HELLENIC REPUBLIC
HELLENIC BUREAU FOR MARINE CASUALTIES INVESTIGATION

MARINE CASUALTY INVESTIGATION REPORT

07/2015

GROUNDING OF B/C GOODFAITH

ON ANDROS ISLAND ON 11-02-2015

December 2017

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Foreword

The Hellenic Bureau for Marine Casualties Investigations was established by Law 4033/2011 (Government Gazette 264/12.22.2011), in the context of implementing EU Directive 2009/18/EC. HBMCI conducts technical investigations into marine casualties or marine incidents with the sole objective to identify and ascertain the circumstances and contributing factors that caused it through analysis and to draw useful conclusions and lessons learned that may lead, if necessary, to safety recommendations addressed to parties involved or stakeholders interested in the marine casualty, aiming to prevent or avoid similar future marine accidents.

The conduct of Safety Investigations into marine casualties or incidents is independent from criminal, discipline, administrative or civil proceedings whose purpose is to apportion blame or determine liability. This investigation report has been produced without taking under consideration any administrative, disciplinary, judicial (civil or criminal) proceedings and with no litigation in mind. It does not constitute legal advice in any way and should not be construed as such. It seeks to understand the sequence of events occurred on the 11th of February 2015 and resulted in the examined veryserious marine casualty. Fragmentary or partial disposal of the contents of this report, for other purposes than those produced may lead to misleading conclusions. The investigation report has been prepared in accordance with the format of Annex I of respective Law (Directive 2009/18/EC) and all times quoted are Local Time (LT, UTC +2) unless otherwise stated.

Under the above framework HBMCI has been examining the grounding of M/V GOODFAITH, occurred on the 11th of February 2015, on the North West coast of Andros Island, while crossing the Kafirea Strait. This report is based on information and evidence that have been derived from the interview process and information collected from those individuals involved in the marine casualty as well as vessel’s VDR, IMDatE, and AIS data.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS		
1	AB	Able seaman
2	AIS	Automatic identification system
3	ARPA	Automatic radar plotting aid
4	Bfrs	Force of wind in beaufort scale
5	CoC	Certificate of Competency
6	CoG	Course Over Ground. The actual path of a vessel with regard to the seabed, measured in degrees.
7	COLREGs	International regulations for preventing collisions at sea, 1972, as amended
8	°	degrees (of angle)
9	DOC	Document of Compliance
10	GMDSS	Global maritime distress and safety system
11	GPS	Global positioning system
12	Gt	Gross tonnage
13	HDG	Heading. The direction in which a vessel is pointed at any given moment. Heading may be relative to true north (true heading) or magnetic north (magnetic heading)
14	HCG	Hellenic Coast Guard
15	Integrated Marine Data Environment (IMDatE)	a technical framework that collects and combines data from EMSA's (European Maritime Safety Agency) maritime applications and other external sources
16	IMO	International Maritime Organization
17	ISM	International Management Code for the safe operation of ships and for pollution prevention
18	JRCC	Joint Rescue and Coordination Centre
19	Knots	unit of speed equal to one nautical mile (1.852 km) per hour
20	kW	Kilowatt
21	LT	Local time
22	MLC	Maritime Labour Convention
23	mt	Metric ton
24	nm	Nautical miles
25	O(s)OW	Officer(s) on the watch
26	OS	Ordinary seaman (deck crew)
27	rpm	revolutions per minute
28	SAR	Search and Rescue
29	SMC	Safety management certificate
30	SMS	Safety management system
31	SOG	Speed Over Ground
32	SOLAS	Convention for the Safety of Life at Sea 1974, as amended
33	STCW	International Convention on Standards of Training,Certification and Watchkeeping for seafarers
34	S-VDR	Simplified Voyage Data Recorder
35	UTC	Universal coordinated time
36	VDR	Voyage data recorder
37	VHF	Very high frequency (radio)

1. Executive summary

M/V Goodfaith under Cyprus Flag was a Bulk carrier engaged in international trade. On the 10th of February 2015 she had sailed from Elefsis/Greece in ballast condition heading to Odessa /Ukraine for loading, with 22 crew members. On the previous day, she had just completed her special survey maintenance operations at Elefsis shipyard and was inspected by her Class. The voyage plan projected on her navigational charts included standard passages that are followed by vessels trading between ports of the Mediterranean Sea, Marmaras Sea and Black Sea.Goodfaith would gradually reach and pass through Kafireas Strait (between south of Evia Island and Andros Island) and would progressively head towards Dardanelles Strait, Marmaras Sea, Bosporus Strait and Black Sea.

On the morning of 10th of February 2015, the National Meteorological Service had issued a storm warning at the sea area of South Evvoikos –Kafireas Strait, that forecasted N – NE winds 9-10 bfrs, and wave height of 3.5m – 6.5m. Goodfaith, having exited Piraeus Traffic Separation Scheme, commenced her voyage at open sea running at 13 knots and steering was in Autopilot.

At approximately 1530, while she was entering Steno Keas, the Master ordered to lower engine speed to 95-100 rpm and the “rough seas” mode was activated to avoid main engine over speed, as she was encountering heavy pitching and rolling due to the prevailing bad weather conditions, wind force 7-8 Bfrs and high waves, while steering was set to manual. By that time, Goodfaith was running at an average speed of 6-7 knots. At approximately 1930, while the Chief Officer was on the watch, the weather conditions had significantly worsened to stormy (N winds force 9 bfrs) and had a continuous impact on Goodfaith’s navigation, on the grounds that she was making a slow progress on her passage at an average speed of 3-4 knots towards Steno Kafireas by keeping the charted 026° heading course. At approximately 2130, while Goodfaith entered Steno Kafireas and had to sail about 8nm to its exit, her speed (SOG) had been further reduced and was recorded between 1.5 and 2.5 knots while Master was still at the bridge.

At 0000, the 2nd Officer took over the navigational watch while the Master had left from the bridge at approximately 0005. At approximately 0050 Goodfaith could hardly be maneuvered with her speed (SOG) slightly over 2.0 knots for the reason that she was encountering severe rolling, pitching and slamming as heavy seas were breaking over her forecastle. By that time, she was about 2nm Northwest off the rocky coast of Andros Island. The 2nd Officer having appraised the situation, called the Master who arrived at the bridge at 00:55. The 2nd Officer reported the experiencing situation to Master, as Goodfaith had started to considerably drift to starboard notwithstanding her rudder was set hard to port and her engine to full ahead at 120 rpm. The Master ordered to alert the Chief Engineer and the Chief Officer and having assumed a steering failure, deployed the 2nd Officer, the Chief Engineer and the AB on the watch to the emergency steering gear compartment to check its operation. The 2nd Officer hurried to the emergency steering gear and reported that he did not observe a steering failure and that the rudder was set hard to port.

At approximately 0100, Goodfaith was recorded to be almost 1.7 nm off the NW coast of Andros Island and heavily drifting to starboard. She was practically not under command making no headway, despite the fact that her engine was running at full ahead with 120 rpm. The Master realizing the emergency and the imminent danger of an uncontrollable and violent grounding ordered to alert the crew and activated the general alarm. All crew members were mustered on the bridge with their lifejackets on. Due to the fact that Goodfaith was actually not under command, as no further actions were taken by the Master, she was laying abeam on to the wind and the high waves of more than 7-8 m height as reported by her crew, that were causing heavy rolling. The Master ordered the Chief Officer and the Bosun to go to the forecastle to drop the anchors in order to avoid the anticipated grounding, nonetheless it was not possible with the encountering situation and weather conditions.

At approximately 0128, Goodfaith grounded on the rocky coastline at the Northwest seafront of Andros Island. Most of the crew were rescued by a Hellenic Navy helicopter and 04 remained onboard.

2. Factual information

2.1Vessel's particulars

Nameofvessel	GOODFAITH
Typeofvessel	BULK CARRIER
Nationality/flag	CYPRUS
Portofregistry	LIMASSOL
IMO number	9076404
Callsign	C4SY2
Managing company	STARMARINE MANAGEMENT/GREECE
IMO company No. (DOC)	1317884
Yearbuilt	1994
Shipyard	Mitsubishi Heavy Industries Shimonoseki, Japan
Classificationsociety	NIPPON KAIJI KYIOKAI (NKK)
Minimum Safe Manning	12
Length	158 m
Breadth	27 m
Gross tonnage	16,446
Deadweight	27,308 t
Draught	9.5 m
Engine power	5,369 kW
Service speed	14.1 knots
Hull material	Steel
Hull design	Double bottom hull

Figure 1:*Goodfaith grounded at Andros Island.*

2.2Weather data

Wind – direction	7 to 8 bf, later on 9 to 10 bf gusts– N/NE
Wave height	3,5-6,5 m
Visibility	Poor
Visibility	Poor
Light/dark	Dark
Current	5-7 knots (S-SW direction according to pilot book)

2.3 Voyage particulars

Port of origin	Elefsis/Greece
Port of call	Odessa/Ukraine
Type of voyage	International
Cargo information	Ballast
Crew on board	22

2.4 Marine casualty information

Type of marine incident	Very serious marine casualty
Date, time	11 February 2015 at 01:28 LT
Location	NW coast of Andros Island, Central Aegean Sea Greece
Position	Lat.:37° 58’ 46’’ N, Long.:24° 43’ 36’’ E
Ship’s operation, voyage segment	En route
Place on board	Fore peak section, cargo holds & Engine room bottom- Double bottom Ballast and Fuel storage tanks structural damages
Consequences to individuals	No
Consequences to environment	Sea and shore pollution from bunkers
Consequences to property	Extended structural damages /semi-sinking /total loss

3. Narrative

3.1Departure from Elefsis anchorage

On the 10th of February 2015 at approximately 1100, Goodfaith was at Elefsis anchorage and all crew was on standby and the necessary pre-departure checks, including checks of the main engine propulsion (ahead/astern), routine checks of the navigational/radio equipment and steering gear had been completed without any remarks. At that time the Pilot came on board and vessel's anchor was heaved up and secured in place.

The weather conditions were reported to be bad with winds close to 7-8 bfr and occasionally it was snowing. The vessel was in ballast condition with a forward draught of 3m and aft draught of 6.20m while the mid draught was calculated to almost 4,65m, and the vessel was trimmed by the stern.
At approximately 1218 Goodfaith had exited Salamis Channel and the Pilot disembarked. Goodfaith followed an 181^{o} course to enter Piraeus separation traffic zone and by 1353 the vessel had cleared the southbound fairway, proceeding with full ahead making a good speed of 13 knots

The voyage plan, according to Goodfaith shipboard operational procedure was prepared by the 2nd Officer, signed by the Chief Officer and approved by the Master. The initial segment of the voyage plan was comprised of a passage plan with a 112^{o} headed course followed by a 90^{o} course to her next way point at position 37^{o} 35' N, 024^{o} 08,5'E south of Akrotirio Sounio, where an alteration of course to 036^{o} North-East was planned just before crossing the strait between Nissos Makronissos and Nissos Kea. At that time, approximately 1540 the vessel was making a good way with a speed of 10 knots and steering was set to Autopilot.

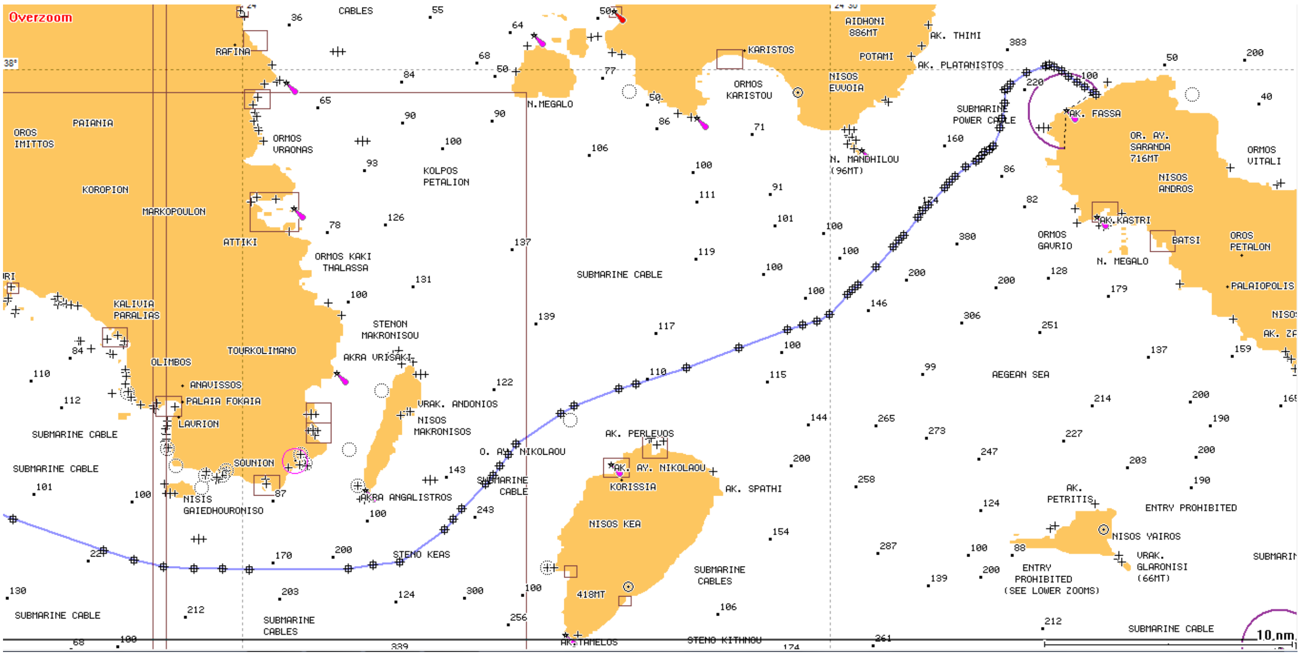


Figure 2:Overview of Goodfaith's passage (reconstructed by HBMCI according to AIS & VDR data)

3.2The Chief Officer 1600-2000 watch

At 1600 the vessel was crossing the Steno Keas and the Chief Officer came on the bridge to take over the 16:00-20:00 OOW duties. At that time the Master was still on the bridge with the 2nd Officer and the lookout AB.As the weather conditions started to deteriorate with strong north winds 7-8 bfrs and big waves causing heavy pitching and rolling, the Master ordered to reduce main engine speed from normal sea speed of 110 rpm to 95 rpm and the “rough seas mode” was activated to avoid main engine over speed and surging[1] of main engine’s turbocharger.

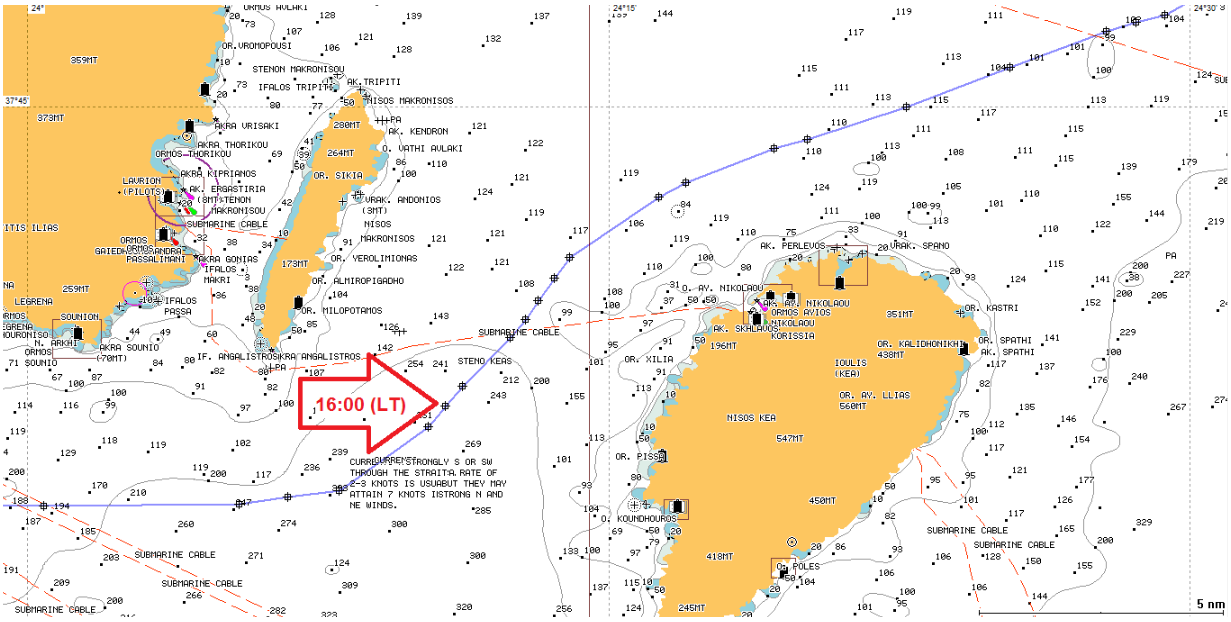


Figure 3: *Crossing of Steno Kea during change over of the watch (16:00).*

At approximately 17:00 (Figure 4) Goodfaith passed her next way point at position 037^{o} 42'N, 024 15'E, where a change of course to 052^{o} was planned. At 1717 she had cleared Keas Strait and sea speed (SOG) was decreased to approximately 6 knots. While proceeding towards Steno Kafirea the weather conditions had further deteriorated and wind at force was recorded at 10Bfrs. It was reported that the ship’s yaw[2] was reaching almost 20^{o} in the 50-60 knots winds. At approximately 1735 in order to reduce the effects of the big waves the Master ordered the Chief Officer to set the steering to manual and maintain a course–030^{o},in order to navigate with the sea at the vessel’s port bow. By 1849 Goodfaith’s speed was approximately 5 knots (SOG), however the vessel was drifting Southeasterly with an approximate COG 61^{o},and she was 2.86 nm south off her charted course. In order to bring Goodfaith back to the charted course, the heading was readjusted to port and by the end of the watch at 2000 the ship’s COG was recorded to approximately 32^{o} while Goodfaith was making a slow progress approaching to Steno Kafirea with an average SOG of 4 knots.

[1]Turbocharger surging may be defined as a high pitch audible vibration coming from the blower end or compressor end of the turbocharger, associated with a disruption of gas flow causing a reversal of scavenge air through the diffuser and impeller blades. One of the main reasons of surging can be attributed to bad weather when due to the ship’s pitching the propeller moves in and out of the water causing the sudden reduction in load of the engine.

[2]The ship’s heads winging from one side to the other

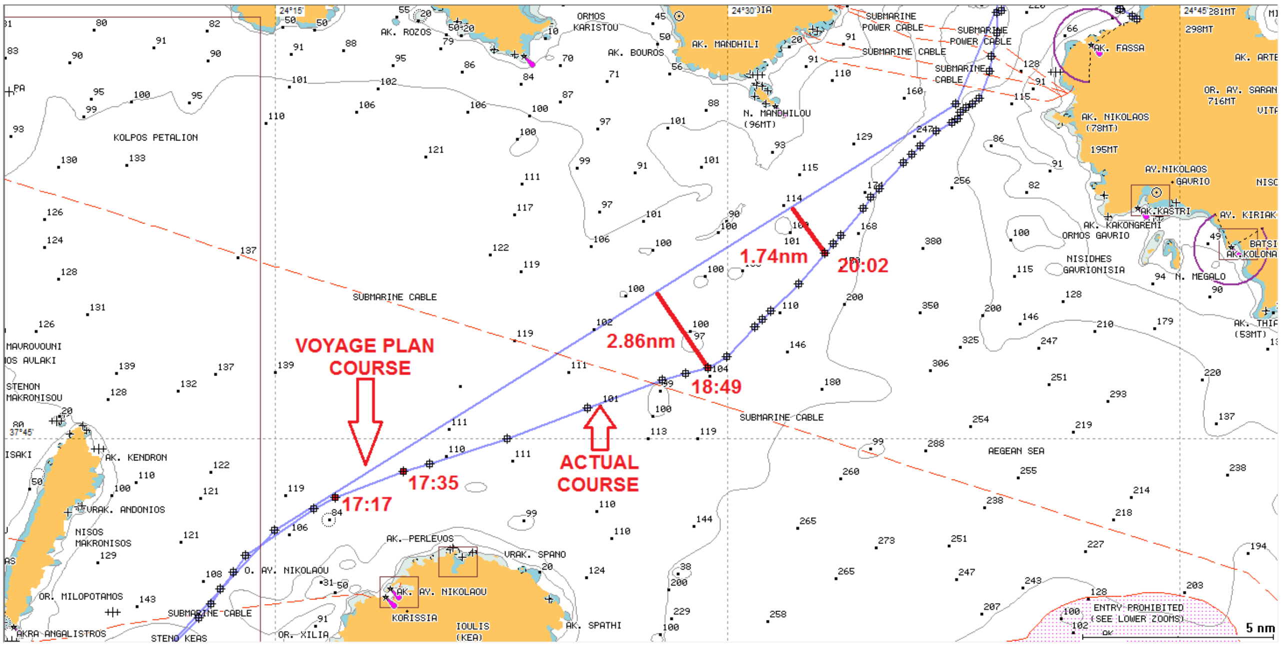


Figure 4: *Goodfaith off course position at approximately 17:35, 18:49 and 20:02 heading to Steno Kafirea*

Shortly afterwards the Chief Officer handed over the watch to the 3rdOfficer, without any notably remarks since the Master had remained on the bridge to monitor the safe navigation during the adverse weather condition. After a short talk with the Master the Chief Officer was informed that the managing company had requested to re-calculate the cargo quantity at the loading port so he went to the ship's office to prepare the stowage plan for the loading port of Odessa. At 2100 he finished with the required paperwork and went to his cabin to rest.

