The Bahamas Maritime Authority

Marine Safety Investigation Report

into an inadvertent steam release, resulting in a fatality on Navigator of the Seas, 14 July 2020

The Bahamas conducts marine safety or other investigations on ships flying the flag of the Commonwealth of the Bahamas in accordance with the obligations set forth in International Conventions to which The Bahamas is a Party. In accordance with the IMO Casualty Investigation Code, mandated by the International Convention for the Safety of Life at Sea (SOLAS) Regulation XI-1/6, investigations have the objective of preventing marine casualties and marine incidents in the future and do not seek to apportion blame or determine liability.

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Contents

1. Summary 1
2. Factual Information 2
3. Analysis 10
4. Conclusions 17
5. Lessons to be learned 18
6. Actions taken 19
7. Recommendations 20
8. Glossary and Definitions 21

1. Summary

What happened

On 14 July 2020, the Bahamas registered passenger vessel, Navigator of the Seas, was at anchor off CocoCay, The Bahamas. In preparation for inspection and maintenance, feedwater tank 1 had been emptied, confined space entry paperwork had been completed and the deck team assigned to the task had discussed the hazards and control measures identified in the job safety analysis. Initial entry was made at 10:00 and the space deemed safe for work.

At 10:43, with three crew members inside, there was a sudden release of steam into the tank. All three managed to exit the tank but two seafarers suffered significant burns. Both were evacuated to a hospital that afternoon, but one seafarer died from injuries, five days later.

Why it happened

The tank provided feedwater (via the hot well) to, and functioned as the blow-out tank for, auxiliary boiler #1. At the time of the casualty, the boiler was in operation. There were one pneumatic and two manual valves on the blow-out line. The engineers that isolated the tank believed the manual valves were closed but had not isolated the pneumatically operated valve.

When additional heat from an exhaust gas economiser raised the temperature in the boiler, the boiler water level reached 80% and the pneumatic valve automatically opened. The passage of steam was not halted by the manual valves - allowing steam to enter the tank.

Testing identified that one manual valve could not be fully closed due to internal corrosion and the other was not fully closed.

What can we learn

The industry has suffered an unacceptable number of deaths in “enclosed” or “confined” spaces for decades but deaths in these spaces are not always due to a lack of breathable air. The personnel that entered the feedwater tank were not aware of its particular hazards.

It is essential to involve those with knowledge and control of a system in the hazard identification process so that the most appropriate controls for each risk can be put in place.

2. Factual Information

Navigator of the Seas

Vessel Type	Passenger	**Flag**	Bahamas
Owner	Navigator of the Seas Inc.	**Manager**	Royal Caribbean Cruises Ltd.
Classification Society	DNV GL	**Gross/Net Tonnage**	139,999 / 117,123
Built	Meyer Turku shipyard, Finland	**Propulsion**	Two azipods, one fixipod

IMO No.	Callsign	Length overall	Breadth	Moulded depth
9227508	C6FU4	311.1m	38.6m	11.7m

Last BMA Inspection	Last PSC Inspection
03 May 2019 at Miami, Florida. No deficiencies.	17 May 2019 at Miami, Florida. No deficiencies.

Crew details

Rank/Role on board	JS (victim)	OS 1	OS 2	Second bosun	Duty 3/E	Duty 2/E(E)	First officer
Qualification	STCW II/4	STCW II/4	STCW II/4	STCW II/5	STCW III/1	STCW III/2	STCW II/2
Certification Authority	India	Philippines	Philippines	Philippines	Poland	Italy	Ukraine
Time in rank	1 year	2 years	6 months	23 years	1 year 6 months	4 years 5 months	6 years 7 months
Time on board present vessel	5 months	4 months	2 years 6 months	3 years 6 months	1 years 6 months	4 years 5 months	3 years 11 months
Total time served at sea	1 year	5 years 4 months	2 years 6 months	29 years	3 years	4 years 5 months	7 years

Environmental Conditions

Wind Direction	Wind Force	Wave Height	Swell Height	Precipitation / Sky	Visibility Range	Light Conditions
South	3 (Beaufort)	0.3m	0.3m	Partly cloudy	Unlimited	Day light

Voyage Details

At the time of the casualty, Navigator of the Seas was anchored off CocoCay, The Bahamas.

Narrative

All times used in this report are UTC -4.

On 14 July 2020, Navigator of the Seas was at anchor off CocoCay, The Bahamas, in an extended period of lay-up due to the SARS CoV 2 pandemic.

At around 08:00, the first officer held a work planning meeting with the second bosun (bosun), two ordinary seafarers (OS1 and OS2) and a junior seafarer (JS) to discuss entry and inspection of technical water tank no.1 (feedwater tank 1). The task was routine planned maintenance, scheduled[1] to be completed every 12 months and assigned to the deck department.

The vessel's first officer was the designated officer in charge and he had prepared a permit to work for entry during his morning anchor watch,[2] passing it to the Chief Officer (safety) for approval during the watch hand-over.

