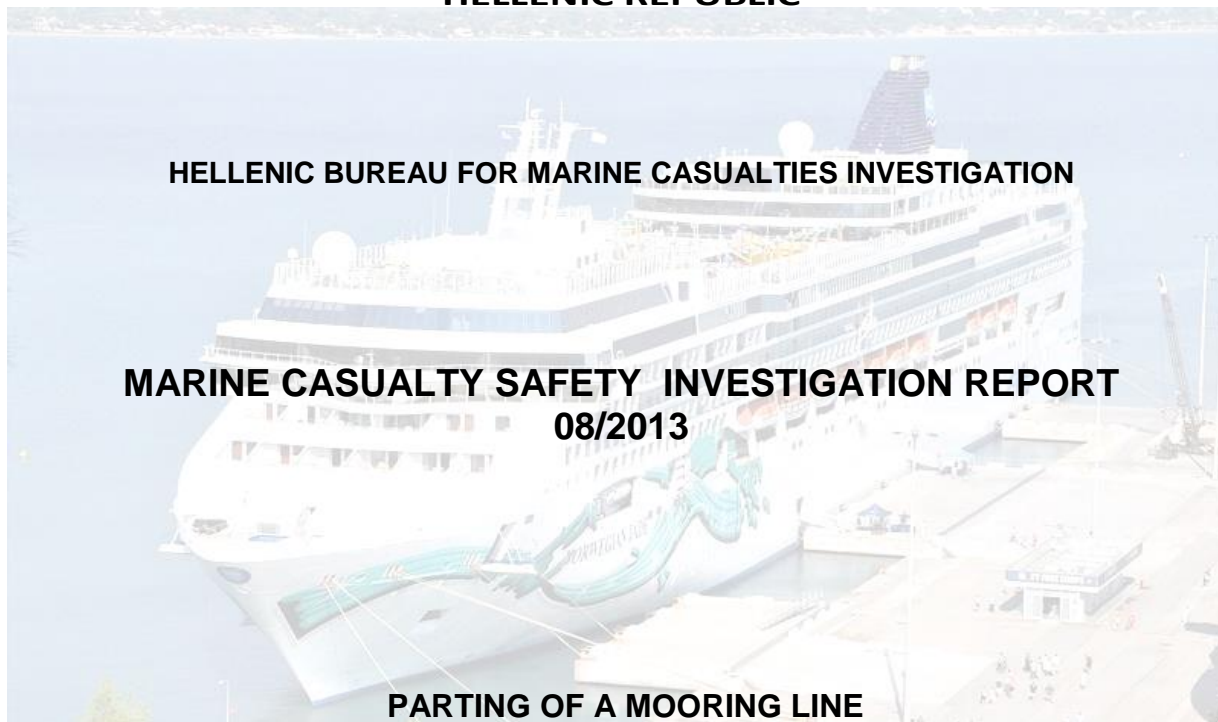




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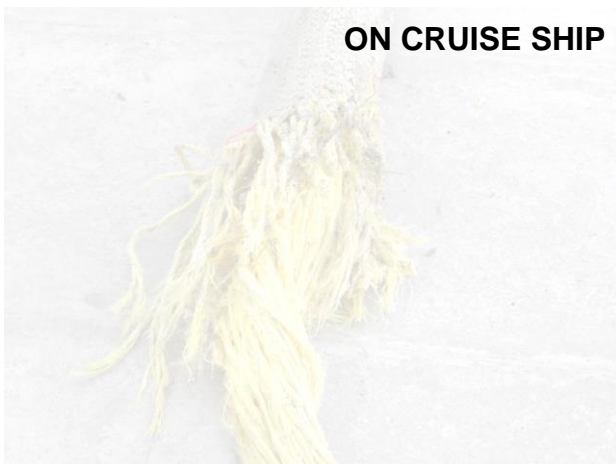
**HELLENIC BUREAU FOR MARINE CASUALTIES INVESTIGATION**

**MARINE CASUALTY SAFETY INVESTIGATION REPORT  
08/2013**

**PARTING OF A MOORING LINE**

**RESULTING IN FATAL INJURY OF A SEAMAN**

**ON CRUISE SHIP NORWEGIAN JADE**



**MAY 2015**

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**GLOSSARY OF ABBREVIATIONS AND ACRONYMS**

1.	AB	Able seaman
2.	Bf	Beaufort (wind force measuring unit of Beaufort Scale)
3.	CoC	Certificate of Competency
4.	DNV	Det Norske Veritas (Classification Society)
5.	DOC	Document of compliance
6.	HCG	Hellenic Coast Guard
7.	IMO	International Maritime Organization
8.	ISM	International Management Code for the safe operation of ships and for pollution prevention
9.	kW	kilo Watt (power measuring unit)
10.	kN	Kilo Newton (force measuring unit)
11.	MBL	Minimum Breaking Load
12.	m	meters
13.	min	minute
14.	mm	millimeters
15.	MOB	Man Over Board
16.	NMS	National Meteorological Service
17.	LT	local time
18.	OCIMF	Oil Companies International Marine Forum
19.	O(s)OW	Officer(s) on the watch
20.	OS	Ordinary seaman (deck crew)
21.	SAR boat	Search and Rescue boat of HCG
22.	SMC	Safety management certificate
23.	SMS	Safety management system
24.	SOLAS	Convention for the Safety of Life at Sea 1974, as amended
25.	UTC	Coordinated Universal Time
26.	VHF	Very high frequency (radio)

## 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 the events that occurred on March 08, 2013 and resulted in the examined very serious marine casualty and aims to prevent and deter repetition.

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 times (UTC +2) unless otherwise stated.

Under the above framework HBMCI has been examining the fatal injury of an Ordinary Seaman on board cruise ship Norwegian Jade following the parting of a mooring line during her berthing procedures at Katakolo port, occurred on the 08<sup>th</sup> of March 2013.

## 1. Executive summary

On 08 March 2013, at approximately 0740, cruise ship Norwegian Jade had entered the port of Katakolo, at Peloponnese Greece which was one of the ports of call on the ship's cruise schedule and was approaching the berthing dock. The weather conditions were reported to be good with southwesterly winds 3-4 Bf. However, port sea area withstood a slight swell following previous day's strong southwesterly winds.

Fore and aft mooring teams were positioned in bow and aft mooring stations. The Second Officer was in charge of the fore mooring team and was controlling the mooring operations from the port bow mooring platform and the Bosun was in charge of the aft mooring team. Shortly before 0800 six fore lines and six aft lines were made fast on the bollards of the dock, bridge had ordered "stop with engines" and Norwegian Jade was berthed alongside with her port side.

Although the mooring operation was almost completed, the need to shift the vessel one or two meters astern became clear, as the setting of the forward passenger disembarkation ladder on the dock was blocked by a cement structure.

Master ordered to proceed with the ship's shifting by handling the spring lines. For said operation the aft lines were slacked while the forward spring line was heaved and the ship shifted in position as instructed.

By that time the Second Officer in charge of the fore mooring team was stationed on the port mooring platform monitoring the handling of the spring line while an AB was standing very close to him.

At that time, approximately 0802, fore spring line parted and snapped back towards the mooring platform striking the AB who was pulled over the guard rails and fell overboard. He was instantly gone underwater and was lost from sight. His body was recovered from the seabed few hours later by Coast Guard divers.

Norwegian Jade departed from Katakolo Port at late afternoon hours on the same day and followed her regular voyage schedule towards Piraeus port.

## 2. Factual information

### 2.1. Vessel's details

Figure 1. Cruise ship Norwegian Jade



Name of Vessel	Norwegian Jade
Call Sign	C6WK7
Managing Company (ISM Code A 1.1.2)	NCL (Bahamas) Ltd
Ownership	Pride of Hawaii, INC
Flag State	Bahamas
Port & No of Registry	Nassau 9000236
IMO Number	9304057
Type of Vessel	Cruise ship
Classification Society	Det Norske Veritas
Year built	2006
Ship Yard	Builder Meyer Werft GmbH
Loa (Length over all)	266,15 m
Boa (Breadth over all)	32.20 m
Gross Tonnage	93558
Main Engine	MAN Diesel AS – 74000 KW
Document of Compliance	DNV
Safety Management Cert	DNV
Last PSC Inspection (prior to casualty)	MED MOU – Turkey 09-05-2012

### 2.2. Voyage details

Vessel's name	Norwegian Jade
Port of departure	Civitavecchia (Palaiopolis), Italy
Port of arrival	Katakolo (east of Peloponnese)
Type of voyage	International
Passengers	2,487
Crew on board	1,021
Minimum safe manning	23

### 2.3 Marine casualty information

Vessel's name	Norwegian Jade
Type of casualty	Very serious
Date and time	08 March, 2013 at approximately 0802

Position – location	lat: 37° 38' 45'' N - long: 021° 19' 14'' E at Katakolo port berthing dock
External environment	variable wind, force 3-4 Bf - good visibility, short swell in the port scattered clouds - rain showers forecasted - day time
Ship operation	Warping procedure following berthing
Voyage segment	Arrival
Consequences (to individuals, environment, property)	<ul style="list-style-type: none"> <li>• Fatal injury of an OS</li> <li>• Minor damages on mooring platform</li> </ul>

## 2.4 Emergency response actions

Following the incident the Coast Guard Authority of Katakolo immediately launched the “Emergency response plan” and reported the marine casualty to the Joint Search & Rescue Coordination Center of the Hellenic Coast Guard (HCG). The Search & Rescue Boat moored in the port as well local divers were mobilized to start searches for the recovery of the casualty. Coast Guard Officers that witnessed the incident from the dock voluntarily dived in the water to recover the casualty, however the OS had instantly gone underwater. In parallel one rescue boat was launched from Norwegian Jade and participated in the searches.

A diving team of Hellenic Coast Guard (HCG) Seals Squad was also deployed to Katakolo Port and took over the searches’ coordination and recovered the casualty from the seabed at 1233.

An ambulance of the National Emergency First Aid Centre arrived on scene and his attendants transferred the casualty to the local Hospital.

Authorities – Services involved	
Katakolo Coastguard Authority	→ 10 Coast Guard Officers
S&R Boat Norwegian Jade	→ 01 – 05 crew members
S&R Boat HCG	→ 01 – 08 Coast Guard crew
HCG divers	→ 02
Local divers	→ 02
National Emergency First Aid Service	→ 01 Ambulance with 03 attendants



### 3. Narrative

Norwegian Jade, under the Flag of Bahamas, was built in 2006 by Meyer Werft Shipyard in Germany and was operated by Norwegian Sea Lines in cruises mostly in the Mediterranean Sea. On 8 March 2013 she had arrived at Katakolo port under a seven day's round cruise in the East Mediterranean Sea. She was accommodating 2.487 passengers and was operated under 1021 crew members.

#### 3.1 Arrival at the port of Katakolo

At approximately 0715, on 08 March 2013 cruise ship Norwegian Jade was hauling in Katakolo Port, coming from Civitavecchia/Italy and she was standing-by for the pilot embarkation. According to the weather bulletin issued by National Meteorological Service, the prevailing weather conditions in the sea area were variable with moderate winds, force 3 to 4 Bf, good visibility 1-3 miles and scattered clouds with a chance of showers. It was reported that during ship's entry, the port withstood short swell due to the prevailing strong southern winds force 7 in Ionian Sea on the previous day of the marine accident.

According to Norwegian Jade's log book, recorded through an electronically developed application, at 0721 the pilot was boarded and the procedure for entering the Port commenced.

At 0722, the Master being on the bridge, took over the conning from the navigational watch. At approximately 0729 Norwegian Jade had already entered the port and was approaching the berthing dock in maneuvering speed mode.

#### 3.2 Mooring Teams and mooring stations

Norwegian Jade's Safety Management System for mooring shipboard operations, provided two mooring teams of six deck crew members each.

The fore mooring team was composed by six deck crew members with the Second Officer in charge and the aft mooring team was composed by six deck crew members and the Bosun as the Officer in charge. The coordination of the mooring teams was carried out by the Staff Captain, stationed at port bridge wing and supervising the process relaying Master's commands to the Officers in charge of the mooring teams, through portable VHF devices.

The First Officer was in charge of the crew at the passengers' disembarkation areas at no 4 deck in order to direct the exact positions of the disembarkation doors in relation to the berthing dock as its construction layout provided limited space for setting the two passengers' disembarkation gangways.

The fore mooring station of Norwegian Jade is a covered mooring deck located at No 7 deck while the aft mooring station, covered type as well, is located at deck No 4. The fore mooring station is equipped with two mooring platforms fitted on port and starboard bow respectively, close to the aft bulkhead of the mooring deck. The platforms are opened during berthing operations in order for the Officer in charge to have an oversight of the ship's berthing side and of the dock's layout so that to control and direct the mooring operation. The mooring platform is also used by the mooring teams' members for sending the heaving lines to mooring gangs on the dock.

#### 3.3 Mooring of the Ship

As evidenced by Norwegian Jade's log book entries, at 0742 the first head spring line, attached to a messenger line, was send ashore from the port bow mooring platform. At 0742 thrusters were switched off and the ship was recorded to had arrived at Katakolo port.

At 0743, she was cleared for guests and crew and at 0745 the bridge ordered the engine control room “finish with engines”.

At 0750 “finish with engines” for deck was also recorded. By that time Norwegian Jade was berthed alongside the dock with her port side by six fore mooring lines and six aft mooring lines, following her regular mooring plan, as shown in figure 2 & 3.

The mooring operation and the securing of the mooring lines had been completed and the mooring teams continued with their tasks for handling the mooring and heaving lines.

In particular, the securing procedure of the mooring lines included the following sequence of actions:

- clutching of the drum of each mooring line to the winch motor.
- mooring line tensioning to the point where the tension load reached 50% of the pulling force of the winch.
- mooring line securing by setting the band brake mechanism.
- declutching of the winch drum.

The procedure that was carried out at the bow included the same actions, however, no 1 spring line was still about 2 m slacked as its securing was blocked up by the opened mooring platform. Consequently its final tending and securing was to be carried after closing the mooring platform (see figure 2).

It was a practice on board during the berthing operation in Katakolo to tension and secure no 1 fore spring line after closing the mooring platform at the end of the mooring operation.

