

**THE COMMONWEALTH OF THE BAHAMAS  
&  
THE UNITED STATES OF AMERICA**



**“CARNIVAL TRIUMPH”**

**IMO Number 9138850  
Official Number 732044**

**Joint report of the investigation  
into an engine room fire  
on February 10<sup>th</sup>, 2013**

*The Bahamas Maritime Authority investigate incidents at sea for the sole purpose of discovering any lessons which may be learned and to ascertain whether any changes to the present Regulations are desirable with a view to preventing any repetition. It is not the purpose of the investigation to establish liability or to apportion blame, except in so far as emerges as part of the process of investigating that incident.*

*It should be noted that the Bahamas Merchant Shipping Act, Para 170 (2) requires officers of a ship involved in an accident to answer an Inspector's questions fully and truly. If the contents of a report were subsequently submitted as evidence in court proceedings relating to an accident this could offend the principle that a person cannot be required to give evidence against himself. The Bahamas Maritime Authority makes this report available to any interested parties on the strict understanding that it will not be used as evidence in any court proceedings anywhere in the world.*

*The United States Coast Guard (USCG) investigates marine casualties under the authority of Title 46, United States Code, Chapter 63(46 USC Chapter 63), for the purpose of deciding, among other things: (1) the cause of the casualty and (2) whether there is a need for new laws or regulations, or amendment or repeal of existing laws or regulations, to prevent the recurrence of the casualty. This joint report represents the USCG's report of the investigation conducted under 46 USC Chapter 63.*

It should be further noted that the basis for Marine Safety Investigation is found in the International Convention on the Safety of Life at Sea (SOLAS) Chapter 1 Regulation 21 and the Casualty Investigation Code Resolution MSC.255 (84). Where issues have arisen from the investigation regarding matters which are not subject to the Convention these are commented upon in the Appendices.

This report will be forwarded to International Maritime Organisation (IMO) when published for further consideration under the formal casualty analysis process.

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Date of Issue: 12<sup>th</sup> September 2014

### Conversion Factors

	<b>SI Units</b>	<b>Conversion factor</b>	<b>US Units</b>
<b>Pressure</b>	Bar	x 14.5	psi
<b>Temperature</b>	° Celsius	× 9/5 + 32	° Fahrenheit
<b>Length</b>	metre	x 3.28	Feet (ft)
<b>Weight</b>	tonnes	x 1.102	US ton
<b>Volume</b>	cubic meter (m <sup>3</sup> )	x 35.314	Ft <sup>3</sup>
<b>Density</b>	Kg/m <sup>3</sup>	x 0.0624	lb/ft <sup>3</sup>
<b>Power</b>	Kilowatts (kW)	x 1.3405	Horsepower (hp)
<b>Speed</b>	Nautical miles per hour (knots)	X 1.1508	Miles per hour (mph)
<b>Barometric Pressure</b>	mbar	x 0.0295	Inches of mercury

### Abbreviations

CE	Chief Engineer
EGR	Emergency Generator Room
FO	Fuel Oil
FOTP	Fuel Oil Transfer Pump

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## 1. SUMMARY

- 1.1. During the early morning hours of February 10th, 2013, the Carnival Triumph was underway off the coast of Mexico when a flexible pipe on the fuel oil return line forward of the No.6 Engine, located in the centre section of the Aft Engine Room, failed in service.
- 1.2. Fuel oil, mist and vapour<sup>1</sup> can be considered to be present, under a reported pressure of 10 bar and temperature of 122°C, sprayed upwards from below the floor plates. The fuel oil reached a height of approximately 5 meters, between the turbo chargers at the forward end of the No.6 engine in the Aft Engine Room.
- 1.3. Fuel oil contacted a hot spot in the vicinity of the turbo charger for the No.6 diesel generator, resulting in a flash fire that severely damaged diesel generator Nos.5 & 6.
- 1.4. The main cabling overhead in the Aft Engine Room serving the switchboard rooms was also damaged resulting in a loss of power from generators Nos.1, 2 and 3 in the forward engine room. The Port and Starboard propulsion electrical motors (PEM) were also damaged, thereby disabling the propulsion irrespective of the generator cables. This loss of power and the limited ability of the crew to restore it, extended throughout the entire time the vessel was being towed to Mobile, Alabama.
- 1.5. Generator No.4 and the switchboards did not suffer cable damage, as it is located in the port side section of the Aft Engine Room; however, this engine was out of service for overhaul at the time of the event.
- 1.6. Prior to its ignition atomized fuel oil from the failed flexible pipe triggered the fire alarm system. Engineering staff entered the space to investigate whereupon spraying fuel was observed and emergency procedures, including activating the emergency stop on Engine No.6 and isolating the fuel to the Aft Engine Room, were initiated.
- 1.7. Several minutes later a fire erupted on Engine No.6. The Hi-Fog® fixed water fire fighting system started automatically as designed. However it subsequently failed when the power supply to the main switchboard shorted in the fire. The Hi-Fog® Local Application Systems only requirement is for a main power source to be connected, no emergency back-up is required<sup>2</sup>.

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<sup>1</sup> All 3 elements (oil, mist, vapour) present, given the temperature of the compartment, engine and turbo charger.

<sup>2</sup> The issue was resolved in International Code of Fire Safety Systems (FSS Code) by Resolution MSC.98(73) adopted in December 2000. Chapter 8 - 2.2.1

- 1.8 Following the permission of the Captain the CO<sub>2</sub> flooding system was activated but it failed to release from the remote operating station outside the Engine Control room, and the main supply valve had to be opened manually inside the CO<sub>2</sub> bottle store room. This action was hampered by CO<sub>2</sub> leaking into the bottle store room. The lead fire investigator for the NTSB reported finding two bottles that discharged direct into the CO<sub>2</sub> room, there may well have been additional bottles that were not tight – this was not noted at the time.
- 1.9. To overcome the absence of an emergency back-up system to the Hi-Fog® System, power was restored by running a cable to supply power from the emergency generator, using a breaker designed to power the main engine No.2 start air compressor. Hot spot monitoring and boundary cooling continued until the fire was determined extinguished.
- 1.10. There were no direct injuries or fatalities as a result of this incident. However, there were some minor passenger injuries that reportedly occurred in the days that followed the event.
- 1.11. The vessel was towed to Mobile, Alabama, to disembark all passengers and to effect repairs.

## 2. DESCRIPTION OF VESSEL

### GENERAL PARTICULARS AND LAYOUT

- 2.1 “Carnival Triumph” is a purpose built passenger vessel, constructed at the Fincantieri Yard at Monfalcone, Italy in 1999. The vessel has diesel electric propulsion, and six main generators provide power to the two electro propulsion units. The vessel has 3,540 passenger berths in 1,379 cabins and 1,118 crew berths. The vessel has 4 decks plus 7 superstructure decks.
- 2.2 At the time of the incident she was operated by Carnival Cruise Lines.
- 2.3 The vessel was first registered under the Bahamas Flag in March 2000 and was entered with Lloyds Register Classification Society. At the time of this incident, the ship held all the necessary and required statutory certification.

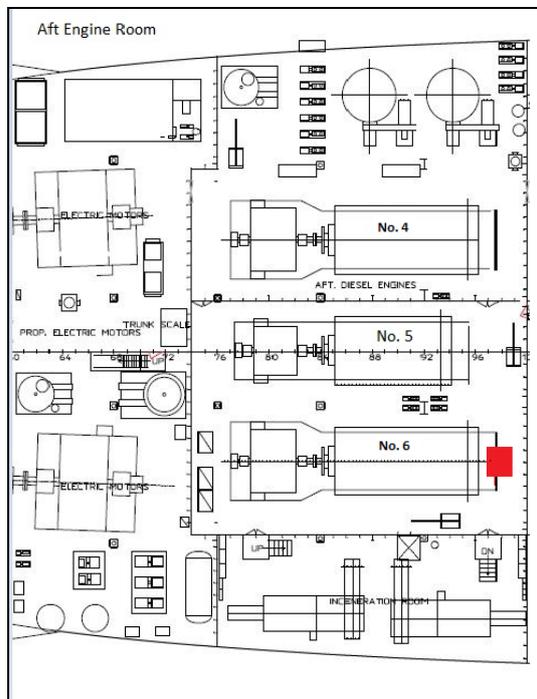
Official Number -	732044
IMO Number -	9138850
Length overall -	272.82 metres
Length BP -	230.00 metres
Breadth -	35.54 metres
Depth -	11.20 metres
Gross Tonnage -	101,509 tonnes
Net Tonnage -	73,744 tonnes
Deadweight -	10,984 tonnes
Call Sign -	C6FN5

- 2.4 The machinery and engine spaces are located on Decks O, A, B, and C, as follows:

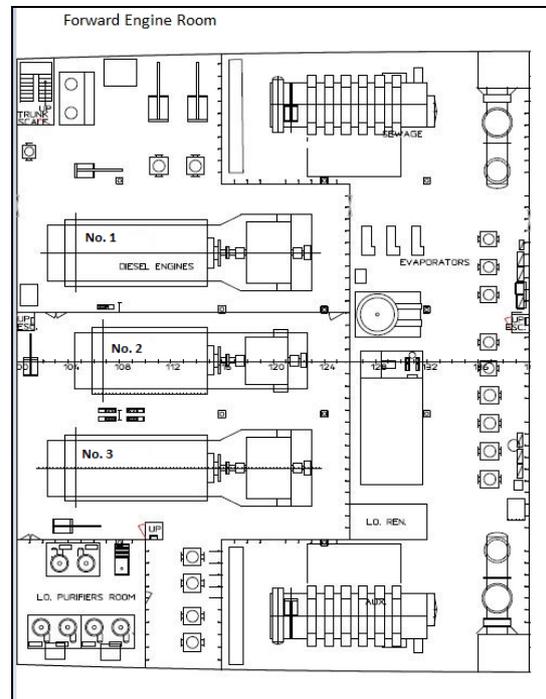
Deck 0	CO <sub>2</sub> release station; Quick closing valve release station; Chief Engineer’s Office; and Engine control room.
Deck A:	Forward engine room; Aft Engine room; Electric motor room
Decks B & C:	Forward Engine Room - Engine No: 1, 2 & 3 Aft Engine Room – Engine No: 4, 5 & 6 Electric Motor Room Forward thruster room; Forward auxiliary machinery room; Air conditioning compressor room; Fixed sprinkler fire suppression main, riser and water supply;

Fresh water tanks;  
 Stabilizer fin controls;  
 Fuel oil settling and service tanks;  
 Fuel oil separators;  
 Fuel modules;  
 Evaporators;  
 Sewage system;  
 Lubricating oil separators;  
 Incinerator room, 2 Auxiliary Boilers, Main  
 Switchboard room, Electric propulsion room;  
 Refrigeration compressors and Hi-Fog® system;  
 Aft auxiliary machinery room; and the aft thruster  
 room.

- 2.5 The Forward and Aft Engine Rooms contain a total of six diesel engines, two of which are twelve (12) cylinder engines mounted along the vessels centreline: Engine No.2 in the forward engine room and No.5 in the Aft Engine Room. The remaining four are sixteen (16) cylinder engines. These are mounted one each to port and starboard of the centreline engines and are designated as Engines No.1 and No.3 (in the Forward Engine Room), and Engines No.4 and No.6 (in the Aft Engine Room). Electrical generators are directly coupled to these engines. Each of the six generator engine assemblies are skid mounted on resilient mounts for the isolation and suppression of the effects of vibration from the hull and fixed structures. Each diesel generator's ventilation trunk is supported from the vessel's structure by resilient fixtures; this also limits the transfer of vibration.



■ Source of Fire

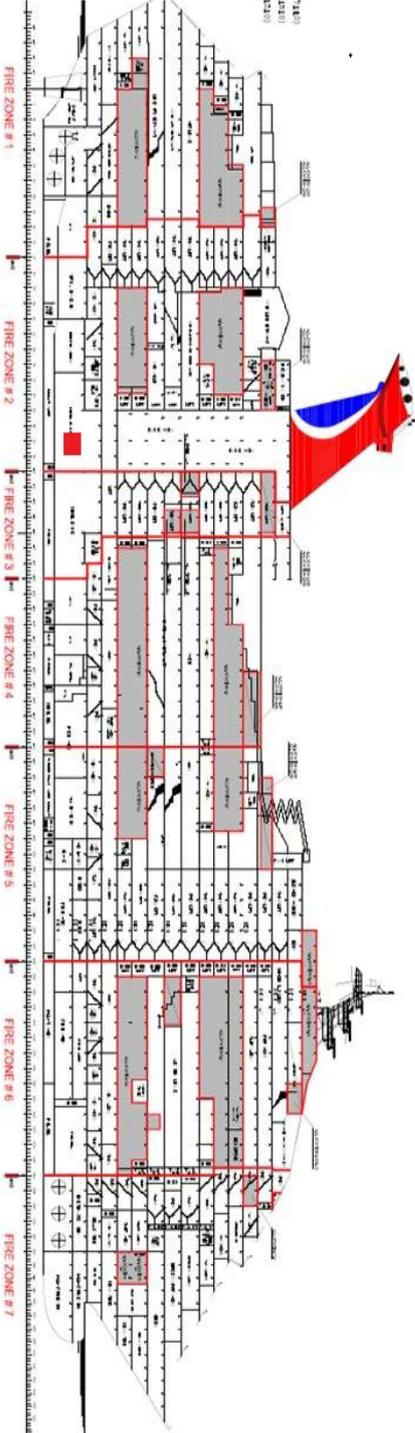


- 2.6 In the Aft Engine Room, the generators are mounted on the aft end of each engine with turbo chargers mounted on the forward end. Each skid is fitted with a series of flexible pipe sections in order to allow for movement due to vibration. These connect the engines' operating systems with a means to the associated vessel's systems for fuel oil, lubricating oil, cooling water etc.
- 2.7 In the forward engine room, Engines 1, 2 and 3 are aligned with generators forward and turbo chargers aft of each engine. Power cables lead from each generator in the Forward Engine Room up to the overhead, towards the centreline of the vessel, and then aft to a penetration at bulkhead 100. From the forward bulkhead of the Aft Engine Room, the cables pass over engines 5 & 6 and into the main switchboard aft of frame 84. In the Aft Engine room, power cables lead up from each generator aft, directly into the main switchboard room, aft of frame 84.
- 2.8 The vessels engine room machinery and systems are all controlled from a central engine control room (ECR) on Deck 0. This space contains the remote operating controls for the engine room machinery, data recorders, event and alarm logs, closed circuit TV monitors, emergency shutdowns for the generator engines and ventilation fans, and the remote controls for the Hi-Fog® system.
- 2.9 The "Carnival Triumph" has a total of seven (7) vertical fire zones. These are numbered one to seven from aft forwards. The Aft Engine Room is located in Fire Zone No.2.

Fire Zones

Profile view showing fire zones

■ Source of Fire



## **MARIOFF HI-FOG® FIRE PROTECTION SYSTEM**

2.10 Nordica Engineering of Miami, Florida completed the installation of a “Hi-Fog” water spray fixed fire fighting system in the engine spaces of the “Carnival Triumph” on February 12th, 2004. The system, manufactured by Marioff Oy, has a Lloyds Register certificate of approval as a fixed local application fire fighting system of the type required by SOLAS II-2 Regulation 10.5.6.3:

*5.6.3 Fixed local application fire-fighting systems are to protect areas such as the following without the necessity of engine shutdown, personnel evacuation, or sealing of the spaces:*

- .1 the fire hazard portions of internal combustion machinery or, for ships constructed before 1 July 2014, the fire hazard portions of internal combustion machinery used for the ship's main propulsion and power generation;*
- .2 boiler fronts;*
- .3 the fire hazard portions of incinerators; and*
- .4 purifiers for heated fuel oil.*

2.11 The system installed is described by Marioff as using water under high pressure. The Hi-Fog® system uses fresh water but a salt water connection is also provided. Spray heads cause the water to enter the space as a fine fog or mist at high speed. The small droplets yield a very large total water surface area, providing efficient cooling of the fire and surrounding gases. The high speed of the small droplets enables the fog to penetrate hot flue gases and reach the combustion source.