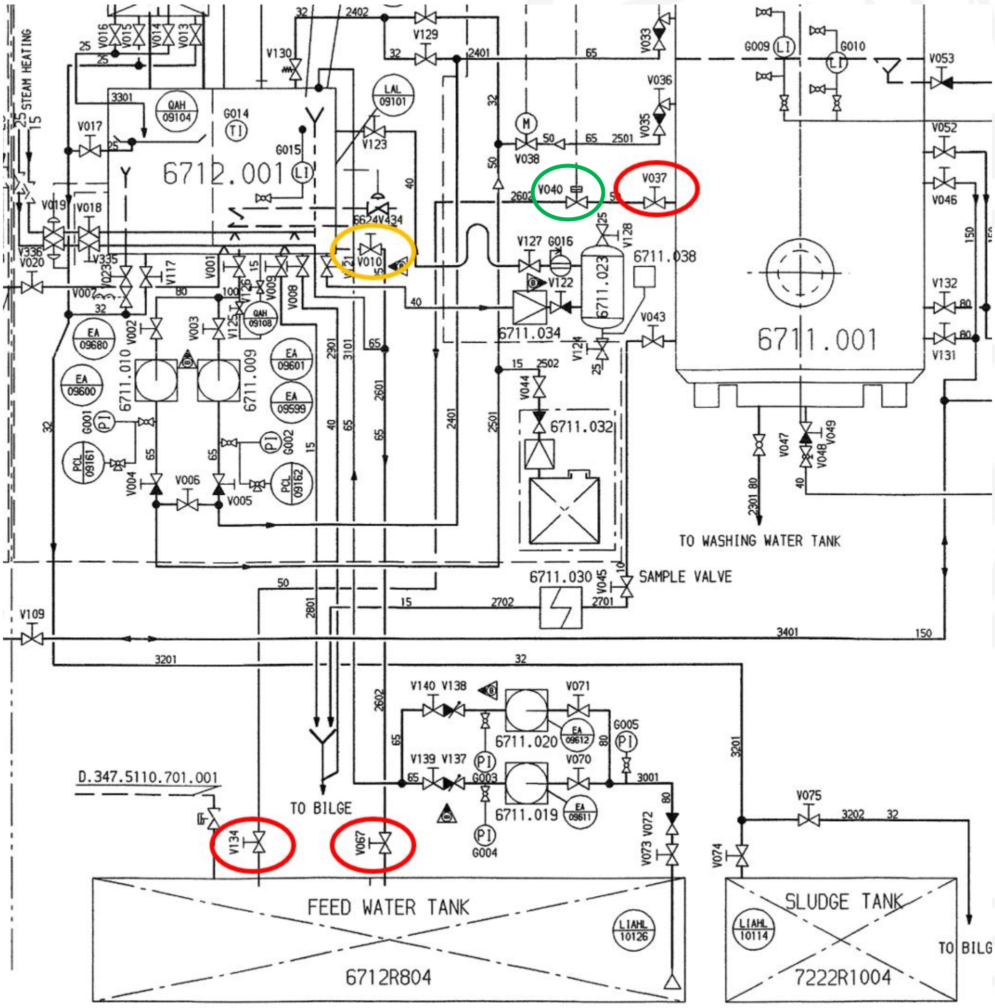
After the meeting, the bosun, OS1, OS2 and JS went to the forward main engine room to remove the tank's two manhole covers. At 08:47, the bosun called the bridge and informed the officer of the watch that the tank was open.

Approximately 13m[3] of water remained in the tank that could not be removed using the system's pumps. The engineering team advised the bosun that this could be transferred to feedwater tank 2 using a portable pneumatic pump. Shortly afterwards, the third engineer and second engineer (environment) were tasked with isolating the tank.

Whilst the bosun set up the pneumatic pump, the second engineer (environment) and third engineer split the task of isolating the tank: one closed valves V037 and V067. One closed valves V134 and V010. The second engineer (environment) then put the tags on the valves V037, V067 and V134. Valve V010 was not tagged. A further valve on the blow-out line (V040) was pneumatically operated and was not isolated.

Valves V037, V040 and (right) V134 post-casualty

[1] Initially scheduled for 13 July, it has been delayed by one day at the request of the engineering team
[2] He kept the 00:00-04:00 watch and the Chief Officer (safety) kept the 04:00-08:00 watch.



Valve locations: valves marked in red were reported closed and tagged out. The valve in marked in amber was closed but not tagged. The valve marked in green was not isolated

At 09:45, the third engineer informed the bosun that the valves were closed and the tank was isolated. Two minutes later, with the tank almost empty, the bosun called the first officer to inform him that the tank was ready for inspection.

Whilst checking off the final items on the confined space entry checklist, the first officer conducted a safety briefing, detailing confined space entry protocols and the hazards and control measures identified in the job safety analysis.

At around 10:00, the first officer and bosun entered the tank to check oxygen levels and make an initial inspection. The environment of tank was found satisfactory and they exited the tank.

At 10:10, the bosun called the bridge requesting that the vessel list to starboard to facilitate removal of the remaining water in the tank and, a minute later, JS, OS1 and OS2 entered the tank to clean, scrape and re-paint the areas of the tank that required attention.

