



INTERIM REPORT

SINKING OF THE VESSEL BOURBON RHODE ON 26 SEPTEMBER 2019



DATE OF ISSUE: 15 April 2021

The information in this interim safety investigation report is subject to change and may contain errors. It will be supplemented or corrected during the course of the investigation.

ADMINISTRATION OF TECHNICAL INVESTIGATIONS

CIVIL AVIATION – RAILWAYS – MARITIME – RIVER – ROAD



Ministry of Mobility and Public Works

Department of mobility and transports

Administration of Technical Investigations

Report N° AET/TM-2021/01

INTERIM REPORT

Sinking of the vessel *Bourbon Rhode* on 26 September 2019

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FOREWORD

In accordance with Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and Luxembourg amended law dated 30 April 2008 on technical investigations in relation to accidents and serious incidents which occurred in the domains of civil aviation, maritime transport, railways and vehicle traffic on public roads, it is not the purpose of the maritime accident investigation to apportion blame or liability.

The sole objective of the safety investigation and the Final Report is the prevention of accidents and incidents.

Consequently, the use of this interim report for purposes other than accident prevention may lead to wrong interpretations.

Note 1: All times indicated in this report are in Universal Coordinated Time (UTC), unless stated otherwise.

Note 2: The reference coordinate system used in this report is WGS 84, unless stated otherwise.

Cover photo: Source – Bourbon Marine & Logistics

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AET	Administration des enquêtes techniques (Luxembourg safety investigation authority)
AHTS	Anchor Handling Tug Supply
ANA	Air Navigation Administration
 AIS	Automatic Identification System
BEAmer	Bureau d'enquêtes sur les événements de mer (French maritime safety investigation authority)
BOG	Bourbon Offshore Greenmar
BV	Bureau Veritas Marine & Offshore
CAM	Luxembourg maritime administration
Cf.	Confer
COMSAR	Sub-Committee on Radiocommunications and Search and Rescue
CROSS	Regional Operational Centres for Monitoring and Rescue
°C	Degree Celsius
DSC	Digital selective call
E	East
EGC	Enhanced Group Calls
EMSA	European Maritime Safety Agency
EPIRB	Emergency Position-Indicating Radio Beacon
ETA	Estimated time of arrival
FMCC	French Mission Control Centre
GMDSS	Global Maritime Distress Safety System
GPS	Global Positioning System
gt.	Gross tonnage
HF	High Frequency
hPa	Hectopascal
HSFAT2	High Seas Marine Text Forecasts for the Tropical Atlantic
Hz	Hertz
IAFS	International Convention on the Control of Harmful Anti-fouling Systems on Ships
ILO	International Labour Organization
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
ISM	International Safety Management
JRCC	Joint Rescue Coordination Centre
kHz	Kilohertz
Km	Kilometre
kt (s)	Knot (s)
kW	Kilowatt
LLCF	Load Line Change of Flag Survey
LLPI	Load Line Annual Survey
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSA	Lifesaving appliances

LT	Local Time
m	Metre
MF	Medium Frequency
mm	Millimetre
MAIB	Marine Accident Investigation Branch
MARPOL	International Convention for the Prevention of Marine Pollution
MHz	Megahertz
MMSI	Maritime Mobile Service Identity
MRCC	Maritime Rescue Coordination Centre
NAVTEX	Navigational text
N	North
NASA	National Aeronautics and Space Administration
NM	Nautical mile
NSIA	Norwegian Safety Investigation Authority
NTSB	National Transport Safety Board
NOAA	National Oceanic and Atmospheric Administration
OSC	On Scene Coordinator
PLB	Personal locator beacon
SAR	Search and Rescue
Sarsat	Search and Rescue Satellite Aided Tracking
SAT-AIS	Satellite - Automatic Identification System
SITREP	Situation report
SMS	Safety management system
SOLAS	International Convention for the Safety of Life at Sea
SSAS	Ship Security Alert System
t	Ton
TRS	Tropical Revolving Storm
TSIB	Transport Safety Investigation Bureau
USA	United States of America
UTC	Universal Coordinated Time
V	Volt
VHF	Very High Frequency
VSAT	Very-small-aperture Terminal
W	West
WGS 84	World Geodetic System (dating from 1984), the reference coordinate system used by the Global Positioning System

1. SUMMARY

On 17 September 2019 at 22:36, the Offshore Deep Water Anchor Handling Tug Supply (AHTS) vessel *Bourbon Rhode* left the port of Las Palmas, Gran Canaria (Spain) after extensive service and maintenance works in a local shipyard. The destination was Georgetown (Guyana), where a new contract was scheduled to start at the beginning of December 2019.

The transit voyage was uneventful up to the afternoon of 25 September 2019, when the vessel entered an area of tropical storm force winds¹ associated with hurricane Lorenzo.

In the morning of 26 September 2019, at 07:50, the Ship security alert system (SSAS)² transmitted an alert message via Inmarsat-C² which was first received by the Joint Rescue Coordination Centre (JRCC) Stavanger, Sola (Norway). A distress message was then sent by Digital Selective Call (DSC)² and was received by the Maritime Rescue Coordination Centre (MRCC) in Madrid (Spain) at 08:03. The Emergency Position-Indicating Radio Beacon (EPIRB) on the *Bourbon Rhode* was activated by the crew and the signal was received at 08:06 by the French mission control centre (FMCC) in Toulouse (France) via a MEOSAR³ satellite. At 08:45, the Master reported to the Bourbon Offshore Greenmar (BOG) ship manager by Inmarsat-C text message that the vessel was sinking, with water in the engine room.

The vessel was located in the West Indies sector where the MRCC Fort-de-France, Martinique (France) was in charge of search and rescue (SAR) operations. At 09:18, the MRCC Fort-de-France launched the active SAR operations with a call for assistance to the bulk carrier *SSI Excellent*, located approximately 200 NM to the south of the *Bourbon Rhode*'s position. At 12:43, the last position received from the vessel's Satellite-Automatic Identification System (SAT-AIS) was 15°35.383' N, 040°12.783' W. The EPIRB continued transmitting signals that were received by the Cospas-Sarsat² system until 13:50 on 30 September 2019.

On 28 September 2019, at 12:41, three survivors were recovered from a life raft by the bulk carrier *Piet*. According to the survivor statements, the *Bourbon Rhode* had foundered on 26 September 2019 shortly after they abandoned the vessel. The vessel's position was approximately 963 NM east of the coast of French Guiana and 896 NM west of Cape Verde.

On 12 October 2019, the MRCC Fort-de-France suspended the SAR operations but continued to request vessels in the accidents greater area to keep a sharp lookout.

During the SAR operations, three survivors and the bodies of four crew members were recovered. At the time of publication of this interim report, seven crew members were still missing.

¹ Zone with winds of at least 34 kts.

² Cf. chapter "3.2.3. Communication equipment".

³ MEOSAR stands for Medium Earth Orbiting Search and Rescue. The search and rescue receivers are placed on the (Global Positioning System) GPS satellites operated by the United States, Russia, and Europe. These satellites are medium-altitude Earth orbit, at an altitude between 19,000 and 24,000 km. This next generation satellite system gives almost instantaneous locations and worldwide coverage for a vastly improved search and rescue system. (<https://www.sarsat.noaa.gov/meosar.html>)

2. FACTUAL INFORMATION

2.1. ORGANISATION OF THE INVESTIGATION

This marine casualty involved six substantially interested states:

- Croatia – nationality of one crew member
- Russia – nationality of one crew member
- South Africa – nationality of one crew member
- The Philippines – nationality of one crew member
- Ukraine – nationality of ten crew members
- Luxembourg – flag state of the *Bourbon Rhode*

In accordance with the provisions of International Maritime Organization (IMO) codes and Directive 2009/18/EC, the Administration of Technical Investigations (AET) initiated a Safety Investigation after having been informed in the evening of Saturday, 28 September 2019, that a Luxembourg-registered vessel had sunk at sea near the position 15°35.383' N, 040°12.783' W.

During the morning of 29 September 2019, the AET notified the occurrence to the five substantially interested states. It was agreed that the AET would be coordinating the safety investigation with the respective safety investigation authorities and take the lead of the investigation.

The AET further established contact with the following maritime safety investigation authorities to assist the investigation:

- The Bureau d'enquêtes sur les événements de mer (BEAmer, France) to facilitate the contact with the MRCC Fort-de-France and the judicial authority of Martinique;
- the Marine Accident Investigation Branch (MAIB, United Kingdom) to establish contact with INMARSAT based in London;
- the Norwegian Safety Investigation Authority (NSIA) to provide information from the JRCC Stavanger in Sola, Norway;
- the Transport Safety Investigation Bureau (TSIB, Singapore) to establish contact with the builder of the *Bourbon Rhode*;
- the Maritime administrator of the Republic of the Marshall Islands to provide information related to the rescue operations by the *SSI Excellent*;
- the Marine investigations department from the Republic of Liberia to provide information related to the rescue operations by the *Piet*.

The AET established contact with the following companies:

- Bourbon Services Luxembourg Sàrl, the company which the vessel was registered to on the Luxembourg Merchant register;
- Bourbon Marine & Logistics (Marseille, France), the bareboat charterer;
- Bourbon Offshore Greenmar (Bambous, Mauritius), the ship manager of the vessel.

2.2. SHIP PARTICULARS



Figure 2.1 – Picture of the *Bourbon Rhode*
(Source: Bourbon Marine & Logistics)

Ship Name:	<i>Bourbon Rhode</i>
Flag:	Luxembourg
IMO N°:	9356359
Call sign:	LXDZ
Type:	Offshore terminal tug
Built:	2006
Builder:	Keppel Singmarine Singapore
Hull material:	Steel
Hull Info:	One hull
Length overall:	49.5 m
Breadth:	15 m
Depth:	6.75 m
Draught:	5.6 m
Gross tonnage:	1375 t
Engine power and/or type:	2 x 2970 kW - Diesel
Propulsion:	2 x Azimuth Stern Driven Controllable Pitch Propeller
Auxiliary generators:	2x 250 kW + 580 kW, 440 V / 60 Hz each
Emergency generator:	94 kW, 440 V / 60 Hz
Rated speed:	13.5 kts
Fuel oil tank:	576 m ³ (maximum)
Potable water tank:	128 m ³
Minimum safe manning:	10

2.3. VOYAGE PARTICULARS

On 17 September 2019, at 22:36, the *Bourbon Rhode* departed from Las Palmas (Spain) with the destination Georgetown (Guyana). The daily report of the same day from 12:00 LT stated an estimated time of arrival (ETA) on 4 October 2019, at 04:00 Guyana LT and the vessel was supposed to start working for a new contractor on a five year contract at the beginning of December 2019.

Prior to departure, the *Bourbon Rhode* spent six weeks at a Las Palmas shipyard, where service and maintenance works were performed (Cf. chapter “3.2.9. Works performed at the shipyard in Las Palmas”). Furthermore, a change of the flag State to Luxembourg and an International Safety Management (ISM)⁴ ship management change to the company Bourbon Offshore Greenmar (Bambous, Mauritius) were executed.

The Master of the *Bourbon Rhode* prepared a rhumb line⁵ course to cross the Atlantic Ocean, as a great circle⁶ course planning would not have brought a great saving in distance.

The last position received from the vessel’s SAT-AIS on 26 September 2019, at 12:43, was 15°35.383’ N, 040°12.783’ W, about 963 NM northeast off the nearest South American coastline and 896 NM west of Cape Verde.

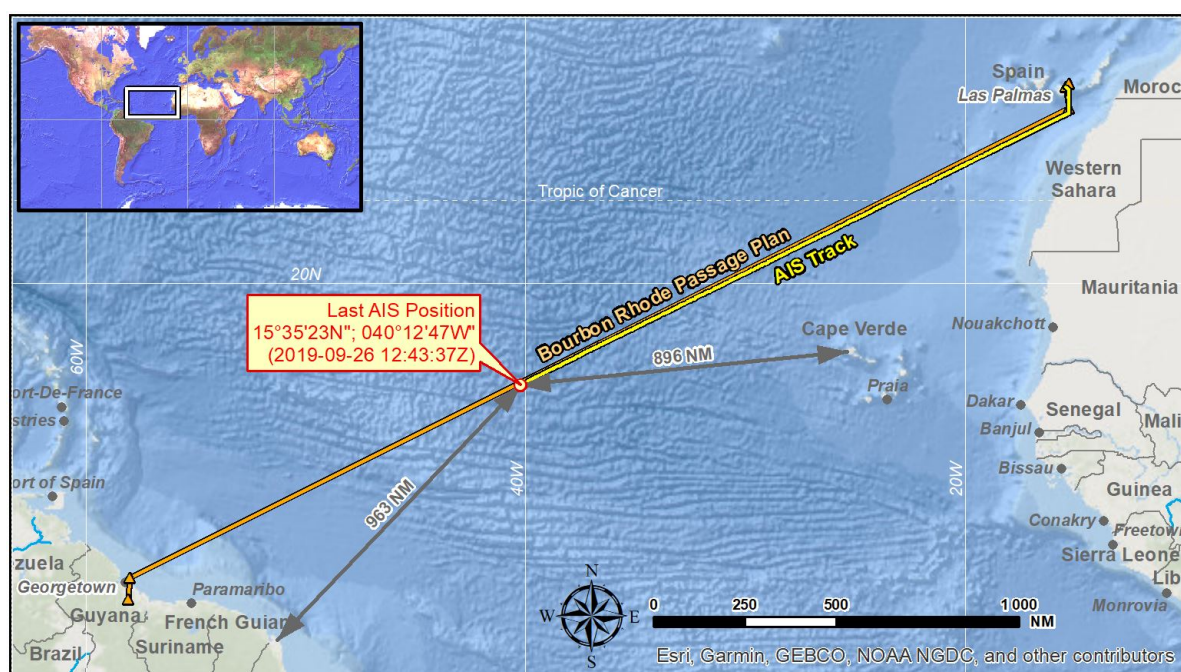


Figure 2.2 – *Bourbon Rhode*, track and last known position
(Source: Esri)

⁴ The International Safety Management (ISM) Code provides an international standard for the safe management and operation of ships at sea.

⁵ Rhumb line: also known as loxodrome, a path of constant bearing.

⁶ Great circle: also known as orthodrome, the segment of a circle representing the shortest distance between two terrestrial points.

2.4. MARINE CASUALTY OR INCIDENT INFORMATION

2.4.1. Accident details

Time and date:	At 12:43 on 26 September 2019
Causality event:	Foundering and sinking
Location of the accident:	15°35.383' N, 040°12.783' W (SAT-AIS, 12:43)
Persons on board:	14
Rescued:	3 <ul style="list-style-type: none">- Able seaman, Male, aged 26, Ukrainian national, 1 year of experience at sea- Able seaman, Male, aged 40, Ukrainian national, 5.5 years of experience at sea- Fitter, Male, aged 58, Russian national, 36 years of experience at sea
Deceased:	4
Missing:	7

2.4.2. Environmental summary

On 26 September 2019 at 12:00:

Sea state:	Very high (waves 9 - 14 m)
Wind:	Beaufort Force 12, hurricane wind speed > 64 kts
Precipitation:	Unknown
Lighting conditions:	Daylight
Visibility:	Very poor
Water temperature:	26°C

The environmental details will be dealt with in particular under the chapter "3.5. ENVIRONMENTAL DETAILS".

2.5. SHORE AUTHORITY INVOLVEMENT AND EMERGENCY RESPONSE

On 26 September 2019 at 07:50, the SSAS alert message was sent via Inmarsat-C and was first received by the JRCC Stavanger, Sola (Norway).

At 08:03, the MRCC Madrid (Spain) received a distress message via DSC and immediately informed the MRCC Fort-de-France and the company BOG ship manager, who initiated the company's internal emergency response procedure.

At 08:06, the crew activated the EPIRB of the *Bourbon Rhode* and the distress signal was received by the FMCC Toulouse, who forwarded the distress message to the MRCC Fort-de-France and to the Air Navigation Administration's (ANA) Aeronautical Information Service (AIS) in Luxembourg. The information was then forwarded by the ANA to the Luxembourg maritime administration (CAM). The MRCC Fort-de-France initiated and coordinated the SAR operations, alerting all vessels in the greater vicinity of the emergency and requesting assistance. The first co-ordinating instruction was a call for assistance to the *SSI Excellent* at 09:18. At 10:21, the CAM forwarded the distress information received from the FMCC Toulouse by email to the AET.

On 28 September 2019, at 12:41, the *Piet*, a vessel participating in the SAR operations, recovered three survivors from a life raft.

On 12 October 2019, the MRCC Fort-de-France suspended the SAR operations by active means and continued to issue messages to vessels in the area where the *Bourbon Rhode* sank, requesting a sharp lookout and to report any related sightings.

During the SAR operations, the bodies of four crew members were recovered. Seven crew members were still missing at the time of publication.

The SAR operations are detailed under the chapter "3.11.2. Search and rescue operations".

2.6. INFORMATION COLLECTED DURING THE INVESTIGATION

In this safety investigation, the following information and documents were used:

- The situation reports (SITREP) issued by the MRCC Fort-de France,
- The information issued by the prefecture of Martinique,
- The daily reports issued by the *Bourbon Rhode*
- The data sent by the EPIRB of the *Bourbon Rhode*,
- The navigational tracks from the *Bourbon Rhode*'s SAT-AIS and FUELTRAX system,
- The data of hurricane Lorenzo issued by the National Hurricane Centre, United States of America (USA),
- The statements of the Master of the *Piet* and the navigational tracks,
- The statements of the Master of the *SSI Excellent* and the navigational tracks,
- The communications sent from and received by the *Bourbon Rhode* between 20 September 2019 and 27 September 2019,
- The documents issued by the classification society,
- The experience, certification and training documents related to the crew,
- The documents issued by the Luxembourg maritime administration,
- The general arrangements and construction plans of the *Bourbon Rhode*,
- The METAREA⁷ II and the High Seas Marine Text Forecasts for the Tropical Atlantic region⁸ (HSFAT2) forecasts, warnings and the navigational text (NAVTEX) messages,
- The documents in relation with the lifesaving appliances (LSA) used on board the *Bourbon Rhode*,
- The vessel's safety management system (SMS) document and relevant procedures,
- The work orders and works performed at the shipyard in Las Palmas,
- The information received from the ship builder,
- The documents and information received by the vessel's management,
- The documents received by the judicial authorities in Luxembourg and France,
- The interviews and statements of the three rescued crew members.

Due to the sinking of the *Bourbon Rhode*, neither on-board documents nor shipborne-recorded data were available to the investigation.

⁷ METAREAs are geographical sea regions for the purpose of coordinating the transmission of meteorological information to mariners on international voyages through international and territorial waters. These regions are part of the Global Maritime Distress Safety System. Mariners receive the meteorological and navigational information via NAVTEX.

METAREA II – Issued and prepared by METEO-France
Covering the Atlantic waters east of 35° W, from 7° N to 48°27' N, and east of 20° W from 7° N to 6° S, including the Straits of Gibraltar

⁸ HSFAT2 – Issued by the National Hurricane Centre Miami (US)
Covering the Atlantic waters from 7° N to 31° N west of 35° W including the Caribbean Sea and the Gulf of Mexico.

3. NARRATIVE

The *Bourbon Rhode*, an Offshore Deep Water AHTS vessel with 100 t bollard pull and two 2970 kW diesel engines, was built at the Keppel Singmarine Shipyard (Singapore) in 2006. A second vessel of the same design, the *Bourbon Rhesos*, was built the same year at the same shipyard and brought into service shortly after the *Bourbon Rhode*. Both vessels were under contract in West African waters off the Nigerian coast and sailed under Saint Vincent and the Grenadines flag from April 2007 on. At the time, they were under the management of Bourbon Interoil Nigeria Limited and remained in the region from thereon. In August 2014, the flag of the *Bourbon Rhode* was changed to Nigeria.

The *Bourbon Rhode* was relocated for the first time in July 2019 to Las Palmas (Spain) at a local shipyard, where extensive maintenance work was performed, including the dry docking, to prepare the vessel for the next charter contract in Guyana. The job list included the annual classification and statutory surveys, which were completed on 13 September 2019 with no recommendations.

Further to the works at the shipyard, the vessel was transferred to the Luxembourg flag and an ISM ship management change to the company Bourbon Offshore Greenmar was performed. The certification by the Bureau Veritas Marine & Offshore (BV) was completed on 13 September 2019.

The crew joined the vessel at the shipyard and prepared the *Bourbon Rhode* for the trans-Atlantic voyage to the next area of operation, as per company requirements. The standard manning was complemented with a supernumerary Fitter, who was tasked to finish steel works that had not been completed at the shipyard.

The Passage Plan (Cf. chapter “3.4. *PASSAGE PLAN*”) was prepared in accordance with the vessel’s SMS and the Master sent it to the company BOG ship manager on 17 September 2019. The plan did not contain any special requirements or remarks and was accepted as presented.

The operational communication equipment was compliant with the Global Maritime Distress Safety System (GMDSS) and VSAT⁹ was considered as operational. The vessel’s FleetBroadband⁹ was not operational and the Inmarsat-C system was intended to be used as a backup.

On 17 September 2019, 431.33 m³ of fuel were bunkered and the *Bourbon Rhode* departed Las Palmas at 22:36. The vessel was planned to sail at economical speed¹⁰. The daily report from that day stated an ETA at destination in Georgetown (Guyana) on 4 October 2019 at 04:00 LT. The start of operations as terminal tug at the offshore oil field was scheduled in December 2019.

Upon voyage commencement, the weather conditions were calm. No meteorological warnings had been issued at that time and a direct track to the next waypoint on a heading of 244°, situated 2722 NM to the west, was steered at 08:50 on 18 September 2019.

⁹ Cf. chapter “3.2.3. *Communication equipment*”.

¹⁰ Economic speed is the rotation per minute at which an engine can be run at minimum fuel consumption.

On 22 September 2019, the weather reports received by the *Bourbon Rhode* first mentioned a tropical wave on an axis along 16° / 17° W and south of 19° N, moving west at 10 - 15 kts. The associated low pressure system at 1007 hPa was located near the position 11° N, 16° W and expected at 1004 hPa near position 11° N, 23° W by 23 September at 12:00.

On 23 September 2019 at 12:00, the low-pressure system evolved into tropical storm Lorenzo, at that time approximately 700 NM southeast of the *Bourbon Rhode*'s position. On 25 September 2019 at 06:00, tropical storm Lorenzo was upgraded to a category 1 hurricane and continued to intensify. In the afternoon of 25 September 2019, the vessel entered an area of tropical storm force winds associated with hurricane Lorenzo. On 26 September 2019 at 00:00, Lorenzo evolved to a category 2 hurricane with sustained winds of 85 kts.

In the morning of 26 September 2019, at 07:50, a first SSAS distress alert message was sent via Inmarsat-C and received by the JRCC Stavanger, Sola (Norway). At 08:03, a distress message was received via DSC by the MRCC Madrid (Spain) and passed on to the MRCC Fort-de-France. The EPIRB on the *Bourbon Rhode* was activated by the crew and the signal was received at 08:06 by the FMCC Toulouse (France). Further SSAS distress alert messages with updated positions were sent at 08:10 and 08:50 and received by the JRCC Stavanger.

At 09:18, the MRCC Fort-de-France initiated and coordinated the SAR operations, alerting all vessels in the greater vicinity of the emergency and requiring assistance. Furthermore, aerial assets were requested to assist the SAR efforts.

Based on the Inmarsat-C communication between the vessel and the company BOG ship manager, it could be assessed that the *Bourbon Rhode* experienced water ingress in the Z-Drive compartment (aft-most compartment) and lost propulsion and steering in the morning of 26 September 2019.

On 26 September 2019 at 12:00, Lorenzo was upgraded to a category 3 hurricane with sustained winds of 110 kts. The *Bourbon Rhode* sank at about 12:30, shortly after the Master of the *Bourbon Rhode* sent the last message received ashore via Inmarsat-C, stating that the engine room and Z-Drive compartment had been isolated and that the water levels were increasing.

At 12:43, the last position received from the vessel's SAT-AIS was 15°35.383' N, 040°12.783' W. The hurricane reached category 4 winds later that afternoon and continued to intensify. The EPIRB continued to transmit a distress signal until 30 September 2019 at 13:50.

Two days after the sinking, the *Piet* rescued three crew members from one of the life rafts of the *Bourbon Rhode*.

The SAR operations by active means were initially suspended on 5 October 2019. On 7 October 2019, after the offshore tug *ALP Striker* sighted a white flare, SAR operations by active means resumed and were finally suspended by the MRCC Fort-de-France on 12 October 2019 with no further sightings or findings.

The SAR operations had involved 20 vessels and 15 overflights. Three survivors were rescued and the bodies of four crew members were recovered, leaving seven crew members of the *Bourbon Rhode* unaccounted for at the time of publication.

3.1. FACTUAL TIMELINE

Date	Time	Event	Comment
17.09.2019	22:36	The <i>Bourbon Rhode</i> departed Las Palmas Port	At appr. 8 kts ¹¹ , based on SAT-AIS data
19.09.2019	-	VSAT performance (Voice and Data) erratic	Change of satellite coverage not effective
21.09.2019	07:58-09:57	Engine 2 stopped for maintenance	Based on FUELTRAX data
22.09.2019	09:21-10:34	Engine 2 stopped for maintenance	Based on FUELTRAX data
26.09.2019	07:34	Significant speed drop due to loss of propulsion	Based on FUELTRAX data
	07:50	SSAS alert message sent via Inmarsat-C and received by the JRCC Stavanger, Sola (Norway)	LAT: 15°45' N LON: 39°53' W Course : 209° Speed : 02 kts
	08:03	Distress message received via DSC by the MRCC Madrid and forwarded to the MRCC Fort-de-France	
	08:06	EPIRB first detected by the Cospas-Sarsat system	Detected by MEOSAR satellite
	08:10	SSAS alert message sent via Inmarsat-C and received by the JRCC Stavanger, Sola (Norway)	LAT: 15°44' N LON: 39°34' W COURSE: 251° SPEED: 13 kts
	08:10	First EPIRB message sent from the Cospas-Sarsat FMCC, Toulouse, to the MRCC Fort-de-France and to ANA AIS in Luxembourg	
	08:20	SSAS alert message sent via Inmarsat-C and received by the company BOG ship manager	LAT: 15°44.48' N LON: 039°55.04' W COURSE: 195° SPEED: 03 kts
	08:45	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>“Bourbon Rhode sinking. Water in the engine room.”</i>	

¹¹ Speed derived from GPS position, equals to speed over ground.

	09:13	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"Bourbon Rhode sinking. Water in the engine room. LAT 15°43.6 N; LONG 039°56.1 W"</i>	
	09:18	Call for assistance to the SSI <i>Excellent</i> by the MRCC Fort-de-France, Martinique	First coordinating instruction
	09:23	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"Distress message received. Rescue operations organisation ongoing. Confirm situation on board: Injury? Propulsion availability? Life raft launching?"</i>	
	09:42	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"MRCC is coordinating the rescue Confirm the water level in the engine room (full or partial ingress). Confirm source and location of the water ingress. Confirm if the emergency generator is available and of bilge pump is running. Are you able to contain the water ingress and keep the vessel afloat/stability? We are all mobilized to assist you."</i>	
	09:42	Contact with the <i>Bourbon Rhode</i> reported by JRCC Australia	REPORT CREW ABANDON SHIP - 14 Persons On Board
	09:51	JRCC Australia: <i>"Bourbon Rhode unreachable"</i>	
	09:51	Engine 1 stopped	Based on FUELTRAX data
	09:57	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"No injuries, but we have no more engine, they are all down. All crew muster, ready and on standby... Life rafts not possible to launch, very rough sea, swell 10 metres or more."</i>	Engine 2 still running
	10:25	SSAS alert message sent via Inmarsat-C and received by the ship manager	LAT: 15°40.56' N LON: 040°03.22' W COURSE: 272° SPEED: 04 kts
	10:36	Engine 2 stopped, Generator 1 and Generator 2 starting	Based on FUELTRAX data

	10:51	Loss of the Generator 3	Based on FUELTRAX data Suspected cause: water ingress in the engine room
	10:52	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"We are no longer sustain, pump is out"</i>	
	11:02	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"Please confirm if the emergency generator is running"</i>	
	11:21	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"Rescue organisation ongoing. Confirm situation on board: injuries? Is the propulsion available? Life rafts launching?"</i>	
	11:35	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"M/V SSI Excellent is on her way to your position. Confirm which are the compartments flooded"</i>	
	11:46	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"Z-Drive compartment. Aft part of the engine room flooded."</i>	
	11:54	Message sent by the ship manager via Inmarsat-C and received by the <i>Bourbon Rhode</i> : <i>"Confirm if the Z-drive compartment is isolated. Confirm if the engine room is isolated. Confirm the source of the water ingress if possible."</i>	
	12:00	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"What is the estimated time of arrival at our location????"</i>	
	12:05	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"The water is increasing"</i>	

	12:26	SSAS alert message sent via Inmarsat-C and received by the ship manager	LAT: 15°36.14' N LON: 040°11.57' W COURSE: 245° SPEED: 04 kts
	12:28	Message sent from the <i>Bourbon Rhode</i> via Inmarsat-C and received by the ship manager: <i>"Z-drive isolated / Engine room isolated. The water is increasing"</i>	
	12:41	Message sent by the ship manager via Inmarsat-C: <i>"Confirm if the emergency generator or auxiliary generator is running"</i>	Message not received by vessel, delivery failure received by the ship manager
	12:43	Last position report received by SAT-AIS	LAT:15°35.383' N LON: 040°12.783' W
	13:32	Message sent by the ship manager via Inmarsat-C: <i>"Maintain the communication and send us a message every 15 minutes"</i>	Message not received by vessel, delivery failure received by the ship manager
27.08.2019	10:38	US MRCC confirms flight by US aircraft <i>Hurricane Hunter</i>	Aircraft expected to be on scene at 12:00
	12:42	The <i>SSI Excellent</i> arrives on scene	
	19:26	The <i>SSI Excellent</i> has investigated the position of the lifejackets spotted by aircraft <i>Hurricane Hunter</i>	Lifejackets found at sea, nothing else to report in the area
	22:38	The <i>SSI Excellent</i> has sighted the EPIRB at sea	Nothing else to report in the area
28.09.2019	12:41	The 3 survivors were rescued from a life raft by the <i>Piet</i>	Survivors confirmed the sinking of the <i>Bourbon Rhode</i> on 26 September 2019

3.2. VESSEL

3.2.1. Vessel design

The Rampage 5000 Z-M class single hull *Bourbon Rhode* was constructed of welded steel, had an overall length of 49.5 m and a breadth on main deck of 15 m. The vessel was equipped with two azimuth stern driven controllable pitch propellers powered by two 2970 kW diesel engines allowing a rated speed of 13.5 kts and a bollard pull of 100 t.

The *Bourbon Rhode* was divided into 5 decks, with the tank top being the lowest deck. Starting from above, the wheelhouse deck was the smallest area deck accommodating the navigational bridge and towards the stern, the ship and winch control station.

Situated one deck below, the accommodation deck provided space for four cabins, including those of the master, the chief engineer and the chief mate. The accommodation deck also housed the air intake for the heating, ventilation and air conditioning system on the starboard aft outside corner next to the funnel.

Below the accommodation deck was the forecastle deck which gave space for an office, one junior officer cabin and 3 crew cabins. The forecastle deck also provided open deck space for the fast rescue boat mounted to a davit on port side, the mooring winch and bollards forward, the provision crane on starboard and the life rafts (two on each side of the deck). The engine room air intake was positioned on the starboard side corner facing aft of the forecastle deck accommodation.

The vessels main deck was divided, to the forward, into accommodation spaces and to the stern, the open working deck. The interior spaces included the bosun's store at the bow, the mess and day rooms, dry and cold stores, 2 crew cabins and the ship's hospital. The outside deck area accommodated the vessel's winch with its 120 t tow hook, the emergency generator room and a deck store on port side, the paint locker and CO₂ fixed firefighting system room on starboard side. Behind the vessel's winch, two weather tight doors provided access to the vessels accommodation spaces. Further aft on the starboard side was a watertight engine room escape hatch, followed in the centre by a watertight engine room skylight hatch.

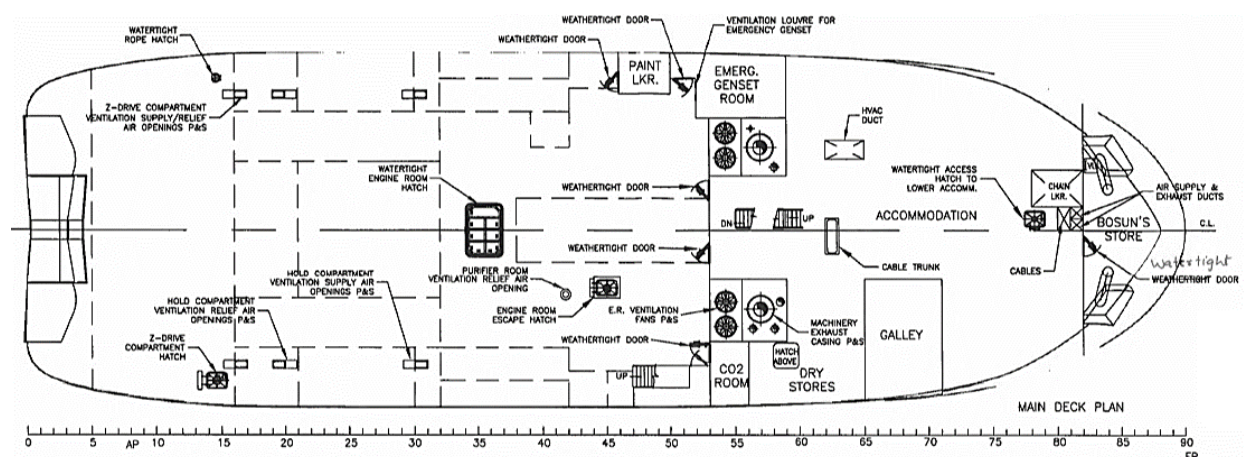


Figure 3.1 – *Bourbon Rhode*, Main deck plan
(Source: Bourbon Marine & Logistics)

The main deck had a designated working and cargo area separated from the port and starboard walkways by steel protective constructions, intended to allow safe passage on both sides of the vessel to reach the stern capstans, bollards, bulwark gates, several ventilation ducts and the Z-Drive compartment hatch on the starboard side. Located in the middle of the aft-most part of the work deck, in front of the stern roller, were the retractable towing pins and shark jaws. When retracted both systems were flush with the deck.

3.2.1.1. Watertight compartments

Below the main deck and the waterline of the *Bourbon Rhode*, the lower deck was divided into four watertight compartments, comprising of five separated spaces. The most forward space accommodated further cabins, the ships laundry and linen store. Behind that, separated by a fire door, were the engine control room on starboard side and the workshop on port side. From here, next to the centre line of the vessel on port side and adjoining the watertight door leading to the engine room, a staircase lead up to the main deck.

