deck and explosions were heard. The master retrieved all the documents and passports of the crew and shut off all watertight compartments from the bridge. He then gave the 'abandon ship' order, called off the boundary cooling, and ordered the chief engineer to shut off all fuel valves and the generator from the fire locker located on the starboard side of the yacht, before leaving the bridge.

Following a final head count, the forward tender was launched, with the child inside. All crew members and passengers then jumped into the water off the bow of the yacht to board the tender. In the meantime, several other vessels arrived at the scene and assisted the crew and guests out of the water.

At around 0845, further explosions were heard, however, by this time, the tender along with all crew and passengers, was at a safe distance from the burning yacht.

⁴ Unless specified otherwise, all times mentioned in this report are in Local Time (UTC + 2).

Battery packs of the electric surfboards

Kanga had on board a total of four Lithium-ion battery packs for the electric surfboards. The technical specifications of these battery packs were:

- Maximum electrical discharge - 130 A;
- Nominal voltage - 44.4 V;
- Capacity (rated) - 1500Wh⁻¹;
- Recharge 120 min;
- Weight - 10 kg.

The surfboards' manufacturers had provided their clients with recommended guidelines for the battery packs, which contained a number of precautions that were to be taken. A printed version of these guidelines were said to be attached to all batteries and unit deliveries. These guidelines were also posted on their official website, as well as on their social media pages. The guidelines carried the following warning:

CAUTION – Lithium-Ion Batteries have been known to catch fire. Always recharge and store the Battery under supervision in a dry and safe place.

The guidelines went on to state:

...there is always the risk that one of the cells has an internal malfunction causing energy liberation disregarding the Battery Management System. This can lead, in rare occasions, to the raise in temperature causing even fire.

Documentary evidence indicated that the crew had been experiencing some problems with the batteries of the electric surfboards, namely sea water leakage into three of the four battery packs. The crew had noticed brownish-coloured water leaking from the inside of the batteries, and had notified the manufacturers that they had intended to return them for repair / replacement. The manufacturers had advised the crew of the yacht to check the internal status of the battery packs before sending them back. The manufacturers had also advised that defective

battery packs were neither to be used nor charged.

Lithium-ion batteries⁵

A Lithium-ion (LI-ion) battery refers to a battery where the materials of the anode⁶ and the cathode⁷ serve as a host for the Lithium ion (Li +). An electrolyte composed of an organic solvent (typically a mixture of organic carbonates, such as Ethylene Carbonate or Diethyl Carbonate) and dissolved lithium salt (most commonly, Lithium Hexafluorophosphate) provides the media for transport of the Li ions. These ions move from the anode to the cathode, during discharge, and are intercalated⁸ into the cathode. During charging of the battery, these ions reverse direction.

Li-ion cells behave differently compared to other cells that contain a water-based electrolyte (such as Lead Acid and Nickel Cadmium cells). Even if a Li-ion cell is fully discharged, it contains an appreciable amount of chemical energy that can be released through combustion of the electrolyte.

As Li-ions are intercalated into host materials during charge/discharge, there is no free Li metal within a Li-ion cell; thus, rendering

⁵ *Source:* Lithium-Ion Batteries Hazard and Use Assessment: Final Report. Retrieved on 01 February 2019 from <https://www.nrc.gov/docs/ML1719/ML17191A294.pdf>

⁶ The anode is composed of a Lithium intercalation compound coated in a thin layer onto a metal current collector. The most common anode material is graphite, in powder form, combined with binder material.

⁷ The cathode is a powdered material, combined with conductivity enhancers (such as carbon) and binder, which is coated in a thin layer onto a current collector. The most common material used is Lithium Cobalt Dioxide. Other materials such as Lithium iron Phosphate, Lithium Manganese Oxide, Lithium-Nickel Cobalt Aluminate, and Lithium-Nickel Manganese Cobaltite are also known to be used.

⁸ Inserted into voids in the structure of the cathode.

metal fire suppression techniques inappropriate for controlling a fire involving Li-ion batteries⁹.

Flammability of Lithium-ion batteries

The electrolyte inside a Li-ion battery has a high volatility and is intrinsically highly flammable. Table 1 shows the flash points and auto-ignition temperatures of commonly used Li-ion cell electrolytes. It should be noted that the electrolyte is not the only battery component that is combustible. When the batteries are highly charged, the anode material is also combustible.