At around the same time, the vessel was preparing to leave the anchorage. The officer of the watch called the first officer to cancel the permits for confined space entry and open tanks. The bosun closed feedwater tank 2 and, at 10:19, the first officer called the bridge to say that one tank was closed and that the crew were continuing to work in the other - he requested they call the bosun directly before departure and they could stop work with a few minutes' notice. He then left the engine room to rest in his cabin.

After feedwater tank 2 was closed, OS2 was tasked with adjusting the portable pump's suction hose to remove the last of the water, which was pumped to the bilge. At this time three crew members: JS, OS1 and OS2, were inside the tank.

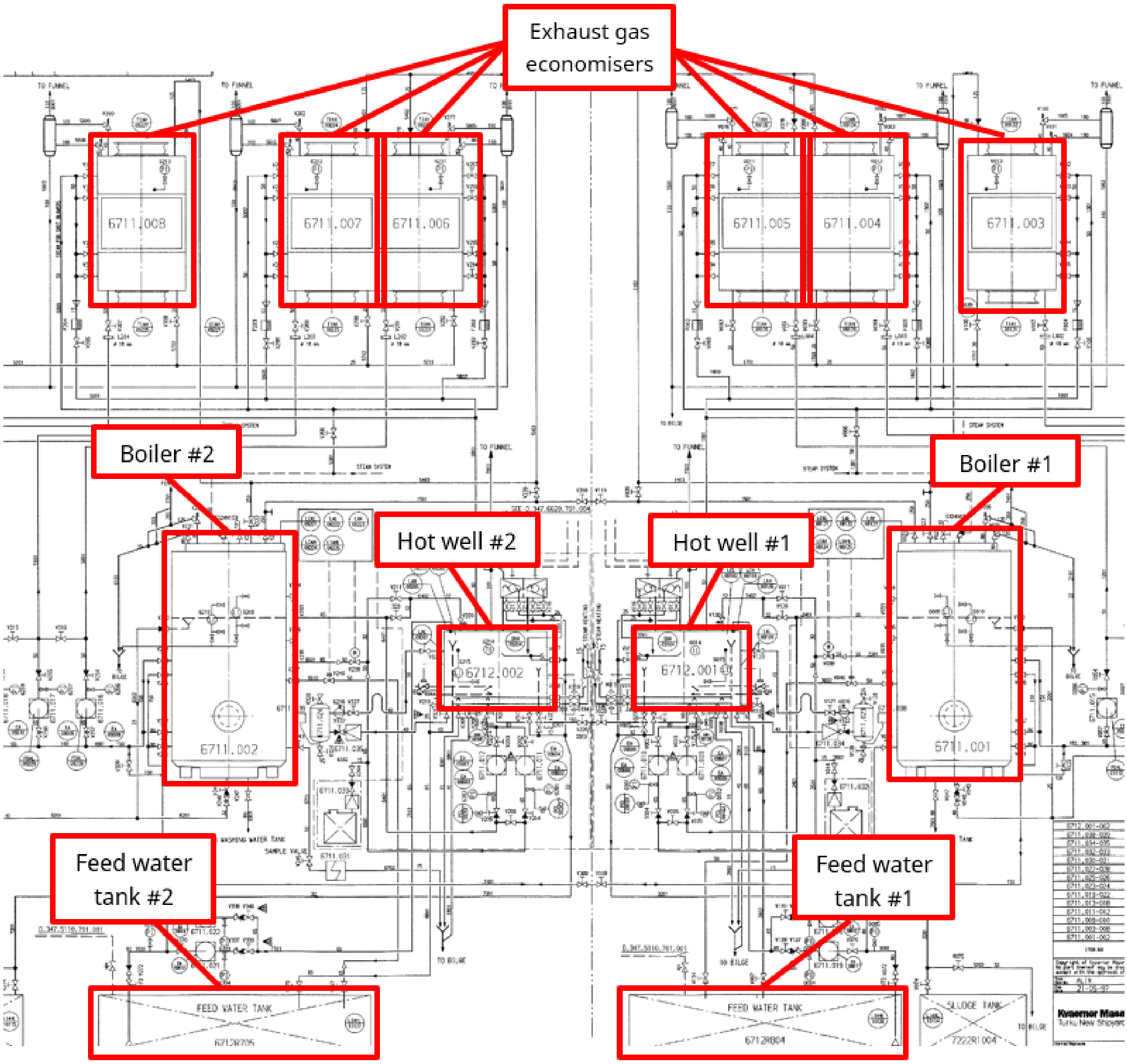
At 10:34, as part of the pre-departure checklist, the officer of the watch requested an additional diesel generator. A few moments later diesel generator 2 was started. At 10:43 there was a sudden release of pressurised steam to feedwater tank 1, directly above where JS and OS1 were working. Despite significant injuries they (and OS2, who was unharmed) managed to leave the tank and, as the bosun raised the alarm, walked to the ship's medical facility where they were given first aid.

The ship berthed at CocoCay pier at 12:41 and at 16:10 the two injured crew were flown by air ambulance to a hospital in Miami where they were admitted to the critical care unit.