3.3 The 3rd Officer 2000-0000 watch

The 3rdOfficer went on the bridge at approximately 1950 to take over the navigational watch from the Chief Officer. Goodfaith was almost approaching Steno Kafirea, between Nissos Andros and the South coast of Evvoia Island, following the course correction to port as the vessel was approaching to her charted course. At that time COG was recorded approximately to 32^{o},speed (SOG) was around 4 knots, there was no traffic affecting the vessel's course and steering was still in manual mode. The Master ordered the 3rdOfficer to maintain a course so as the vessel would navigate with the sea at the port bow in order to minimize the effects of strong pitching and rolling. The monitoring of the actual course in relation to the passage plan was performed by extracting Goodfaith's position from her GPS and plotting it at the nautical chart at regular intervals. When the 3rd Officer took over the watch Goodfaith was approximately 6.17nm from the next way point (WP 15: Lat. 37^{o}56'N, Long 24^{o}37,4' E) where according to the passage plan the vessel should follow a course of026^{o} to navigate through Steno Kafirea. Regular fixes by the 3rdOfficer were plotted, as shown in figure 5.

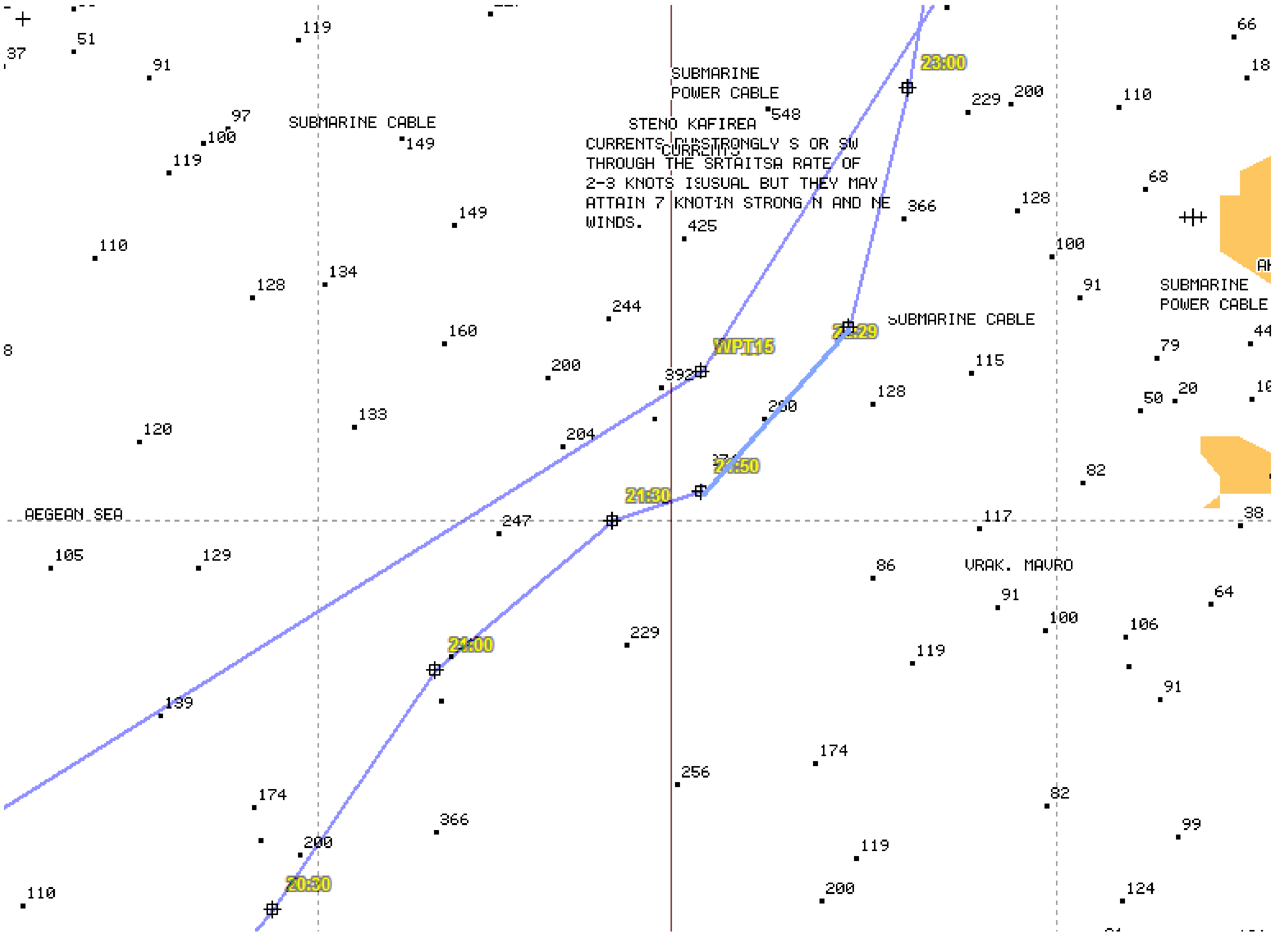


Figure 5: *Goodfaith positions at approximately 2030, 2100, 2130, 2150, 2229 and 2300(Source: AIS & VDR data)*

At approximately 2215 Goodfaith passed at a distance of 0.4nm south from her next way point (WP 15) making a slow progress through Steno Kafirea with a SOG of around 2 knots reaching at the midway of the strait at approximately 2300. Goodfaith was proceeding with a speed of 2-3 knots as she was trying to cope with the strong N-NE winds reaching a scale of 10bfrs as well as with the high waves, dragging her sideways while at the same time she was trying to maintain her planned course. It is indicative that during the 3rdOfficer's watch the vessel's COG was recorded to range from 96^{o} to 304^{0}. Despite the rough weather conditions Goodfaith was heading towards her charted course. At 0000 the 3rd Officer handed over the watch to the 2nd Officer.

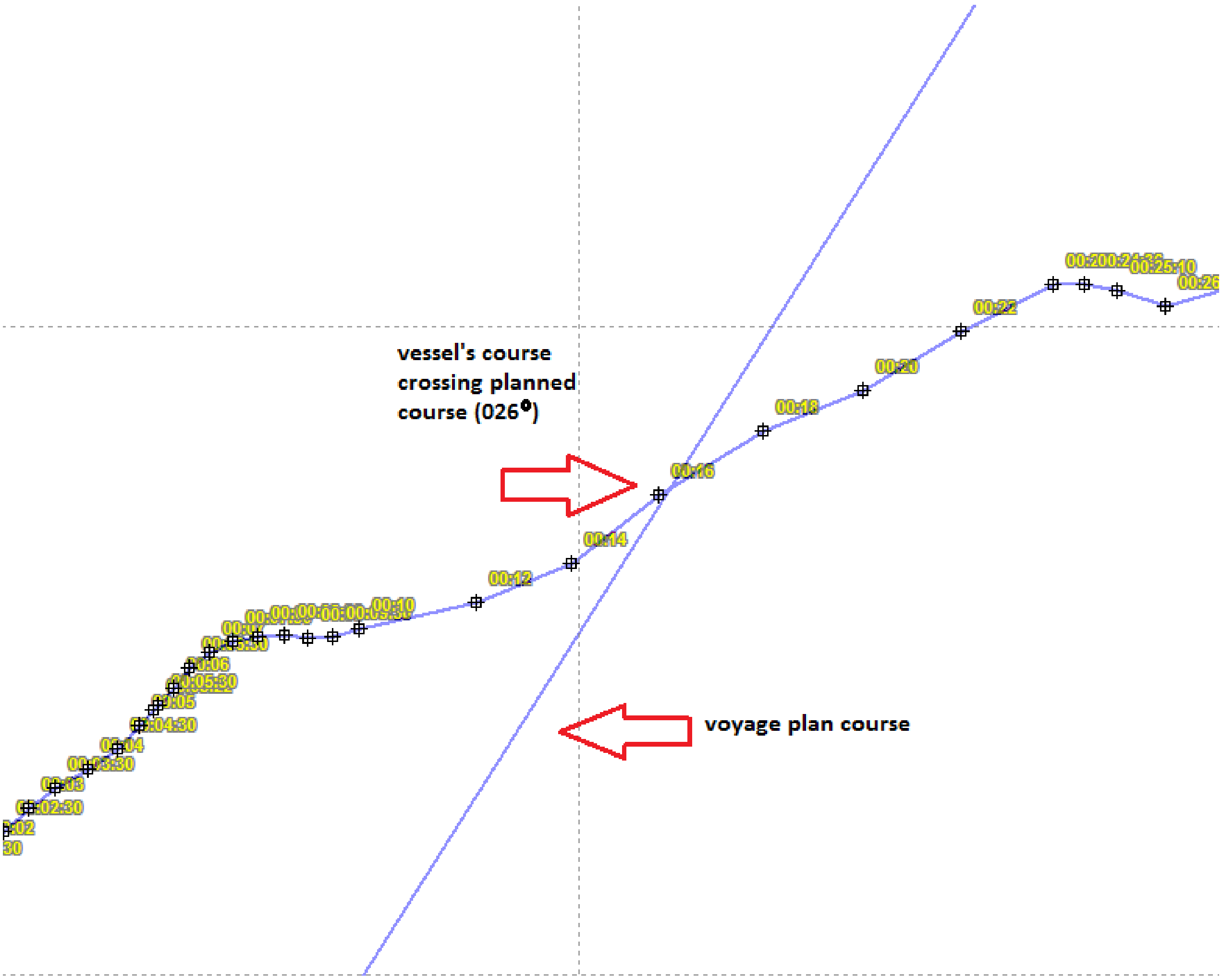


Figure 6: Goodfaith position a few minutes after the change over of the watch (00:16)

3.4 The 2nd officer 0000-0400/1200-0400

The 2nd Officer arrived at the bridge at approximately 2345 to take over the watch from the 3rd officer while the Master was still at the bridge. The only information he received by the Master was that he had to maintain the course to 030°, 4°easterly of the planned course for navigating the heavy sea. The Master has left from the bridge at approximately 0005.

A few minutes after the change over of the watch at 0016 the vessel's course (Figure 6) had crossed the plotted course (026°) as projected on the plan under her passage plan but that was not recorded on the chart. By that time Goodfaith was nearly exiting the Steno Kafirea heading towards the fully exposed to North winds area of the Central Aegean Sea. From the information collected through the VDR data and the sound recordings from the bridge, it was evident that the prevailing weather conditions had a severe impact on Goodfaith's navigation, on the grounds that she was making a slow progress on her passage with her speed (SOG) at times being less than 2.0 knots and her COG to almost 62° despite the fact that her heading was 24°, close to the planned course (026°). The last fixing of the vessel's position on the chart was marked at 2400; however it is noted that according to the VDR data the vessel's position was wrongly marked as the actual position at that time was nearly 1.2nm south-west of that point (Figure 7). The wrong position on the chart indicated that the vessel had drifted almost 0.5 nm East from her planned course and she was almost 2 nm away from the North west coast of Andros. Nonetheless the OOW did not alter the vessel's course to north and proceeded with the same course.

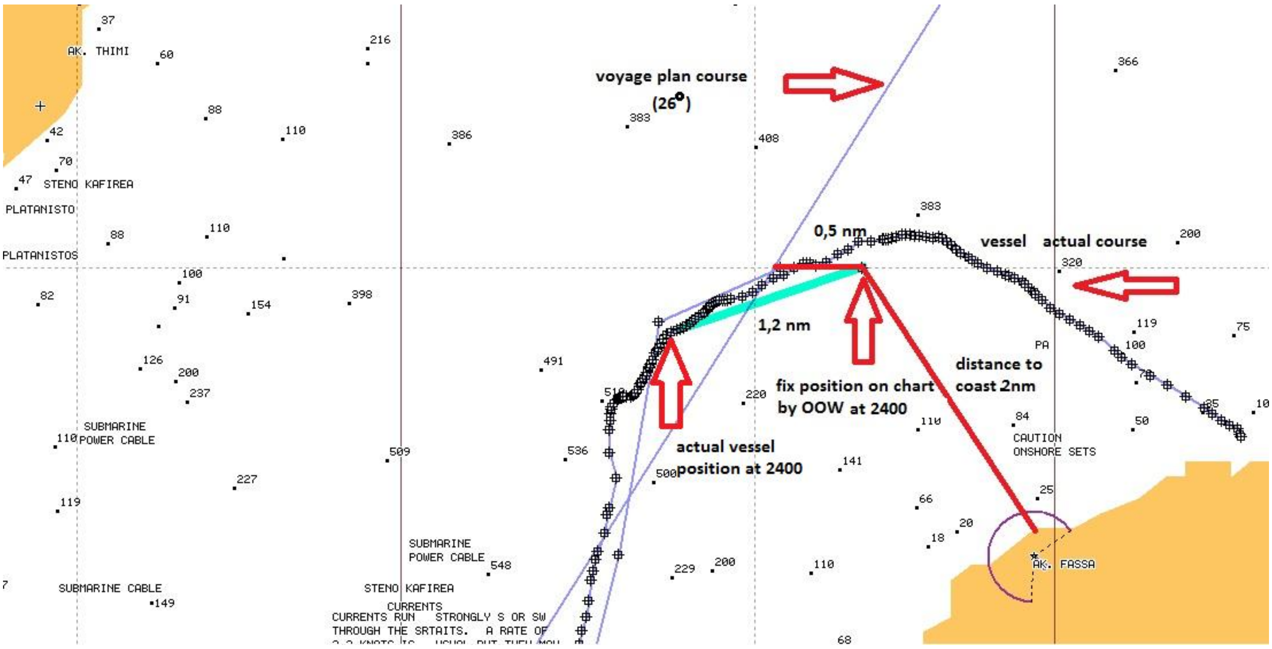
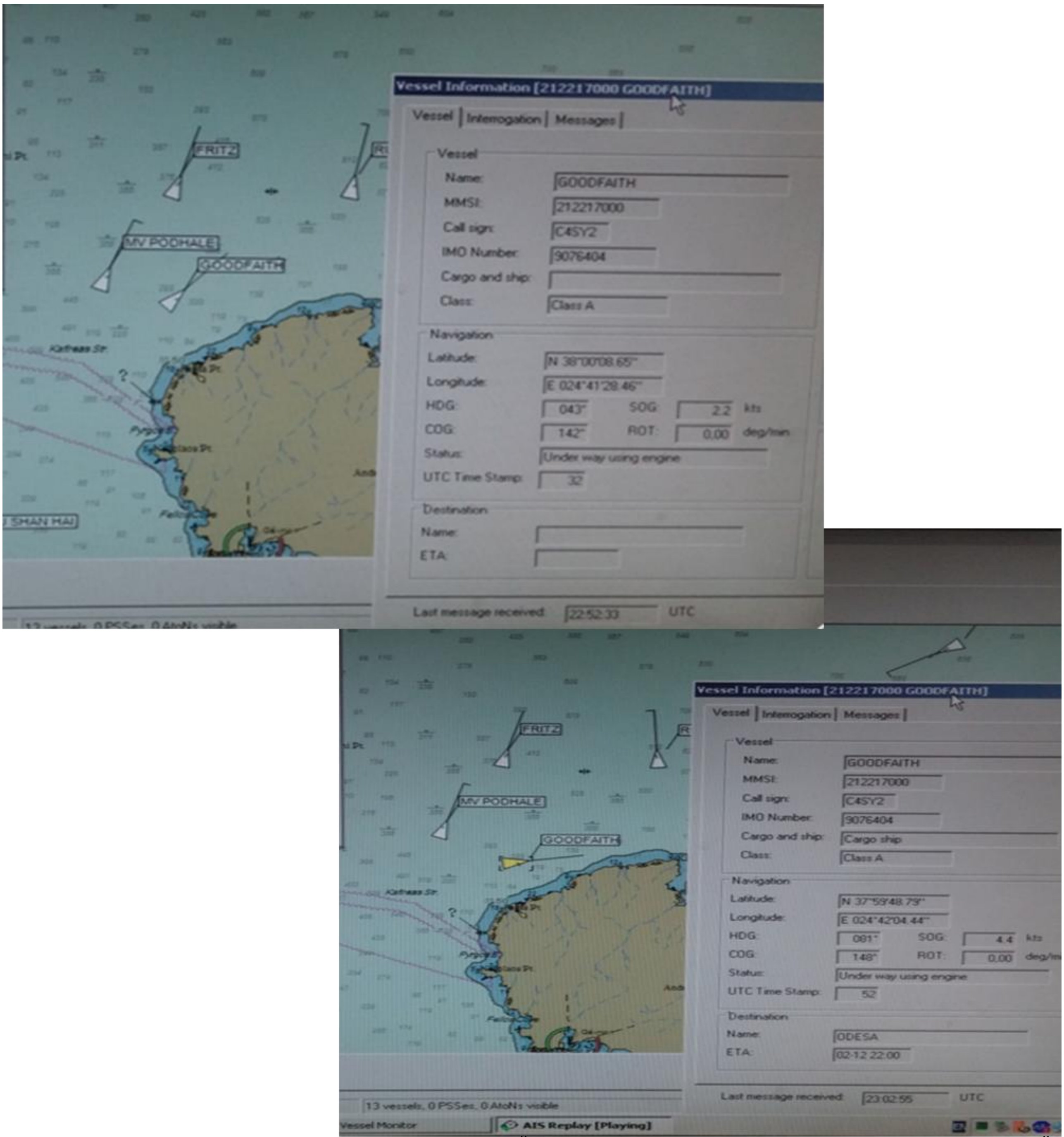


Figure 7: *Goodfaith's last fixing position on chart at approximately 24:00 as marked on the chart by the OOW and actual vessel's position sailing through the exit of steno Kafireas.*

As the vessel was exiting Steno kafirea she started drifting further to East following an almost 80^o course as she was affected by the strong north winds of 50-60kn and the high waves coming from the open Central Aegean Sea as Goodfaith's heading was highly increased from 30^o to 81^o with a respective increase of COG to 148^o (Figures 8,9) and the vessel was approaching the Northwest coast of Andros, with a SOG of approximately 4,5 knots.



Figures 8,9: Goodfaith's positions at 00:52:33, HDG 043^0 (COG 142^o), SOG 2,2 knots and at 01:02:55, HDG 081^0 (COG 148^0), SOG 4,4 knots. (Source: SafeSeaNet)

3.5 The grounding

At approximately 0045 the AB was situated at the helm performing manual steering and he observed from the gyro compass repeater that the heading increased to starboard despite his efforts to maintain the ordered 030^o course. He informed the 2ndOfficer who initially ordered to put the rudder 10^o to port, and after hard to port, but without any impact to the vessel's course. By that time (0051) it was evident that the maneuverability of the vessel was directly affected by the high waves and the strong N-NE winds of force 10, which increased the vessel's set of drift, forcing Goodfaith towards the rocky coast, as presented in the table below. From that moment Goodfaith never headed back towards her intended course.