Table 1: Measured Flash Points and Auto-ignition Temperatures of some typical Lithium-ion cell electrolyte components

Electrolyte Component	Flash Point	Auto-ignition Temperature
Propylene Carbonate	135°C	455°C
Ethylene Carbonate	145°C	465°C
Di-Methyl Carbonate	18°C	458°C
Diethyl Carbonate	25°C	445°C
Ethyl Methyl Carbonate	25°C	440°C

Source: Vide Footnote 4.

Thermal runaway

Research confirms that one of the most catastrophic failures of a Li-ion battery would be a ‘thermal runaway’ event, which could occur if an exothermic reaction goes beyond control. Under these circumstances, the internal temperature increases to a point where the electrolyte evaporates and generates gases, which should vent when the pressure inside the cell rises above a certain design value. In a battery, a thermal runaway will lead to a failure of a cell and may result

⁹ Under certain abuse conditions, Li metal (in very small quantities) can plate onto anode surfaces. However, this is not known to have any appreciable effect on the fire behaviour of the cell.

in fire propagation to neighbouring cells. As a result, a battery pack can be destroyed within a matter of a few seconds or over several hours, as each cell is consumed.

Thermal runaway in a Li-ion battery would generally start from overheating of the battery due to overcharging, over discharging,¹⁰ exposure to excessive temperatures, external short circuits due to faulty wiring, or internal short circuits¹¹ due to cell defects, the latter being relatively hard to control. Damages caused by crushing or puncturing of the cells or battery packs can also lead to thermal runaway. As the internal temperature increases, the intercalated Li in the anode will react with the organic solvents in the electrolyte, releasing hydrocarbon gases. Taking Ethylene Carbonate as an example:



This reaction is exothermic, driving the temperature even higher. Eventually, the heat causes decomposition of the cathode, resulting in the release of Oxygen, which accumulates within the battery. This decomposition is also highly exothermic, further increasing the temperature and pressure and, as a result of which, further speeds up the reactions. As soon as enough heat and Oxygen would have accumulated, the combustion of the battery will start.

¹⁰ Lithium-ion batteries have a specific working range regarding the voltage. A discharge deeper than the specified cut-off voltage can cause damage to the electrodes and current collectors. If a Li-ion battery is discharged below its stated cut-off voltage, thermal runaway may occur when the battery cell is recharged.

¹¹ Causes of internal short circuits could include penetration by external metal debris, impact, Lithium Dendrite formation (under high current density charging, under overcharging conditions, or at low temperatures), and flawed separators created during battery assembly.

Possible consequences of thermal runaway

There are three possible consequences of thermal runaways:

- *Gas emission through battery venting:* The main consequences of thermal runaway are the emission of heat and flammable vapours. Some cell designs include a specially designed vent to release these gases; which, although, helps in preventing complete failure of the battery, releases toxic and flammable vapours. The gases released from Li-ion cells would generally include hydrocarbons, Hydrogen, Carbon Monoxide, and Hydrogen Fluoride. However, if the vent is obstructed, or does not open correctly, it could result in bulging or rupture of the battery enclosure;
- *Fire:* As indicated earlier, as soon as enough heat and Oxygen have accumulated within the battery, during a thermal runaway, the flammable components of the battery can catch fire;
- *Explosion:* During a thermal runaway, Li-ion cells can explode and eject their contents. Studies indicate that the energy released is roughly proportional to the state of charge of the battery *i.e.*, the contents of most cells with zero charge will not be ejected, while all cells with 100% charge will be ejected. Furthermore, an explosion can also occur if the flammable gases, produced during thermal runaway, either mix with the remaining air within the battery enclosure, or when fresh air enters the battery enclosure from vents or openings, and the resultant mixture is ignited either by the failing cells or a different source of ignition within the enclosure. In the event of an explosion, battery debris can be projected and the space can quickly fill with white dense smoke;

Past reported fires

A number of fire accidents due to Li-ion batteries have occurred in the past, including:

- an auxiliary power unit battery fire on board a Japan Airlines Boeing 787-8, on 07 January 2013¹²;
- a crash and post-crash fire of an electric-powered car, on 23 March 2018¹³;
- a battery fire in an electric-powered car, on 15 June 2018¹⁴; and
- various fires involving the batteries of smart phones¹⁵.