OS1 suffered 6% - 10% body surface burns and was discharged from the hospital on 16 July 2020. JS suffered 60 - 80% body surface burns and died in the hospital five days after the casualty.

Boiler system

The boiler plant consisted of two fully automatic oil-fired auxiliary boilers and six exhaust gas economisers. The auxiliary boilers were of vertical combined fire/water tube type with natural water circulation and side-mounted heavy oil burners.



Boilers and feedwater tank system

The exhaust gas economisers recovered waste heat from the exhaust of the vessel's diesel generators which was subsequently fed to the boiler, increasing operating efficiency. Boiler #1 was connected to economisers on the aft diesel engines, boiler #2 was connected to economisers on the forward diesel engines.

The boiler's normal operating pressure was 7-8 bar. The safety valves were set at 9 bar for the boilers and 10 bar for the economisers. The boilers were independently connected to the steam ring line, where steam was distributed to various systems onboard. After starting the boiler burners, fuel and feedwater supply was controlled by an automated system.

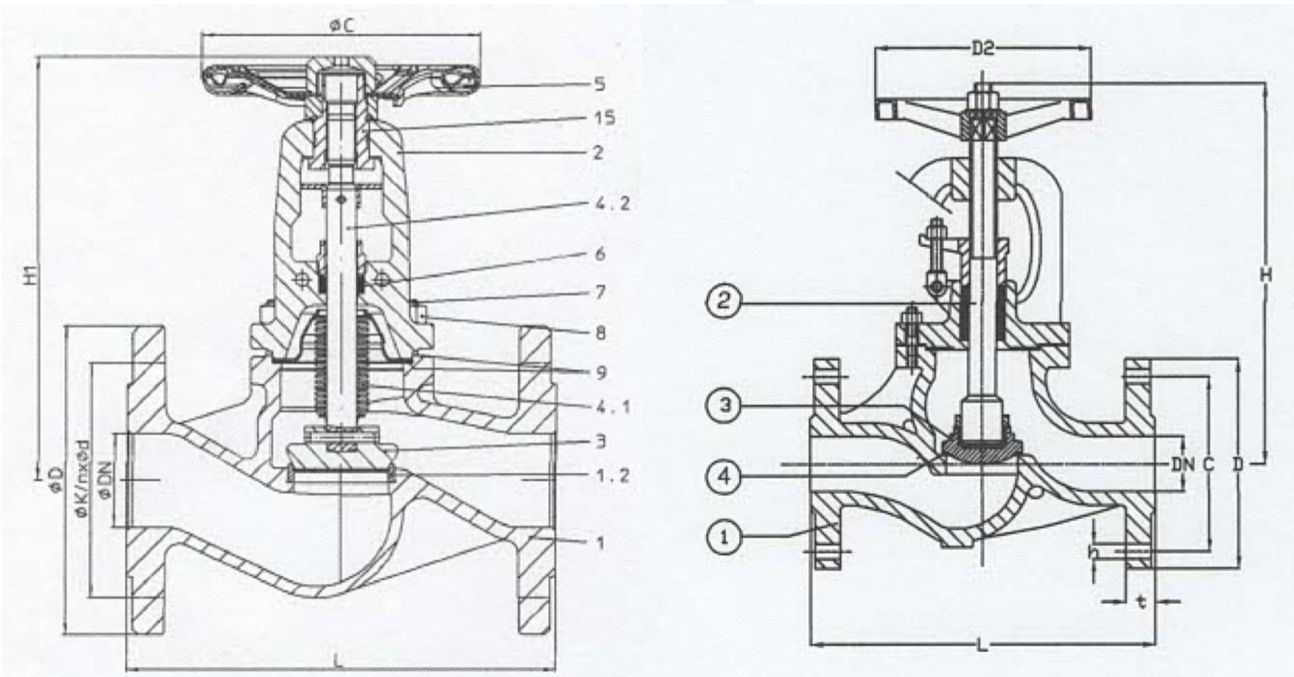
The boilers could be operated independently (single mode) but, normally, one boiler was operated as master with the other in slave mode. If the master boiler tripped, the slave boiler would automatically switch to single mode – ensuring uninterrupted supply.

The master boiler was generally selected on the basis of which diesel engines (and therefore exhaust gas economisers) were running. At the time of the casualty, boiler #1 was in master mode and boiler #2 was in slave mode.

The hot well provided feedwater to the boiler and received steam condensate after onboard consumption. The water level in the hot well was maintained using the circulating pumps, providing water from the feedwater tank. Each boiler had a blow-out line from boiler to the feedwater tank to maintain the maximum water level in the boiler, in case of a rise in water level.

The blow-out line from boiler #1 had three isolation valves: two manual globe valves (V037 and V134) and one pneumatic gate valve (V040). During normal operation of the boiler, the manual globe valves were open and the pneumatic valve was operated automatically by the boiler's control system: if the boiler water level rose above the determined high level (80% of capacity), the pneumatic valve would open allowing the excess water/steam to blow to the feedwater tank.

There was no position indicator on any of the valves on the system.