2.12 The system covered the following areas: Fuel Oil Separators and Lubricating Oil Purifiers, Incinerator, Boiler, Diesel Generators 1 to 6 and the Garbage Storage, and Garbage Room.

2.13 In January 2011, the Hi-Fog® system was modified to include an automatic release system.

## **FULL FLOOD CARBON DIOXIDE (CO<sub>2</sub>) FIRE EXTINGUISHING SYSTEM**

2.14 The “Carnival Triumph” has a Carbon Dioxide fixed fire fighting system that can be used to extinguish fires in the following areas:

- i Emergency Diesel generator Room;
- ii Engine Control Room;
- iii Port and Starboard Main Switchboard rooms;
- iv Fuel Oil and Diesel Oil Separator Room;
- v Propulsion Electric Motors and Cyclo Converter Space;
- vi Forward Engine Room & Lube Oil Purifier Room; and
- vii Aft Engine Room, Incinerator Space and Garbage handling Room;

- 2.15 Local Carbon Dioxide systems serves seven galley areas. The main CO<sub>2</sub> system is housed on Deck 11, and contains 109 x 60 litre cylinders in five banks. The Aft Engine Room is served by Banks 3, 4 and 5, with a total of 98 cylinders which provide a volume of 5,488 cubic meters of gas.



General view of CO<sub>2</sub> room

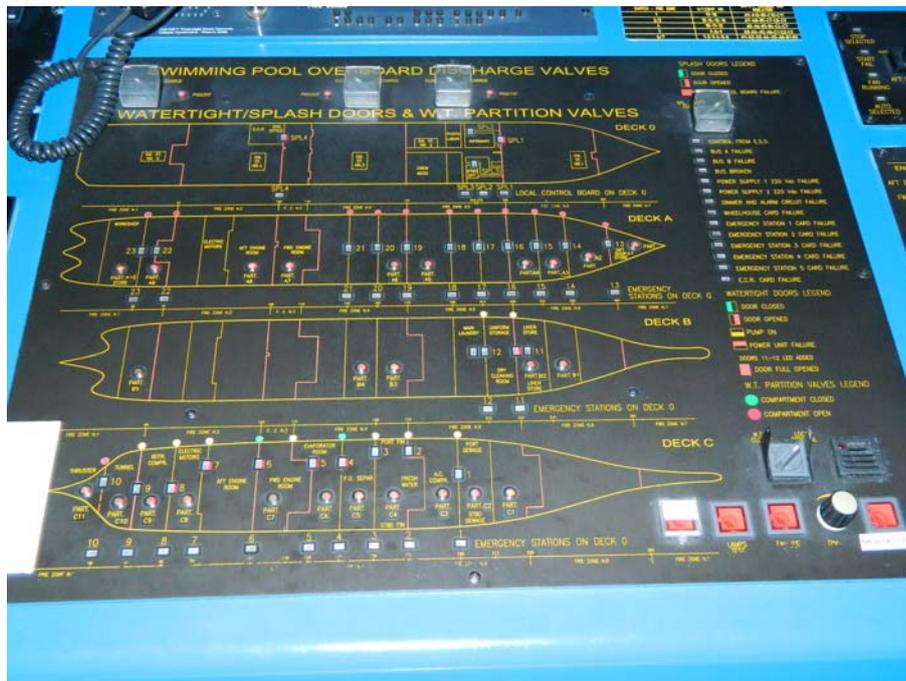
### **AUTRONICA FIRE DETECTION SYSTEM**

- 2.16 The “Carnival Triumph” is fitted with an Autronica fire detection system. This system monitors the vessel to detect heat, smoke and flame throughout. Detectors are mounted in critical areas of the vessel. This system is not linked to the closed circuit camera system.
- 2.17 The four alarm panels for the Autronica are located in the vessel’s wheelhouse and each has a display detailing any alarms received; data are also fed to a printer at each panel. The system monitors the fire detectors, manual fire alarm points and sprinkler section stations.

### **MARTEC SYSTEM**

- 2.18 The “Carnival Triumph” is fitted with a Martec Emergency Shut Down system. It records data from, and interfaces with, the vessels: CO<sub>2</sub> system; Autronica fire detection system; watertight door controls; and vessel automation controls. There is no requirement for an Emergency Management System to be fitted.
- 2.19 The system on the “Carnival Triumph” has a mimic panel on the bridge to monitor the status of Emergency Shut downs, dampers, ventilation, watertight doors, and the sprinkler system by means of red, yellow and green lights. Failure to

acknowledge an alarm within two minutes initiates the automatic closing of fire doors, ventilation systems and dampers.



Martec Watertight Door display

## VOYAGE DATA RECORDER (VDR)

- 2.20 The “Carnival Triumph” has a Voyage Data Recorder (VDR), installed to comply with SOLAS Chapter V Regulation 20. The model installed on the “Carnival Triumph” is a SAM Electronics VDR 4350, this model records navigation, propulsion, alarms, weather and radar data. Additionally, bridge audio and communications audio channels are recorded by the system. Data are retained for a minimum of 12 hours and a back-up procedure is posted to secure data at any time.
- 2.21 The VDR audio data was reviewed over a time period between 0515 and 0618 on February 10<sup>th</sup>, 2013.

## FUEL

- 2.22 The vessel operates on differing grades of fuel oil. A cold start of the main engines would be accomplished using Marine Gas Oil (MGO). When suitably heated Heavy Fuel Oil (HFO) is available the engines are switched over. HFO has a lower calorific value and is more economical; however it requires heating to be at the correct viscosity at the engine fuel injectors. HFO is carried in two grades, “high” and “low” sulphur, to comply with environmental restrictions on engine emissions in certain areas.

- 2.23 The vessel received fuel deliveries in Galveston, TX on 2<sup>nd</sup> February 2013 as follows:
- 550 cubic meters “low” sulphur HFO into No 3 port, No 3 centre, and No 3 starboard double bottom tanks.
  - 700 metric tons of “high sulphur” HFO into No 1 port, No 1 starboard, and No 5 centre double bottom tanks.
- 2.24 Fuel is transferred from storage tanks using a transfer pump to associated settling tanks. These are narrow vertical tanks where fuel is allowed to stand for a period of time to allow water, sediment, and heavy particles to settle to the bottom of the tank and are then removed.
- 2.25 The fuel is then transferred from the settling tank via a separator feed pump to a separator. The separator operates as a centrifuge, removing any remaining water, sediments or heavy particles, and the fuel is then discharged into a service tank for use in the engines. A cascade system causes fuel to revert back to the settling tank if the service tank reaches a high level, for example, if the engines were slowed or stopped and fuel demand was reduced.
- 2.26 The engine manufacturers, Wartsila, were contacted regarding the pressure in the fuel oil return line from the engine, and they confirmed the recommended range for the inlet pressure to the engine is from 8~10 bar and usually fixed to 9 bar. Under normal operating conditions the return line pressure is less than 8 bar with an expected outside limit for return pressure of 10 bar. A review of the vessels Damatic<sup>3</sup> Menu for diesel generator No.6 on Saturday February 9th indicated the fuel inlet pressure was at 11.31 bars and at 123.7° C with the engine running at 73% and providing 8500 kW. The flexible fuel pipe fitted had been type approved by the Italian Ministry of the Mercantile Marine, prior to its supply in July 1997. However it should be noted the outlet pipe failed and not the inlet pipe. The Pipe had a working pressure of 11 bar, with a Test Pressure of 17 bar. Spare flexible fuel pipes were available on board, still in the original sealed packaging.

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<sup>3</sup> Damatic Menu: proprietary name for a Distributed Control System, in this case relating to Engine Room control and monitoring systems.

2/9/2013 6:17  
Damatic Menu Running Applications Current User: Everyone 6:17:10 Saturday, February 09, 2013

Select Window Desktop [Capture Window]

▼ Menu 13-02-09 06:07:10

**UGO main data**

POWER .....	8500 kW	EXH.GAS CYL .OUT.	EXH.GAS CYL .OUT.
POWER FACTOR .....	5437185 kWh	CYL TEMP.	TEMP .DEV.
FUEL RACK POSITION .....	0.71	1A..429.C..	1.0 C
SPEED .....	515 rpm	2A..484.C..	56.2 C
CHARGE AIR PRESS .....	2.272 bar	3A..430.C..	1.9 C
CHARGE AIR TEMP .....	48.6 C	4A..402.C..	-25.6 C
ST-AIR INLET PRESS .....	27.19 bar	5A..355.C..	-73.5 C
FUEL OIL INLT. PRESS .....	11.51 bar	6A..401.C..	-27.3 C
FUEL OIL INLT. TEMP .....	123.7 C	7A..451.C..	22.8 C
FUEL OIL VISC. ....	16.0 cSt	8A..473.C..	44.8 C
NOZZLE CW PRESS .....	3.13 bar	BIG ENGINE BRNG.MONIT	
NOZZLE CW INLT. TEMP .....	76.6 C	1A	1B
NOZZLE CW OUTLT. TEMP .....	79.2 C	2A	2B
LO INLET PRESS .....	6.37 bar	3A	3B
LO INLET TEMP .....	54.9 C	4A	4B
LO REG. V/V POS. ....	13%	5A	5B
LO SUMP FRAME TK LVL .....	64%	6A	6B
HT CW INLET PRESS .....	4.68 bar	7A	7B
HT CW INLET TEMP A .....	79.6 C	8A	8B
HT CW INLET TEMP B .....	79.3 C		
HT CW AFTER TURB.A .....	84.6 C		
HT CW AFTER TURB.B .....	83.7 C		
HT CW OUTLET TEMP .....	87.5 C		
HT CW REG. V/V POS. ....	17%		
LT CW INLET PRESS .....	3.82 bar	TURBO CHARGER-A	TURBO CHARGER-B
LT CW INLET TEMP .....	34.1 C	EXH.GAS .INLT.	518 C
LT CW OUTLET TEMP A .....	38.9 C	EXH.GAS .OUTLT.	352 C
LT CW OUTLET TEMP B .....	39.0 C	T/C BEAR.TEMP.	97.1 C
		SPEED TURBINE	15966 rpm
			SPEED TURBINE 16269 rpm
FO FEED	HIGH TEMP	LOW TEMP	NOZZLE
DG 4-5-6	CW 4-5-6	CW	DG 4-5-6
			LUBE OIL
			DG 4-5-6
			AUTOSTOP
			CRITICAL
			SHUTDOWN
			CRITICAL

Extract from vessel's Damatic menu on February 9<sup>th</sup>, 2013 showing operating parameters on diesel generator No.6.

- 2.27 A supply pump delivers fuel from the service tank to a mixing tank on the fuel oil module, where unused fuel returning from each engine is collected.
- 2.28 The vessel has two Viscochief Fuel Oil Modules located on the starboard side of the Fuel Oil Separator Room. The forward module serves diesel generators Nos.1, 2 and 3 in the Forward Engine Room, and the aft module serves diesel generators Nos.4, 5 and 6 in the Aft Engine Room. Each module consists of a mixing tank, a steam powered heater, a Viscometer and a booster pump. From the mixing tank, the fuel is run through the heater which is regulated by the Viscometer to assure that the proper viscosity fuel is delivered to each engine for combustion.
- 2.29 Above the Forward and Aft Engine Rooms, the diesel engine's exhaust trunks penetrate Deck 0. They are mounted inside the vertical engine casing, which extends from Deck 0 to Deck 11. At Deck 0, the engine casing is located between frames 84 and 106 on either side of the centreline passageway. The casing extends to approximately 7 meters to the port side and 10 meters to the starboard side of the passageway. The casing is bordered by public areas as it transits through Decks 1 through 11, and the cross sectional areas are reduced as it crosses Decks 1, 3 and 10.
- 2.30 In addition to six engine exhaust trunks, the engine casing contains the Engine Rooms' ventilation ducting and the exhaust gas waste heat boiler systems. The casing itself also acts as a plenum for the Engine Rooms' ventilation system, with

large registers fitted with automatic fire dampers<sup>4</sup> mounted at Deck 0 directly above the Forward and Aft Engine rooms.

## **EMERGENCY GENERATOR**

- 2.31 The vessel's Emergency Generator Room is located on the starboard side of Deck 11, between frames 71 and 82. This space contains the emergency generator, its marine gas oil fuel supply storage tank, and the emergency switchboard. The emergency generator is rated at 971 kW at 1800 rpm with an electrical output of 800 kW. This space also contains a 5 cubic meter marine gas oil storage tank that is set up to automatically flush all six engine fuel systems of heavy fuel. This occurs in event of a loss of electrical power from the main switchboard in order to prepare engines for restarting. In the Aft Engine Room there is an automatic dump valve for this system, located on the forward bulkhead between diesel generators No.5 and No.6.

## **LIST OF EQUIPMENT SERVED BY THE EMERGENCY GENERATOR**

- 2.32 The Emergency Generator provides power to the following systems

- 2 Battery Chargers – ship service
- 33 Emergency Light panels
- Engine Room Emergency panels 1 and 2
- Emergency Diesel generator Radiator Fan
- Automation System
- Fire and Wash Topping Up Pump panel
- Sprinkler sea water pump panel
- Steering Gear, Port and Starboard
- Engine Room Emergency Group Starter Panel No.918.
- 440V Miscellaneous Wheelhouse panel
- Emergency Diesel Control panel
- Emergency Diesel Starting Battery Charger
- Emergency Bilge Pump panel
- Engine Room Supply Fans 1 and 2
- Engine Room Air Compressor
- 16 Crew and Passenger Elevators
- Lifeboat Winches Emergency panels 1 and 2
- 5 Watertight Door panels
- 2 220V Stabilized Sections
- UPS for the Public Address System
- 2 Hotel Management Systems
- UPS for Low Lighting

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<sup>4</sup> Fire damper is a passive fire protection equipment used on ships to prevent spread of fire

- 3 Air Condition emergency panels
- Infirmary Small Power panel
- Battery Charger for Diesel Reg panel No.2
- Low Level Lighting distribution panel

### 3. NARRATIVE OF EVENTS

Note: all times noted in this narrative are given in the style of the standard 24 hour clock without additional annotation and as local time in the Gulf of Mexico, which was GMT-6. Other timing is noted in brackets.

- 3.1 At 1630 hours on the 9<sup>th</sup> of February 2013 the vessel departed Cozumel, Mexico, northbound for Galveston, Texas.

#### **VESSEL OPERATIONAL STATUS 0400-0800 FEBRUARY 10, 2013**

- 3.2 The bridge manning for the morning 4-8 watch on was as follows:

- First Officer (Bridge Manager), a 33 year old Italian citizen, with a STCW II/2 certificate issued by the Government of Italy.
- 3<sup>rd</sup> Officer, a 23 year old Italian citizen, with a STCW II/1 Certificate issued by the Government of Italy.
- Deck cadet, a 25 year old Italian citizen

A quartermaster and lookout completed the bridge team but played no critical role in the events described.

- 3.3 The Engine room manning for the morning 4 – 8 watch was as follows:

- 2nd Engineer, a 28 year old Italian citizen, with a STCW III/2 – V/2 – V/3 Certificate issued by the Government of Italy
- 3rd Engineer, a 21 year old Italian citizen, with a STCW III/1, V/2 Certificate issued by the Government of Italy
- Engine cadet, a 24 year old Italian citizen, who joined Carnival in 2012.
- Oiler, a 29 year old Philippine citizen, on his 8<sup>th</sup> contract with Carnival.

Carnival Cruise Lines carry out all onboard Crowd Management and Crisis Management Training.

All Carnival crew members have crowd management training.  
Personnel in management positions also have Crisis Management training.