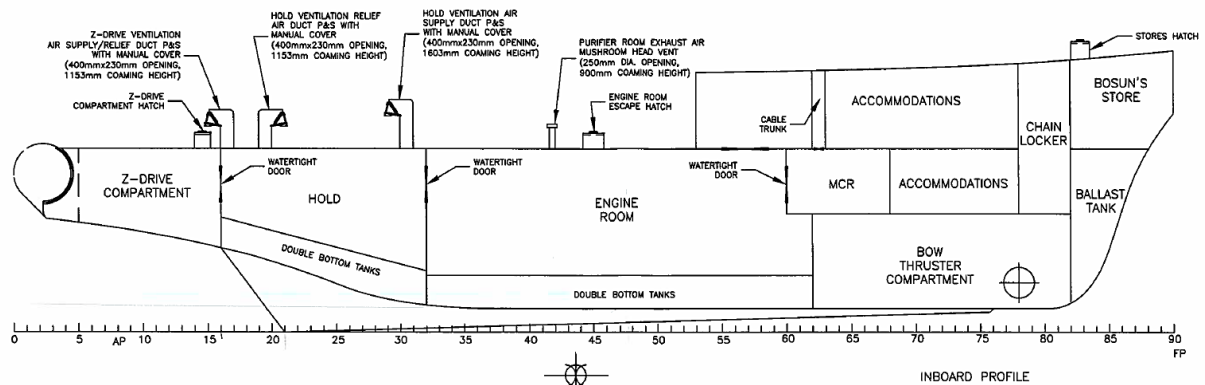


Figure 3.2 – *Bourbon Rhode*, Compartments plan
(Source: Bourbon Marine & Logistics)

The engine room, the largest inside space, was divided into two levels and could be accessed through a watertight door on the lower deck onto a walkway leading to spaces for the cold room, the air conditioning compressor set, the air compressors and the separate purifier room.

From this level, stairs on the port and starboard side lead down to the tank top level where the generator sets and the two main engines, one on port and one on starboard side, were located. Fuel oil and lube oil tanks were positioned between the main engines.

On the lower deck level, at the aft end of the engine space, two separate walkways located in the hold could be accessed through watertight sliding doors. The walkways on either side of the fuel oil tanks and situated next to the port and starboard shaft tunnels, both gave access to the Z-Drive compartment through a further pair of watertight doors.

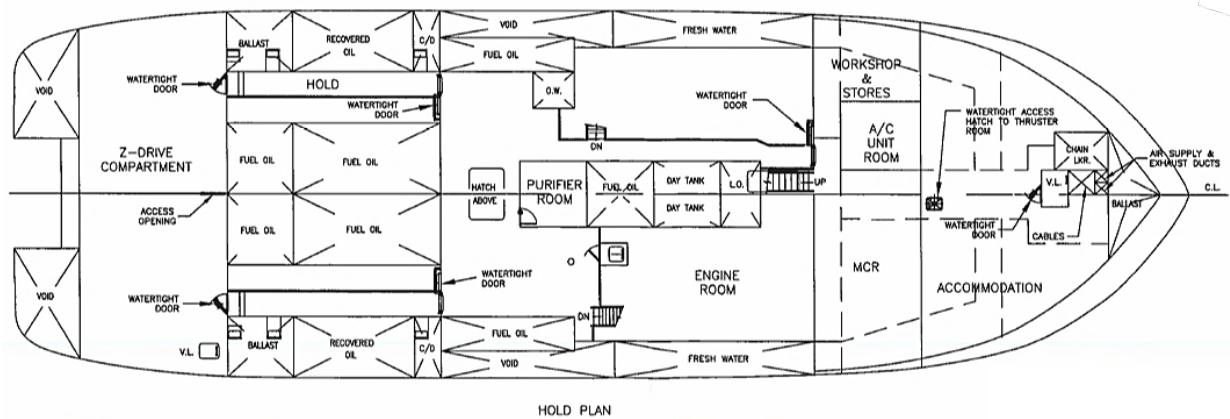


Figure 3.3 – *Bourbon Rhode*, Lower deck
(Source: Bourbon Marine & Logistics)

On tank top level, forward of the engine spaces and separated by a bulkhead, further tanks for fuel, ballast, fire and oil pollution fighting liquids were situated. The emergency fire and foam pump and sewage treatment plant were positioned between the ballast tanks. The bow thruster was located below and was only accessible through a hatch from the lower deck above. The bilge pump system was located midship on the starboard side

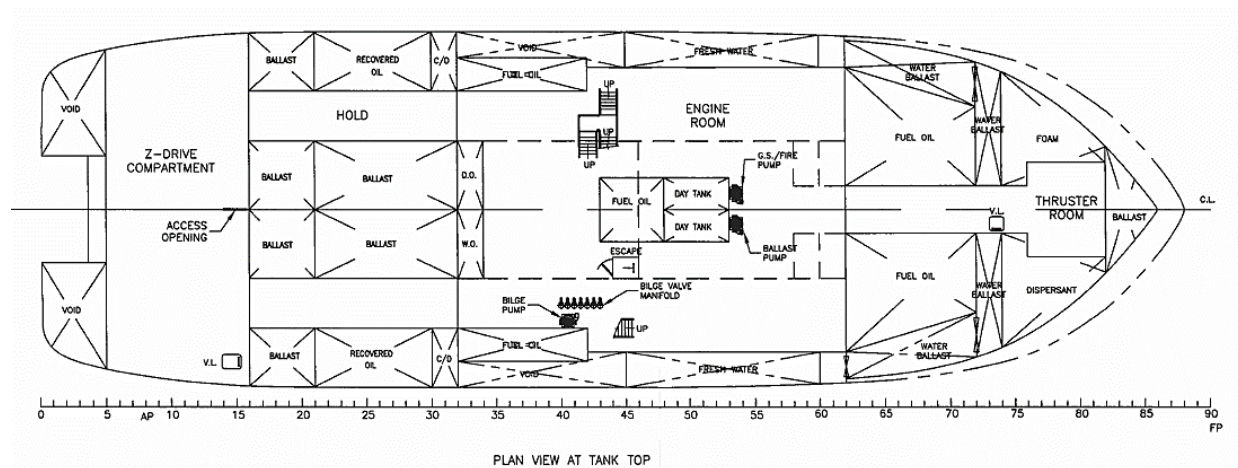


Figure 3.4 – *Bourbon Rhode*, Tank top plan
(Source: Bourbon Marine & Logistics)

3.2.1.2. Z-Drive compartment

The Z-Drive compartment, situated at the stern of the *Bourbon Rhode*, was as a relatively low volume space fitted with propulsion and steering equipment and the self-contained units for the shark jaws and towing pins. Due to the vessel's under water hull design, the stern section of the hull only had little draft due to the position of the large Z-Drive azimuth pods. The floor plates of the compartment were just above the tank top level at the stern.

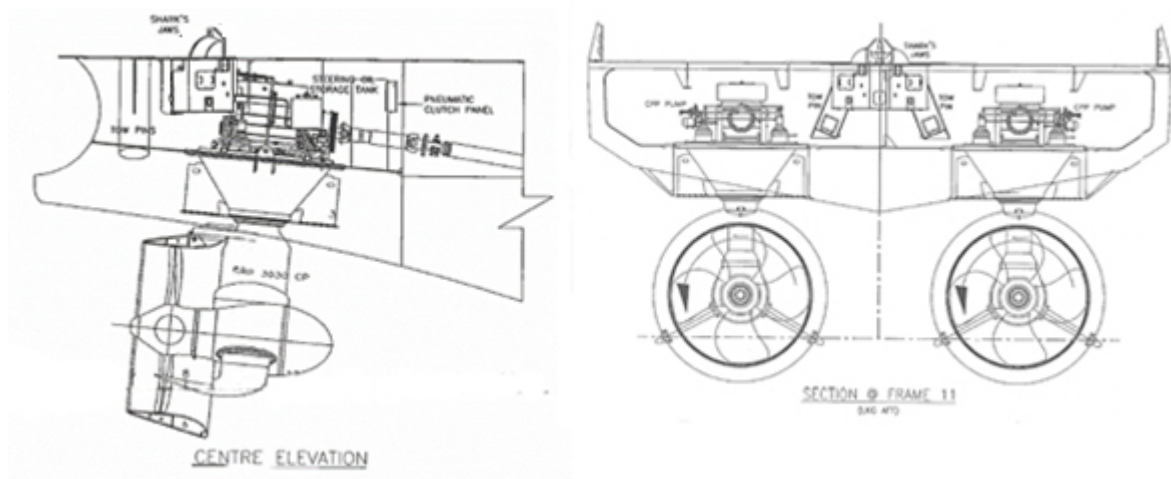


Figure 3.5 – Bourbon Rhode, Z-Drive compartment plan
(Source: Bourbon Marine & Logistics, modified by the AET)

The Z-Drive compartment space accommodated the Z-Drive azimuth pods, including the related hydraulic pumps and electrical cabinets. The installed electrical equipment included the port and starboard Schottel rudder propeller terminal boxes, the port and starboard pitch aggregate terminal boxes, feedback units and the pitch warning transmitters.



Figure 3.6 – Pitch Aggregate Component on one Z-Drive (Bourbon Rhode, 2015)
(Source: Bourbon Marine & Logistics)

The steering system and electrical cabinets were positioned on floor plate level. The cabinets were open at the base and thus left the electrical components unprotected against water in case of flooding.



Figure 3.7 – Electrical Cabinets in Z-Drive compartment (*Bourbon Rhesos*, 2019)
(Source: Bourbon Marine & Logistics)

3.2.1.3. *Aspects related to the vessel design*

The Z-Drive compartment was a compartment of comparably small volume fitted with, on the upper side the Shark Jaws and towing pins housing frames and on the lower part the two Z-Drive azimuth pods with all essential equipment to operate the propulsion and steering system.

From a stability and floatability perspective, the flooding of the watertight Z-Drive compartment alone would not have had a major effect on the vessel. However, the presence of unprotected electrical equipment required to operate the Z-Drive azimuth pods, and thus ensure the propulsion and steering, made the vessel vulnerable in case of water ingress into this compartment.

In the event of flooding of the Z-Drive compartment, it can be assumed that contact of the electrical components with water would lead to a short circuit and thus affect the ability of the vessel to maintain propulsion and steering.

In the investigated case, priority was given to maintaining the propulsion and steering operational by trying to control the water level in the Z-Drive compartment. Isolating the Z-Drive compartment in case of flooding would entail the loss of steering and propulsion, thereby exposing an uncontrollable vessel to inclement weather and sea conditions.

3.2.1.4. Z-Drive failure modes in case of flooding

In order to assess the failure mode of the Z-Drive in case of flooding of the Z-Drive compartment, Bourbon Marine & Logistics performed tests on the sister vessel *Bourbon Rhesos*.

The *Bourbon Rhesos* crew simulated potential short circuits caused by flooding by pulling the circuit breakers with fully operational propulsion and steering.

The results of the simulation were as follows:

- the propeller blades remained in the same pitch position as they were before opening the electrical circuit with the breakers;
- the direction of the thrusters remained in the same position that they were set to before opening the electrical circuit with the breakers;
- Propulsion to the thrusters was removed through declutching.

It was further noted that any failure of the Z-Drive triggered an immediate declutching, thus removing propulsion and associated steering by the thrusters.

3.2.2. General arrangement plan

RAmpage 5000 Z-M

PARTICULARS:

LENGTH OVERALL	49.50 METRES
LENGTH, WATERLINE	47.00 METRES
BEAM MAX	15.00 METRES
DEPTH, MOULDED	6.75 METRES
HULL DRAFT	4.75 METRES
LOADLINE DRAFT	5.60 METRES
TOTAL POWER	2 x 2970kW
BOLLARD PULL	100 TONNES
COMPLEMENT	22

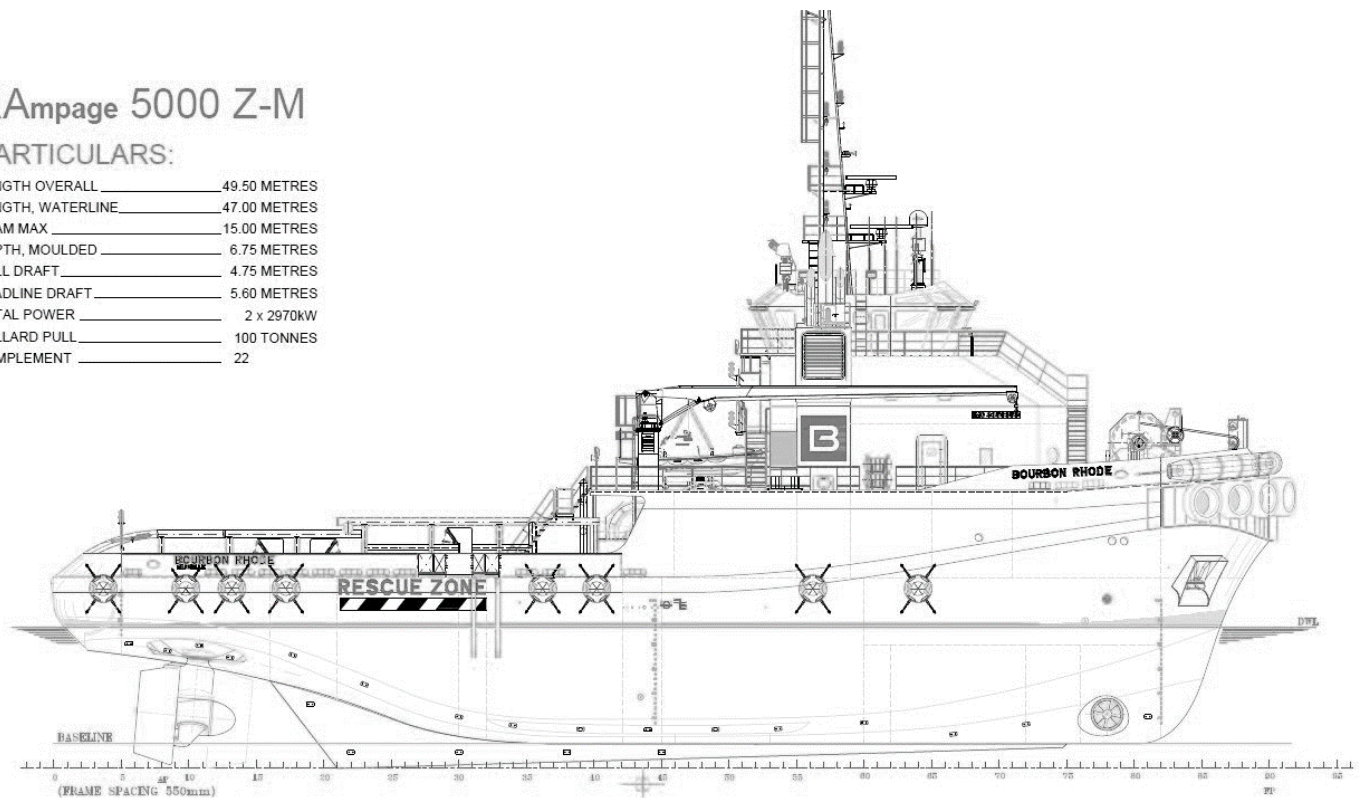


Figure 3.8 – Bourbon Rhode, Starboard side view
(Source: General arrangement plan, CAM)

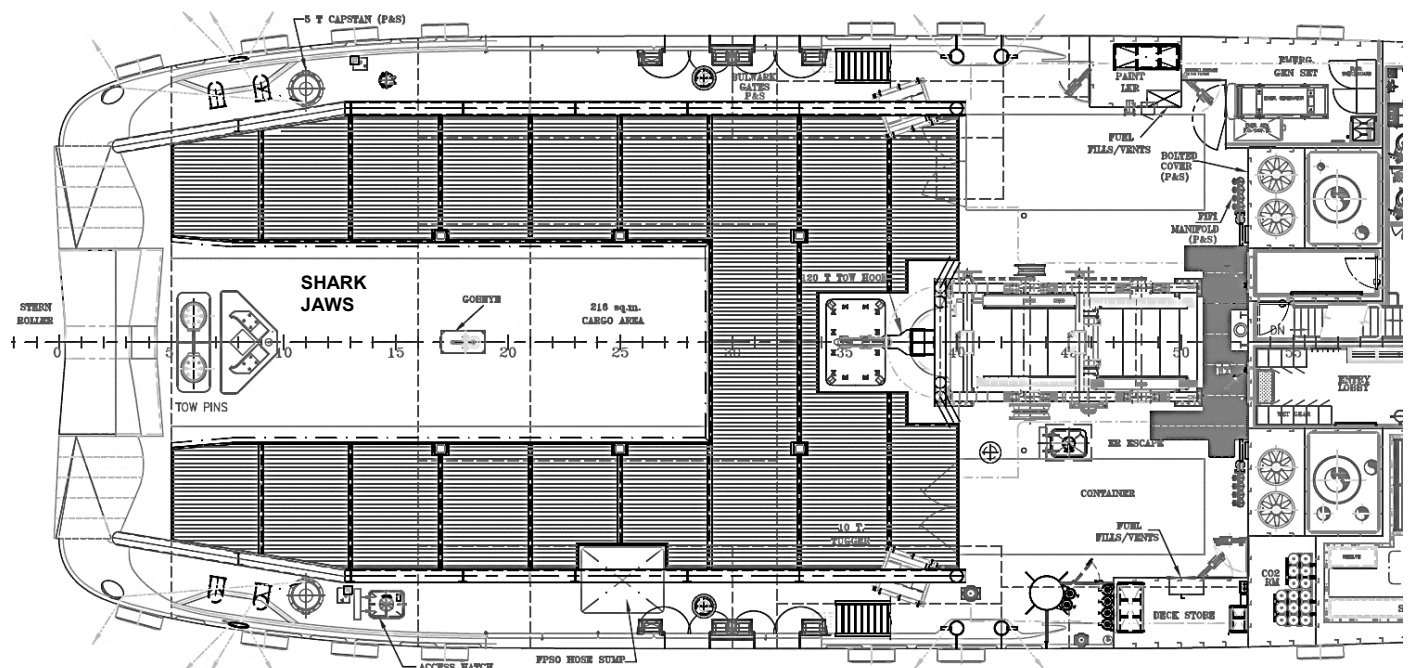


Figure 3.9 – Bourbon Rhode, Main deck, aft part
(Source: General arrangement plan, CAM)

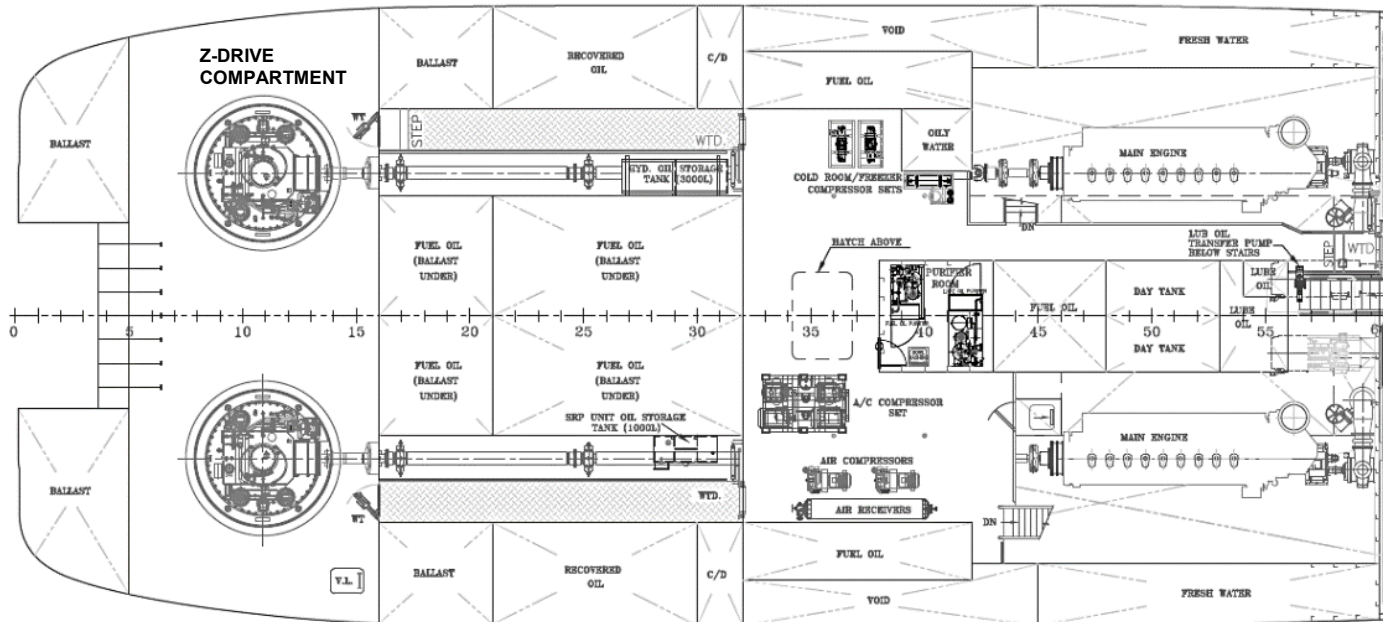


Figure 3.10 – Bourbon Rhode, Lower deck, aft part
(Source: General arrangement plan, CAM)

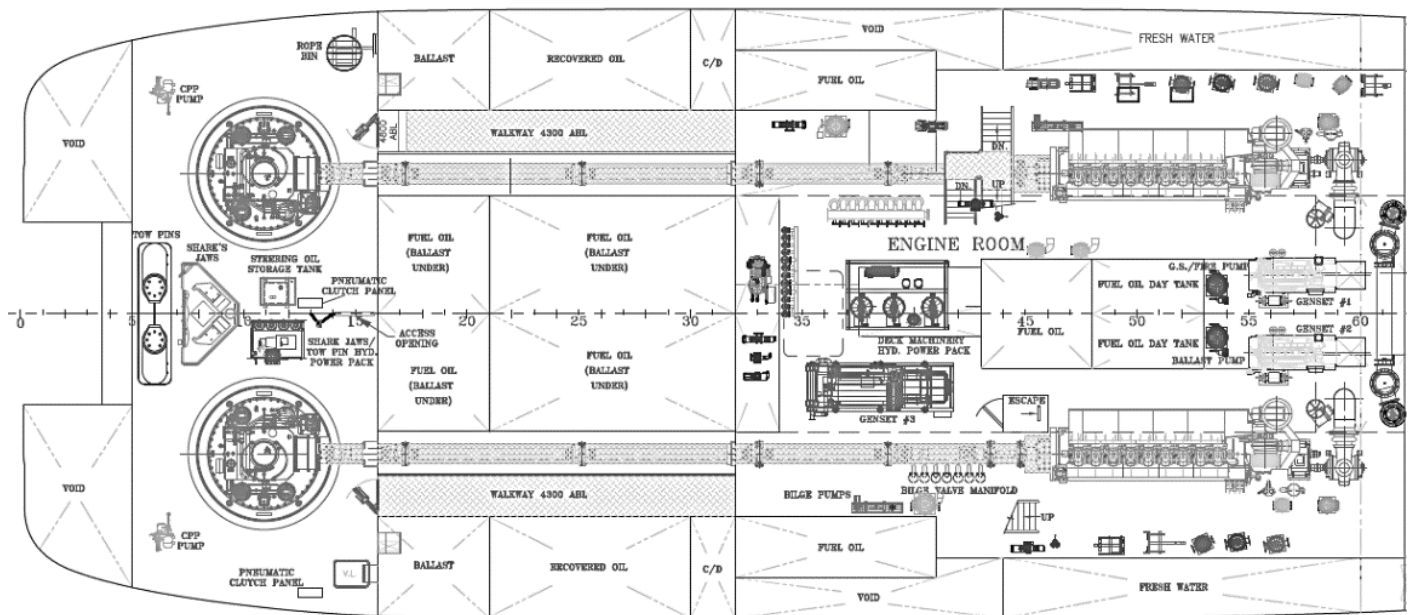


Figure 3.11 – Bourbon Rhode, Tank deck, aft part
(Source: General arrangement plan, CAM)

3.2.3. Communication equipment

3.2.3.1. *Mandatory communication equipment*

In accordance with the *IMO, Sub-Committee on Radiocommunications and Search and Rescue (COMSAR) / Circ.32, HARMONIZATION OF GMDSS REQUIREMENTS FOR RADIO INSTALLATIONS ON BOARD SOLAS¹² SHIPS, Chapter 2.2, Equipment requirements (including duplication of equipment) for SOLAS ships*, the GMDSS equipment requirements in force for all passenger ships in international trade as well as cargo ships of 300 gt. and upwards in international trade are the following:

Equipment	A1	A2	A3 Inmarsat solution	A3 HF solution	A4
VHF with DSC	x	x	x	x	x
DSC watch receiver channel 70	x	x	x	x	x
MF telephony with MF DSC		x	x		
DSC watch receiver MF 2187,5 kHz		x	x		
Inmarsat ship earth station with EGC receiver			x		
MF/HF telephony with DSC and NBDP				x	x
DSC watch receiver MF/HF				x	x
Duplicated VHF with DSC			x	x	x
Duplicated Inmarsat SES			x	x	
Duplicated MF/HF telephony with DSC and NBDP					x
NAVTEX receiver 518 kHz	x	x	x	x	x
EGC receiver	x ¹	x ¹		x	x
Float-free satellite EPIRB	x	x	x	x	x ⁴
Radar transponder (SART)	x ²	x ²	x ²	x ²	x ²
Hand held GMDSS VHF transceivers	x ³	x ³	x ³	x ³	x ³
For passenger ships the following applies from 01.07.97					
“Distress panel” (SOLAS regulations IV/6.4 and 6.6)	x	x	x	x	x
Automatic updating of position to all relevant radiocommunication equipment regulation IV/6.5. This also applies for cargo ships from 01.07.02 (chapter IV, new regulation 18)	x	x	x	x	x
Two-way-on-scene radiocommunication on 121,5 and 123,1 MHz from the navigating bridge. (SOLAS regulation IV/7.5)	x	x	x	x	x

¹⁾ Outside NAVTEX coverage area.

²⁾ Cargo ships between 300 and 500 gt.: 1 set. Cargo ships of 500 gt. and upwards and passenger ships: 2 sets.

³⁾ Cargo ships between 300 and 500 gt.: 2 sets. Cargo ships of 500 gt. and upwards and passenger ships: 3 sets.

⁴⁾ Inmarsat E-EPIRB cannot be utilized in sea area A4.

Figure 3.12 – GMDSS requirements for radio installations on board SOLAS ships
(Source: IMO COMSAR / Circ.32)

¹² International Convention for the Safety of Life at Sea.

The sea areas are defined as follows:

- A1: sea area within range of shore-based VHF DSC coast station (40 nautical miles);
- A2: sea area within range of shore-based MF DSC coast station (40 to 150 nautical miles);
- A3: sea area within the coverage of an Inmarsat geostationary satellite (approximately 70° N to 70° S, excluding sea areas A1 and A2);
- A4: the remaining sea areas, covering the Polar Regions.

The mandatory communication equipment (A3 Inmarsat solution) was operational on the *Bourbon Rhode* and the vessel was also equipped with satellite communication by VSAT, which could be used for data and voice communications

3.2.3.2. Communication equipment of the *Bourbon Rhode*

This section describes the means of communication which were installed on the *Bourbon Rhode* and details their availability during the passage. It also includes means for communicating distress and security alert messages. The respective source of the descriptions is indicated in a footnote.

- *Digital Selective Call*¹³

Digital Selective Call (DSC) is a standard for transmitting pre-defined digital messages via the medium-frequency, high-frequency and very-high-frequency maritime radio systems. It is a core part of the Global Maritime Distress Safety System (GMDSS).

On the *Bourbon Rhode*, DSC was available via VHF, watch receiver channel 70 and watch receiver MF 2187.5 kHz (both through Inmarsat-C).

- *Emergency Position-Indicating Radio Beacon*¹⁴

The Emergency Position-Indicating Radio Beacon (EPIRB), a Cospas-Sarsat beacon, also called a distress radio beacon or emergency beacon is a radio transmitter that can be activated in a life-threatening emergency to summon assistance from government authorities.

The *Bourbon Rhode* was equipped with an EPIRB model which did not transmit position data when activated.

- *FleetBroadband*¹⁵

FleetBroadband provides cost-effective voice and data through a compact antenna, delivered globally via the I-4 satellite and ground network, which maintains over 99.9 per cent network availability.

¹³ https://en.wikipedia.org/wiki/Digital_selective_calling

¹⁴ <http://www.cospas-sarsat.int/en/18-frontpage-articles/603-what-is-a-cospas-sarsat-beacon>

¹⁵ <https://www.inmarsat.com/service/fleetbroadband/>

Although equipped with FleetBroadband, the system was not operational during the passage due to delays in delivery of a new antenna, which was initially planned to be mounted and connected at the shipyard in Las Palmas. A subsequent safety assessment was performed and concluded that an operational Inmarsat-C system was an appropriate back-up to FleetBroadband, as emails and files could be exchanged through that system. FleetBroadband was not part of the mandatory communication equipment.

- *Global Maritime Distress Safety System*¹⁶

The Global Maritime Distress Safety System (GMDSS) is based upon a combination of satellite and terrestrial radio services and has changed international distress communications from being primarily ship-to-ship-based to primarily ship-to-shore-based.

As shown in Figure 3.12, GMDSS incorporates a number of different communication systems required to be installed on SOLAS ships. The *Bourbon Rhode* was compliant with the GMDSS requirements.

- *Navigational Text Messages*¹⁷

Navigational Text Messages (NAVTEX) is an international automated medium frequency direct-printing service for delivery of navigational and meteorological warnings and forecasts, as well as urgent maritime safety information to ships.

The *Bourbon Rhode* was equipped with an operational NAVTEX receiver.

- *Inmarsat-C*¹⁸

Inmarsat-C is a two-way, packet data service operated by the telecommunications company INMARSAT which operates between mobile earth stations and land earth stations. The service works with a store-and-forward method which enables interface with data network transfer. Voice communications are not possible.

The *Bourbon Rhode* was equipped with an operational Inmarsat-C terminal.

- *Ship Security Alert System*¹⁹

The Ship Security Alert System (SSAS) is provided to a ship for the purpose of transmitting a security alert to the shore to indicate to a competent authority that the security of the ship is under threat or has been compromised.

In all cases, transmission initiated by security alert system activation points should include a unique code/identifier indicating that the alert has not been generated in accordance with GMDSS distress procedures. The transmission should include the ship identity and current position. The transmission should be addressed to a shore station and should not be addressed to ship stations.

¹⁶ <https://www.navcen.uscg.gov/?pageName=GMDSS>

¹⁷ <https://en.wikipedia.org/wiki/NAVTEX>

¹⁸ <https://en.wikipedia.org/wiki/Inmarsat-C>

¹⁹ Excerpt from Resolution 136 of the Maritime Safety Committee at the International Maritime Organization.

The ship security alert system, when activated, should continue the ship security alert until deactivated and/or reset.

The *Bourbon Rhode* was equipped with an operational SSAS.

- *Very High Frequency radio*²⁰

Marine Very High Frequency (VHF) radio is a worldwide system of two way radio transceivers on ships and watercraft used for bidirectional voice communication from ship-to-ship, ship-to-shore, and in certain circumstances ship-to-aircraft. It uses frequency modulation channels in the very high frequency radio band in the frequency range between 156 and 174 MHz, inclusive.

The *Bourbon Rhode* was equipped with an operational VHF equipment.

- *Very-Small-Aperture Terminal*²¹

Maritime VSAT is the use of satellite communication through a Very-small-aperture Terminal (VSAT) on a moving ship at sea. Since a ship at sea moves with the water, the antenna needs to be stabilized with reference to the horizon and True north, so that the antenna is constantly pointing at the satellite it uses to transmit and receive signals.

To ensure continuous operational readiness of the VSAT system during the crossing of the Atlantic Ocean, a change of satellite coverage was notified to the provider of the VSAT system before the departure of the *Bourbon Rhode* from Las Palmas (Spain).

Upon departure, the satellite beams E7B, T11N Africa, and IS21 were active in the vessel's VSAT system.

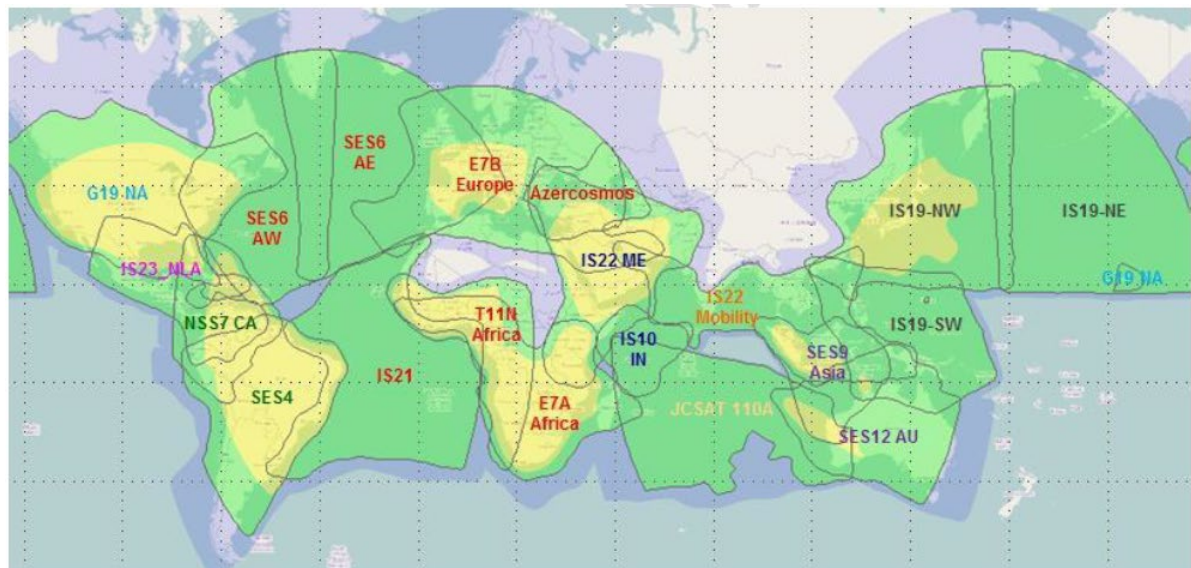


Figure 3.13 – VSAT beam²² coverage map
(Source: Bourbon Marine & Logistics)

²⁰ https://en.wikipedia.org/wiki/Marine_VHF_radio

²¹ https://en.wikipedia.org/wiki/Maritime_Vsat

²² A spot beam, is a satellite signal that is specially concentrated in power so that it will cover only a limited geographic area on Earth.

On 17 September 2019, the provider added the following beams to the *Bourbon Rhode*'s VSAT system (SES-6 NAE, SES-4 and NSS-7) and requested BOG to inform the vessel that a reboot of the system was necessary to make the changes effective.

From 19 September 2019, the VSAT performance became unreliable.