Cross-section drawings of V037 (left) and V134 (right)

Prior to the casualty, the boiler and all associated valves were last opened, inspected and cleaned as part of a Classification Society survey on 29 September 2017. All valves were found in satisfactory condition.

Safety management system

The Company operated a computer-based safety management system that included policies, permits to work, guidance, checklists and proformas for job safety analysis.

Entry into Feedwater tank 1 was subject to two sets of controls: the lockout tagout policy and the confined space entry policy. The safety management system also included a steam system work permit which was not used.

3. Analysis

The purpose of the analysis is to determine the contributory causes and circumstances of the casualty as a basis for making recommendations to prevent similar casualties occurring in the future.

Source of injures

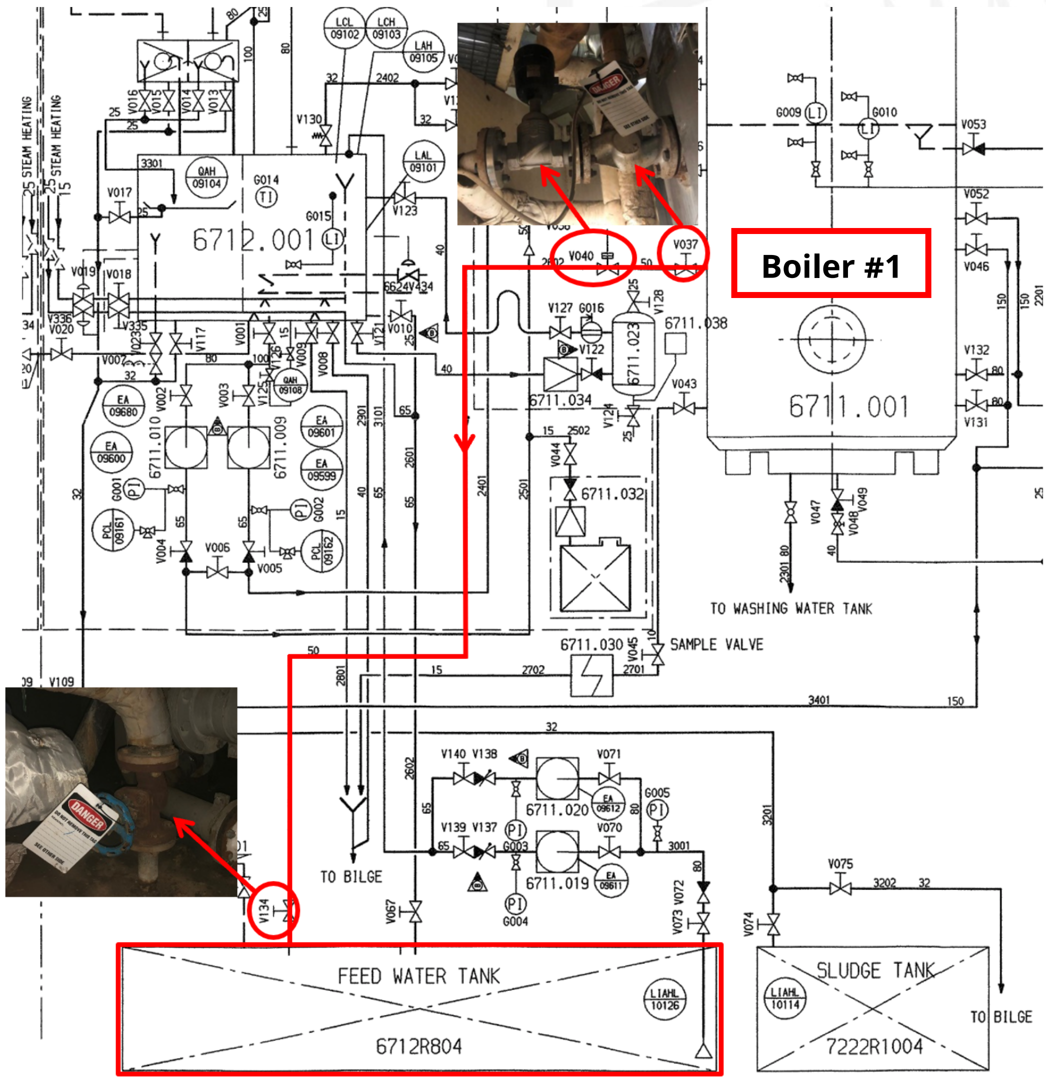
The injured crew were exposed to steam at the saturated temperature of around 170°C. It was released from boiler #1 at a pressure of around 8 bar, via the blow-out line.

At the time of the casualty, boiler #1 was operating and in master mode. When diesel generator 2 was started in preparation for departure, its exhaust gases raised the economiser temperature which in turn heated the boiler’s circulating water and increased pressure.

Boiler #1 water level and pressure readings[3]

When the boiler water level reached 80% the pneumatic valve (V040), which had not been electronically or physically isolated, automatically opened. The passage of steam was not halted by the manual valves (V037 or V134) on the blow-out line, allowing steam to enter feedwater tank 1.