Time	HDG^o	SOG(knots)	COG^o	Audio
00:43	30	1.6	78	
00:44	33	1.7	102	strong vibrations on the bridge from the pounding of the waves
00:45	32	1,5	109	strong vibrations on the bridge from the pounding of the waves
00:46	31	2.1	103	strong vibrations on the bridge from the pounding of the waves
00:47	34	2.3	93	
00:48	31	2.4	101	strong vibrations on the bridge from the pounding of the waves
00:49	31	1,9	73	
00:50	37	1,3	133	
00:51	37	2,1	134	
00:52	38	2,3	140	
00:53	44	2,2	134	
00:54	57	3,0	130	
00:55	61	3,5	122	Sound of bridge door opening/captain on the bridge. Order to port steering
00:56	67	4	129	Bridge telephone rings/communications inside bridge for steering
00:57	63	4,2	119	communications inside bridge for steering
00:58	57	3,9	115	communications inside bridge for steering
00:59	61	3,6	115	

Table 1: Goodfaith's VDR abstract. HDG and set of drift the period before and after the Master was called on bridge.

The 2nd Officer having appraised the conditions called the Master at his cabin and reported the situation. The master came on the bridge at approximately 0055 and confirmed that the helm was set hard to port but the vessel could not turn to her course. He assumed a steering failure and ordered to alert the Chief Engineer and the Chief Officer and deployed the 2nd Officer and the AB on the watch to the steering gear compartment to perform emergency/manual steering. The 2nd Officer hurried to the steering gear room, together with the Chief Engineer and the AB and reported that he did not observe a steering failure and that the rudder was indeed set hard to port.

At approximately 0100 the general alarm was sounded by the Master, while Goodfaith was recorded to heavily drift to starboard, with a heading of 85^o, a COG of 143^o, a speed of 4.2 knots while she was almost 1.7nm off the NW coast of Andros Island. Goodfaith was practically not under command making no headway, despite the fact that her engine was running at 95 rpm. At 01:07':30'', the Master realizing the imminent danger of grounding ordered the crew to muster at the bridge by the public address system. All crew members except the crew assigned at the steering gear room, were mustered on the bridge with their lifejackets and immersion suits on. No further actions were taken by the Master and Goodfaith was actually not under command, laying beam on to the wind and the high waves of more than 7-8 m height, as reported by her crew, that were causing heavy rolling.

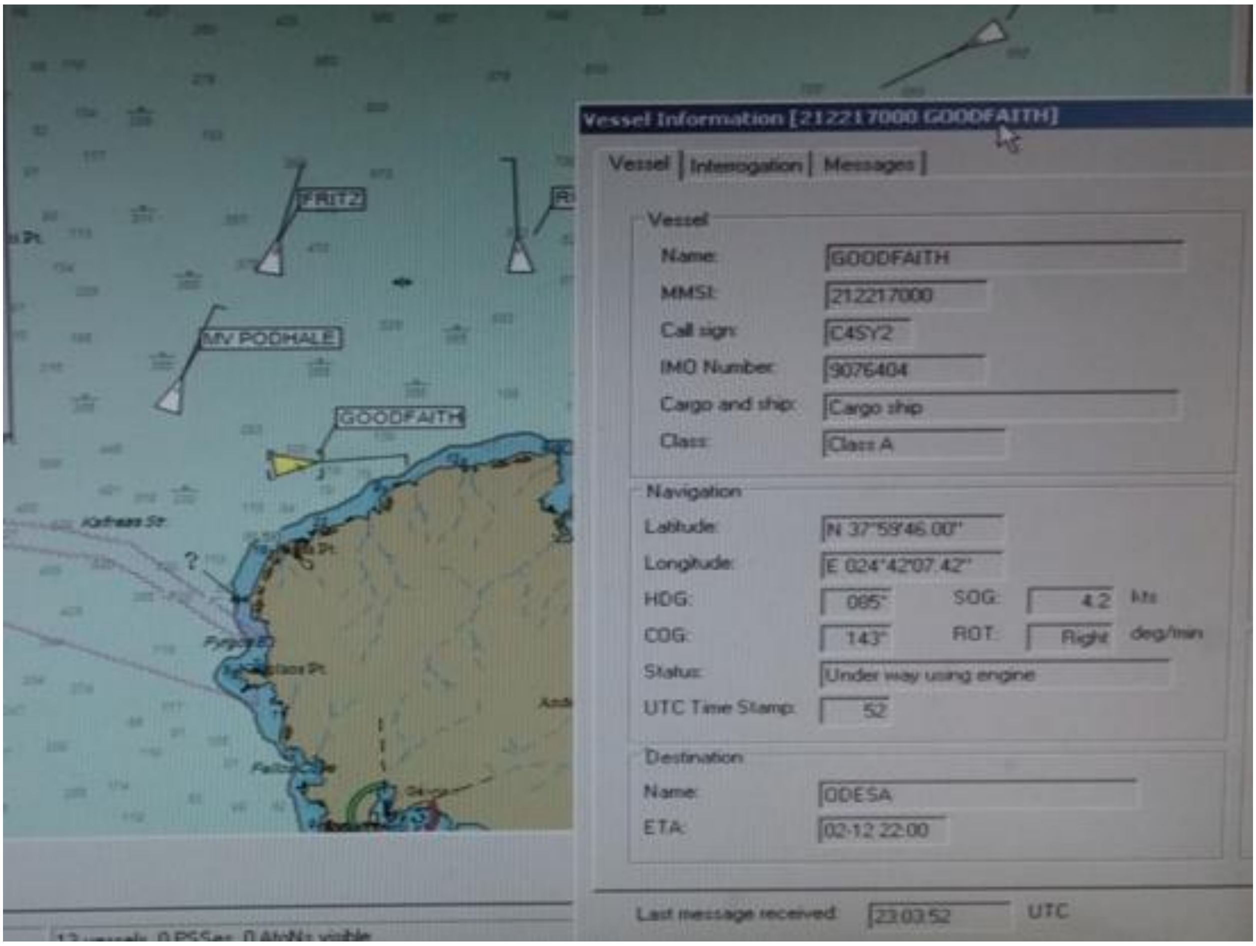


Figure 10:*Goodfaith's position at approximately 01:03 (source AIS information system)*

The Master deployed the Chief Officer and the Bosun to the forecastle to drop the anchors as a last option in order to avoid the anticipated grounding, nonetheless the crew replied that it was not possible to walk through the main deck with the encountering situation and the extreme weather conditions. The following minutes, the Master was unable to take any further action and due to the strong winds and waves Goodfaith was drifting towards the North Coast of Andros with a speed of around 4 Knots and a COG of 148^{o} while her heading was around 85^{o}.

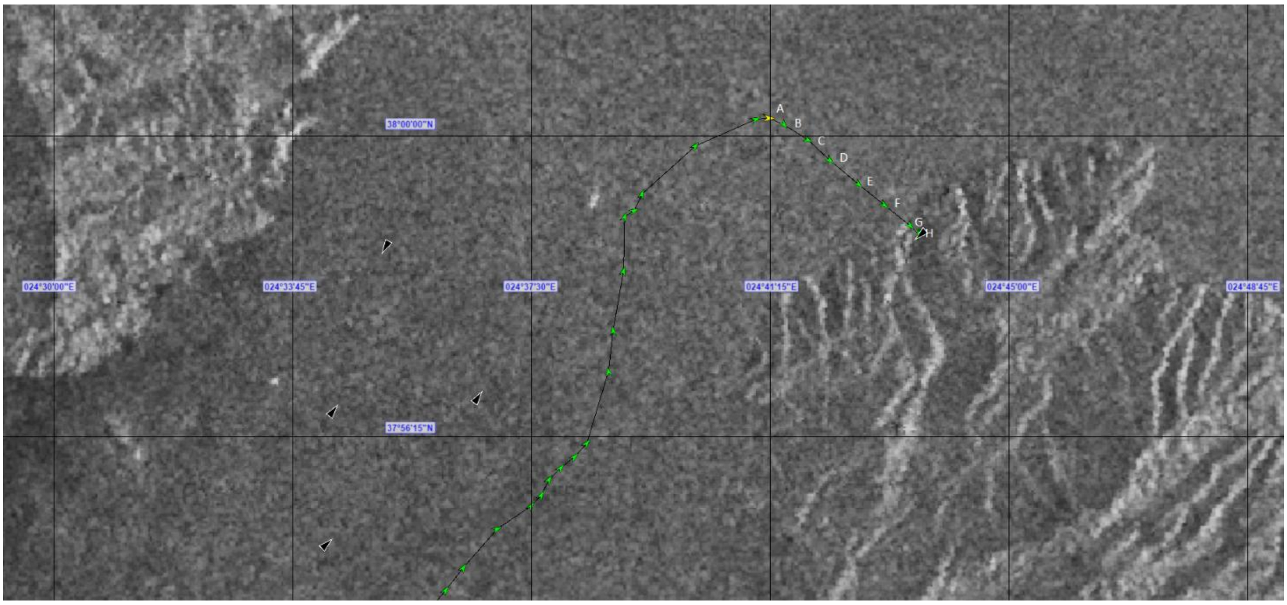


Figure 11 :*Overview of Goodfaith passage to the grounding point as extracted by IMDatE*

At 0105 in order the effects of the vessel’s anticipated grounding to be minimized, the engine telegraph was set to Half Ahead followed by Slow Ahead at 0123. Vessel’s SOG was reduced to 1 knot at approximately 0127. One minute later, at 0128 Goodfaith grounded on the rocky coastline at the Northwest seafront of Andros Island.

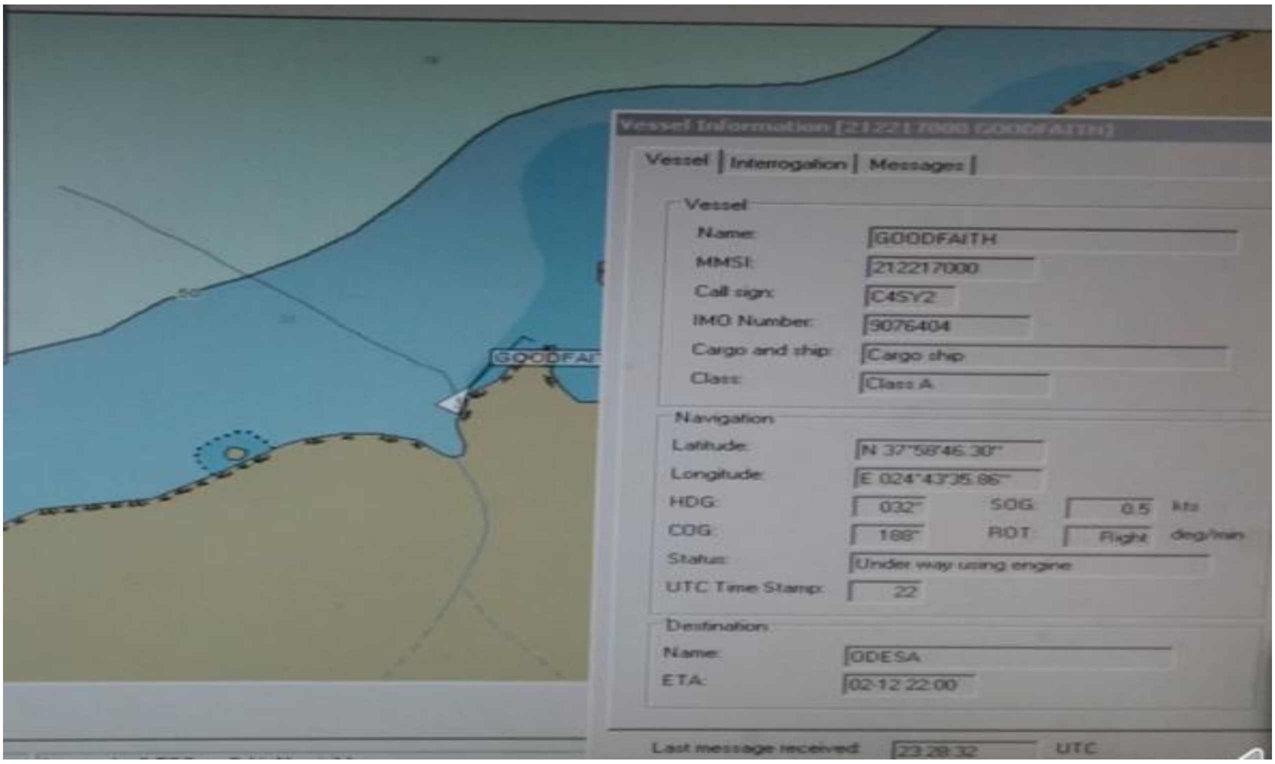


Figure 12: *At 01:28’ 32’’Goodfaith grounded at position* Lat.:37° 58’ 46’’ N, Long.:24° 43’ 36’’ E *as recorded by HCG AIS system*

3.6 Crew Emergency Response-Hellenic Coast Guard Response

Immediately after the grounding the Master set the engine control lever at stop position and the engine was stopped. At 01:28’ 35’’ the general alarm was activated again and through the public address system the Master ordered an “Abandon ship” while the remaining crew members, that is the 2nd Officer and the AB who were still located at the emergency steering gear room came on the bridge. All crew were mustered on the bridge carrying their lifejackets and immersion suits. A Mayday distress signal was transmitted at 01:29’:25’’ through VHF channel 16 and INMARSAT –C, to all stations reporting the name of the vessel and the grounding situation and requesting immediate assistance to abandon her. The call was received by Olympia radio, which immediately informed Piraeus JRCC at approximately 0134.

Figure 13: Immersion suits as were found after the crew's evacuation inside the bridge

Piraeus JRCC immediately mobilized available means and dispatched three SAR helicopters to the area of the casualty. In addition the local Coast Guard Authority deployed a team to monitor the situation from ashore, as well as the Fire Service Emergency Response Squad was mobilized to assist the evacuation of the crew from the shore.

M/V Goodfaith was stranded lengthwise with her starboard side and wedged on a rocky slightly sloped flat reef, meters away from the coast's steep cliffs. Due to the strong impact and the fact that huge waves of 9-10 meters were unceasingly slamming her port side, covering her deck and causing striking violent rocking, the cargo hold water ingress alarm system was activated indicating that the hull was breached and cargo holds No.1 and No.2 were flooded. Consequently the vessel started listing about 10° to port. The Master urgently reported the ongoing situation to the Coastguard Authorities and requested again assistance for evacuating the vessel.

Figure 14: M/V Goodfaith grounding position and view from the clinometer inside the bridge indicating a list of 10^0 to port.

At approximately 0300, the vessel experienced a blackout as the engine room compartment had breached and flooded. After 2 to 3 minutes the emergency generator started and the ship's emergency power was restored. The 3rd Officer used 3 or 4 parachute rockets as an additional attempt to alert nearby vessels and rescue personnel from ashore. The Master considered to abandon the vessel by launching the lifeboat located at the vessel's starboard side, but due to the close proximity of Goodfaith to the rocks and the heavy rolling of the ship, the Master was concerned that the lifeboat would hit against the rocks, putting his crew into greater danger.

As a last option to deploy vessel's life saving equipment, the 2nd Officer with the assistance of the 3rd Officer, attempted to launch the inflatable life raft situated at the port side. They tied the life raft with a lanyard at the ship's port side railings as they planned to use the accommodation ladder to board on it. Unfortunately the life raft was forced astern by the strong winds and waves and the painter line was cut.

At about 0400, a SAR Helicopter recovered the first crew member which was the 3rd Engineer who seemed to be in the most difficult condition, as he had fainted after the grounding. Until about 0730-0800, ten more crew members were air lifted to shore, while 40 minutes later,7 more crew members were recovered by a SAR helicopter. It was stated that during the evacuation process a big wave, swept away one O/S who was standing on the main deck waiting for his recovery, but he managed to hold himself from the stanchions of the main deck railings. The Master and three crew members remained on board and were rescued at approximately 1420 by the Fire Service Emergency Response Squad that launched a successful rescue operation from shore.

Figure 15: Image during the rescue operation (source web)

Until crew's evacuation there were no information regarding the vessel's condition as the waves were covering the main deck, causing heavy rocking. Under these extreme conditions it was impossible for the crew to go around the vessel to inspect and take soundings from bunker/ballast tanks and cargo holds bilges and to check for leakages, water ingress and marine pollution. Consequently all crew were mustered on bridge deck wearing their lifejackets. Due to the intense rolling and slamming of the vessel's hull against the rocks followed by extreme vibration, bridge equipment was thrown all over the place and some crew members started to feel sick and vomit. It was reported that it was difficult to stand on the bridge and some crew members used ropes tied around the main bridge console railings in order to remain steady in place.

Figure 16: Ropes as were found after the evacuation process inside the bridge.

3.7 Sustained damages and salvage, antipollution and wreck removal operations[3]

The Owners of Goodfaith, under the direct supervision and coordination of the competent HCG Authorities assigned a salvage company to carry out the necessary salvage and antipollution operations. Additionally the owners appointed a consultant office to ascertain the extend, cause and quantum of the damages. However the following days of the casualty, the access to the area was not feasible due to the prevailing gale winds blowing from northern directions and the rough sea as well as the rocky grounding site.

M/V Goodfaith had sustained severe damages, heavy indentations, cracks and fractures lengthwise on her bottom and side shell plating, including underwater hull damages in her fore section, cargo holds and engine room which can be summarized as follows;

[3]Provided information derives from the respective reports received by the contracted salvage and consultant companies.

- Cargo holds 1, 3, 4, 5 were flooded with water at sea level. Especially holds 4 & 5 were contaminated with oily waters most probably due to the fractures of the tank top with the double bottom oil centre tanks.

- Engine room was found flooded up to the 3rd deck level as shown in Figure 17 with oily water/sludges reaching the main engine scavenge space level on stbd side and purifiers room as well as main engine's emergency controls unit level on the port side. Moreover from the extend of the damages it was apparent that the engine room in whole and main engine in particular had been lifted upwards in various locations, as a result of the impact of the grounding. It appeared that the main engine had been rotated to port, with the port side displaced down and the starboard side displaced upwards. Consequently all machinery, electrical, automation and in general all equipment of the flooded compartment were considered completely damaged from the oily water contamination. Finally it was assumed that the double bottom tanks of the engine room had been heavily buckled/damaged in order such distortion at the top deck of the engine room and main engine braces to be evident.