**WEATHER CONDITIONS**

- 3.4 The vessels log book records the following conditions at 0500, immediately preceding the incident:

Latitude	23° 42.1' N
Longitude	088° 12.6' W
Course true	314°.0
Course gyro	314°.4
Gyro error	0°.7 W
Wind direction	151°
Wind force	16.30 knots
Sea direction	SE Swell 3-4 feet
Sea force	F4 Beaufort scale
Visibility	Good
Dry air temperature	24 °C
Wet air temperature	21 °C
Barometric pressure	1016 mbar
Sea temperature	24.60 °C
Humidity	85.00 %
Propeller RPM SB	119.90
Propeller RPM P	118.90
Diesel generators	1/2/3/6 running
Speed	19.60 knots
Stabilizer fins	In

**EVENT – START OF THE MORNING 4-8 WATCH ON FEBRUARY 10TH**

- 3.5 On the morning of February 10<sup>th</sup>, the 2<sup>nd</sup> Engineer arrived in the engine room at approximately 03:30, and assumed the watch from the previous watch keeper. The handover was reported to have been routine. During the 0400-0800 watch, the 2<sup>nd</sup> Engineer intended to remain in the Engine Control Room where he had a view of the closed circuit television screens. He planned to send the 3<sup>rd</sup> Engineer, cadet and oiler to the Air Conditioning Compressor Room (ACCR) to carry out maintenance work.
- 3.6 The ACCR is on “C” deck in the engine room, four watertight compartments forward of the Engine Control Room access stairwell, and watertight compartments five watertight compartments forward of the Aft Engine Room. There are three (3) watertight zone doors that are required to be closed at sea between the ACCR and the Aft Engine Room. An additional two (2) watertight doors may be open at sea.
- 3.7 The 3<sup>rd</sup> Engineer arrived in the engine room for the 0400-0800 watch between 03:00 and 03:30 hours. The handover from the 3<sup>rd</sup> engineer on the previous watch was reported to be routine. After meeting with the 2<sup>nd</sup> Engineer in the Engine

Control Room, the 3<sup>rd</sup> Engineer headed to the ACCR with the oiler and cadet, as directed, entering the engine spaces via stairwell 100, aft in the Forward Engine Room. En route forward to the ACCR the 3<sup>rd</sup> Engineer viewed running equipment including the evaporators and bilge separator, but did not go to the Aft Engine Room.

- 3.8 The cadet arrived in the Engine Control Room at 03:50 hours on February 10<sup>th</sup>. There was no cadet on the earlier watch and so he did not receive a direct handover. The 2<sup>nd</sup> and 3<sup>rd</sup> engineers were in the Engine Control Room when he arrived. The 3<sup>rd</sup> Engineer updated the cadet on what equipment was running. The cadet did not enter the engine room before 04:30 hours as he proceeded to the ACCR.
- 3.9 The oiler arrived in the engine room at 03:45 hours on March 10<sup>th</sup>, having met with the previous 1200-0400 watch oiler at the changing room for a handover. The oiler then made a round of the engine room as usual. During his interview, the oiler indicated that these rounds usually take 30-45 minutes and include the fuel oil separator room, evaporator room, forward and aft engine rooms, electro-propulsion room and refrigeration compressors. On completion of the engine room round at the start of the 4-8 watch on February 10<sup>th</sup>, the oiler reported to the 3<sup>rd</sup> Engineer and then proceeded to collect tools for the work in the ACCR. The oiler reported that he was instructed to proceed to the ACCR at approximately 05:00 hours.
- 3.10 At 04:00 hours, diesel generators 1, 2, 3 and 6 were running with the load balanced, supplying power to the vessels electro-propulsion system, ship services and the hotel load.
- 3.11 As part of his round, during the inspection of the Aft Engine Room the oiler inspected the No.6 engine. He noticed nothing out of the ordinary and in particular, neither smoke nor steam nor odours. A review of the closed circuit television cameras, notably diesel generator No.4 aft camera, verifies the oiler making his round both at 04:35 hours and at 04:48 hours.

#### **EVENT – FAILURE OF FLEXIBLE FUEL PIPE**

- 3.12 At 05:16:05, according to the Damatic log, a fire alarm was indicated on the bridge. During the post-casualty interview, the 2<sup>nd</sup> Engineer reported receiving a call from the bridge that a fire alarm had been activated from diesel generator No.6. He called the 3<sup>rd</sup> Engineer on the ships internal phone system and instructed him to investigate.
- 3.13 The 3<sup>rd</sup> Engineer, accompanied by the Cadet and Oiler, travelled from the ACCR to the Aft Engine Room, opening three (3) closed watertight doors enroute. The Investigation team determined that this process takes 3-4 minutes total travel time. A review of the CCT monitor at Deck C Diesel Generator No. 1 location shows the team proceeding to the Aft Engine Room at 05:18 hours.

- 3.14 The 3<sup>rd</sup> Engineer reported to the 2<sup>nd</sup> Engineer that oil was spraying at the No.6 engine and that the engine must be stopped. In his interview the 3<sup>rd</sup> Engineer reported “he could smell fuel and while the engine room was very dark he could see oil spraying”. In his post-casualty interview the cadet described opening the door in the bulkhead between engines No.4 & No.5 and seeing fuel oil spraying from beneath the deck plates, to a height of an estimated 5-6 meters, between the No.6 engine turbo chargers.
- 3.15 The 2<sup>nd</sup> Engineer (as reported in his interview) called the bridge at 0515 to have engine No.6 generator to be taken out of sequence, and then he stopped the fuel feed pump and booster pump. The Damatic log records that the manual emergency stop on diesel generator No.6 was activated at 0519:28 hours. The engine is recorded as stopped at 0519:30 and the fuel feed and booster pumps are recorded on stand-by at 0520:53.
- 3.16 The OOW in the Engine Room has the ability to trip any engine at any time by activating the emergency stop. The actions of the 2nd Engineer were intended to reduce the load and stop the engine. At 0515 the Bridge reported an alarm at No. 6 Generator, following the ER request to take No. 6 generator out of sequence; the Emergency Stop was activated at 0519. Had the emergency stop been activated immediately in the ER, it is unlikely the outcome would have been any different; the spray was of such concentration that the fire was inevitable even as early as when the smoke alarm first sounded.
- 3.17 The 3<sup>rd</sup> Engineer, Oiler and cadet proceeded to the Fuel Oil Separator room to close the fuel oil supply valve on the fuel oil feeder module for engines No.5 & No.6. This was verified from closed circuit television recordings (Deck C fuel oil separators location) as completed between 0524:15 and 0525:45. The valve is on the fuel oil supply side of the system; the valve is normally open and supplies fuel to the aft engine room.

#### **EVENT – FIRE IN AFT ENGINE ROOM**

- 3.18 At 05:25:09, without being instructed to do so, the cadet left the Fuel Oil Separator Room to check the situation at the Aft Engine Room. On arrival, he found the engine stopped and he then witnessed the ignition of the fire a few metres in front of him. The closed circuit television “diesel generator 5 Bank A diesel generator 6 Bank B” camera shows the fire ignited at 05:27:13 hours. The cadet left the Aft Engine Room and went to the Engine Control Room to report to 2<sup>nd</sup> Engineer that there was a fire.
- 3.19 The First Officer, the 0400-0800 watch Bridge Manager, made the “Alpha Team” call at 05:28 (recorded on VDR) after seeing engine room flames on the cameras and multiple fire alarms. Alpha Team is discussed further later in this report.
- 3.20 The Captain awoke hearing the Alpha Team announcement, and at the same time he received a call from the bridge to report a fire in the engine room. The

Captain's stateroom is less than 5 metres from the wheelhouse and he proceeded directly to the wheelhouse.

- 3.21 Present at this time on the bridge were: the 0400-0800 watch keepers; the Staff Captain; the Cruise Director and the Environmental Officer. The Captain was updated on the situation by the Staff Captain and the First Officer, who reported seeing flames on the closed circuit television monitor. According to all reports received by the Investigation Team, the Master took clear command of the fire response, assisted by the Bridge Manager.

#### **EVENT – ACTIVATION OF THE HI-FOG® SYSTEM**

- 3.22 At 05:27:47 the Hi-Fog® fixed water fire fighting system automatic release actuated. At this time, the 2<sup>nd</sup> Engineer was on the phone to the Chief Engineer advising him of the fuel leak. In his post-casualty interview the Chief Engineer recalled the 2<sup>nd</sup> Engineer's phone call and being informed that the speed of engine No.6 had been reduced due a fuel leak. The Chief Engineer started to dress and immediately heard the Alpha Team announcement. He then ran from Deck 8 where his accommodation is located, to the Engine Control Room, about 100 steps down stairs and 120 metres aft.

#### **EVENT – FAILURE OF HI-FOG® SYSTEM**

- 3.23 The 2<sup>nd</sup> Engineer examined the Hi-Fog® control panel in the engine control room where he noted that it was operating at diesel generator No.6 but he recalled that the power to the system fluctuated and then stopped whereupon all the control panel lights went out. The 2<sup>nd</sup> Engineer began shutting down all engines prior to the Chief Engineer's arrival in the Engine Control Room.

#### **ACTION – OPERATION OF THE QUICK CLOSING VALVES**

- 3.24 When the Chief Engineer arrived in the Engine Control Room, the 2<sup>nd</sup> Engineer advised him that diesel generator No.6 was on fire. The Chief Engineer then went to the Hi-Fog control panel and found that it had no power and was non-functional. At this time there was the odour of smoke in the Engine Control Room but visibility remained good. The 3<sup>rd</sup> Engineer and the cadet describe the fuel leak to the Chief Engineer as "huge".



Operating levers for Fuel System Quick Closing Valves

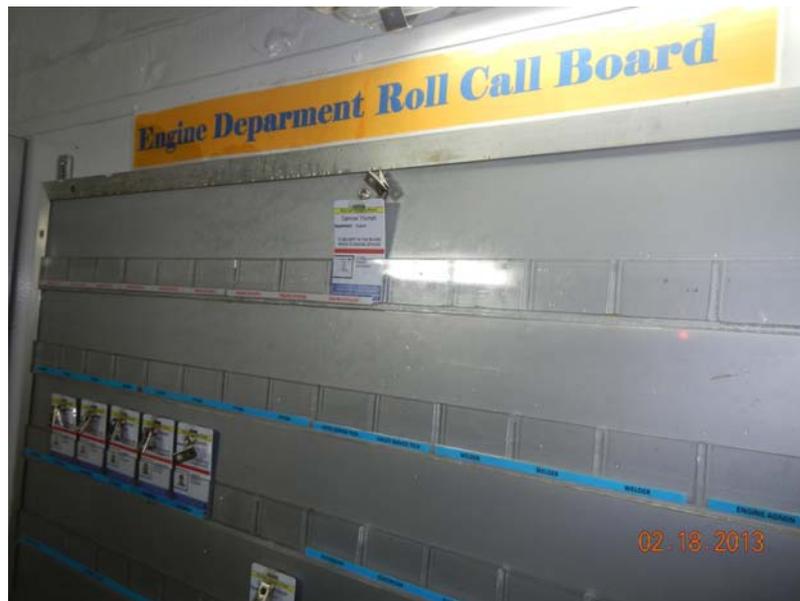
3.25 The Chief Engineer and 2nd Engineer operated all quick closing valves using the remote levers located in the vestibule outside the Engine Control Room. These levers close the following valves:

- Lube oil tanks No.1 Port, No.1 Starboard and the Stern tank
- Incinerator and sludge tanks
- Lube Oil Tank No.13
- Waste Oil tank
- Fuel oil service tanks No.2 and No.3 Starboard
- Fuel Oil settling tanks No.1 Port and No.1 Centre
- Diesel Oil service tanks
- Fuel Oil storage tanks No.1 Port and No.1 Starboard
- Fuel Oil double bottom tanks No.1 Port and No.1 Starboard

3.26 The 3rd Engineer and cadet were both in the Engine Control Room, and recalled that at this time smoke was present and it was difficult to breathe.

#### **EVENT – ROLL CALL AND ACTIVATION OF THE CO<sub>2</sub> SYSTEM**

3.27 The Chief Engineer called the bridge and advised the Captain that the situation was “serious”, and he requested permission to release the CO<sub>2</sub>. The Captain concurred but required a roll call to be completed first. The Engineering roll call board is located outside the Engine Control Room door in a vestibule. Standard operating procedure is for each person to leave their ID badge on the board when entering the engine room. There were 2 badges on the board for crew who were located at the crew marshalling area on Deck 0.



Engine room roll call board

3.28 The Chief Engineer dispatched teams to verify that the engine room had been secured before releasing the CO<sub>2</sub>. Notably, the Chief Engineer also wanted to verify that the doors to the garbage handling room were closed and that there were no crewmembers in this area. The garbage handling room is in the same CO<sub>2</sub> zone as the Aft Engine Room. The Chief Engineer went to the CO<sub>2</sub> remote activation cabinets which were directly outside the engine room vestibule.



CO<sub>2</sub> system remote release station.

**EVENT – FAILURE OF REMOTE CO<sub>2</sub> SYSTEM ACTIVATION**

- 3.29 Once the CE was certain that the CO<sub>2</sub> release alarm was sounding and that the auto close for the fire doors and dampers had time to operate, due to the failure at the local station to activate the CO<sub>2</sub> system at the Aft Engine Room, the CE proceeded from Deck 0 to Deck No.11, via the stairways, to access the CO<sub>2</sub> room. In the event the failure was due to a fault to the distribution valve in the CO<sub>2</sub> Room. En route, he noted that the vessel's lights were flickering.
- 3.30 Outside the CO<sub>2</sub> bottle storage room, the visible CO<sub>2</sub> alarm was flashing, indicating the presence of CO<sub>2</sub> in the CO<sub>2</sub> room and that the space was unsafe to enter. The CO<sub>2</sub> room is adjacent to the Emergency Generator Room where the Senior Electronics Officer and First Engineer were stationed.
- 3.31 The Chief Engineer sent the Chief Refrigeration Engineer to verify that the fire dampers above the Aft Engine Room were closed: these would not permit the CO<sub>2</sub> release if open. All dampers and the garbage room fire doors were reported to have been closed.
- 3.32 The Electronics Officer, wearing breathing apparatus, entered the CO<sub>2</sub> room. He noted that the lights were on and that on the main control panel, the red light for the release valve was not illuminated. One leaking CO<sub>2</sub> bottle was clearly visible, with CO<sub>2</sub> escaping from the bottle top. Later, a second bottle was also found loosely connected.
- 3.33 The Electronics Officer requested confirmation to release the CO<sub>2</sub>, and instruction was given to activate the system. The CO<sub>2</sub> system was under pressure as far as the main distribution valve, as determined by the fact that this valve was hard to open. The Electronics Officer turned it two times by hand and then the stem lifted, relieving the pressure and making the valve easy to open.
- 3.34 The appearance of ice on the discharge side piping clearly indicated that the CO<sub>2</sub> had released. The pressure manometer then fell to zero in the line. The designated CO<sub>2</sub> bottle banks 3, 4 and 5 for Zone A had released, and the Electronics Officer tapped the bottles to verify they were indeed empty. After exiting the CO<sub>2</sub> room the Electronics Officer was able to see white smoke coming from the funnel, which ceased shortly thereafter.

**ACTION – FIRE FIGHTING**

- 3.35 The Safety Officer and the Captain discussed whether to open the internal doors between Deck 0 and the aft mooring station, to vent smoke from the marshalling area and the Engine Control Room. During interviews with passengers, it was determined that the stairwell door stayed open and smoke entered the passenger deck No.1 aft.



Access door from crew to passenger decks with defective closing device.