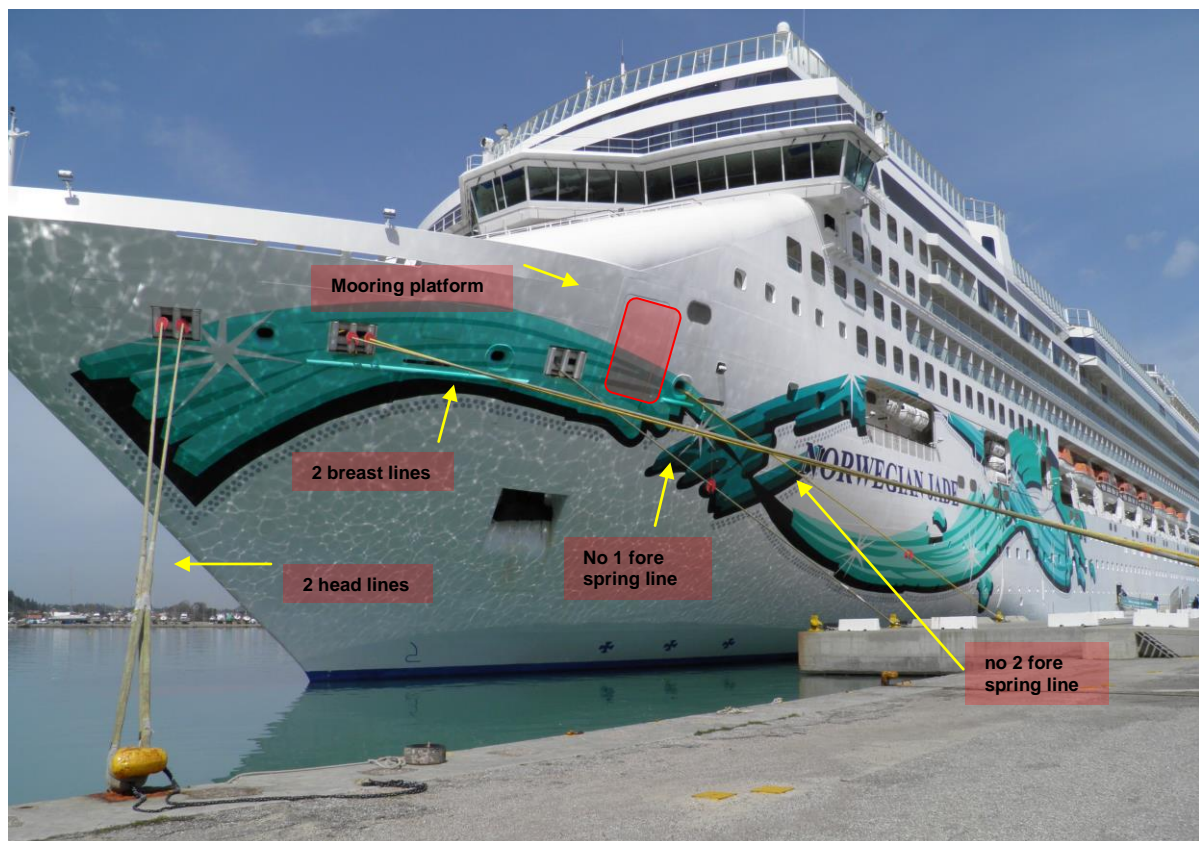


Figure 2. Norwegian Jade's bow's berthing configuration pattern at Katakolo port



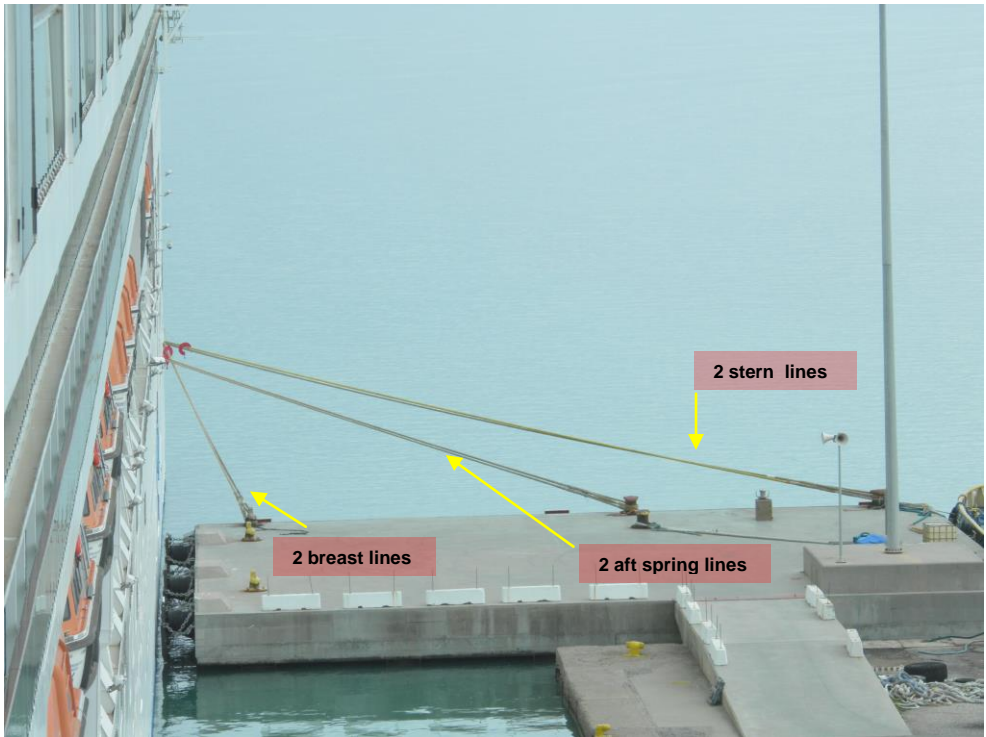


Figure 3. Norwegian Jade's aft's berthing configuration pattern at Katakolo port

The First Officer, already on the dock, noted that the ship was slightly forward from the anticipated position by almost 1m and the passengers' fore gangway could not be set as it was blocked by a small concrete pedestal above ground construction at the edge of the dock (see figure 4). The First Officer reported to the bridge that Norwegian Jade had to be shifted slightly astern in order to set the passengers' disembarkation gangway. The Master ordered to proceed with the warping operation by slacking the stern lines (figure 3) and heaving no 2 fore spring line (figure 2).

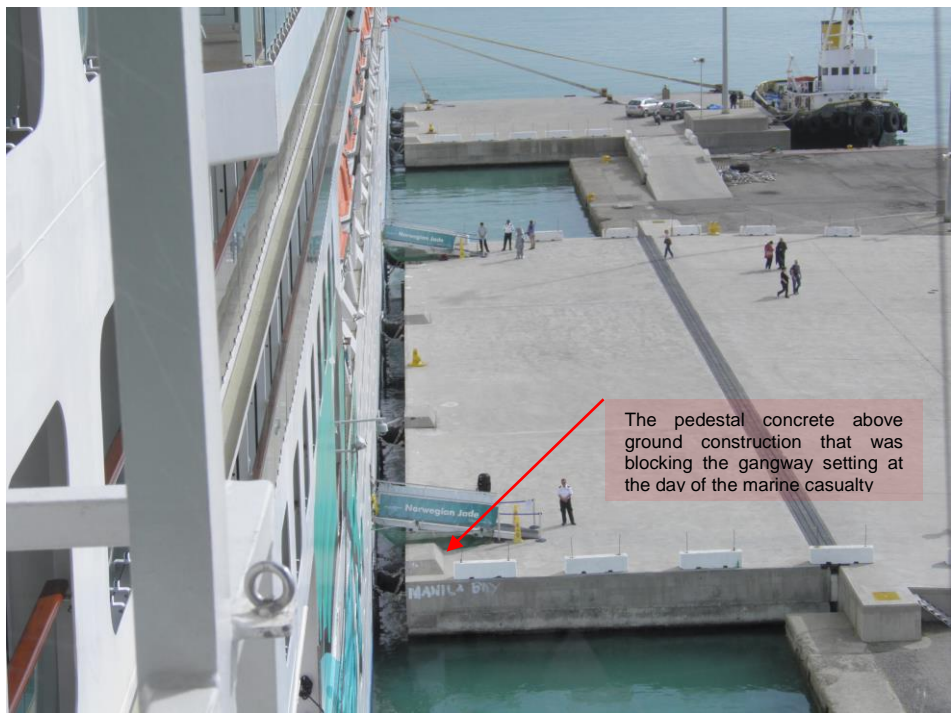


Figure 4. Norwegian Jade berthed at Katakolo Port. Passengers' gangways arrangement.

The Staff Captain ordered the Bosun, Officer in charge of the aft mooring team, to slack the stern mooring lines and the Second Officer, in charge of the fore mooring team, to heave no 2 fore spring line.

The warping operation and the securing of the mooring lines was completed by approximately 0800, however no 1 fore spring was to be secured after closing the mooring platform that was still open.

### 3.4 Parting of the Forward Spring Line

During the shifting operation, the Second Officer was stationed on the mooring platform at the outer aft edge controlling the operation. At the end of the process an OS was also standing on the platform closer to its opening, approximately 1,5 m away from the Second Officer, handling the messenger lines that were sent ashore at the outset of the mooring operation.

The rest of the mooring team members were in the covered mooring deck. An AB was stationed on the winches' control panel platform, another AB was at the port winch band brake and three ABs were handling the mooring lines and the winch band brakes.

By that time the head lines and fore breast lines, including no 2 fore spring line serviced for the warping operation, were secured as mentioned above, while no 1 fore spring line was about 2 m slacked and its securing was to be done post to the closing of the mooring platform.

During the preparation of the winch for hauling in no 1 fore spring line, not under tension and still under the platform, no 2 fore spring line parted at a point of approximately 20 meters from the quayside's bollard. The parted line attached on Norwegian Jade snapped back towards her bow and the mooring platform under extreme force, struck the OS standing on it, forced him towards the guard rails and pulled him overboard while the Second Officer stationed at the edge of the mooring platform was not accidentally injured (figure 5).

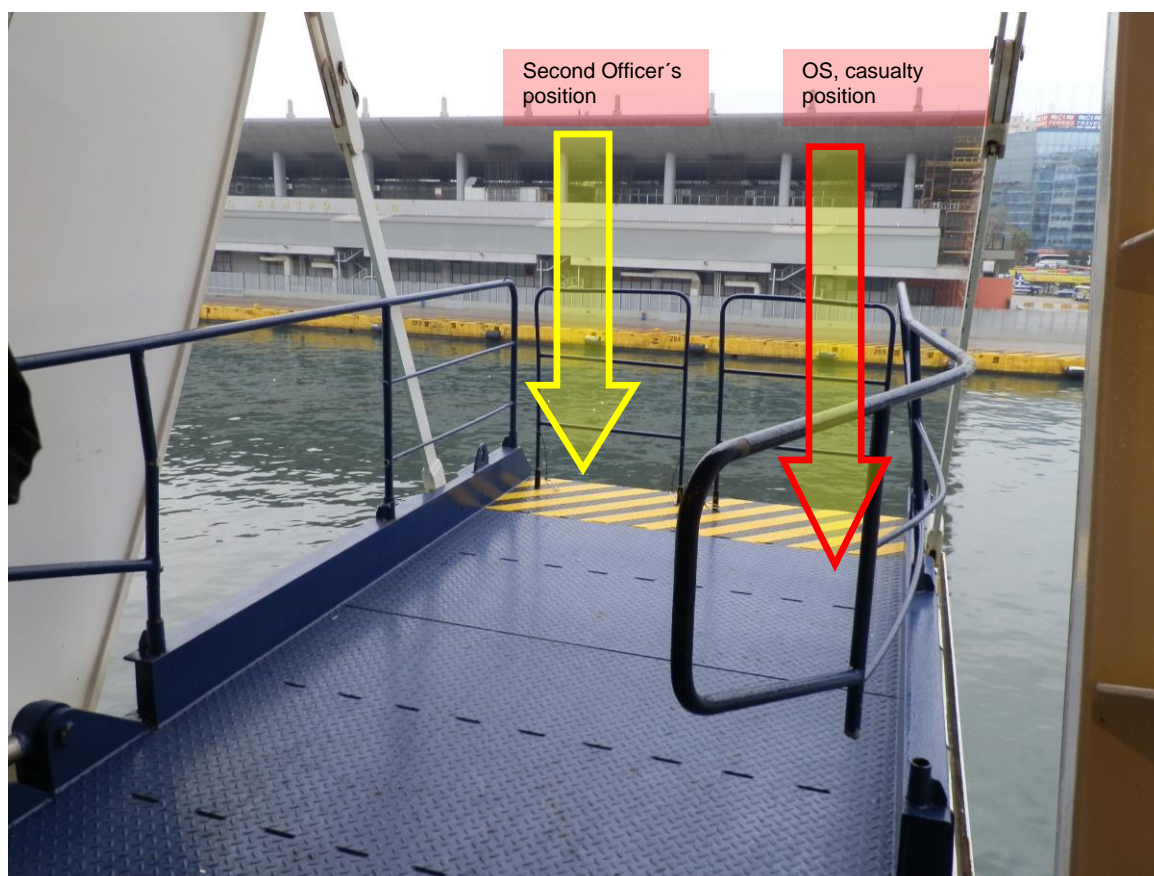


Figure 5. Mooring platform. Guard rails distorted. Positions of Second Officer and OS.

The spring line attached on quayside's bollard coiled towards the bollard fortunately without causing any injuries to dock mooring personnel as they had accidentally moved away from the area. Norwegian Jade shifted slightly forward until restrained and stopped by no 1 fore spring line, which unexpectedly got under tension and stretched, causing distortion on the fittings supporting the mooring platform (figure 6).



Figure 6. The damaged mooring platform following the marine casualty

### 3.5 Crew emergency response actions

The Second Officer stationed on the mooring platform and very close to the casualty position, although shocked immediately reported the occurrence and the "Man overboard" incident to the bridge through his portable VHF.

However, the report was not understood by the Officers on the bridge and the Second Officer called the bridge by the telephone fitted in the mooring deck. An immediate announcement was called by the public address system using communication codes "CODE OSCAR" and "CODE ALPHA", concerning the activation of the teams responsible for the emergency response on man overboard incidents and first aid, respectively.