[3] Time stamps in vessel’s system are in UTC (local time +4)



Boiler #1: blow-out line to feedwater tank, valves ringed

Boiler blow-out line (physical barriers)

Due to travel restrictions imposed by the SARS CoV 2 pandemic, BMA investigators could not travel to conduct a scene examination. On 17 July 2021, ship's staff ran a series of tests to identify the operation of the valves on the blow-out line. Each valve was, in turn, closed and exposed to blow-out from the boiler in a simulation of the conditions experienced on the day of the casualty. They identified that:

- pneumatic valve V040 was operating as designed
- manual valve V134 held pressure when exposed to blow-out
- manual valve V037 did not hold pressure when exposed to blow-out

Valves V134 and V037 (and valve V067 that isolated the hot well) were removed from the ship and sent for inspection and testing at an independent laboratory. All were shipped in the open position.

After an initial inspection at the laboratory, the valves were subjected to bench testing by connecting the upstream flange to an air source and applying pressure. After an initial check for leaks, pressure was increased in 20psig increments to 140psig (9.65barg).

- V134 was found to have a minor leak at 140psig – flow could be felt on the back of the hand
- V067 was found to have no leaks at any test pressure
- V037 would not close so had unrestricted flow

Initial inspection and bench testing was followed by further examination.

V037 was disassembled and found to have corrosion on the stem and bushing. On turning the valve stem with mechanical assistance, it was found to be slightly bent. The valve could not be fully closed due to the excessive corrosion on the stem and bonnet and degradation of the graphite packing.

Cross-section of valve V037 – significant corrosion to stem and bonnet, degraded packing

Metallurgical testing found that the valve's metal components were within specification. Testing of the packing identified the presence of chlorine. There were no traces of salt.

Shipboard tests indicate that valve V037 was free but unable to fully close at the time of the casualty. Testimony from the crew indicates that the valve wheel could be turned a sufficient number of times to lead the operator to believe it was closed.

A second bench test of V134 found that the valve did not leak at 140psig. The valve's bonnet, stem and packing were intact with no significant corrosion or other defect. Considering the shipboard and bench test, it is concluded that the valve was not fully closed at the time of the casualty.

Lock out/tag out procedures (administrative barrier)

The purpose of a Lock out/tag out (LOTO) policy is to protect employees from an energy source (including thermal energy) either by physically isolating a system with a padlock or similar (lockout) or with a tagout device (label) used to indicate that the energy control device (in this instance a valve) is not to be operated until the tagout device is removed. A lockout device offers more protection than a tagout device.

The Company's LOTO policy covered work "servicing, inspecting, or maintaining machines and/or equipment" it did not specifically reference tank isolation but this policy was applied as normal practice and referenced in the confined space entry permit. The policy did not expressly cover effective isolation of non-electrical systems or identify a need to apply additional controls to systems incapable of being locked out (such as blanking-off pipework).

There was no standard operating procedure for isolating the feedwater tanks and the written procedure for isolating the boilers did not include identification of the valves on the blow-out line. That notwithstanding, the second engineer (environmental) was familiar with the system and the location of the valves – he therefore did not review the line diagram before starting the isolation process and did not see the need to isolate the pneumatic valve as well as the two other valves on the line.

The tagout procedure was ineffective due to the pneumatic valve being left "live," valve V037 being physically unable to be closed and V134 not being fully closed.

Regardless of the effectiveness of the LOTO operation, the safety management system provided guidance on roles and responsibilities for covered work and isolation:

'The supervisor of the "Covered Work" has direct responsibility for carrying out the Energy Control Program Procedures.'

'*Lockout or Tagout shall be performed only by, or under the direction of, the* "Authorized Employee(s)" *who are performing the service or maintenance, and in accordance with the guidance in this subsection.'*

'Authorized Employee(s)': *'the person who will be authorized to remove or direct the removal of a particular lockout device or tag. Usually this will be the person with overall responsibility for carrying out the Energy Control Program procedures (e.g., the supervisor of the "Covered Work").'*

The first officer was, in effect, the supervisor of the covered work but he did not have any knowledge of the system connected to the tank, the practicalities of isolation or control of the LOTO process. In line with the requirements of the confined space entry permit, he relied on the engineering team to confirm that the tank was isolated.

Confined space entry procedures (administrative barrier)

The Company's confined space entry policy ran to 30 pages and covered definitions, personal protective equipment, ventilation, atmospheric testing, decontamination, permits and training. Whilst the policy stated that it did not address every hazard that may be present in the confined space (and that a risk assessment must be completed for each space), risk controls established within the policy were focused on atmospheric testing and the supply of breathable air.

In line with the LOTO procedure, the confined space entry procedure required a "competent person" to be in charge of the work. A key element of being deemed a competent person was "Knowledge of the location and type of space in which work is being performed...ability to inspect and evaluate spaces for all hazards that may be present." Similarly, the standby attendant and all entrants were required to be trained to identify the hazards associated with the confined space they were entering.

The confined space entry permit ran to five pages with a six-page guidance document for assistance in its completion. There was an additional one-page checklist to document training of the stand-by attendant. Isolation was covered in section 3.3. It did not require those involved in the task to check isolation, just confirm that it had been done.