→ Direction of Opening

- 3.36 Boundary cooling<sup>5</sup> was carried out on Deck 0, directly above the Aft Engine Room, by means of intermittent use of fire hoses to avoid flooding. Squad Alpha carried out the cooling. With CO<sub>2</sub> released boundary cooling was necessary “only on the top” (meaning Deck Zero). Teams were changed out to avoid exhaustion.
- 3.37 Approximately 10 minutes after the CO<sub>2</sub> had been released into the Aft Engine Room, the Chief Engineer, Staff Engineer and cadet re-entered the Engine Control Room. The Electronics Officer and the Safety Officer entered the Forward Engine Room wearing breathing apparatus. They inspected the spaces that surround the Aft Engine Room including the Forward Engine Room, Main Switchboard Rooms, and Propulsion Motor Room.
- 3.38 The Captain directed the Safety Officer to begin monitoring bulkheads for hot spots<sup>6</sup> using thermal measuring guns. In his interview, he reported finding the forward and aft bulkheads of the Aft Engine Room were at 50°C. The temperature close to the switchboard rooms was higher, 45-50°C to port and 100°C to starboard. The highest measurements, as high as 220°C, were found where boundary cooling was in progress.

<sup>5</sup> Boundary Cooling: is used as a supplement to direct attack on the fire to reduce temperature and prevent failure of the containment.

<sup>6</sup> Hot spots; exceptionally high temperatures detected

- 3.39 Instructions reported from Carnival Miami were to “take any steps necessary” to restart the Hi-Fog® system. The Staff Chief Engineer, assisted by the Electronics Officer, ran a temporary power line in the propulsion motor room to the Hi-Fog® system to return it to service. Power was taken from an emergency panel in the propulsion room that supplies an engine start air compressor.
- 3.40 The time period to restart the Hi-Fog® system is reported to have been between 45 and 60 minutes. The Hi-Fog® system was restarted, and was run continuously, with monitoring of hot spot areas. The exact time the system was finally secured could not be determined but information obtained during interviews indicated it to be “after lunchtime”.
- 3.41 At approximately 05:36 hours (Blackout time as indicated on VDR and Damatic with time differences applied) the Blackout tank released its contents – this would have flushed all fuel galleries and so not all contents were released to the fire.
- 3.42 The ships Damatic log has a reported time correction of 9 minutes and 22 seconds, the Autronica has a reported correction of 11 minutes and 48 seconds (both slow) and the Martec 10 minutes and 32 seconds (fast). This has been applied to all noted events. Other system time clocks are believed to be accurate.
- 3.43 The following times are recorded (these have been noted below to the whole minute for clarity, actual event timing is recorded to the second)

**10<sup>th</sup> February 2013**

- 05:14 Smoke at diesel generator 6 (closed circuit television)
- 05:15 Bridge reports an alarm at diesel generator No.6 and asks this be checked into (VDR)
- 05:16 Fire alarm at diesel generator No.6 (Damatic)
- 05:18 White smoke at diesel generator No.6 (closed circuit television)
- 05:18 Engine Room request bridge reduce speed (VDR)
- 05:18 Engine Room request bridge take diesel generator No.6 out of sequence (VDR)
- 05:19 diesel generator No.6 Emergency Stop activated  
Subsequent alarms may have been due to the fire and resulting power loss.
- 05:20 Black smoke at diesel generator No.6 (closed circuit television)
- 05:20 Fuel oil feed and booster pumps on stand-by (Damatic)
- 05:21 Bridge engages Hand Steering (VDR)
- 05:24 Cadet closing fuel valve in FO Purifier room (closed circuit television)
- 05:24 Fire detection system fault (Damatic)
- 05:24 Oiler assisting closing overhead valve in FO separator room (closed circuit television)
- 05:24 Difficulty closing valve in FO separator room, (closed circuit television)
- 05:25 3<sup>rd</sup> Engineer and oiler closing an overhead valve in FO separator room (closed circuit television). This aforementioned blue handled valve at

Viscochief – needs formal ID – suggest “Fuel Oil Supply valve to Aft Engine Room”

- 05:26 3<sup>rd</sup> Engineer & oiler leave FO separator Room (closed circuit television)
- 05:27 Fire erupts forward of diesel generator No.6 (closed circuit television)
- 05:27 Fire alarm Tunnel Casing (Damatic)
- 05:27 Oiler appears between diesel generator No.5 and No.6, sees fire and exits (closed circuit television)
- 05:27 Smoke appears in lubricating oil Purifier Room port side (closed circuit television)
- 05:27 Bridge receives a call from the Engine Room to activate the Alpha Team (VDR)
- 05:28 Alpha Team announcement made (VDR)
- 05:28 Smoke appears in the Forward Engine Room (closed circuit television)
- 05:28 Diesel generator No.6 oil mist alarm (Damatic)
- 05:28 Diesel generator No.6 oil mist detector shutdown (Damatic).
- 05:28 Fire alarm accommodation (Damatic)
- 05:28 3<sup>rd</sup> Engineer closes the forward watertight door at the Aft Engine Room (closed circuit television)
- 05:28 Smoke appears in the Incinerator Room at burner 1 (closed circuit television)
- 05:28 Smoke appears in the Incinerator Room at burner 2, Hi-Fog© activated over Diesel generator No.6 (closed circuit television)
- 05:29 Captain notified of fire by telephone (VDR)
- 05:29 Fire alarm aft diesel generator No.6 (Damatic)
- 05:30 Sprinkler release (Damatic)
- 05:31 Safety Officer at Deck A aft requests evacuation of crew cabins aft on Deck A (VDR)
- 05:32 Staging area set t Marshalling Area (VDR)
- 05:32 diesel generator No.6 fuel oil inlet pressure fault (Damatic)
- 05:32 CO<sub>2</sub> Zone A directional valve fully open (Martec)
- 05:32 CO<sub>2</sub> leakage detector 1 Alarm
- 05:33 Fire alarm MSD room (Damatic)
- 05:34 Smoke appears in the propulsion room (closed circuit television)
- 05:34 CO<sub>2</sub> leakage detector 2 Alarm (Martec)
- 05:35 Main manifold fill up (Martec)
- 05:36 Not under command lights illuminated (VDR)
- 05:36 Blackout and Gyro failed (VDR)
- 05:37 Staging Area moved to Medical Centre (VDR)
- 05:38 The Emergency Generator had started by the time the CE arrived in the CO<sub>2</sub> Room.
- 05:38 CO<sub>2</sub> Zone A directional valve fully open (Martec)
- 05:39 Guest announcement “Situation in Engine Room” (VDR)
- 05:39 CO<sub>2</sub> gas released protected area A (Martec)

- 05:46 Captain confirms no requirement for mustering (VDR)
- 05:47 Cruise Director announcement to guests “Not required to Muster” (VDR)
- 05:48 Two shell doors open (for clearing smoke) (VDR)
- 05:52 Chief Engineer recommends staying at Zero RPM (VDR)
- 05:56 Shell doors closed, smoke cleared (VDR)
- 06:08 Cruise Director announces engineers working on restoring power (VDR)
- 06:11 Bridge Officer reports team ready to start hot spot monitoring (VDR)

#### **EVENT – FIRE EXTINGUISHED**

- 3.44 At approximately 13:30 hours the Captain gave permission to re-enter the engine rooms for inspection. The Forward Engine Room was reported clear of any fire with some smoke. The Safety Officer was part of the team entering the engine room, and during his interview he describes entering via watertight door No.6 into the Aft Engine Room, port side, at the No.4 engine space and then through the fire screen door into the centre compartment containing engines No.5 & No.6. A fire team with hose and extinguisher was in attendance.
- 3.45 While there was no visibility, it was established that there was no fire and the temperature was measured at 45°C. The fire was declared extinguished at 13:30 hours.
- 3.46 To remove heat and odour, it was decided to open the engine stores hatch and vent the space out through a side shell door. Fire watch and fire patrols continued until late on February 10<sup>th</sup>. Fire squads stood down 14:00~14:30 hours. Fire-fighting equipment was returned to the fire lockers, serviced, and made ready for further use.

#### **EVENT – LOSS OF PRIMARY POWER**

- 3.47 Upon review of conditions in the engine room, the Chief Engineer advised the Captain that no further propulsion would be possible. The vessel was disabled some 160 miles north of Progresso, Mexico and some 390 miles south of Mobile Bay and was drifting northwards.

#### **EVENT – LOSS OF EMERGENCY POWER**

- 3.48 During the evening of February 11<sup>th</sup>, the Emergency Generator was shut down to replace a leaking fuel pipe, leaving the vessel solely on battery power. During this time the public address system was not available. The Public Address system has battery back-up (30 minutes as required by SOLAS II-1 Reg:42 4.1.2) but it cannot be determined when the batteries are possibly depleted”
- 3.49 During the morning of February 12<sup>th</sup> the Emergency Generator was shut down for one hour to make a repair to a leaking fuel line. Through the afternoon of February

12<sup>th</sup>, the Emergency Generator load was reduced to 50% due to a radiator coolant leak. The Chief Engineer decided to have the Emergency Generator Room manned on a 24 hour basis in order to manage the leak.

- 3.50 Through February 13<sup>th</sup> the Emergency Generator continued at 50% load, post incident, additional load was added upto 60% load, Finally increased to 75% on the morning of February 14<sup>th</sup>, so enabling provision for additional services – galley equipment , music etc.

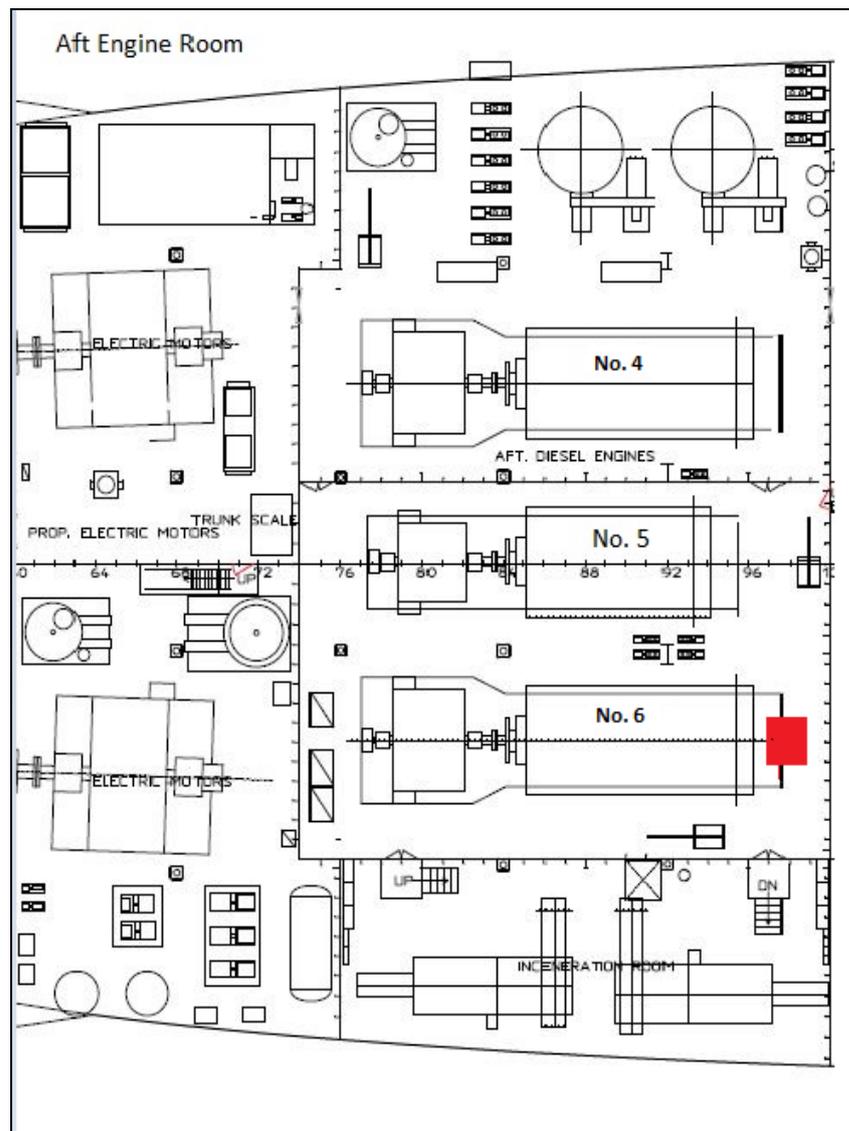
#### **EVENT – FAILURE OF FIRE HYDRANT/FLOODING**

- 3.51 Upon re-entry to the Aft Engine Room the Staff Chief Engineer observed that the forward starboard side fire hydrant was leaking a substantial amount of water into the Aft Engine Room bilge. The emergency fire pump was stopped to allow replacement of the hydrant.

## 4. POST FIRE INVESTIGATION

### ENGINE ROOM

- 4.1 The Aft Engine Room is fitted with two non-continuous, non-watertight longitudinal bulkheads with diesel generators Nos.5 and 6 in the central area between the bulkheads. Outside of these bulkheads, diesel generator No.4 and two auxiliary boilers are located to the port side and two incinerators on the starboard side.



■ Source of Fire

- 4.2 The bilge area is common and free of any segregation for the entire space. It was found full almost to the deck plates with water and what appeared to be a layer of oil on top.
- 4.3 Outboard of the port partition bulkhead diesel generator No.4 was found with its paint system intact, and a limited amount of soot accumulation. There was no apparent heat damage. This engine was noted to be under maintenance with high pressure fuel injection lines removed.



Upper part of diesel generator No.4 – looking aft.

- 4.4 On the starboard side of the partition the incinerators were found to have paint systems intact and a limited amount of soot accumulation, heat damage was noted in way of cable trays running along the outboard side of the starboard partition bulkhead.



Flooding in the Incinerator Room (note tidemark ↓)

- 4.5 The central area between the port and starboard partition bulkheads of the Aft Engine Room contain diesel generators Nos.5 and 6. This area was found with heavy soot accumulation and heat damage to varying degrees, from section to section.
- 4.6 The highest concentration of heat appeared to be forward of diesel generator No.6, a section of the engines cooling water piping was found with the flexible joint melted, the coating system burnt away and no soot accumulation. The lack of soot is evidence that the heat in this area was sufficient to consume all combustible material, and it is therefore considered to be one of the hottest areas discovered.
- 4.7 Deformation of fittings, including lights, loudspeakers, alarm panels, fire activation points and fire fighting equipment indicate that the heat from the fire was concentrated forward of engine No.6, and between that engine and along the starboard partition bulkhead to the aft bulkhead at frame 74.



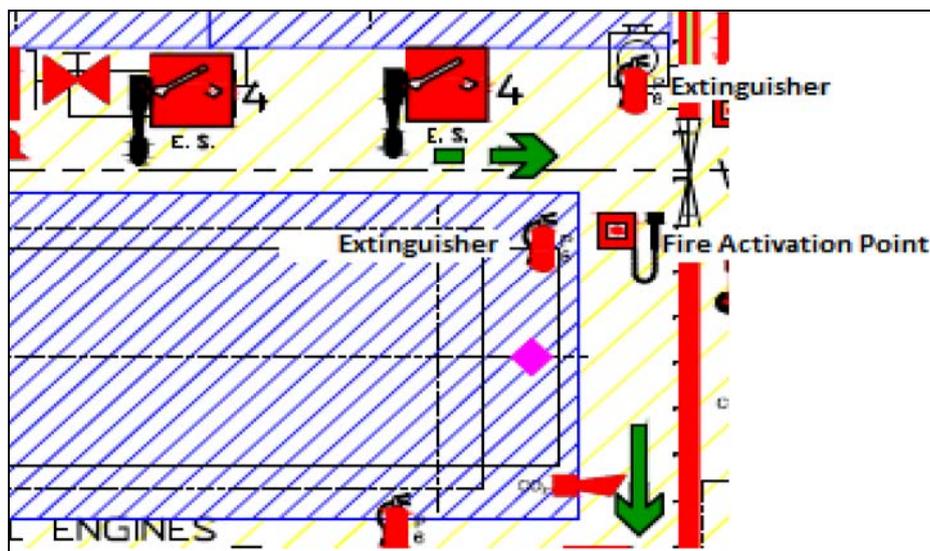
Inboard side of upper part of diesel generator No.6 – looking aft



Forward end of diesel generator No.5 below Turbo Chargers



Fire alarm activation point melted onto fire extinguisher



- 4.8 The fire hydrant valve at the fire station, located forward, and to the starboard, of diesel generator No.6, was noted to be newly installed and free of fire damage. It was reported that this valve had been replaced after the fire. Inspection of the original hydrant revealed that the diaphragm failed during the fire. As a result, the fire main continuously discharged water into the space, flooding the bilges.