One manned rescue boat was prepared and launched and the medical team was mustered. The rescue boat carried out searches at the sea area of the incident however without being able to locate the casualty.

### 3.6 Port personnel response actions

The incident of ship's mooring line parting and the OS falling into the sea was seen by port staff and Hellenic Coast Guard Officers who were on the dock. Two of the latter instantly reacted and jumped in the water in order to recover the casualty. However, the OS was sunk almost in a second and only his helmet was found floating nearby. The underwater limited visibility prevented his prompt location and recovery.

At the same time Katakolo Coast Guard Authority was immediately alerted and the "Emergency Response Plan" was launched. The SAR boat of the Hellenic Coast Guard, moored at Katakolo port, was immediately ordered to commence searches at the sea area of the incident. The National Emergency Aid Centre was also notified in order to deploy an ambulance while local divers were called by the Coast Guard Authority to offer assistance for the location of the casualty.

Following the initial spontaneous response of the Officers at present, searches continued by the local divers as well as by a team of two divers of the HCG Seals Squad, deployed at Katakolo Port.



At 1233 the casualty was located on the seabed and recovered by the HCG diving team (figure 7); the body was transferred by an ambulance to the nearest hospital where he was pronounced as deceased.

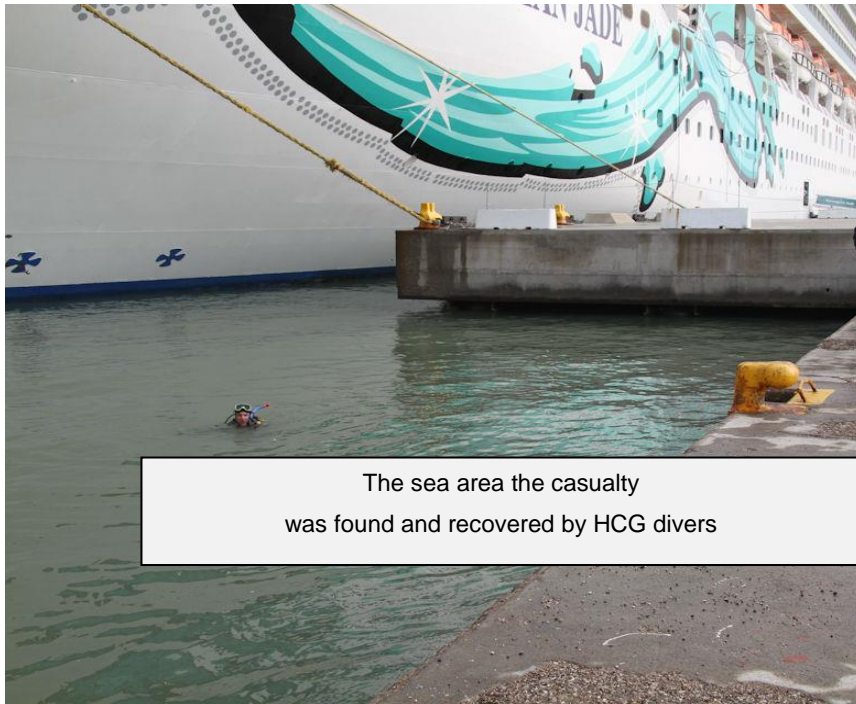


Figure 7. Sea area of the casualty

According to the post mortem examination report, conducted by the competent Authority of Patras the death of the Seaman was caused due to heavy head, thorax, abdomen and upper limb injuries.

At approximately 1800 Norwegian Jade departed Katakolo port and continued her scheduled voyage to Piraeus. HBMCI's Investigation Team boarded her on 09 March 2013 following her arrival at Piraeus port.

On 18 March 2013 the HBMCI's Investigation Team revisited Norwegian Jade and boarded prior to her arrival at Katakolo port in order to monitor the mooring procedures.



Figure 8. Norwegian Jade berthed at the port of Katakolo on the day of the marine casualty

## 4. ANALYSIS

The analysis of the examined marine casualty aims to identify and determine the factors and causes contributed to the occurrence, taking into account the sequence of events and the collection of investigation information and data focusing both on specific points of the temporal evolution of these, as well as to the root causes in order to draw useful conclusions leading to safety recommendations.

### 4.1 Mooring operations general hazards

Mooring is a shipborne operation performed firstly and foremost by the deck crew as a ship reaches a port. It is likewise considered to be one of the most difficult, complex and risk operations as enormous strains are imposed on lines and major forces are developed. The hazardous factor is particularly high during mooring operations and several marine accidents have occurred resulting in crew injuries or even fatalities. One of the main reasons that may cause a marine accident in the course of mooring operations is parting of a mooring line during which a significant amount of energy is released and the two parts of the mooring line are coiled at high speed towards the restraint points, resulting in the injury of people inside the danger zone. According to studies conducted by organizations (IMO, MCA, OCIMF, P & I, INTERTANKO, ICS, BIMCO, etc.) for reducing such marine accidents the danger zone (snap-back zone) of mooring line's parting towards the restraint points cannot be accurately determined. However, it is estimated that it can reach twice the length of the mooring line at an angle of about  $10^\circ$  from the breaking point. This area increases when pedestal rollers or bollards are used to change the direction of the mooring line (figure 9). Therefore, the crew involved in mooring operations is advised to take into account the danger areas and access in these areas to be prevented, or when it is necessary to be quick and alerted, with due care even when the mooring line is under minor or no tension.

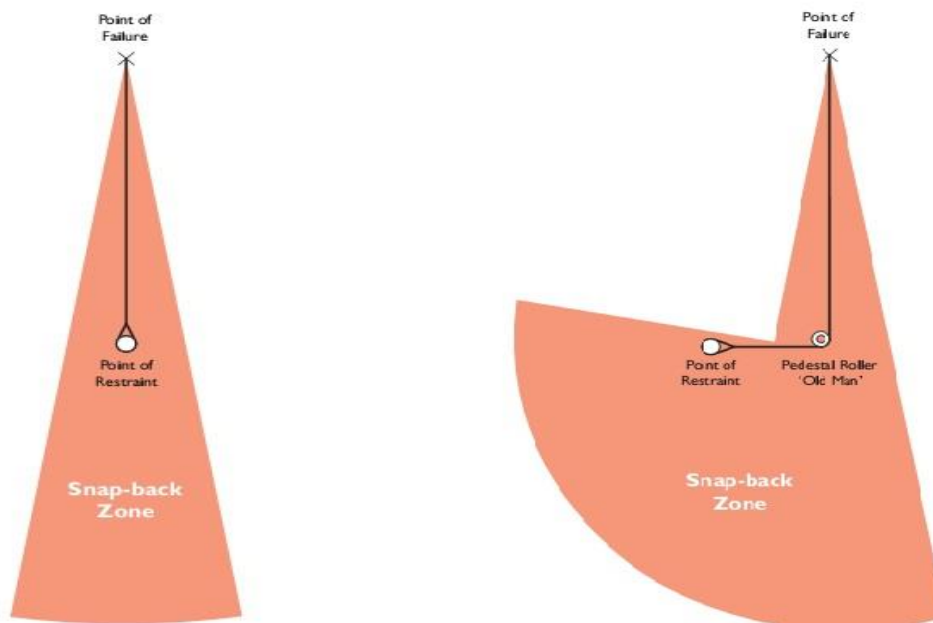


Figure 9: Dangerous snap-back zone of mooring line



### 4.2 Katakolo Port

The port of Katakolo is located in Katakolo Bay at the western coast of Peloponnese. Katakolo is a regular destination for cruise ships operating in the east Mediterranean Sea due to its proximity to the archeological site of Olympia.

The port is structured by a curved big breakwater of approximately 750 m length at its south boundaries and a second breakwater located northwards of approximately 240 m length. The northern breakwater forms a cove for the mooring of fishing and sailing boats. The port entrance is open to the northeast and is protected from southwesterly waves by the breakwater extending initially eastwards for about 460 m and northeastwards for approximately 260 m.

The inner part of the northeastwards breakwater provides one berthing position with 230 m length. At the inner port area a dock is east-northeastwards laying, facilitating two mooring positions; the south berthing position close to 204 m of length and the north berthing position close to 230 m of length.

Norwegian Jade’s regular berthing position was at the north side of the inner dock. On the day of the casualty she berthed as usual, alongside with her port side, however, her overall length of approximately 266 m exceeded the 230 m long dock to an extent close to 30-40m. Consequently all Norwegian Jade’s aft mooring lines towards the dock bollards were directed to her bow under sharp angles (figures 3,10 & 11).

The Master and the crew were familiar with the mooring operation and arrangements at Katakolo port as it was a regular port of call with a standard berthing position and mooring plan.



Figure 10. Katakolo Port overview image. General overview image of Greece pointing out Katakolo. Source Google Earth

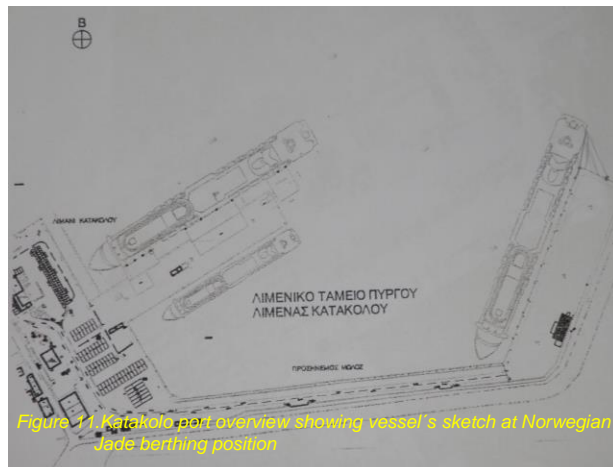


Figure 11 Katakolo port overview showing vessel's sketch at Norwegian Jade berthing position

## 4.3 Weather Conditions

### 4.3.1 Wind effect

According to the weather bulletin prevailing weather conditions were reported to be easterly winds, force 3-4 BF, that is with approximately 12-18 knots of speed. However the actual wind speed at Katakolo port was stated to be less than 10 knots directed to Norwegian Jade's stern starboard quarter windage while approaching the berthing dock.

It was reported that at the time of the marine casualty the actual wind speed was close to 2-3 knots and it was not considered to have any effect on Norwegian Jade's warping operation.

### 4.3.2 Swell effect

The port sea area was also withstanding a short swell due to the prevailing strong southerly winds, force 7 Bf on the previous days.

Prevailing swelling was accessible from the port entrance and was directed towards the head of the berthing dock. Nonetheless the wavelength, the height and its frequency were of low values and as stated by the Master were not affecting Norwegian Jade's maneuvering during the mooring procedures.

However, during the interviewing process a number of Deck Officers stated that the short port swelling, Norwegian Jade encountered by the time of the warping operation, could have had a dynamic effect on her squared shaped stern and may have subjected the headspring line to excessive loads as it was the only restraining line to ship's potential forward motion.

Nonetheless said allegation was not confirmed by the mooring gangs and HCG Officers observing Norwegian Jade's arrival and mooring.

It is also noted that the weather conditions during the previous days as well as Norwegian Jade's berthing maneuvering with the thrusters and propellers had considerably reduced underwater visibility by causing turbidity and consequently hindered the searches for the casualty recovery.

## 4.4. Mooring Equipment

### 4.4.1 Mooring deck layout

The mooring stations of Norwegian Jade are located at covered mooring decks. Foreword mooring station is structured at Deck no 7 and aft mooring station at deck No 4.

The fore mooring deck is fitted with three mooring winches, two anchor windlasses, 7 pedestal roller fairleads, 8 double bollards and stowage capacity for the mooring ropes. The fore mooring deck layout extended for approximately 24 m forward to the stem post while the greatest transverse breadth at the aft bulkhead was close to 25 m.

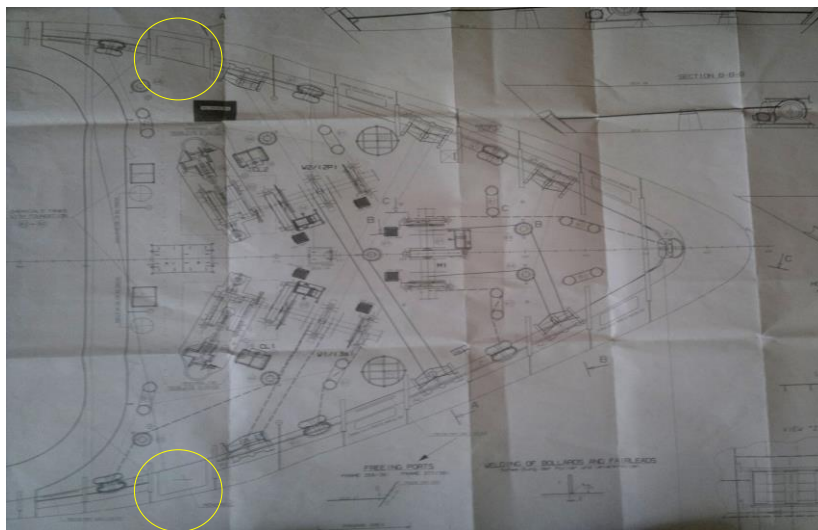


Figure 12. Plan view of the fore mooring deck. Mooring platforms openings are shown in yellow circles

Two watertight mooring platforms were mounted close to the aft section of the mooring deck, one at the portside and one at the starboard side. The mooring platforms offered view for supervision of the berthing operation to the Deck Officer in charge and facilitated the handling of the messenger lines by the deck mooring crew as there was no alternative position for performing those tasks (figures 12 & 13).

The mooring platforms were fitted peripherally with removable protective guard rails with approximately 1 m height in order to protect deck mooring personnel from falling overboard. No other specific measures were applied in relation to personnel's safety.

The evaluation of the events leading to the marine casualty has shown that the identified dangers for the personnel stationed or standing on the platform were limited to those falling overboard, potentially by lack of balance tripping or slipping, factors mostly depending on an individual's actions and behavior.

To ensure personal safety in mooring operations, personnel engaged should as far as reasonably practicable be able to stand in protected positions. The risk of injuries to a crew member caused by external factors such as the use and handling of the mooring equipment had not been feasible, as the mooring platform was considered to be a safe location for the Deck Officer in charge or the mooring personnel. However the evolution of the events leading to the casualty revealed that the mooring platform, under certain conditions of the mooring lines' configuration and dock berthing arrangement, could become a danger zone in cases a mooring line parts and snaps back towards the ship's bow.