3.3	Verify the space has been segregated by blanking off or isolating all connecting pipelines, valves, electrical power automation/monitoring systems and associated equipment shutdown ***(Lockout / tagout procedures shall be performed per SQM Policy and confirmed with the ECR)***	☑

Extract from permit to work

Where it was determined that the hazards of the planned work were not all addressed by the confined space permit, a job safety analysis was required to be completed. No formal risk assessments were available for the feedwater tanks[4] but a job safety analysis was completed by the first officer and attached to the permit to work.

The format of the job safety analysis (JSA) meant that for each step of the work, hazards and controls had to be identified. LOTO was identified as a control against suffocation or explosion. The JSA did not identify any risks associated with the boiler system because those involved in the assessment were not aware that feedwater tank was connected to an operational boiler.

[4] The only confined spaces that had specific additional controls highlighted were for caustic soda tanks

Steps	Potential Hazards	Controls and Barriers	Responsible for Control Verification (Print Name, Signature and ID#)
Empty the tank where the work is to take place	Emptying the wrong tank	1st Officer to verify the appropriate tanks with ECR and Bridge.	[redacted]
Opening and ventilating the tank	Flooding Compartment, Breathing in possible gases from the tank	If water starts leaking when loosening bolts, stop and ask ECR to strip the tank more. Rescue Pack and/or Breathing apparatus standing by and verified to work well.	[redacted]
Remote Atmospheric Testing	Oxygen enriched >23.5% – extreme fire hazard, Oxygen deficiency < 20.5% - Respiration issues, Suffocation Hydrogen sulfide (<10PPM) - highly toxic and flammable gas, Carbon Monoxide (<25 PPM) - poisoning, All combustible gases (<1 LEL)	Atmospheric testing to be done and levels to be recorded in Confined Space Entry Check list. H2S (less than 10 ppm), LEL (less than 1%), O2 (19.5%-22%), CO (less than 25 ppm)	[redacted]
Entering of Tank	Suffocation or explosion	Ensure that all valves leading into tanks are closed and isolated according to L.O.T.O. procedures by the Staff Chief Engineer. Complete Confined Space Entry Checklist prior to anyone entering tank. Multi Gas detector to be worn.	[redacted]
Secure working area	Possibility of injury to persons not involved in job.	Signs should be posted and area roped off to prevent anyone from entering the area or tank without permission. Follow procedures for Entering Confined Space.	[redacted]
Cleaning Tank	Injury to persons working in area	Ensure all persons are wearing proper PPE to protect skin, eyes, and inhalation.	[redacted]
Painting Job	Fainting or poisoning on paint fumes	Ensure all persons are wearing proper PPE to protect skin, eyes, and inhalation.	[redacted]

Extract from job safety analysis

Whilst not contributory to the casualty, the policy's atmosphere testing requirements were confused and, at the time of the casualty, guidance for wearing breathing apparatus for initial atmosphere testing and duties of the stand-by attendant were not strictly followed.

Atmospheric Testing Requirements

	FOR ENTRY PURPOSES	WHILE WORKING IN CONFINED SPACE
O2	Less than 19.5% or greater than 22.0%	Less than 20.8% (+/- 0.2%)
LEL / LFL	Greater than 10%	Less than 10%
H2S	Less than 10 ppm	Less than 10 ppm
CO	Less than 25 ppm	Less than 25 ppm
Flammable	Greater than 0%	Greater than 0%

If these levels or better atmospheric readings cannot be met, additional ventilation sequence shall be conducted a re-testing shall be conducted after a suitable interval.

Personnel performing the initial air sampling and inspection shall wear a Self-Contained Breathing Appara

Extract from Confined space entry policy: gas meters and atmospheric testing requirements – a mix of prohibitive and permissive conditions

Failure to eliminate the hazard

With limited exceptions, the planned maintenance system designated tank inspection and cleaning tasks to the deck department. Regardless of whether the tank in question was accessed via a machinery space or attached to operational systems controlled by the engineering department, the designated responsible officer was from the deck department. For the engineering department, involvement and oversight was limited to emptying a tank on request and completing isolations as required.

For this task, the responsible officer (first officer) was not aware of the particular hazards associated with the feedwater tank, the limitations of the isolation process in protecting the workers from steam exposure or how the isolation process was completed. He was fundamentally not in a position to understand the risks associated with the task under his direction and the crew had no idea of the actual risk they were exposed to. During interviews, the surviving injured crew member stated that he would not have entered the tank if he had known it was attached to an operational boiler.

The engineering department were not involved in the morning's toolbox talk and did not have any input to the hazard identification of the job safety analysis, involvement in the issue of the confined space entry permit or awareness of the status of the tank/personnel within, after the lock out/tag out process was completed.

Senior engineers were aware of the planned inspection of feedwater tank 1 four days in advance (and had delayed it by one day to ensure it did not clash with other work) but did not consider elimination of the hazards associated with the task that were under their control. There were no operational constraints on running boiler #2 in lieu of boiler #1: it was considered that closing the valves on the hot well and blow-out line was sufficient to isolate the feedwater tank from the boiler system.