Fire hose adjacent to Engine No.6

- 4.9 The forward end of diesel generator No.6, its turbochargers and exhaust manifold were examined for a source of ignition. Thermal insulating blankets were found saturated with an oily residue. These were carefully removed from between the two turbochargers, revealing the heat shield where the exhaust manifold splits to enter the inboard and outboard turbocharger. In the lower outboard corner of the heat shield, an area of approximately 250 mm<sup>2</sup> was found free of soot. This represented the hottest and closest area to the failed section of flexible pipe where the heat was sufficient to consume all combustible material and thus was considered the point of ignition.



Forward end of diesel generator No.6 between turbo chargers

- 4.10 Equipment surrounding diesel generator No.6 was found with heat damage and a heavy accumulation of soot. The insulation for electrical cables in trays forward of the engine, along the starboard partition bulkhead, and above the turbochargers, was found with severe heat damage.



View of heat damaged electrical cables above diesel generator No.5 & No.6

- 4.11 The overhead was examined and sections of the transverse under deck support beam at Frame 96 were found distorted 0-75mm at two (2) locations. Each of the areas found distorted were in way of the fixed points for the resilient fixtures, which supported the inboard and outboard ventilation trunks. In addition, the ventilation register immediately above the turbochargers for engine No.6 was found with the automatic fire dampers closed. Close examination revealed that some of the individual damper panels for this register appeared to have been bent and distorted from extreme heat.



Heat damaged overhead transverse beam in Aft Engine Room

- 4.12 The spaces bordering the Aft Engine Room were examined. The bulkhead between the Forward and Aft Engine Rooms, Frame 100, has thermal insulating blankets installed. There was no evident heat damage to those blankets. The aft bulkhead of the Aft Engine Room borders the propulsion room at Frame 73. Heat damage resulted in the peeling of paint over a 9 m<sup>2</sup> area, approximately 16 metres off the centreline to starboard.



Heat damage to the forward bulkhead in the Propulsion Room

- 4.13 The main Switchboard Room is located on Deck A. It is above the three generators in the Aft Engine Room, between Frames 73 & 84. The transverse space is subdivided port and starboard by a door at the centreline. The forward bulkhead has thermal blankets installed, and these were found in place. A door leads to the Aft Engine Room, approximately 16 meters off the centreline to starboard. Inspection revealed a slight discolouration of the sheathing over the insulation on the forward bulkhead at frame 84 in the Starboard Switchboard Room. Additionally some soot, over an area of 200 cm<sup>2</sup> was present at the lower right hand corner of the door frame leading to the Aft Engine Room. Apart from these areas, the Switchboard Room was found free of any evidence of heat or smoke damage.
- 4.14 An examination was made of Deck 0 directly above the Aft Engine Room. The centreline passageway was found free of any evidence of heat or smoke damage, with the single exception of an area at the base of the starboard longitudinal bulkhead near Frame 100. In this area, an examination found only a slight discolouration of the coating system.
- 4.15 To the port side of the centreline passageway, the Engine Casing was found free of any evidence of heat or smoke damage. Starboard of the centreline passageway the Engine Casing was found free of any accumulation of soot. The deck itself was found severely distorted over an area of approximately 8m<sup>2</sup>, between Frames 92 & 100. A series of steel boxes, approximately 2000x1000x700mm, and mounted on the deck are used as ventilation registers. These boxes also housed automatic fire dampers. The top of each register is fitted with bar grate covers.



Fire dampers above Aft Engine Room

- 4.16 The sides of the ventilation register box, located between Frames 96 & 100, approximately 16 meters to starboard of the centreline was found severely distorted. Some of the individual panels of the fire dampers were also found bent and distorted. The actuators for fire dampers were distorted and the linkage was found detached. The bar grate cover was found set down and sagging between framed supports.
- 4.17 On Deck 0, there are two vertical trunks near Frame 100. These were found bent and distorted, with an inspection cover found lying on the deck. The cover was apparently blown off the trunk. An inspection of the trunking between decks 0 and 11 revealed that the two trunks were bent and distorted throughout. The segment flanges were found to be bent, and distorted. Flanges were separated at numerous locations throughout.



View of sagged grating covers

- 4.18 Within the Engine Casing, cables in trays, plastic light fixtures, phone stations, alarm indicating panels, fire detection head covers, and the Exhaust Gas Boiler control station on Deck 3 were found with heat damage. The heaviest soot accumulation was noted at Deck 5.



Heat damage to deck 11 ventilation fan

- 4.19 Two ventilation fans located on the starboard side of the casing, at Deck 11, were found with severe heat damage. The two fan motors were found severely charred. The fire dampers between the fans and the Engine Casing appear to have fully closed. These ventilation fans share a common space with the fans mounted immediately below, on Deck 10. The fans on Deck 10 were found unaffected by any heat.
- 4.20 An examination of the Blackout Recovery Tank in the Emergency Diesel generator space revealed it was empty. This tank has a capacity of 4.607 m<sup>3</sup>.
- 4.21 The exhaust manifold and turbocharger insulation blanketing and heat shields appeared to have been of relatively new installation, well secured and in good condition. The high pressure fuel pipe protection required under SOLAS Reg II-4 / 2.2.5.2 was found to have been installed on the high pressure injector lines on each cylinder and a drip collection system was installed on all engines.

*2.2.5.2 External high-pressure fuel delivery lines between the high-pressure fuel pumps and fuel injectors shall be protected with a jacketed piping system capable of containing fuel from a high- pressure line failure. A jacketed pipe incorporates an outer pipe into which the high- pressure fuel pipe is placed, forming a permanent assembly. The jacketed piping system shall include a means for collection of leakages and arrangements shall be provided with an alarm in case of a fuel line failure.*

- 4.22 Individual covers had also been installed on each cylinder's high pressure injection fuel pumps on all engines.
- 4.23 Diesel generator No.6 was the sole engine found with a series of aluminium plates forming boxed enclosures for the fuel piping and the areas in between the individual cylinder heads. The Chief Engineer reported that this was being evaluated for all engines.



View of additional box covers at diesel generator No.6

- 4.24 A survey of each engines flexible line arrangement revealed that the generator engines were provided with flange shields and guards in place for the fuel oil supply and return flexible lines, with the following exceptions:
- diesel generator No.2 was found without flange shields, and insulating blankets had been used to cover the upper flanges of each of the supply and return lines.
  - diesel generator No.4 (out of service and under maintenance at the time of the incident) was found without flange shields or line guards on either the supply or return lines. Pieces of insulating blankets had been used to cover each of the flanges on the supply line. The supply and return flexible lines were found without any additional thermal insulation. Both sections of piping were found positioned completely under the deck plates.
  - diesel generator No.5 (out of service and under maintenance at the time of the incident) return flexible line was found without flange shields. Pieces of insulating blanket were used to cover each of the flanges. A line guard was in place without any additional thermal insulation.
  - diesel generator No.6 was found without a line guard on the return line. This section of pipe was found positioned under the deck plates.



View of the diesel generator No.4 fuel oil return line flexible pipe in position, located beneath engine room floor

- 4.25 In the Fuel Oil Purifier Room the aft Viscochief fuel oil module discharge valve was found to have been manually closed. This would have stopped the flow of fuel oil to diesel generators Nos.4, 5 and 6.



View of the Viscochief unit for the Aft Engine Room showing the isolating valve (blue handle) closed.

- 4.26 Temporary power cables were found run to the Hi-Fog® Pump and a Fuel Oil Transfer pump.

- 4.27 The Fuel Oil Transfer pump was used to pump the flooded Aft Engine Room bilge to the No.2 centre fuel oil double bottom, in an attempt to reduce the free surface in the Aft Engine Room. This transfer would reduce the loss of stability, remove the adverse effect on stability and the list caused by the amount of water free to shift across the Aft Engine Room as the vessel heeled in the wind. The FOTP was used as it serves the FO system.

## 5. CAUSATIVE FACTORS

- 5.1 The initiating event of the fire was the failure of the return fuel oil line at the No. 6 diesel generator in way of a flexible pipe resulting in fuel oil spraying up and fuel mist igniting when it hit the hot surface at one end of the No. 6 diesel generator engine in the vicinity of its turbocharger:
- i. The vessel suffered a total loss of main electrical power and propulsion.
  - ii. The Hi-Fog® system in the engine room lost power.
  - iii. The main CO<sub>2</sub> distribution valve to the Aft Engine Room failed to open.
  - iv. A fire hydrant in the Aft Engine Room failed causing flooding in the bilge up to the deck plate.
  - v. The emergency generator experienced a fuel leak, cooling problems and problems coping with power demands.
  - vi. The vessel developed a list due to the free surface effect from flooding in the Aft Engine Room bilge.
  - vii. The failure of the cold start fuel valves to close.

### **FLEXIBLE PIPE FAILURE**

- 5.2 Each of the six main engines on the Carnival Triumph has two flexible pipe connections for fuel oil. These connect the supply and return line piping to the engine and compensate for movement and vibration on machinery. Spare flexible pipes supplied originally by the shipyard were available on board, although no information regarding the shelf life of the flexible hoses was available. The manufacturer (Tubiflex) of the flexible pipes, asserts the flexible pipes have an indefinite shelf life (if stored in a non-corrosive environment).
- 5.3 Carnival Corporation Advisory Notice 02/2012 referred to a fire caused by a generator fuel leak aboard the “Costa Allegra” on 27<sup>th</sup> February 2012. The Notice required fuel pipe connections be inspected and in particular where these were subject to vibration.
- 5.4 The Chief Engineer on the “Carnival Triumph” confirmed that on 21<sup>st</sup> March 2012 the fuel pipe connections to all six engines had been visually inspected and appeared in good working condition.
- 5.5 Flexible pipes were the subject of a second internal Carnival Corporation Advisory Notice, Number 15 of 2012, issued on the 28<sup>th</sup> of December 2012. This Notice reported that a flexible fuel oil pipe had failed although a machinery space fire had been averted on that occasion. This was stated to have been due to the fact that a spray shield had been installed around the pipe preventing any jet leakage<sup>7</sup> from

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<sup>7</sup> jet – high pressure in a liquid extinguished through a small aperture such as a hole in a hose causing a high pressure spray.

impinging on any surface which was hot enough to lead to ignition. The Notice recognised that there had been 9 fuel leakages incidents over a 2 year period.

- 5.6 The markings on the end flanges of the pipe that failed on the “Carnival Triumph” were decoded with the assistance of the pipe manufacturer, “Tubiflex” based in Orbassano, Italy:
- The customer for this pipe was Fincantieri Navali Italiani S.p.A
  - The pipe was manufactured in July 1997 and shipped from Tubiflex on July 30<sup>th</sup> 1997
  - The pipe was type approved by the Italian Ministry of the Mercantile Marine.
  - The pipe working pressure is 11 bars.
  - Carnival is unable to provide any documentation regarding this pipe, the delivery date is unknown and there is no certification.
  - The vessel’s inventory control system does not track individual pipes.
- 5.7 During September 2012, a program was implemented to provide each flexible pipe and pipe end flanges with a splash guard. For the diesel generator engine fuel oil supply and return system a total of 12 pipes were identified (amongst other pipes on different equipment in the engine spaces).
- 5.8 An e-mail on September 18<sup>th</sup> 2012 from Carnival Cruise Lines, Miami, instructed the Chief Engineer that in regards to splash guards the flexible fuel pipes and fuel flanges were priority. Splash guards were received aboard on December 8<sup>th</sup> 2012 and installation commenced thereafter.
- 5.9 When interviewed, the Chief Engineer advised that pipes above the floor plates were given priority over those partly shielded by the plates. The Chief Engineer also confirmed that the return pipe that failed on February 10<sup>th</sup> was below the plates and remained at that time on the “to do” list for the shielding program.
- 5.10 The vessel’s planned maintenance system indicates that the fuel supply and return flexible pipes on the No.6 engine were replaced and inspected on August 24<sup>th</sup> 2012. No leaks or other anomalies were found upon inspection.
- 5.11 Inspections of flexible fuel pipes are scheduled at 6 month intervals and following change of policy, the flexible pipes are now replaced at 18 month intervals. The pipe which failed in this case was inspected at Mobile, Alabama post-casualty. The engine room floor plates were removed and the return line exposed. The pipe was found wrapped with thermal insulation which was removed to uncover the pipe.



Diesel generator No.6 fuel return line flexible pipe in-situ beneath floor plates, thermal insulation shown in place. The floor plates have been removed to afford access.

- 5.12 The thermal insulation blanket for the fuel oil return flexible pipe was found saturated with what appeared to be oil, the insulation was removed and found oil soaked. The thermal insulation was removed until found oil free and the pipe flanges exposed. The pipe flanges were unbolted and disassembled at both ends of the flexible pipe, once disconnected it was noted that there was marine gas oil with a smaller component of heavy fuel oil present in the line.
- 5.13 The fuel oil return line flexible pipe was removed together with two sections of adjacent piping and taken to the vessel's machine shop. The flexible pipe was seen to be a 600x65 mm section of lined stainless steel braided mesh pipe, collared, and fitted with stainless steel slip on flanges at each end. The steel braided mesh pipe segment was jacketed with an insulated cloth which was held in position with two each stainless steel threaded pipe clamps at each end.
- 5.14 The pipe clamps and insulated cloth jacket were removed and the braided pipe was found to have a 25 mm diameter bubble extending out from the surface of the pipe approximately 15 mm. Viewed from either end flange into the pipe, light was clearly visible entering at the site of the bubble. Gaskets at both flanged connections to fixed piping were examined and found intact and in satisfactory condition.



Diesel generator No.6 fuel return line flexible pipe (uppermost in this photograph ↓) shown with the thermal insulation removed prior to disconnection.



Diesel generator No.6 fuel oil return line flexible pipe shown with Jacket insulation removed to expose the pipe and apparent rupture.

- 5.15 Immediate inspection indicated the pipe to be a 600x65 mm Teflon pipe inside a mesh stainless steel sleeve, with stainless steel slip on end flanges at each end. A bubble was noted approximately 25mm in diameter, standing proud of the pipe surface by approximately 15mm. The fuel oil piping removed with the pipe was disconnected and returned to service.

- 5.16 Analysis of the flexible fuel oil return line pipe from the No.6 engine was carried out in a New York laboratory in May 2013. The failure of the pipe was determined to be due to stress corrosion cracking of the austenitic stainless steel wire braid sheath. The fuel oil inlet pressure was reported as 11.31 bars, there was no recording of the outlet pressure, which would vary depending on the engine load.

## **LOSS OF POWER AND PROPULSION**

- 5.17 The vessel's main power cables, connecting the supply from engines in both the Forward Engine Room and the centre section of the Aft Engine Room to the Main Switchboard Room are located above diesel generator No.5 and No.6.
- 5.18 The fire at diesel generator No.6 resulted in additional fires in the overhead cabling which subsequently lost integrity and failed. This single point failure effectively cut off any connection between engines and switchboards. Post casualty inspection revealed that the extent of damage precluded any onboard repairs.
- 5.19 The total and unrecoverable power loss was determined to be due to the vessel's design that routed the entire power distribution through a single and potentially hazardous location. The Ship was built in compliance of the International Convention for the Safety of Life at Sea 1974, as modified by the Protocol of 1988.
- 5.20 Following previous fire incidents affecting the cable installations, steps were taken to mitigate this hazard. Engine Room cables were treated with an intumescent coating, Firetec FS1, supplied by Fire Security of Norway, designed to protect them in event of a fire. This coating is reported by the manufacturer to make the cables fire resistant in accordance with IEC 331, and has been approved by Class Societies such as Det Norske Veritas, Germanischer Lloyd and American Bureau of Shipping, and by the US Coast Guard. This type of fire, resulting after a substantial oil mist had soaked hot surfaces and had also penetrated into spaces between the cables in the cable tray, may be one that a coating cannot react to in a short enough time to protect the cables. Field application does leave gaps in the coating which are expected to close as the coatings intumesce.
- 5.21 The nature of this fire, with substantial oil mist prior to ignition, is likely to have engulfed the cables directly above the forward end of diesel generator No.6. The intumescent nature of the coating causes it to expand and cover any gaps in the application to protect cables, in this instance the fire would have ignited oil already inside cable runs prior to the coating reacting to the heat. Due to the short time between ignition and power failure, it would appear that the cables were not effectively protected from the fire attack by the Firetec FS1 coating although it cannot be ascertained whether or not the conditions in the conflagration exceeded the coating test conditions. The lack of effective protection from the effects of the fire may have been due to a combination of factors, such as the coating protection properties or the adequacy of the coating application.