Taking into account the above it is suggested that had the mooring platform been identified as a snap back zone for parting of mooring lines, protective or precautionary measures such as the increase of railing's height could had been taken in order to protect personnel stationed or standing on it.

The lack of controls taken in the direction of crew safety when undertaking duties on the mooring platform has been identified as a contributing factor into the examined case.



Figure 13. View of starboard mooring platform. Vessel berthed at Piraeus Port



#### 4.4.2 Mooring Equipment Arrangement

Mooring equipment is a set of mechanisms (winches, windlasses) and fittings (double bollards<sup>1</sup>, roller fairleads<sup>2</sup>, roller chocks<sup>3</sup>, panama chocks etc) that are used to secure a ship alongside docks with a combination of mooring lines leading to bollards on the quayside. Said mechanisms are also required to be sufficiently powerful to heave a ship alongside once the ship is close enough to send a line ashore and secure it in various weather and environmental conditions.

Norwegian Jade's fore and aft mooring stations were equipped with efficient fittings and modern intergraded automatic self-tensioning mooring units electro-hydraulic driven while berthing maneuvering alongside the dock was mainly assisted by three bow thrusters.

##### 4.4.2.1 Windlasses and mooring winches

The fore mooring station was fitted with two windlasses, one at the port side and one at the starboard side. Each windlass was a combination of a cable lifter unit and an anchor and mooring winch. A mooring winch was also fitted at the forward center of the mooring deck. All units were manufactured by "Maritime Pusnes SA". The arrangement and layout of the units could facilitate a safe berthing on either port or starboard side.

The design of each mooring winch arrangement, generally integrated the operability of two declutchable split tension drums with auto tension mode; one tension drum and one storage drum; and a warping end; and was capable of storing and handling two mooring lines at the same time or separately, as required (figure 14).

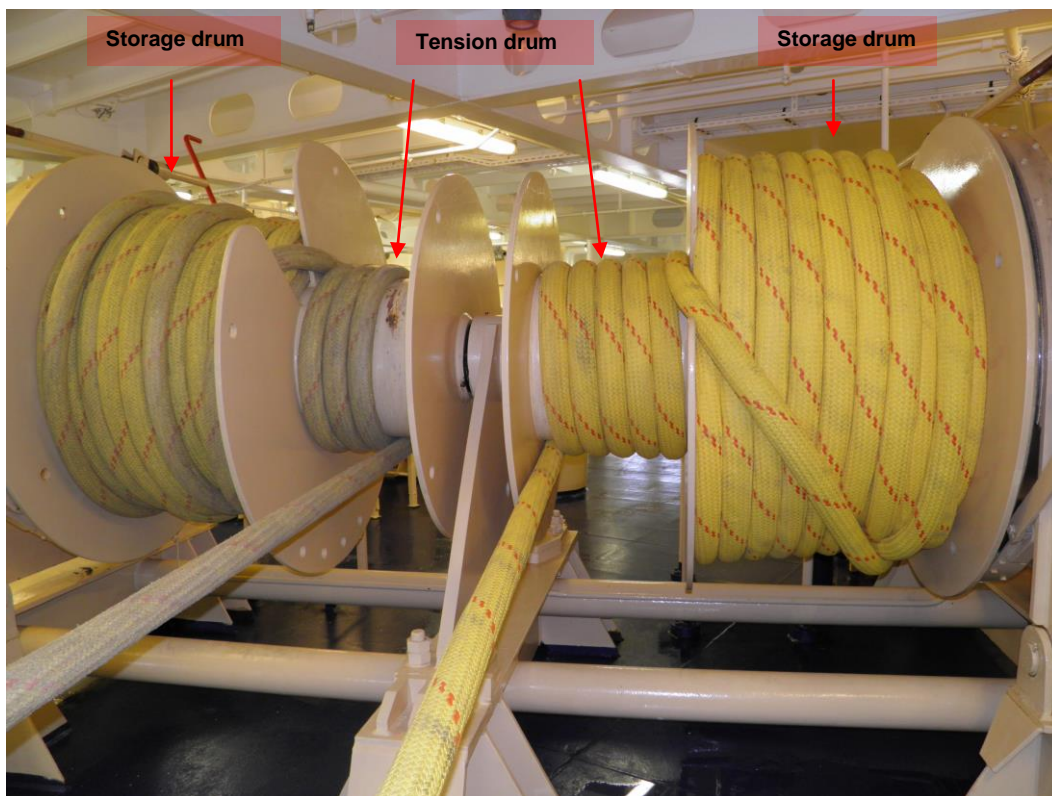


Figure 14. Port mooring winch arrangement

<sup>1</sup> Vertical steel posts mounted in pairs around which a line can be secured.

<sup>2</sup> A guide for a mooring line which enables the line to be passed through a ship's bulwark or other barrier or to change direction through a congested area without snagging or fouling.

<sup>3</sup> A guide for a mooring line enabling the line to be passed through a ship's bulwark or other barrier.

#### 4.4.2.2 Mooring winches pedestal control posts

The operation of the winches at fore mooring station was controlled by two pedestal control posts located near by the port and starboard winches, respectively. Each control post unit's operating features incorporated the handling of all fore mooring winches. The control post location offered visual contact between the operator and the Officer in charge of the mooring procedure, stationed on the mooring platform (figure 15).



Figure 15 . Pedestal control post of port mooring winch as seen from port mooring ramp.

The mooring winches' operation was utilized and monitored by the panel mounted on each control post as well as by a portable controller. Three control levers were fitted on each pedestal control post for controlling the operation of the winches (paying out or hauling in lines) while two control levers were fitted on the portable controller for the operation of the forward center winch. The instruments fitted indicated the pulling force during tending a mooring line and monitored winches' torque overload limit (figure 16).



Figure 16. Control panel fitted on control post.

The indications provided, under the percentage rated value of the winches' nominal pulling force as a coefficient at the maximum value of 110%. In cases when the indication exceeded the percentage value of 100%, a red lighted alarm was activated on the panel.



### 4.4.2.3. Mooring fittings

The fore mooring deck was also equipped with a set of mooring fittings such as eight (8) double bollards to secure the lines, seven (7) pedestal fairleads for the feeding of lines to the required direction, seven (7) multipurpose panama chocks and six (6) double roller chocks, for the guidance of the mooring lines from the ship’s side towards the berthing dock.

The design of fittings configured a multipurpose panama chock at the stem post (no 1 fitting) and in sequence, each bow side was mounted with the following fittings in table 1, as by order of location (figure 17):

Table 1. Bow’s mooring fitting description

mooring fitting description	location (distances are approximate)	reference in report
1 a double roller chock,	5 m from the stem post panama chock	no 1
2 a multipurpose panama chock	about 2 m from the double roller chock	no 2
3 a double roller chock	2 m from the multipurpose panama chock	no 3
4 a multipurpose panama chock	5 m from the double roller chock	no 4
5 a double roller chock following	very close to mooring platform opening	no 5
6 a multipurpose panama chock	1 m from the mooring platform	no 6

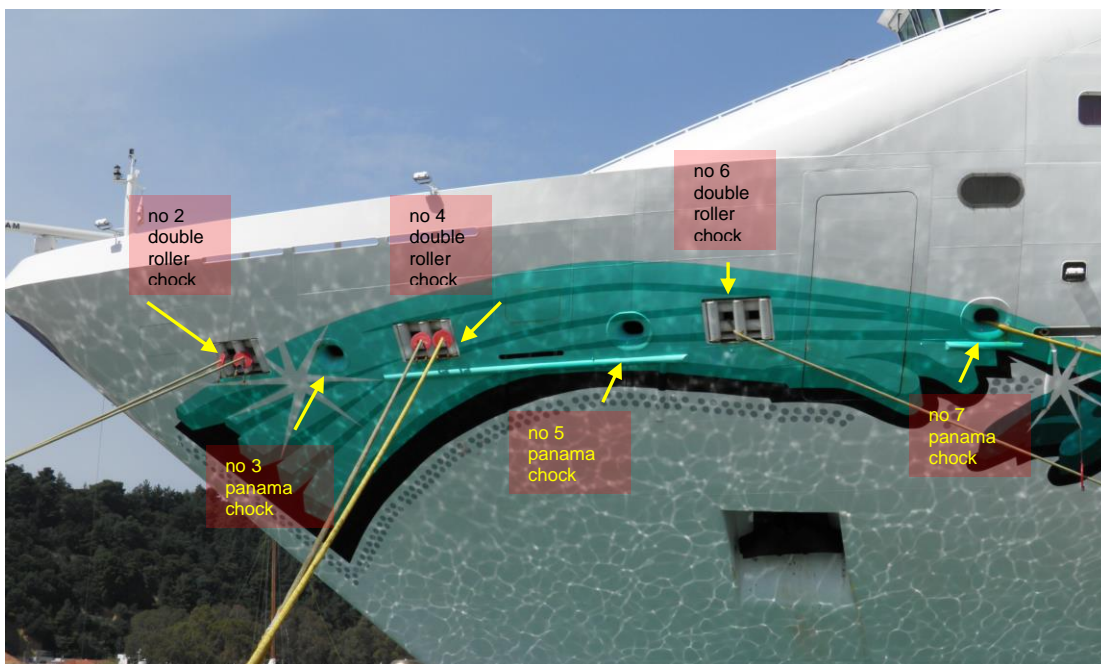


Figure 17. Port bow’s mooring fittings

The setting of the mooring fittings was ergonomic and could service and utilize the mooring operation as the mooring patterns were practically standard in regular ports of call.

However as stated during the course of the interview process in certain ports, as in Katakolo, one of the head springs, that had to be guided at shore bollards through no 6 double roller chock fitted ahead of the mooring platform, could not be hauled in and tensioned when the mooring platform was opened.

In consequence of the above, no 1 fore spring line could only be secured and service the holding capacity of no 2 fore spring line after the closing of the mooring platform when the fore mooring lines tending was completed. The time period that no 2 fore spring was servicing as a single spring is estimated to approximately ten minutes for Katakolo port berthing operation.

During the investigation process “on scene” it was denoted that the option of guiding a fore spring line through no 5 panama chock was not in favor as it could not actually service as a spring line.

Yet, aforesaid spring line arrangement was configured post to the marine casualty and serviced Norwegian Jade's berthing until her departure from Katakolo port, as shown in figure 25.

#### 4.4.3 Description of mooring equipment

##### 4.4.3.1 Mooring winch operation

As mentioned above, the mooring winches' arrangement on Norwegian Jade had the operability of handling two mooring lines. The selection of the winch to be operated for warping operation between the two arrangements was performed by a coupling lever by which the selected winch is engaged to the driving motor. Each winch had a band brake for holding the line, following the disengagement of the drum from the driving motor.

The technical specifications of Norwegian Jade's mooring winches were as follows:

- Nominal pull: 350kN, (110%=385 kN)
- Speed: 6,5 – 19,5 – 39 m/min (slow – normal – fast)
- Brake Holding Capacity: Designed (80% MBL), that is 1120 kN for MBL 1400 kN  
Service (60% MBL), that is 840 kN for MBL 1400 kN

The value of MBL (Minimum Breaking Load), is specified and declared by the rope's manufacturer in kilonewtons and is defined as the lowest braking strain of a rope when testing to destruction, in dry conditions.

In the examined case, the parted line's MBL was specified to 1270 kN.

It is noted that the "Designed Brake Holding Capacity" is rated to 80% of the Minimum Breaking Load of the mooring line, while the "Service Brake Holding Capacity" is rated to 60% of the Minimum Breaking Load of the mooring line.

Aforementioned percentage values are given by manufacturers and have also been introduced following thorough studies produced by OCIMF<sup>4</sup> (*Mooring Equipment Guidelines, 3rd edition, 2008*) and have been applied as standard recommended practices by interested Manufactures and Organizations<sup>5</sup>.

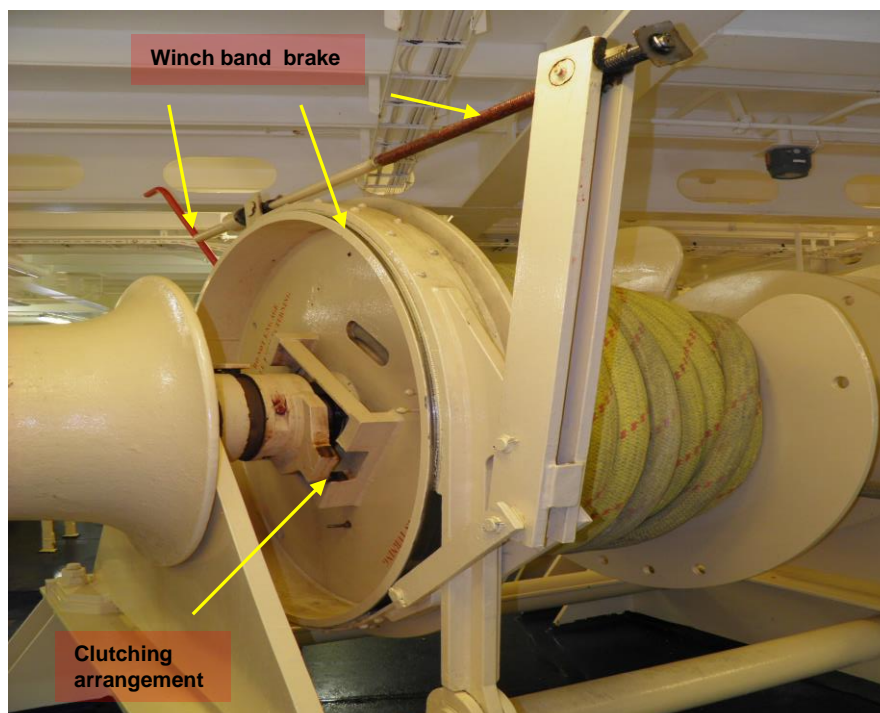


Figure 18. View of winch band brake and clutching arrangement

<sup>4</sup> OCIMF: Oil Companies International Marine Forum

<sup>5</sup> Recognized Organizations, ISO Standard 3730

By definition the winch band brake (figure 18) is the safety arrangement for securing the winch drum and the mooring line spooled and layered on it. It also acts as a safety device in case the load of a line becomes excessive (overloaded) beyond the pre-set levels by rendering and allowing the line to shed its load before its potential breaking. Based on the above and having regard to the design specifications of the mooring winches and the parted mooring line, two safety factors' thresholds were projected as preventive measures against breaking, as presented below:

- the mooring winch's brake holding capacity at normal service operation coefficient of 60% correlating to a safety factor<sup>6</sup> of 1,6.
- the mooring winch's designed brake holding capacity coefficient of 80% , correlating to safety factor of 1,25.