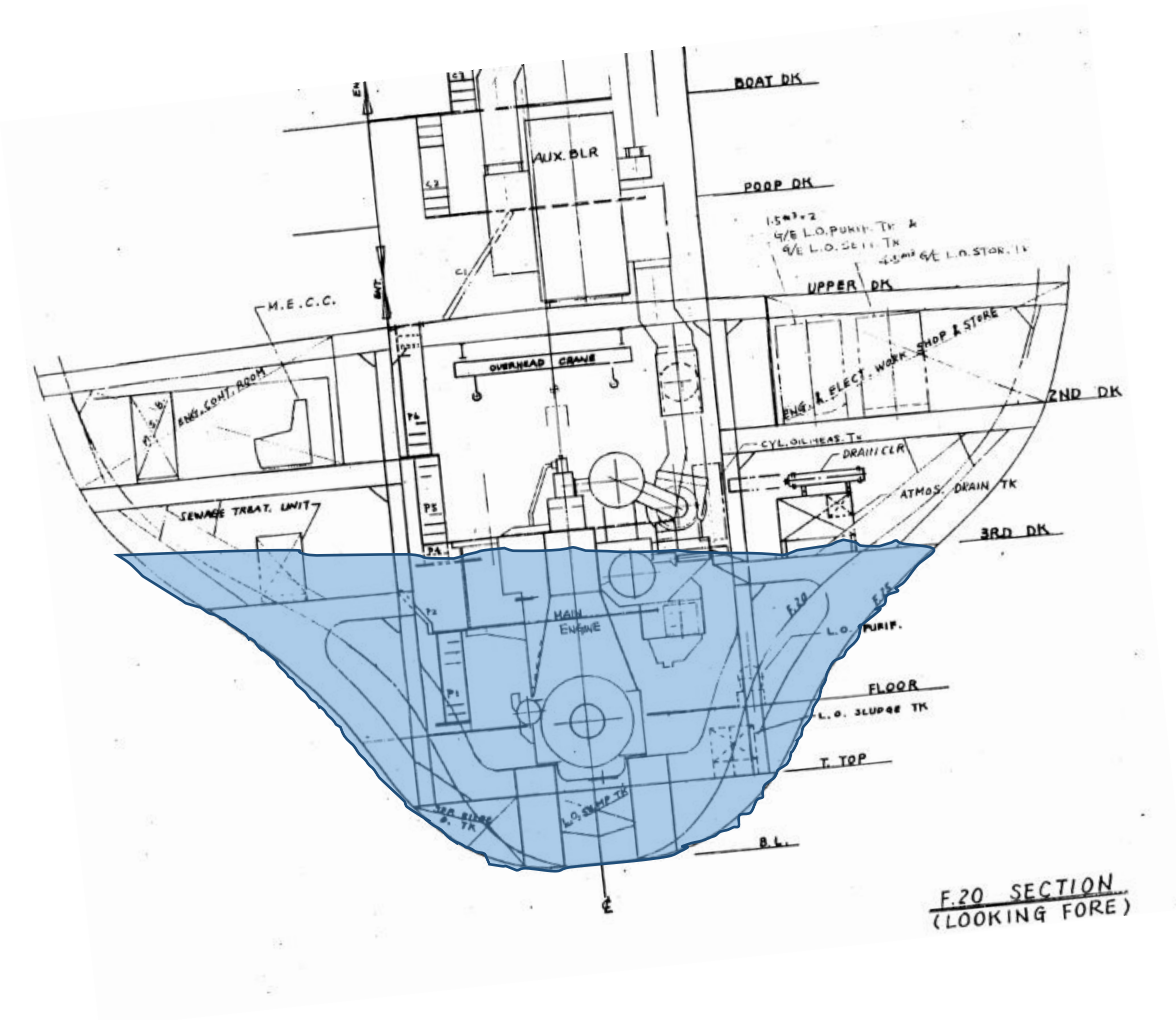


Figure17: *Depiction of engine room flooded and rotated to port for illustration purposes (source consultant company)*

- Underwater hull damages ascertained by divers are summarized in the following Figure 18. Indicatively they included port side shell plating between frames 53 to 12, in way of Cargo hold No.5 and Engine room which were found heavily deformed/buckled. Starboard from forward to frame 190 (in way of the forepeak tank) side shell plating was heavily deformed with longitudinal fractures of various dimensions, extended over entire underwater area of bulbous bow. Additional areas were found heavily deformed with associated transverse and longitudinal cracks and holes where starboard side and bottom shell plating was touching the rocky seabed,in way of Cargo holds No.1, 2, 3, 5 and engine room as illustrated at figure 18.

- Finally it was estimated that the rudder system had suffered extensive damages from top to bottom including its foundation and surrounding structure.

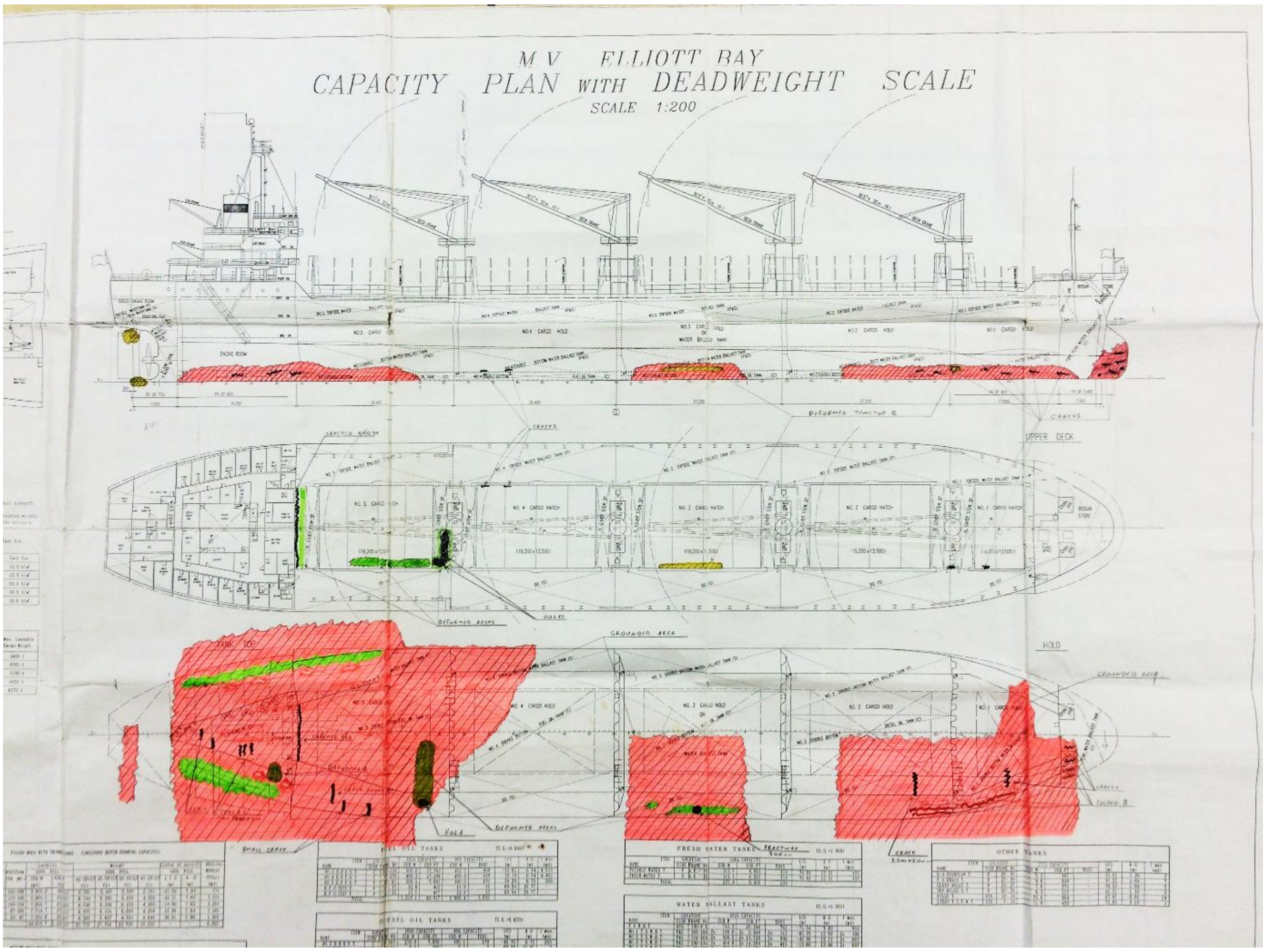


Figure 18: *Indicative depiction of damaged areas of Goodfaith as inspected by divers (green color indicates deformed areas, black color indicates cracks/holes/fractures, yellow color indicates deformed tank top, red color represent firmly grounded areas of the vessel (source consultant company).*

The above description of underwater damages is not exhaustive since there was an extensive bottom damage that could not be inspected, particularly in way of double bottom tanks no.5 port, centre and starboard, and the engine room, as the vessel was sitting firmly on the rocky seabed all along the above areas. It appeared however that these cracks extended towards the centre line but full extend was unknown.

Bearing in mind the actual extend of the damages as found above and calculating the estimated costs for the proper repairs of the M/V Goodfaith to be reinstated in her full operating condition, it was apparent that the repair costs exceeded the insured value of the vessel therefore she was considered a constructive total loss.

On the 21st of February, bunkers pumping operations were initiated and were completed on the 28th of March 2015, as there were occasionally ceased due to prevailing bad weather conditions. As reported the total quantity of bunkers (F.O. plus D.O.) pumped out from the vessel was 301MT, a quantity which was very close to the initial quantities reported (F.O. 250MT, D.O. 50MT).

M/V Goodfaith was towed on the 10th of July 2015 from Andros to a shipyard facility in Salamis island (Greece) until her final destination to the demolition yard for its disposal on the 17th of October 2015.

***Figures 19 a, b, c: Photos** from the wreck removal operation and the vessel being removed from the casualty area (source contracted Salvage Company).*

4. Analysis

The analysis of the examined marine casualty aims to identify the factors and causes that contributed to the marine casualty, taking into account the sequence of events and the collection of investigation information in order to draw useful conclusions leading to safety recommendations. It is noted that the majority of the information derived from the interviews of Goodfaith crew members, the recorded data from the vessel's S-VDR as well as from AIS information collected from external sources.

4.1Goodfaith's positioning data from external sources

The position of the vessel and other navigational information prior to the grounding were extracted from the data recorded in the vessel's S-VDR as well as from the IMDatE of the European Maritime Safety Agency (EMSA) .

Based on the aforementioned data, the course of the casualty vessel was projected on an electronic chart, in order to reconstruct the passage leading to her grounding. An overview of the plotted positions is presented in figures 20, 21 in contrast to Goodfaith's planned course, as recorded on the navigational chart.

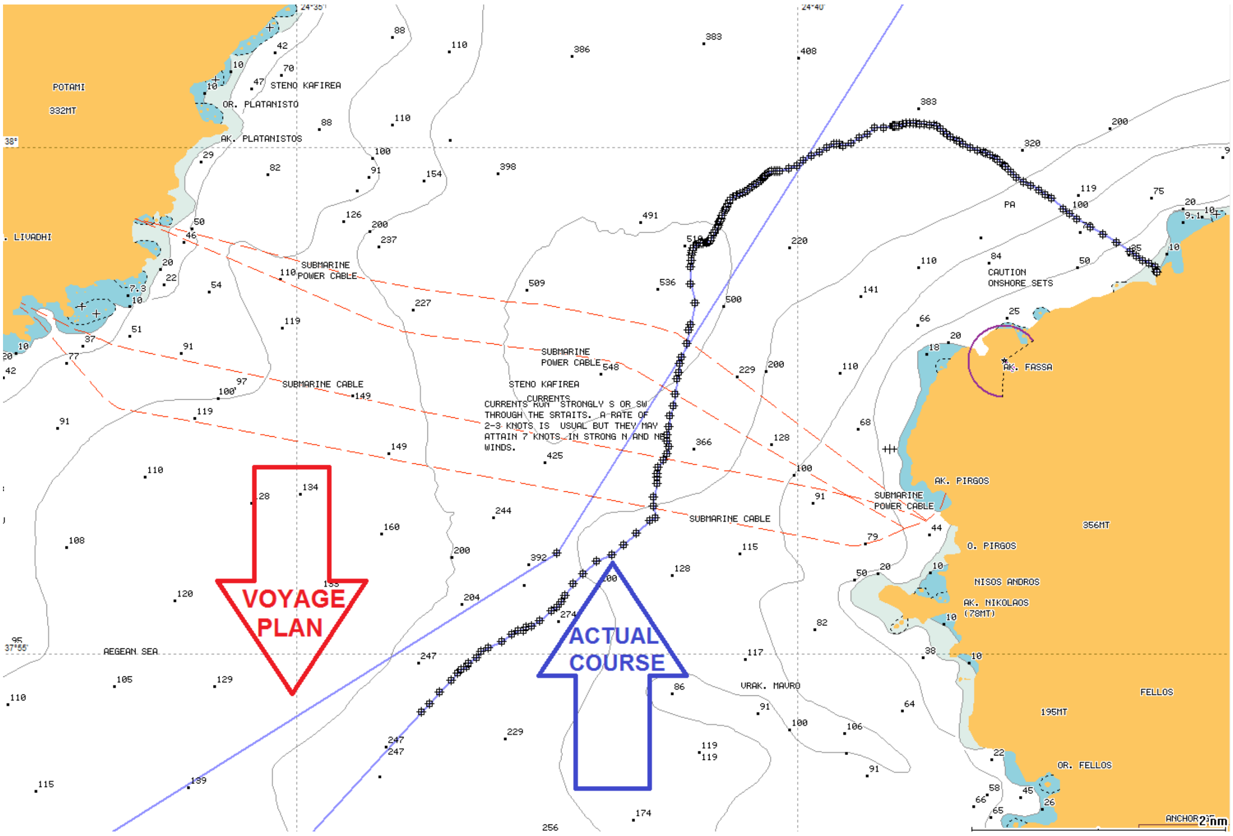


Figure 20:. Goodfaith voyage plan and positioning data as plotted on electronic chart.

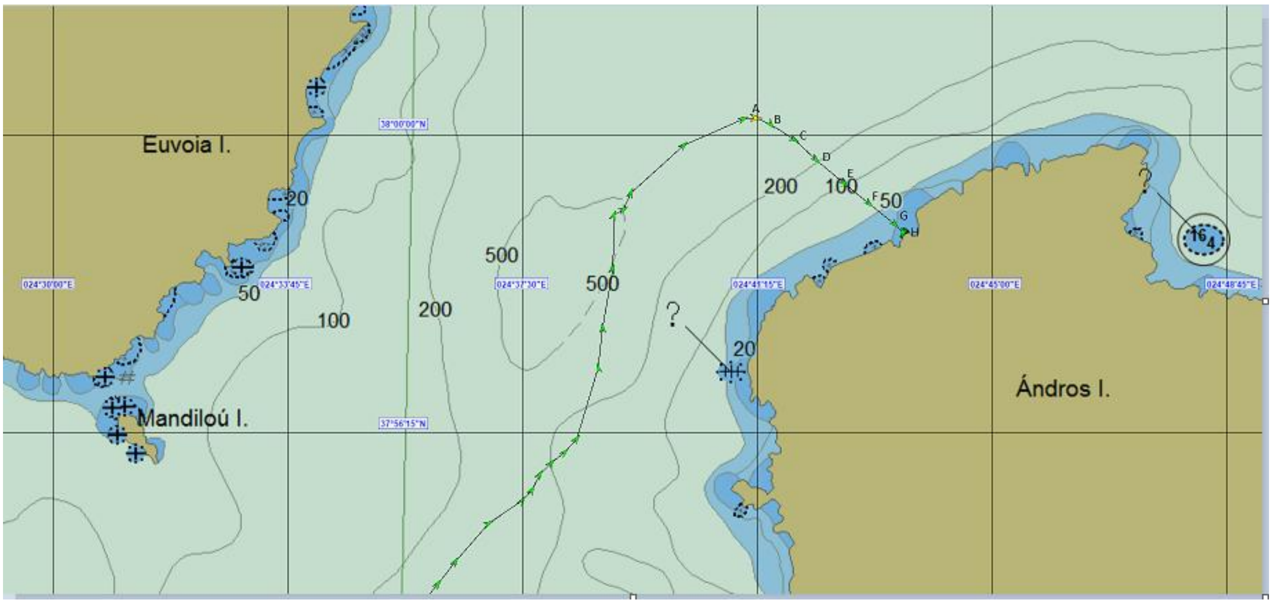


Figure 21: *Overview of Goodfaith passage as extracted by IMDatE*

4.2Goodfaith's Crew

At the time of the casualty Goodfaith was operating under a crew complement of 22 seafarers including Master. All crew members were Philippine nationals, except from the 3rd Officer being Romanian so the established working language on board was English.

Goodfaith's Minimum Safe Manning Document was issued by her Flag, pursuant to SOLAS Regulation V/14 as applied, providing a minimum crew of 12 seafarers. However, she was manned with 10 crew members in excess of the Flag requirements. The supernumerary crew in relation to the Minimum Safe Manning Document encompassed the capacities of one 3rdOfficer, one Fitter and two Ordinary Seamen, for the deck department and two 3rdEngineers, one Electrician, one Oiler and two Motormen for the engine department.

4.3. Watch keeping schedule

4.3.1 Deck Department

The Deck Department numbered 04 Officers including the Master, 01 Bosun,03 ABs, and 02 OSs. The navigational watch keeping schedule as presented in Table 2, was performed under a three-watch pattern, assigned to Chief, 2nd and the 3rd Officers, while an AB was forming part of each navigational watch respectively, as a lookout.

It was reported that although the watch keeping schedule was normally carried out on board Goodfaith, from the start of her voyage from Elefsis anchorage at approximately 1100 on the 10th of February, the Master remained on the bridge until approximately 0005 on the 11th February, when Goodfaith had almost cleared the Steno Kafireas strait. His decision was taken due to the encountering weather conditions that the vessel was facing and the anticipated maneuvering during the vessel's passage through usually high traffic sea areas as south of Sounio sea area, then heading to Steno Keas strait and ultimately the passage segment through the Steno Kafireas strait. However during the interview process it emerged that for the most part of their watches the Officers had little input or interaction with the Master, apart from responding to his orders.

	Position/rank	Watch keeping schedule	Non Watch keeping working hours
1	Master		0700-1200/1300-1700
2	Chief Officer	0400-0800/1600-2000	-
3	2nd Officer	0000-0400/1200-1600	-
5	3rd Officer	0800-1200/2000-2400	-
7	AB 1	0000-0400/1200-1600	-
8	AB 2	0400-0800/1600-2000	-
9	AB 3	0800-1200/2000-2400	-

Table 2: *Goodfaith shipboard watch and working arrangement at sea.*

4.4 Crew information

4.4.1 The Master

The 41 year old Master acquired his Master diploma in 2008. He started his career with Goodfaith's company in 1994 as a mess boy and during the years he was promoted to a 3rdMate position in 1999. He then joined vessels of another company and returned back to Star Marine Management in 2010 as a Chief Mate, where he served for about 15 months in two vessels before he joined Goodfaith for the first time as a Chief Mate in 2012 for almost a year. He boarded Goodfaith to serve for the first time as a Master on the 7th of November 2014 for a nine month contract.

4.4.2 The Chief Officer

The 57 year old Chief Mate graduated in 2000 as Chief Officer and from that time he was serving mainly in bulk carriers as he was experienced with their operation. His career as a seaman started in 1979 as an apprentice officer and in 2005 he acquired his Master diploma. This was his first contract with Goodfaith's Shipping Company. He had joined the vessel on 20thNovember 2014 and his contract was expected to last for 8 months. In addition to his watch-keeping duties, he was tasked with the safety and environmental Officer's duties and was in charge of the cargo operations.

4.4.3 The 2nd Officer

The 54 years of age, 2nd Officer had completed his naval academic studies, in 1985. He worked with the company's ships from 2005 until 2014, for an 8 months service approximately each time, starting as a 3rdOfficer. In 2000 he acquired his 2ndOfficer diploma and he had served again in Goodfaith on 2011. He was tasked, in addition with his watch keeping duties as a navigation officer, with preparation the voyage plan, updating the charts and he was responsible for the vessel's communication equipment. He had joined Goodfaith on August 2014 and was running the sixth month of his contract. His experience as a seaman involved only bulk carriers and he was considered to be very familiar with their operation.

4.4.4 The 3rd Officer

The 25 year old 3rd Officer, started his naval career with the managing company of Goodfaith in December 2011 as a deck cadet. He then served as an AB for approximately 8 ½ months and then he acquired his navigational watch officer diploma in 2014, when he was promoted to serve as a 3rdOfficer in the company's vessels. He joined the vessel for the first time 3 months before the accident and his contract was expected to last until July 2015.