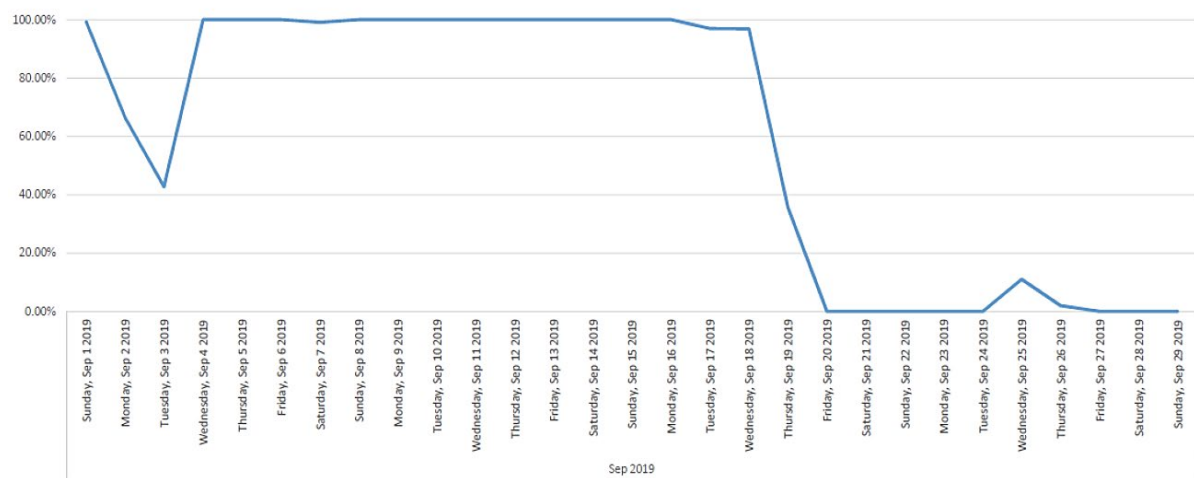


Figure 3.14 – *Bourbon Rhode*'s VSAT availability graph for September 2019
(Source: Bourbon Marine & Logistics)

The reboot request was forwarded to the *Bourbon Rhode* on 20 September 2019. At that time the VSAT reception had already been erratic.

3.2.4. Shark Jaws and towing pins

3.2.4.1. *Design of the Shark Jaws and towing pins*

The Shark Jaws are a steel fabricated device designed to temporarily secure heavy chains or wires under load. They are the so-called stopper in front of the towing or guide pins. Both the Shark Jaws and the towing pins are situated at the end of the open work deck of the vessel, in front of the stern roller.

The 'Operation Manual of Deck Machinery' of the manufacturer Plimsoll Corporation Pte Ltd states under the chapter "2.1 Technical description" that the Shark Jaws and towing pins units are watertight.

The Shark Jaws mounting frame is watertight and has three drain fittings for connection by the installing shipyard. The mounting frame top and bottom plates are furnished with extra length and width and weld bevels to facilitate an easier installation. The design and supply of supporting and / or reinforcement structures are the responsibility of others.

Figure 3.15 – Operation Manual of Deck Machinery
(Source: Plimsoll Corporation Pte Ltd, received by Bourbon Marine & Logistics)

This is the only chapter of the operations manual where the watertightness of the mounting frame is mentioned.

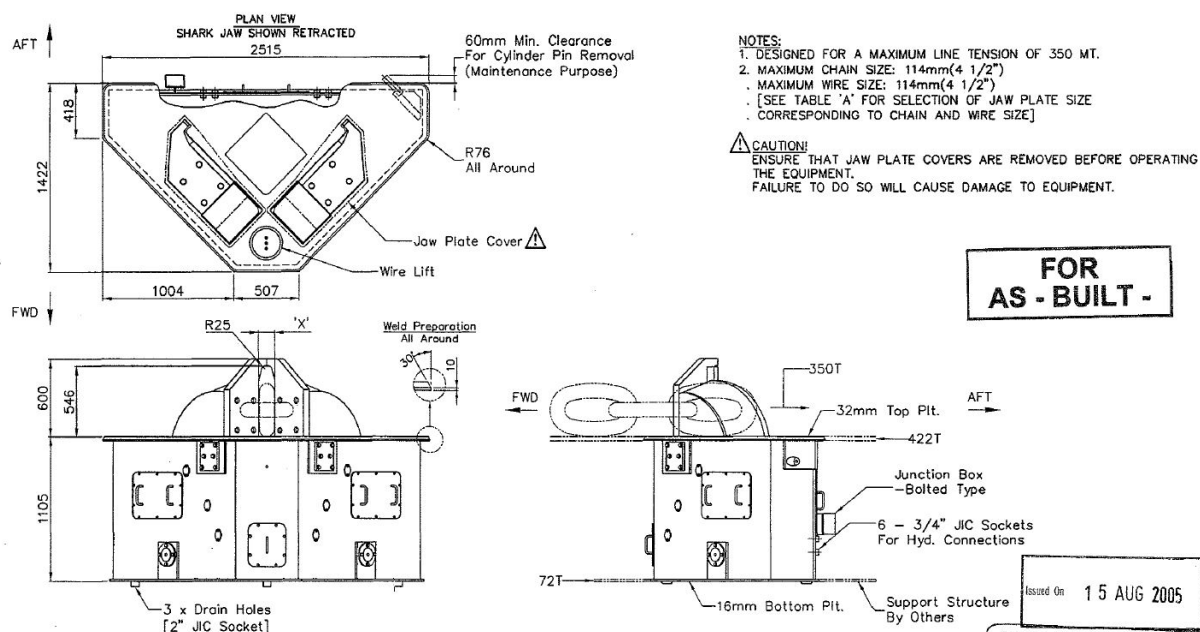


Figure 3.16 – Original design drawing of the Shark Jaws from the Manufacturer Manual
(Source: Bourbon Marine & Logistics)

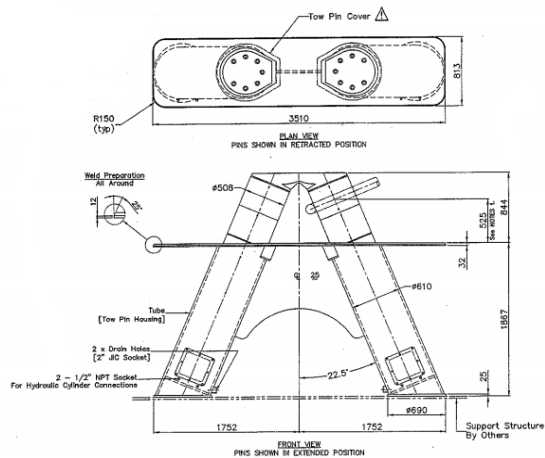


Figure 3.17 – Original design drawing of the Towing Pins from the Manufacturer Manual
(Source: Bourbon Marine & Logistics)

When not in use, both the Shark Jaws and the towing pins are lowered hydraulically into self-contained units, situated in the Z-Drive compartment on the vessel's centre line aft of the two Z-Drive units.

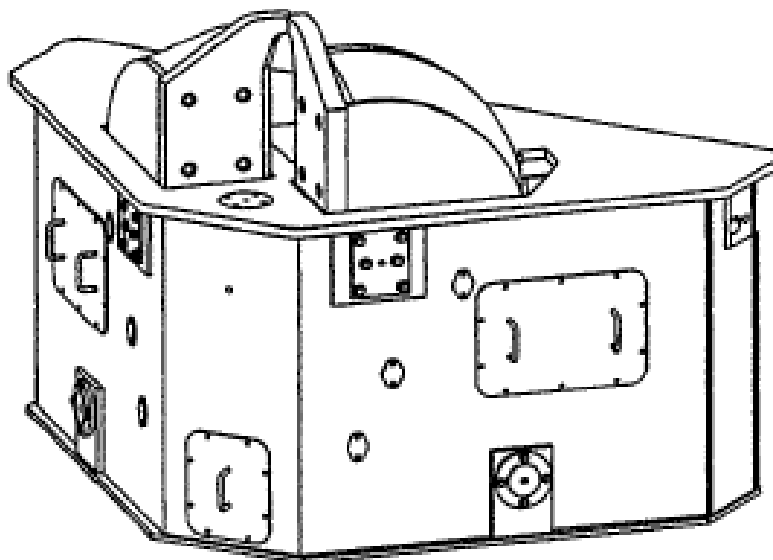


Figure 3.18 – *Bourbon Rhode*, Shark Jaw housing frame
(Source: Bourbon Marine & Logistics)

The Shark Jaws unit has three 2" drainpipes and the towing pins unit has two 2" drainpipes. All drainpipes drain into the bilge of the Z-Drive compartment where the water is then to be pumped out by the bilge pump system.

The 'Operation Manual of Deck Machinery' of the manufacturer Plimsoll Corporation Pte Ltd states under the chapter "7. Onboard installation procedure (Shark Jaw & Tow Pin)" that the drainpipes of the Shark Jaw unit must be connected to the vessel's drainage system.

The 3 - 2" drainpipe of lockjaw and 2 - 2" drainpipe of tow pin must be connected to the drainage system by yard with isolating valve and check valve to prevent the flow of water into the lockjaw and tow pin.

Figure 3.19 – Operation Manual of Deck Machinery
(Source: Plimsoll Corporation Pte Ltd, received by Bourbon Marine & Logistics)

During operation, water from the deck can enter the watertight housing frames. When not in use, the Shark Jaws and the towing pins are lowered into their housing frames and are flush with the deck. In lowered position, gaps around the shark jaws also allow water to enter the housing frame. This issue is of lesser importance regarding the towing pins, due to smaller gaps.



Figure 3.20 – *Bourbon Rhesos*, Shark Jaw retracted position
(Source: Bourbon Marine & Logistics)

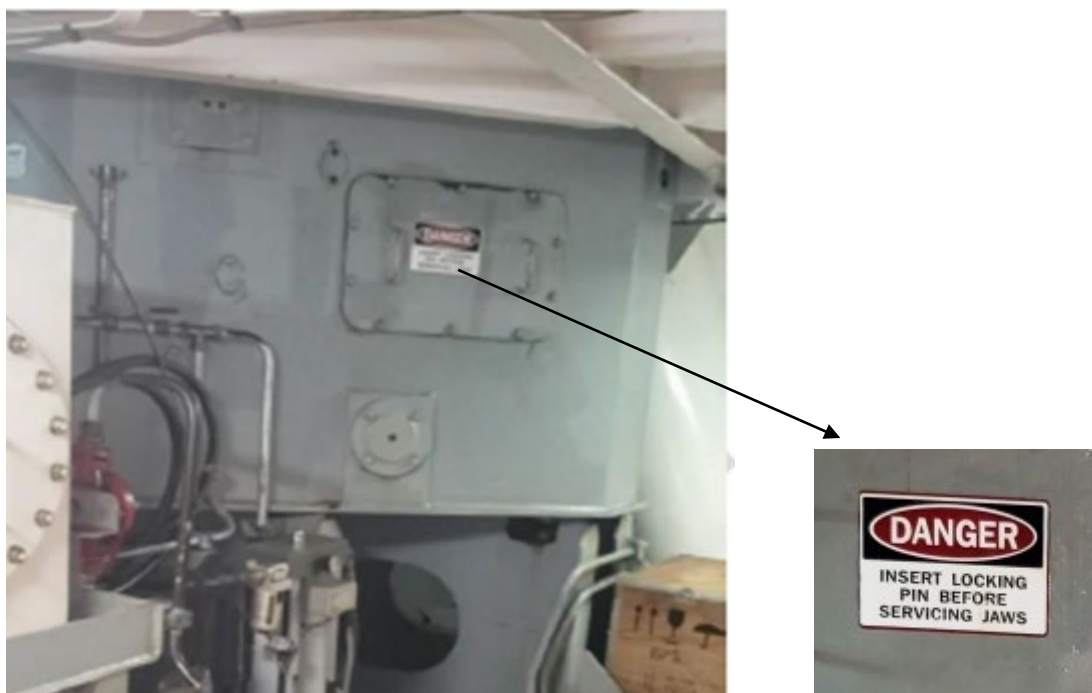


Figure 3.21 – Self-contained system as seen from inside the Z-Drive compartment's port side, *Bourbon Rhesos*, November 2019
(Source: Bourbon Marine & Logistics)

The Shark Jaws housing frame situated below deck inside the Z-Drive compartment is equipped with four inspection covers (one forward, one aft and two side covers) for maintenance of the system. The inspection covers are to be fitted with a silicone sealant or a gasket and are secured by bolts.

3.2.4.2. Maintenance of the Shark Jaws and towing pins

The operations manual of the manufacturer Plimsoll Corporation Pte Ltd states under the chapter 8.2 the following maintenance items for the Shark Jaws and the towing pins units:

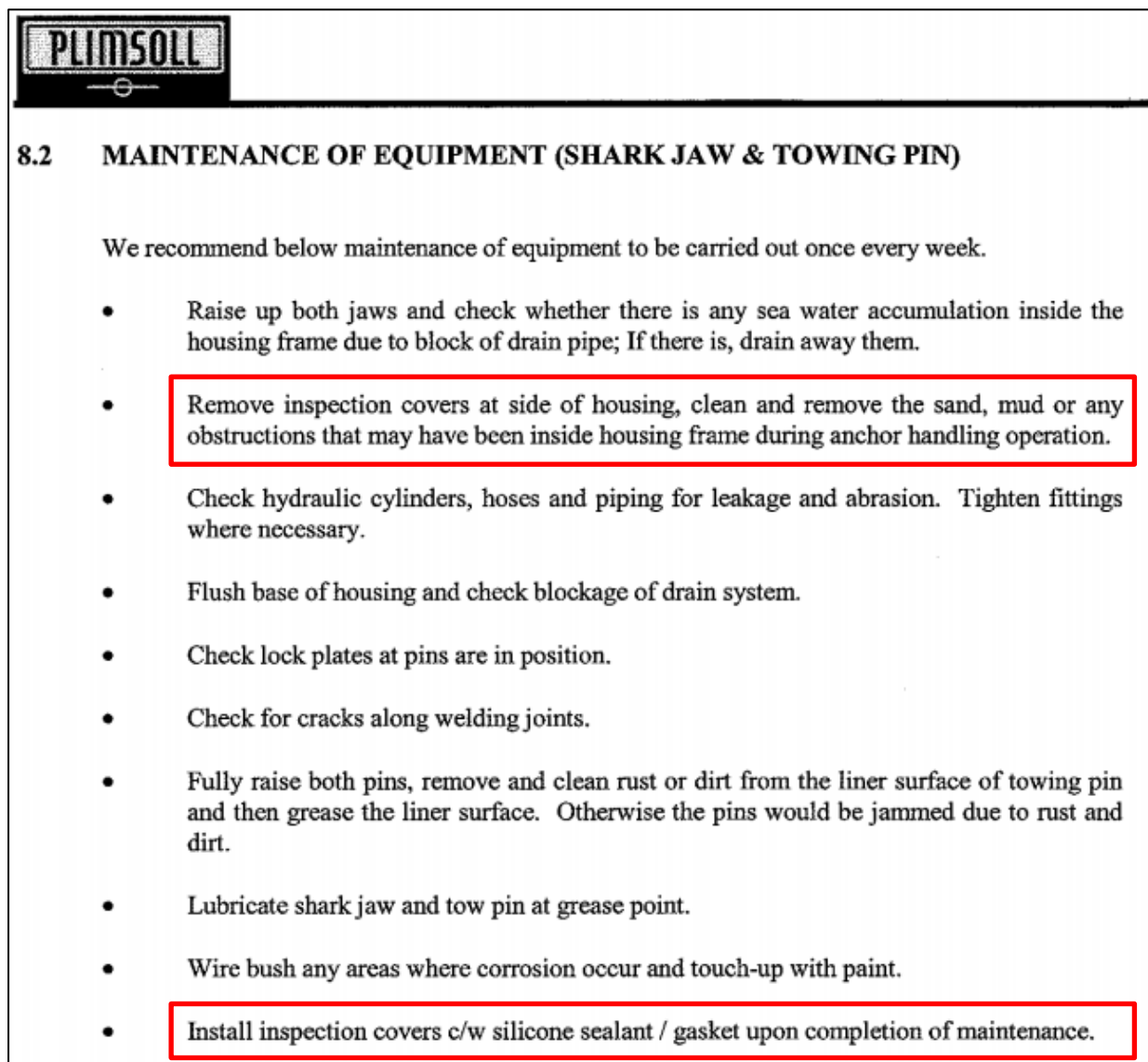


Figure 3.22 – Operation Manual of Deck Machinery
(Source: Plimsoll Corporation Pte Ltd, received by Bourbon Marine & Logistics)

3.2.4.3. Issues related to the Shark Jaws inspection covers

The technical inspection performed on 8 March 2019 identified the need for new covers for the anchor handling system (Shark Jaws, towing pins and cable lifter) to be fabricated. The standard procedure defined by the manufacturer is to install the inspection covers with a rubber gasket or silicone sealant and secure them by bolts in order to establish watertightness.

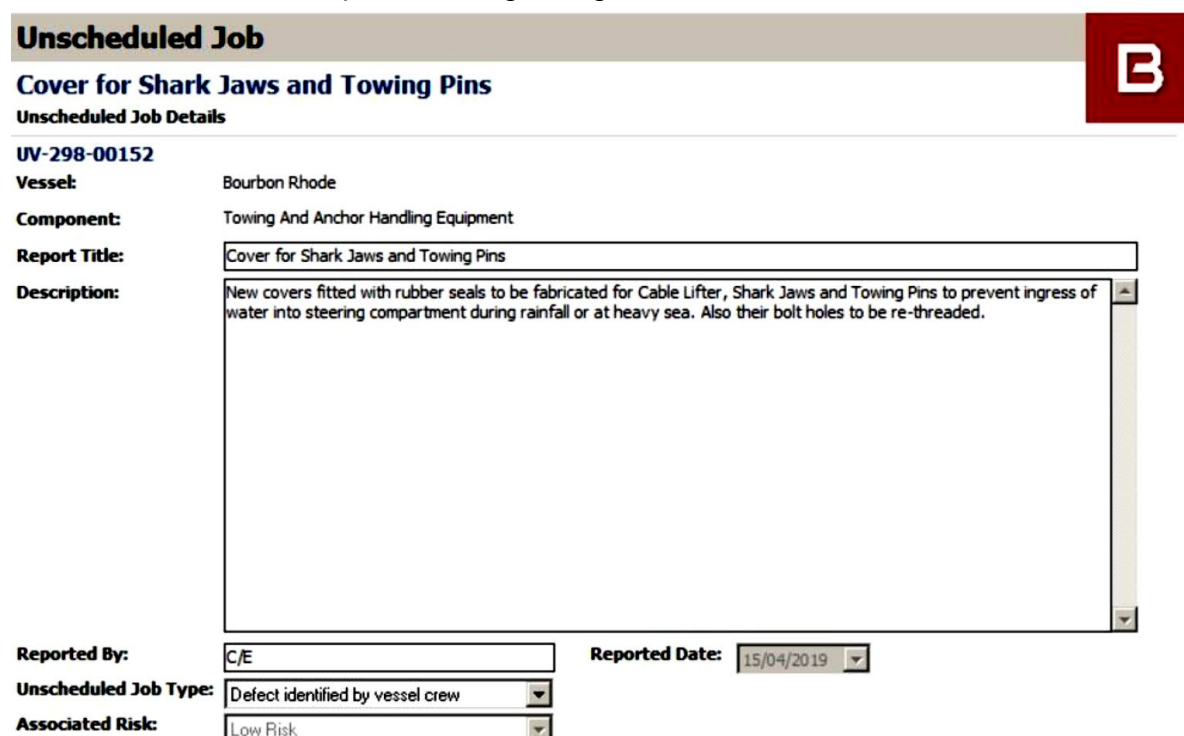
The *Bourbon Rhode* technical inspections report BINL-FRM-2601.0014 states:

- New covers for shark jaws, towing pins and cable lifter to be fabricated and installed with rubber seals to prevent ingress of water in compartments during rain or heavy sea when they are not in use. Also their needs to be re-threaded.

Figure 3.23 – Vessel Technical Inspection Report BINL-FRM-2601.0014
(Source: Bourbon Marine & Logistics)

Two ‘Unscheduled Jobs’ have been added in the Task assistant²³ to address this finding:

- The first on 19 April 2019 regarding the fabrication of new covers;



Unscheduled Job

Cover for Shark Jaws and Towing Pins

Unscheduled Job Details

UV-298-00152

Vessel: Bourbon Rhode

Component: Towing And Anchor Handling Equipment

Report Title: Cover for Shark Jaws and Towing Pins

Description: New covers fitted with rubber seals to be fabricated for Cable Lifter, Shark Jaws and Towing Pins to prevent ingress of water into steering compartment during rainfall or at heavy sea. Also their bolt holes to be re-threaded.

Reported By: C/E

Reported Date: 15/04/2019

Unscheduled Job Type: Defect identified by vessel crew

Associated Risk: Low Risk

Figure 3.24 – Task assistant
(Source: Bourbon Marine & Logistics)

²³ Bourbon Marine & Logistics maintenance planner.

- The second on 26 April 2019 as item number 7 on the welding job list.

Unscheduled Job

B

Welding Jobs
Unscheduled Job Details

UV-298-00159

Vessel: Bourbon Rhode

Component: Deck

Report Title: Welding Jobs

Description:

1. Deck plates of Staircases on deck are badly wasted and needs to be renewed
 2. Some sections of handrails on main, tween and bridge decks are badly wasted and needs to be renewed
 3. Support base for lightings on weather deck are badly wasted and needs welders attention
 4. Hatch cover on main deck port close to port side capstan needs serious welder attention
 5. Scupper drain pipes around MOB storage area is block and needs to be renewed
 6. Split containment/drip trays for F.O. Tank # 16C on Main Deck is badly wasted and new one needs to be fabricated
 7. New covers needs to be constructed for Shark jaws and Towing pins and their holding down bolt holes re-threaded
 8.

Reported By: C/E

Reported Date: 26/04/2019

Unscheduled Job Type: Defect identified by vessel crew

Associated Risk: Low Risk

Figure 3.25 – Task assistant
(Source: Bourbon Marine & Logistics)

The *Bourbon Rhode* technical inspections report from 19 May 2019 identified the inspection covers to be leaking, with evidence of staining on the housing frame.

The inspection report B-FRM-K2.0026 states the following:

GRADING CODE DESCRIPTION (Grading explanation) 1-Very Good, 2-Good, 3-Satisfactory, 4-Unsatisfactory, X-Not examined or not on the vessel		ACTION REQUIRED (YES/NO)	UNSCHEDULED JOB REFERENCE
			replacement if thickness is reduced by 3- 5mm. Check the condition of the wire rope, turn it end-to-end and grease it. Tugger winches overhaul.
➤ Tow Hook (Pneumatics and control, condition, etc.)	4	Yes	Chipping, priming and painting to be done
➤ Shark Jaws (Lifting pin, alignment, locking, etc.)	3	Yes	Covers for shark Jaws compartment leaking

Figure 3.26 – Vessel Technical Inspection Report B-FRM-K2.0026
(Source: Bourbon Marine & Logistics)

Furthermore, the report shows a picture of a shark jaw inspection cover with the associated remark 'Shark jaw comp. leaking cover'.

<p>Insert picture here</p>  <p>Tugger winch Port</p>	<p>Insert picture here</p>  <p>Tugger winch Stb</p>
<p>Insert picture here</p>  <p>Tow Hook</p>	<p>Insert picture here</p>  <p>Shark Jaw comp. leaking cover</p>

Figure 3.27 – Vessel Technical Inspection Report B-FRM-K2.0026
(Source: Bourbon Marine & Logistics)

In addition to the technical inspection report, Bourbon Marine & Logistics provided the following two pictures showing the Shark Jaws inspection covers in May and August 2019. Both pictures show stains on the shark jaws housing frame suspected to come from leaking inspection covers.



Figure 3.28 – Starboard Inspection Cover, May 2019
(Source: Bourbon Marine & Logistics)



Figure 3.29 – Port Inspection Cover, August 2019
(Source: Bourbon Marine & Logistics)

According to statements of the previous crew operating the voyage from Onne (Nigeria) to Las Palmas (Spain), the leakage of the inspection covers had been identified and the replacement of these covers was entered into the Task Assistant to be completed during the upcoming maintenance works (PMP) at the shipyard in Las Palmas. It was further stated that with the jaw plate covers installed and sealed, water was still leaking through the inspection covers during times of heavy rainfall.

According to the above statement, the items entered into the Task Manager relate to the inspection covers and not the jaw plate covers. Unfortunately, the use of the generic term ‘cover’ was ambiguous, as it could be mistaken for the jaw plate covers instead of the inspection covers.

3.2.4.4. Jaw plate covers

According to the manufacturer's '*Operation Manual of Deck Machinery*', jaw plate covers are not part of the supply list and can hence be considered as optional (unless mandated by the operator of the vessel). They can be installed to cover the retracted Shark Jaws when they are not in use. When fastened to the securing bolts of the Shark Jaws, they provide a flat and even surface, thereby reducing the risk of injury to crewmembers working on deck. Furthermore, when installed with appropriate sealing, they can prevent or reduce water ingress into the watertight housing frame of the Shark Jaws.

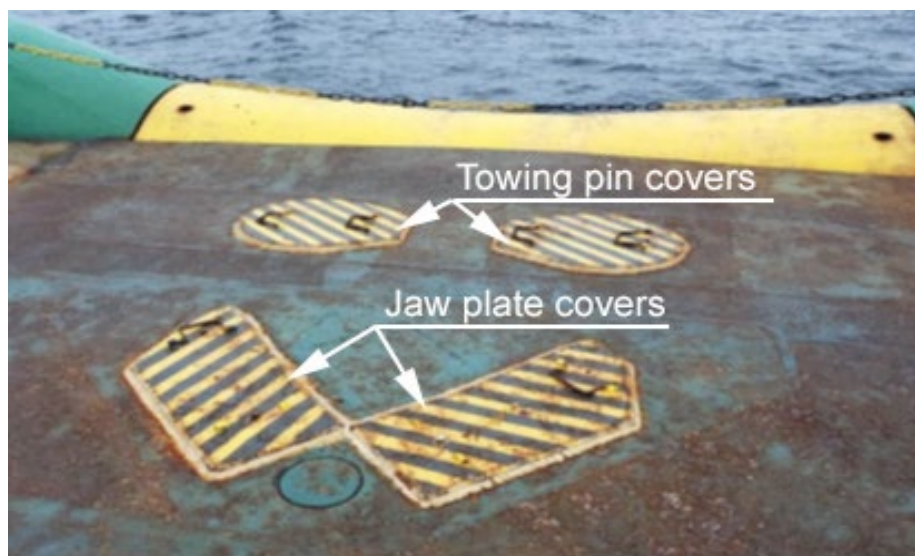


Figure 3.30 – *Bourbon Rhesos*, sister vessel, Shark Jaws in retracted position with jaw plate covers fitted and cemented to the working deck
(Source: Bourbon Marine & Logistics)

The manufacturer's '*Operation Manual of Deck Machinery*' does not specifically address the use of jaw plate covers. In fact, they are mentioned once in the section '*2.2 Control Functions*' under the first bullet point '*B) Shark Jaw Operation*' with the following statement: '*If the unit has a cover plate, ensure the cover has been removed*'.

Furthermore, the following caution can be found in the '*General Arrangement Plan*': '*Ensure that jaw plate covers are removed before operating the equipment. Failure to do so will cause damage to equipment*'.

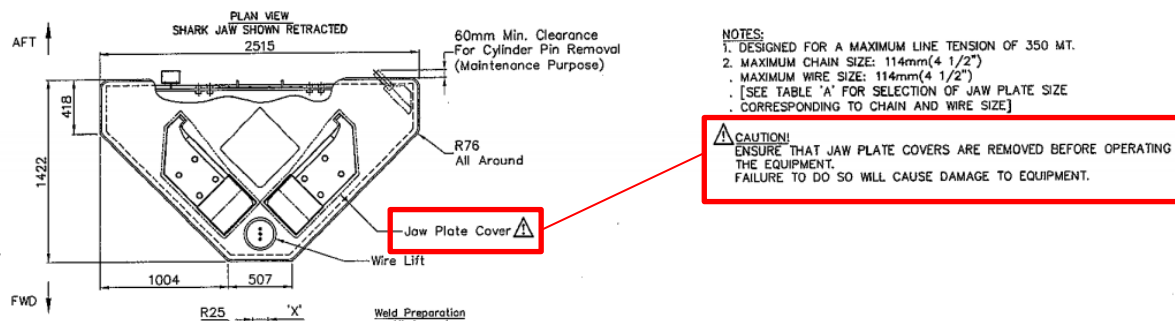


Figure 3.31 – Original design drawing from the Manufacturer Manual
(Source: Bourbon Marine & Logistics)

During the investigation, a communication exchange related to the use of jaw plate covers has shown that Bourbon Marine & Logistics believed that the ‘covers’ entered in the Task Assistant were related to the jaw plate covers and not the inspection covers. The wording used in the Task Assistant could be seen as ambiguous, although the picture inserted in the technical inspections report from 19 May 2019 showed an inspection cover with staining on the housing frame pertaining to the leakage.

3.2.4.5. *Watertightness issues related to other anchor handling systems*

- A post-accident fleet survey by Bourbon Marine & Logistics has identified other anchor handling vessels with leaking inspection covers of the anchor handling system (includes shark jaws, forks, towing pins).
- The Safety Flash 24/17²⁴, published by the International Marine Contractors Association (IMCA) in October 2017, described the occurrence of a vessel that lost the control of its steering gear due to a leakage through the Karm fork seals, leading to uncontrolled flooding in the steering compartment.

²⁴ <https://www.imca-int.com/alert/1272/flooding-steering-gear-compartment/>

3.2.5. Bilge pump system

On the *Bourbon Rhode*, the bilge pumps were part of an inter-connected ballast, bilge and fire main system. By use of a system of valves, the ballast, bilge and fire pumps were operated for ballasting, bilge evacuation and pressurizing of the fire main.

A bilge pump is a water pump used to remove the bilge water and is located at the lowest point of the bilge.

3.2.5.1. Design of the bilge pump system

The bilge wells of the compartments were connected to the bilge pump located in the vessel's engine room on the starboard side by one 2" pipe. The vessel was equipped with a primary and a stand-by bilge pump. The 2 bilge pumps had a capacity of 35 m³ per hour each. In case of water entering the bilge well, a high level bilge alarm was triggered on the Noris Alarm System and the bilge pump had to be activated manually to evacuate the water. An automatic bilge pump activation linked to a high level bilge alarm was not implemented.

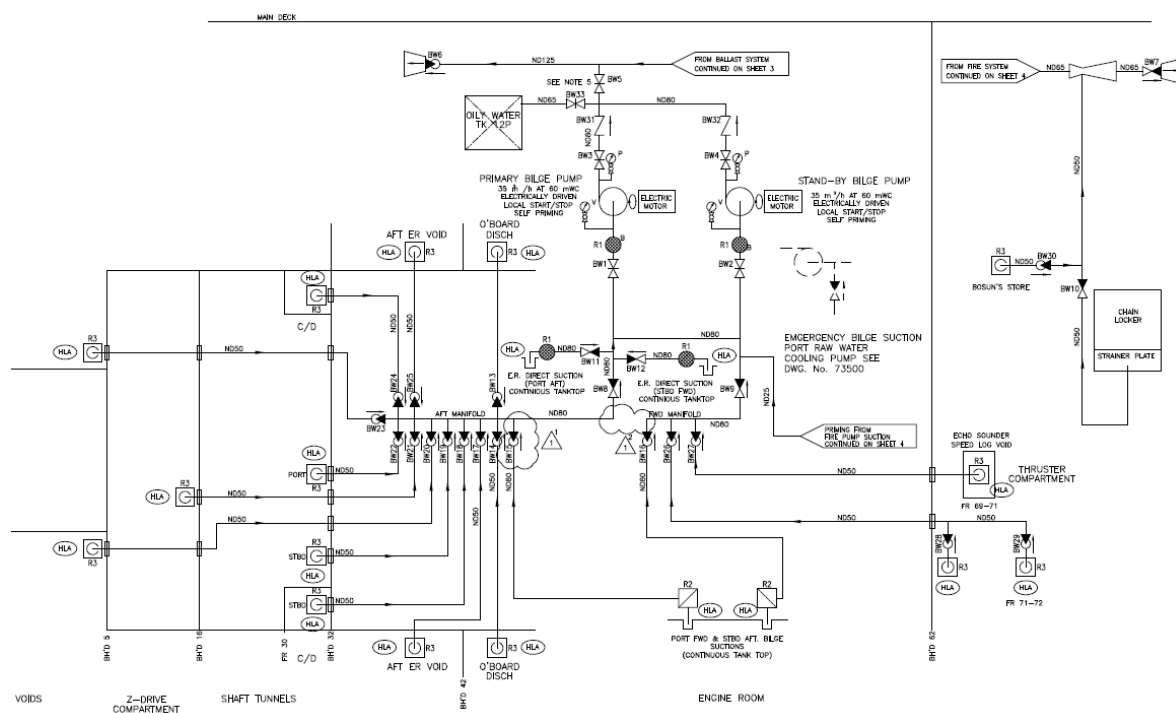


Figure 3.32 – Bilge pump system
(Source: Keppel Singmarine, received by the CAM)

The bilge pump system was part of the items checked during the surveys conducted by the BV (Cf. chapter “3.2.10.2. Other relevant items surveyed”) and all tests were carried out with satisfactory results.

3.2.5.2. Maintenance of the bilge pumps

During the voyage, a scheduled maintenance run of the bilge pumps was last documented on 22 September 2019.

3.2.5.3. Nuisance alarms related to the bilge pumps

Based on the survivor statements, the vessel's ballast and bilge system had ongoing issues with nuisance alarms²⁵. The bilge alarms were tested by the Class Surveyor in Las Palmas with no findings.

3.2.6. Noris Alarm System

3.2.6.1. *Design of the Noris Alarm System*

The *Bourbon Rhode* was equipped with a Noris Alarm System. The system was connected to two central, redundant master stations that collect and monitor the data received from the connected I/O modules (digital input/output). It was used to monitor and control the ship technology, such as engines, generators, pumps, valves, ventilators or other auxiliary systems.

In addition to the other high level alarms, the Noris alarm system was fitted with 18 high level bilge alarm sensors. Each bilge well, except for the forward located bosun's store, was fitted with a high level alarm sensor, including the cofferdam and void spaces. These high level alarms were all tested and found operational by the class surveyor during the surveys at the shipyard in Las Palmas.

The Noris Alarm System was independent of and not connected to the vessel's General Alarm system.

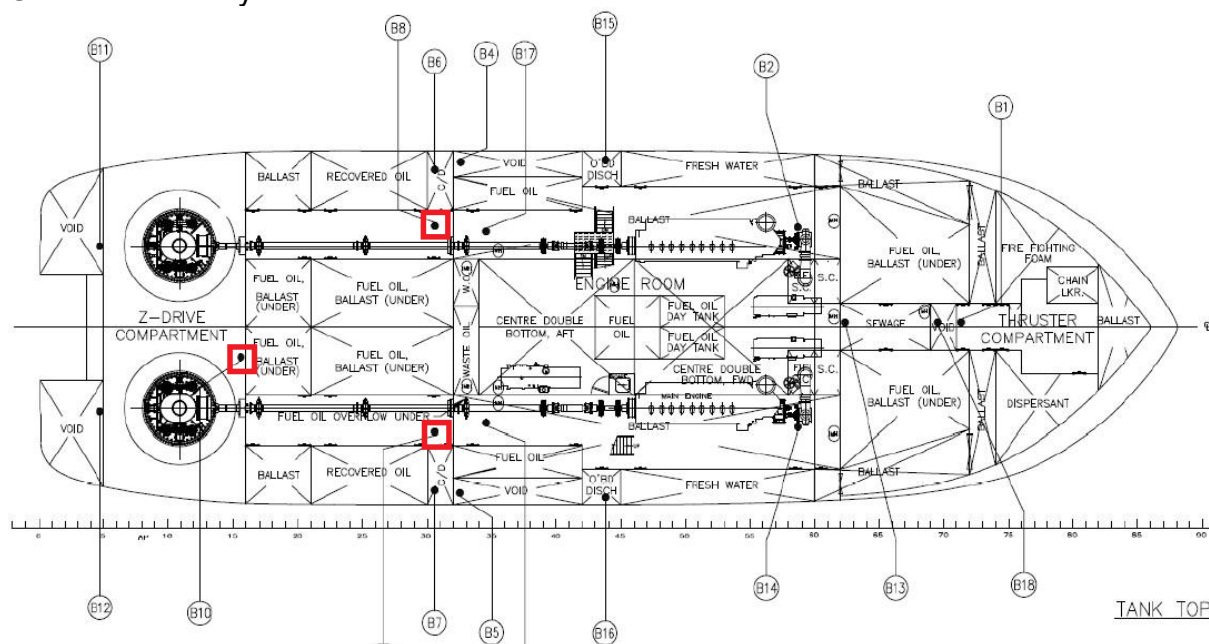


Figure 3.33 – Bilge High Level Alarm Sensors Location
(Source: Bourbon Marine & Logistics)

The above drawing shows that one bilge high level alarm sensor was located in the bilge well of the Z-Drive compartment and one in the bilge well of each shaft tunnel further forward (highlighted in red).