While the aircraft and (most of) the smart phone accidents occurred due to internal short circuits, the car incidents could have most likely occurred due to external damage to the batteries.

In-built safeguards in the Li-ion batteries used for the electric surfboards

In-built protections were provided for the batteries of the electric surfboards used on board the *Kanga*. These protections were intended to protect the batteries against short circuit, over charge, temperature, and ingress of water.

¹² NTSB Incident Report AIR-14/01.

¹³ NTSB Preliminary Report HWY18FH011.

¹⁴ NTSB Preliminary Report HWY18FH014.

¹⁵ <https://news.samsung.com/us/Samsung-Electronics-Announces-Cause-of-Galaxy-Note7-Incidents-in-Press-Conference>.

Guidance by the United Kingdom's Maritime and Coastguard Agency (MCA) Marine Guidance Note MGN 550 (M+F)¹⁶ of April 2016 provides, amongst other aspects, guidance on protection against fires associated with Li-ion batteries.

Section 9.11 emphasizes that, in order to prevent thermal runaway, early identification of a potential Li-ion battery fire is important. This could involve the monitoring of cell temperatures or detection of electrolyte solvent vapours.

A recommendation to design and install one or more fixed fire-fighting systems, capable of being operated from a safe location with feedback to confirm proper activation, is contained in Section 9.12 of the MGN.

Furthermore, the MGN also addresses crew training by recommending that crew has an awareness of the vessel's emergency procedures regarding the battery.

ANALYSIS

Aim

The purpose of a marine safety investigation is to determine the circumstances and safety factors of the accident as a basis for making recommendations, and to prevent further marine casualties or incidents from occurring in the future.

Immediate cause of the fire in the garage

Although the seat of the fire in the garage of *Kanga* was not established, the potential sources of fire, as identified earlier in this

¹⁶ It is to be noted that the intent of MGN 550 (M+F) is to provide best practice guidance for vessels utilising Li-ion batteries as part of a hybrid power system or as the sole source of propulsion power. However, considering the fire hazards associated with any size of Li-ion batteries, the safety investigation is of the opinion that the best practice guidance provided in this document is relevant.

safety investigation report, and the fittings that were provided for the fire protection of the garage, drew the attention of the investigation towards the leaking battery packs of electric surfboards.

Although the batteries had an in-built safeguard against water ingress, as stated earlier in this report, the crew had complaints about sea water leaking into the battery and brownish-coloured water leaking from the inside of the battery. The safety investigation could not ascertain whether this was only sea water, sea water mixed with the electrolyte, or the product of a reaction.

If moisture / water seeps into a Li-ion cell, it would react with the Lithium salt in the electrolyte, over time, to release Hydrogen Fluoride, as indicated below.



As the concentration of HF increases, the colour of the electrolyte could change from colourless to a yellowish-brown to a reddish-brown colour during storage. Furthermore, sea water, due to its high conductance and corrosive properties, is a hazard, as it can cause a short circuit.

Fire patrols / Monitoring of spaces

The fire was noticed at around 0820. At this time,

- the master was in his cabin, located on the starboard side on the main deck – aft of the bridge;
- the first officer, who first heard the fire alarm, was on watch on the bridge;
- the chief engineer and the chief stewardess were in the crew mess room, located forward of the engine room, on the bottom deck;
- the bosun, who noticed smoke coming out of the garage, was on the aft deck (lower deck);

- the chef and the third stewardess were in the galley, which was the space with B-15 fire-resistant divisions adjoining the garage;
- the second stewardess was on the bow; and
- the deckhand was sleeping in the accommodation.

It remained unclear as to whether any fire patrols were carried out at any time before the actual fire, especially in the garage. It was also unknown if anyone, for any reason, had entered the garage at any point in time before the fire.

The smoke detector fitted in the garage of *Kanga* was of the photoelectric¹⁷ type, due to which the fire alarm would have only been triggered after a sufficient amount of smoke would have accumulated in the garage and reached the detector. This would explain why the bosun had had seen smoke coming out of the garage around the same time as the first officer had heard the initial fire alarm on the bridge.