4.4.5 The Able Seamen

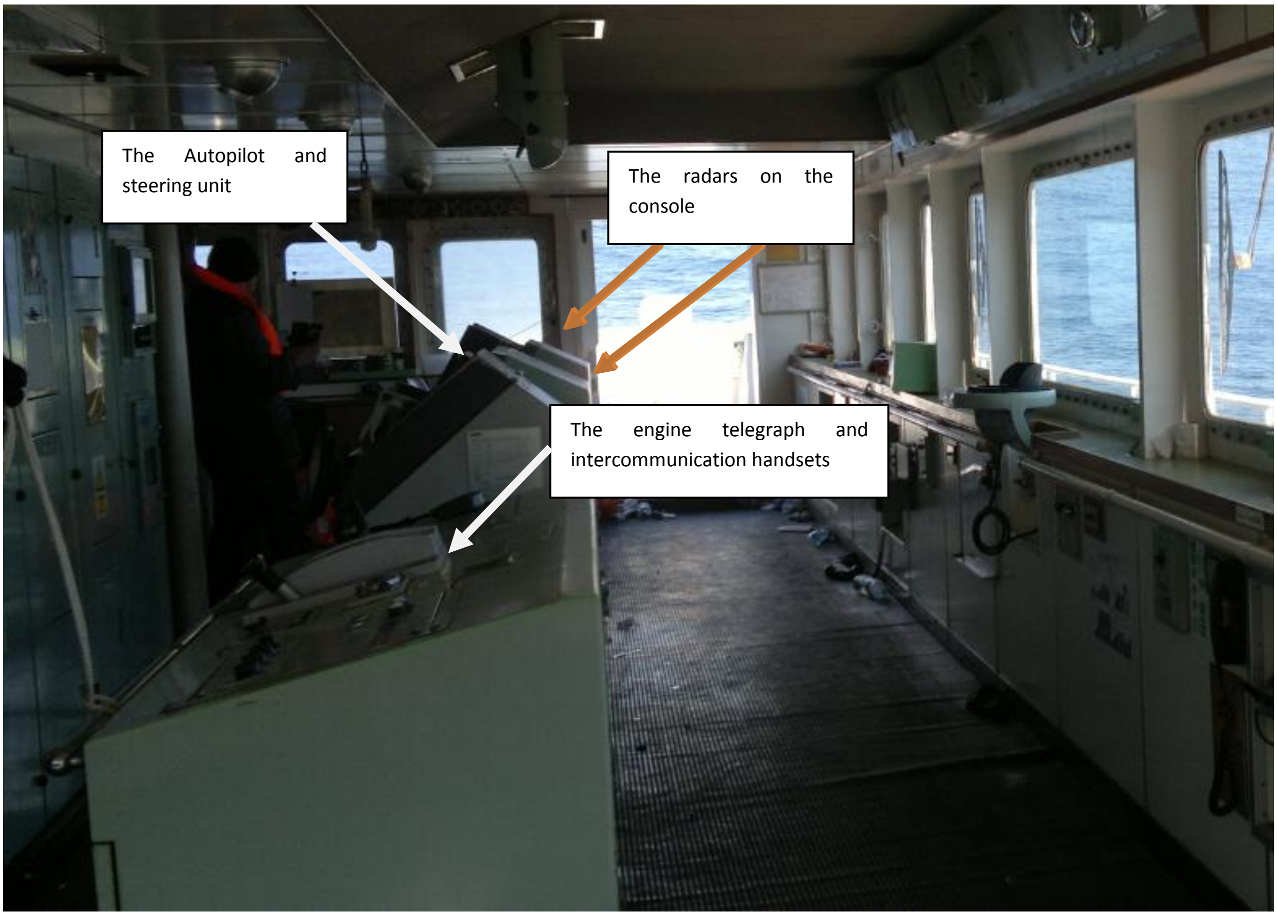
The ABs serving on Goodfaith, were holding an STCW II/4 Certificate of Competency, enabling them to participate in navigational watches. It was reported that they had many years of sea service, mainly on bulk carrier vessels and they were considered well experienced.

Their contracts were mainly based on a standard service period, of approximately 8-10 months and they were involved on daytime deck operations and watchman duties when the vessel was at sea.

4.5 Main Bridge equipment arrangement - Conning Position view

4.5.1 Main Bridge equipment arrangement

Goodfaith's bridge was equipped with one main console mounted in the middle next to the steering and autopilot unit. The console was fitted with the ship's engine control lever and the intercommunication handsets. Two radars (9 GHz) were fitted next to the autopilot unit, with the option to work both on the X-Band (9GHZ) and on the S-Band (3 GHz) scale. One of them was featuring ARPA utilities (Figure 22).



FigFigure 22:*General view of the bridge arrangement and the two radars at the main console*

The GPS, Echo sounder and Navtex units were allocated next to the chart room at the bridge aft section. An S-VDR unit was also provided.

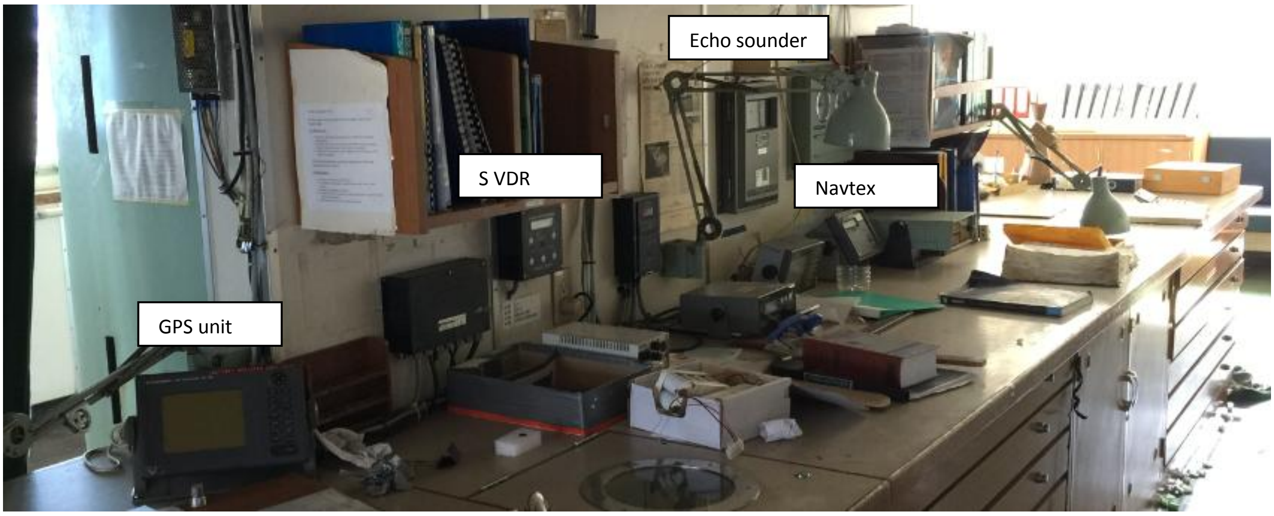


__Figure 23:__ view of the navigational equipment located next to the chart room.

The rest of the navigational and radio telecommunication equipment like INMARSAT-C, the MF/HF device and the weather facsimile receiver were located at the aft portside of the bridge.

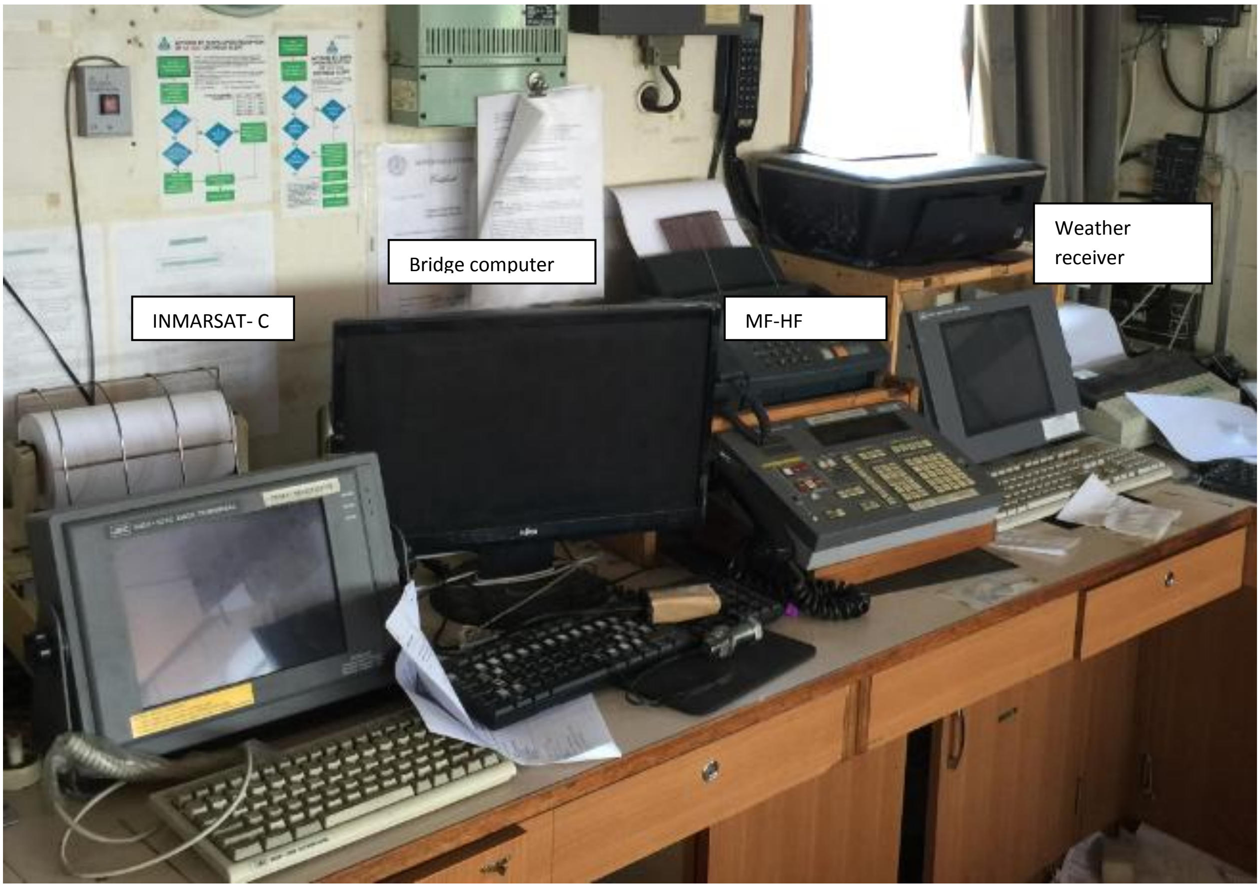


__Figure 24:__navigational equipment located at the aft port side of the bridge.

4.5.2 Wheelhouse view

Goodfaith's wheelhouse structural arrangement offered a good visibility from the conning position to the navigated sea area. The OOW could maintain a very good visual contact and monitoring of surrounding vessels and land. However, her cargo cranes located in line amid ships, created a limited blind horizontal sector, as usually exists on such type ships which could be administered by the relocation of the OOW at the bridge wings.

Figure 25: *Goddfaith conning vision*

4.6 Means of Navigation and Navigational Aids

4.6.1 Passage Planning- Appraisal and planning stages

Irrespectively of the nature of a vessel's operation (loaded or in ballast condition), it is imperative that every voyage is properly planned taking into account the factors necessary to ensure that all hazards are identified and avoided, including the possibility to abort the plan if necessary. Goodfaith's SMS required the Master to ensure that a plan for the vessel's intended passage was prepared before sailing. Indicatively the SMS applied on board specifically stipulated that:

"……It is particularly important that this procedure is adopted both for that part of the voyage in coastal waters (restricted waters) and for the open sea. Before leaving port the Master is to satisfy himself that the vessel is equipped with the necessary charts and hydrographic publications for the safe navigation of the ship. In particular he should ensure that the vessel can be safely navigated at all times and in all areas of the intended passage .He is to verify that the intended courses do not take the vessel through restricted or hazardous areas. The initial courses to be followed are to be laid on the chart prior to leaving the port. If the Master delegates this duty to a Navigating Officer he is to personally check them before sailing. If he lays the courses off himself, then one of the Navigating Officers should check them before the ship leaves the port…."

The Master had appointed this responsibility to the 2ndOfficer who had prepared the plan, which subsequently was checked by the Chief Officer and countersigned by him. The passage plan was not retrieved from the wreckage area of Goodfaith and therefore it was not submitted for the scope of the safety investigation.

However it was expected that all relevant information should be gathered to develope a detailed berth to berth plan for the voyage between Elefsis and Odessa in accordance to the IMO's Guidelines for Voyage Planning[4]. It was the role of the Master to provide guidance to the Navigating Officers, to assess and approve this plan and to monitor the execution phase.

According to said IMO Guidelines indicatively some of the key areas when planning a voyage plan include among others:

.1 the condition and state of the vessel, its stability, and its equipment; any operational limitations; its permissible draught at sea in fairways and in ports; its maneuvering data, including any restrictions;

.2 appropriate scale, accurate and up-to-date charts to be used for the intended voyage or passage, as well as any relevant permanent or temporary notices to mariners and existing radio navigational warnings;

.3 accurate and up-to-date sailing directions, lists of lights and lists of radio aids to navigation; and

.4 any relevant up-to-date additional information, including:

.1 mariners' routeing guides and passage planning charts, published by competent authorities;

.2 current and tidal atlases and tide tables;

.3 climatological, hydrographical, and oceanographic data as well as other appropriate meteorological information;

.4 volume of traffic likely to be encountered throughout the voyage or passage;

.5 any additional items pertinent to the type of the vessel or its cargo, the particular areas the vessel will traverse, and the type of voyage or passage to be undertaken.

.5 the method and frequency of position fixing, including primary and secondary options, and the indication of areas where accuracy of position fixing is critical and where maximum reliability must be obtained;

.6 contingency plans for alternative action to place the vessel in deep water or proceed to a port of refuge or safe anchorage in the event of any emergency necessitating abandonment of the plan, taking into account existing shore-based emergency response arrangements and equipment and the nature of the cargo and of the emergency itself.

[4] Guidelines for voyage planning (IMO Resolution A.893(21)-Annex 25 of SOLAS Chapter V

.7 It is important for the master to 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 voyage or passage plan, introduces an unacceptable hazard to the safe conduct of the passage; and thus whether that section of the passage should be attempted under the conditions prevailing or likely to prevail.

During the analysis of the present investigation particular importance has been given to the above items in order to identify and analyze the factors that contributed to the grounding of M/V Goodfaith.

4.6.2 Meteorological Information

Meteorological information is a crucial part of the voyage planning and should always be taken into account while new and updated information received should be evaluated by the responsible crew members carrying out the watch.

At 07:53, Goodfaith's Inmarsat-C terminal printed the following weather report:

" (abstract)…….SECURITE

STORM WARNING ON METAREA 3

HELLENIC NATIONAL MET. SERVICE.

WARNING NR115-TUESDAY 10 FEBRUARY 2015/0930UTC

CENTRAL AEGEAN, KAFIREAS STRAIT, SOUTH EVVOIKOS

CONTINUING AT LEAST TO 11/04 UTC

NORT NORTH EAST 9 H (or) 10

Note. Please be aware: Wind gusts may be a further 40 per cent stronger than the average given here, and maximum waves may be up to twice the height….."

Subsequent weather reports received by the Hellenic National Meteorological Service at 1341, 1547, and at 2154 continued to repeat the storm warning. From the beginning of the voyage the weather conditions were reported to be bad with winds close to 7-8 bfrs and occasionally it was snowing. At the South Evvoikos area, after Steno Keas, weather conditions deteriorated with winds 9-10 Bfr as forecasted by the storm warning. It was also reported that the Master had not discussed the weather issue with the navigational Officers. The only actions that were taken to counteract the effects of the heavy weather conditions were to change to manual steering, reduce engine speed, set to "rough seas" mode and slightly alter the course so as to navigate with the sea at the port bow. There were times that storm winds of 50-60 knots force were recorded by the crew while the waves height was estimated to more than 7-8 meters.

It is inferred that the above contributed on the grounding of the vessel since the Master's decisions were not communicated or discussed thoroughly with the rest of the bridge team and the mates did not question them. One of such decisions was to proceed to the intended voyage despite the weather predictions and the vessel's draught, being confident that Goodfaith was in a sufficient ballast condition to overcome the encountering bad weather that was lying ahead. His belief was probably strengthened by the fact that until 00:05, when he left the bridge to rest, the vessel was making an acceptable steer to course despite the heavy pitching and rolling she was experiencing. It was only after that time, when unfortunately the Master was not on the bridge, that M/V Goodfaith got fully exposed to the open sea and the deteriorating weather conditions, which affected and caused the loss of her steering, ultimately forcing her to drift sideways towards the coast.

4.6.3 Steno kafireas strait

Goodfaith’s voyage plan projected on her navigational charts included standard passages that are followed by vessels coming or exiting from Piraeus, that is passing south-east of cape Sounio and then the Steno Kafireas heading North-East through the Central Aegean sea to reach Dardanelles strait. Her voyage included standard routings through sea areas of occasionally increased marine traffic that is crossing Nissos Kea and Nissos Makronissos strait and Steno Kafireas. An indicative general view of marine traffic at Goodfaith followed passage is demonstrated in Marine traffic density map (Figure 26) according to data from marine traffic service density maps statistics during the year of 2015.

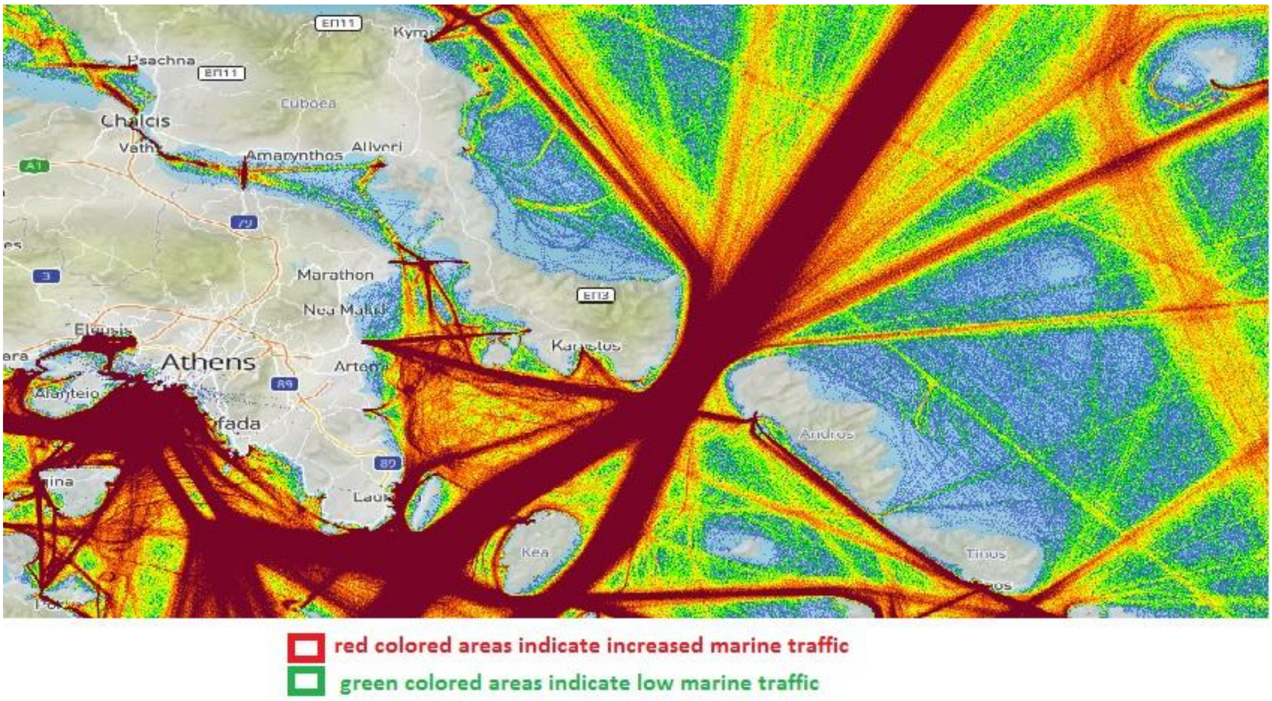


Figure 26: *Indicative marine traffic passing Kafireas strait to central Aegean sea (source Marine Traffic).*

The area of Kafireas strait is known for strong tidal and sea conditions that must be taken into account by all vessels when planning their passages through that area. Admiralty Sailing Directions[5] contain detailed guidance on safe navigation which include:

<u>General information:</u>

7.378. Steno kafirea (38^{o}00’ 00N 24^{o} 39’ 00E), the strait between Nissos Andros (7.3) and Nissos Evvoia (10.4), leads from the vicinity of 37^{o}53’ 00N 24^{o} 35’ 00E to 38^{o} 10’ 00N 24^{o} 50’ 00E about 21 miles NNE. The strait has a least width of 6 miles and is clear of dangers.