## ENGINE ROOM HI-FOG® SYSTEM FAILURE

- 5.22 The Hi-Fog® system started operation automatically on February 10<sup>th</sup> as reported by the 2<sup>nd</sup> Engineer on duty. Auto activation is triggered when one heat and one smoke detector on a single loop activate. At this time as he was calling the Chief Engineer to advise him of the fuel leak, the 2<sup>nd</sup> Engineer reported *“I receive a diagnostic, the hi-fog released. I went to check the hi-fog compartment and there was the hi-fog released on engine No.6”*.
- 5.23 The Hi-Fog® system is described in the original 2004 manual as taking power from the main supply. The water mist system is not required to be in the Emergency Generator power grid – SOLAS II-2 Part C Reg 10 5.6.2 ... “to protect areas such as the following without the necessity of engine shutdown, personnel evacuation or sealing of spaces” i.e. the vessel remains on normal power. Once the heat damage occurred to cabling overhead of the No.6 engine, all power to the main switchboard was lost and the Hi-Fog® system shut down.
- 5.24 On 10<sup>th</sup> February after the fire had been extinguished, and in response to instructions from Carnival’s Miami office, a temporary electrical connection was made to the Hi-Fog® system. The connection was made using a power supply from the Emergency Generator to a now defunct engine start air compressor.

## CARBON DIOXIDE (CO<sub>2</sub>) FIRE FIGHTING SYSTEM

### SYSTEM INSPECTIONS, SERVICING & TRAINING

- 5.25 Tyco attended the “Carnival Triumph” at Key West Florida on 16<sup>th</sup> May 2011 and carried out a functional test, verifying the activation sequence and completing a technical survey. The report issued after this inspection indicated that the Aft Engine Room & Incinerator system (Banks 3, 4 and 5) operated in the correct sequence, alarm indications were also verified. ADT, a Tyco subsidiary – manufacturer of the CO<sub>2</sub> system, attended the vessel in October 2011 at Freeport, Grand Bahama and conducted crew training in the operation of the CO<sub>2</sub> system, including a system description, components, system operation, maintenance and live instruction.
- 5.26 Tyco again attended the vessel on 20<sup>th</sup> May 2012 at Galveston, Texas, and completed an annual inspection of the system. They reported that the system was in satisfactory condition.

## TECHNICAL INSPECTION POST FIRE

- 5.27 Tyco attended the vessel post fire and completed a technical analysis. A report was issued on February 18<sup>th</sup>, 2013. The report stated that the release levers in the remote operating cabinet for the Aft Engine Room were opened in the incorrect order from the posted instructions. This is verified by the Martec alarm system printout. However, it was suggested that the reversed operation of the two levers would not affect the safe and proper release of CO<sub>2</sub> to the intended space. Post fire system tests were made to determine that this had no bearing on the system failure and an interlock has subsequently been installed to control the order of operation.



Main distribution manifold at the CO<sub>2</sub> room

- 5.28 Valve A, the distribution valve that would permit the flow of carbon dioxide from bottle banks 3, 4 and 5 to the Aft Engine Room is pictured above. This valve failed to open when the Chief Engineer operated the system from the remote station.
- 5.29 The indication from analysis of this valve is that the actuator had been pressed down onto a gasket inside the valve and there was insufficient clearance between actuator and gasket for the pilot cylinder nitrogen pressure to operate the actuator. An inspection of the valve by the manufacturers, DAB Engineering, indicated the root cause to be internal damage caused by an external force.



Pilot seat retainer from Carnival Triumph (right) in comparison with new (left). Note longitudinal compression and “barrelling”



Gasket between pilot valve housing and valve body cover. Absent the damage found in the valve removed from Carnival Triumph a small clearance exists between the surfaces of the gasket and pilot valve.

- 5.30 Tests run by DAB Engineering were unable to replicate the damage to the pilot seat retainer using abnormally high actuating pressure. It was therefore concluded that the most likely reason for the damage was external force such as would be experienced, for example, by the valve having been dropped with the valve stem impacting onto a hard surface. It was also noted that this valve had been manufactured in August 2011 and had therefore been in place on board the Carnival Triumph for less than 2 years.

- 5.31 Functional testing carried out at DAB Engineering also indicated that, with the damaged parts reassembled, the valve operated at an actuating pressure of 75 psi which is well below the manufacturer’s recommended input pressure of 160 psi. A new valve of similar model actuated at a pressure of 50 psi.

### LEAKING FIRE HYDRANT

- 5.32 The forward starboard hydrant on the fire main in the Aft Engine Room centre section, adjacent to the forward end of engine No.6 failed during the fire.
- 5.33 The hydrant was subsequently disassembled at Lucius Pitkin laboratory in New York where the internal diaphragm was found to have failed during the fire.



Fire hydrant removed from Aft Engine Room, found leaking post fire.



Fire hydrant diaphragm removed for investigation

- 5.34 The hydrant pictured above was manufactured by Rizzio SpA of Valduggia, Italy and approved by the Classification Societies RINA and Lloyds Register under British Standard BS5041 “Fire hydrant systems equipment”. The hydrant was supplied to Fincantieri for installation aboard the Carnival Triumph amongst a delivery of 350-500 such valves. Rizzio reports they have supplied more than twenty thousand similar hydrants for fire fighting systems, predominantly to cruise ships.
- 5.35 The hydrant is type tested at Rizzio prior to distribution up to 540°C (+/- 10 °C) for a 20 minute period at maximum working pressure. Rizzio reports that they apply 20 bars water pressure and require zero leakage. The standard time for a diaphragm to last without maintenance is reported by Rizzio to be at least 5 years under normal working conditions.
- 5.36 Rizzo indicated in post casualty interactions with investigators that diaphragm failures may result from fires at higher than foreseen temperatures or duration,

water hammer, defective valves maintained in service by placing a cap to stop leakage or use of non-compatible water additives.

- 5.37 The diaphragm and hydrant were stripped, fully inspected and report issued by Lucius Pitkin Inc. – Consulting Engineers’ Laboratory. The diaphragm probably failed due to a combination of age related deterioration and heat from the fire.

### **EMERGENCY GENERATOR**

- 5.38 On the evening of 11<sup>th</sup> February the Emergency Generator was stopped to change a leaking small diameter fuel pipe. The time frame was chosen to coincide with the passengers being asleep to cause minimum disruption.
- 5.39 The governor on the Emergency Generator malfunctioned and it was not possible to maintain 100% load capacity on the generator, although had sufficient power to meet the current demand.
- 5.40 The Emergency Generator radiator leaked coolant from February 12<sup>th</sup> onwards. From that time the Emergency Generator Room was permanently manned and crew members regularly topped up the coolant system.
- 5.41 During the morning hours of 12<sup>th</sup> February the vessel entered the 200 mile range limit for air support, and a portable generator was delivered to the vessel by the US Coast Guard.
- 5.42 Issues with the proper and intended use of the Emergency Generator were only revealed by the prolonged operation of the system.

### **VESSEL STABILITY**

- 5.43 The leaking fire hydrant caused flooding to the Aft Engine Room, the total amount of flooding would have been added to by the Hi-Fog® system albeit to a minor degree. The resultant shift of water to one side as the vessel heeled due to wind increased the list to almost 5 degrees to starboard.
- 5.44 The vessel’s First Officer entered relevant data into the vessels stability program, and in order to determine the worst possible case, he included the adjacent compartments in the flooding i.e. the Forward Engine Room and the Propulsion Room. The vessel’s computer based loading program indicated the vessel remained stable even if the additional spaces were to flood. In the event flooding was confined to the Aft Engine Room only.
- 5.45 To reduce the level of flooding in the Aft Engine Room bilge, an electrical connection was made to a fuel oil transfer pump from the emergency generator. The level of flooding in the Aft Engine Room bilge was lowered by pumping the oil and water mixture to No.2 centre fuel oil double bottom tank.

- 5.46 The reduction of stability was primarily due to the flooding from the failed fire hydrant. At no time was the vessel in any danger from the reduction of stability.

## 6. FINDINGS

6.1 As part of the investigative process the following were reviewed:

- Safety Management System;
- Fire fighting procedures manual;
- The Alpha Code system;
- Decisions made during the fire fighting effort and post fire.
- Previous fire incident at diesel generator No.6 in January 2013

### **SAFETY MANAGEMENT SYSTEM**

6.2 Carnival Cruise Lines Safety Management System (SMS) is a computer based system. This system incorporates: Circular letters; Compliance Verification reports; Corporate Environmental, Health, Safety, Security and General Standards and Job Descriptions.

Carnival Cruise Lines' Safety Management System (SMS) is built on a computer based Document Control system.

The SMS was developed to satisfy requirements that include:

- regulations contained in SOLAS and the ISM Code
- the Company's Safety and Environmental protection policies;
- instructions and procedures in order to ensure safe ship operations and environmental protection with regards to national and international regulations;
- definitions of authority levels and hierarchy including lines of communication;
- procedures to report marine casualties, incidents, accidents and non-conformities;
- procedures to respond to emergency situations; and
- procedures to carry out internal audits and system verification.
- hose replacement was set for 18 month intervals and 6 monthly inspections as a result of "lessons learnt."
- inspection and maintenance of Fire Hydrants incorporated in Planned Maintenance System.

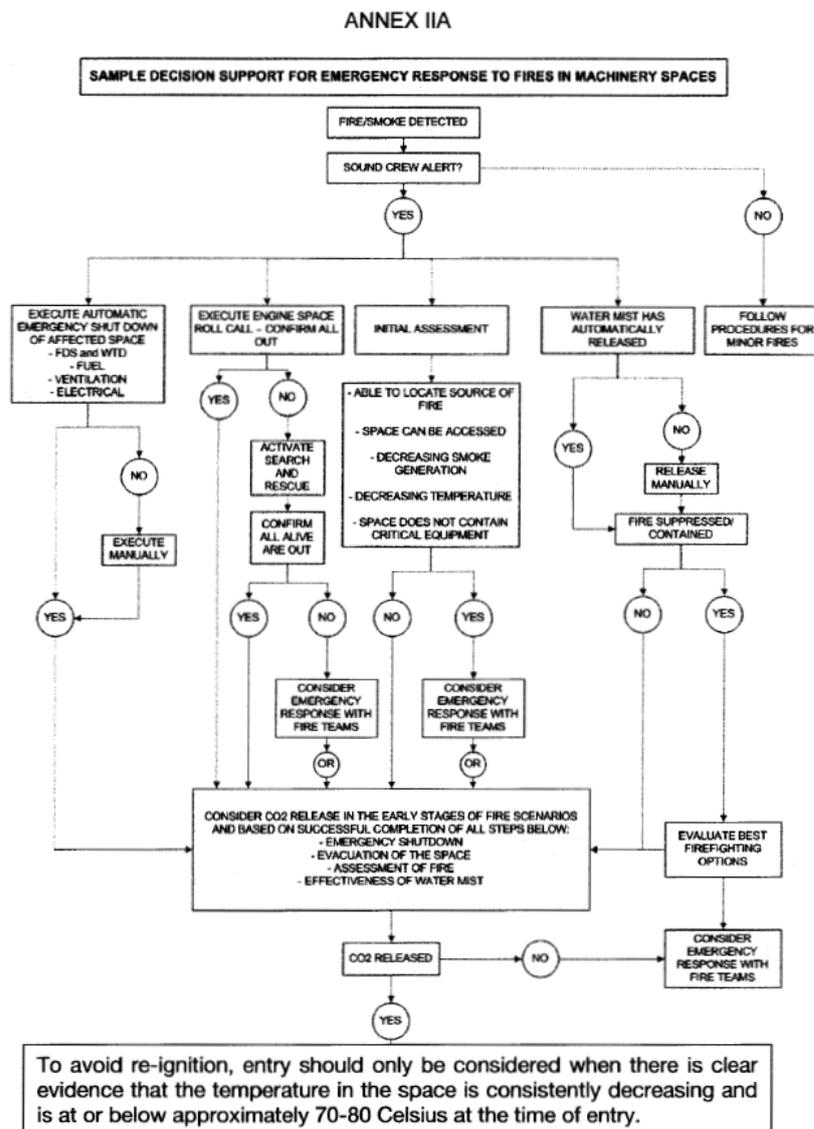
6.3 The vessel's Safety Management Certificate was issued following verification carried out by Lloyds Register as the Recognised Organisation acting on behalf of the Bahamas. The most recent audit was held by Lloyds between September 3<sup>rd</sup> and 10<sup>th</sup> 2011 and resulted in one (1) non-conformity and three (3) observations and the appropriate Certificate endorsed. All reports were signed by the vessels Designated Person Ashore (DPA) as closed. The vessel was otherwise found to be in compliance with the requirements of the ISM Code.

**FIRE FIGHTING PROCEDURES MANUAL**

6.4 Carnival Cruise Lines, in a cooperative agreement with the Marine Technical Institute of Fort Lauderdale, Florida, supplied the vessel with a Standard Operating Procedure for Shipboard Firefighting. The version aboard the Carnival Triumph was dated 13<sup>th</sup> April 2012 and marked revision 02. This manual contains: General Guidelines; bridge Responsibilities; Engine Control Responsibilities; Operations Area Responsibilities; and Fire Fighting Guidelines (Area specific).

**A review of the guidelines for engineering space fires indicates that the actions onboard the Carnival Triumph on the morning of 10<sup>th</sup> February did follow these guidelines closely.**

The SOP manual for firefighting contains a sample decision support matrix for emergency response to engine room fires, which is reproduced below.



Vessel decision support matrix for engine room fires.

## ALPHA CODE SYSTEM

6.5 The crewmembers aboard the “Carnival Triumph” carry out regular safety drills, these are categorized as:

- General Emergency Drill
- Alpha Team
- Operation Bright Star
- Medical Disaster
- Helicopter Evacuation
- Man Overboard

The individual roles of crew members on fire fighting teams are pre-determined according to a Muster List, the Alpha Team is primarily for firefighting.

A review of recent drills held by Alpha Team revealed the following scenarios were practised;

DATE	DRILL
26 August 2012	Fire at Dry Provision Store.
25 September 2012	Fire at Crew Laundry
01 October 2012	Fire at Carpenter Workshop
20 October 2012	Fire at rear of Stage
15 November 2012	Fire at Main Laundry
5 December 2012	Fire at Carpenter Workshop
9 January 2013	Fire at Provision Store
23 January 2013	Fire at Fuel Oil Separator Room

Review of the Drill Matrix required to consider quarterly fire drills to be conducted in the Engine Room and not just the F.O. Separator Room.

**The investigation team finds that a fire drill was held in the Engine Space 18 days prior to the fire in the Aft Engine Room. This is concluded to have made a positive contribution to the effectiveness of fire fighting on 10<sup>th</sup> February.**

## DECISION NOT TO MUSTER PASSENGERS

6.6 The Master’s decision not to muster the passengers during the early hours on 10<sup>th</sup> February, immediately after the fire started, avoided the likely scenario of trip and fall injuries and the spread of undue alarm. This action was based on an evaluation of the situation early on 10<sup>th</sup> February with the Aft Engine Room on fire. The Master and Staff Captain determined the fire was completely contained in the Aft Engine Room and, did not pose any threat to the passengers in their staterooms.