The requirements of the Commercial Yacht Code

The installation of automatic fixed fire suppression systems on unrestricted range yachts is not mandatory under Section 11.3.3

¹⁷ A photoelectric smoke detector operates on the light scattering principle, and is more responsive to fires that begin with a long period of smouldering (burning slowly with smoke, but no flame). In this detector, a light source is aimed into a sensing chamber, at an angle away from the sensor. When smoke enters the chamber, it reflects light onto the sensor, triggering an alarm.

An ionization smoke detector, in comparison, is more responsive to flaming fires. Here, the detector contains a small amount of radioactive material between two electrically charged plates, which ionizes the air and causes current to flow between the plates. When smoke enters the chamber, it disrupts the flow of ions, thus reducing the flow of current and then activates an alarm.

of the Code and the fire plan indicated that such a system was not fitted on *Kanga*.

Section 11.3.4 requires garages to be fitted with a manual water spray system having coverage of 3.5 litres m⁻² min⁻¹ over the total deck area, which may be supplied from an adjacent fire main connection. As an alternative, a remotely operated fixed drencher system could be installed. This section of the Code also required the garage to be fitted with a fixed smoke, heat and gas detection system.

The Fire Plan did indicate that a fire hydrant with a hose reel was actually located on the forward bulkhead within the garage (towards the port side of the centre line of the yacht), along with a 9-litre foam fire extinguisher; however, whether this arrangement met this particular requirement of the Code, seemed debatable.

A fire in the garage of *Kanga*, with this arrangement, would either require fire fighters to be present in the garage at the time of a fire, or would require them to enter the garage through the sole access from the galley, which was towards the starboard side of the garage. The opening valve for the international shore connection was also located within the garage – near the shell door, on the port side. Moreover, the garage was neither fitted with a heat detector, nor a gas detector.

Spread of the fire

Evidence has indicated that the fire had spread from the garage to the sun deck, which was the uppermost deck (Figure 6), in less than 15 minutes.

The entire engine-room (located just below the garage) and the first two bulkheads, forward of the engine room, had A-30 class fire-resistant divisions (Figure 7). Besides these spaces, only the galley, which was located just forward of the garage, had B-15 class fire-resistant divisions (Figure 4).