²⁵ An alarm can be considered a nuisance alarm when, although it has been correctly triggered (no false alarm), the triggering condition does not represent an unsafe condition and no further response is required. Repetitive nuisance alarms may lead to a reduced alertness and induce a lack of response to the related alarm.

3.2.6.2. *Maintenance of the Noris Alarm System*

The Noris Alarm System was serviced by a manufacturer maintenance technician during the maintenance in Las Palmas. During the service some alarm failures were detected and some defective wires were noted to be repaired. The service report issued on 22 August 2019 stated that several alarms were checked and found to be correctly indicated in the Noris Alarm System. The BV survey report LPM0/2019/J5109 issued on 13 September 2019 further stated that the tests of the bilge / flooding alarms were carried out with satisfactory result.

The weekly testing of the Noris Alarm System was documented throughout the voyage, with the last testing recorded in the Task Assistant on 24 September 2019.

3.2.6.3. *Issues with the Noris Alarm System*

Issues with the alarms and sensors were recorded in an internal investigation report dated 13 March 2015 by the company Bourbon Offshore Greenmar in the maintenance documentation and in a service report dated 22 August 2019 by a manufacturer technician. These issues were described as faulty reoccurring alarms, sensor faults and problems with the insulation.

According to survivor testimony, a high-level bilge well alarm sounded in the port side emergency generator room on 22 September 2019, which was most likely a nuisance alarm due to the presence of water in the compartment, combined with the rolling of the vessel in the seaway.

3.2.7. FUELTRAX system

The *Bourbon Rhode* was equipped with an Enhanced Fuel Monitoring System required by the new contractor for operation. Both main engines and the three diesel generators situated in the engine room were connected to the FUELTRAX system.

The system monitors and logs the fuel consumption by Coriolis mass flow meters. It has an independent battery and antenna, with a computer located on the bridge. It is described as being self-contained and secure, measuring fuel consumption directly, sending out the acquired data via the connected independent IRIDIUM communication system. The system is intended to monitor fuel consumption, detect discrepancies caused by non-optimized machinery and prevent fuel theft. In addition to the fuel consumption, the system also logs the GPS position of the vessel in 1-minute intervals and for each logged event.

A snapshot of the logged data was sent ashore every 15 minutes. Daily data sets were stored and were sent ashore on the following day at 12:00.



Figure 3.34 – Flowmeters connected to engine
(Source: Bourbon Marine & Logistics)



Figure 3.35 – Control Unit on the bridge
(Source: Bourbon Marine & Logistics)

The FUELTRAX system was connected to two cameras, one with a view of the bow and the other one with a view of the aft deck and stern. Both cameras took a picture every hour and the 24-hour data was sent ashore as one video file per camera once a day at 24:00.

The collected data, including the image files, sent ashore during the transit voyage of the *Bourbon Rhode*, were made available to the investigation and provided valuable information up to the final moments before the sinking of the vessel.



Figure 3.36 – FUELTRAX camera, stern view
(Source: Bourbon Marine & Logistics)

The FUELTRAX system has additional functions. Video data can be requested through the system by specifying a start and end time. This video recording will be in one-minute intervals with higher image resolution and send ashore after the recording ended.

Manual retrieval of video data in full-HD quality is also possible by connecting a flash drive to the FUELTRAX system aboard the vessel.

3.2.8. Lifesaving appliances

The *Bourbon Rhode* was equipped with the following standard lifesaving appliances:

- 25 lifejackets of the type Lalizas 70169,



- 4 life rafts of the type DSB LR07,



All 4 life rafts were serviced and new certificates issued on the 10 September 2019 at the shipyard in Las Palmas. The Hydrostatic Release Units had a stated expiry date of January 2022. Manufactured in 2012 the DSB rafts were made of natural rubber and had a capacity of 20 persons. The maximum stowage height was stated to be 25 m with the painter line stored inside having a length of 35 m.

- 1 rescue boat of the type VikingNorsafe AS; Midget-530 MKII, Waterjet,



(Source: www.viking-life.com)



The NORSAFE AS Midget-530 MKII, Waterjet rescue boat of the *Bourbon Rhode*, was mounted to a VIKING NORSAFE NDA-16 Davit designed to ensure a safe and efficient launch and retrieval. The fast rescue boat was designed and built in accordance SOLAS/IMO requirements and in combination with the davit, fulfilled all set requirements for rescue boats on commercial vessels. With an overall length of 5.32 m and a maximum capacity of eight persons, it was constructed of fire retardant glass reinforced polyester

and filled with polyurethane foam as buoyancy material. The launch and lifting is arranged by single point with a hook installed on the engine casing. A painter hook forward and bollard aft complete the arrangement.

3.2.9. Works performed at the shipyard in Las Palmas

The *Bourbon Rhode* was transferred as planned to the shipyard in Las Palmas, Gran Canaria (Spain) with works commencing on 30 July 2019 and ending on 14 September 2019. Extensive works and required class surveys were scheduled to prepare the vessel for the newly assigned area of operation off the coast of Guyana.

During the stay at the shipyard, the following works were performed:

- Ship Hull cleaning and painting;
- Changing and maintenance of overboard valves;
- Changing of sea chest;
- Deck steel work;
- Work and maintenance on piping;
- Installation and commissioning of a bow staple;
- Maintenance and repairs to flaps and superstructure entry doors; (Including Emergency Generator Room)
- Servicing of Safety Equipment;
- Servicing of navigational equipment;
- Installation of FUELTRAX system;
- Installation of Hawkeye 7200 GPS Tracking System;
- Service of Main Engines;
- Service of Gearboxes;
- Service of Bow Thrusters;
- Pressure testing of cargo hoses.

A sea trial was performed on 3 September 2019 from 11:32 to 13:35 in order to verify the operational readiness and to test the serviced engine performance.

3.2.10. Certificate of classification and surveys of the *Bourbon Rhode*

The latest certificate of classification was issued on 17 February 2017 with the following elements:

- Class Symbols: I , ~~⌘~~Hull , ~~⌘~~Mach
- Service Notations: Anchor handling vessel Tug Firefighting ship 1 - water spraying, Oil recovery ship
- Navigation Not.: Unrestricted navigation
- Add. Class Not.: ~~⌘~~AUT-UMS (SS)
- Machinery: ~~⌘~~MACH
- Equipment: 1 Main anchor, chain diameter 30 mm, steel quality Q2 (High tensile strength steel)

The certificate of classification was valid until 10 September 2021.

The BV, Classification Society and Recognized Organisation of the *Bourbon Rhode*, surveyed the work performed at the shipyard in Las Palmas and, upon completion, carried out the following required surveys:

Class:

- Hull Annual Survey (ASH);
- Annual survey of structure - Complete (ASHS);
- Hull Intermediate Survey - Complete (INT);
- Periodical Bottom Survey in Dry Dock (DOK);
- Hull Occasional Survey (OSH);
- Machinery Annual Survey (ASM);
- Automated Installations Annual Survey (ASA).

Statutory:

- Load Line Annual Survey (LLPI);
- Load Line Change of Flag Survey (LLCF);
- Harmonized Safety Construction Annual Survey (HSCA);
- Safety Construction Change of Flag Survey (CNCF)
- Harmonized Safety Equipment Renewal Survey (HSEQ);
- Harmonized Safety Equipment Occasional Survey (HSEO);
- Harmonized Safety Radio Periodical Survey (HSRP);
- Harmonized Safety Radio Occasional Survey (HSRO);
- IOPP Annual Survey (POMA);
- IOPP Change of Flag Survey (POCF);
- Sewage System Occasional Survey (SEWO);
- International Air Pollution Prevention Annual Survey (IAPA);
- International Air Pollution Prevention Occasional Survey (IAPO);
- International Energy Efficiency Occasional Survey (IEEO);
- Ballast Water Management Annual Survey (BWMA);
- Ballast Water Management Change of Flag Survey (BWCF);
- ILO 152 Cargo Gear Annual Survey (CGAS);

- ILO 152 Cargo Gear Occasional Survey (CGOS);
- Anti-Fouling System Renewal Survey (AFSS);
- Anti-Fouling System Occasional Survey (AFSO).

The following certificates were then issued or extended:

- Classification Certificate;
- LL Load Line;
- SOLAS Safety Construction Harmonized;
- SOLAS Safety Equipment Harmonized;
- SOLAS Safety Radio Harmonized;
- MARPOL Annex I Prevention of Oil Pollution;
- MARPOL Annex IV Prevention of Pollution by Sewage;
- MARPOL Annex VI Prevention of Air Pollution;
- MARPOL Annex VI IEE Certificate;
- Ballast Water Management;
- IAFS Anti-Fouling System.

The BV issued the survey statement on 13 September 2019, with “*no recommendations issued during this attendance*”²⁶.

The *Bourbon Rhode* was considered in alignment with the applicable standards.

²⁶ Excerpt from the BV Interim Survey Statement (Report number - LPM0/2019/J5109).

3.2.10.1. Load Line survey

From 31 July 2019 to 13 September 2019, the BV conducted both a Load Line Annual Survey (LLPI) and a Load Line Change of Flag Survey (LLCF) of the *Bourbon Rhode*. Further to the verification of documents, the following items from the BV survey report LPM0/2019/J5109 were checked during these surveys:

3. Hull

Hull and hull equipment

CAC021	LLPI-HSCA-LLCF-ASH-CNCF	Coef : 0.0	See Remark
Examination of the means of closing and securing the weathertightness of miscellaneous openings in freeboard, superstructure and exposed decks (cargo hatchways, other hatchways and other openings)			
Remark Visual examination carried out with satisfactory results. All closing appliances were maintained accordingly.			
CAC043A	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Examination of guardrails, gangways, walkways, ladders and any other means provided for the protection of the crew and means for safe passage for crew.			
Remark Visual examination carried out with satisfactory results.			
CAC051	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Examination of ventilators, including their coamings and closing appliances.			
Remark All ventilator closing appliances were maintained and identify satisfactorily.			
CAC052	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Examination of air pipes and overflow pipes, including their coamings and closing appliances.			
Remark Visual examination carried out with satisfactory results.			
CAC061	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Examination of superstructure end bulkheads and openings therein (doors, sills, closing arrangements).			
Remark All closing appliances were maintained accordingly.			
CAC064	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Examination of scuppers, inlets and discharges below the margin line.			
Remark Scuppers on decks were cleaned satisfactorily.			
HAE020	LLPI-LLCF-ASH	Coef : 0.0	See Remark
Verification that no alterations have been made to the hull or superstructures that would affect the position of the load lines.			
Remark Visual examination carried out with satisfactory results.			

Marking

MAR010	LLPI-LLCF-ASH-INT	Coef : 0.0	Done in current job	See Remark
Verification of the position of the deck line (or reference line) and load lines and timber marks, if any, which, if necessary, are to be re-marked and re-painted.				
Confirmation that BV letters are engraved and painted.				
Confirmation that the marks on the hull are in line with those shown on LL Certificate.				
Remark BV letters were found accordingly as indicated in the Load Line certificate.				
CAC190	LLPI-HSCA-LLCF-ASH-CNCF	Coef : 0.0		See Remark
Examination of the means of securing the weathertightness of machinery-space hatchways and of other hatchways on decks.				
Remark Visual examination carried out with satisfactory results.				

20. National Requirements

NRQ010B	POCF-POMA-LLCF-HSEQ-LLPI-JAPA-HSCA-CNCF	Coef : 0.0	See Remark
Confirmation that the possible additional requirements of the Administration are complied with.			
Remark			
Cargo Ship Safety Equipment and Cargo Ship Safety Radio surveys in the scope of Renewal Surveys were carried out with satisfactory results.			

Figure 3.37 – Survey report LPM0/2019/J5109
(Source: BV, received by the CAM)

During the investigation, questions were raised as to whether the load line survey should include a check for watertightness of the inspection covers of the anchor handling systems. A representative of BV was contacted on this matter and provided the following answer²⁷:

“During the construction of the Bourbon Rhode, BV performed the initial load line survey and issued a report setting out the conditions of assignment of freeboard in accordance with the applicable IMO convention on load lines. As required by the convention, all openings on the freeboard decks and superstructures were inspected in accordance with rule n°18.

The shark jaw system is retractable and can be secured flush in closed position, the whole system being contained in a closed and watertight structure in relation to the compartment below. The continuity of the deck integrity and watertightness are assured. Furthermore, tests with a water jet performed during the initial visit confirmed this. Hence, the shark jaw system was not considered as part of the load line inspection and does not appear on the related report.

By delegation of the consecutive flag states of the Bourbon Rhode, BV periodically performed the load line survey without noting any modifications with regard to the initial conditions of assignment of freeboard. Neither did the shipowner declare any modification performed on the shark jaw system.

By default, our surveys always consider all installed systems to be correctly operated and continuously maintained by the shipowner, in accordance with the manufacturer’s user guides and the applicable regulations.”

²⁷ Original answer in French, complimentary English translation provided by the AET.

3.2.10.2. Other relevant items surveyed

Excerpts from BV survey report LPM0/2019/J5109:

8. Automated installation

Protection against flooding

ENV150A	ASA	Coef : 0.0	See Remark
Test of bilge / flooding alarms.			
<u>Remark</u>			
Test carried out with satisfactory results			

17. Miscellaneous surveys

Anchor handling system

AHV001	ASH	Coef : 0.0	See Remark
Visual examination of winches including: drums, end flanges, reduction gears and brakes			
<u>Remark</u>			
Visual examination carried out with satisfactory results.			
AHV030	ASH	Coef : 0.0	See Remark
Visual examination of equipment foundations, including related reinforcements of the structure			
<u>Remark</u>			
Visual examination carried out with satisfactory results.			
AHV040	ASH	Coef : 0.0	See Remark
General examination of hydraulic and electric systems.			
<u>Remark</u>			
Visual examination carried out with satisfactory results.			
AHV070	ASH	Coef : 0.0	See Remark
General examination and test, as far as practicable, of emergency quick-release system			
<u>Remark</u>			
Running test of the hook release system carried out with satisfactory results.			

6. Machinery and electricity

Machinery installation

MAI250	HSCA-ASM-CNCF	Coef : 0.0	See Remark
Arrangements for bilge pumping : Examination of each bilge pump and confirmation of its satisfactory condition, including remote reach rods and level alarms where fitted; Examination, as far as practicable, of the bilge wells; Confirmation that the bilge-pumping system for each watertight compartment is satisfactory.			
<u>Remark</u>			
Running test of all bilge alarms carried out with satisfactory results.			

Figure 3.38 – Survey report LPM0/2019/J5109
(Source: BV, received by the CAM)

3.2.10.3. Annual Survey – Rules of the Classification of Steel Ships

The following Chapter presents excerpts of the Annual Survey documentation from BV concerning the rules of the Classification of Steel Ships that are relevant for the present investigation.

PART A – Classification and Surveys

Chapter 2, Section 1, Point 2.1.2 – Assignment of Class, New building procedure
The Society:

- *approves the plans and documentation submitted as required by the Rules*
- *proceeds, if required, with the appraisal of the design of materials and equipment used in the construction of the ship and their inspection at works*
- *carries out surveys, attends tests and trials provided for in the Rules, or obtains appropriate evidence to satisfy itself that the scantlings and construction meet the rule requirements in relation to the approved drawings*

....

Chapter 3, Section 1, Point 2.1.1 – Annual survey, Hull and hull equipment

The survey is to include a general external examination and testing, where appropriate, of the following items, as applicable:

...

- *means of closing and securing the weathertightness of miscellaneous openings in freeboard, superstructure and exposed decks (cargo hatchways, other hatchways and other openings)*

PART E – Service Notations for Offshore Service Vessels and Tugs

Chapter 2, Section 4, 1 – Anchor handling vessels, Hull structure

Point 1.1, Documents to be submitted

1.1.1 In addition to the documentation requested in Part B, the plans and documents listed in Tab 1 are to be submitted as applicable.

The listed plans are to be construction plans complete with all the dimensions and are to contain full indication on the type of materials employed.

Plans of equipment which are type-approved by the Society need not be submitted, provided the types and model numbers are made available.

Table 1 : Documents to be submitted

No.	I / A (1)	Document
1	I	General arrangement showing: <ul style="list-style-type: none"> - detail arrangement of anchor handling deck equipment (wire stopper, guide pins, etc.) - typical arrangement of cargo on deck (anchors, wires, chain cables, etc.) - chain lockers used for mooring deployment - anchor handling/towing winch - tugger winches - stern roller, including lateral limits on both ends - lifting appliances, if any - typical paths of lines between winches and stern roller, showing the limit line sectors
2	I	Design information of deck winches, including: <ul style="list-style-type: none"> - detailed drawing of winches - maximum rated line pull (RP), and the reeled layer for which the rated line pull is defined - brake holding load (BHL), and the reeled layer for which the rated line pull is defined - rendering load (RL) - specification of emergency quick release system including response time and intended remaining holding force after release - strength calculation of the drum with flanges, shafts with coupling, framework and brakes - minimum guaranteed breaking strength of the wire
3	I	Design information of wire stopper, including: <ul style="list-style-type: none"> - safe working load (SWL) - emergency release capabilities in normal and dead ship conditions
4	I	Design information of guide pins, including: <ul style="list-style-type: none"> - safe working load (SWL) - emergency release capabilities in normal and dead ship conditions
5	I	Safe working load (SWL) of stern roller
6	I	Design bollard pull (T_{BP})
7	I	Maximum weight of anchors on deck
8	I	Maximum weight of wire/chain cable stored on deck
9	I	Operational manual
10	A	Detailed drawing of wire stopper
11	A	Detailed drawing of guide pins
12	A	Detailed drawing of stern roller
13	A	Deck reinforcements in way of deck equipment, including foundations and supports
14	I / A	Loading manual, if relevant (see [2.2])
(1)	A : For approval I : For information.	

Figure 3.39 – Rules for the Classification of Steel Ships
(Source: BV)

3.2.11. Liquid bulk and consumption

Before departing Las Palmas on 17 September 2019, 431.33 m³ of fuel, 105 m³ of fresh water and 2.44 m³ of lubrication oil were bunkered and taken on board.

On 25 September 2019, at noon, the vessel reported 343.23 m³ of fuel, resulting in an average consumption of 11.75 m³ of fuel per 24 hours, a daily consumption of 3 m³ of fresh water and no change in the quantity of lubrication oil.

Based on the above consumption, the bunkered fuel was sufficient for a voyage of 36 days and the fresh water reserves were sufficient for 33 days, well in excess of the quantities required for the Atlantic Ocean crossing.

3.3. TRAINING, EXPERIENCE AND CERTIFICATION OF THE CREW

Based on the documents provided by Bourbon Marine & Logistics, all crew members had appropriate training, experience and valid certifications to perform their specific duties on this voyage of the *Bourbon Rhode*.

All crew signed on at the shipyard well before the departure from Las Palmas, from August 2019 up to the beginning of September 2019. The Master hand-over was conducted during 5 days and included all main emergency drills with most of the crew for the upcoming voyage present.

3.3.1. Crew experience and certification

The Master joined the Bourbon Group as Chief Officer in November 2008 and worked on supply vessels for 6 months on contracts in Italy and India. From mid-2009 to October 2012, he achieved multiple contracts as Chief Officer at offshore Nigerian oil fields. From December 2012 to November 2013, he had several contracts as Chief Officer on the *Bourbon Rhode* in Nigeria and was then contracted as Master on the *Bourbon Rhesos* on multiple contracts in Angola from November 2013 to April 2016. He then returned as Chief Officer to the *Bourbon Rhode* from October to December 2016, before being contracted as Master on the *Bourbon Rhode* from February 2017 to the occurrence voyage.

Since the Master joined the Bourbon Group in 2009, he acquired no experience with ocean crossings. Experience with ocean crossings prior to joining the Bourbon Group could not be ascertained.

The Master's certificates and courses as per STCW were up to date, his Certificate of Competency for a ship up to 3000 GT, issued by the Croatian Maritime Authority on 1 June 2016, was due to expire on 1 June 2021. Before joining the vessel in Las Palmas, he spent a six months ashore to complete his unlimited licence by attending several training courses.

All officers could be described as experienced certified seamen. The Chief Engineer, Chief Officer and 2nd Deck Officer had well over 10 years of experience at sea, mostly on Anchor Handlers and Supply Vessels. It should be noted that, except for the Master, it was the first contract with the Bourbon Group for all other officers.

The ratings on board the *Bourbon Rhode* were experienced in their duties as deck and engine crew. The Bosun had sailed for four years on AHTS vessels managed by the Bourbon Group.

According to the information and documentation available to the investigation, the bareboat charterer's procedures in relation to recruitment, including minimum experience for offshore support vessels requirements and internal assessment, skill development and crew management were adhered to. All officers and ratings were in compliance with the standards applicable in the offshore industry.

Crew Rank and Certification

No	Rank	Certificates/Endorsements & Validity	STCW
1	Master	Master Licence 01.06.21 Lux Endorsement 01.06.21 GMDSS General Operator 24.03.2020 Unrestricted	II/2
2	Chief Officer	C/O Licence 29.06.2021 Lux Endorsement 06.12.2019 GMDSS General Operator 16.06.2021 Unrestricted	II/2
3	2 nd Officer	OOW Licence 19.10.2021 Lux Endorsements 19.10.2021 GMDSS General Operator 19.10.2021 Unrestricted	II/2 & IV/2
4	Chief Engineer	Licence 17.07.2022 Lux Endorsement 21.11.2019	III/2
5	2 nd Engineer	Licence 03.01.2024 Lux endorsement 03.01.2024	III/2
6	3 rd Engineer	Licence 16.01.2022 Lux Endorsement 16.01.2022	III/1
7	Bosun	Certificate Rating Deck 26.03.2022	II/5
8	AB Deck	Certificate Rating Deck issued 20.07.2018	II/5
9	AB Deck	Certificate Rating Deck issued 23.02.2019	II/5
10	AB Deck	Certificate Rating Deck issued 29.08.2016	II/5
11	Oiler	Certificate Rating engine 16.02.2020	III/1
12	Cook	National Cert. issued 13.10.2015 Lux Attest. 06.08.2024	MLC
13	Fitter	Certificate Rating Engine issued 02.11.2014	III/4
14	ETO	Licence 22.07.2020	III/6

3.4. PASSAGE PLAN

In accordance with the vessel's SMS, a Passage Plan was sent to the BOG ship manager on 17 September 2019 and accepted without any remarks. The Passage Plan contained five waypoints that added up to a total distance of 2793 NM. The indicated time of departure was 17 September 2019 at 22:30 LT and the estimated time of arrival was 1 October 2019 at noon, Guyana LT. The Passage Plan also contained a completed list of items to be checked and was signed off by the master and the chief mate. The effective time of departure was on 18 September 2019 at 00:36 LT (UTC: 17 September 2019 at 22:36).

BOURBON

Passage plan
B-FRM-K4-5003-ver.01

FINAL WAYPOINTS TO BE SET TO CROSS FROM 10M FROM ANY INSTALLATION AND NEVER HEAD DIRECTLY TOWARD AN INSTALLATION

Voyage Number	1901	Departure Date / Time	17.09.2019 22:30	Estimated Arrival Date / Time	01.10.2019 12:00
Departure Location	LAS PALMAS	Security Conditions for the vessel	GOOD	Security Conditions for the cargo	GOOD
Weather	27M	POB	14		

WPT	Latitude	Longitude	Way Point Remarks	Course to next WPT	Distance to go	Count Number	Publications Used	Consent Security / Comments	Remarks
WPT 1	28 05.54'N	015 24.22'W	GPS WPT 882 JRE 4511Y	146T	2781.50NM	1861	ALRS6100 VOL 1 ASD VOL 1 NP 281(1)	LAS PALMAS RADIO LAS PALMAS RADIO	WPT CH 1216
WPT 2	28 00.00'N	015 17.60'W	GPS WPT 882 JRE 4511Y	190T	2781.51 NM	1861	ALRS6100 VOL 1 ASD VOL 1 NP 281(1)	LAS PALMAS RADIO LAS PALMAS RADIO	WPT CH 1216
WPT 3	27 55.00'N	015 17.60'W	GPS WPT 882 JRE 4511Y	264T	55.14NM	2726.41 NM	ALRS6100 VOL 1 ASD VOL 1 NP 281(1)	SEA VICENTE COAST STATION	WPT CH 1216
WPT 4	07 00.00'N	059 00.00'W	GPS WPT 882 JRE 4511Y	320T	3722.17 NM	434NM	ALRS6100 VOL 1 ASD VOL 1 NP 281(1)	DEMARRA HARBOR BRIDGE	WPT CH 1216
WPT 5	06 50.00'N	058 03.50'W	GPS WPT 882 JRE 4511Y		4.24NM	4012.02T	ALRS6100 VOL 1 ASD VOL 1 NP 281(1)	DEMARRA HARBOR BRIDGE	WPT CH 1216
WPT 6					2793.00NM				
WPT 7									
WPT 8									
WPT 9									
WPT 10									

MASTER

BOURBON

Passage plan
B-FRM-K4-5003-ver.01

Items to be checked

Items to be checked	Checked (Yes/No/Comments)
Passage plan covers complete voyage between ports, from berth to berth and between installations	YES
Stability Calculation completed	YES
Displacement in stability calculation verified through manual reading of draught marks (if possible)	YES
VTS and Reporting points (if comments: VMS Frequency in chart)	YES MARK ON THE CHART
Port of call, navigation and water marks	YES MARK
Port of call, navigation and water marks (if comments: Port of call, navigation and water marks)	YES
Landfall targets, light buoys and leading lights	YES
Methods and frequency of position fixing	YES
Clear of Obstacles	YES
Range, heading, speed and timing	YES
Significant tide or current	YES
Safe speed and necessary speed alterations	YES SAFE SPEED
Changes in weather conditions	YES
Minimum under keel clearance (as per draft)	YES
Position where the ship should be activated	YES ECHO SOUNDER ON
Cross to and high visibility alert	YES LAS PALMAS AREA
Safe distance off	YES
Anchor clearance	YES
Contingency plans (Port of refuge, safe anchorage) - available and updated	YES
Abort position (Port of refuge)	YES
Any special considerations of the cargo	NO CARGO ONBOARD
Up to date navigation charts of appropriate scale selected and are available on board	YES NEW SUPPLY AND UPDATED
Up to date publications identified and are available on board	YES
Electronic charts (if comments: Electronic charts)	YES
Electronic charts (if comments: Electronic charts)	YES
No. of hours identified and high precision charts (Electronic charts) identified	YES MARK ON THE CHART
Latest navigational messages considered	YES NAVTEX AND RIN MSC
Primary and secondary position fixing methods, proximity of fixed objects, minimum UCL (as per draft) and minimum UCL, electronic charts and electronic charts	YES
After start of VTS, position and heading of vessel during period	YES
Backup or other position fixing methods (if comments: Backup or other position fixing methods)	YES
Navigation, 10.0 of any other of the voyage, and change over procedure deployment data identified	YES
If any change of entry to the port of call (if comments: If any change of entry to the port of call)	NO
Emergency procedures	YES
Emergency procedures (if comments: Emergency procedures)	YES
Port - formation	YES NP 281(1) VOL 1
Port - formation	YES NP 281(1) VOL 1

Prepared by (Name/Signature/Date)

2nd MATE

Officers (Name/Signature)

CHIEF MATE

Master's Approval (Name/Signature/Date)

CAPT

The following figure is a graphic representation of the approved Passage Plan.

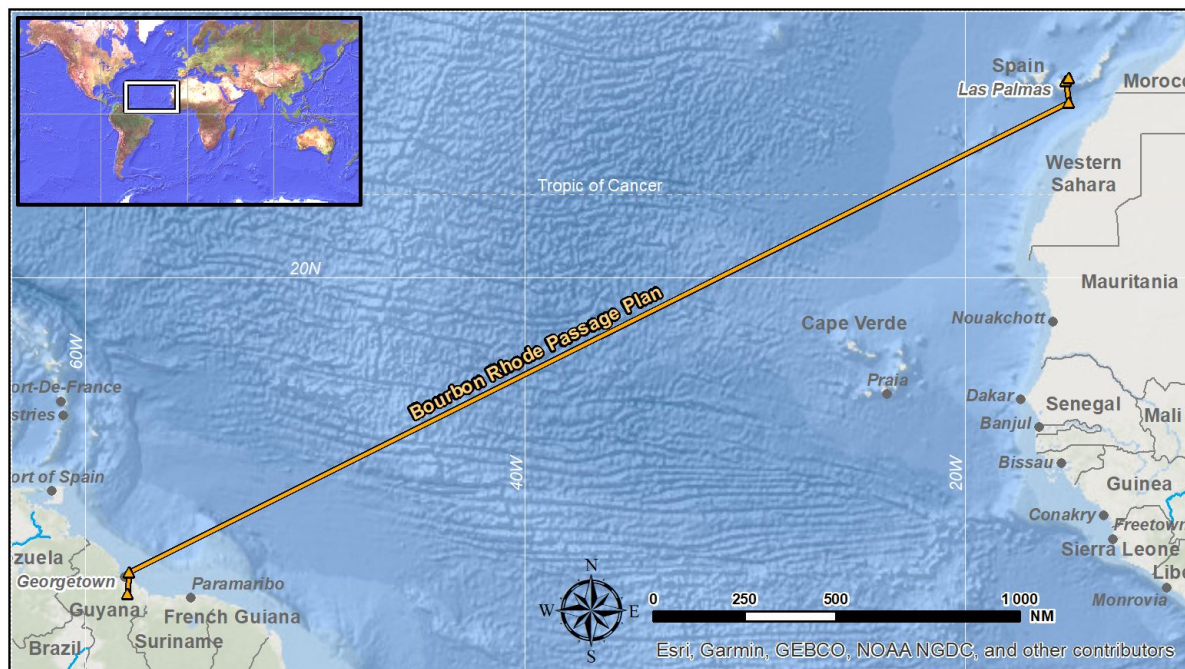


Figure 3.40 – Graphic representation of the Passage Plan
(Source: Esri)

3.5. ENVIRONMENTAL DETAILS

3.5.1. Weather forecasts and navigational warnings

The NAVTEX weather forecasts and warnings were available on the first two days of the transit, the 18 and 19 September 2019. Thereafter, the vessel was outside of the NAVTEX coverage area and did not receive any further NAVTEX data.

The *Bourbon Rhode* was not equipped with a weather facsimile and had no reliable VSAT coverage which would have made weather charts accessible via the internet. The crew subsequently had no graphic representation of the weather situation.

The forecasts and warnings issued on 18 September 2019 at 10:15 gave no specific warnings.

From 19 September 2019 onwards, the Inmarsat-C Enhanced Group Call weather bulletin & navigational warnings, which are sent automatically from shore to the ship, were available to the crew. The Inmarsat-C terminal has to be programmed and activated to receive the forecasts for a specific region. These transmissions are not logged ashore and, in case of a delivery failure, no error message is logged.

The vessel had to use the METAREA II and HSFAT2 navigational weather bulletins & warnings. These weather bulletins & warnings are updated every 6 hours.

3.5.1.1. *METAREA II bulletins issued by METEO-France*

On 23 September 2019, at 08:10, METEO-France issued the following warning bulletin Nr 322 for the METAREA II:

WONT50 LFPW 230814

SECURITE ON METAREA 2, METEO-FRANCE,
WARNING NR 322, MONDAY 23 SEPTEMBER 2019 AT 0810 UTC

GENERAL SYNOPSIS, MONDAY 23 AT 00 UTC.

TROUGH OVER BRITISH ISLES AND FRANCE MOVING TOWARDS NORTH SEA.

LOW "EX-HUMBERTO" 973 51N28W MOVING NORTHEAST, EXPECTED 980 53N18W BY 24/00 UTC, THEN EXPECTED 53N11W BY 24/12UTC. ASSOCIATED TROUGH CROSSING FROM WEST ALL AREAS ABOVE 38N, WITH COLD FRONT EXPECTED FROM IRELAND TO WEST PORTUGAL BY 24/00 UTC.

HIGH 1021 33N20W, EXPECTED 1024 32N26W BY 24/00 UTC, THEN 1026 35N28W BY 24/12UTC, WITH ASSOCIATED RIDGE BUILDING NORTHWARDS. A TROPICAL WAVE ALONG 18W EXTENDS FROM 19N TO A 1008 LOW NEAR 10N18W TO 03N, MOVING W AT 10-15 KT. A TROPICAL DEPRESSION OR TROPICAL STORM IS EXPECTED TO FORM LATER TODAY OR TONIGHT.

AN ATLANTIC TROPICAL WAVE WITH AXIS ALONG 34W FROM 21N SOUTHWARD IS MOVING W AT 10-15 KT.

This was the first forecast, in the METAREA II reports received by the *Bourbon Rhode*, which mentioned a tropical depression or storm expected to form later and moving west off the coast of West Africa.

On 23 September 2019, at 18:25, the Tropical Storm Lorenzo was first mentioned in the following warning bulletin:

WONT50 LFPW 231827

SECURITE ON METAREA 2, METEO-FRANCE,
WARNING NR 323, MONDAY 23 SEPTEMBER 2019 AT 1825 UTC

GENERAL SYNOPSIS, MONDAY 23 AT 12 UTC.

LOW "EX-HUMBERTO" 975 53N22W MOVING NORTHEAST, EXPECTED 988 53N12W BY 24/12 UTC, THEN EXPECTED 995 52N05W BY 25/00 UTC. ASSOCIATED TROUGH CROSSING FROM WEST ALL AREAS ABOVE 38N, WITH COLD FRONT CROSSING BAY OF BISCAY SOON.

HIGH 1024 33N19W, EXPECTED 1027 37N29W BY 25/00UTC, WITH ASSOCIATED RIDGE BUILDING WESTWARDS.

TROPICAL STORM LORENZO 1006 NEAR 11.1N 24.1W AT 23/15 UTC, MOVING WEST AT 16 KT, EXPECTED 11.5N 26.2W AT 24/00 UTC, 12N 26.2W AT 24/12 UTC THEN 12.5N 31.6W AT 25/00 UTC. MAX WIND NEAR CENTER 8, WITH GUSTS 45 KT, INCREASING 9 OR 10 LATER, WITH GUSTS 60 KT.

On the same day, at 22:15, METEO-France issued the following warning bulletin for the METAREA II:

FQNT52 LFPW 232012

A

SECURITE

Weather bulletin on METAREA 2,
METEO-FRANCE Toulouse, Monday 23 September 2019 at 2215 UTC.

Wind speed in BEAUFORT SCALE.

Sea state in DOUGLAS SCALE.

Please be aware, wind gusts can be a further 40 percent stronger than the averages given here, and maximum waves may be up to twice the significant height.