[5]NP 48, Mediterranean pilot vol.4, 16th Edition 2014

Topography

7.379. The NW coast of Nissos Andros is arid and rocky. The SE coast of Nissos Evvoia is wooded.

Natural conditions

7.380. **Local winds**. The N winds which prevail in the area, especially in summer, blow through the strait with exceptional force and persistence.

Sea conditions. Strong N winds raise a short steep sea which can be dangerous for boats.

Currents. The rate of the S-going current depends upon the direction and strength of the wind locally and over the Aegean sea as a whole. A rate from 2 to 3 knots is usual, but during strong N and NE winds, rates of 5knots or more may be attained. Small vessels and low-powered vessels NE bound may experience difficulty making progress against the current and the prevailing N wind. Onshore sets may be experienced on both sides of the strait.

Visibility. The NW end of Nissos Andros is frequently obscured by cloud and rain.

Principal Marks

7.381 **Landmarks.**

Nisida Mandilou Lighthouse (round tower and dwelling 11m in height) (37^{o} 55’ 86N 24^{o} 31’ 61E)

Akra Fassa Lighthouse (37^{o}57’ 92N 24^{o} 42’12E) (round tower on dwelling, 18m in height)

Akra Kafireas (38^{o}09’ 50N 24^{o} 35’ 20E)(7.382)

Major Lights

Nisida Mandilou Light –as above (Nisida Mandilou light is exhibited near the SE end of the islet.

Akra Fassa Light- as above.(Akra Fassa light is exhibited about 5 cables inland at an elevation of 201m.

Caution:

The NW coast of Nissos Andros between Akra Fassa and Ak Kampanos should be given a wide berth, especially by sailing vessels, owing to the strong S-going current which sets onshore.

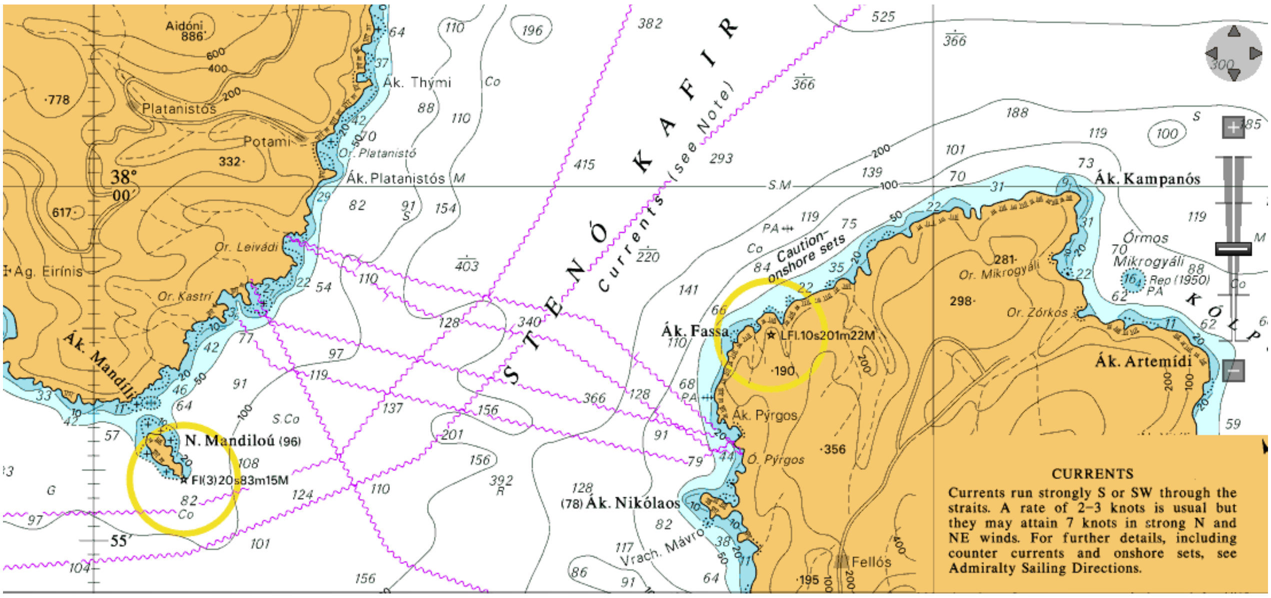


Figure 27: A general view of steno Kafireas nautical map with all navigational warning information presented.

On referred grounds it is suggested that the Master remained on the bridge to personally supervise the vessel's passage until she exited Kafireas strait since he was concerned, about the anticipated marine traffic at the area in addition to the prevailing bad weather conditions. After almost clearing Kafireas strait and heading to open Central Aegean Sea at midnight hours on the 11th of February 2015, he decided to go to his cabin to rest. Shortly before the Master left the bridge he ordered the OOW to follow a course of 30˚. Before this alteration the vessel was steaming with an average heading of 20˚ and an average COG of 30˚, that means that Goodfaith's actual course deviated 10˚ to the East. After the alteration of course to 30˚ the average COG was recorded to be approximately 50˚ for the first ten minutes and it was progressively increasing as shown in figures 6,7. Indicatively, at 0009 the heading was 33˚ and the COG was 100˚, while at 0026 the heading was 33˚ and the COG was recorded to be 105˚. That means that the actual course of the vessel deviated initially by 20˚ to the East and progressively reached approximately 70˚. However the increase of the vessel's actual course deviation after altering the heading to 30˚ was not observed and no further instructions were given by the Master to the OOW, regarding the monitoring of the vessel's heading in relation to the direction of the waves and the winds and the planned course.

In addition, while the vessel was proceeding towards the open sea of the Central Aegean, alteration of the direction of wind, waves and tidal streams should have been expected, as their parameters are affected by the south coast of Nissos Evvoia. Considering the navigational data of the S-VDR, it is suggested that as the vessel was exiting Steno Kafirea keeping a heading of 30˚, the wind and waves started hitting the vessel more sideways until a point where it was impossible to maintain her course and the OOW called the Master on the bridge.

Based on the above it derives that the increase of the actual course deviation after altering to 30˚ was not observed and the Master left the bridge without fully appraising the vessel's navigational behavior after exiting the Steno Kafireas and proceeding to the open Central Aegean Sea in order to provide sufficient instruction to the OOW regarding the monitoring of the vessel's actual course.

4.6.4 Navigational Charts -Monitoring of the passage plan

Paper charts were the primary means of navigation on board Goodfaith. The navigational Chart No. 1038 (Steno Sifnou to Steno Kafireas) of British Admiralty was used during the

night of the marine accident. The map was properly updated since it had been checked up to week 05/15.
Basic navigational practice when using paper charts as primary means of navigation requires the OOW to check the vessel's position on an regularly basis, and plot it on the chart in order to identify possible deviation from the planned course and proceed to necessary corrections.

Based on information derived from the investigation process and the vessel's SMS, the vessel's position had to be checked on a frequent basis by plotting GPS positions on the chart. When the vessel was navigating through a high risk area, and with the prevailing bad weather conditions, the ship's position should have been checked more frequently and recorded on the chart as well. The relevant SMS procedures under the title "safety of navigation" specifically stated that:

"…During the watch the courses steered, position and speed shall be checked at appropriate intervals, using the available navigational aids as necessary, to ensure that the ship follows the planned course…"

Additionally based on the SMS, Master's standing orders had been issued and posted on the bridge, which were also signed by all O(s)OW. According to those orders for coastal navigation it was stated that :

" *… the OsOW must verify position frequently, and pay particular attention to any possible set/ or drift. Beam bearings and distances off prominent marks to be noted in the chart and log book. All courses to be checked no matter by whom they were laid out…*"

The examination of the used paper chart showed that the vessel's positions, prior to the casualty were recorded on a frequent basis since 2100, when Goodfaith was entering the Kafirea strait, until almost 2400 during the changeover of the watch. In fact at 2400 the last vessel's position on the chart was recorded, almost 1½hours before her grounding. Similarly the last record of the vessel's position on the bridge log book was recorded at 2200 almost 3½ hours before her grounding. However as mentioned earlier, in the narrative part of the report (see Figure 7), the position obtained at 2400 was wrongly marked on the chart as Goodfaith at that time was actually located nearly 1,2nm Southwest of that point.

According to the available information there were no recordings on the used chart and in the bridge log book concerning the use of beam bearings and the calculation of the distances off prominent marks like the Akra. Fassa lighthouse, located in the North West tip of Andros island, either by means of utilizing the radar plotting aids or by other navigational method like parallel indexing.

Additionally no safety contours were planned in order to alert the O(s)OW about the maximum allowable deviation from the planned course of the vessel. Considering the wrong position fixing of 2400, which indicated a drift of 0.5 nm east from the planned course, it is suggested that the utilizing of the safety contours would have alerted the OOW to monitor the vessel's COG and to take appropriate actions to follow the planned course by altering the heading to port. This would have provided different navigational conditions while exiting the Steno Kafireas and would have decreased the applied yawing forces due to the wind and waves to the vessel's bow that after a point overcame the turning force of the hard to port steering and the vessel could not restore her 30˚ course.

In light of the above it derives that the disregard to standard navigational procedures, concerning the monitoring phase of the passage planning allowed the OOW to remain inactive for a period of time and it increased the potential to lose his continuous and accurate positional awareness.

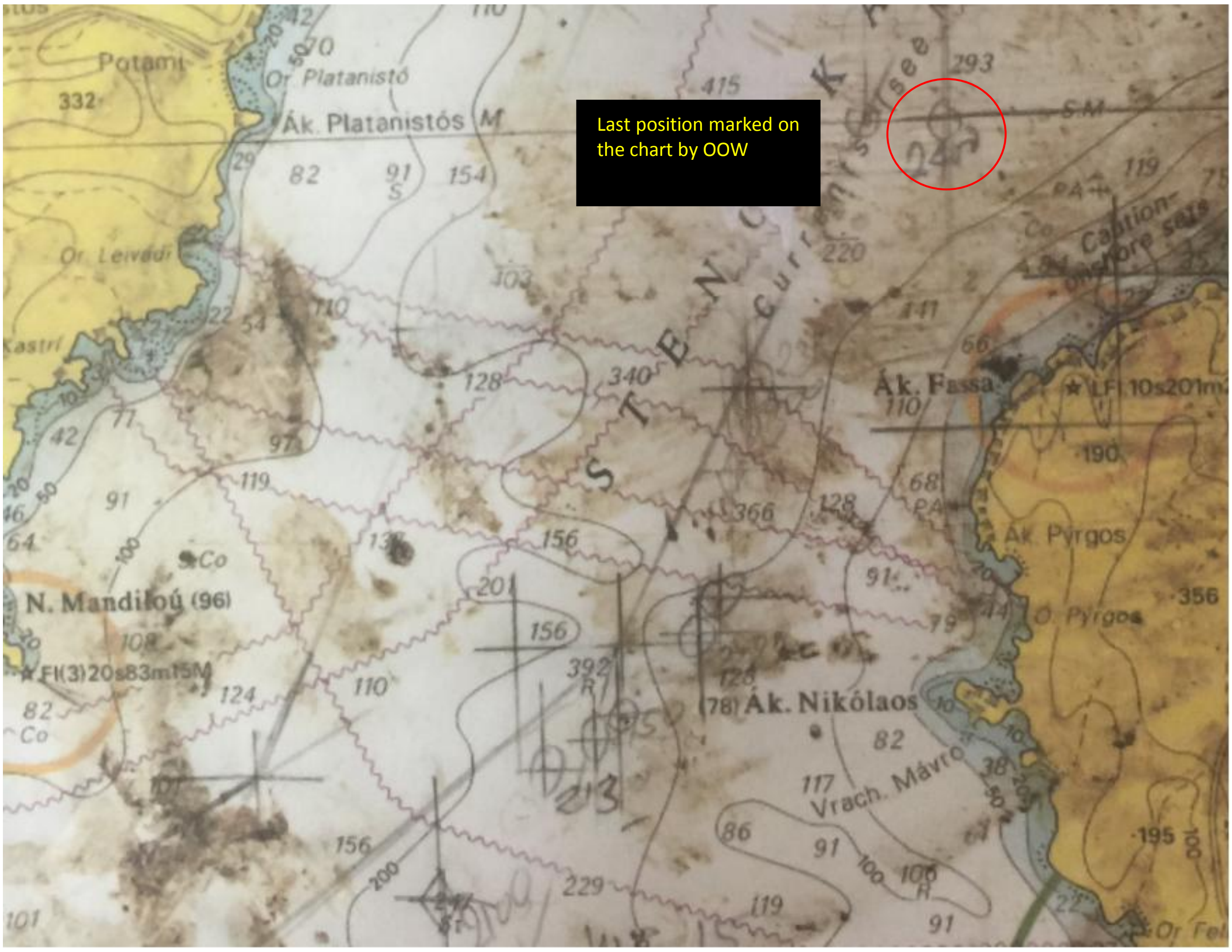


Figure 28: *View of the used paper chart where frequent vessel's positions are shown at 2100, 2130, 2150, 2229 2300 and the last (wrongly) recorded position at 2400 respectively.*

The above was verified through the analysis of the S-VDR (see table 3) data for the period from the changeover of the watch until a few minutes after the master returned on the bridge, at 0055, as can be seen also in Figure 29. The analysis of the data revealed that at least until 0050, when the vessel's heading started to increase significantly to starboard, and in fact never returned back towards the original course, the OOW had probably not realized that the vessel was drifting at such rate, despite the fact that the COG had already been increased, affected by the strong waves and winds, reaching a maximum of 105,2^{o} at 00:25':10''. When the Master ultimately arrived on the bridge, M/V Goodfaith was 2 nm away from the rocky coast of Andros island and had limited options to counteract to the evolving situation.

Time	HDG°	SOG(knots)	COG°
23:59	30	2,2	51
00:05	25	2,5	39
00:07	33	2,1	51
00:22	27	2,5	32
00:25	**37**	**2,2**	**105,2**
00:36	31	2.6	92
00:50	37	1,3	133
00:54	57	3,0	130
01:01	70	3,4	134
01:04	85	4,1	141

Table 3:*S-VDR data for the period from the changeover of the watch (0000) until a few minutes after 0100*

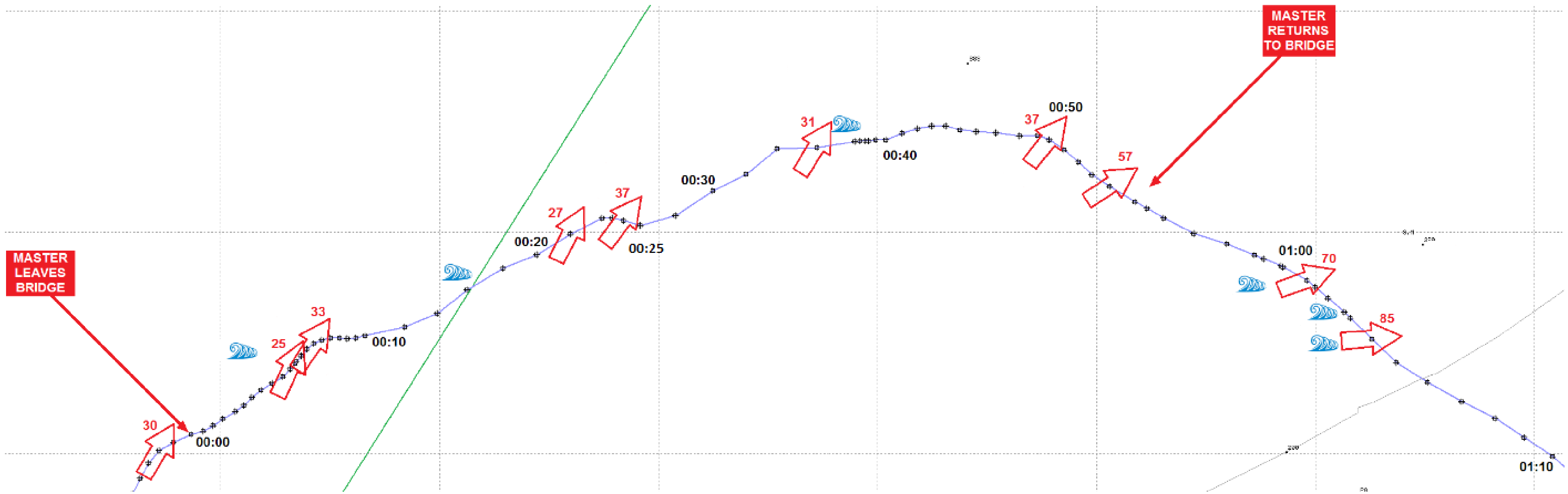


Figure 29: *Goodfaith's voyage plan (green line) and actual course (blue line) as plotted on the electronic chart for the period when the Master was not on the bridge. The red arrows and numbers indicate the vessel's HDG. The effect of the strong waves and winds to the vessel's drifting is also indicated by the blue wave icons, as their effect can be heard causing intense vibrations in the bridge (sourceS-VDR data).*

Had the OOW acknowledged the rate of the vessel's drift from the planned course and realized in time that the vessel was approaching the rocky coast he might have called the Master at an earlier stage on the bridge when additional actions could have been considered in order to avoid the grounding.

Moreover from the information derived during the investigation process, it was evident that during the appraisal of voyage planning there was no risk assessment carried out and no contingency plans were developed to take into account the prevailing bad weather conditions. It is perhaps easy to suggest that the master should have anchored up prior to entering the restricted waters, for example at the anchorage of Karystos bay which provides a good shelter when strong north winds prevail at stenos Kafireas and waited for the weather to ease. As stated there were no commercial pressures at play, so it was not really worth the risk to press on in a marginal weather.

4.6.5 Radars

Goodfaith was equipped with two 9 GHz radars which were fitted next to the console, with the option to work on the X-Band (9GHZ) or on the S-Band (3 GHz) scale. The "X" band, provides a higher resolution and a clear image because of its higher (9 GHz) frequency, and is mostly operated during day or night time under good weather conditions, usually at open sea and at 12nm range scale. The "S" band Radar, operating at 3 GHz, is mostly used during night time or under restricted visibility and in coastal passages or congested waters.

One of the installed radars on board was also featuring ARPA utilities including the "Guard Zones" function. Guard zones function offers the ability to the operator to customize zones acting as a shield to the vessel. If utilizing the function, when the unit receives radar returns inside the guard zone or a target enters the guard zone, visual and audible alarms are activated to alert the OOW in order to take actions as appropriate. In that way the "Guard Zones" are considered as an additional safeguard for a vessel's safe navigation to avoid the risk of collision or grounding.

According to the information provided, both radars were operating prior to the marine accident, one at 6nm range and the other at 12 nm range. It also emerged through the analysis of the S-VDR data that no audible alarms were heard on the bridge for almost 40 minutes before the captain arrived on the bridge at 0055 which leads to the conclusion that although all duty Officers were aware of the radar's utility, however they were not using it, despite the relevant procedures (Navigation officers on watch /relevant form P070409) which clearly stated that:

"……The Officer of the Watch should use the radar when appropriate and whenever restricted visibility is encountered or expected, and at all times in congested waters having due regard to its limitations. Whenever radar is in use, the Officer of the Watch should select an appropriate range scale, observe the display carefully and plot effectively. The Officer of the Watch should ensure that plotting or systematic analysis is commenced in ample time……."

Other clues that the vessel was not regaining the planned track were available. Had the 2ndOfficer correlated visual observations from the radar screen with the chart, it would have been readily apparent that the vessel's actual track was diverging away from the intended track. Radar parallel indexing techniques could also have been used to accurately monitor the vessel's position relative to track. The basic principle of this method is that a bearing line is being drawn, usually taken from a fixed object, parallel to the original course with a known and fixed perpendicular distance. The increase or decrease of this distance between the bearing line drawn parallel to the course and ship's position at any time will indicate a deviation from the initial planned course and thus advise the OOW if he is close to a navigational danger.

It is therefore suggested that had the radar features been utilized effectively, the 2nd Officer would have been alerted earlier regarding the vessel's drifting so he could identify the imminent grounding risk and proceed in due time to the necessary actions to counteract as explained in the previous paragraph or by calling the Master earlier, who could attempt a starboard circle turn, searching for a place of shelter and aborting the passage of the strait for that time.