**4.4.3.2 Parted mooring rope features**

Norwegian Jade mooring equipment was mostly supplied with synthetic fiber mooring lines used for the mooring operations. The forward spring line that parted during the warping procedures at Katakolo Port was a high modulus synthetic fibre rope<sup>7</sup> and had been delivered to the ship on 24 January 2005.

Its technical specifications, according to the manufacturer's certification were as follows in table 2:

Table 2: Specifications of parted no 2 fore spring line

Description	TIPTO WINCHLINE	
Dimensions	nominal diameter	80 mm
	length	220 m
	circumference	240 mm /10 inch
Construction	number of strands	7 with jacket
	composition	Over braided <sup>8</sup>
Material	Bi-Constituent fiber of PP(Polypropylene) /PE (Polyethylene)	
Minimum Breaking Load (MBL)	1270 kN	

Under the general selected features of the manufacturer the "Tipto Winchline" is especially developed to be used on self tensioning winches with very good fatigue and abrasion properties. The 7strands core integrates high strength and relative low elongation while the braided jacket provides protection to the core, longer life time and increasing the crew safety by minimizing the risk of snapping-back. The rope is easy to handle due to its low weight and floating characteristics.

The post to the marine casualty examination of the parted line showed the following:

- ✓ the rupture of the rope was caused by tensile overload stress.(fig.19, 20, 21);
- ✓ no surface external abrasion was found as the line was stored in the covered forward mooring deck and therefore it was not exposed to external environmental conditions;
- ✓ its diameter was measured at 78 mm, that is 2,5% less than its nominal diameter;
- ✓ no signs of kinks or twists were observed.

<sup>6</sup> Safety factor is a margin over MBL to allow for uncertainties.(ref. to OCIMF Glossary of terms)

<sup>7</sup> The generic term given to a range of fibre materials that include Aramid, LCP and High modulus Polyethylene fibres.

<sup>8</sup> Braided rope: A rope produced by intertwining a number of strands.



Figure 19. Cross section of the parted line very close to breaking point



Figure 20 . Cross section part of the parted line found onboard



Figure 21. Damaged cross section of parted mooring line

#### 4.4.4 Inspection and maintenance of mooring equipment

The inspection and maintenance of the mooring equipment falls within the relevant provisions of the International Safety Management Code. More specifically relevant provisions *state that*:

**Ch. 10.1:** *“the owning or managing Company of a ship should establish procedures to ensure that the ship is maintained in conformity with the provisions of the relevant rules and regulations and with any additional requirements which may be established by the Company.”*

**Ch.10.2:** *“in meeting the inspection and maintenance requirements the Company should ensure that: 1, inspections are held at appropriate intervals, 2. any non conformity is reported, with its possible cause, if known, 3. Appropriate corrective action is taken, 4. Records of these activities are maintained.”*

**Ch.10.3:** *“The Company should identify equipment and technical systems the sudden operational failure of which may result in hazardous situations. The safety management system should provide for specific measures aimed at promoting the reliability of such equipment or systems. These measures should include the regular testing of stand-by arrangements and equipment or technical systems that are not in continuous use.”*

**Ch. 10.4:** *“The inspections mentioned in 10.2 as well as the measures referred to in 10.3 should be integrated into the ship’s operational maintenance routine.”*

##### 4.4.4.1 Inspection and maintenance of mooring winches

The inspection and maintenance system implemented on board Norwegian Jade was electronically based, applied and monitored. Regarding her mooring winches’ condition, it included periodical checks on a fortnightly basis as well as on annual basis, taking under consideration the guidelines provided by the manufacturer’s manual. The checks were carried out by the Second Engineer and the Electrician and included the following actions and tasks:



**Fortnight checks and maintenance**

- grease lubrication of the friction points;
- checking of the gear unit, the cogwheels and the bearings;
- checking of the brake mechanisms and the braking material in order the maximum braking force to be achieved;
- checking of the support and mounting points,;
- checking of the lubricating oil;
- checking the lubrication nipples.

**Annually checks focused on mechanical parts**

- checking the condition of the complete electric winch;
- check for wear and damages;
- oil sampling taken, change if necessary;
- gearcase to clean inside prior to oil replacement.

Based on the data collected during the investigation process the inspection and checks were carried out systematically in accordance with the Safety Management Manual and no irregularities were found.

However, during the annual inspection of the winches in May 2011 conducted by a specialized technician of the manufacturer, a special “band brake test kit” was recommended, for the calibration of the loadcells and the testing of mooring winches band brakes. It is to be noted that the winch band brake test is not part of the periodically maintenance instructions provided by the manufacturer, however it is recommended to be carried out at regular intervals without any further details and specific time periods.

Nonetheless it should be underlined that periodic testing is essential to assure a safe mooring. Principal and summarized guidelines<sup>9</sup> as referred in OCIMF “Mooring equipment guidelines – 3<sup>rd</sup> edition” are summarized below:

- ✓ each winch manufacturer will have their own test equipment and procedures which should be followed by the operator;
- ✓ individual winches should be tested after completion of any modification or repair involving the winch brakes, or upon any evidence of premature brake slippage or related malfunctions;
- ✓ brakes should be tested to prove that they render at a load that is equivalent to 60% of the line's MBL;
- ✓ a winch test specification is prepared incorporating specific instructions for setting up the test gear, preparation of the winch for testing, setting of the winch brakes, application of the test load, revision of torque wrench or hydraulic pressure readings, if required;
- ✓ testing is to be carried out under the supervision or in the presence of a senior officer designated by the Master or Chief Engineer or a repair superintendent familiar with the test procedure and the operation of the winches;
- ✓ recording of test results;
- ✓ a complete set of test equipment is placed on board each ship, properly stowed in an appropriate location. Alternatively, the Owner may elect to procure one or two sets of testing equipment for each type and size of winch and retain this equipment in a convenient central location for shipment to repair facilities as required.

In respect to the above it is considered that a proper maintenance and inspection program for the setting and operation of the band brake mechanism, is one of the most important safeguards that should be placed for avoiding any risk of ropes parting or incidents that could lead to marine accidents, as mooring operations may impose great loads on mooring lines, gear and winch band brakes.

Having evaluated the collected data and the evolution of the events leading to the examined marine casualty it is suggested that the lack of an applied comprehensive inspection and maintenance system of the winch equipment is considered to have been a contributing factor.

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<sup>9</sup> Reference to OCIMF “Mooring equipment guidelines – 3<sup>rd</sup> edition” Chapter 7.4.5 Winch Brake Testing

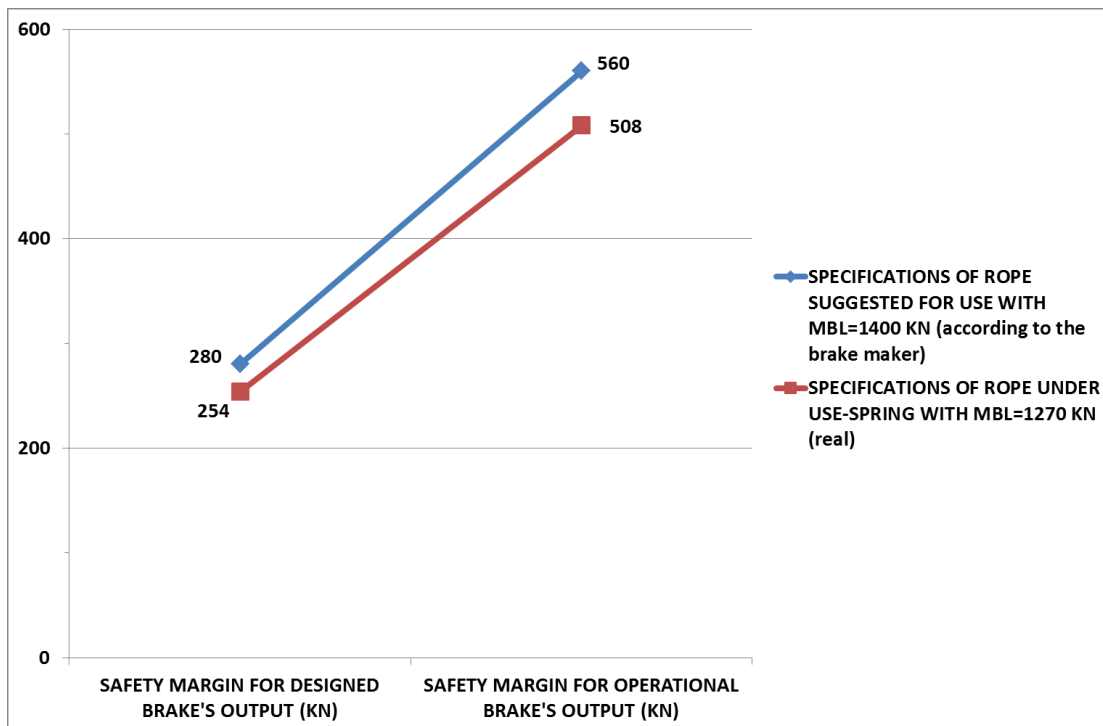


**4.4.4.2 Customized performance utilizations of mooring winches band brakes**

It is worth repeating that the designed and service band brake holding capacity of a mooring winch in function with the minimum braking load (MBL) of the mooring line used, defines the margin of a safety spectrum in which rendering the band brake mechanism is expected to operate, preventing the line-tensioning from reaching the minimum breaking load (MBL).

In the examined case, according to the specifications of the winch manufacturer, the initial setting of the service band brake holding capacity (60%) customized with the minimum breaking load of the rope MBL=1400kN, is equal to 840kN. Based on the above data a safety margin of 560kN is resulted. However, the Minimum Braking Load of the spring line that parted during the berthing operation at Katakolo port was 1270 kN, whereas there was no evidence showing that the band brake mechanism had been customized accordingly under the existing MBL.

Consequently the range of the above mentioned safety margin for the overloading of the line was reduced from 560kN to 508kN. Inductively, the width of the resultant safety factor range according to the designed band brake holding capacity was reduced too, as indicated in the following diagram (figure 22).



*Figure 22. Diagram showing the reduction of the safety levels by using a rope with a MBL smaller than the one provided by the winch manufacturer.*

**4.4.4.3 Inspection of mooring ropes**

The set of ropes in service for the safe berthing operation of a vessel is part of her mooring equipment. Such equipment should be subjected to regular inspections for wear and tear under a program aiming to prevent any failures or alternatively identify any potential failures or irregularities at an early stage so as to eliminate dangerous situations that could result in personnel's injuries or damages to machinery.

Ropes that are to be used in mooring operations should be in good condition and should be frequently inspected for both external wear and wear between strands under an inspection documented program. Such documented program falls under the provisions of the International Safety Management Code Chapter 10 as referred in par. 4.4.4.

Norwegian Jade was equipped with high modulus synthetic fibre mooring ropes that may lose strength due to abrasion or flexing directly related to the amount of broken fibres in the rope's cross-section.

Having regard to standard recommended guidelines<sup>10</sup> high modulus fibre mooring lines should be inspected for abrasion, inconsistent diameter, discoloration, inconsistencies in texture and stiffness, glossy or glazed areas and visible elongation.

Winch-mounted synthetic lines should be periodically end-to-ended to distribute wear due to serviced usage.

As mentioned above, Norwegian Jade's parted spring line was customized with 7 strands, jacked and over-braided.

Braided rope construction has an independent inner-core, possessing approximately 50% of the total rope strength. This core, since it is not subjected to surface abrasion and wear, tends to retain a larger percentage of its original strength over a longer period of time. Therefore, wear on surface strands does not constitute as large a percentage of strength loss as in other constructions.

In parallel strand rope construction, the core represents 100% of the rope strength. The outer braided jacket acts as a protection against external abrasion for the strength member and, therefore, massive damage to this outer braid does not dramatically reduce the overall strength of the rope.

Based on the above the regular on board inspections of ropes constructed as the parted spring line, is only visual, limited mainly to the condition of the jacket and it is difficult to locate internal wear. Signs of wear due to overloaded tending-line could also be identified by a targeted inspection of its actual diameter compared with its nominal diameter. These inspections and their results are recommended to be properly recorded and kept onboard in a standardized format including the dates of purchase and in-service and any other useful information.

The comprehensive conduct of inspections and record keeping of the in-service mooring lines by a competent person as a regular process could ensure and facilitate the good management of ropes, including retirement, before reaching critical condition.

During the investigation process "on scene" it was stated that visual inspections were carried out by the mooring deck crew before mooring operations and no particular findings were being observed on specific mooring line that parted, nevertheless said visual inspections were not recorded.

Based on the above it became apparent that no record for mooring lines' inspections was kept on board Norwegian Jade.

As already referred above the post examination of the parted mooring line did not indicate any elongation or inconsistencies in texture and stiffness apart from the damaged part.

Notwithstanding the fact that the macroscopic inspection on mooring lines carried out by the deck mooring crew of Norwegian Jade prior to the commencement of the mooring procedure at Katakolo had not detected any defects, however the existing of any form of damage in the inner-core of the mooring line at the ruptured area, that may have contributed to the reduce of the mooring rope's strength, cannot be excluded.

The lack of a systematic and detailed inspection program for the mooring lines in service is considered a contributing factor into the marine casualty.

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<sup>10</sup> Reference to OCIMF "Mooring equipment guidelines – 3<sup>rd</sup> edition" Appendix D.1 Inspection of ropes.

### 4.5 Norwegian Jade arrival at Katakolo port

Norwegian Jade’s configuration of mooring lines as projected by her “mooring plan” could facilitate her berthing tailored to the needs of Katakolo port dock layout (figure 23, 24).



Figure 23. Port bow mooring configuration



Figure 24. Port stern quarter mooring configuration.