Part 1 : WARNING NR 323.

Part 2 : General synopsis, Monday 23 at 12 UTC

Low "Ex-HUMBERTO" 975 53N22W moving northeast, expected 988 53N12W by 24/12 UTC, then expected 995 52N05W by 25/00 UTC. Associated trough crossing from west all areas above 38N, with cold front crossing Bay of Biscay soon.

High 1024 33N19W, expected 1027 37N29W by 25/00UTC, with associated ridge building westwards.

Tropical storm LORENZO 1006 near 11.1N 24.1W at 23/15 UTC, moving west at 16 kt, expected 11.5N 26.2W at 24/00 UTC, 12N 26.2W at 24/12 UTC then 12.5N 31.6W at 25/00 UTC. Max wind near center 8, with gusts 45 kt, increasing 9 or 10 later, with gusts 60 kt.

Tropical wave with axis along 35W from 21N southward moving west at 10 kt.

Monsoon trough extends from the coast of Senegal near 14N17W to 10N20W to 06N37W.

3.5.1.2. HSFAT2 bulletins issued by the National Hurricane Centre Miami

The chart below provides an overview of the track of hurricane Lorenzo, with the associated area of tropical storm force winds, in relation to the vessel's track and shows the extent of the frame used for the graphic representation of the HSFAT2²⁸ bulletins in this section.

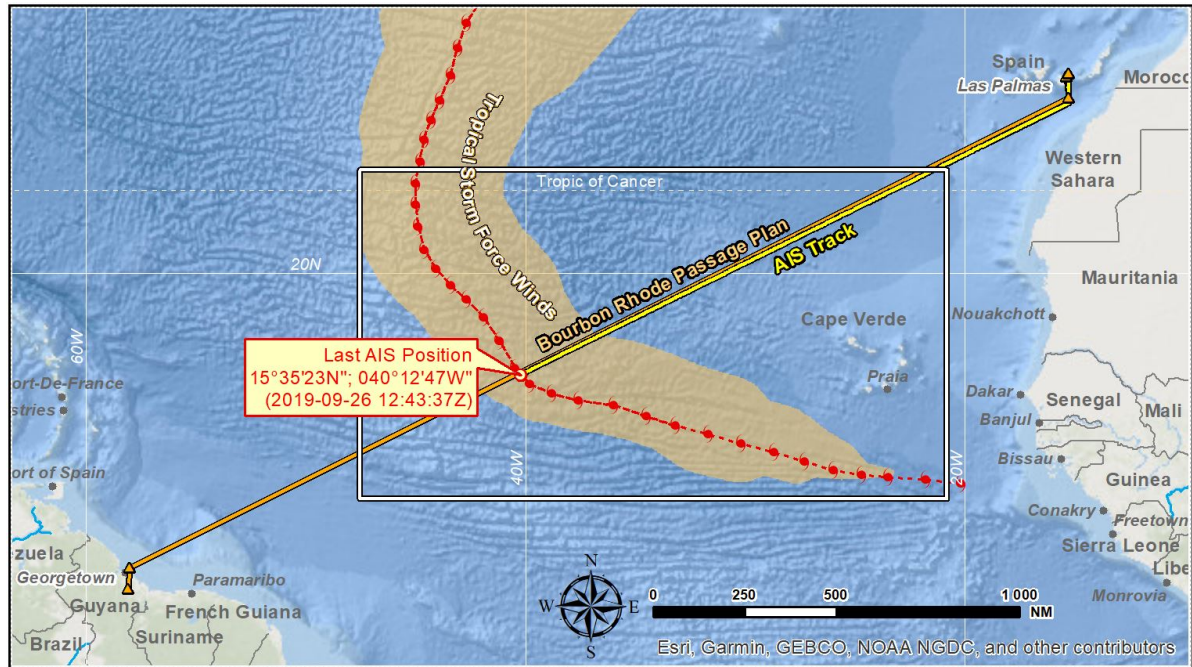









Figure 3.41 – Overview of the HSFAT2 graphic representations
(Source: Esri)

The following charts show a graphic representation of the HSFAT2 bulletins from 23 September 2019 onwards, which were available to the *Bourbon Rhode* crew for route planning via an operational Inmarsat-C terminal.

Each chart depicts the actual position of the vessel at the time of the 3-hour forecast and the projected position of the vessel, based on a track of 244° and an average speed of 8 kts, for the remaining forecasts. Furthermore, the chart shows the distance between the storm centre and the vessel for the respective forecasts contained in the HSFAT2 bulletins.

The legend below is valid for the HSFAT2 graphic representations in this section:

Legend

-  Vessel position (actual position for the 3h forecast, projected position for the other forecasts)
-  Hurricane center (forecast)
-  Hurricane track (forecast)
-  Tropical storm force winds (forecast)
-  Distance from vessel position to Hurricane center
-  Passage plan
-  AIS track

²⁸ <https://www.nhc.noaa.gov/archive/text/HSFAT2/2019/>

On 23 September, at 22:30, the National Hurricane Centre Miami issued the following HSFAT2 valid for 18:00:

000
FENT02 KHC 232211
HSFAT2

HIGH SEAS FORECAST
NWS NATIONAL HURRICANE CENTER MIAMI FL
2230 UTC MON SEP 23 2019

SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE
HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE
MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.

PAN PAN

ATLANTIC FROM 07N TO 31N W OF 25W INCLUDING CARIBBEAN SEA AND
GULF OF MEXICO

SYNOPSIS VALID 1800 UTC MON SEP 23.
24 HOUR FORECAST VALID 1800 UTC TUE SEP 24.
48 HOUR FORECAST VALID 1800 UTC WED SEP 25.

.WARNINGS.

...HURRICANE WARNING...
.TROPICAL STORM LORENZO NEAR 11.2N 25.5W 1004 MB AT 2100 UTC SEP
23 MOVING W OR 275 DEG AT 14 KT. MAXIMUM SUSTAINED WINDS 40 KT
GUSTS 50 KT. TROPICAL STORM FORCE WINDS WITHIN 30 NM N
SEMICIRCLE...20 NM SE QUADRANT AND 0 NM SW QUADRANT. SEAS 12 FT
OR GREATER WITHIN 30 NM OF CENTER EXCEPT 0 NM SW QUADRANT WITH
SEAS TO 14 FT.
.24 HOUR FORECAST TROPICAL STORM LORENZO NEAR 12.4N 30.2W.
MAXIMUM SUSTAINED WINDS 40 KT GUSTS 55 KT. TROPICAL STORM FORCE
WINDS WITHIN 110 NM N SEMICIRCLE...90 NM SE QUADRANT AND 40 NM SW
QUADRANT. SEAS 12 FT OR GREATER 90 NM OF CENTER EXCEPT 40 NM SW
QUADRANT WITH SEAS TO 15 FT.
.24 HOUR FORECAST HURRICANE LORENZO NEAR 12.1N 32.0W. MAXIMUM
SUSTAINED WINDS 70 KT GUSTS 85 KT. OVER FORECAST WATERS FROM 12N
TO 14N E OF 24W N WIND 20 TO 33 FT. SEAS 9 TO 11 FT. ELSEWHERE
OVER FORECAST WATERS FROM 11N TO 20N E OF 27W WINDS 20 KT OR
LESS. SEAS 8 TO 10 FT IN MIXED SWELL.
.48 HOUR FORECAST HURRICANE LORENZO NEAR 12.4N 35.7W. MAXIMUM
SUSTAINED WINDS 75 KT GUSTS 90 KT. TROPICAL STORM FORCE WINDS
WITHIN 150 NM N SEMICIRCLE...120 NM SE QUADRANT AND 70 NM SW
QUADRANT. SEAS 12 FT OR GREATER 210 NM N AND 180 NM S
SEMICIRCLES WITH SEAS TO 25 FT. ELSEWHERE WITHIN 300 NM N AND 210
NM S SEMICIRCLES WINDS 20 TO 33 FT. SEAS 9 TO 12 FT. REMAINDER OF
AREA OVER FORECAST WATERS FROM 06N TO 22N E OF 40W WINDS 20 KT OR
LESS. SEAS 8 TO 11 FT IN MIXED SWELL.
.72 HOUR FORECAST HURRICANE LORENZO NEAR 15.4N 40.7W. MAXIMUM
SUSTAINED WINDS 85 KT GUSTS 105 KT.
EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST HURRICANE LORENZO NEAR 18.3N 42.0W. MAXIMUM
SUSTAINED WINDS 95 KT GUSTS 115 KT.
.120 HOUR FORECAST HURRICANE LORENZO NEAR 21.0N 46.5W. MAXIMUM
SUSTAINED WINDS 100 KT GUSTS 120 KT.

FORECAST WINDS IN AND NEAR ACTIVE TROPICAL CYCLONES SHOULD BE
USED WITH CAUTION DUE TO UNCERTAINTY IN FORECAST TRACK...SIZE
AND INTENSITY.

...TROPICAL STORM WARNING...
.TROPICAL STORM JERRY NEAR 28.4N 68.3W 991 MB AT 2100 UTC SEP 23
MOVING NNW OR 330 DEG AT 5 KT. MAXIMUM SUSTAINED WINDS 55 KT
GUSTS 65 KT. TROPICAL STORM FORCE WINDS WITHIN 110 NM NE
QUADRANT...150 NM SE QUADRANT...40 NM SW QUADRANT...AND 70 NM NW
QUADRANT. SEAS 12 FT OR GREATER WITHIN 180 NM NW AND SE
QUADRANTS...210 NM NE QUADRANT AND 120 NM SW QUADRANT WITH SEAS
TO 23 FT. ELSEWHERE WITHIN 240 NM E SEMICIRCLE...150 NM SW
QUADRANT...AND 210 NM NW QUADRANTS WINDS 20 TO 33 KT. SEAS 8 TO
12 FT. REMAINDER OF AREA OVER FORECAST WATERS N OF 23N BETWEEN
63W AND 78W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.
.24 HOUR FORECAST TROPICAL STORM JERRY NEAR 30.9N 68.4W. MAXIMUM
SUSTAINED WINDS 50 KT GUSTS 60 KT. TROPICAL STORM FORCE WINDS
WITHIN 130 NM NE QUADRANT...150 NM SE QUADRANT...40 NM SW
QUADRANT...AND 70 NM NW QUADRANT. SEAS 12 FT OR GREATER
240 NM NE QUADRANT...180 NM SE QUADRANT...150 SW QUADRANT...AND
210 NM NW QUADRANT WITH SEAS TO 25 FT.
.48 HOUR FORECAST TROPICAL STORM JERRY NEAR 33.3N 64.0W. MAXIMUM
SUSTAINED WINDS 45 KT GUSTS 55 KT. TROPICAL STORM FORCE WINDS
WITHIN 120 NM E SEMICIRCLE AND 50 NM W SEMICIRCLE. OVER FORECAST
WATERS N OF 30N BETWEEN 59W AND 65W WINDS 20 KT OR LESS. SEAS 8
TO 9 FT IN MIXED SWELL.
.72 HOUR FORECAST TROPICAL STORM JERRY NEAR 35.0N 58.0W. MAXIMUM
SUSTAINED WINDS 45 KT GUSTS 55 KT. EXTENDED OUTLOOK...USE FOR
GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST TROPICAL STORM JERRY NEAR 36.0N 53.5W. MAXIMUM
SUSTAINED WINDS 40 KT GUSTS 50 KT.
.120 HOUR FORECAST TROPICAL STORM JERRY NEAR 35.0N 50.0W.
MAXIMUM SUSTAINED WINDS 35 KT GUSTS 45 KT.

FORECAST WINDS IN AND NEAR ACTIVE TROPICAL CYCLONES SHOULD BE
USED WITH CAUTION DUE TO UNCERTAINTY IN FORECAST TRACK...SIZE
AND INTENSITY.

...TROPICAL STORM WARNING...
.TROPICAL DEPRESSION KAREN NEAR 15.9N 65.6W 1007 MB AT 2100 UTC
SEP 23 MOVING NNW OR 335 DEG AT 11 KT. MAXIMUM SUSTAINED WINDS
30 KT GUSTS 40 KT. SEAS 12 FT OR GREATER WITHIN 0 NM W
SEMICIRCLE...60 NM NE QUADRANT AND 30 NM SE QUADRANT WITH SEAS
TO 13 FT. ELSEWHERE WITHIN 0 NM W SEMICIRCLE...210 NM NE
QUADRANT...AND 270 NM SE QUADRANT WINDS 20 TO 33 KT. SEAS 8 TO 12
FT. REMAINDER OF AREA WITHIN 240 NM NE QUADRANT...300 NM SE
QUADRANT...150 NM SW QUADRANT...AND 60 NM NW QUADRANT WINDS 20 KT
OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.
.24 HOUR FORECAST TROPICAL DEPRESSION KAREN NEAR 18.9N 66.6W.
MAXIMUM SUSTAINED WINDS 30 KT GUSTS 40 KT. SEAS 12 FT OR GREATER
WITHIN 0 NM ALL QUADRANTS EXCEPT 90 NM SE QUADRANT WITH SEAS TO
13 FT. ELSEWHERE WITHIN 0 NM W SEMICIRCLE...120 NM NE
QUADRANT...AND 180 NM SE QUADRANT WINDS 20 TO 33 KT. SEAS 9 TO 12
FT. REMAINDER OF AREA OVER OPEN WATERS WITHIN 240 NM NE
QUADRANT...210 NM SE QUADRANT...30 NM SW QUADRANT...AND 0 NM NW
QUADRANT WINDS 20 KT OR LESS. SEAS 8 TO 10 FT IN MIXED SWELL.
.48 HOUR FORECAST TROPICAL STORM KAREN NEAR 23.3N 65.9W. MAXIMUM
SUSTAINED WINDS 35 KT GUSTS 45 KT. TROPICAL STORM FORCE WINDS
WITHIN 60 NM E SEMICIRCLE AND 0 NM W SEMICIRCLE. SEAS 12 FT OR
GREATER 0 NM W SEMICIRCLE...90 NM NE QUADRANT...AND 120 NM SE
QUADRANT WITH SEAS TO 16 FT. ELSEWHERE FROM 120 NM NE
QUADRANT...150 NM SE QUADRANT...30 NM SW QUADRANT...AND 60 NM NW
QUADRANT WINDS 20 TO 33 KT. SEAS 9 TO 12 FT. REMAINDER OF AREA
WITHIN 180 NM NE QUADRANT...210 NM SE QUADRANT...120 NM SW
QUADRANT...AND 90 NM NW QUADRANT WINDS 20 KT OR LESS. SEAS 8 TO
11 FT IN MIXED SWELL.
.72 HOUR FORECAST TROPICAL STORM KAREN NEAR 26.5N 65.0W. MAXIMUM
SUSTAINED WINDS 45 KT GUSTS 55 KT.
EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST TROPICAL STORM KAREN NEAR 27.5N 65.5W. MAXIMUM
SUSTAINED WINDS 50 KT GUSTS 60 KT.
.120 HOUR FORECAST TROPICAL STORM KAREN NEAR 27.5N 67.0W.
MAXIMUM SUSTAINED WINDS 55 KT GUSTS 65 KT.

FORECAST WINDS IN AND NEAR ACTIVE TROPICAL CYCLONES SHOULD BE
USED WITH CAUTION DUE TO UNCERTAINTY IN FORECAST TRACK...SIZE
AND INTENSITY.

.SYNOPSIS AND FORECAST.

.GULF OF MEXICO FROM 22N TO 25N BETWEEN 83W AND 90W. WINDS 20 TO
25 KT. SEAS 8 TO 9 FT.
.06 HOUR FORECAST WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

.REMAINDER OF AREA WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

\$\$

.FORECASTER KONARIK, NATIONAL HURRICANE CENTER.

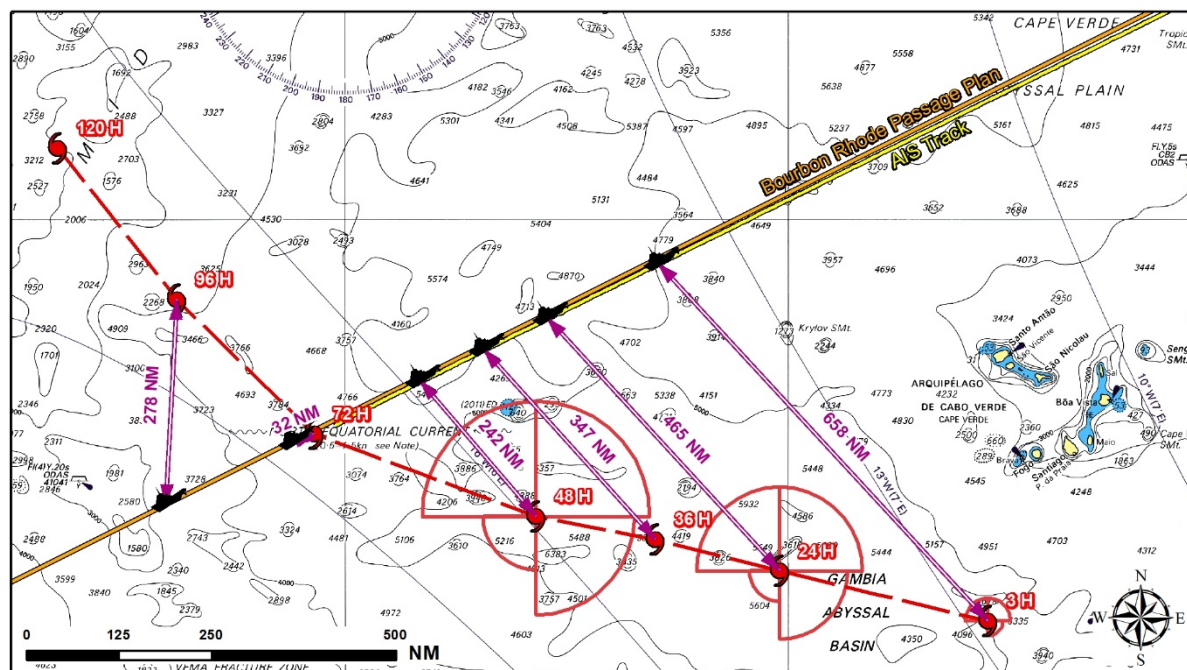


Figure 3.42 – Graphic representation of the HSFAT2 valid on 23 September for 18:00

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The HSFAT2 excerpts related to the tropical storm/hurricane Lorenzo issued by the National Hurricane Centre Miami from 24 to 26 September 2019 are shown hereafter:

Issued at 04:30 and valid for 00:00 on 24 September.

...HURRICANE WARNING...
 .TROPICAL STORM LORENZO NEAR 11.6N 26.7W 1002 MB AT 0300 UTC SEP
 24 MOVING W OR 280 DEG AT 13 KT. MAXIMUM SUSTAINED WINDS 45 KT
 GUSTS 55 KT. TROPICAL STORM FORCE WINDS WITHIN 80 NM N
 SEMICIRCLE...40 NM SE QUADRANT AND 0 NM SW QUADRANT. SEAS 12 FT
 OR GREATER WITHIN 60 NM OF CENTER EXCEPT 0 NM SW QUADRANT WITH
 SEAS TO 15 FT.
 .24 HOUR FORECAST HURRICANE LORENZO NEAR 12.8N 31.5W. MAXIMUM
 SUSTAINED WINDS 65 KT GUSTS 80 KT. TROPICAL STORM FORCE WINDS
 WITHIN 130 NM NE QUADRANT...100 NM SE QUADRANT...60 NM SW
 QUADRANT...AND 120 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN
 WITH 90 NM OF CENTER EXPECT 30 NM SW QUADRANT WITH SEAS TO 16 FT.
 OVER FORECAST WATERS FROM 12N TO 20N E OF 37W WINDS 20 KT OR
 LESS. SEAS 8 TO 9 FT IN MIXED SWELL.
 .48 HOUR FORECAST HURRICANE LORENZO NEAR 14.0N 37.0W. MAXIMUM
 SUSTAINED WINDS 80 KT GUSTS 100 KT. TROPICAL STORM FORCE WINDS
 WITHIN 150 NM N SEMICIRCLE...130 NM SE QUADRANT AND 70 NM SW
 QUADRANT. SEAS 12 FT OR GREATER WITHIN 210 NM ALL QUADRANTS
 EXCEPT 150 NM SW QUADRANT WITH SEAS TO 26 FT. ELSEWHERE WITHIN
 330 NM N SEMICIRCLE...270 NM SE QUADRANT...AND 210 NM SW QUADRANT
 WINDS 20 TO 33 KT. SEAS 10 TO 12 FT. REMAINDER OF AREA OVER
 FORECAST WATERS S OF 23N E OF 42W WINDS 20 KT OR LESS. SEAS 8 TO
 11 FT IN MIXED SWELL.
 .72 HOUR FORECAST HURRICANE LORENZO NEAR 16.1N 41.3W. MAXIMUM
 SUSTAINED WINDS 90 KT GUSTS 110 KT.
 EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
 .96 HOUR FORECAST HURRICANE LORENZO NEAR 19.0N 44.2W. MAXIMUM
 SUSTAINED WINDS 100 KT GUSTS 120 KT.
 .120 HOUR FORECAST HURRICANE LORENZO NEAR 22.0N 46.0W. MAXIMUM
 SUSTAINED WINDS 100 KT GUSTS 120 KT.

FORECAST WINDS IN AND NEAR ACTIVE TROPICAL CYCLONES SHOULD BE
 USED WITH CAUTION DUE TO UNCERTAINTY IN FORECAST TRACK...SIZE
 AND INTENSITY.

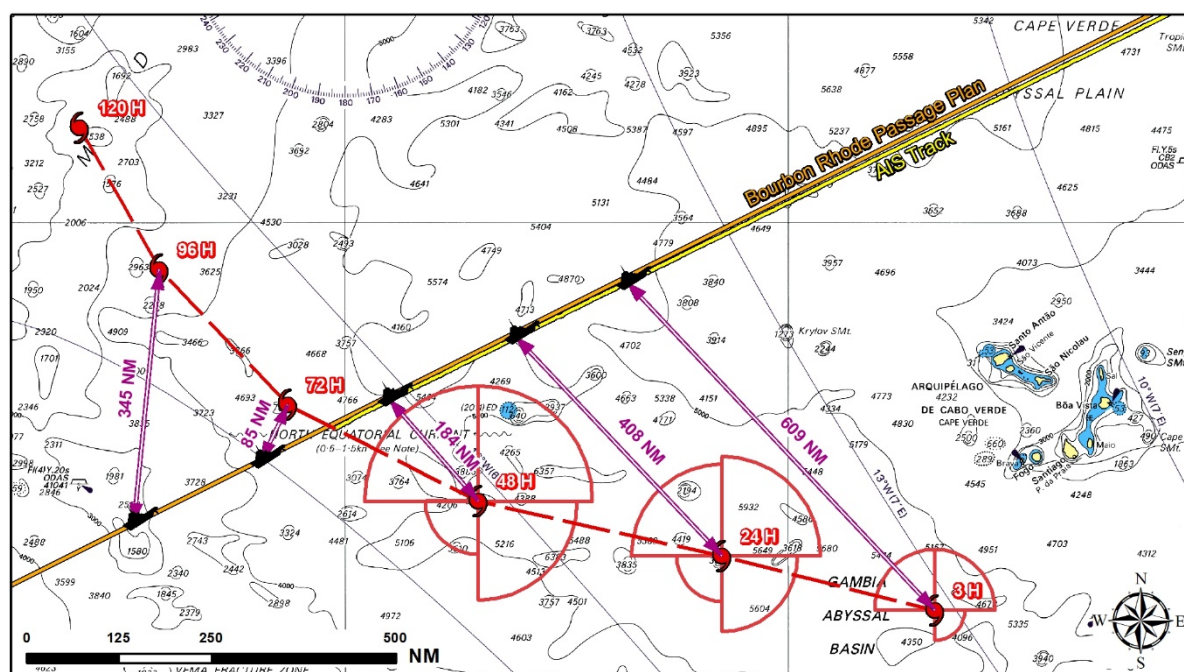


Figure 3.43 – Graphic representation of the HSFAT2 valid on 24 September for 00:00

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Issued at 10:30 and valid for 06:00 on 24 September.

...HURRICANE WARNING...

.TROPICAL STORM LORENZO E OF AREA NEAR 12.0N 28.0W 999 MB AT 0900 UTC SEP 24 MOVING WNW OR 285 DEG AT 14 KT. MAXIMUM SUSTAINED WINDS 55 KT GUSTS 65 KT. TROPICAL STORM FORCE WINDS WITHIN 100 NM NE QUADRANT...60 NM SE QUADRANT...20 NM SW QUADRANT...AND 90 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 120 NM NE QUADRANT...90 NM SE QUADRANT...45 NM SW QUADRANT...AND 75 NM NW QUADRANT WITH SEAS TO WITH SEAS TO 19 FT. OVER FORECAST WATERS WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

.12 HOUR FORECAST HURRICANE LORENZO E OF AREA NEAR 12.6N 30.0W. MAXIMUM SUSTAINED WINDS 65 KT GUSTS 80 KT.

.24 HOUR FORECAST HURRICANE LORENZO E OF AREA NEAR 13.3N 32.7W. MAXIMUM SUSTAINED WINDS 75 KT GUSTS 90 KT. TROPICAL STORM FORCE WINDS WITHIN 170 NM NE QUADRANT...120 NM SE QUADRANT...50 NM SW QUADRANT...AND 130 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 240 NM NE QUADRANT...120 NM S SEMICIRCLE AND 210 NM NW QUADRANT WITH SEAS TO 31 FT. OVER FORECAST WATERS WITHIN 11N35W TO 15N37W TO 17N37W TO 20N35W TO 11N35W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED NE AND SE SWELL.

.36 HOUR FORECAST HURRICANE LORENZO NEAR 13.9N 35.5W. MAXIMUM SUSTAINED WINDS 85 KT G 105 KT. TROPICAL STORM FORCE WINDS WITHIN 170 NM NE QUADRANT...120 NM SE QUADRANT...60 NM SW QUADRANT...AND 130 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 300 NM NE QUADRANT...180 NM S SEMICIRCLE AND 270 NM NW QUADRANT WITH SEAS TO 34 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 11N35W TO 12N38W TO 15N39W TO 19N37W TO 19N35W TO 11N35W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS WITHIN 07N35W TO 08N37W TO 13N40W TO 17N40W TO 22N35W TO 07N35W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED NE AND SE SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 14.4N 38.0W. MAXIMUM SUSTAINED WINDS 95 KT GUSTS 115 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM NE QUADRANT...120 NM SE QUADRANT...70 NM SW QUADRANT...AND 130 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM NE QUADRANT...180 NM SE QUADRANT...240 NM SW QUADRANT AND 330 NM NW QUADRANT WITH SEAS TO 36 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 12N35W TO 12N40W TO 16N42W TO 20N41W TO 20N35W TO 12N35W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS WITHIN 07N35W TO 12N39W TO 07N40W TO 21N44W TO 24N35W TO 07N35W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.72 HOUR FORECAST HURRICANE LORENZO NEAR 17.0N 41.7W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.

EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.

.96 HOUR FORECAST HURRICANE LORENZO NEAR 20.0N 44.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

.120 HOUR FORECAST HURRICANE LORENZO NEAR 23.0N 46.0W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

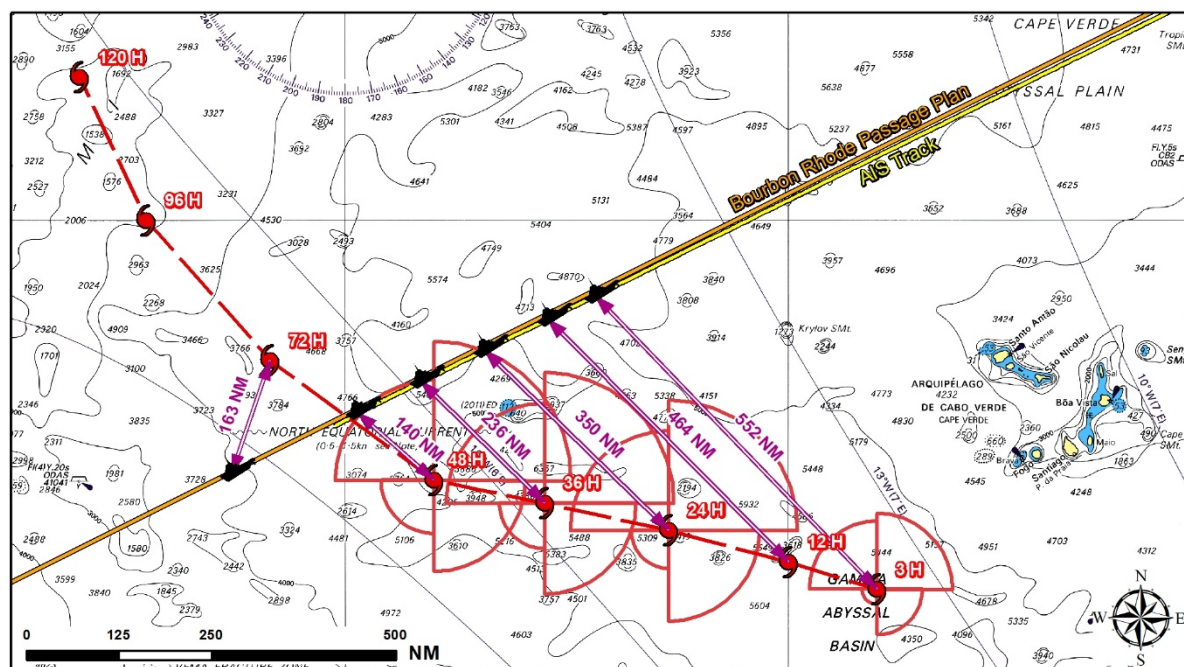
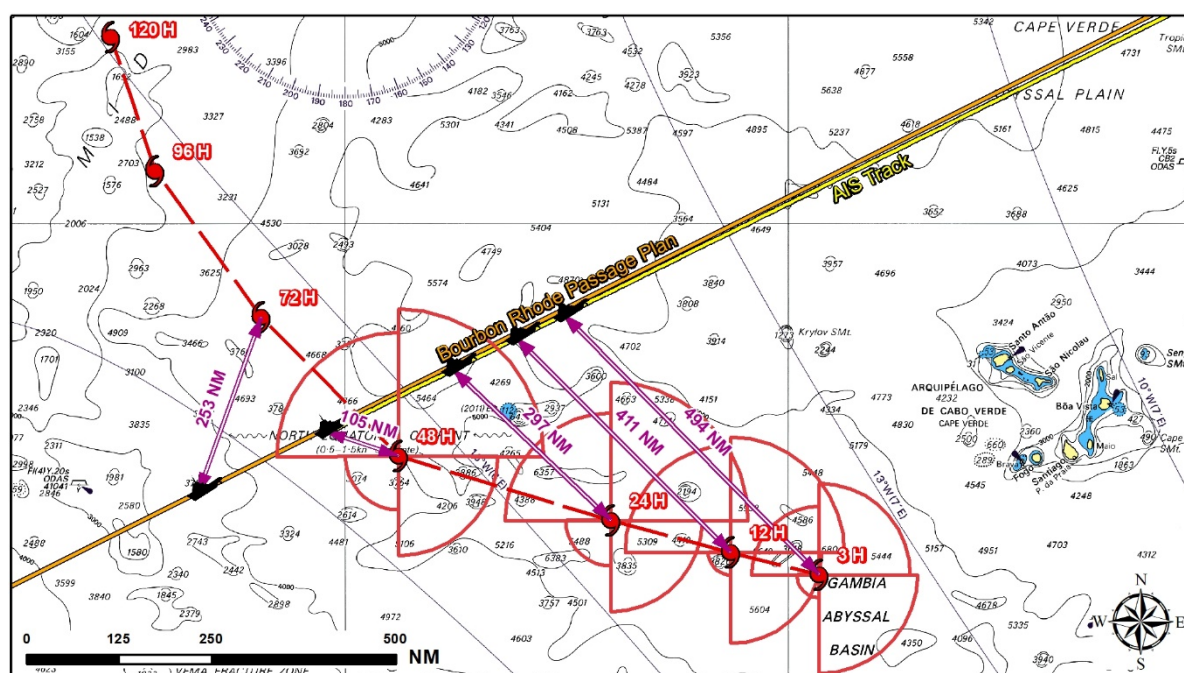


Figure 3.44 – Graphic representation of the HSFAT2 valid on 24 September for 06:00

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...ATLC HURRICANE WARNING...
 .TROPICAL STORM LORENZO E OF AREA NEAR 12.4N 29.3W 997 MB AT 1500 UTC SEP 24 MOVING WNW OR 285 DEG AT 14 KT. MAXIMUM SUSTAINED WINDS 55 KT GUSTS 65 KT. TROPICAL STORM FORCE WINDS WITHIN 120 NM NE QUADRANT...130 NM SE QUADRANT...130 NM SW QUADRANT...AND 90 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 60 NM S SEMICIRCLE...150 NM NE QUADRANT AND 75 NM NW QUADRANT WITH SEAS TO 23 FT. OVER FORECAST WATERS FROM 13N TO 19N E OF 38W WINDS 20 KT OR LESS. SEAS 8 TO 8 FT IN NE SWELL.
 .12 HOUR FORECAST HURRICANE LORENZO E OF AREA NEAR 12.9N 31.3W. MAXIMUM SUSTAINED WINDS 65 KT GUSTS 80 KT. TROPICAL STORM FORCE WINDS WITHIN 150 NM NE QUADRANT...120 NM SE QUADRANT...30 NM SW QUADRANT...AND 140 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 180 NM NE QUADRANT...90 NM S SEMICIRCLE AND 150 NM NW QUADRANT WITH SEAS TO 28 FT. ELSEWHERE OVER FORECAST WATERS FROM 13N TO 21N E OF 39W WINDS 20 KT OR LESS. SEAS 8 TO 9 FT IN MIXED SWELL.
 .24 HOUR FORECAST HURRICANE LORENZO JUST E OF AREA NEAR 13.6N 34.0W. MAXIMUM SUSTAINED WINDS 75 KT GUSTS 90 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM NE QUADRANT...120 NM SE QUADRANT...60 NM SW QUADRANT...AND 140 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 240 NM NE QUADRANT...120 NM S SEMICIRCLE AND 210 NM NW QUADRANT WITH SEAS TO 31 FT. ELSEWHERE OVER FORECAST WATERS E OF LINE FROM 20N35W TO 15N38W TO 11N35W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS S OF 21N E OF 39W WINDS 20 KT OR LESS. SEAS 8 TO 9 FT IN MIXED SWELL.
 .48 HOUR FORECAST HURRICANE LORENZO NEAR 15.0N 38.8W. MAXIMUM SUSTAINED WINDS 95 KT GUSTS 115 KT. TROPICAL STORM FORCE WINDS WITHIN 190 NM NE QUADRANT...130 NM SE QUADRANT...70 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM NE QUADRANT...180 NM SE QUADRANT...240 NM SW QUADRANT AND 330 NM NW QUADRANT WITH SEAS TO 38 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 330 NM N AND 120 NM S SEMICIRCLES WINDS 20 TO 33 KT. SEAS 9 TO 14 FT. REMAINDER OF AREA OVER FORECAST WATERS S OF 24N E OF 47W WINDS 20 KT OR LESS. SEAS 8 TO 12 FT IN MIXED SWELL.
 .72 HOUR FORECAST HURRICANE LORENZO NEAR 18.0N 41.9W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.
 EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
 .96 HOUR FORECAST HURRICANE LORENZO NEAR 21.1N 44.3W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.
 .120 HOUR FORECAST HURRICANE LORENZO NEAR 23.9N 45.3W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.