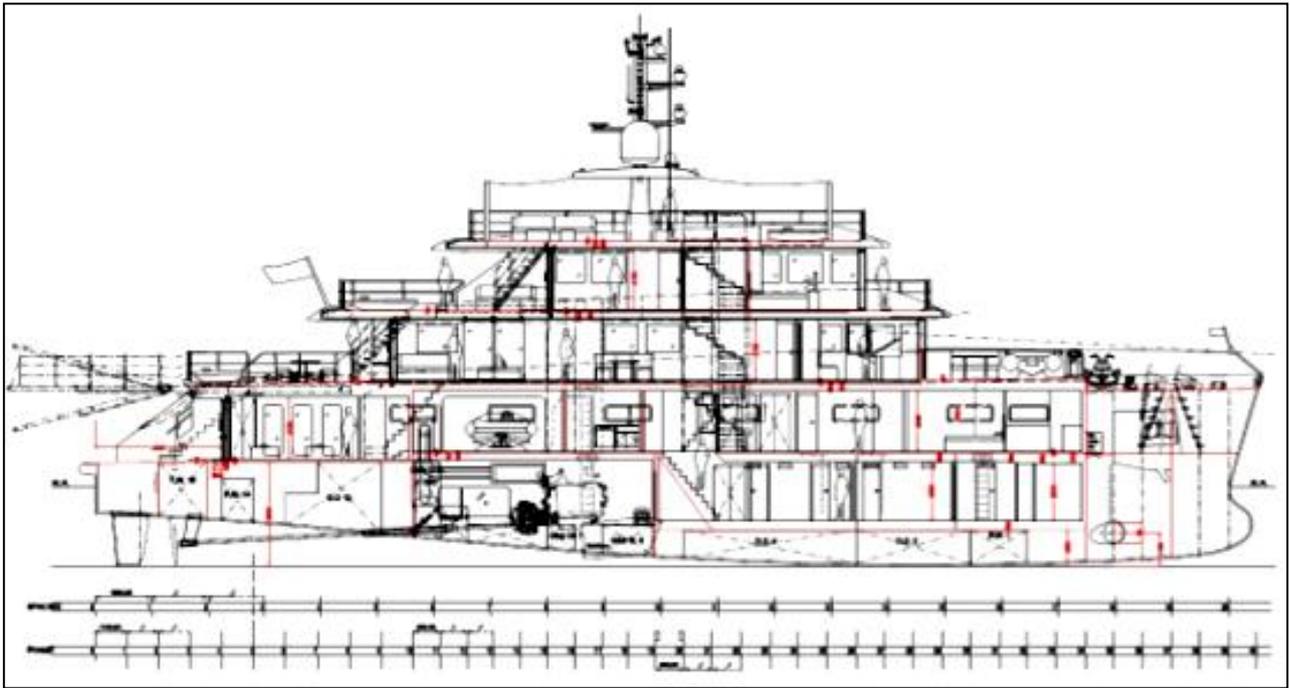


Figure 6: Side Profile of *Kanga*

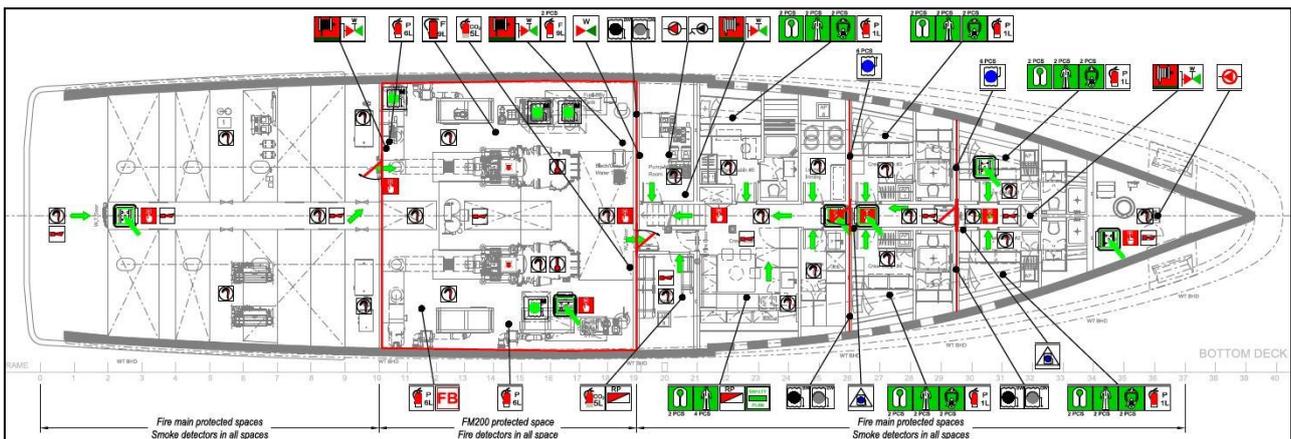


Figure 7: Extract of Fire and Safety Plan – Bottom Deck

As stated elsewhere, the initial survey of the yacht indicated that the garage space was not considered to be a service space and, therefore, did not require any fire-resistant divisions. Furthermore, the garage had a removable shutter on the ventilation grid and, due to its location, the ventilation to the garage could not be shut off in order to prevent air from entering into the garage. This would, therefore, have facilitated the feeding of Oxygen to the fire. There was no evidence of the garage extraction fan being

stopped at any point, however, even if it were, Oxygen would have still been available in the garage through the ventilation grid.

The master of *Kanga* had shut off all fire doors and dampers from the bridge panel, however, as seen from the fire plan, the garage ventilators were not fitted with fire dampers.

Section 11.4.3 of the Commercial Yacht Code, 2015 requires that the lowest covering

of decks in accommodation spaces, wheelhouses, navigation rooms, staircases and corridors, situated above rooms which pose a fire hazard, to be either type-approved, or of a certified material that is not easily flammable. This seems to have been the case with *Kanga*, in addition to an overhead fire-resistant division in the engine-room.