#### 4.5.1 HBMRI actual berthing procedures monitoring

On 18 March 2013, HBMRI’s investigation team boarded Norwegian Jade during her arrival at Katakolo port and witnessed the berthing procedures, that are presented in the following table:

Table 3. Abstract of arrival mooring procedures monitored and recorded by the Investigation Team of HBMRI

Time	Procedures – actions	
0710	Pilot & HBMRI Investigation team embarkation	
0715	Attendance of mooring procedures Fore & Aft	
	<b>Fore mooring station</b> <b>Second Officer in Charge</b>	<b>Aft mooring station</b> <b>Bosun in Charge</b>
0725	sending ashore heaving line of no 2 fore spring line guided through the panama chock	
0727	no 2 fore spring line fastened on dock bollard. Sending heaving line ashore of two breast lines	two aft spring lines ashore by heaving line / positioned on same dock bollard
0730	No 2 fore spring line heaved and tensioned both breast lines ashore	Aft spring lines fastened on dock bollard by mooring gang

0732		two breasts lines released
0734		one spring line heaved, tensioned and secured by <b>Brake</b>
0735	two head lines released ashore	
0736		breasts lines fastened on bits by shore personnel
0737-8	breast lines heaved, tensioned and secured by <b>Brake</b> / Heaving head lines	breasts lines heaved, tensioned and secured by <b>Brake</b>
0738	no 2 fore spring line secured by <b>Brake</b>	first stern line released
0739	head lines on <b>Brake</b>	
0740	lowering of no 1 fore spring line	first stern line fastened on dock bollard
0741	mooring platform closing	
0742	no 1 fore spring line tensioned and secured by <b>Brake</b>	First stern line heaved, tensioned and secured by <b>Brake</b>
0742		second stern line ashore
0743-4		second long line fastened on dock bollard
0745		second long line heaved, tensioned and secured by <b>Brake</b>
0747		heaving second slacked Spring Line
0747-8		second spring line heaved, tensioned and secured by <b>Brake</b>

Considering the above, the following are summarized:

- berthing procedures lasted for 25 minutes;
- mooring teams were well organized and familiar with the process;
- Officers in Charge controlled the procedures efficiently;
- bridge supervision and communication with the mooring teams was sufficient;
- ship correctly positioned;

In respect to the above it follows that the mooring plan was adequately implemented as projected.

#### 4.5.2 Warping procedure planning

Warping vessels on mooring lines should be viewed as a different procedure from the berthing operation. Warping operation along the face of the berth is considered an interacted procedure as fore and aft mooring lines have to be properly handled and set before its completion whilst loads have to be equally distributed to the mooring configuration.

A shifting operation depends on various factors such as weather conditions, other vessels at berth, type and size of the shifting vessel and any special condition relating to it, the shifting distance, the dock layout and the safety of the operation.

In regard to the above several Port Authorities have incorporated specific measures in practices and procedures for shifting operations such as pilot embarkation, use of port tugs and mooring gangs.

In consideration of the aforesaid, shifting or warping procedure is highlighted as a shipborne operation and should be adequately integrated in ships safety management procedures.

In the examined case the warping requirement was of a slight distance, of approximately 1 m and it was decided to be carried out only by Norwegian Jade's mooring equipment and personnel without informing the Port or Coast Guard Authority as it was not required, nevertheless the mooring gangs still on berthing dock, were not notified either.

Furthermore it was reported that the warping operation was considered as a part of the mooring procedure that was about to be completed as it was only no 2 fore spring line remained to be heaved and secured after closing the mooring platform.

Resultantly the instructions given by the bridge were generic and the operation was left to be performed under the experience and knowledge of the Officers in charge of the mooring teams



while no risk assessment was reported to have been carried out, in order to identify any potential hazards or risks to mooring personnel or equipment.

Nevertheless, given the evolution of the events, the warping operation was not safely completed as certain measures or safeguards were not taken under consideration as neither by the supervising bridge Officer and Master nor by the Officers in charge of the mooring teams.

Having evaluated the actions carried out in relation to Norwegian Jade's mooring equipment and mooring deck layout as well as the berthing dock layout it was denoted that an extra fore spring line could have been released ashore prior to shifting in order to service and contribute to the restraint capacity of no 2 fore spring line as the securing of the tensioned aft spring lines could have undoubtedly anticipated greater forces than usual when the ship would be "in position" by the applied loads of the tensioned and secured aft springs lines, aft breast lines and stern lines.

It is to be noted that the forward motion of Norwegian Jade generated, following the failure and parting of no 2 fore spring line was restrained by no 1 spring line, being slacked until that time, as concurrently the aft spring, breast and stern tensioned lines, got slightly slacked as the vessel shifted forward and consequently stopped from acting forces upon no 1 single headspring. A second additional spring line was released and secured post to the occurrence, guided through no 5 panama chock, mounted forwardly of the roller fairlead that serviced the restraint capacity of no 1 fore spring line, as shown below. (figure 25)

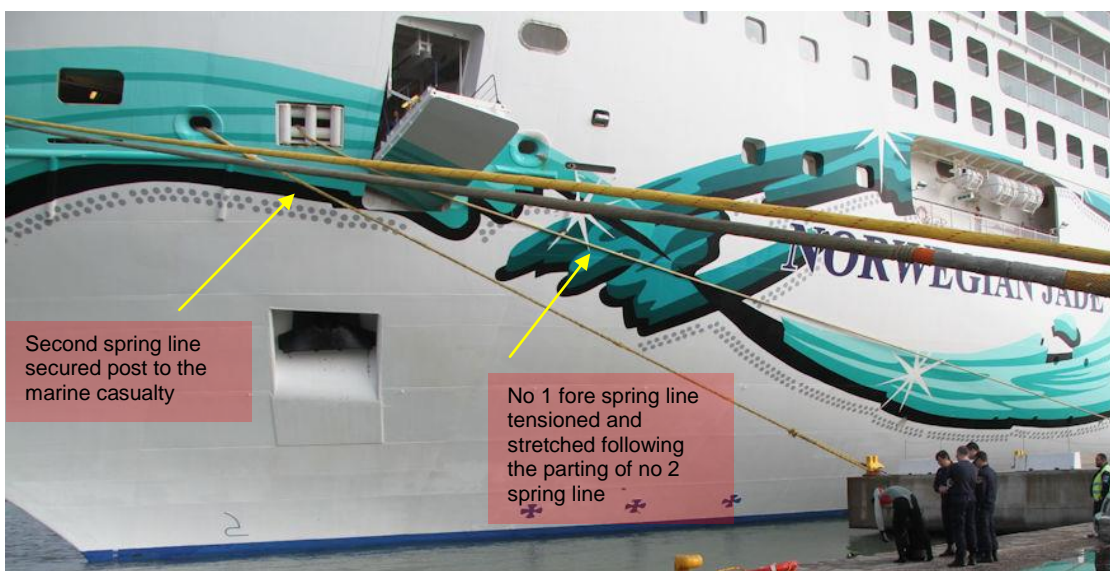


Figure 25. Port bow's mooring configuration post to marine casualty

#### 4.5.3 Communication

As already reported in par. 4.5.1 the communications established by portable VHF during the mooring operation were effective. The Officers in charge of both mooring teams were maintaining communication and coordination with the Staff Captain on the Bridge, reporting the ongoing procedure. The Staff Captain was respectively reporting to Master and relaying his orders to the Officers in charge.

Howbeit having regard to the references outlined in par. 4.5.2 and to the resulted marine casualty, it is suggested that communication for reporting the executed actions by the mooring stations to the Staff Captain that was practiced during the interacted warping operation in relation to mooring lines handling and securing as well as winch band brake setting was not effective.



#### 4.5.4 Risk assessment process

The International Safety Management Code (ISM Code-SOLAS 74), as applied in Chapter. 1.2.2 & 1.2.2.2 states that: *“The Safety Management objectives of the Company should inter alia assess all identified risks to its ships, personnel and the environment and to establish appropriate safeguards”*.

Even though, the ISM Code does not provide any further explicit reference apart from the above general requirement, risk assessment<sup>11</sup> or risk analysis is fundamental for the compliance with most of the Code’s clauses.

It is to be noted that although there is not an exact formal definition of risk, IMO defines it as: “The combination of the frequency and the severity of the consequence”<sup>12</sup>

The risks concerned are those that are reasonably expected and are related to shipborne procedures or operations in respect to:

- the health and safety of all those who are directly or indirectly involved in the activity, or who may be otherwise affected;
- the property of the company and others;
- the environment.

A hazard could be defined as a situation or practice that has the potential to cause harm. Hence a risk analysis process or management of risk could concisely include the following phases:

- ✓ the identification of hazards;
- ✓ the assessment of the risks associated with those hazards;
- ✓ the application of controls to reduce the risks that are deemed intolerable. The controls may be applied either to reduce the likelihood of occurrence of an adverse event, or to reduce the severity of the consequences;
- ✓ the monitoring of the effectiveness of the controls.

The ISM Code does not lay down any particular venue models to the management of risk and therefore the company is to stipulate methods in view of its organizational structure, its ships and operations. The methods should be systematic, if assessment and response are to be complete and effective, and the procedures should be documented so as to provide evidence for the decision-making process.

Norwegian Jade, as already mentioned, was operating under an electronically based application of her “Safety and Environmental Management System – SEMS” utilizing, integrating and multitasking projected procedures.

The risk assessment policy was thoroughly promulgated through her SEMS providing procedures for conducting risk assessments to key shipboard activities by the safety or responsible officers and to be recorded in specific checklist and documented.

Nevertheless the standard risk assessment procedure had not identified any specific risks related to the mooring platform. Likewise, prior to the ship entering the port of Katakolo at the day of the marine casualty, a risk assessment process was not performed and recorded by the competent Officer as it did not deem necessary, taking into account that the actual weather conditions were good and no risk was foreseeable that could trigger any additional controls or measures.

It was reported that a thorough briefing of the involved crew was carried out during pre-arrival procedure under established good practice prior to each mooring operation. Following said briefing the deck mooring teams were mustered at the mooring decks and the usual setting up of the mooring lines and equipment prior to the ship’s approach to port was followed.

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<sup>11</sup> Risk management may be defined as: “The process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence.” (ISO 8402:1995/BS 4778)

<sup>12</sup> Reference to (MSC Circ.1023/MEPC Circ.392)

#### 4.5.4.1 Mooring Platform position

Furthermore, during the investigation process “on scene” it was stated that the standard risk assessment process that had been applied for the mooring operation and the deck mooring crew, had not identified any risks or hazards related to the mooring platform as a potential snap-back zone in case a mooring line or spring line parts.

In respect to the above it is suggested that if the mooring platform had been assessed and classified as snap-back dangerous zone, effective preventive controls or measures could have been taken in order to eliminate any risk of injury or casualty to the Officer in Charge stationed on it during the mooring operations or to any member of the fore mooring team that had to work on it for a certain time interval.

Such measures could include:

- increase of guard rails’s height so as to safeguard an individual stationed or standing on it;
- limited time stay for any crew member and only for mooring operational purposes;
- no-crossing or stationary area for crew during hauling or tending line operation.

In addition to the above and despite the fact that the sequence of the events leading to the occurrence indicated that the need to shift Norwegian Jade backwards arose prior to her berthing completion and thus the procedure followed was included in the standard mooring operation, it is suggested that the Master and the Staff Captain should have provided detailed instructions to the Officers in Charge and had closely supervised the procedure from bridge port wing (figure 26) for the close coordination of both mooring teams during the interacted warping procedure, so as to ensure that it is being safely performed.



Figure 26. View from the supervision position at port bridge wing at Katakolo Port

#### 4.5.4.2 Snap-back danger zones<sup>13</sup>

During mooring operations mooring lines can pose a great risk to mooring personnel if not properly used. A significant danger is snap-back, that is the sudden release of the energy stored in the tensioned mooring line when it breaks.

When a line is loaded it stretches. Energy is stored in the line in proportion to the load and the stretch. When the line breaks, this energy is suddenly released. The ends of the parted line snap back striking anything in its path with significant force.

Snap-back is common to all lines. Synthetic lines are more elastic and thus the danger of snap-back is more severe.

As stated, Norwegian Jade used High modulus synthetic fibre ropes (HMPE) of high performance. However, snap-back from these ropes will generally be along the length of the line.

Crew engaged in mooring operations and lines' handling must stand away of the potential snap-back direction, which extends to the sides of and far beyond the ends of the tensioned line.

A broken line will snap back beyond the point at which it is secured, possibly to a distance almost as far as its own length. If the line passes around a fairlead, then its snap-back path may not follow the original path of the line. When it breaks behind the fairlead, the end of the line will fly around and beyond the fairlead.

However it is not always possible to estimate all the potential danger zones from snap-back lines, thus crew personnel should be kept away from any line under tension while keeping in mind the following tips<sup>14</sup>:

- ✓ be familiar of the potential snap back zones under the actual mooring configuration;
- ✓ be aware of all the executing operations;
- ✓ passing close to a line under tension should be as quickly as possible;
- ✓ standing or passing near a line while it is being tensioned or while the ship is being moved along the pier should be avoided;
- ✓ tasking near a line under tension, should be done promptly and the danger zone should be cleared out as soon as possible. The activity should be planned before approaching the danger zone;
- ✓ undertaken activities or line handling should be done under a safe manner.

#### 4.5.4.3 Recommended practices highlighting snap-back zones as hazardous areas

As mentioned above parting lines' snap-back zones are considered to be deck areas of high risk and could pose great dangers to human life.

Marine casualties caused during mooring operations have been a major issue of concern for many stakeholders of the shipping industry such as Shipping Administrations, Recognized Organizations, P&I Clubs, ships owners and operators, Forums and so forth and on that account many studies have been carried out on the grounds of occupational marine accidents' statistics that have led to published guidelines and advisory notes.

According to an indicative study produced by a Club and based on statistics of occupational marine accidents occurred during mooring operations on board its listed vessels for the years 2000 to 2009, 53% were caused due to parted mooring lines or wires, 5% was attributed to mooring equipment failure while 42% were associated with falls, jammed on equipment cases, caught up by rope bights incidents etc.