The decision was taken NOT to muster passengers, as the fire did not pose any immediate threat or danger to the passengers and they were considered safer in their staterooms. Frequent PA announcements were made.

**The investigation team finds this was the appropriate decision.**

## **EARLY USE OF CO<sub>2</sub> SYSTEM**

- 6.7 The CO<sub>2</sub> was the primary method of fire fighting, the preparations – closing ventilation, checking dampers etc supported the CO<sub>2</sub> release. Other responses – such as boundary cooling followed on from the CO<sub>2</sub> release.

The early deployment of CO<sub>2</sub> into the Aft Engine Room when suggested by the Chief Engineer extinguished the oil fires at the engines shortly after deployment. The fire in the electrical cable conduits above the engines continued to burn. This was monitored by temperature measurements at surrounding spaces, and ancillary damage prevented by boundary cooling. The cable fires were eventually extinguished by the Hi-Fog® system, once it was reactivated.

**The investigation team finds that the early use of CO<sub>2</sub> as mandated in the Carnival SOP for fire fighting prevented the spread of this fire beyond the Aft Engine Room.**

## **DECISION NOT TO EVACUATE VESSEL**

- 6.8 The “Carnival Triumph” does not have tenders that can be boarded whilst stowed and then launched and recovered. The deployment of the ship’s lifeboats or the use of tenders from another vessel in moderate sea conditions has the potential to cause passenger injuries due to the risks inherent in attempting transfer at sea. The Master, using Risk/Benefit considerations, determined that while the passengers and crew may suffer some discomfort they were safer onboard the “Carnival Triumph”.

**The investigation team finds that the decision not to attempt an evacuation at sea was appropriate in the circumstances and likely prevented numerous injuries to passengers.**

## **DECISION TO PROCEED TO MOBILE, ALABAMA**

- 6.9 The vessel’s northerly drift awaiting tug support put the ship equidistant between Mobile, Alabama and Progreso, Mexico. The tow northwards would be aided by prevailing currents, and consequently would take less time. The logistics of moving passengers from Mobile, Alabama to destinations within the USA was less complicated than from Progreso, Mexico. This would result in the passengers’ return home sooner than if made from Mexico. It is also noted that the safety of the passengers was not put at risk in remaining on board, although conditions were uncomfortable.

**The investigations team finds the decision to proceed to Mobile, Alabama, to be reasonable.**

#### **REPORTS OF BINS OF SEWAGE ALL OVER THE VESSEL**

- 6.10 The investigation team received reports of plastic bins of sewage sitting "...all around the ship". While the team was on board to conduct interviews, the lead investigator for the US Coast Guard was taken by a visibly very upset passenger to a bar area to see some of these bins. The investigator took pictures of the bin, which appeared to contain dirty water that was dripping from the overhead. Pictures of some of bins also appeared on the internet in the days after the ship docked in Mobile.

During the course of the investigation, crew members were questioned as to the origin and content of those bins.

**Investigators were able to determine that those bins in the pictures and in the bar contained water that was leaking through the overhead from a machinery space above which was flooded when the sprinklers went off during the fire. It should also be noted that there is no sewage system piping in the overhead above where any of these bins were located.**

#### **JANUARY 2013 FIRE AT DIESEL GENERATOR NO.6**

- 6.11 A repair team from ABB Inc of Miramar, Florida attended aboard the "Carnival Triumph" between January 28<sup>th</sup> and February 3<sup>rd</sup> 2013. A repair to diesel generator No.6 main electrical connection box was made subsequent to a flash fire inside the box. The main connection box was deemed un-useable and was replaced with parts taken from diesel generator No.4 which was out of service for overhaul. A copy of their service report was reviewed as part of this investigation.

**Investigators determined that there was no connection between the January 2013 electrical short circuit inside diesel generator No.6 connection box and the February 2013 fire resulting from the return fuel oil flexible pipe failure.**

#### **ADMINISTRATIVE**

- 6.12 The investigations team concluded that all parties involved with the casualty acted properly and in accordance with documented procedures.

## POST-CASUALTY ACTIONS TAKEN BY CARNIVAL CRUISE LINES

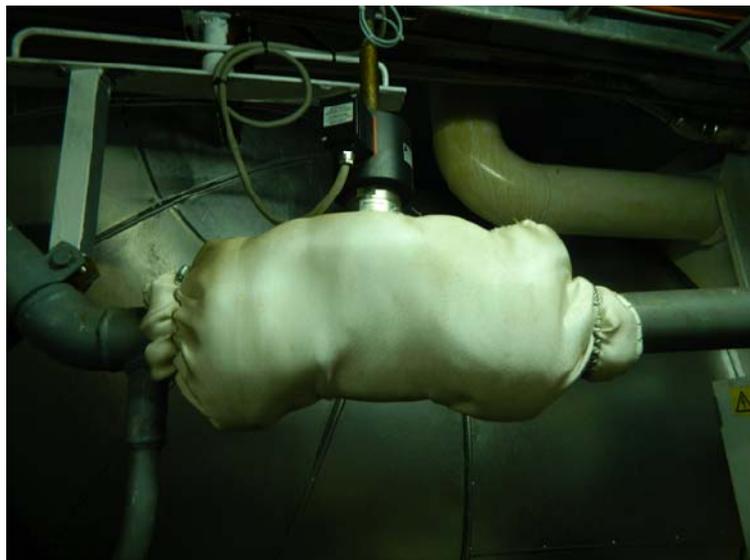
6.13 The investigation team notes that Carnival Cruise Lines has taken a proactive approach to improve a number of engineering and safety systems as follows:

- Black Out Recovery Tank Valve In The Engine Room
- Quick Closing Valves at Diesel Generators 1 to 6
- Main Electrical Cables Rerouted
- Neutral Points
- Bulkhead Insulation
- Additional Generator
- Hi-Fog® Extension
- Garbage Handling Room
- Flange Guards
- Fire Patrols
- CO<sub>2</sub> Release Interlock
- Training

### BLACK OUT RECOVERY TANK VALVE IN THE ENGINE ROOM

6.14 Originally mounted on the forward bulkhead of the Aft Engine room, this valve is now located in the Engine Casing, Deck 0, Starboard side. The valve is protected from fires by wrapping in a fire blanket, splash guards are fitted to the flanges on the valve.

6.15 This valve is connected to the Damatic Automation System and the logic is changed such that the valve is normally closed, a UPS (uninterrupted power supply) power supply allows operation in event of main power failure.



## QUICK CLOSING VALVES AT DIESEL GENERATOR 1 THROUGH 6

6.17 Quick closing valves have been installed on Fuel Oil inlet piping close to each engine. These are operated at the same location as all existing quick closing valves. The operator's decision to install similar valves on outlet lines is a corporate decision, not mandated by this report.

The Operator completed installation of similar valves by January 2014



Control levers for the newly installed quick closing valves



Quick closing valve at diesel generator No.1 fuel inlet

## MAIN ELECTRICAL CABLES REROUTED

6.18 Electrical cables have been rerouted to remove the possibility of a single point failure again leading to a total power loss.

- Cables from diesel generator No.1 run along the port side of the Forward Engine Room, forward through the forward bulkhead to the Evaporator Room, then through the deck head to Deck A, aft on Deck A, along the port side of the Aft Engine Room and into the main switchboard.
- Cables from diesel generator No.2 in the Forward Engine Room, are led via the casing onto Deck 1, exit the casing aft of Staircase 100 and pass via trunking to Deck A and into the switchboard.
- Cables from diesel generator No.3 are led up to Deck B aft and then via the Garbage Room to the Switchboard.
- Cables from diesel generator No.4, No.5 and No.6 have the original layout.

Operators intend to coat all newly installed cables with Firetec FS-1 or equivalent fire protection coating.



Rerouted electrical cables ↑

## NEUTRAL POINTS

- 6.19 The Aft Engine Room diesel generator neutral points<sup>8</sup> have been relocated from aft of diesel generator No.6 to positions directly aft of the diesel generator they serve.



Diesel generator No.6 Neutral Point

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<sup>8</sup> A “Neutral Point” is a component of the ships electrical system that retains power to the connected ship system in the event of a single earth fault. It ensures that critical components e.g. generators, continue to function, avoiding risks to the ships safety in event of such a fault.

## BULKHEAD INSULATION

6.20 In way of the Aft Engine Room the bulkhead partitions between the Boilers & diesel generator No.4 to diesel generator No.4 & No.5 and between diesel generator No.1 & No.2 and the Incinerator Room, fire insulation has been fitted. Dampers have been installed in openings. This addition improves the fire resistant capabilities of the vessel.

The underside of the switchboard room, overhead in the Aft Engine Room, fire insulation has been fitted. In the Forward Engine Room the bulkhead between diesel generator No.1 and No.2 has been similarly insulated.



Blanket insulation in Aft Engine Room at the underside of the Switchboard Room

## ADDITIONAL GENERATOR

6.21 Installation is in progress of a 1.825 MW Caterpillar 3516B generator set. Located directly above the existing Emergency Generator, this set will be connected directly to the existing Emergency Generator switchboard; in addition there will be connections to the port and starboard shore power connecting points. This will allow the generator to supply the Emergency Board or either the Port or Starboard main switchboards.

It is intended that this unit will also provide full power to an Engine Room Total Flooding water mist system, once installed.

## HI-FOG® EXTENSION

6.22 The original Hi-Fog® system, pictured forward and left below, has been dedicated to cable tray protection, two additional units provide the remainder of the system. The power supply has been modified to include an auto power transfer from main to emergency power supply.



The Hi-Fog® system units

- 6.23 The control panels for the Hi-Fog® system have been extended to include the cable tray protection. Manual release points have also been relocated, the Forward Engine Room release is positioned at the base of Stairway 100 in the stairwell immediately outside the Forward Engine Room. The Aft Engine Room release is inside the Forward Engine Room at the exit door to Stairway 100.



Hi-Fog® Cable Tray protection control panel

## GARBAGE HANDLING ROOM

- 6.24 A fire screen door has been installed at the top of the stairway leading from the Garbage Handling Room down to the Incinerator. Training has been reinforced regarding exiting the space once the CO2 alarm sounds, an engine room fire may not be evident in this area. This space is considered part of the Engine Room and all staff are required to place their ID badges on the Engine Room Roll Call board.



Garbage Handling Room on Deck 0

## FLANGE GUARDS

- 6.25 Piping flanges and the length of the flexible pipes have been fitted with an updated type of spray guard to provide effective spray shielding.



## FIRE PATROLS

- 6.26 Additional staff have been employed to carry out dedicated Engine Room fire Patrols on a 24 hour basis. These new crewmembers have backgrounds as oilers and have been specially trained in the manual release of the Hi-Fog® system.

## **CO<sub>2</sub> RELEASE INTERLOCK**

- 6.27 An interlock device has been installed in the CO<sub>2</sub> release cabinets which prevents opening the CO<sub>2</sub> bottles until the lever for the relevant distribution valve has been opened, these levers are now marked “First” and “Second”.

## **TRAINING**

- 6.28 Shore based leadership training for fire fighting has been introduced for senior officers as part of the continuing improvement in vessel management.

## 7. RECOMMENDATIONS

### FROM INVESTIGATION AND APPENDIX 1.

**1. ISSUE: The vessel experienced a single point failure of the vessel's power and propulsion as a result of a fire in a single engine space.**

**Finding:**

The vessel was susceptible to a complete loss of power resulting from damage to a single area of the electrical system in the Aft Engine Room.

**Recommendation:**

Carnival Cruise Lines should review the electrical system layout of this vessel, and others of the same class or age, built at Fincantieri Shipyard and take appropriate action to introduce redundancy and resilience in the various systems to prevent a re-occurrence of these events.

**Actions being implemented by CCL**

Action already taken (part of the approved vessel enhancement program)

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**2. ISSUE: The oil mist from the leaking fuel pipe was clearly visible on a number of closed circuit televisions prior to the alarms and outbreak of fire.**

**Finding:**

The vessels closed circuit television system does not include any form of automatic monitoring for unusual or extended movement.

**Recommendation:**

Carnival Cruise Lines should evaluate a system whereby any unusual movement on a closed circuit television would activate an alarm or other mechanism which would alert duty personnel to a situation outside normal parameters.

**Actions being implemented by CCL**

Action already taken (part of the approved vessel enhancement program)

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**3. ISSUE: The fuel oil return pipe that failed on the No.6 engine has no history in the vessels inventory control despite being aboard since delivery.**

**Finding:**

There is no record of the fuel pipe being delivered aboard, no individual inventory record or any test certificate. Subsequent to the installation of this pipe and prior to its failure Carnival issued a requirement that *“New flexible hoses or pipes that are not individually tested and certified by the manufacturer must be tested after installation under the pressure and for the time specified in the type approval certificate to allow checks to be made for possible malfunctions and leakages” (Hess 001 Machinery Space Fire Prevention).*

**Recommendation:**

Carnival Cruise Lines should amend their Planned Maintenance System to include details of each main spare part, its order and delivery dates, serial numbers or other pertinent data and the date it was placed into service.

**Actions being implemented by CCL**

Action already taken for flexible pipes. Action plan under development for other critical spares

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**4. ISSUE: The Fuel Oil system Diesel Flush Tank does not have a quick closing valve inside the engine spaces.**

**Finding:**

The Fuel Oil System has a diesel oil storage tank, located at the Emergency Generator Room. This tank is designed to automatically flush the fuel system in event of a black out to facilitate restarting engines on diesel fuel. The system operated on the “Carnival Triumph” and flushed all engines, including No.6.

**Recommendation:**

Carnival Cruise Lines should install a quick closing valve, operated from the same location as the main quick closing valve bank, inside the engine spaces, to shut off the diesel supply in event of a piping failure or similar catastrophic event.

**Actions being implemented by CCL**

Action taken QCV installation in progress, fleet wide installation by March 2015. Contingency plan in place in the interim.

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**5. ISSUE: Engine room inspections by oilers not to a predetermined schedule**

**Finding:**

The rounds of the engine spaces made by the oilers, at the start of their watch duty and at regular intervals during that time period are not to a set pattern. Each individual oiler sets their own route and this may not encompass all areas.

**Recommendation:**

Carnival Cruise Lines should institute a structured route, one that covers all engineering spaces and machinery.

**Actions being implemented by CCL**

Action already taken, dedicated watch standers follow established routes. However, idle spaces are covered by detection systems and CCTV

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**6. ISSUE: It took an extended amount of time to operate the fuel supply valve on the fuel oil feed module to the Aft Engine Room.**

**Findings:**

Due to the height of the valve, it was necessary for the crewmember to climb on associated fuel piping in order to reach the valve. Additionally, the valve was difficult to close, more than likely due to lack of use.

**Recommendations:**

- A) Carnival Cruise Lines should provide a safe means of access to the fuel supply valve so that it is readily accessible in normal and emergency situations.
- B) Carnival Cruise Lines should include regular operation and maintenance of this valve in their Planned Maintenance System.

**Actions being implemented by CCL**

Solution under evaluation; installation of quick closing valves being considered

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**7. ISSUE: Failure of the Emergency Generator to operate as intended and designed.**

**Finding:**

The Emergency Generator experienced issues with the fuel supply (leak), governor (inability to maintain full load), and the coolant system (leak).

**Recommendation:**

Carnival Cruise Lines should amend the Planned Maintenance Schedule to include running the Emergency Generator under load for a period of time suitable to demonstrate proper operation.

**Actions being implemented by CCL**

Action already taken, regular load tests now conducted as part of PMS procedures

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**8. ISSUE: One fire hydrant in the Aft Engine Room failed during the fire causing the unrestricted flow of water from the emergency fire pump into the bilges.**

**Finding:**

The diaphragm inside the hydrant failed allowing water to pass through the valve, flooding the Aft Engine Room bilge and ultimately causing a reduction in stability, an increased list gray water migration into passenger accommodation areas.