The starboard turn would involve, for a period of time, approaching the coast rapidly. It would also involve moving the ship's stern through the wind. At the time the Master entered the bridge (0055), Andros NW coast was about 2 nm away and getting closer. The ship's maneuvering characteristics indicate that, in calm weather at full sea speed with the propeller running at 121rpm, the ship could make a turn in 700 m, in a normal ballast condition. However, in the extreme weather conditions at that distance from the rocky shore the attempted turn by the time the Master got onto the bridge was considered as a very high risk maneuver with little prospect of success,
On the above grounds, the followed practice of not utilizing all the available radar features is considered to have been a contributing factor in the marine accident.

4.6.6 GPS

GPS or other positioning systems enhance the safe navigation, namely by providing in accuracy the vessel's position. Moreover they offer a wide range of utilities in several display modes such as entering the planned routes and the waypoints.

They can also monitor the vessel's track on plotted routes and sound an audible alarm when the vessel is off course. Similar features could be utilized for approaching arriving points or waypoints. The audible alarm alerts the Duty Officer in order for him to take the appropriate actions.

The above GPS "off course" or "waypoint arrival" alarm features may be an additional safeguard for the vessel's safe navigation, assisting the OOW for his course monitoring duties.

According to information derived from the S-VDR audio data there was no "off course" alarm for the monitoring of the vessel's course approximately 40 minutes before the Master was called on the bridge. Said alarms, had they been set, would have sounded when the vessel's course deviated to the East of the planned course and when the vessel was approaching to the coast and Similarly to the radar features as analyzed in the previous paragraph, the 2ndOfficer would have been alerted and he would probably have proceeded to the appropriate actions at an earlier stage.
Apart from the above it is suggested that had the route monitoring feature of the GPS been set, the wrong position fixing on the nautical chart at 2400 could have been avoided, as the OOW would have noticed that it didn't correspond to the GPS indication and most probably he would act on this discrepancy.

The disregard to utilize the GPS "off course" alarms is suggested to have contributed to the examined marine casualty.

4.7 Heavy weather Ballast

In the normal light ballast condition, a ship's draught and trim should be sufficient to ensure that, in good weather, the propeller is fully immersed and slamming forward is prevented. To achieve these conditions in adverse weather with bigger waves, a deeper draught is necessary. One or more large cargo holds, usually near the mid-length of a large bulk carrier are, therefore, designated for heavy weather ballast. When the cargo hold is filled with ballast water, the ship becomes more manageable in adverse weather and thus it navigates safer. Goodfaith had her mid-hold (cargo hold no.3) designated for heavy weather ballast.

The deeper draught of a ship in a heavy ballast condition increases the propeller immersion. Consequently, engine power is used more efficiently because the propeller is more likely to remain fully submerged. When the propeller breaks out of the water in rough seas, not only does it not provide the same thrust as when it is submerged, it also draws down air with its blades which further reduces its efficiency. Moreover the engine is more prone to over-speed. At a deeper draught, the likelihood of the propeller breaking out of the water is reduced as well as the risk of structural damage by the forward slamming.

The vessel was in ballast condition with a forward draught of 3m and aft draught of 6.20m while the mid draught was calculated to almost 4,65m, and the vessel was trimmed by the stern. Forepeak tank was less than 50% filled (about 300m^3) while the aft peak tank was about 63% filled (about 115m^3).

On 10thFebruary 2015, Goodfaith's aft draught during her departure from Elefsis / Greece was about only 15 cm more than the minimum necessary to fully submerge the propeller in still water. In the heavy weather, even a 04 degree pitching would have exposed the entire 5.30 m diameter propeller at times. Had the aft peak tank been full, the ship's increased aft draught would have had a better effect to the propeller's operation, considering the prevailing conditions.

The minimum forward draught specified in the ship's stability book could not be provided by the ship's Managing Company after the casualty[6]; however it was estimated to have been approximately 6.50 m. On this ground it derives that the ship's forward draught of 3.00 m was not sufficient to prevent the ship's forward slamming. The heavy weather ballast draught also were not provided by the ship's Managing Company[8], however it was estimated to have been deeper than 7.00 m for even keel condition, and it would have reduced the negative effects of the stormy weather to the ship's maneuverability.

Reduced windage surface at a deeper draught is also considered a significant factor. Strong winds exert large forces on the hull and superstructure and, when underway, these forces have a significant effect on a ship's true course and her maneuverability.

The wind force may be calculated using the following Air Resistance Formula[7]:

$$F = \frac{\rho C_D A}{2} v^2$$

Taking into account certain assumptions and roundings regarding the air density and the drag coefficient[8] which are used in the abovementioned formula, an approximation of the

[6]Critical information regarding the ship's stability in various conditions as well as data relevant to her "Heavy Weather Ballast" condition were not provided to HBMCI by the ship's Managing Company after the casualty.

[7]The wind force **F**(unit for this force is Newtons) depends on the density of the air (**ρ**, unit: kg/m^3), the exposed area (**A**, unit: m^2) of the vessel, the relative velocity between the vessel and the wind (**v**, unit: m/sec), and the "drag coefficient"(**C_D**, unitless) that accounts for other properties such as the surface roughness, the turbulence etc.

[8] $\rho \approx 1.2$kg/m^3, $C_D \approx 0.9$

wind force, in tones, may be calculated by the following simple formula, which appears in most ship-handling manuals and is usually used onboard ships:

$$W = \frac{Av^2}{18000}$$

Where W is the wind force in tones, A is the area exposed to the wind in m², and v is the relative wind speed in m/sec. It is important to note that the force varies as the square of the wind speed. Therefore, αsmall increase in wind speed can be translated into large increase of the wind force. On this ground, it derives that wind gusts, which may reach 40% stronger than the average, amplify the applied force significantly.

On 10thFebruary 2015, Goodfaith's windage surface, when the ship was facing the wind, was about 600 m² and with the wind abeam, it was about 2070 m². Had the ship's no 3 cargo hold been fully ballasted for heavy weather, the additional 8,096 tones of ballast would have increased the mean draught significantly and would have reduced the windage areas accordingly. It is estimated that at a 7.00 m even keel draught, the windage areas would have been reduced to approximately 490 m^2 (facing the wind) and 1800 m^2 (with the wind abeam), respectively. The table below shows the estimated wind forces for the ship with the figures in bold for reduced windage in a heavy ballast condition.

Wind speed		knots m/sec	40 20,6	45 23,2	50 25,7	55 28,3	60 30,9
Force (relative wind ahead)	with A=600 m^2	tonnes	14,15	17,94	22,02	26,70	31,83
	with A=490 m^2	tonnes	**11,55**	**14,65**	**17,98**	**21,80**	**25,99**
Force (relative wind abeam)	with A=2070 m^2	tonnes	48,80	61,90	75,96	92,10	109,80
	with A=1800 m^2	tonnes	**42,44**	**53,82**	**66,05**	**80,09**	**95,48**

Table 4: *Estimated wind forces for the ship with the figures in bold showing the forces for reduced windage (in a heavy ballast condition).*

The lower wind forces due to reduced windage at the deeper heavy weather ballast draught, combined with the increased propeller immersion, can significantly improve the control of a ship. The greater underwater hull area at a deeper draught offers more resistance to waves thus reducing rolling and pitching. The reduced movement of the ship further increases the likelihood of the propeller remaining submerged.

It is a good practice to ballast the cargo hold while in port as when it is performed at sea due to the ship's motion the sloshing of the ballast water in a partially filled cargo hold magnifies the dynamic internal forces on the hold's boundaries and also can cause the loss of the vessel's stability.

Ballasting of cargo hold is a shipboard operation that requires certain amount of time and preparation and at sometimes may conflict with the vessel's commercial schedule and obligations. A practical guidance for Masters and companies for the ballasting of cargo hold provides:[9] :

- The hold should be washed or, failing that, swept. Before a ballast hold is ballasted the ballast line must be unsealed and the bilge line and CO_2 injection line must be sealed.

[9]Bulk carrier practice, Second edition, published by the Nautical Institute

- Any sweepings or rubbish which could block the ballast suction must be removed from the hold.
- If time permits and the next cargo will or may require a high standard of cleanliness, the hold should be meticulously cleaned.
- If there is insufficient time to clean the hold thoroughly or if the ballast water is dirty, there may be an opportunity to deballast the hold and clean it during the voyage, refilling with clean sea water thereafter if necessary and always in good weather conditions.
- If there is no opportunity to clean the hold at sea and a clean hold is required quickly in the loading port, the crew can usually commence hosing down the open hold from deck level whilst the ballast is still discharging and can enter the hold to continue washing down when the water level reaches 30-40 cm over the tanktop.
- When the ballast has been discharged and washing down, if required, has been completed, a fresh water rinse will be required for cargoes which require holds which are free of salt. On completion of washing and rinsing, the bilge suction and CO_2 injection must be opened and tested and the ballast suction must be blanked off.
- Sufficient time to complete these tasks must be provided in the loading plan.

During the investigation process it was stated that during the period of the vessel's stay at Elefsis port and before departure, there was no time to prepare cargo hold No.3 from previous cargo (sugar) for ballasting, since dry dock surveys were carried out continuously and were just concluded the previous day. Additionally it was calculated that it would require approximately 16 hours more to fill the relevant ballast hold, after washing or sweeping had been finished. The use of the vessel's dedicated ballast pump with a capacity of 500m3/h was considered, to fully ballast the 7899m3, No.3 cargo hold.

On or before arrival at the loading port of Odessa, the cargo hold should had empty to be ready for loading which would mean further delay for the vessel before loading her next cargo. Finally, the option of preparing the cargo hold and ballasting it during the voyage was rejected, due to the anticipated bad weather conditions.
In light of the above it is concluded that the insufficient ballast condition of M/V Goodfaith had reduced her maneuverability during the prevailing stormy weather conditions and is considered as a contributing factor to the examined marine casualty. Additionally commercial time constraints and environmental factors had not permitted the ballasting of the vessel after dry dock surveys had been concluded, and are also considered as a contributing factor to the marine casualty.

4.8 Courses followed by other vessels

As mentioned in the narrative part of the report Goodfaith's original planned course in the chart was 26^{o}. However following Master's orders at 1735 the steering was set to manual and the course was altered in order to steam with the sea at the port bow and lessen the effects of the high waves pounding on the ship from the north, whereas shortly before the Master left from the bridge at approximately 0005 he ordered the 2ndOfficer to maintain that course.
The courses of two other vessels that crossed Steno Kafireas strait approximately after two hours of Goodfaith's passage were also extracted from the Integrated Marine Data Environment in an attempt to evaluate their courses. The purpose was to examine their maneuverability and control of their steerage in comparison to Goodfaith. Based on the aforementioned data, the course of M/V Goodfaith was projected on an electronic chart, in comparison to the courses of the other vessels. An overview of the plotted positions is presented in the following figures:

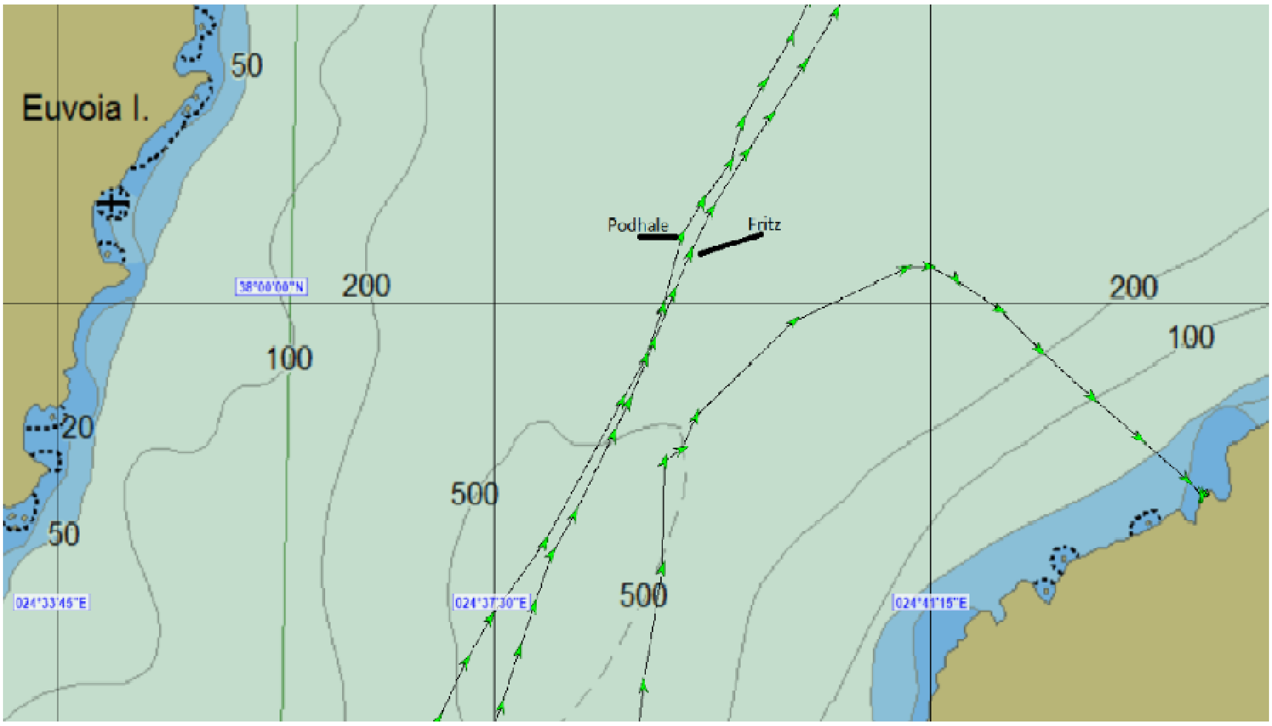


Figure 30: An overview of the other two vessels' courses in relation to Goodfaith's course as extracted from AIS information system (source IMDatE).

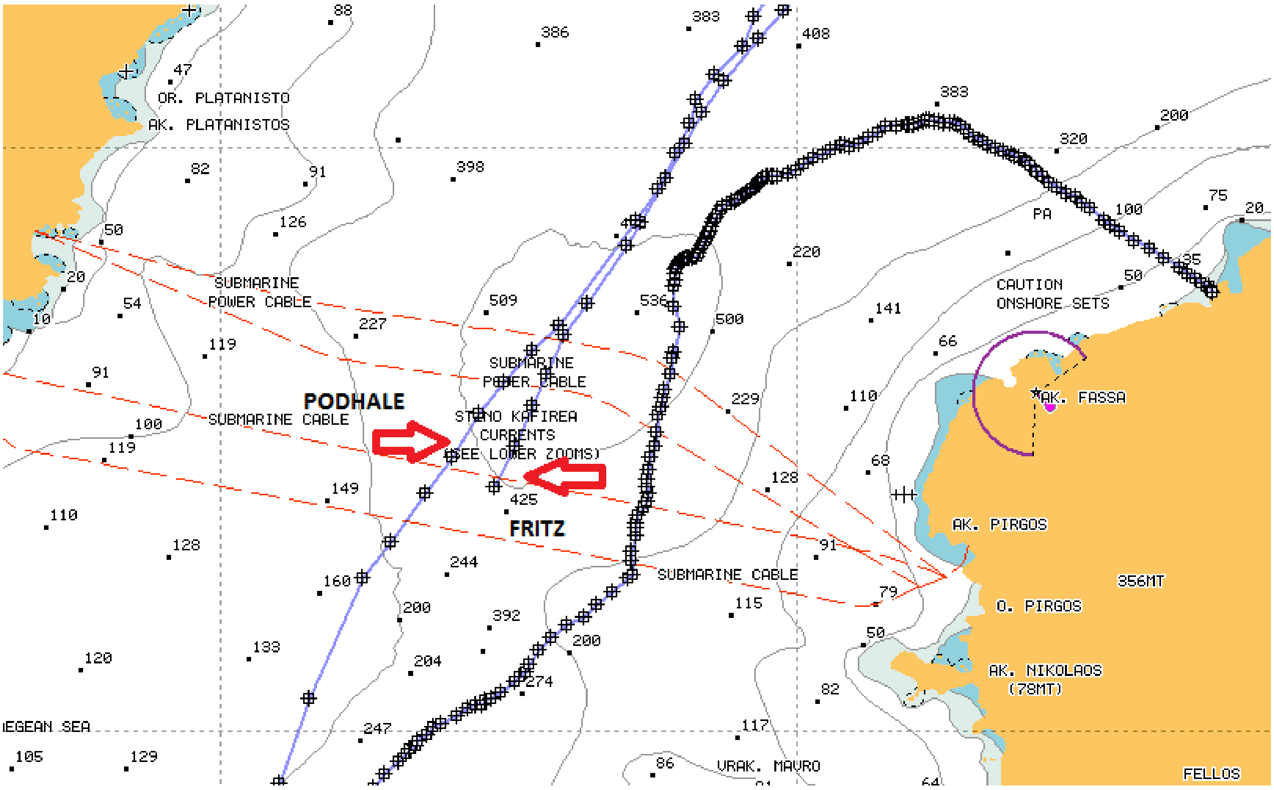


Figure-31: An overview of the other two vessels' courses in relation to Goodfaith course as plotted in the electronic chart (source HBMCI).

According to the information collected during the investigation process it derived that both vessels were Bulk Carriers of similar size with Goodfaith[10], and were navigating in ballast condition. Nonetheless, it could not be verified if they were in heavy ballast condition. Comparing their courses with the course of Goodfaith in the chart, it was evident that both presented a better maneuverability and control of their steerage so ultimately they were able to maintain their original course despite the severe weather conditions. Moreover it is evident that both vessels were able to keep a steady course in relation to Goodfaith and this enabled them to successfully pass the strait.

4.9 Master's Night Orders

The Night Orders are a supplement to the Standing Orders that come into force as the Master proceeds to take rest during the night. The Standing Orders are in force at all times whereas the Night Orders add specific points to the Standing Orders. The Master writes his orders every night to the Night Order Book, with specific regard related to the existing conditions. The OOWs should check the Night Order Book for the Master's specific orders and sign it.

As already mentioned in paragraph 4.6.5 Master's Standing orders had been issued on board and signed by all O(s)OW. Supplementary night orders had also been issued for the voyage from Elefsis to Odessa which specifically stated the following:

1. *Follow Muster and bridge standing orders*
2. *Check your gyro and magnetic error every watch*
3. *Maintain a proper sharp look out*
4. *Give a wide berth to any meeting vessel*
5. *Don't leave the bridge unattended, don't stay long time on chart*
6. *Check for any weather message*
7. *Maintain a moving patrol every watch*

These night orders had not been signed by the Chief Officer and by the 2nd Officer during his 0000-0400 watch**.** The aforementioned orders do not provide any specific guidance with regard to navigation under the prevailed weather conditions and the need to follow additional measures such as effective monitoring of the vessel's course using the available means as already described in the previous paragraphs or of the vessel's drift from the planned course. The only instruction that the Master gave to the 2^{nd} Officer , before he went to rest at 0005, was to maintain the 030^{o} course.
As regards the verification of the vessel's position during coastal navigation, the term *"frequently"* referred to the Master's standing orders was not defined in the night orders by specifying the time intervals of the position fixing. Under these conditions it is inferred that the monitoring of the vessel's position was left upon the OOW experience and personal judgment and therefore position fixings were not projected on the navigational chart during the critical period when the vessel was drifting south-east from the planned course towards the north coast of Andros.

The lack of specific instructions in the Master's Night Orders Book with regard to the existing environmental conditions while exiting Steno Kafireas is considered as a contributing factor to the examined marine casualty.

[10]Bulk carrier Ludogorets IMO 9415155 (Ex. Fritz) GT:20491, DWT:29618, Length:190m

Bulk Carrier PODHALE IMO 9285134 GT:24109, DWT38056, Length:190m

4.10 Safety Management System (SMS)

In pursuance to ISM Code Chapter 7 “Shipboard operations”, procedures, plans and instructions, including checklists, as appropriate, should be established by the Company concerning the personnel’s and ship’s safety and the protection of the environment. The various tasks should be identified and assigned to qualified personnel.

On the above ground, the bridge organization should be properly supported by a clear navigation policy incorporating shipboard operation procedures, in accordance with the company’s safety management system onboard ships as required by the ISM Code.