The various studies and analysis on aforementioned issue based on useful lessons learned, have presented a cluster of recommendations of precautionary and preventive measures and

<sup>13</sup> Reference to OCIMF "Mooring equipment guidelines – 3<sup>rd</sup> edition" Chapter 6.1.1

<sup>14</sup> Maritime and Coastguard Agency Marine Guidance Note 308 as well as guidelines by Clubs and ROs

safeguards, including the marking<sup>15</sup> of the dangerous snap-back zones as a good practice for avoiding crew injuries during mooring operations.

The marking of mooring lines' snap-back zones has been established as a good practice on board ships by many operators and is largely implemented notably for liners berthing alongside in the same mooring set-up. Painted dangerous deck areas can be a significant safeguard for mooring crew safety performance. It is to be noted that although qualified seafarers, familiar with a vessel mooring arrangements and operations are aware of the fact that a snapback zone exists when a mooring line is under tension, however, it is doubtful if they take this into account when they are engaged in the mooring operation on deck. On above grounds snap back zones' marking practice could ensure:

- ✓ a good reminder for the Officer in charge of the mooring operations to conduct a briefly meeting on the spot before the mooring operation commences;
- ✓ a practical hint and warning for the Officer supervising the mooring operation to constantly instruct crew members to keep clear when lines are coming under tension;
- ✓ crew alertness when standing in a highlighted zone;
- ✓ crew being able to visibly see the hazardous areas without having to intentionally consider about them while performing tasks.

The snap-back zones on the covered mooring decks of Norwegian Jade were not marked or painted.

It follows that safeguards and preventive measures in order to avoid the dangerous snap-back zones was left to the knowledge and experience of mooring teams members and the Supervising Officers as well as to the familiarization and implementing procedures regarding the mooring operation by the involved personnel.

#### **4.5.4.4 Shifting - Warping operation risks**

Shifting - warping operation as shipborne procedures should be subjected to a systematic and documented assessment of risks and hazards in order to set measures and controls for its safely execution.

It was highlighted that the warping process performed by Norwegian Jade's deck crew was not managed under any evaluation of risk. The lack of properly implementing the risk assessment relevant provisions is considered to has been a contributing factor in the marine casualty.

#### **4.5.5 Mooring procedures & personnel's safety**

Mooring procedures involves many aspects of ship's equipment as well as skilled and qualified crew and careful consideration should be taken for safe berthing and unberthing operations. Such procedures may include the establishment of a mooring pattern or mooring plan that is to be documented and followed when berthing at a port.

##### **4.5.5.1 Mooring arrangement & pattern practice**

A safe mooring arrangement depends on various factors such as size and type of the moored ship, mooring ropes specifications and equipment, protected port and dock, dock layout and port withstanding weather conditions such as wind, swell or wave forces and current.

Mooring pattern does not fall under any regulations to be implemented as it could only follow the qualification status and good seamanship of Master and crew as well as established procedures by a ships Safety Management System.

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<sup>15</sup> Reference to: Seahealth Denmark "Mooring - Do it safely"  
Maritime and Coastguard Agency Marine Guidance Note 308 par. 5.2, 5.3, 5.4  
The International Marine Contractors Association par. 2.5



Amongst the aforementioned factors, mooring lines' handling is of paramount importance due to the fact that it is directly related with deck personnel's safety.

Basic guidelines for optimizing mooring lines handling and their load distribution, may include the following<sup>16</sup>:

- (1) mooring lines should be arranged as symmetrical as possible about the midship point of the vessel;
- (2) breast lines should be orientated as vertical as possible to the longitudinal centre-line of the vessel and as far as possible close to bow and stern;
- (3) spring lines should be orientated as parallel as possible to the longitudinal centre-line of the vessel;
- (4) head and stern lines should generally directed ashore at an angle of 45° to the longitudinal center line.  
This means that a vessel can be moored most efficiently within its own length.
- (5) the vertical angle of mooring lines should be kept to a minimum as far as possible. The flatter a mooring line is oriented, the more efficient it is in resisting horizontal loads acting on the vessel.
- (6) mooring lines should be arranged in a manner that when used for the same restraint purpose, about same length between the vessel's winch and the quayside bollard should be used.
- (7) good and equal line tending to ensure share of loads to the maximum extent possible.
- (8) in practice, the final selection of the mooring pattern must also consider local operational requirements, weather conditions, dock geometry and ship's design.

#### 4.5.5.2 Norwegian Jade mooring pattern

The regular mooring pattern that Norwegian Jade was practicing at Katakolo port, was utilizing ships equipment and lines as follows:

- (1) the forward center mooring winch for handling two head lines, usually secured on the same quayside's bollard (figures 2, 23);  
two pedestal fairleads, mounted approximately 3 m ahead of the winch tension drums, were used to direct the two headlines passing through the forward port no 2 double roller chock, fitted 3 m from ship's stem post.(figures17, 27)



Figure 27. Fore mooring winch and mooring equipment arrangement as seen from stem post section

- (2) the port mooring windlass at the berthing side for handling the two headsprings (fig. 15);

<sup>16</sup> Reference to OCIMF ch. 1.5

- no 1 headspring (fore spring line) was directly guided from the tension drum to no 6 port double roller chock, mounted slightly ahead of the mooring platform's opening (fig.17,23) ; no 2 headspring (fore spring line) was led off the tension drum and passing anticlockwise on a pedestal fairlead fitted abreast of the port windlass pedestal control post and passed clockwise from a second pedestal fairlead, fitted at the port aft area of the mooring deck, close to the mooring platform and guided to no 7 panama chock, mounted at the last port aft section of the bow's bulwark (fig. 17, 23);
- (3) the windlass reciprocal to berthing side for handling the breast lines;  
both breast lines were led off the tension drum directly to no 4 port double roller chock and guided to quayside bollards (fig. 2, 17).

#### 4.5.5.3 Mooring procedures

Mooring procedures are inherent to ISM Chapter 7 "*Development of plans for Shipboard operations*" by which it is stated that:

*"The Company should establish procedures for the preparation of plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the ship and the prevention of pollution. The various tasks involved should be defined and assigned to qualified personnel".*

Based on the above an indicative and not exhaustive set of practices, as it is considered essential to be guided by good seamanship that could accommodate the mooring procedures are cited:

- (1) planning and supervision;
- (2) proper communication;
- (3) competency of personnel;
- (4) sufficient members in the mooring teams;
- (5) familiarization with ship's mooring equipment and any specific shore requirements relating to shore moorings;
- (6) weather conditions forecasted and actual;
- (7) clear layout on deck prior operations;
- (8) the use of proper personal protective equipment;
- (9) identification and monitoring of dangerous zones during mooring operations;
- (10) quick and close communication between stations;
- (11) identification, evaluation and recording of any unsafe situation;
- (12) conducting a Formal Risk Assessment for each type of mooring patterns / arrangements, to assess and minimize risk to crew associated with the operation.

The mooring operations of Norwegian Jade were performed under standardized practices as ports of calls were regular.

The followed procedure, under the implemented scope of ship's Safety & Environmental Management System, was practicing the below:

- fore mooring team composed by six deck crew members, supervised by the Second Officer reporting to Staff Captain,
- stern mooring team composed by six deck crew members, supervised by the Bosun reporting to Staff Captain,
- procedure controlled by Staff Captain reporting to Master and relaying his orders to Officers in Charge of the mooring teams,
- communications established via portable VHF.

Based on collected data during the investigation and interview process as well as on the development of the events at the day of the casualty, it follows that Norwegian Jade's mooring

teams were sufficiently manned, personnel involved was qualified and familiar with the mooring operation and equipped with personal protected equipment. Communications were well established with the bridge and Staffed Captain. The weather conditions were not posing any particular problems or risk as evaluated by Master and mooring planning was to be performed under the normal process.

The temporal order of actions performed, as stated when the ship was close to berth are referred below:

- (1) throwing the first heaving line attached with no 2 forward spring line from the mooring platform,
- (2) throwing the heaving line of two aft spring lines from the stern secured on the same dock bollard,
- (3) lowering the two fore breast lines ashore to be secured on the same dock bollard,
- (4) releasing of two aft breast lines to be secured on the same dock bollards,
- (5) hauling in and tensioning no 2 fore spring line and aft spring lines, securing of the spring lines by setting the band brake mechanism when the ship is in position,
- (6) hauling in, tensioning and securing of fore and aft breast lines, set of band brakes,
- (7) sending the head lines and aft lines ashore, hauling in, tensioning and securing by setting the band brake,
- (8) sending no 1 fore spring line ashore,
- (9) handling the heaving lines send ashore,
- (10) hauling in no 1 fore spring line,
- (11) closing the mooring platform,
- (12) tensioning and securing no 1 fore spring line by setting the band-brake mechanism.

The process of line tensioning and securing required the winch setting up to 50% of its nominal pulling force, that is 175 kN, applying the band brake and declutching the drum from the motor drive by properly setting the dog clutch.

Having regard to the aforementioned it is suggested that the mooring procedures that were carried out prior to the marine casualty in combination with the warping process did not practice the identification and monitoring of dangerous zones; quick and close communication and coordination between the mooring stations; the identification and evaluation of any unsafe situation and foremost the conduct of a Risk Assessment to assess and minimize risks and hazards to crew engaged with the operation.

#### 4.5.6 Parting of the spring line

As mentioned above, the warping operation to move Norwegian Jade backwards was performed by heaving no 2 fore spring line since the shifting distance was between 1 to 2 m. By that time the main engines were stopped and no 1 fore spring line was slacked and could not service the operation since it was blocked by the opened mooring platform.

According to the operator of the port bow winches the maximum pulling force developed during the tensioning of no 2 fore spring line did not exceed 70% of the nominal pulling force of the winch, that is 245kN. It was reported that in cases the winch load reached 50% of the maximum pulling force of the winch he was informing the Officer in Charge.

However, when no 2 fore spring line was secured by applying the band brake the indicator showed 50% of the nominal pulling force, that is 175kN. As soon as the warping operation was about to complete and Norwegian Jade was in position, the Staff Captain ordered the Officers in charge of the mooring teams to secure the mooring lines.

The mooring configuration at that time just prior to the occurrence could be considered to have a serious effect on the loads applied on the secured headspring under tension, as it was the only

mooring mean to prevent ship's potential forward motion that could result either by the effect of the short swelling in the port or by the applied forces of the secured six stern tensioned lines that were actually functioning to some extent as backsprings.

On the grounds of the above the failure of the winch band brake to properly operate and render no 2 fore spring line when overloaded and before the critical point of parting, is presumed to have been a contributing factor in the marine casualty.

#### 4.5.6.1 Fore and aft mooring team actions

The exact actions of the fore mooring team by the time no 2 fore spring line parted could not be determined. As stated during the interview process the securing of the head lines, breast lines and no 2 fore spring line had been completed and the team was preparing the hauling in and tensioning of no 1 fore spring line in order to secure it after closing the mooring platform.

By that time when no 2 fore spring line parted the members of the fore mooring team were stationed as shown in figure 23 and reported below :

- the Second Officer (1) was stationed at the edge of the mooring platform supervising and commanding the procedure following instructions ordered by the bridge,
- the casualty OS (2), was standing on the mooring platform and close to its opening handling the heaving lines used,
- an AB (3), was stationed on the winch control post operating the port winch,
- two ABs (4) and (7), were setting the band brakes and winch clutches,
- two ABs (5) and (6), were assisting the process standing close to roller fairleads.

Similarly, the actions of the aft mooring team by the time no 2 fore spring line parted were not possible to be exactly determined.

However taking into account that the warping operation had been completed it could be inferred that aft lines were tensioned and crew was handling the band brakes for securing the lines.

Furthermore, it became evident through the interview process that the mooring gangs servicing the berthing procedure of Norwegian Jade's fore and aft mooring teams were not informed for the warping process by the Officers in charge of the mooring stations or by any of her crew members. It was reported that a member of the fore mooring gang had accidentally stepped aside from parted lines snap back zone towards the dock.

Based on the above it follows that the lack of informing mooring dock personnel for ship's warping operation could have caused injuries to a mooring gang member.



**Figure 28:** The fore mooring deck of Norwegian Jade with the positions of the crew at the time of the marine accident



#### 4.5.6.2 Aft mooring lines effect

As already reported Norwegian Jade's longitudinal dimension was exceeding the length of her berthing dock, hence apart from the two aft spring lines, the two breast lines and the two stern lines were oriented forwardly under acute angles, as shown in figure 29.

Bearing in mind that at the time no 2 fore spring parted, the release of its tension allowed Norwegian Jade to move forward, it is highly possible that the retraction of aft spring and breast lines as well as stern lines, secured on the winches caused the development of overloaded tension to the foreward spring line which led to its rupture.

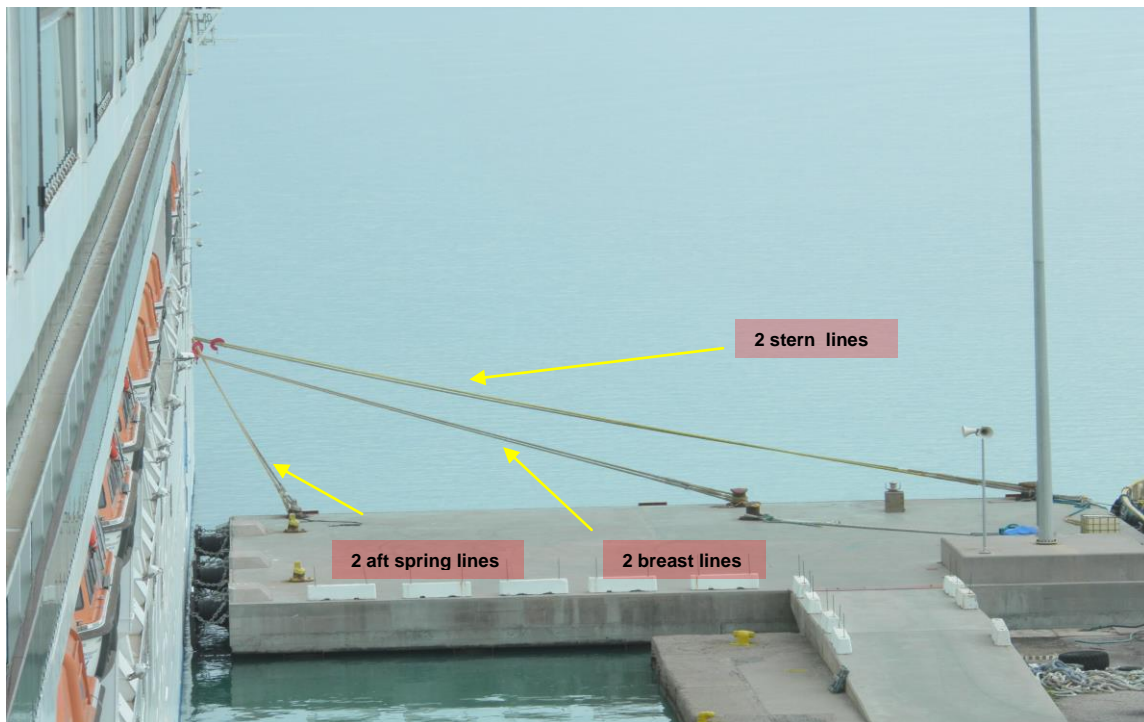


Figure 29. Aft mooring lines configuration. Breast and stern lines forwardly oriented.