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Issued at 22:30 and valid for 18:00 on 24 September.

...HURRICANE WARNING...

.TROPICAL STORM LORENZO NEAR 12.8N 31.0W 997 MB AT 2100 UTC SEP 24 MOVING WNW OR 285 DEG AT 15 KT. MAXIMUM SUSTAINED WINDS 55 KT GUSTS 65 KT. TROPICAL STORM FORCE WINDS WITHIN 120 NM NW AND SE QUADRANTS...130 NM NE QUADRANT AND 0 NM SW QUADRANT. SEAS 12 FT OR GREATER WITHIN 90 NM OF CENTER EXCEPT 180 NM NE QUADRANT WITH SEAS TO 25 FT. ELSEWHERE OVER FORECAST WATERS FROM 13N TO 19N E OF 39W WINDS 20 KT OR LESS. SEAS TO 8 FT IN NE SWELL.

.12 HOUR FORECAST HURRICANE LORENZO NEAR 13.2N 33.0W. MAXIMUM SUSTAINED WINDS 65 KT GUSTS 80 KT.

.24 HOUR FORECAST HURRICANE LORENZO NEAR 13.8N 35.6W. MAXIMUM SUSTAINED WINDS 75 KT GUSTS 90 KT. TROPICAL STORM FORCE WINDS WITHIN 190 NM NE QUADRANT...120 NM SE QUADRANT...70 NM SW QUADRANT...AND 150 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 300 NM N AND 270 NM S SEMICIRCLES WITH SEAS TO 35 FT. ELSEWHERE OVER FORECAST WATERS FROM 09N TO 20N E OF 40W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF FORECAST WATERS S OF 22N E OF 31W WINDS 20 KT OR LESS. SEAS 8 TO 9 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 15.6N 40.0W. MAXIMUM SUSTAINED WINDS 90 KT GUSTS 110 KT. TROPICAL STORM FORCE WINDS WITHIN 190 NM NE QUADRANT...120 NM SE QUADRANT...80 NM SW QUADRANT...AND 150 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM N AND 270 NM S SEMICIRCLES WITH SEAS TO 40 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 390 NM N AND 300 NM S SEMICIRCLES WINDS 20 TO 33 KT. SEAS 9 TO 12 FT. REMAINDER OF FORECAST WATERS S OF 25N E OF 49W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.72 HOUR FORECAST HURRICANE LORENZO NEAR 18.8N 42.9W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.

EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.

.96 HOUR FORECAST HURRICANE LORENZO NEAR 21.9N 45.1W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

.120 HOUR FORECAST HURRICANE LORENZO NEAR 24.9N 45.3W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.

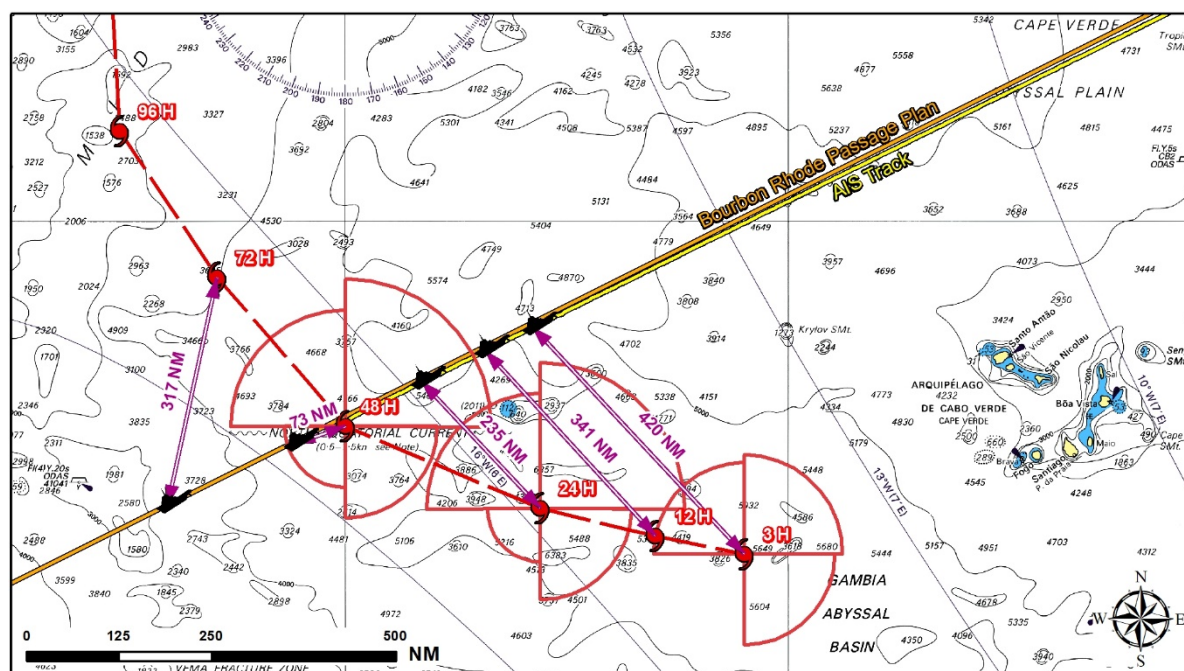


Figure 3.46 – Graphic representation of the HSFAT2 valid on 24 September for 18:00

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Issued at 04:30 and valid for 00:00 on 25 September.

...HURRICANE WARNING...

.TROPICAL STORM LORENZO NEAR 13.2N 32.4W 993 MB AT 0300 UTC SEP 25 MOVING NNW OR 285 DEG AT 14 KT. MAXIMUM SUSTAINED WINDS 60 KT GUSTS 75 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM E SEMICIRCLE...20 NM SW QUADRANT AND 130 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 120 NM OF CENTER EXCEPT 210 NM NE QUADRANT WITH SEAS TO 27 FT. ELSEWHERE OVER FORECAST WATERS FROM 13N TO 20N E OF 39W WINDS 20 KT OR LESS. SEAS TO 8 FT IN NE SWELL.
.12 HOUR FORECAST HURRICANE LORENZO NEAR 13.6N 34.4W. MAXIMUM SUSTAINED WINDS 70 KT GUSTS 85 KT.
.24 HOUR FORECAST HURRICANE LORENZO NEAR 14.2N 37.0W. MAXIMUM SUSTAINED WINDS 80 KT GUSTS 100 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM E SEMICIRCLE...90 NM SW QUADRANT AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM NW...330 NM NE...270 NM SE...AND 240 NM SW QUADRANTS WITH SEAS TO 37 FT. ELSEWHERE OVER FORECAST WATERS FROM 08N TO 20N E OF 41W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF FORECAST WATERS S OF 23N E OF 43W WINDS 20 KT OR LESS. SEAS 8 TO 10 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 16.4N 40.9W. MAXIMUM SUSTAINED WINDS 95 KT GUSTS 115 KT. TROPICAL STORM FORCE WINDS WITHIN 190 NM NE QUADRANT...180 NM SE QUADRANT...100 NM SW QUADRANT...AND 170 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 390 NM NW...360 NM NE...330 NM SE...AND 300 NM SW QUADRANTS WITH SEAS TO 41 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 360 NM N SEMICIRCLE...330 NM SE...AND 180 NM SW QUADRANTS WINDS 20 TO 33 KT. SEAS 10 TO 12 FT. REMAINDER OF FORECAST WATERS S OF LINE 26N35W TO 21N50W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.
.72 HOUR FORECAST HURRICANE LORENZO NEAR 19.9N 43.6W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.
EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST HURRICANE LORENZO NEAR 23.0N 45.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.
.120 HOUR FORECAST HURRICANE LORENZO NEAR 26.0N 45.0W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

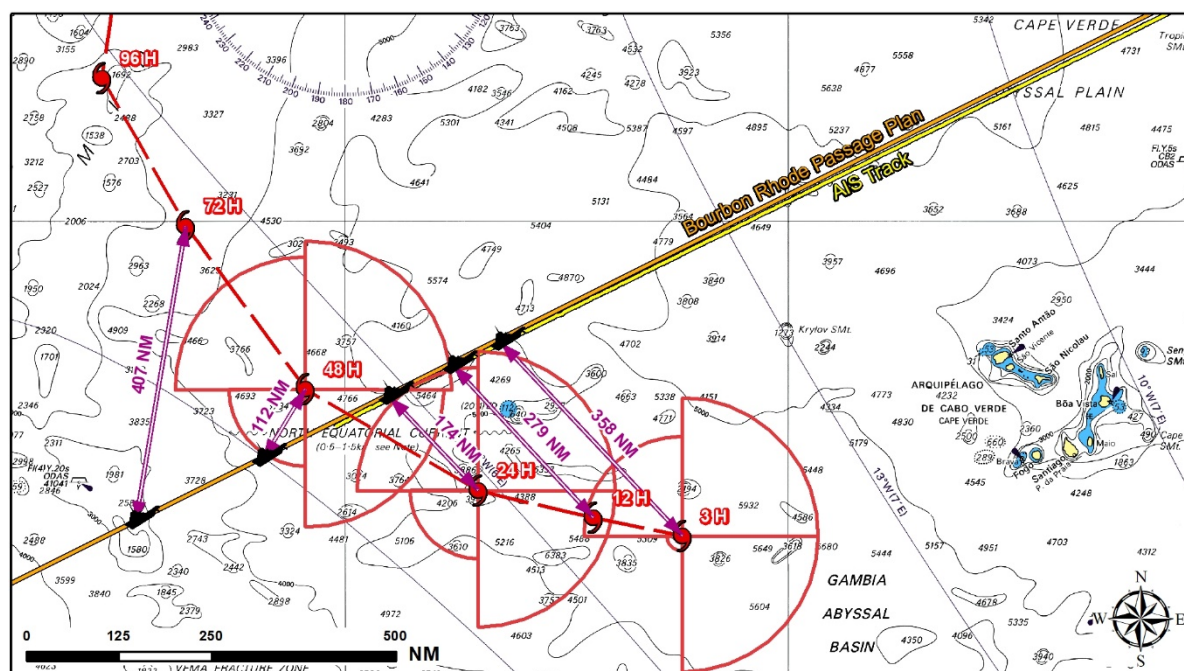


Figure 3.47 – Graphic representation of the HSFAT2 valid on 25 September for 00:00

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Issued at 10:30 and valid for 06:00 on 25 September.

...ATLC HURRICANE WARNING...

.HURRICANE LORENZO E OF AREA NEAR 13.6N 33.9W 988 MB AT 0900 UTC SEP 25 MOVING WNW OR 285 DEG AT 15 KT. MAXIMUM SUSTAINED WINDS 70 KT GUSTS 85 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM E SEMICIRCLE...30 NM SW QUADRANT AND 130 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 180 NM OF CENTER EXCEPT 270 NM NE QUADRANT WITH SEAS TO 32 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 12N35W TO 15N37W TO 17N37W TO 19N35W TO 12N35W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS WITHIN 17N37W TO 08N35W TO 18N39W TO 19N38W TO 21N35W TO 17N37W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED NE AND SE SWELL.

.24 HOUR FORECAST HURRICANE LORENZO NEAR 14.7N 38.4W. MAXIMUM SUSTAINED WINDS 95 KT GUSTS 115 KT. TROPICAL STORM FORCE WINDS WITHIN 160 NM NW AND SE QUADRANTS...200 NM NE QUADRANT AND 90 NM SW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM N SEMICIRCLE AND 240 NM S SEMICIRCLE WITH SEAS TO 38 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 11N35W TO 09N37W TO 17N44W TO 21N38W TO 20N35W TO 11N35W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS WITHIN 08N35W TO 09N41W TO 19N45W TO 23N43W TO 24N35W TO 08N35W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 17.5N 41.6W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT. TROPICAL STORM FORCE WINDS WITHIN 200 NM NE QUADRANT...180 NM SE QUADRANT...100 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 270 NM NE QUADRANT...300 NM SE QUADRANT...420 NM SW QUADRANT AND 390 NM NW QUADRANT WITH SEAS TO 42 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 15N38W TO 11N41W TO 16N47W TO 21N46W TO 15N38W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA OVER FORECAST WATERS WITHIN 08N39W TO 07N46W TO 22N49W TO 25N40W TO 19N35W TO 08N39W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.72 HOUR FORECAST HURRICANE LORENZO NEAR 21.1N 44.3W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT. EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.

.96 HOUR FORECAST HURRICANE LORENZO NEAR 24.0N 45.0W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

.120 HOUR FORECAST HURRICANE LORENZO NEAR 27.4N 43.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

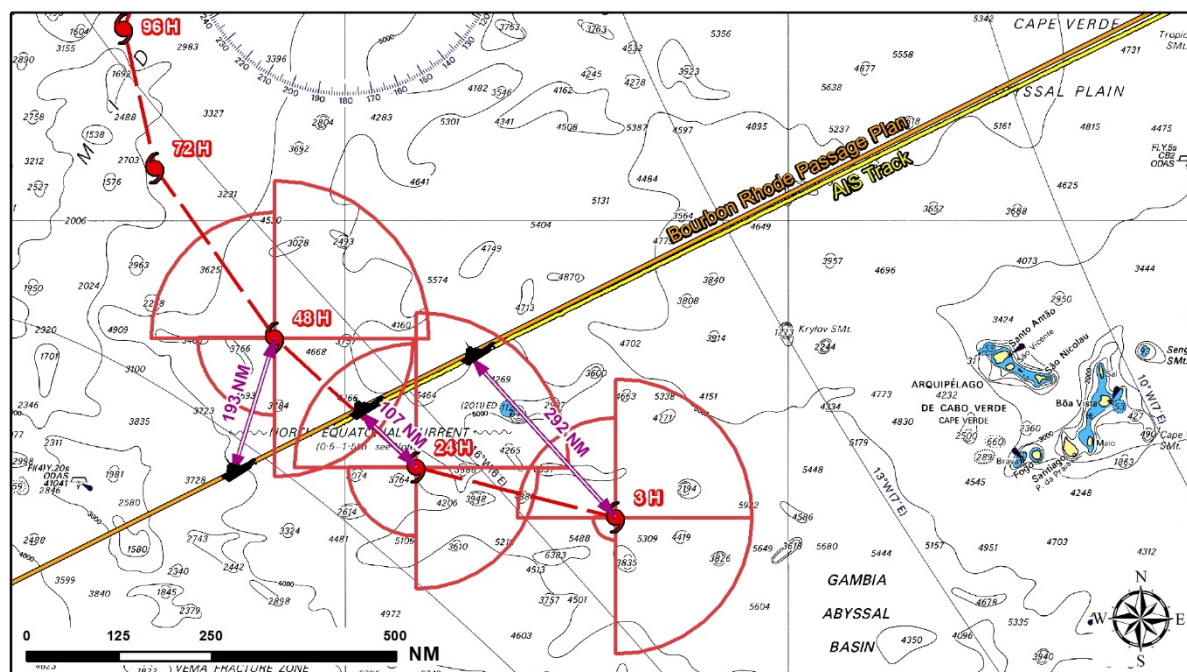


Figure 3.48 – Graphic representation of the HSFAT2 valid on 25 September for 06:00

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Issued at 16:30 and valid for 12:00 on 25 September.

...ATLC HURRICANE WARNING...

.HURRICANE LORENZO NEAR 14.1N 35.1W 983 MB AT 1500 UTC SEP 25 MOVING NNW OR 285 DEG AT 15 KT. MAXIMUM SUSTAINED WINDS 75 KT GUSTS 90 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM NE QUADRANT...130 NM SE QUADRANT...30 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 180 NM W SEMICIRCLE...270 NM NE QUADRANT AND 210 NM SE QUADRANT WITH SEAS TO 35 FT. ELSEWHERE FROM 09N TO 21N E OF 39W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA E OF LINE FROM 24N35W TO 15N48W TO 07N36W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED NE AND SE SWELL.

.24 HOUR FORECAST HURRICANE LORENZO NEAR 15.3N 39.2W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT. TROPICAL STORM FORCE WINDS WITHIN 160 NM NW AND SE QUADRANTS...200 NM NE QUADRANT AND 90 NM SW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM N SEMICIRCLE AND 300 NM S SEMICIRCLE WITH SEAS TO 40 FT. ELSEWHERE FROM 10N TO 22N E OF 44W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA S OF 25N AND E OF LINE FROM 25N35W TO 22N45W TO 18N48W TO 12N45W TO 07N44W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 18.4N 42.2W. MAXIMUM SUSTAINED WINDS 110 KT GUSTS 135 KT. TROPICAL STORM FORCE WINDS WITHIN 200 NM NE QUADRANT...180 NM SE QUADRANT...100 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 270 NM NE QUADRANT...330 NM SE QUADRANT...420 NM SW QUADRANT AND 390 NM NW QUADRANT WITH SEAS TO 44 FT. ELSEWHERE FROM 11N TO 23N BETWEEN 38W AND 48W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA BOUNDED BY 27N44W TO 24N52W TO 14N53W TO 07N49W TO 07N37W TO 17N35W TO 27N44W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.72 HOUR FORECAST HURRICANE LORENZO NEAR 21.9N 44.2W. MAXIMUM SUSTAINED WINDS 110 KT GUSTS 135 KT. EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.

.96 HOUR FORECAST HURRICANE LORENZO NEAR 25.0N 44.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

.120 HOUR FORECAST HURRICANE LORENZO NEAR 29.0N 42.0W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

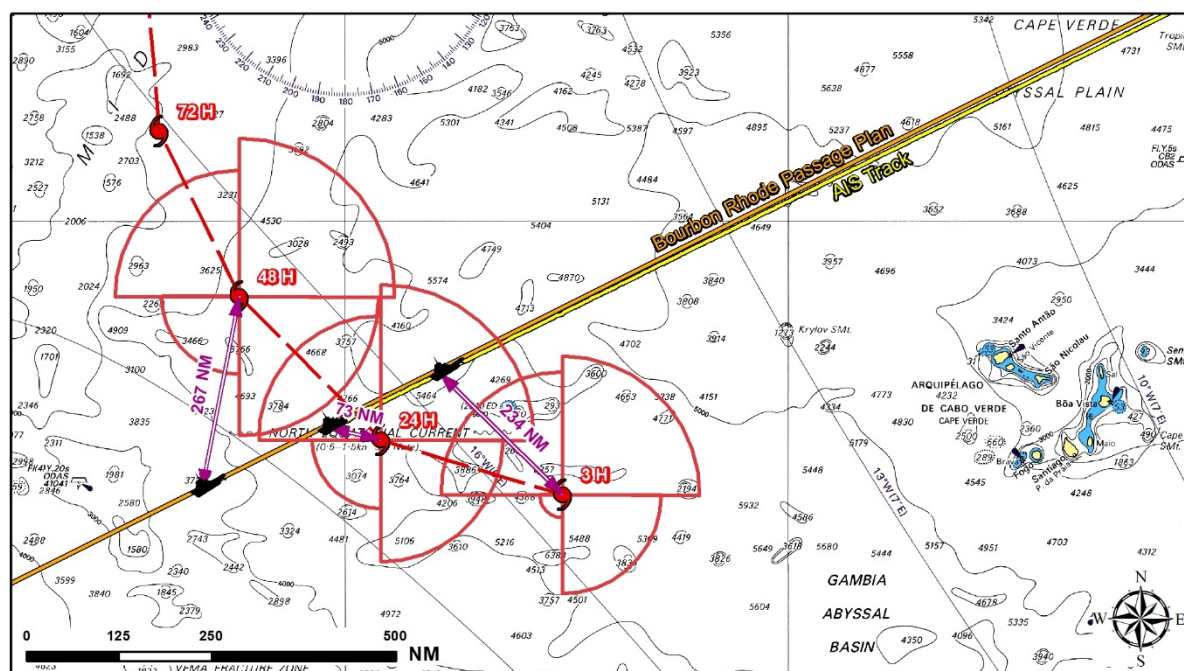


Figure 3.49 – Graphic representation of the HSFAT2 valid on 25 September for 12:00

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Issued at 22:30 and valid for 18:00 on 25 September.

...HURRICANE WARNING...

.HURRICANE LORENZO NEAR 14.5N 36.9W 978 MB AT 2100 UTC SEP 25 MOVING NNW OR 285 DEG AT 16 KT. MAXIMUM SUSTAINED WINDS 80 KT GUSTS 100 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM NE QUADRANT...130 NM SE QUADRANT...30 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 300 NM NE QUADRANT...240 NM SE QUADRANT...180 NM SW QUADRANT...AND 210 NM NW QUADRANT WITH SEAS TO 36 FT. ELSEWHERE OVER FORECAST WATERS FROM 08N TO 21N E OF 40W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA E OF LINE FROM 24N35W TO 20N43W TO 10N41W TO 07N39W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED NE AND SE SWELL.

.24 HOUR FORECAST HURRICANE LORENZO NEAR 16.1N 40.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT. TROPICAL STORM FORCE WINDS WITHIN 160 NM NW AND SE QUADRANTS...200 NM NE QUADRANT AND 90 NM SW QUADRANT. SEAS 12 FT OR GREATER WITHIN 360 NM NE...240 NM SE...360 NM SW...AND 390 NM NW QUADRANTS WITH SEAS TO 42 FT. ELSEWHERE FROM 10N TO 22N E OF 45W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA S OF LINE 26N35W TO 23N47W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 19.5N 43.0W. MAXIMUM SUSTAINED WINDS 110 KT GUSTS 135 KT. TROPICAL STORM FORCE WINDS WITHIN 200 NM NE QUADRANT...180 NM SE QUADRANT...100 NM SW QUADRANT...AND 160 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN 390 NM W SEMICIRCLE...330 NM NE QUADRANT...AND 360 NM SE QUADRANT WITH SEAS TO 46 FT. ELSEWHERE FROM 13N TO 25N BETWEEN 36W AND 46W WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF AREA FROM 10N TO 27N E OF 54W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.72 HOUR FORECAST HURRICANE LORENZO NEAR 23.0N 44.3W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT. EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.

.96 HOUR FORECAST HURRICANE LORENZO NEAR 26.5N 43.5W. MAXIMUM SUSTAINED WINDS 105 KT GUSTS 130 KT.

.120 HOUR FORECAST HURRICANE LORENZO NEAR 31.0N 40.5W. MAXIMUM SUSTAINED WINDS 100 KT GUSTS 120 KT.

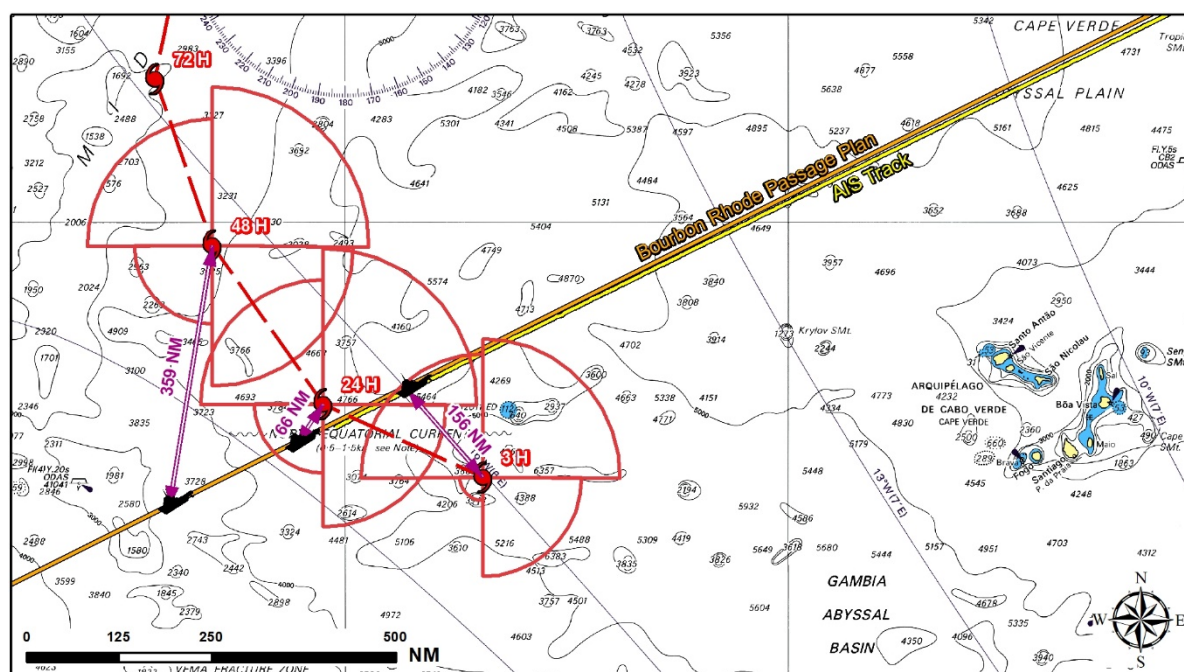


Figure 3.50 – Graphic representation of the HSFAT2 valid on 25 September for 18:00

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Issued at 04:30 and valid for 00:00 on 26 September.

...HURRICANE WARNING...

.HURRICANE LORENZO NEAR 14.7N 38.1W 974 MB AT 0300 UTC SEP 26
MOVING NNW OR 285 DEG AT 13 KT. MAXIMUM SUSTAINED WINDS 85 KT
GUSTS 105 KT. TROPICAL STORM FORCE WINDS WITHIN 180 NM NE
QUADRANT...90 NM SE QUADRANT...80 NM SW QUADRANT...AND 170 NM NW
QUADRANT. SEAS 12 FT OR GREATER WITHIN 330 NM NE QUADRANT...280
NM SE QUADRANT...210 NM SW QUADRANT...AND 300 NM NW QUADRANT
WITH SEAS TO 39 FT. ELSEWHERE OVER FORECAST WATERS WITHIN 330 NM
N SEMICIRCLE...270 NM SE AND 120 NM SW QUADRANTS WINDS 20 TO 33
KT. SEAS 8 TO 12 FT. REMAINDER OF AREA E OF LINE FROM 25N35W TO
21N43W TO 10N43W TO 07N41W WINDS 20 KT OR LESS. SEAS 8 TO 11 FT
IN MIXED NE AND SE SWELL.
.24 HOUR FORECAST HURRICANE LORENZO NEAR 16.8N 41.2W. MAXIMUM
SUSTAINED WINDS 105 KT GUSTS 130 KT. TROPICAL STORM FORCE WINDS
WITHIN 200 NM NE QUADRANT...120 NM SE QUADRANT...100 NM SW
QUADRANT...AND 170 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN
330 NM E AND 360 NM W SEMICIRCLES WITH SEAS TO 44 FT. ELSEWHERE
WITHIN 330 NM OF CENTER...EXCEPT 150 NM SW QUADRANT...WINDS 20
TO 33 KT. REMAINDER OF AREA S OF LINE 26N35W TO 23N48W WINDS 20
KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.

.48 HOUR FORECAST HURRICANE LORENZO NEAR 20.4N 43.3W. MAXIMUM
SUSTAINED WINDS 110 KT GUSTS 135 KT. TROPICAL STORM FORCE WINDS
WITHIN 200 NM NE QUADRANT...140 NM SE QUADRANT...100 NM SW
QUADRANT...AND 170 NM NW QUADRANT. SEAS 12 FT OR GREATER WITHIN
360 NM OF CENTER...EXCEPT 330 NM SW QUADRANT...WITH SEAS TO 48
FT. ELSEWHERE WITHIN 420 NM NE...330 NM SE...120 NM SW...AND 300
NM NW QUADRANTS WINDS 20 TO 33 KT. SEAS 8 TO 12 FT. REMAINDER OF
AREA FROM 10N TO 29N E OF 55W WINDS 20 KT OR LESS. SEAS 8 TO 11
FT IN MIXED SWELL.
.72 HOUR FORECAST HURRICANE LORENZO NEAR 23.8N 43.9W. MAXIMUM
SUSTAINED WINDS 105 KT GUSTS 130 KT.
EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE.
.96 HOUR FORECAST HURRICANE LORENZO NEAR 27.5N 42.4W. MAXIMUM
SUSTAINED WINDS 100 KT GUSTS 120 KT.
.120 HOUR FORECAST HURRICANE LORENZO NEAR 31.9N 39.1W. MAXIMUM
SUSTAINED WINDS 95 KT GUSTS 115 KT.

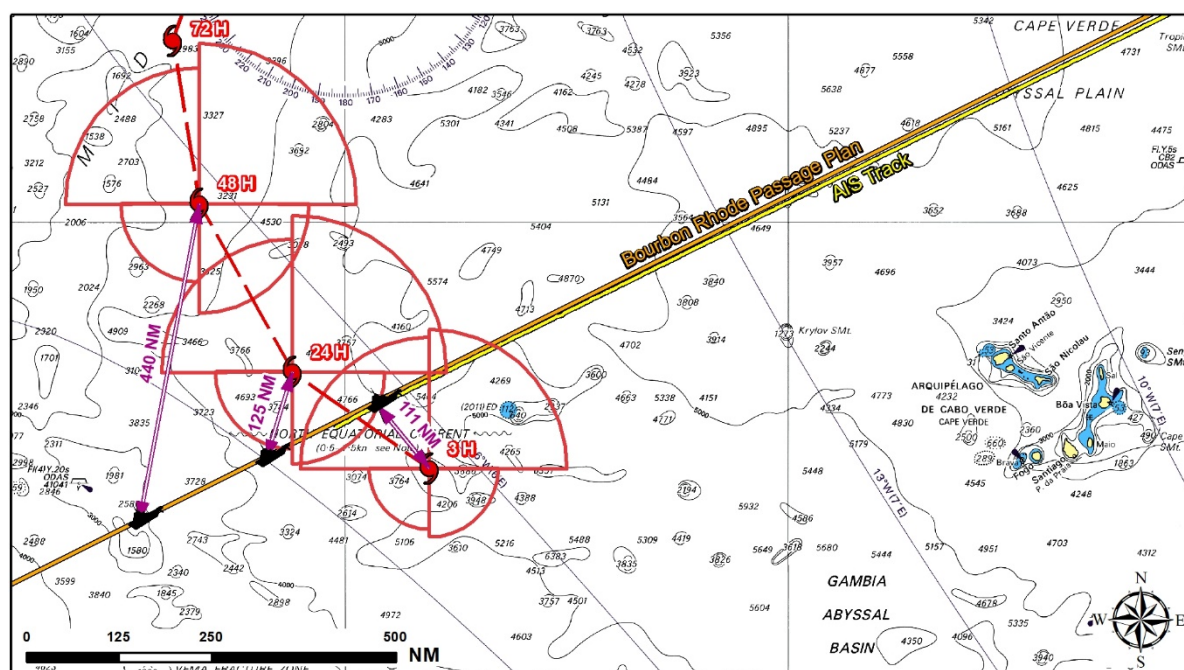


Figure 3.51 – Graphic representation of the HSFAT2 valid on 26 September for 00:00

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3.5.2. Weather observations

Upon leaving the Port of Las Palmas on 17 September 2019, the weather conditions were calm and remained unchanged for the next days. On 23 September 2019, the daily report stated light winds from the east at 7-10 kts (Beaufort force 3) and a slight swell from the southeast with wave heights of 1.5 m. At that time, tropical storm Lorenzo was about 720 NM to the southeast. The daily report from 24 September 2019 was similar to the day before, with wind speeds increasing to 10-13 kts and wave heights up to 2.0 m. Lorenzo had intensified to 55 kts winds and was centred about 520 NM southeast of the vessel.

On 25 September 2019 at 00:00, Hurricane Lorenzo intensified over the next 48 hours. At 06:00, Lorenzo was categorized as a hurricane with its centre located about 530 NM west of Cape Verde and 320 NM southeast of the *Bourbon Rhode*. The last daily report from the *Bourbon Rhode*, dated 25 September 2019, mentioned rough seas at Beaufort force 6 and wave heights of 3-4 m.

On 26 September 2019 at 00:00, while located about 130 NM southeast of the *Bourbon Rhode*, Lorenzo was upgraded to a category 2 hurricane with winds of 85 kts. When the vessel sank at around 12:43 on 26 September 2019, Lorenzo was rated as a category 3 hurricane with sustained winds of 110 kts.

On 27 September 2019 at 00:00, Hurricane Lorenzo initially peaked at an intensity of 125 kts, before weakening during the next 24 hours. In the morning of 28 September 2019, Lorenzo began to strengthen again, with a 40 kts gain of intensity in 21 hours. On 29 September 2019 at 03:00, the hurricane reached its peak intensity with winds of 140 kts, briefly becoming a category 5 hurricane. At that time, Lorenzo was centered about 600 NM northwest of the *Bourbon Rhode*'s last AIS position and did not affect the ongoing SAR operations.

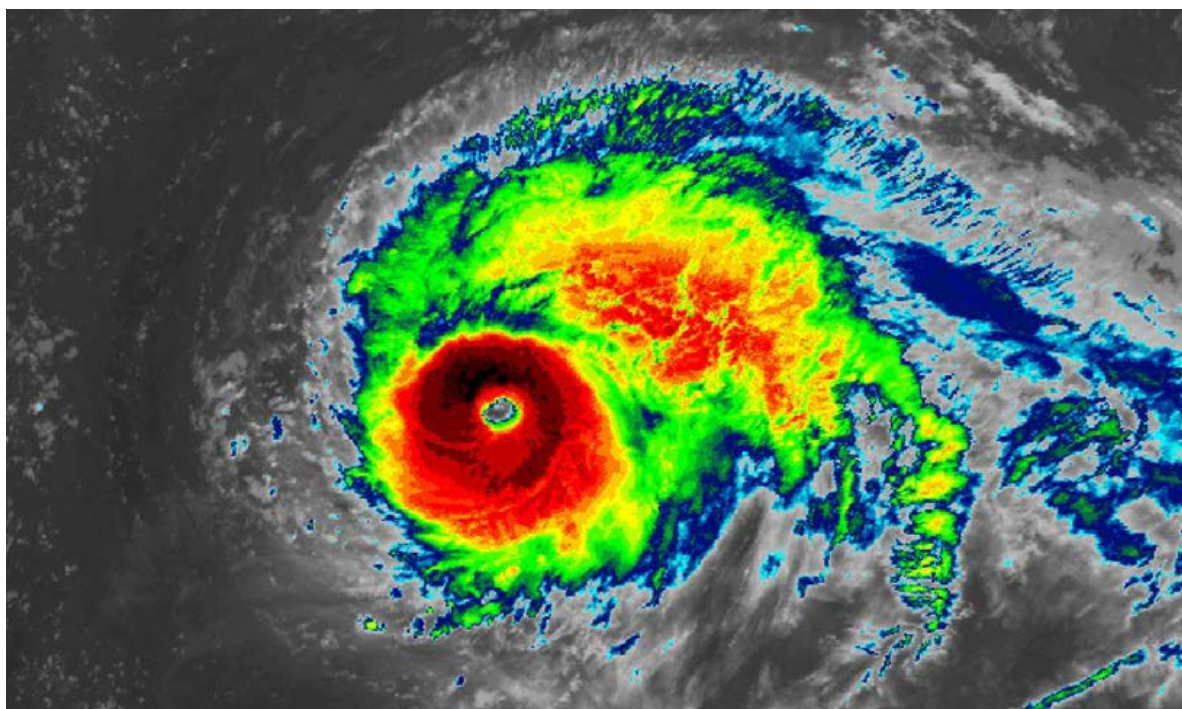


Figure 3.52 – Infrared image of hurricane Lorenzo at 02:00 on 29 September 2019 near the time of its peak intensity (Source: National Oceanic and Atmospheric Administration (NOAA) report)

From thereon, the hurricane continued its path to the northeast until being downgraded to an extratropical storm on 2 October 2019 at noon, then situated about 1120 NM west of Cape Finisterre (Spain).