As it can be seen in Figures 8, 9 and 10, the engine-room sustained minimal damages due to the fire, with mainly some electrical wirings and fittings on the engine room deck-head being subjected to excessive heat.

The aforementioned facilitated the safety investigation in understanding why the fire on board *Kanga* had rapidly spread upwards from the garage, at least initially.



Figure 9: Heat detector, located above the port side engine



Figure 8: Heat Detector located above the starboard side engine



Figure 10: Engine-room emergency escape hatch – located on the starboard side

CONCLUSIONS

1. The crew did not seem fully aware of the hazards associated with the Li-ion batteries, which resulted in an inadequate assessment of the risks involved with these batteries, even after three of the four batteries were found leaking.
2. The garage space of *Kanga* was not considered a service space, within the meaning defined by the Commercial Yacht Code, 2015 and therefore, additional measures to prevent the spread of, as well as to extinguish, the fire were not deemed necessary to be provided in the garage.
3. Unlike SOLAS II-2/5.2.1.1, which requires the main inlets and outlets of all ventilation systems to be capable of being closed from the outside of the spaces being ventilated, as well as the means of closing to be easily accessible, the Commercial Yacht Code, 2015 placed this requirement only for ventilation ducts/fans of the machinery spaces and galleys (sections 11.1.3 and 11.2.2.1).
4. Only Section 4.2.8.1 of the Commercial Yacht Code, 2015 required ventilators to be provided with permanently attached means of weathertight closure, which were to be easily accessible. The Code did not address the means of closure from the point of view of control of air supply, which could pose a potential for fire growth.
5. The only means to detect a fire in the garage were through a photoelectric smoke detector and a fire patrol.
6. There was no gas detector fitted in the garage, which could have provided an early warning of the situation in the garage; probably even before the activation of the fire alarm triggered by the smoke detector.

7. There was no evidence of the garage extraction fan being stopped after the fire was discovered.
8. A fire in the garage could only be extinguished by fire fighters using the sole access from the galley. No fixed fire extinguishing system was installed on *Kanga*.

RECOMMENDATIONS

Floating Life International S.A. is recommended to:

16/2019_R1 review the procedures on the frequency of, and intervals between fire patrols on board;

16/2019_R2 where applicable, consider additional means of surveillance of various spaces on board, to ensure early warning of a fire;

The flag State Administration is recommended to:

16/2019_R3 either revise Information Notice 20, or issue a new Information Notice to address the potential hazards of Li-ion batteries;

16/2019_R4 review the Commercial Yacht Code, 2015 to address the storage of Li-ion batteries and equipment powered by Li-ion batteries;

16/2019_R5 review the Commercial Yacht Code, 2015 to address the means of closing ventilation systems on board yachts for fire protection;

16/2019_R6 review the 'Commercial Yacht Initial Inspection Report' and the 'Commercial Yacht Survey Report' to take into account the equipment stored / intended to be stored in a garage space and which may necessitate additional safety and fire-protection measures.

SHIP PARTICULARS

Vessel Name:	<i>Kanga</i>
Flag:	Malta
Classification Society:	RINA
IMO Number:	9842425
Type:	Commercial Yacht
Registered Owner:	Lady Luck Ltd.
Managers:	Floating Life International S.A.
Construction:	Steel & Aluminium
Length Overall:	40.88 m
Registered Length:	39.20 m
Gross Tonnage:	497
Minimum Safe Manning:	6
Authorised Cargo:	Not applicable

VOYAGE PARTICULARS

Port of Departure:	Montenegro
Port of Arrival:	Dubrovnik, Croatia
Type of Voyage:	Coastal
Cargo Information:	Not applicable
Manning:	9

MARINE OCCURRENCE INFORMATION

Date and Time:	07 September 2018, at 0845 (LT)
Classification of Occurrence:	Very Serious Marine Casualty
Location of Occurrence:	42° 46.1' N 017° 45.9' E
Place on Board	Garage space
Injuries / Fatalities:	None
Damage / Environmental Impact:	Material damage with operational consequences
Ship Operation:	Anchored
Voyage Segment:	Arrival
External & Internal Environment:	Weather: Clear. Visibility: 5 nautical miles. Wind: Beaufort Force 1. Sea State: Calm. Swell: Nil.
Persons on board:	13