For the consideration of the above mentioned condition a theoretical approach is followed, in which the following parameters were taken into account:

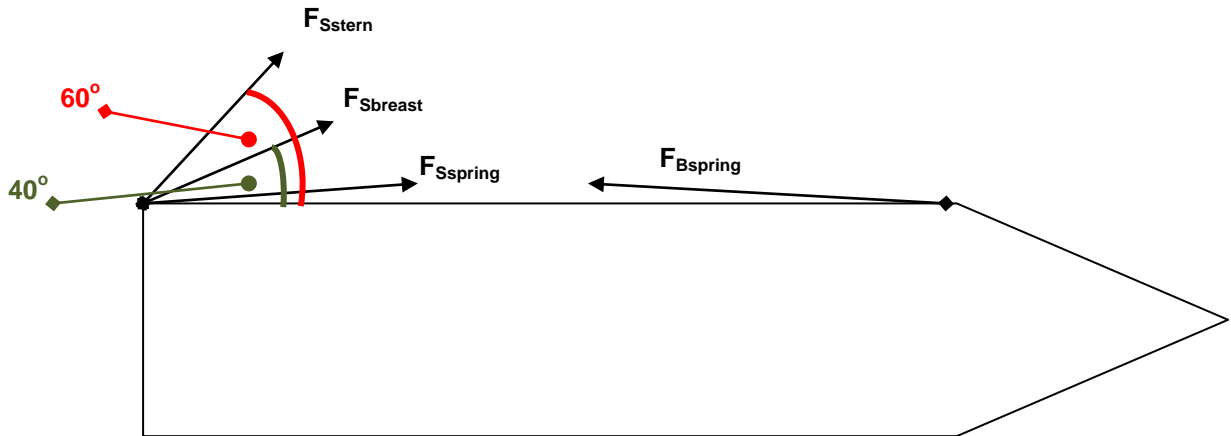
- the MBL minimum required force for the parting of the spring line, that is 1270kN,
- the nominal pulling force of the stern winches which is equal to 350kN,
- the fact that according to the usual practice followed by the crew of Norwegian Jade, the securing of the brakes was applied after the tensioning of the mooring ropes with a force equal to 50% of the nominal pulling force of the winch, that is 175kN,
- the angles formed by the stern lines to the longitudinal axis of the ship. Specifically, the angles of the aft breast lines and stern lines, were considered equal to 40° and 60° respectively.

Additionally, since the precise determination of all parameters was not possible, the worst case for the loads that were developed on the forward spring line by the forcing effect of the stern lines was presumed, as follows:

- the angle of the aft spring lines to the longitudinal axis of the ship was considered equal to 0°. Therefore, the longitudinally to the ship applied force during the retraction of no 2 spring line is considered to be equal to the pulling force of the winch and;
- the vertical component force due to the height of the mooring deck from the pier was considered negligible.

Based on the above and considering that during the rupture of no 2 fore spring line, three aft lines (1 stern, 1 breast and 1 spring) were secured on the brake as the remaining respective three aft lines (1 stern, 1 breast and 1 spring) were not secured yet and the pulling force by the winch was only applied, the maximum potential total longitudinally applied force at the stern lines, is calculated by the following formula:

$$F_{stern} = F_{Sspring} + F_{Sbreast} + F_{Sstern} = (175+175) + [(175+175)\cos40^\circ] + [(175+175)\cos60^\circ] = 350 + 268 + 175 = \mathbf{793 \text{ (kN)}}$$



**Figure 24:** descriptive design of applied forces on “NORWEGIAN JADE”:  
 F<sub>Sbreast</sub>: Force applied by the stern breast lines  
 F<sub>Sstern</sub>: Force applied by the stern lines  
 F<sub>Sspring</sub>: Force applied by the stern spring lines  
 F<sub>Bspring</sub>: Force applied by the forward spring lines  
 It is noted that the angles of the spring lines and the vertical angles are considered to be negligible

It is noted that for the identification of the cause of the spring line’s rupture, the function of the service brake holding capacity is an important factor. However, its determination was not possible due to the lack of proper equipment. Therefore the initial value set by the manufacturer (60% MBL) is considered, that is 840 kN for a MBL equal to 1400kN.

Following the above it derives that the theoretically calculated total longitudinal force by simultaneous retraction of all three stern lines (spring line, breast line, stern line) approximates the value of **793kN**, which accounts for a percentage of **62,4%** of the MBL of the forward spring line. Hence it follows that the resultant force of the stern lines can not cause by itself the parting of the forward spring line. Additionally, it is also taken under consideration that band brake mechanism would have slightly rendered the line, provided that it was properly operating.

Given the above it is concluded that the maximum force which could be developed by the stern lines could not had been the sole cause for the rupture of the forward spring line. However, its contribution cannot be excluded, combined with the short swell the ship’s stern was encountering (§ 4.3.2), the condition of the spring line (§ 4.4.4.3) and possible malfunction of the brake mechanism (§ 4.4.4.2).

Consequently it appears that in addition to the developing loads by the stern lines applied to the ship, one or more of the above factors contributed to the rupture of the spring line.

#### 4.6 Emergency response actions

Following the marine accident the fore mooring team was alerted, two lifebuoys were thrown overboard and the incident was reported to the Bridge. "CODE OSCAR" and "CODE ALPHA", was called by public address system and competent crew was mobilized. The medical team was assembled and “Man OverBoard” search and recovery operation was commenced by launching two ship’s rescue boats.

Shortly after the marine accident HCG Officers dived into the sea in order to rescue and recover the casualty. However being unconscious he was instantly sunk.

The Coast Guard Authority was notified and activated the provisional “Emergency Response Plan” by mobilizing the S&R HCG Boat and reported the marine casualty to S&R Operational Center of HCG. A diving team was immediately deployed and participated in the underwater searches. The casualty body was recovered about two hours later by HCG diving team as he the recovery of the casualty was accomplished almost two hours after the incident by the.

The standard protective equipment of deck crew for mooring operations included suitable clothing, gloves and helmet.

However it was a practice on board Norwegian Jade not to wear life vests during the mooring operations.

It follows that if the casualty was wearing a life vest he could had remained afloat and his recovery although fatal injured would had been promptly.

Nevertheless there was no requirement for the fore mooring team and the Officer in Charge to wear lifejackets.

It is noted that a lifejacket could maintain the casualty body afloat and would had facilitate his immediate recovery.

#### **4.7 Norwegian Jade´s key personnel**

##### **The Master**

The 49 years of age had been contracting with the Company for 14 years. He received his Master License in 1994. He first served as a Master in 2008 and on board Norwegian Jade in 2010. He was a qualified and experienced Master.

His contracts were based on a three months on-three months off service.

Katakolo port was a regular port of call and he was familiar and experienced with ports and dock layout.

##### **The Staff Captain**

The Staff Captain aged 51, was also an experienced seafarer, with 23 years of sea service all in cruise ships. He was a holder of a Master CoC. He had been contracting with the managing company of Norwegian Jade since November 2003 mainly on a service pattern of three months on – three months off.

He had joined Norwegian Jade on January 2013, that is, 2 months before the marine accident.

##### **The Second Officer**

The 28 years of age Second Officer was on his first contract as an Deck Officer. However he had been contracting with the managing Company for three years as an Apprentice Officer. He was running his fifth month of service on board Norwegian Jade. He was performing OOW duties and he was the Officer in charge of the fore mooring team.

##### **The Bosun**

The Bosun aged 53, started his seafarers career in 1978 having served in various types of vessels such as bulk carriers, containers, chemical tankers, heavy lift ships. He had also served on passenger vessels for about 12 years. He had been contracting with Norwegian Jade´s Company since 2009 mainly on a four months on – two months off service pattern.

### **The Casualty**

The OS fatal injured during the marine casualty was running his fifth month in service on board Norwegian Jade. It was reported that he was familiar with the ships mooring operations according to ship's procedures.

### **The ABs of deck mooring teams**

Based on the collected data the crew members of the mooring teams had the appropriate Certificates of Competency and before taking over their duties as part of the bridge navigational teams and the mooring team they had completed the familiarization period provided with the vessel's operations. It was also reported that most of them were permanently contracting with the managing Company for servicing on board Norwegian or on others of its managing cruise ships.

### **4.8 Working language**

Norwegian Jade working language as recorded in her Log Book was English. Master, Officers and deck crew members could speak and communicate fluently in English.

### **4.9 Fatigue**

The examination of the working and resting hours of key personnel involved in the marine casualty, the Company's recruiting policy of personnel as well as the interview process did not show that fatigue was a contributing factor to the marine accident.



**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.**

## 5. Conclusions

### 5.1 Conclusions and safety issues leading to safety recommendations

1. The MBL of the spring line was less than the MBL for the calculation of the design and service brake holding capacity that are specified by the winches' manufacturer (§ 4.4.3.1, § 4.4.3.2).
2. The parted spring line was in good condition. However, possible internal wear or deformation of the rope at the rupture point prior to the accident, cannot be excluded (§ 4.4.3.2, § 4.4.4.3).
3. The vessel was not equipped with a special brake test kit recommended by the manufacturer for checking and accordingly adjusting the winches's band brake holding capacity (§ 4.4.4.1).
4. The ship had not implemented a documented inspection and maintenance system for the mooring lines (§ 4.4.4.3).
5. The mooring platforms were not assessed and identified as dangerous - snap back zone - area (§ 4.5.4.1, § 4.5.4.2, § 4.5.4.3, § 4.5.4.3).
6. The mooring personnel stationed or standing on mooring platform during berthing operations is not protected from parting lines snapping back (§ 4.4.1, § 4.5.4.1).
7. The secured headspring under tension was the only mooring mean to prevent ship's potential forward motion (§ 4.5.6).
8. The headspring line was already secured by the band brake when parted however the line was not rendered (§ 4.5.6).
9. The warping operation was considered as a part of the mooring procedure and the instructions given by the bridge were generic (§ 4.5.2).
10. The interacted warping operation was mostly performed under the experience and knowledge of the Officers in charge of the mooring teams (§ 4.5.2).
11. No risk assessment was carried out, in order to identify any potential hazards or risks to mooring personnel or equipment prior to warping operation (§ 4.5.2, 4.5.4.4).
12. The reporting communication for executed actions by the mooring stations was not effective. (§ 4.5.3).
13. No risk assessment was conducted for the mooring at Katakolon port (§ 4.5.1).
14. The maximum force that could theoretically be developed to the vessel longitudinally by the retraction of the stern mooring lines could not be considered as a sole causal factor for the parting of the spring line as it could not exceed 62,4% of the spring line's MBL (§ 4.5.6.1).
15. The rupture of the headspring could have been caused due to a combination of factors such as the short swell the ship's stern was encountering (§ 4.3.2); the condition of the spring line (§ 4.4.4.3); the possible malfunction of the brake mechanism (§ 4.4.4.2); and the applied forces by the secured six stern tensioned lines that were actually functioning to some extend as backsprings (§ 4.5.6, § 4.5.6.2).

16. The personnel stationed or undertaking tasks at mooring platforms was not equipped with a life jacket (§ 4.6).

## 5.2 Conclusions and safety issues that did not lead to safety recommendations

1. All stern mooring lines were directed forwardly towards Norwegian Jade's bow as her longitudinal dimension exceeded the length of the berthing dock (§ 4.2, § 4.5.1, § 4.5.3).
2. The low port swell may have had an effect on ship's forward motion during her warping operation (§ 4.3).
3. The service and design brake holding capacity of the winch band brake mechanism create two levels of safety for the prevention of rope rupture with safety factors equal to 1,6 and 1,25 respectively (§ 4.4.3.1).

## 6. Actions taken

According to information provided by the managers of the vessel, following the marine casualty NCL has taken following actions:

- A documented planned maintenance system for the mooring lines has been implemented fleetwide.

## 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 owners/managers of Norwegian Jade are recommended to:

- 47/2013 Review the applied mooring equipment inspection system for winches band brake mechanisms by focusing on the configuration of value settings corresponding to MBL of servicing mooring lines.
- 48/2013 Review the Safety and Environmental Management System taking under consideration the good practices for highlighting snap back zones as hazardous areas.
- 49/2013 Supplement standing shipborne operation procedures by incorporating shifting/warping operations planning and risk assessment analysis.
- 50/2013 Take necessary safeguards and preventive measures for mooring personnel protection when stationed or standing at mooring platforms.
- 51/2013 Emphasize through training or familiarization procedures that snap-back zones are high risk deck areas that could pose great dangers to human life.
- 52/2013 Take effective measures to reassure that mooring deck personnel is equipped with life vests during mooring operations.

### 7.2 The Master of Norwegian Jade is recommended to:

- 53/2013 Review the mooring plan for Katakolo port or for ports with similar dock layout and mooring configuration patterns based on the findings as presented in respective sections of the report.

**7.3 The Port Authority of Katakolo is recommended to:**

54/2013 Consider of installing a mooring buoy at the head of the inner dock for facilitating the berthing of cruise ships with length exceeding the docks length.

**7.4 The Coast Guard Authority of Katakolo in cooperation with the competent Directorate of the Hellenic Coast Guard is recommended to:**

55/2013 Consider of drafting a port regulation for mandatory reporting by cruise ships or other commercial vessels indented shifting/warping operation by incorporating measures as referred in par. 4.5.2.

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