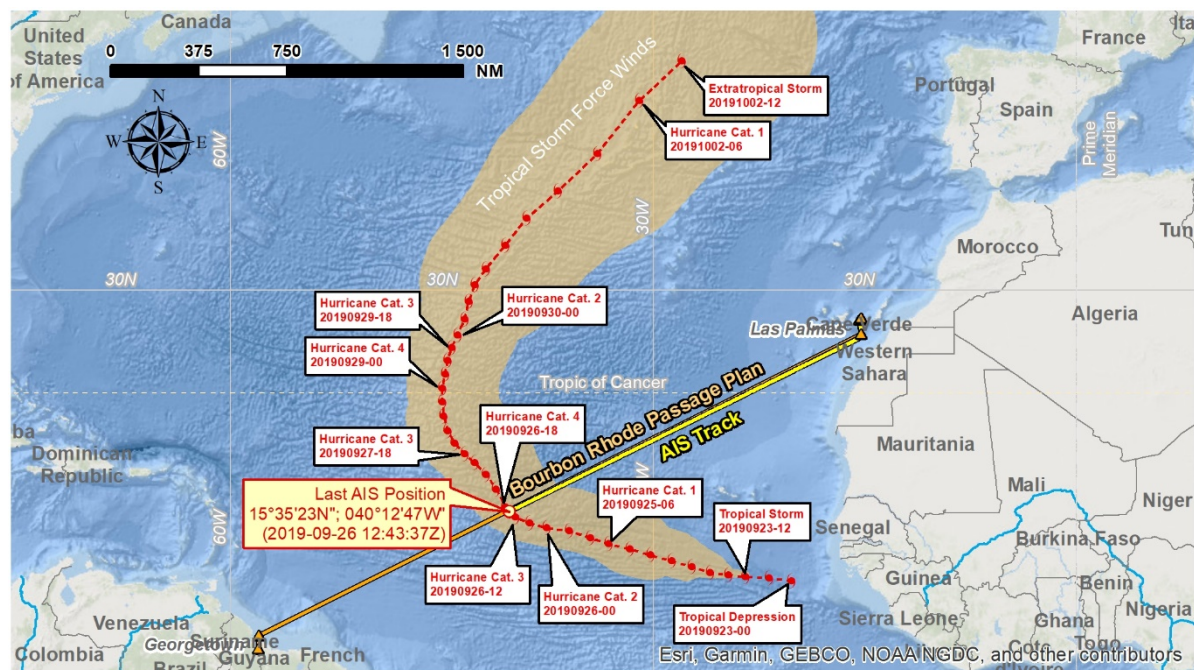


Figure 3.53 – Actual track of hurricane Lorenzo with categorization
(Source: NOAA)

According to the NOAA Tropical Cyclone Report dated 16 December 2019²⁹, Lorenzo was one of the strongest hurricanes on record in the eastern or central Atlantic. The report further states that *'Its 140-kt peak intensity is the highest for any hurricane east of 50°W in the Atlantic hurricane database back to 1851'*.

²⁹ https://www.nhc.noaa.gov/data/tcr/AL132019_Lorenzo.pdf

3.5.3. Hurricane Lorenzo track predictions

The track predictions of hurricane Lorenzo have been analysed against the actual track in order to assess the forecast accuracy and the possible effect of track errors on the *Bourbon Rhode* route planning. The analysis has been focussed on an area where the vessel's track was likely to come closest to the hurricane. As the vessel sank on 26 September 2019 at around 12:34 in proximity of the eyewall³⁰ of the hurricane, the forecasts from 24 and 25 September 2019, valid for 26 September on 12:00, have been selected for analysis and compared to the actual hurricane position at that time.

The Figure 3.54 provides an overview of the track of Lorenzo with the associated area of tropical storm force winds in relation to the vessel's track and shows the extent of the frame used for the analysis of the predicted track errors of Lorenzo for the selected date and time.

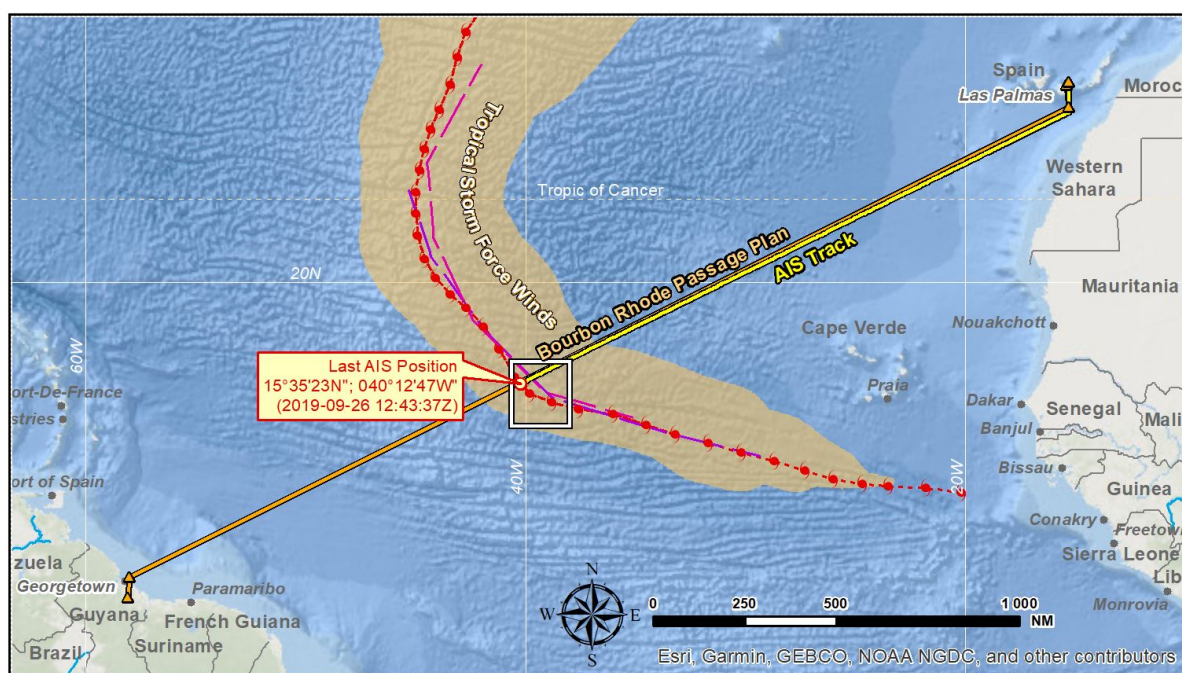


Figure 3.54 – Overview of the actual track of Lorenzo in relation to the vessel's passage plan and AIS track (Source: Esri)

The Figure 3.55 shows the predicted position of hurricane Lorenzo from the HSFAT2 forecast from 24 and 25 September 2019, valid for 26 September 2019 at 12:00, and the actual hurricane position in relation to the vessel's AIS track.

The left chart shows:

- the position errors between the forecasts from 24 and 25 September 2019, valid for 26 September 2019 at 12:00;
- the respective position errors between both forecasts and the actual hurricane position on 26 September 2019 at 12:00.

³⁰ The eye of a hurricane is surrounded by the eyewall, a ring of towering thunderstorms where the most severe weather and highest winds occur.

[https://en.wikipedia.org/wiki/Eye_\(cyclone\)](https://en.wikipedia.org/wiki/Eye_(cyclone))

(Source: Wikipedia)

The right chart shows:

- the distance between the predicted hurricane position from the forecasts dated 24 and 25 September 2019 and the vessel's projected position on 26 September 2019 at 12:00;
- the actual distance between hurricane Lorenzo's position and the vessel's AIS position on 26 September 2019 at 12:00.

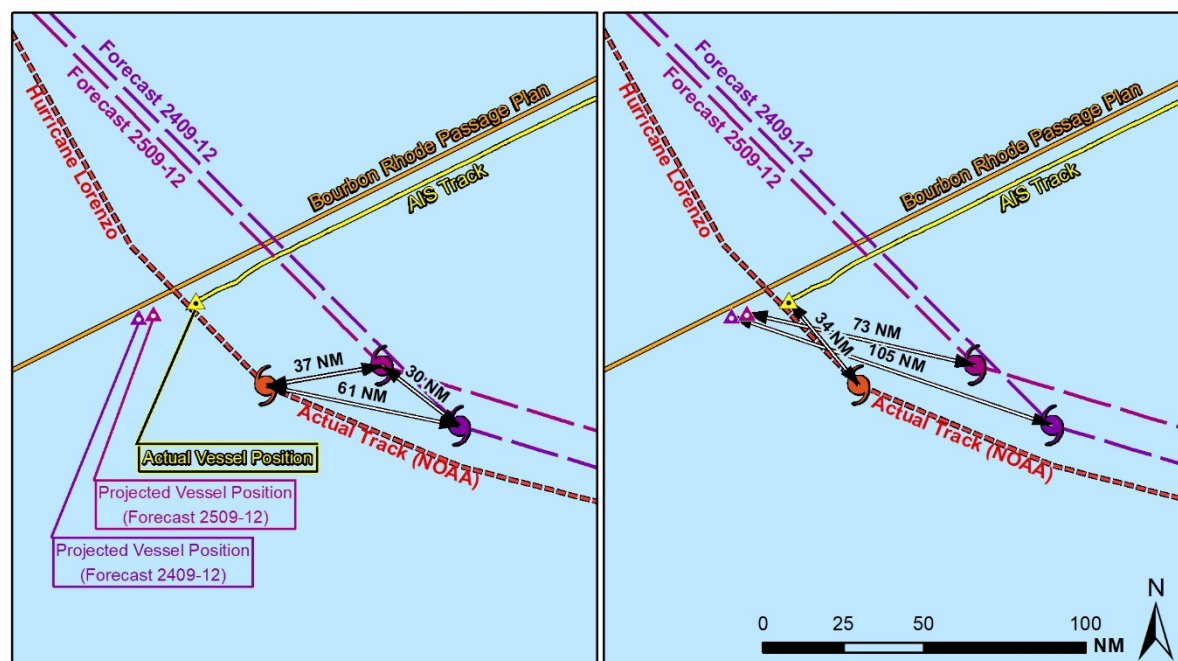


Figure 3.55 – Graphical representation of Hurricane Lorenzo's predicted track errors

The analysis has come to the following results:

- On the left chart, the predicted position of hurricane Lorenzo from the forecast on 25 September 2019 and valid for 26 September at 12:00 was 30 NM to the W-NW of the forecast for that same time on 24 September. The actual position of Lorenzo on 26 September 2019 at 12:00 was 37 NM to the W-SW of the predicted position from the forecast on 25 September 2019 and 61 NM to the W-NW of the predicted position from the forecast on 24 September 2019.
- On the right chart, based on the forecast dated 24 September 2019 and valid for 26 September 2019 at 12:00, the vessel's projected position was 105 NM to the W-NW of the predicted centre of hurricane Lorenzo. The forecast from 25 September 2019 and valid for that same time showed the projected vessel position at 73 NM to the W-NW of the predicted hurricane centre. The actual AIS position of the *Bourbon Rhode* on 26 September 2019 at 12:00 was 34 NM to the N-NW of the centre of Lorenzo.

The analysis shows that based on the forecasts from 24 and 25 September 2019, both valid for 26 September at 12:00, the vessel would have crossed the predicted hurricane track in front of the hurricane centre and would then have entered the

'*navigable semicircle*'³¹ of the hurricane. In all events, the *Bourbon Rhode* would have sailed within the zone of tropical storm force winds.

The fact that the hurricane's speed increased and that its actual track first shifted to the southwest before turning to the northwest, combined with the vessel's reduced speed due to the loss of propulsion, put the vessel in closer proximity to the hurricane centre than anticipated. The last received AIS position was located almost on the actual track of Lorenzo and near the eyewall of the hurricane, exposing the crewmembers to life-threatening sea conditions while abandoning ship at around 12:30.

According to survivor statements, the relative calm experienced when entering the eye of the storm allowed them to turn the life raft upright and board it, thus increasing their survivability. At that time, they were three survivors in the life raft.

3.6. VESSEL'S SAFETY MANAGEMENT SYSTEM (SMS)

The following paragraph describes relevant aspects of the vessel's SMS in the context of the occurrence. It should be noted that the vessel's SMS is built upon the bareboat charterer's generic SMS and can be adapted to the specifics of the vessel and its operational environment by the BOG ship manager if deemed necessary.

Section 9 – Safety management manual defines as main objective:

To develop a proactive approach to safety management, both onboard and ashore. This proactive approach includes the identification of hazards (including exposure to substances hazardous to health) and the implementation of preventive and mitigation measures.

Effective safety management requires the systematic identification of hazards, and measures to eliminate or reduce risks to the lowest practicable level.

It also describes the additional measures that shall be taken to promote an effective safety culture and motivate staff to ensure that they understand and embrace the requirements of the Safety Management System.

The following paragraphs show excerpts of the procedures in place at the time of and in relation with this accident.

³¹ Navigable semicircle: The side of a tropical cyclone to the left of the direction of movement of the storm in the Northern Hemisphere (to the right in the Southern Hemisphere), where the winds are weaker because the cyclone's translation and rotation speeds subtract.

https://glossary.ametsoc.org/wiki/Navigable_semicircle
(Source: American Meteorological Society)

3.6.1. Passage planning and manoeuvring procedure

The vessel's SMS describes the purpose of this procedure as to define "*the standards for passage planning and minimum informations that shall be contained in it*". The scope of this procedure extends to "all vessels under Internal Safety Management System (ISM) certification or any crew boat equal to greater than 32 meters in length".

The description of the passage planning states the following:

Passage planning is a mandatory company requirement. A Passage Plan shall be formulated for each voyage and updated when necessary for each separate passage made by the vessel along the same route.

Passage planning is required from berth to berth or berth to offshore location and shall include any intermediate offshore locations such as drilling rigs and platforms. The Passage Plan shall determine the safest, shortest and most economical route whilst maintaining adequate passing distances from identified hazard and allowing safety margins as required. Where applicable, weather routing shall be used during Passage Planning.

The Master is responsible for establishing and approving the Passage Plan but can delegate preparation to another Officer.

Prior to proceeding to sea, the Master shall:

- *Consult with the Chief Engineer to verify that the vessel has sufficient fuel, water and lubricants for the intended voyage;*
- *Ensure that the intended voyage has been planned using appropriate charts and publications for the area concerned.*
- *The charts and publications used in the preparation of the Passage Plan shall be documented in the Passage Plan;*
- *The courses laid down for the Passage Plan are safe;*
- *Consider at which specific points of the passage there may be a need to utilize additional deck or engine room personnel;*
- *Consider whether any particular circumstance, such as the forecast of restricted visibility in an area where position fixing by visual means at a critical point is an essential feature of the Passage Plan introduces an unacceptable hazard to the passage. He or she shall determine whether that section of the passage shall be attempted under the conditions prevailing or likely to prevail.*

The plan shall be available at all times on the bridge to allow Bridge Watch Officers immediate access and reference to the details of the plan.

Each Bridge Watch Officer shall view and discuss the Passage Plan as applicable during each watch handover.

The progress of the vessel in accordance with the Passage Plan shall be closely and continuously monitored.

Any information related to the present or future passage shall be reported to the Master and the Passage Plan shall be updated, as the situation requires.

Whenever necessary to deviate substantially from the planned route, an amended route shall be planned and approved by the Master.

If the Passage Plan is modified during the voyage, for example changes in course or speed to those specified or required because of a potentially hazardous situation; a new destination or changing weather conditions, the Master or duty Bridge Watch Officer shall ensure that subsequent relieving Bridge Watch Officers are aware of the changes before assuming watch duty. Such changes to the Passage Plan shall be recorded in the Bridge Logbook.

3.6.2. Navigation and Watch keeping Procedure - Open seaways navigation

The Bridge Watch Officer shall:

- *Carefully appraise the situation based on sight and hearing as well as the appropriate charts and nautical publications;*
- *Ensure that the largest scale chart for the applicable area is being used and is fully corrected and up-to-date;*
- *Constantly check and affirm the current position of the vessel according to the approved passage plan and as per Vessel Standing Orders using appropriate methods;*
- *Record the vessel position at appropriate intervals;*
- *Tune and constantly monitor the radar equipment to detect weak echoes (small craft, navigational marks and other small floating objects, etc.) and perform regular radar plots;*
- *Where fitted, ensure that the Bridge Navigational Watch Alarm System is in operation;*
- *Use all available bridge navigational instruments and equipment to ensure a safe watch is maintained.*

The Engine Watch Officer responsibilities include:

- *Ensure the engineering watch is aware of the nature of the vessels current tasking; position and operation;*
- *Ensure instant response to command of the vessel;*
- *Maintain maximum machinery efficiency at all times and in a full-running condition at all times;*
- *Promote a safe working environment;*
- *Provide immediate response to emergencies (fire, flood, machinery breakdown, steering gear breakdown, etc);*
- *Ensure fire pumps are ready to be used;*
- *Ensure permanent air pressure: electrical power is available for sound signals;*
- *Ensure standby machinery is available at immediate notice.*

3.6.3. Navigation and Watch keeping Procedure - Adverse/Heavy weather

The Master is responsible for documenting his requirements for heavy weather sailing in the Master's Standing Orders and with the Bridge Watch Officers ensuring they are followed.

Adverse or heavy weather conditions shall be considered, at the least

- *Navigating in or near a Tropical Revolving Storm;*
- *Storm as per Beaufort scale, Force 8 and above;*
- *Snow/Sand storm,*
- *Sea ice and Icing*

Ideally, a vessel should "ride" heavy weather on a course and at a speed to maintain heading while limiting the effects of breaking seas and to prevent damage.

A full risk assessment shall be carried out prior to onset of heavy weather to ensure the safety of the vessel and crew. To assist the Master and the vessel's crew Navigation in Heavy Weather checklist has to be used by the vessel in the event of encountering adverse or heavy weather.

Logbook entries shall clearly detail the onset of the weather, preparations on board and checklists completed. Further entries shall be made in the Bridge Logbook to record the weather experienced throughout its duration, and any consequences of that weather on the vessel, cargo or crew.

During heavy weather, in addition to other documented safe navigational practices, the Bridge Watch Officer shall:

- *If prior warning of heavy weather is received (or if a proposed course alternation shall cause severe motion) ensure that all personnel are made aware, cargo should be checked to ensure movable objects are suitably secured and all practical precautions are taken to avoid any damage that may otherwise occur;*
- *Consideration shall be given to finding shelter from the seas; a port of refuge shall be considered if the vessel is taking or is likely to take unacceptable punishment;*
- *Crew activity on deck or any exposed area shall be avoided unless necessary for the safety of personnel, the vessel or assets;*
- *If crewmembers have to go onto the deck or into other exposed areas, the use of lifelines or similar protection shall be considered in addition to floatation devices;*
- *Whilst personnel are exposed, the vessel shall be manoeuvred into a position and at an optimized speed to afford maximum protection for crew on-deck, who shall be constantly monitored until safely clear from the deck;*
- *If object are lost or jettisoned overboard and remain afloat a security message shall be transmitted, the nearest Coastal State authorities shall be informed and Bourbon Incident Reporting procedure complied with. The Contracts Manager, Operation Manager and any applicable offshore installation shall also be informed;*

- *The vessel shall be manoeuvred into a position and at an optimised speed to afford maximum protection for crew on deck, who shall be constantly monitored until safely clear from the deck;*
- *If sizeable objects are lost or jettisoned overboard and remain afloat, a security message shall be transmitted and the nearest Coastal State authorities shall be informed. The Contracts Manager, Operations Manager and any applicable offshore installation shall also be informed;*
- *If the contents of the lost object are hazardous, a marine pollutant or a danger to navigation the appropriate message shall be dispatched. The Contracts Manager, Operations Manager and any applicable offshore installation shall also be informed;*
- *In the event of any damage or other loss, or any other situation developing that is deemed unusually hazardous with consideration to the prevailing heavy weather conditions. The Master shall follow the procedures for incident reporting;*
- *The Contracts Manager, Operations Manager and any applicable offshore installation shall be informed.*
- *In the event of heavy snow or severe ice accretion, stability information shall be consulted and the added mass of the snow/ice calculated to ensure sufficient stability is maintained at all times. The Contracts Manager, Operation Manager and any applicable offshore installation shall be informed.*

During heavy weather, Engineer Watch Keeping responsibilities are as documented for coastal navigation.

As no further guidance on safe navigational practices was found in the vessel's SMS, the bareboat charterer, on whose generic SMS it is based, provided additional information in order to clarify the reference to "*other documented safe navigational practices*". It showed that this mention did not refer to specific documents available within the SMS, but it was a reference to safe navigational practices commonly found in marine literature and supposedly acquired by seafarers through education, training and practice. Safe navigational practices were expected to be part of a seafarer's background and experience, and were hence not addressed by the SMS.

In order to provide formal guidance on safe navigational practices, the bareboat charterer complemented the "*Navigation and Watch keeping Procedure - Adverse/Heavy weather*" by a Tropical Revolving Storm awareness procedure, which is presented under the chapter "**3.12. CORRECTIVE ACTIONS TAKEN BY THE BAREBOAT CHARTERER**".

3.6.4. Fuel Consumption Procedure

The fuel consumption during transit procedure states the following:

Before any transit, the Vessel Master shall estimate the best economical speed taking at least into account the vessel deadweight, the trim and the weather forecast.

This economical speed shall be proposed to Client onshore logistic or to Offshore Installation Manager/Installation Radio Room depending of the transit type (to port/interfiled/to field).

3.6.5. Vessel Daily Report

In accordance with the operating provisions, a Vessel Daily Report was sent from the *Bourbon Rhode* via Inmarsat-C to the ship manager.

The following table shows the relevant voyage data from the *Bourbon Rhode* daily reports:

Date (Noon)	Relevant Data
18 September	LAT: 26°56,6' N LONG: 015° 35,7' W AVERAGE SPD : 7,2 KNOTS PRESENT SPD : 8.4 KNOTS DIST RUNN since departure : 86,1 NM DIST TO GO : 2706.6 NM ETA: 04.10.2019. 04:00 hours LT (Guyana)
19 September	No daily report from noon.
20 September	LAT: 23°43.0'N LONG: 022°49.0'W WEATHER(BEAUFORT) WIND DIR/FORCE: 5 SEA STATE/SWELL DIR/SWELL HT: MODERATE/ NE/ 2-2.5M PRESENT COURSE: 243 DEG MILES COVERED FRM DEP: 520.3 NM AVERAGE VOYAGE SPD: 8.7 KTS DIST COVERED DURING LAST 24 HRS: 207.3 NM AVERAGE SPD DURING LAST 24 HRS: 8.6 KTS DISTANCE TO GO: 2272.4 NM ETA: 01/10/2019
21 September	LAT: 22°20.0'N LONG: 025°51.5'W WEATHER(BEAUFORT) WIND DIR/FORCE: NE/SLIGHT SEA STATE/SWELL DIR/SWELL HT: 3 /NE /1.5 M PRESENT COURSE: 244 DEG MILES COVERED FRM DEP: 705.2 NM AVERAGE VOYAGE SPD: 8.4 KTS DIST COVERED DURING LAST 24 HRS: 184.9 NM AVERAGE SPD DURING LAST 24 HRS: 7.7 KTS DISTANCE TO GO: 2087.5 NM ETA: 01/10/2019

22 September	LAT: 20°57.5'N LONG: 028°50.8'W WEATHER(BEAUFORT) WIND DIR/FORCE: ExNE/SLIGHT SEA STATE/SWELL DIR/SWELL HT: 3 /ExNE /1.5 M PRESENT COURSE: 244 DEG MILES COVERED FRM DEP: 891.5 NM AVERAGE VOYAGE SPD: 8.3 KTS DIST COVERED DURING LAST 24 HRS: 186.3 NM AVERAGE SPD DURING LAST 24 HRS: 7.8 KTS DISTANCE TO GO: 1901.2 NM ETA: 02/10/2019 PRESENT POSITION AT 1200HRS:
23 September	LAT: 19°30.3'N LONG: 031°58.7'W WEATHER(BEAUFORT) WIND DIR/FORCE: SLIGHT/3/E/7-10KTS SEA STATE/SWELL DIR/SWELL HT: SLIGHT/ 3 /SE /1.5 M PRESENT COURSE: 244 DEG MILES COVERED FRM DEP: 1079.2 NM AVERAGE VOYAGE SPD: 8.2 KTS DIST COVERED DURING LAST 24 HRS: 187.7 NM AVERAGE SPD DURING LAST 24 HRS: 7.8 KTS DISTANCE TO GO: 1713.8 NM ETA: 02/10/2019
24 September	LAT: 18°08.6'N LONG: 034°53.3'W WEATHER(BEAUFORT)WINDDIR/FORCE: LIGHT/3/E/10-13KTS SEA STATE/SWELL DIR/SWELL HT:SLIGHT/ 3 /SE /1.5-2.0 M PRESENT COURSE: 244 DEG MILES COVERED FRM DEP: 1262.6 NM AVERAGE VOYAGE SPD: 8.1 KTS DIST COVERED DURING LAST 24 HRS: 183.4 NM AVERAGE SPD DURING LAST 24 HRS: 7.6 KTS DISTANCE TO GO: 1530.4 NM ETA: 02/10/2019
25 September	LAT: 16°49.6'N LONG: 037°41.1'W WEATHER(BEAUFORT) WIND DIR/FORCE :NE/6/ROUGH SEA STATE/SWELL DIR/SWELL HT: NE/ 3-4 M PRESENT COURSE: 244 DEG MILES COVERED FRM DEP: 1440.2 NM AVERAGE VOYAGE SPD: 8.0 KTS DIST COVERED DURING LAST 24 HRS: 177.6 NM AVERAGE SPD DURING LAST 24 HRS: 7.4 KTS DISTANCE TO GO: 1352.5 NM ETA: 03/10/2019

3.7. BAREBOAT CHARTERER'S FLEET MONITORING

The implemented fleet monitoring system allows a vessel to be tracked either via Inmarsat-C or based on SAT-AIS data. Based on the bareboat charterer's statement, the fleet monitoring had no specific role in the vessel transit operation. The user of the fleet monitoring system, usually the ship manager, can decide which vessel to track and which tracking data to use.

With the change of the flag to Luxembourg, the *Bourbon Rhode* received a new Maritime Mobile Service Identity (MMSI) number, which had not been communicated to the provider of the fleet monitoring system. Tracking of the *Bourbon Rhode* was hence not possible in the fleet monitoring system.

3.8. FLOODING CALCULATIONS

This chapter will be supplemented in the course of the ongoing investigation.

3.9. ASPECTS RELATED TO SEARCH AND RESCUE

This chapter will be supplemented in the course of the ongoing investigation.

3.10. SURVIVOR STATEMENTS

3.10.1. Written statements

Written statements of the three rescued crew members were used for this safety report, but will not be made publically available.

3.10.2. Interviews made by the AET

The interviews conducted by the AET were used in this safety report, but the transcripts will not be made publically available.

3.10.3. Summary of the statements

The following relevant statements were made by the three rescued crew members during interviews and in writing:

At the shipyard and before departure:

- The *Bourbon Rhode* did not make a good impression upon boarding at the shipyard. All three survivors stated that they were surprised by the bad condition. One survivor stated that a senior engine crew member was worried about the technical state of the vessel not being in a condition to cross the Atlantic.
- The initially mustered Chief Officer left the shipyard due to the bad condition of the vessel. The replacement Chief Officer also complained about the overall state of the vessel.

- According to a survivor, the Chief Engineer was worried that the majority of the crew did not have enough experience and thus made requests to the company concerning additional crew requirements, which were partly fulfilled before departure.
- Work that was intended to be done at the shipyard was not performed or completed due to missing materials or tools.
- According to a survivor, the Chief Engineer reported to the Master before departure that the vessel was not fully ready for the intended voyage due to the pending repairs and maintenance.
- A crew member had the impression that the sea trials performed on 10 September 2019 upon completion of the overhaul were shorter than usually experienced, taking approximately 2 hours.
- Upon departure, the vessel was considered to be in fair condition and generally ready to sail.

After leaving Las Palmas:

- Upon departure on 17 September in Las Palmas, the vessel was considered to be generally ready to sail and watertight, except for the engine room skylight hatch, which had not been repaired during the dry dock stay.
- A few days after departure, water was reported to leak through the skylight hatch into the engine room. The problem was fixed, except for minor droplets still leaking through.
- One towing pin cover plate was installed and later washed away during the voyage. The other three deck cover plates were not installed and were stored at the port side tugger winch location.
- The vessel's ballast and bilge system were not in order and some alarm failures were noticed. As per survivors recollection this had been a constant problem for years according to crew members having sailed on the *Bourbon Rhode* before.

Further relevant statements are included in the sequence of events.

3.11. SEQUENCE OF EVENTS

3.11.1. Vessel transit

3.11.1.1. 17 September 2019

The vessel was set to cross the Atlantic Ocean to its new operations area in Guyana, for a five-year offshore contract. After completing extensive service and maintenance works at the shipyard in Las Palmas, all required statutory and class certification surveys were passed with no remarks and a change of flag to Luxembourg was completed.

According to survivor statements, the crew considered the vessel as overall fit to proceed to sea. As there were still steel works to be completed, the vessel's Chief Engineer filed a request to the BOG ship manager to allow the Fitter to stay on board for the crossing.

At 22:36, the *Bourbon Rhode* left the port of Las Palmas, Gran Canaria (Spain). According to the survivor's statements, the engine room skylight hatch on the open work deck was not watertight. When water washed over the work deck it entered the engine room trough the hatch, seeping down from the engine room ceiling.

3.11.1.2. 18 September 2019

After passing the port breakwaters and reaching the open sea, the *Bourbon Rhode* proceeded on a course south (180°) with an average speed of 8.7 kts. At 08:50, the vessel altered the course to 244°, set directly to the next waypoint near the port of Georgetown (Guyana).

3.11.1.3. 19 – 20 September 2019

The first days at sea were uneventful and the vessel's crew were going about their duties and performing their assigned work. The weather was favourable with light swell from the stern and good visibility. On 19 September, VSAT reception started to become erratic and from 20 September onward, VSAT reception was down.

3.11.1.4. 21 September 2019

At 07:58, Engine 2 was stopped, assumingly to conduct maintenance. According to survivor statements, the starboard shaft bearing was overheating due to a greasing problem. Portable electric cooling fans were put in place in the hold and connected to a socket in the engine room through the open watertight door. Based on the FUELTRAX data, both engines were up and running at 09:57 and the *Bourbon Rhode* continued her voyage at economical speed. On the same day, the Fitter was instructed to repair the engine room skylight hatch, as water on the work deck from the aft swell was leaking into the engine room. After the repair, the leakage was reported to have been limited to a few droplets and the repair was assessed as sufficient.

3.11.1.5. 22 September 2019

At 09:21, Engine 2 was stopped again, assumingly to conduct maintenance. At 10:34, both engines were back running and the *Bourbon Rhode* continued her voyage at economical speed. As per survivor statements, a high-level bilge well alarm was triggered in the port side emergency generator room, which was most likely due to the presence of water in the compartment, combined with the rolling of the vessel in the seaway.

3.11.1.6. 23 September 2019

Another normal day at sea with noticeable following swell. According to survivor statements, the Master and his bridge team were assessing the weather reports received via the vessels Inmarsat-C system and followed the approved voyage plan.

During the daily meeting, the Chief Officer informed the crew of a developing storm that would pass behind the vessel and thus not affect their voyage.

3.11.1.7. 24 September 2019

A survivor stated that the Master had provided him with his newly amended contract received by email during a short period of VSAT coverage. It is not known if weather data was downloaded while VSAT was operational that day.

The Master and 2nd Officer were witnessed discussing the latest weather report which confirmed that the storm had developed into a hurricane and evaluating alternative options (i.e. stopping the vessel or sheltering in Cape Verde). The master stated that they could not reverse course due to the weather and assessed that they would pass ahead of the hurricane. The vessel continued to sail on the selected course of 244°.

3.11.1.8. 25 September 2019

With the sea state worsening and wind increasing, crew members were reported seasick. According to survivor statements, the Master further monitored the weather reports received via Inmarsat-C. During the day, the Master conducted a further briefing on the situation, stating that they would pass ahead of the hurricane's predicted track and that the expected conditions would not be a problem for the vessel.

The received weather reports showed a slight alteration of the hurricane's predicted track to the west-northwest with an increase of speed by 1 kt to 15 kts. The *Bourbon Rhode* remained on the selected course of 244° at economical speed. In the afternoon, from 15:00 onwards, hurricane Lorenzo strengthened and altered its course to the north later and further south than predicted. Later in the afternoon, the vessel entered the area of tropical storm force winds.

3.11.1.9. 26 September 2019 – Day of the accident

A surviving crew member, who stood watch on the bridge as lookout from 02:00 to 08:00, reported that the vessel was heavily rolling and that the visibility had significantly deteriorated during his watch.

According to a survivor statement, at 06:00, the Chief Engineer alerted the Master and the bridge of a problem in the Z-Drive compartment. The Master sent down the watch keeper to check the situation. On his way to the engine room, the watch keeper saw that the watertight doors between the engine room, the hold and the Z-Drive compartment were all open. The engine crew was using a portable electrical suction pump to pump water out of the Z-Drive compartment, leading the hoses to the adjoining hold compartment. In addition, they used buckets to speed up the process. According to survivor statements, the Chief Engineer had reported that water was entering the Z-Drive compartment through the inspection covers of the Shark Jaws housing frame.

At around 06:15, water was reported reaching the door coaming of the Z-Drive compartment, approximately 30 cm above the floor plates, and entering the hold compartment. Furthermore, water from the engine room skylight hatch situated on the work deck was entering the engine room in a steady wash. As per survivor statement, the Chief Officer stated that it was too late for the vessel to significantly change the course due to the hurricane closing in on them.

At 07:10, one survivor noticed that all watertight (hinged and sliding) doors from the engine room through the hold to the Z-Drive compartment were still in open position. Based on survivor statements, in order to maintain the vessel's steering and propulsion operational, crewmembers were bailing water out of the Z-Drive compartment to prevent it from reaching the electrical installations located just above the floor plates. The portable pump now evacuated the water via a hose passing through the engine room escape hatch outside onto the work deck. The partly open escape hatch caused water washing over the deck to enter the engine room, causing many streams of water cascading from the ceiling.

Based on the FUELTRAX data the *Bourbon Rhode* lost its steering and propulsion capabilities at 7:34 with the two engines still running. As per survivor statements, the loss of propulsion and steering caused a significant increase in rolling and starboard list.

At 07:50, a preconfigured SSAS distress alert message, with vessel details, vessel position and shore contact mobile number of the responsible Bourbon Company Security Officer, was sent via Inmarsat-C and received by the JRCC Stavanger, Sola (Norway).

At 08:00, all crew were hands on. Survivors confirmed that by that time, there was water in the Z-Drive compartment, the hold and approximately 10 cm in the engine room. The Fitter stated that he managed to close one leaking Shark Jaws inspection cover and thereby reduce the water ingress. With the equipment at hand, he did not succeed to close the other leaking inspection cover.