4.10.1 Navigation Officers at watch-Navigation in bad weather

Following the ISM provisions stated in the previous paragraph, navigation watch and bridge watch hand over procedure especially in bad weather conditions had been incorporated to vessels’ SMS under relevant procedures (Navigation officers on watch-Form No.P070409, Navigation in bad weather – Form No.P070405). Said processes were mainly focusing on navigational aspects required to be controlled and evaluated by the duty Officer, as quoted below:

“The relieving Officer should not take over the watch until his vision is fully adjusted to the light conditions and he has personally satisfied himself regarding:

- *a) standing orders and other special instructions of the Master relating to the navigation of the ship.*
- *b) position, course, speed and draught of the ship.*
- *c) prevailing and predicted tides, current, weather, visibility and the effect of these factors upon their course and speed.*
- *d) navigational situation, including but not limited to the following:*
  - *i) operational condition of all navigational and safety equipment being usedor likely to be used during the watch:*
  - *ii) errors of gyro and magnetic compasses;*
  - *ii) presence and movement of ships in sight or known to be in the vicinity;*
  - *iv) conditions and hazards likely to be encountered during his watch;*
  - *v) possible effects of heel, trim, water density and squat on underkeel clearance*

Radar :

.14. Whenever radar is in use, the Officer of the Watch should select an appropriate range scale, observe the display carefully and plot effectively.

17. The Officer of the Watch should ensure that plotting or systematic analysis is commenced in ample time.

Navigation in coastal waters:

19. The largest scale chart on board, suitable for the area and corrected with the latest available information should be used. Fixes should be taken at frequent intervals; whenever circumstances allow, fixing should be carried out by more than one method.

Additionally a heavy weather checklist with a list of actions to be taken in case of bad weather was also included stating the following:

"...1) Steering is checked to be in manual.
2) Master is notified.
3)The Engineer Officer is informed of the anticipated heavy weather.
4)Course and speed are verified to be the appropriate ones for the prevailing or anticipated weather conditions.
5)All free objects are checked to be lashed / secured and all ports closed.
6)Crew is informed of the heavy weather and advised to avoid open decks.
7)"SAFETY LINES" / "MAN ROPES" are placed, where needed.
8)Vessel's meteorological instruments are checked regularly and meteorological reports are received more frequently.
9)Own meteorological report or danger messages are transmitted to stations in the area..."

As already stated, the lack of utilizing the available features of the navigational equipment (alarms, warning settings, guard zones etc of GPS and Radar) are considered to have contributed to the drifting of the vessel south-east of the planned course without any actions taken by the 2nd Officer.

Considering the above, it is suggested that the navigational / watch hand over procedure implemented on board Goodfaith and the heavy weather checklist were not incorporating specific instructions to the Master and the navigational Officers for the operational use of the navigational and safety equipment on the bridge, as for example the setting of the alarm or warning features of the main navigational equipment (Radars, GPS) or the setting of the position fixes intervals or even the possibility to examine a heavy weather ballast voyage under extreme weather conditions. Consequently these actions were left up to the Master's and O(s)OW discretion and experience.

The lack of specific instructions in the vessel's SMS for navigation in bad weather conditions is considered as a contributing factor in the marine accident.

4.11 Bridge resource management

BRM is the effective management and integration of all resources, human and technical, available to the bridge team, to navigate the vessel in a safe and efficient manner. BRM principals, introduce an important aspect for Masters and Officers in charge of navigational watch. Optimized bridge resource management shields safe navigation by fully utilizing all the technical advantages of bridge navigational equipment, maintaining the positional awareness of the watch keeping Officers as well as appropriate communication and exchange of information at all levels of the bridge team.

More specifically, under STCW Code/Part A/Chapter VIII/Part 3 *"Watch keeping Principles In general"* the Bridge Resource Management principals have been introduced, while Chapter VIII/Part 4-1 have laid down a set of mandatory *"principals to be observed in keeping a navigational watch"*.

Aforementioned provisions incorporate instructions to ensure that Masters take all the appropriate actions for the bridge watch arrangement and management, and the Navigational Officers perform their duties effectively. To that end the bridge team is assisted for the command decision making and possible failures or "single man errors" are blocked and counteracted to avoid or lessen consequences of a likely to occur marine accident.

An abstract of the STCW provisions, as numbered in the respective parts of the Code, is presented in below table 5.

STCW Code Part A/Chapter VIII/Part 3
Watch keeping Principles In general
8. Watches shall be carried out based on the following bridge and engine-room resource management principles:
.1 understanding of watch keeping personnel regarding their individual roles, responsibility and team roles shall be established;
.2 the master, chief engineer officer and officer in charge of watch duties shall maintain a proper watch, making the most effective use of the resources available, such as information, installations/equipment and other personnel;
.3 understanding of watchkeeping personnel regarding their individual roles, responsibility and team roles shall be established;
.4 the master, chief engineer officer and officer in charge of watch duties shall maintain a proper watch, making the most effective use of the resources available, such as information, installations/equipment and other personnel;
.7 information from the stations/installations/equipment shall be appropriately shared by all the watchkeeping personnel;
.8 watchkeeping personnel shall maintain an exchange of appropriate communication in any situation; and
.9 watchkeeping personnel shall notify the master/chief engineer officer/officer in charge of watch duties without any hesitation when in any doubt as to what action to take in the interest of safety.
STCW Code Part A/ Chapter VIII/Part 4-1
Watch keeping at sea / *Principles applying to watchkeeping generally*
9. Parties shall direct the attention of companies, masters, chief engineer officers and watchkeeping personnel to the following principles, which shall be observed to ensure that safe watches are maintained at all times.
10. The master of every ship is bound to ensure that watchkeeping arrangements are adequate for maintaining a safe navigational or cargo watch. Under the master's general direction, the officers of the navigational watch are responsible for navigating the ship safely during their periods of duty, when they will be particularly concerned with avoiding collision and stranding.
Watch arrangements
18. When deciding the composition of the watch on the bridge, which may include appropriately qualified ratings, the following factors, *inter alia*, shall be taken into account:
.2 weather conditions, visibility and whether there is daylight or darkness **.3** proximity of navigational hazards which may make it necessary for the officer in charge of the watch to carry out additional navigational duties; **.4** use and operational condition of navigational aids such as ECDIS, radar or electronic position **.5** indicating devices and any other equipment affecting the safe navigation of the ship;
Taking over the watch
21. Prior to taking over the watch, relieving officers shall satisfy themselves as to the ship's estimated or true position and confirm its intended track, course and speed, and UMS controls as appropriate and shall note any dangers to navigation expected to be encountered during their watch.
22. Relieving officers shall personally satisfy themselves regarding the:
.1 standing orders and other special instructions of the master relating to navigation of the ship;
.2 position, course, speed and draught of the ship;
.3 prevailing and predicted tides, currents, weather, visibility and the effect of these factors upon course and speed;
.5 navigational situation, including, but not limited to: .5.4 the conditions and hazards likely to be encountered during the watch;
Performing the navigational watch
25. During the watch, the course steered, position and speed shall be checked at sufficiently frequent intervals, using any available navigational aids necessary, to ensure that the ship follows the planned course.
31. A proper record shall be kept during the watch of the movements and activities relating to the navigation of the ship
37. The officer in charge of the navigational watch shall use the radar whenever restricted visibility is encountered or expected, and at all times in congested waters, having due regard to its limitations.
39 Whenever radar is in use, the officer in charge of the navigational watch shall select an appropriate range scale and observe the display carefully, and shall ensure that plotting or systematic analysis is

commenced in ample time
40 The officer in charge of the navigational watch shall notify the master immediately:
.3 if difficulty is experienced in maintaining course;
Coastal and congested waters
47. The largest scale chart on board, suitable for the area and corrected with the latest available information, shall be used. Fixes shall be taken at frequent intervals, and shall be carried out by more than one method whenever circumstances allow. When using ECDIS, appropriate usage code (scale) electronic navigational charts shall be used and the ship's position shall be checked by an independent means of position fixing at appropriate intervals.

Table 5. STCW basic applicable standards.

Considering the above in relation to paragraphs 4.6.2, 4.6.3, 4.6.4, 4.6.5 and 4.6.6 it emerged that certain functions, as foreseen and emanate through STCW Code applicable standards, were not followed by the Master and the watch keeping personnel.

Planning is essential if BRM is to be effective. Priorities must be set, acceptable limits defined and tasks delegated to each team member. Monitoring the progress of the plan is necessary in order to detect and challenge deviations from it, so that errors can be corrected early. Therefore, if the state of the bridge is optimal and the Master has adequate support, the team can effectively execute the plan.

The bridge team of Goodfaith did not employ in full the recognized BRM techniques. No specific procedures or instructions were presented pertaining to the utilization of the features offered by the bridge equipment and the navigational aids available for use (Radar, GPS), by which safeguards could be set for assisting and ensuring safety of navigation. The master's standing orders posted on the bridge, in a standard format copied from the ship's SMS, made no mention of BRM related checks and nothing in the orders encouraged the use of recognised BRM techniques such as challenge and response.

Taking into account the aforementioned it is concluded that instructions and procedures were not in place for an effective Bridge Resource Management on board. Had Goodfaith bridge navigational equipment been utilized effectively by the watch-keeping Officers, it is highly possible that the 2nd officer on the watch would had monitored the vessel's position effectively and would be alerted on time to take prompt actions such as calling the Master earlier, providing more time to examine alternative options of avoiding the grounding.

The poor bridge resource management in relation to technical resources and bridge team communication are considered to have been a contributing factor to the examined case.

4.12 Fatigue[11]

The Maritime Labour Convention and the STCW Convention have tackled the subject of resting periods of seafarers as lack of resting hours has been considered one of the main factors leading to marine accidents. The most common causes of fatigue are lack of sleep, poor quality of rest, stress and excessive workload.

"Fatigue factors in manning and Safety" have been emphasized and have called the attention to stakeholders of maritime transports by IMO Resolution A. 772(18)[12] adopted

[11]**Fatigue** definition as found in IMO's MSC/Circ.813/MEPC/Circ.330:
"A reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance", leading to degradation of human performance.

[12]Res. A. 772 (18) provisions pertain to manning levels:
1 INTRODUCTION

on the 4th of November 1993. Said Resolutions set outs the basic factors that should be taken into account in making operational decisions.

4.12.1 Master's fatigue[13]

As already stated, the Master had decided to remain on the bridge the whole time from the start of the voyage until approximately 0005 on the 11th of February 2015. Then he left the bridge and went to the mess room to have dinner. He went to his cabin to rest until approximately 0045-0050 when he was called and arrived back on the bridge at 0055. Consequently, since waking up at approximately 0730 on the morning of 10th February, he had had no rest and remained awake for almost 17 hours.

The lack of sleep or the poor quality of rest are attributed to be main factors that result in fatigue and exhaustion, which have a direct negative impact on an individual's performance both physically, emotionally and mentally, such as in decision-making, response time, judgment and so forth. Fatigued individuals become more susceptible to errors of attention and memory. For example, it is common for fatigued individuals to omit steps in a sequence of actions or acting under a state of stress. Therefore, it is likely that the Master's ability to make appropriate decisions under fatique was compromised.

Considering the above the Master's decision to leave the bridge at 0005, can reasonably be explained, apparently due to the fact that he was tired, but most importantly before the vessel had cleared the strait, without assessing properly the vessel's course at the open sea or without giving clear instructions to the navigation Officer for monitoring the vessel's passage, with the new ordered course of 30^0 under the prevailing bad weather conditions.

Additionally according to the information collected from the VDR recordings, there were clear indications that the Master was acting under a state of stress. At least the last 30 minutes of the vessel's passage, the Master realizing the difficult situation at hand and his limited options, he repeatedly communicated with the steering gear room ordering a hard to port steering, despite the fact that rudder was confirmed as being at that position, nevertheless the vessel was not heading back to course. The howling wind, sea spray and the ship uncontrollably approaching the rocky coast would have made the unmanageable situation even more stressing for him.

1.1 The purpose of this document is to provide a general description of fatigue, to identify the factors of ship operations which may contribute to fatigue, and to classify those factors under broad categories to indicate the extent to which the factors may be related.
1.2 The objective is to increase awareness of the complexity of fatigue and to encourage all parties involved in ship operations to take these factors into account when making operational decisions.

2 GENERAL DESCRIPTION OF FATIGUE

2.1 Fatigue results in the degradation of human performance, the slowing down of physical and mental reflexes and/or the impairment of the ability to make rational judgments.
2.2 Fatigue may be induced by factors such as prolonged periods of mental or physical activity, inadequate rest, adverse environmental factors, physiological factors and/or stress or other psychological factors.

4.1 Management ashore, aboard ship, and also the responsibilities of Administrations

4.1.1 The prevention of fatigue in the areas of scheduling of shipboard work and rest periods, manning levels, watchkeeping practices and assignment of duties could largely be accomplished by sensible shore-based management and on-board management techniques. It is also recognized that Administrations have an equally important role to play with respect to legislation leading to acceptance, implementation and enforcement in those areas covered by international conventions. Guidelines and provisions should take into account the relationships between work and rest periods to ensure adequate rest. These considerations should include a review of the voyage length, length of port stay, length of service of individual crew members, periods of responsibility and watchkeeping practices.

4.1.2 It is essential that management should provide clear, concise written policy guidance to ensure that ships' crews are familiar with ships' operational procedures, cargo characteristics, voyage length, destination, internal and external communication practices and ship familiarization procedures.

4.3 Crew-specific factors

4.3.1 Thoroughness of training is considered to be important in the prevention of fatigue. Fitness for duty, including medical fitness, proper working experience and the qualifications and quality of crew members are also considered important in this context.

[13] References based on MSC/Circ.1014 (12-06-2001) Guidance on fatigue mitigation and management

Taking into account the aforementioned it derives that Master's performance was also affected by his fatigue which was accumulated progressively during his stay at the bridge.

4.13 Other Potential Causal and Contributing Factors

It is clear that the magnitude of the breaking sea alone and the effect of storm winds up to force 10 were sufficient to cause the grounding of Bulk carrier Goodfaith. However, the investigation explored a variety of other potential causal and contributory factors. These included the loss of engine power or propulsion and steering control.

After examining the records of the renewal surveys covering all statutory certificates, completed at that time, including hull and machinery items necessary to maintain her class, main engine propulsion or steering gear failures have been discounted as alternative explanations for the course changes and the heavily drifting of the vessel towards the North West Coast of Andros Island. All machinery equipment had the previous days been surveyed by the Class and had not suffered any failures since, and the crew members reported that they had carried out all the required pre-departure tests, including test of the main engine ahead and astern, steering gear tests etc., which also were recorded in the Bridge log book as per relevant SMS requirements.

The only outstanding recommendation associated with the navigation equipment concerned the speed log of the radar plotting aid which was found that was beyond repairs. Subject to flag's administration approval relevant item has been postponed not later than the vessels next docking survey14. Consequently the vessel's radar was clearly marked to inform the Master as well as the bridge officers about the current status of the equipment (Figure 32) .

[14] According to flag administration authorization, as referred to NKK survey record No. 15PR0036 dated 09/02/2015 speed log is to be repaired/renewed as necessary not later than next docking survey on 08 February 2018 subject to the following conditions

- The vessel is fitted with two GPS
- The radar plotting aid shall be clearly marked to inform master/officers on watch that speed and distance through the water is not showing actual conditions.
- The vessel is not under Port State Control detention.

Figure 32: Vessel's radar equipment marked with note that speed and distance through the water is not showing actual conditions.

Conclusively and bearing in mind that no additional information was received during the investigation process, concerning the vessel's condition, it is excluded that the grounding of Bulk Carrier Goodfaith can be attributed to a possible failure of the vessel's machinery or associated navigational equipment.

5. Conclusions

The following conclusions, safety measures and safety recommendations should not under any circumstances be taken as a presumption of blame or liability.
The juxtaposition of these should not be considered as an order of priority or importance.

1. The Master had remained at the bridge from the start of the voyage until 0005 when Goodfaith had almost cleared the strait. The Master remained on the bridge to personally supervise the vessel's passage through Kafireas strait since he was clearly concerned having in mind the usual marine traffic in those areas and the prevailing bad weather conditions. However for the most part of the watches the officers had little input or interaction with the Master apart from responding to his orders. (§4.3.1, 4.6.3).
2. The Master's decisions were not communicated or discussed with the rest of the bridge team and the Mates did not question them as the Master seemed confident that Goodfaith was in a sufficient ballast condition to overcome the encountering bad weather that was lying ahead.(§ 4.6.2).
3. The only actions that were taken to counteract the effects of strong pitching and rolling, that the vessel was facing was to change to manual steering, reduce engine speed and change of course so as the waves to face the ship at the port bow.(§4.6.2).

4. The available navigational information, as presented in the nautical chart used on board and described in the relevant guidance of the admiralty sailing directions had not been appraised sufficiently by the Master and the OOW. (§4.6.3).
5. The Master left the bridge without fully appraising the vessel's navigational behavior after exiting the Steno Kafireas and proceeding to the open Central Aegean Sea in order to provide sufficient instruction to the OOW regarding the monitoring of the vessel's actual course. Consequently the increase of the actual course deviation was not observed (§4.6.3).
6. A disregard of standard navigational procedures concerning the monitoring phase of the passage planning allowed the OOW to remain inactive for a period of time and increased the potential to lose his continuous and accurate positional awareness(§4.6.4).
7. The analysis of the S-VDR data had revealed that at least until 0050, when the vessel's heading started to increase to starboard, and in fact never returned back to the original course, the OOW had not realized that the vessel was drifting affected by the strong waves and winds, despite the increase of COG. When Master had ultimately arrived on the bridge, M/V Goodfaith was 2 nm away from the rocky coast of Andros island. (& 4.6.4).
8. Had the OOW acknowledged the rate of the vessel's drift from the planned course and realized in time that the vessel was approaching the rocky coast he would have called the Master at an earlier stage on the bridge where other appropriate actions could have been considered in order to avoid the grounding (§4.6.4).
9. There was no risk assessment carried out and no contingency plans were developed to take into account the prevailing bad weather conditions. (§4.6.4)
10. The followed practice not to utilize all the available radar features is considered to have been a contributing factor in the marine accident. (&4.6.5).
11. The disregard to utilize the GPS "off course" alarms is suggested to have contributed to the examined marine casualty (§4.6.6).
12. The insufficient ballast condition of M/V Goodfaith, under the prevailing bad weather conditions is considered a contributing factor to the examined marine casualty.(§4.7).
13. The lack of specific instructions in the Master's Night Orders concerning the frequency of the vessel's position fixing during the watch is considered as a contributing factor in the marine accident.(§4.9).
14. The lack of specific instructions in the navigational watch/hand over procedure and in the navigation in bad weather is considered as a contributing factor in the marine accident. (§4.10.1).
15. The poor bridge resource management in relation to technical resources and bridge team communication is considered to have been a contributing factor to the examined case.(§4.11).
16. The Master's performance was also affected by fatigue that was accumulated progressively during his stay at the bridge. (§4.12.1).
17. There was no evidence to suggest that possible failure of vessel's equipment contributed to the grounding. (§4.13)

6. Actions Taken

There was no information provided by the managing company concerning actions taken after the examined marine casualty.

7. Safety Recommendations

Taking into consideration the analysis and the conclusions derived from the safety investigation conducted, the following recommendations are issued:

7.1 The Managers of Goodfaith are recommended to:

45/2015 Take effective action fleet wide to ensure that, during the appraisal phase of voyage planning, under heavy weather conditions, Masters perform a risk assessment according to relevant SMS procedures, so as contingency plans to be developed if required.

46/2015 Provide clear guidelines to the Masters highlighting the importance of clear and specific Night Orders to the O(s)OW, when navigating in coastal areas under adverse weather conditions, concerning the frequent position fixing with alternative methods and the acceptable drifting from the planned course.

47/2015 Establish clear procedure to the Safety Management System Manual (SMSM), concerning navigation in heavy weather ballast condition, involving the competent department of the company when adverse weather is expected.

48/2015 Supplement the guidelines of the SMSM concerning navigation, especially under heavy weather conditions, highlighting the importance of using available features of navigational equipment such as Radar “guard zones”, GPS “off course alarms”, safety contours, parallel indexing etc.

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