Similarly, there was a disconnect between the maintenance and operation of the vessel – the engineers conducting the isolation of the feedwater tank were not aware of the planned departure from anchor and the unintended consequence of starting diesel generator 2 was not foreseen by the duty engineers that had not been involved in the isolation.

4. Conclusions

- The crew working in feedwater tank 1 were exposed to steam at around 170°C. It was released from boiler #1 at a pressure of approximately 8 bar, via the blow-out line, after a pneumatic valve opened automatically. There were two other (manual) valves on the blow-out line but these were not effectively closed.

- Shipboard tests indicate that valve V037 was free but unable to fully close at the time of the casualty. Testimony from the crew indicates that the valve wheel could be turned a sufficient number of times to lead the operator to believe it was closed. Destructive inspection found the valve to be severely corroded.

- Shipboard tests indicate that valve V134 could be closed to prevent a simulated blow-out. The exact position of the valve wheel/seat could not be determined but the laboratory concluded that the valve was not fully closed at the time of the casualty.

- The Company's "lockout/tagout" policy did not cover effective isolation of non-electrical systems or identify a need to apply additional controls to systems incapable of being locked out. There was no standard operating procedure for isolating feedwater tank 1 and the written procedure for isolating the boilers did not include identification of the valves on the blow-out line.

- The Company's confined space entry policy, permit to work and related guidance ran to over 40 pages but risk assessment of individual spaces was extremely limited. Risk controls established within the policy were focused on atmospheric testing and the supply of breathable air.

- None of the crew working in feedwater tank 1 were aware of the function of the feedwater tank - the task specific job safety analysis did not identify any risks associated with the boiler as no-one with any knowledge of the system was involved in the hazard identification.

- There was no reason engine room operations could not have facilitated a full shut down of boiler #1, eliminating the risk of steam release into feedwater tank 1.

5. Lessons to be learned

- The industry has suffered an unacceptable number of deaths in “enclosed” or “confined” spaces for decades but deaths in these spaces are not always due to a lack of breathable air. When policies and procedures focus on this single risk other hazards inherent in a space may be overlooked.

- If hazards cannot be identified, risk cannot be assessed and effectively controlled. Involvement by those with control and operational knowledge of a system that affects others’ safety is essential in the hazard identification stage of any task.

- The hierarchy of controls is a way to think about effectively managing risk: elimination of hazards at source (such as shutting down a boiler) is the most effective way to reduce risk. Engineering controls (such as blanking off pipework) is more effective than administrative controls (such as a lock out/tag out procedure). Reliance on personal protective equipment is the least effective control.

- There were four distinct teams with separate goals involved in this casualty – they interacted to meet the minimum standard required by the safety management system but a lack of full cooperation meant that effective risk reduction measures were not considered - control of risk must have by-in at all levels and across departments to be effective.

6. Actions taken

Royal Caribbean Group has:

- Shared initial investigation findings with its fleet through a safety alert, fleet call and lessons learned discussions on each vessel.

- Stopped inspection of feedwater tanks until function of applicable valves was verified.

- Adapted its confined space entry permit to include a signature for “responsible person” to verify the lockout / tagout process.

- Adapted its safety management system to specify the applicable rank for the “responsible person” section of the confined space permit.

- Directed the fleet to develop ship-specific standard operating practices for isolating tanks forming party of the steam system including, as a minimum, the use of blanking flanges on steam and water lines.

7. Recommendations

Royal Caribbean Group is recommended to:

- Holistically review its confined space entry and lock out tag out policies alongside a review of the structure and application of its confined space and steam system permits. This should include but not be limited to:
  - Effective communication of requirements
  - Incorporation of engineering controls
  - Facilitation of cross-department cooperation
  - Clear guidance on the role of authorized employee, competent person and supervisor

Det Norske Veritas is recommended to:

- Taking into consideration the degradation of valve V037, review the extent and frequency of its auxiliary boiler surveys.

8. Glossary and Definitions

AB	Able-bodied seafarer
Barg	Bar (gauge). Unit of pressure given by absolute pressure minus atmospheric pressure.
BMA	Bahamas Maritime Authority
Company	Owner of the ship or any other organization or person such as the Manager, or the Bareboat Charterer, who has assumed the responsibility for operation of the ship from the Shipowner and who on assuming such responsibility has agreed to take over all the duties and responsibility imposed by the Code (ISM Code, section 1.1.2)
Hazard	A source of potential injury, harm or damage.
IMO	International Maritime Organization
ISM Code	International management Code for the safe operation of ships and for pollution prevention
JS	Junior Seafarer
JSA	Job safety analysis
List	Transverse angle that the vessel adopts due to internal distribution of weights (i.e. Not an external force)
LOTO	Lock out/tag out
m	Metre. Unit of measurement: 1 metre = 1000mm
OS	Ordinary Seafarer
PSIg	Pounds per square inch (gauge). Unit of pressure given by absolute pressure minus atmospheric pressure.
Risk	Risk is a product of the likelihood that harm or damage may occur, considered against the potential severity of the harm or damage.
Saturation temperature	The temperature for a corresponding saturation pressure at which a liquid boils into its vapor phase. The liquid can be said to be saturated with thermal energy.