At 08:03, a distress alert message was sent via the vessel's DSC and received by the MRCC Madrid (Spain). The EPIRB on the *Bourbon Rhode* was activated by the

crew and the signal was received at 08:06 by the FMCC Toulouse (France). At 08:10, the *Bourbon Rhode* sent out another SSAS distress alert message via Inmarsat-C, which was again received by the JRCC Stavanger. A last SSAS distress alert message was sent at 08:50.

The first written distress message was sent out from the vessel to the BOG ship manager via Inmarsat-C at 08:45, stating that the vessel was sinking and that there was water in the engine room. This message was repeated at 09:13 with the vessel's position. At 09:18, the MRCC Fort-de-France launched active SAR operations with a first co-ordinating instruction, which was a call for assistance to the *SSI Excellent*.

Survivor statements indicate that all crew were involved in attempts to prevent the water level in the Z-Drive compartment to further increase, by evacuating the water first to the adjacent hold compartment, and then with hoses through the engine room escape hatch onto the work deck. According to survivor statements, two crew members attempted to install the jaw plate covers on the aft work deck in order to reduce the water ingress through the Shark Jaws unit. Due to the waves washing over the work deck, the attempt was abandoned as the safety of the two crew members was compromised.

Survivor statements, confirmed that the watertight doors between the accommodation and engine room compartment were closed but that water was leaking through, into the forward part of the vessel.

Without being able to control or stop water ingress via the Z-Drive compartment, and with an increasing starboard list in continuously worsening weather and sea conditions, the crew prepared to abandon ship.

The message sent by the *Bourbon Rhode* via Inmarsat-C and received by the ship manager at 09:57 stated that engines were out and crew were mustered and ready to abandon ship, but not able to launch the life rafts due to the rough sea with swell of 10 m or more. Based on FUELTRAX data, Engine 1 stopped working at 09:51 and when Engine 2 stopped working at 10:36, Generators 1 and 2 were starting. At 10:51, Generator 3, which is located in the aft of the engine room and which was running throughout the voyage, was lost probably due to flooding in the engine room. Electrical power was still provided by the Generator 1, Generator 2 and the Emergency Generator. Lights were still working as confirmed by survivor statements.

At 10:52, the message sent by the *Bourbon Rhode* via Inmarsat-C and received by the ship manager indicated that all pumps were out and they could not sustain (hold the vessel).

According to one survivor, who described the situation as in a state of panic, the decision to abandon ship was finally made at around 12:00 and unfolded in an uncoordinated way, hampered by the difficult circumstances caused by an increased list, high seas and strong winds.

At 12:00, the message sent by the *Bourbon Rhode* via Inmarsat-C and received by the ship manager inquired when help would arrive onsite and shortly after, in another message, informed of increasing water in the ship. At 12:28, the last Inmarsat-C message from the *Bourbon Rhode* received by the ship manager stated that the Z-

Drive compartment and the Engine Room were isolated and that the water was increasing.

The last FUELTRAX data was logged at 12:38, with the information that all engines and generators stopped working. The Inmarsat-C communication log shows that the message sent by the ship manager at 12:41 was not received by the *Bourbon Rhode*. At 12:43, the last position received from the vessel's SAT-AIS was 15°35.383' N, 040°12.783' W. The survivors reported that they saw the vessel sinking shortly after they abandoned ship.

Survivors reported that after jumping into the sea, five crewmembers were able to hold on to the external lifeline of an overturned life raft nearby. Three of them were rescued on 28 September 2019 from the life raft, two crewmembers were washed away during the hurricane and are presumed lost at sea.

3.11.2. Search and rescue operations

The search and rescue operations were conducted during 16 days and involved 20 vessels and 15 overflights. Three survivors were rescued and the bodies of four crew members were recovered, leaving seven members of the *Bourbon Rhode* crew unaccounted for and presumed lost at sea at the date of publication.

3.11.2.1. 26 September 2019

At 07:50, a first SSAS distress alert message was sent by the *Bourbon Rhode* via Inmarsat-C and was received by the JRCC Stavanger, Sola (Norway). A distress message was sent via DSC and received by the MRCC in Madrid (Spain) at 08:03, which immediately relayed the message to the MRCC Fort-de-France located on the Caribbean island of Martinique and responsible for SAR operations in the sector where the *Bourbon Rhode* was located. The crew then activated the EPIRB on the *Bourbon Rhode* and the signal was received at 08:06 by the FMCC Toulouse (France) via a MEOSAR satellite, who forwarded the distress message to the MRCC Fort-de-France at 08:10.

The MRCC Fort-de-France situated approximately 1200 NM west of the *Bourbon Rhode*'s distress position initiated and coordinated the SAR operations, alerting all vessels in the greater vicinity of the emergency and requesting assistance. The first co-ordinating instruction was a call for assistance to the *SSI Excellent* at 09:18.

The *SSI Excellent*, located approximately 200 NM to the south of the distress position, responded to the call and estimated their time of arrival to be the next day. At 09:24, the operations centre of the French Navy was contacted to provide assistance in the SAR operations, in addition to other vessels in the greater area.

The message sent at 09:42 by the BOG ship manager via Inmarsat-C and received by the *Bourbon Rhode* informed that the MRCC Fort-de-France was coordinating the SAR operations, asked to confirm the information on vessel flooding and to describe the situation on board.

During the further hours, the MRCC Fort-de-France continued with requesting various states and authorities for assistance by air and sea. At 15:38, the *SSI Excellent* provided an ETA in the assigned area at 09:00 on 27 September 2019. Shortly afterwards the JRCC Miami (US) informed the MRCC Fort-de-France that a flight by the United States National Hurricane Centre was scheduled to leave for the search area in the morning of 27 September 2019.

During the evening, the French Navy surveillance frigate *Ventose* prepared to join the SAR operations.

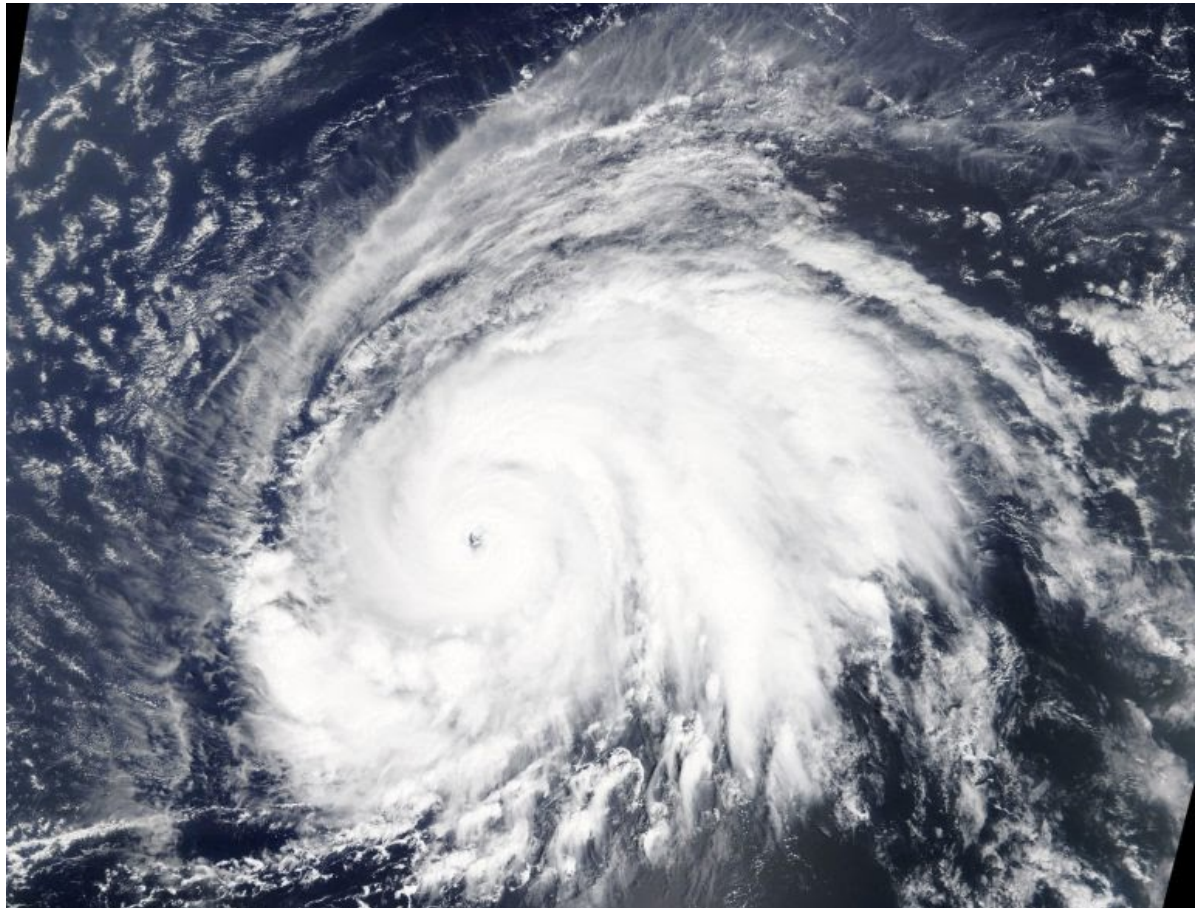


Figure 3.56 – Satellite image of Hurricane Lorenzo over the eastern North Atlantic Ocean on 26 September 2019 (Source: National Aeronautics and Space Administration (NASA) Worldview, Earth Observing System Data and Information System)

3.11.2.2. 27 September 2019

At 00:10, the *Ventose* left port and proceeded to the last known position of the *Bourbon Rhode*, giving an ETA at the distress position of 14:00 on 30 September 2019.

At 10:38, the US MRCC confirmed that the NOAA *Lockheed P-3 Hurricane Hunter* aircraft was expected to arrive on scene at 12:00. The *SSI Excellent* arrived in its designated area at 12:42 and shortly afterwards a French Navy *Dassault Falcon 50* aircraft was confirmed to be available to assist the SAR operations on 28 September 2019 at 09:00.

Further, the *Piet* was instructed at 15:58 by the MRCC Fort-de-France to join the ongoing SAR operations. The general cargo vessel *Ual Lobito*, also instructed to proceed to the search area at 17:21, altered its course to arrive in the search area on the 29 September 2019 at approximately 09:00. The search area allocated by the MRCC Fort-de-France to the *Piet* was received shortly before midnight, with the vessel expected to reach the area on 28 September 2019 at 08:00.

In the afternoon, the *SSI Excellent* was informed by the *P-3 Hurricane Hunter* aircraft of the sighting of two lifejackets and altered course to the given position. At 18:48, the *Hurricane Hunter* returned to its base. At 22:38, the *SSI Excellent* sighted the flashing light of the EPIRB, but was not able to recover the beacon due to the adverse weather conditions. The MRCC Fort-de-France continued to broadcast hourly Enhanced Group Calls (EGC) containing the relevant SAR information.

With the BOG ship manager's approval, the insurer of the *Bourbon Rhode* mobilised the *ALP Striker*, an 88.5 m Anchor Handling Vessel, to join the SAR area as soon as possible.

The *Alp Striker* left Las Palmas in the afternoon of 27 September 2019. The initial plan was to tow the *Bourbon Rhode* once on site. When the sinking of the *Bourbon Rhode* was confirmed, it was decided that the *ALP Striker* should continue her voyage and assist the SAR operations.



Figure 3.57 – Convective cell in an outer rainband of Hurricane Lorenzo, taken during a NOAA43 SAR mission on 27 September 2019. The *SSI Excellent* is also pictured.
(Source: Kelly Ryan, NOAA/AOML/HRD)

3.11.2.3. 28 September 2019

During the early morning, the French *Falcon 50* aircraft arrived in the assigned search area, leaving at 09:53 with no sightings. At 09:58, the JRCC Miami confirmed that a *Hurricane Hunter* aircraft would return on scene at 17:00 from an airport in Barbados. At 10:38, the *Ual Lobito* transmitted its ETA in the search area on 29 September 2019 at approximately 05:00. The general cargo vessel *Erik* was assigned to a search area and the role of On Scene Coordinator (OSC) was allocated to the *Piet*. At 11:00, the *Piet* reported the sighting of a life raft to the MRCC Fort-de-France and began with the rescue of three survivors at 11:50.

At that point, the *Ventose* was still underway with an ETA on 30 September 2019 at 08:30.

The weather conditions had improved, with the winds down to 25 kts, a visibility of 20 Nm and a sea state at 5. Water and air temperatures during the day were both recorded at about 26°C.

The *Piet* reported all three survivors taken on board at 13:15 and informed the MRCC Fort-de-France that the survivors confirmed the *Bourbon Rhode* sank on 26 September 2019 around noon. They could not give further information concerning the other life rafts but recalled that all crew were wearing lifejackets when they abandoned the vessel nearly 48 hours earlier.

During the afternoon, the *Erik* and the crude oil tanker *Maran Triton* took up the search in their assigned areas. The reefer vessel *Baltic Lady* confirmed assisting the SAR operations and proceeded towards the search area with an ETA at around 23:00 that day.

The MRCC Fort-de-France continued to issue the EGC messages every four hours.

At 19:31, the *SSI Excellent* was informed by the NOAA *Lockheed P-3 Hurricane Hunter* to proceed to a capsized rescue boat nearby. Less than 10 minutes later the *SSI Excellent* reported a possible sighting of a body in the water. At the same time, the *Piet* proceeded to the same area. Shortly before 20:00, the NOAA aircraft stopped its search and left the area. At 20:40, the aircraft reported to the MRCC Fort-de-France the sighting of an overturned boat, an unresponsive body, lifejackets and debris in the water. It was later confirmed that the *Maran Triton* had located the floating body, but was not able to retrieve it.

Before the end of the day, the participating vessels continued searching in their allocated search areas. The *Piet* and the *SSI Excellent* arrived in the area of the spotted debris, but could not proceed with the salvage due to the end of daylight.

The MRCC Fort-de-France requested assistance by air from the French Navy *Dassault Falcon 50* for the next day.

The *Baltic Lady* arrived on scene at 23:35 commencing with the search pattern in her assigned area.

3.11.2.4. 29 September 2019

In the early morning hours, the *Erik* and the *Ual Lobito* arrived on scene and started navigating search patterns in their designated areas.

The *Piet* kept the MRCC Fort-de-France informed of the health conditions of the rescued survivors, further taking care of them with the assistance of a medical doctor on shore.

The French Navy *Dassault Falcon 50* returned on scene during early morning and reported the sighting of the capsized rescue boat at 09:11, which the *Erik* was rerouted to. At 09:54, the *SSI Excellent* was released from the SAR operations and resumed navigation to her planned destination. Minutes later the *Falcon 50* left the search area and returned to the Cape Verde Islands. At 10:09, while on her way back, the *Falcon 50* aircraft confirmed that the *Erik* had reached the position of the overturned rescue boat, but that no persons could be located in or around the boat.

The weather on scene was as the day before, with very good visibility and winds of 25 kts.

The *Erik* confirmed arrival at the rescue boat, but reported being unable to salvage it. At 15:27, the MRCC Fort-de-France handed over the role of OSC to the *Ual Lobito* and the JRCC Miami later reported that a US *Lockheed C130 Hercules* aircraft located on Barbados would be available for the next day.

At 17:34, the *Piet* reported the sighting a further body, which they were able to take on board.

To further coordinate upcoming actions with regard to the three survivors, a conference call was held at 18:44 between the *Piet*, the French Tele-Medical Assistance Service and the Regional Operational Centres for Monitoring and Rescue (CROSS) Antilles-French Guiana.

The MRCC Fort-de-France continued broadcasting the EGC messages every four hours.

In the late evening, the *Maran Triton* left the search area.

3.11.2.5. 30 September 2019

The oil products tanker *Navig8 Guard* was expected to arrive at the search area at 10:30 and join the SAR efforts.

The *Baltic Lady* reported to the MRCC Fort-de-France and to the OSC the sighting and retrieval of a lifejacket coming from the *Bourbon Rhode* at 07:34.

The *Ventose* arrived on scene at 08:23 and took over the role of OSC in the ongoing operation. The French Navy *Dassault Falcon 50* aircraft left Cape Verde Islands to re-join the SAR operations, with an ETA of 12:45.

Upon arrival, the *Ventose* headed to the *Piet* in order to airlift a diver and a doctor on board with their Panther helicopter. At 11:48, after being released for airlift by the doctor, the first transfer from the *Piet* started and by 12:33, all three survivors were safely transferred on board the *Ventose*.

Shortly before, at 12:15, the *Falcon 50* aircraft arrived at the search area and assisted the operations until 13:43 with no further sightings.

The oil products tanker *Navig8 Guard*, which arrived on site in the morning, was able to salvage the capsized rescue boat by 13:32 and reported the sighting of a body and a lifejacket at 14:33. At 17:20, the *Navig8 Guard* reported the sighting of another body. The two bodies were retrieved from the sea by the *Ventose*'s helicopter.

The MRCC Fort-de-France continued to broadcast the EGC message throughout the day every four hours. The *Erik* was released during the evening and resumed navigation on its planned voyage.

3.11.2.6. 1 October 2019

The bulk carrier *Labrador* joined the search operations at 04:37 and during the morning, aerial support was provided by the French Navy *Dassault Falcon 50* aircraft for one hour and by the Panther helicopter from the *Ventose*.

The *Ual Lobito* was released from the SAR operation as it had suffered an engine failure and could later resume its intended voyage.

At 12:18, a further body retrieved from the sea by helicopter at 10:08, arrived at the *Ventose*.

At 18:00, the vehicles carrier *NOCC Oceanic* and at 20:39, the general cargo vessel *Happy Dragon* joined the SAR operations in their allocated zones.

Further aerial assistance by a US *Lockheed C130 Hercules* brought no further sightings on that day. The total count of deceased bodies retrieved from sea was four.

3.11.2.7. 2 October 2019

At 00:47, the LPG tanker *Navigator Taurus* joined the SAR operations.

At 10:12, the rescue boat salvaged by the *Navig8 Guard* was transferred to the *Ventose*. Aerial support by the French Navy *Dassault Falcon 50* and the US *Lockheed C130 Hercules* continued throughout the day. Only the *Labrador* reported the sighting of debris.

The *Piet* was released from the SAR operations in the evening hours and the *Ventose* sailed back to Fort-de-France with the three survivors, the four deceased crew members and the salvaged rescue boat. At 20:30, the *Navigator Taurus* took over the role of OSC. At 23:30, the LPG tanker *Seaspeed* joined the SAR operations in the assigned zone.

The MRCC Fort-de-France continued to broadcast the EGC message in a 12-hour interval.

3.11.2.8. 3 October 2019

All involved vessels proceeded on their search patterns in their allocated areas. No further sightings were reported.

3.11.2.9. 4 October 2019

During the early morning hours, the *Happy Dragon* reported the sighting of a lifejacket with a flashing signal light.

All passing vessels not involved in the SAR operations were requested to keep a sharp lookout in the area and report any sightings to the MRCC Fort-de-France.

3.11.2.10. 5 October 2019

The MRCC Fort-de-France stopped the active SAR operations at 05:56 and continued broadcasting the EGC message every 12 hours, requesting all vessels in the area to keep a sharp lookout.

The *ALP Striker* remained in the area to continue the search.

3.11.2.11. 6 October 2019

The *Ventose* arrived at the port of Fort-de-France (Martinique) to disembark the three rescued survivors and the four deceased crew members of the *Bourbon Rhode*. The salvaged rescue boat from the *Bourbon Rhode* was landed ashore and the survivors were accommodated in a local hotel for interviews by the authorities and other involved stakeholders before returning home.

3.11.2.12. 7 October 2019

At 00:39, in good weather conditions, the *ALP Striker* reported the sighting of a white flare to the MRCC Fort-de-France, who immediately relayed an EGC Mayday. While proceeding to the area of sighting, the *ALP Striker* could not report any findings and commenced navigating a search pattern in a newly defined search area.

During the morning, the MRCC Fort-de-France requested aerial support from the United States Coast Guard. During the afternoon, the bulk carrier *Hanze Gdansk*, the bulk carrier *Federal Kibune* and the vehicles carrier *Prime Ace* were engaged in the SAR operations. A US *Lockheed C130 Hercules* provided aerial support on scene from 16:20 to 19:20. No sightings were reported and the *ALP Striker*, in its role of OSC and in cooperation with the MRCC Fort-de-France, continued the SAR operations throughout the night.

3.11.2.13. 8 October 2019

At 06:53, the European Maritime Agency (EMSA) reported an undefined object detected near the search area on a satellite photo to the MRCC Fort-de-France. The *ALP Striker* and the *Prime Ace* altered course towards the reported position and commenced searching in a predefined pattern. The three vessels rerouted the day before joined the SAR operations in the greater vicinity. The *ALP Striker* retrieved small pieces of debris from the water which could not be attributed to the *Bourbon Rhode*.

At 17:35, the container ship *Maersk Vilnius* was requested to join the SAR operations.

3.11.2.14. 9 October 2019

At 06:21, the LPG tanker *Africa Gas* joined the SAR operations. At 19:21, the *Maersk Vilnius* arrived in its assigned search area. No further sightings were reported during the day.

3.11.2.15. 10 October 2019

The SAR operations continued with no further sightings. The MRCC Fort-de-France continued to assign designated search areas to participating vessels. At 19:10, the LNG tanker *Ocean Clean* joined the SAR operations in the assigned zone.

3.11.2.16. 11 October 2019

The SAR operations continued with no further sightings. The MRCC Fort-de-France continued to assign designated search areas to participating vessels.

3.11.2.17. 12 October 2019

The MRCC Fort-de-France finally decided to end the active SAR operations and released all vessels to continue on their planned voyages. The MRCC Fort-de-France continued to broadcast EGC messages every 24 hours, requesting a sharp lookout from all vessels in the area.

3.11.2.18. Summary of the SAR operations

Overall, the SAR operations were conducted over a period of two weeks in the middle of the Atlantic Ocean. Three survivors were rescued and four bodies were retrieved from the sea, leaving seven crew members unaccounted for and presumed lost at sea.

The SAR operations can be considered as a multinational effort at high seas, involving 20 vessels and 15 aircraft overflights. As shown in Figure 3.59, the extent of the SAR zones allocated by the MRCC Fort-de-France covered more than 73.000 km², the area searched by active means³² exceeded 109.000 km².

3.11.2.19. Sighting and recovery positions

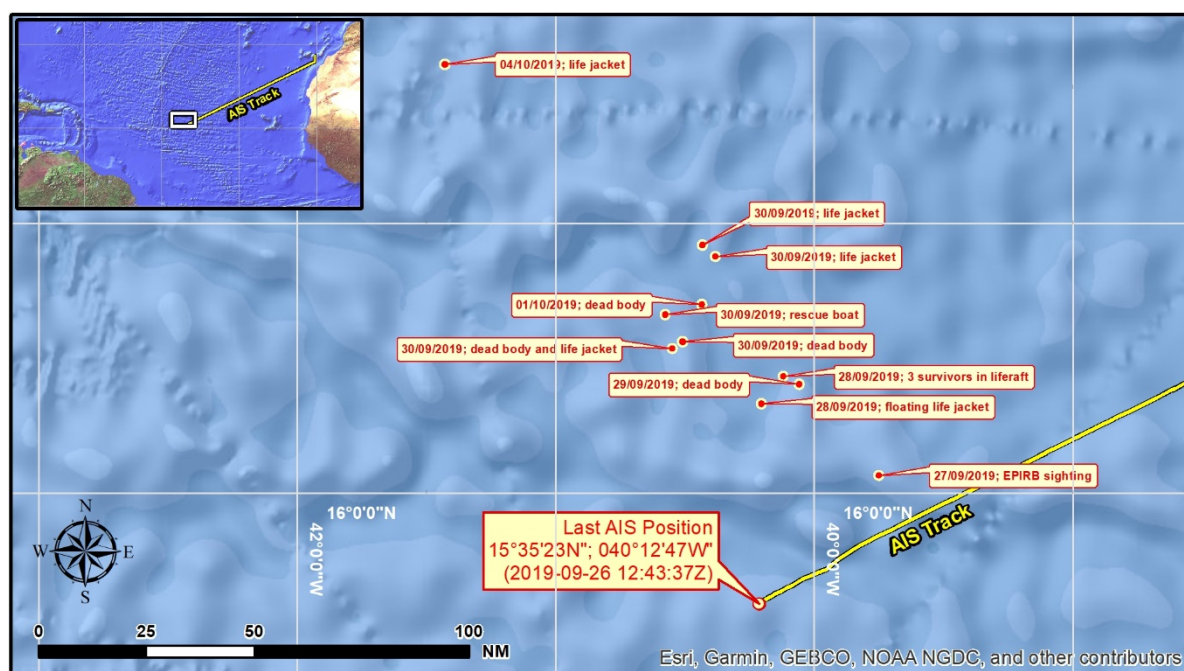


Figure 3.58 – Graphical representation of the sighting and recovery positions
(Source: Esri)

³² Some areas have been subject to multiple search efforts and have been cumulated to determine 'the area searched by active means'.

3.11.2.20. Search and rescue areas

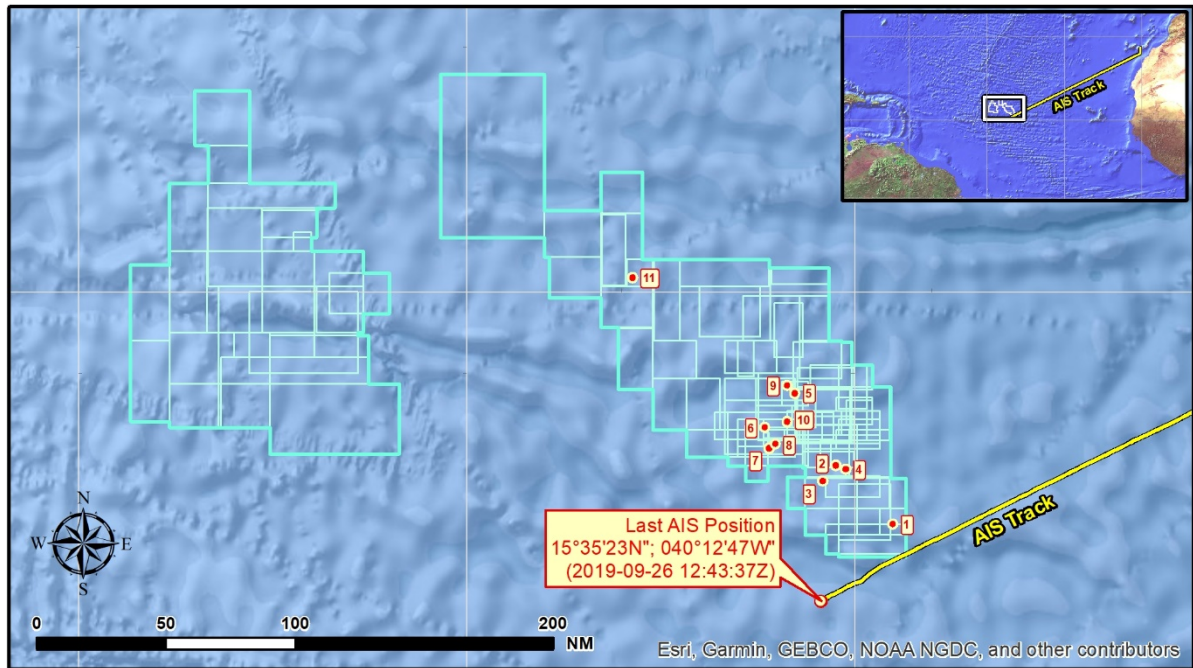


Figure 3.59 – Graphical representation of the SAR areas allocated by the MRCC Fort-de-France
(Source: Esri)

3.11.2.21. EPIRB positions

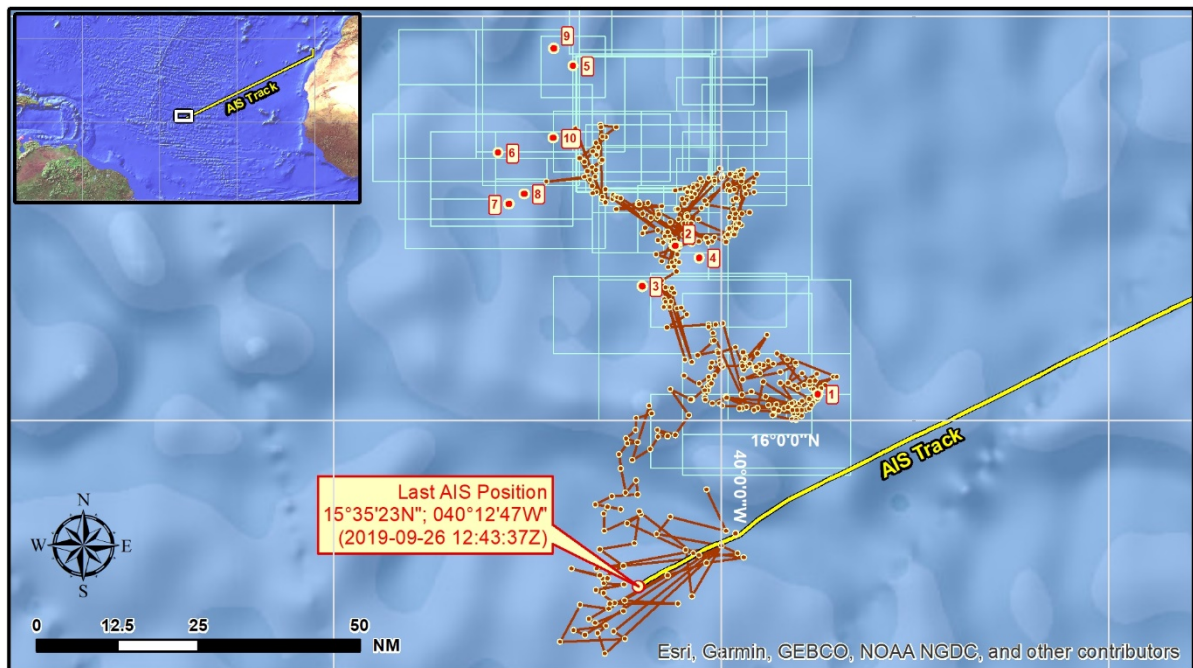


Figure 3.60 – Graphical representation of the EPIRB positions
(Source: Esri)

3.12. CORRECTIVE ACTIONS TAKEN BY THE BAREBOAT CHARTERER

In the aftermath of the accident the bareboat charterer took a number of corrective actions, some of which are still pending. Up to the date of publication of this interim report, the following corrective actions have been implemented:

- The Passage Plan / Routeing Service procedure was upgraded with the following elements:
 - Communicate the existing weather forecasting service details from the company FUGRO to all ship managers.
 - Organise a contract at group level for weather forecasting/weather routeing "on request" and ensure all Ship Managers and Masters have access to it when their vessels prepare to make transit.
- A Tropical Revolving Storm awareness procedure was implemented in the SMS.

The purpose of the procedure is that the awareness about the risk associated of sailing within a tropical storm area is a paramount concern and shall be focused on three points hereunder:

- *The high potential hazard resulting from sailing within a Tropical Revolving Storm (TRS) area;*
- *The unpredictable character of a TRS potentially resulting of a sudden weather change;*
- *The anticipation by using all the means available to avoid sailing within a TRS area.*

The following important safety issues are highlighted:

- In whatever situation a ship shall avoid passing within 250 Nm of the centre of the storm.
 - Two primary methods of evading a TRS and eliminate a potentially high-risk scenario, the "34 kt-rule" and the "1-2-3-rule" are presented as primary evasion tactics.
 - In track analysis, never plan to cross the track of a TRS.
 - TRS Dangerous/Navigable semicircle and evasion in open sea.
 - Masters of vessels encountering a TRS shall make a mandatory report. It shall be done by all available means, to ships in vicinity and to the nearest coast station.
- A 'Condition Monitoring Tour' Best Practice procedure was created at corporate level with existing guidelines and the following lessons learned, including watertight integrity, were added:
 - Checking for leaks (deck and machinery spaces).
 - Inspection of shark jaw/tow pins system (steering compartment).
 - Evaluate Condition Monitoring tour requirements were integrated in the SMS with a special focus on routine engine room tour to ensure that requirements added from best practice meet the practical and operational requirements.

4. ANALYSIS

This chapter will be supplemented in the course of the ongoing investigation. Areas which the investigation will focus on include, but are not limited to:

- Voyage planning;
- Fleet monitoring;
- Crewing aspects;
- SMS implementation on board the vessel;
- Vessel design and maintenance;
- Vessel certification aspects;
- Emergency management.

5. CONCLUSIONS

This chapter will be supplemented in the course of the ongoing investigation.

6. SAFETY ACTIONS

In accordance with the provisions laid down in Art. 9., paragraph 2, of the national amended law dated 30 April 2008 establishing the Administration of technical investigations (AET), safety recommendations and other safety related actions may be issued at any time during the investigation, when such an action is deemed necessary.

6.1. SAFETY RECOMMENDATIONS

On 19 August 2020, the following safety recommendation was issued:

- **LU-MA-SR/2020-003** to the Luxembourg Maritime Administration

The AET recommends to the Luxembourg Maritime Administration:

To require all owners of vessels equipped with the Plimsoll Smith Berger Hydraulic Shark Jaw system P3679-350MTTA or anchor handling systems with similar designs of the inspection covers and registered on the Luxembourg Merchant Fleet register, to implement in the vessel operator's Safety Management System a standard procedure for tasks requiring the opening of the inspection covers of the anchor handling system housing frame.

In addition to the existing maintenance instructions, the items to be addressed by this procedure should include:

- Preventive actions to mitigate the risk of water ingress through the inspection openings during maintenance tasks on the anchor handling systems (e.g. sea state limitations, installation of anchor handling system deck cover plates);

- Instructions for the appropriate sealing method when installing the inspection covers to ensure the watertightness of the anchor handling system housing (e.g. application of silicone sealant, installation of gasket);
- Instructions for testing the watertightness of the anchor handling system after completion of the works and installation of the inspection covers (e.g. flooding of anchor handling system housing frame with closed drainage by use of fire hose).
- Maintenance actions to prevent a degradation of the inspection covers and securing devices, which could compromise the watertightness of the anchor handling system;
- Appropriate documentation of the actions performed during the maintenance work.

<https://aet.gouvernement.lu/dam-assets/l-administration/transports-maritimes/bourbonrhode/Bourbon-Rhode-SR1-final-2020-08-19.pdf>

6.2. SAFETY BULLETINS

On 19 August 2020, the safety bulletin **LU-MA-SB/2020-001** containing the following safety item was published:

The Administration of technical investigations advises all operators of vessels equipped with the Plimsoll Smith Berger Hydraulic Shark Jaw system P3679-350MTTA or anchor handling systems with similar designs of the inspection covers to implement in the vessel operator's Safety Management System a standard procedure for tasks requiring the opening of the inspection covers of the anchor handling system housing frame.

In addition to the existing maintenance instructions, the items to be addressed by this procedure should include:

- Preventive actions to mitigate the risk of water ingress through the inspection openings during maintenance tasks on the anchor handling systems (e.g. sea state limitations, installation of anchor handling system deck cover plates);
- Instructions for the appropriate sealing method when installing the inspection covers to ensure the watertightness of the anchor handling system housing (e.g. application of silicone sealant, installation of gasket);
- Instructions for testing the watertightness of the anchor handling system after completion of the works and installation of the inspection covers (e.g. flooding of anchor handling system housing frame with closed drainage by use of fire hose).
- Maintenance actions to prevent a degradation of the inspection covers and securing devices, which could compromise the watertightness of the anchor handling system;
- Appropriate documentation of the actions performed during the maintenance work.

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