**Recommendations:**

- A) Carnival Cruise Lines should amend the SOP for Shipboard Firefighting manual to include instructions to isolate any fire main under pressure that serves a space where CO<sub>2</sub> has been injected.
- B) Carnival Cruise Lines should initiate a program for annual inspection of diaphragms inside fire hydrants such that over a 5 year period each hydrant is examined and a replacement program based on a 5 year cycle.

**Actions being implemented by CCL**

The procedures are being updated accordingly

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**9. ISSUE: The CO<sub>2</sub> system remote activation cabinets contain two operating levers, identified as “left” and “right”.**

**Finding:**

The markings do not indicate which lever is to be operated first. This is marked in the posted instructions and included in training but is not immediately evident in an emergency situation.

**Recommendation:**

Carnival Cruise Lines should mark the two levers “1” and “2” to remove any question of which lever is to be activated first, and incorporate these changes into the system manuals, operating instructions and training sessions. Incorporate an interlock to prevent operation in an incorrect sequence.

**Actions being implemented by CCL**

Action already taken and implemented

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**10. ISSUE: The operation of the CO<sub>2</sub> system was delayed to ensure the Garbage Handling Room had been evacuated.**

**Findings:**

The Garbage Handling Room, located on Deck 0, is included in the same zone as the Aft Engine Room (containing Boilers, diesel generator Nos.4, 5 &.6 and the Incinerator). A fire in the Garbage Handling Room which required a CO<sub>2</sub> release would then also flood the Aft Engine Room with CO<sub>2</sub>.

**Recommendation:**

Carnival Cruise Lines should investigate a separate and locally operated CO<sub>2</sub> system for the Garbage Handling Room.

**Actions being implemented by CCL**

CCL will investigate and provide feed-back based in the outcome.

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**11. ISSUE: Limited stairwell access for fire teams to enter the engine spaces.**

**Finding:**

There are two stairwells into the engine spaces: Stairwell 70 from the Garbage Handling Room to the Propulsion Motor Room and Stairwell 100 from the Engine Control Room Vestibule to the Aft Port corner of the Forward Engine Room. Access to any other engine space is via vertical ladders inside emergency escape trunking. Use of these ladders by teams, wearing fireman's outfits and using breathing apparatus results in limited air remaining inside air bottles once inside the engine space.

**Recommendations:**

Carnival Cruise Lines should investigate suitable arrangements for the forward machinery spaces to ensure that existing access routes do not impinge on the effectiveness of fire fighting by the over-use of breathing apparatus capacities as described.

**Actions being implemented by CCL**

CCL will investigate and provide feed-back based on the outcome.

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**12. ISSUE: There are distinct inconsistencies in the time displays for the vessels various computer systems, alarm systems and monitoring systems.**

**Finding:**

The ships Damatic log was reported by Carnival to have a time correction of 9 minutes and 22 seconds, the Autronica to have a correction of 11 minutes and 48 seconds (both slow) and the Martec to have a 10 minutes and 32 seconds (fast) correction.

**Recommendation:**

Carnival Cruise Lines should implement a Safety Management System procedure whereby the vessels various time recording systems are synchronised and this is verified on a monthly basis.

**Actions being implemented by CCL**

The current program for synchronization of clocks will be made more robust

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### **13. ISSUE: Decision on when to muster passengers**

#### **Findings:**

Carnival Corporation has not provided Senior Staff with any written guidelines on when to muster passengers and when it may be advisable to avoid mustering.

#### **Recommendations:**

Carnival Cruise Lines should develop guidelines based on experiences from previous fleet incidents to guide Senior Staff in determining when mustering should be undertaken.

#### **Actions being implemented by CCL**

Action already taken, included in new HESS Management System, Emergency Response Procedure currently being rolled out.

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### **14. ISSUE: Lack of training for Cruise Director on format of announcements**

#### **Finding:**

The Cruise Director was unaware of any company training regarding the type and format of announcements that should be provided to passengers in emergency situations.

#### **Recommendations:**

Carnival Cruise Lines should develop guidelines with specific examples of announcements that would inform passengers but at the same time reduce any tendency to panic. The language used for announcements should be determined by the vessel's geographic location and passenger make up.

#### **Actions being implemented by CCL**

Action already taken, included in the new HESS Management System. Emergency Response Procedure currently being rolled out.

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**15. ISSUE: Lack of guidelines on food conservation under extended loss of refrigeration capabilities.**

**Finding:**

The vessels catering department was not provided with any specific guidelines or training in the control of food supplies in event of extended power loss.

**Recommendation:**

Carnival Cruise Lines should develop and provide training in the conservation of food items during extended power outages and include menu planning to consume those items with a tendency to perish or spoil first.

**Actions being implemented by CCL**

Action already taken. New procedures defined and under implementation

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**16. ISSUE: Inability of Department Heads to communicate with their staff once power was lost and the internal telephone system shut down.**

**Finding:**

Department heads reported that once the internal telephone system ceased to function the sole method of communication aboard was by hand held radios and these were in short supply.

**Recommendation:**

Carnival Cruise Lines should identify the minimum number of hand held radios required by each department for safe operations during periods of power loss.

**Actions being implemented by CCL**

Action already taken. Additional radios sent to the ships

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**17. ISSUE: Lack of Fire Drills in the Engine Room.**

**Finding:**

Review of the previous Engine Room fire drills carried out on the vessel, indicated the tendency to hold them in the same location (FO Separator Room).

**Recommendation:**

Carnival Cruise Lines should review the Drill Matrix and consider holding quarterly drills in areas other than the FO Separator Room. Enabling the crew to be more familiar with and well practiced in the Engine Room.

**Actions being implemented by CCL**

Action already taken, included in SMS since August 2013.

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## APPENDIX I

### INVESTIGATION AND ANALYSIS OF THE POST INCIDENT MANAGEMENT AT THE CARNIVAL CORPORATE OFFICE IN MIAMI AND ABOARD THE CARNIVAL TRIUMPH

The response of both Carnival Cruise Lines (Miami) and on board the Carnival Triumph and following on from the initial Incident and the activation of the “Shore Side Incident Response Plan” (SIRP).

#### **Event – Carnival activates the shore based emergency response teams**

Carnival Cruise Lines manned their command centre at 0800 GMT-5, this was 0700 aboard the vessel (the vessel’s time zone was GMT-6).

Carnival has a “Shore Side Incident Response Plan” (SIRP) which is activated in event of a distress message from a company vessel. The overall structure falls under the overall supervision of the CEO, and directly below this position is the Company Response Leader. The plan then splits into two sections supervised by the Incident Commander.

Section one is responsible for:

- Fire fighting and Life Saving
- Stability and Navigation
- Technical support
- Maritime Authorities including US Coastguard
- Environmental Safety and Response
- Port agencies and logistics
- Guest Operations
- Shipboard guest care and evacuation
- Security
- Medical response
- Shore support for guest communications
- PR and Media response

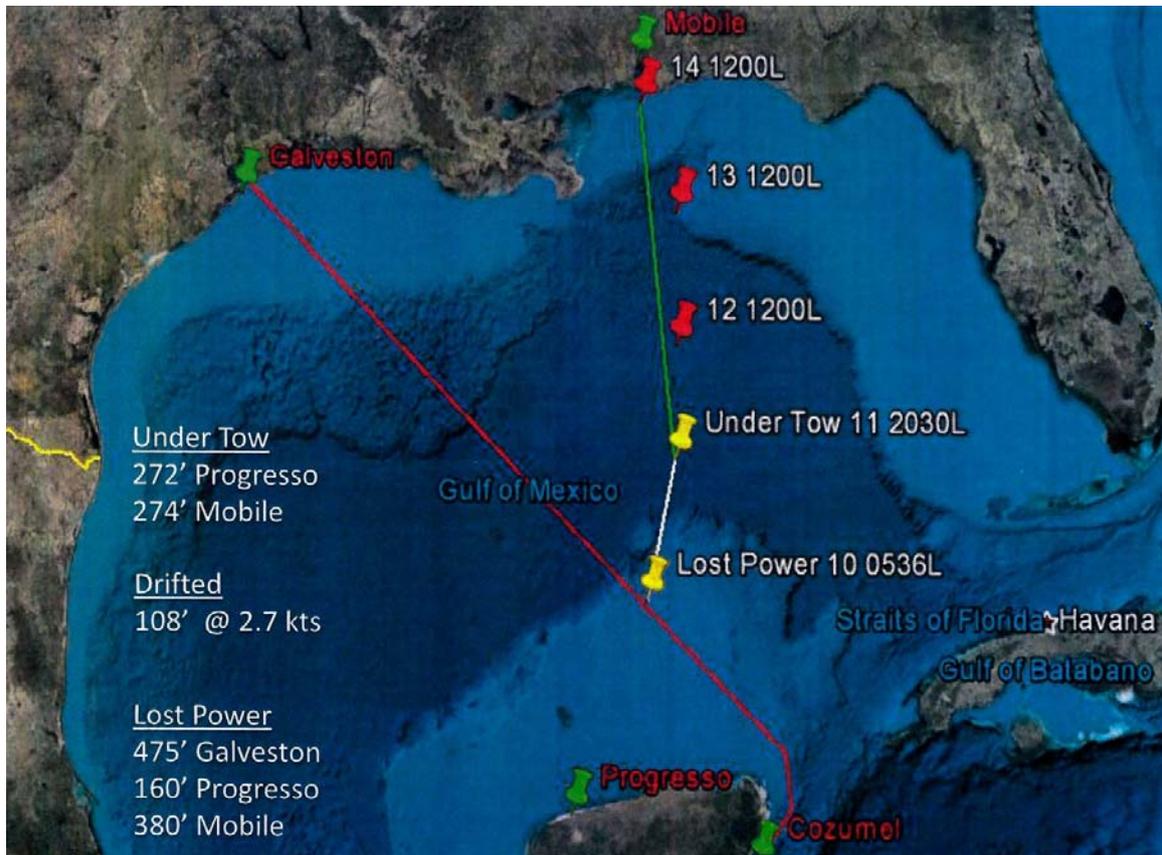
Section two is responsible for:

- Itinerary planning and guest compensation
- Marketing
- Sales
- Finance and Stakeholders
- Legal
- Insurance

Not all sections are relevant to each and every incident. For this incident, the Incident Command structure was set up in one conference room dealing with ship support only, the adjacent conference room was set up with Guest Support and Media, and the response actions were displayed on a widescreen monitor, duplicated at both areas. All staff

involved in the response were supported by back up personnel to ensure a 24 hour operation would continue for as long as required.

The investigation team interviewed the following shore based staff; Corporate Executive VP for Ship Operations; the Senior VP responsible for Marine Operations; the VP of Guest Services; the VP for Housekeeping; the VP for Marine Safety; and the VP for Compliance with Environmental and Safety regulations.



Vessels position at time of the fire and subsequent Northerly drift

### **Event – Vessel to be towed**

The first contact with US and Mexico based tug companies was between 09:00 and 10:00 hours on February 10<sup>th</sup>. It was arranged that the tug “Resolve Pioneer” would depart from the port of Theodore Alabama at 16:00 hours on February 10<sup>th</sup> with a passage time to the Carnival Triumph of 24-48 hours depending on weather and currents. A second tug, the “Svitzer Dahbol” departed Progresso, Mexico on the afternoon of February 10<sup>th</sup> with an initial ETA to the vessel of 12:00 February 11<sup>th</sup>.

At the time of the fire on February 10<sup>th</sup>, the vessel was located approximately 160 nautical miles north of Progresso MX and 380 miles south of Mobile, Alabama. Based on this information, the decision to tow the ship to Progresso was a logical choice. By the time the tugs arrived on scene late on February 11<sup>th</sup>, however, the vessel had drifted 108 miles to the north and was now located 272 miles from Progresso, 274 miles from Mobile, Alabama, and drifting North towards Mobile at 2.7 knots. The decision was amended at

this time to tow the vessel to Mobile, Alabama, as this was determined to be a shorter tow, and with the prevailing winds and current, it would expedite resolution. Tampa and Houston were also considered as destinations, but rejected due to increased time and distance.

### **Event – Food deliveries from additional Carnival Cruise Vessels**

Carnival diverted the “Carnival Elation”, “Carnival Conquest” and “Carnival Legend” to deliver food supplies to the stricken “Carnival Triumph”. These transfers were made using the arriving vessel’s own tenders; the “Triumph” is not equipped with tenders, only lifeboats. Transfers were hampered by winds as high as 35 knots and seas up to 6 feet

## **Incident Management Aboard**

### **Master**

The Captain coordinated guest notifications, both by himself and also with the Cruise Director. Most announcements were made by the Cruise Director as she was already familiar to the passengers. A decision not to sound a general alarm and muster the passengers was made by the Captain, based on the desire to avoid any panic that may result in injuries. Foremost in the decision process was the fact that the fire was contained in the engine room and the ship was not in imminent danger. This was described by Captain as “common sense”.

The Captain had attended training conferences in Miami following a fire aboard another Carnival operated vessel, and applied the lessons learnt in those seminars and also the guidance included in the vessels Safety Management System.

The passengers were considered by the Captain to be safest remaining aboard the disabled Carnival Triumph. Evacuation was considered, but would likely have resulted in injuries to multiple passengers as this would be a difficult transfer from the ship to a tender in 5-6 foot high seas. The Captain did elect to evacuate one passenger who required kidney dialysis to the Carnival Legend.

### **General staff**

Meetings were held on Deck 9 with department heads, to decide how best to provide for passengers.

The Chief Engineer was able to provide power to a galley range to provide limited amounts of hot food – mostly hot dogs and hamburgers.

A plastic bag system was devised to provide sanitation in face of the non-functioning vacuum system toilets. Bags were placed in the toilets and used as temporary toilets. These were collected by the ship’s crew.

Cabin staff were directed to begin constant cleaning.

Thirty crew members wearing reflective vests were set up as runners to constantly patrol the vessel for passenger assistance, as the internal phone system was not working. An announcement was made for passengers to contact these crew members if in need of guest services.

Passengers from interior cabins moved their bedding to open areas which impeded lifeboat access. The crew was instructed that in event of abandoning ship, the area was to be cleared immediately by throwing all bedding overboard. In the meantime, the sleeping in these areas would by necessity continue.

Fire doors had automatically closed. These were later reopened to provide ventilation through the vessel.

### **Medical Centre**

The medical staff comprised a Senior Physician, a Ships Physician, a Lead Nurse and 3 Staff Nurses. Three of the staff were interviewed post-casualty: the Senior Physician, the Lead Nurse, and a Staff Nurse. During their interviews, they reported that on an average voyage, the medical centre has 6-10 patients on a daily basis. The centre is closed at night, but a nurse remains on call. Patients arriving at the centre fill in relevant medical registration forms. The patients are then given vital sign checks by the nurses and then await a doctor. In event that something simple such as a band aid is needed, this is administered by the nurse.

The Senior Physician indicated in his interview that he heard the Alpha Team announcement at 05:30 hours on February 10<sup>th</sup>, and proceeded to the medical centre, per protocol. All of the medical staff arrived at the same time. Also per protocol, the staff prepared stretcher teams and first aid/triage equipment and stood by. They are also tasked with ensuring that the fire fighting teams have water, which they did. No injuries were reported as a result of the fire or recovery. There were no reported cases of burns or smoke inhalation amongst crew or passengers, one passenger was treated for a panic attack late on the 10th.

The Senior Medical Officer stated that the following number of guests seen during the event:

Date	Day	Number of guests
2/10 – Day of fire	Sunday	9
2/11 – First day after fire	Monday	58
2/12 – Second day after fire	Tuesday	125
2/13 – Third day after fire	Wednesday	60
2/14 – Fourth day after fire	Thursday	19

The majority of patients were seen for shortages of prescribed medicines. Patients were given only 2 days refills as anything greater could deplete the ships supply. In many cases, suitable alternatives were provided if the prescribed medication was not

available. Insulin in particular was available at the medical centre, not in the more common individual pen type form preferred in the USA but as injectables, and syringes were prepared as required for passengers with diabetes. Treatment was protracted as the medical centre had limited power and no air conditioning. Passengers were treated on a “first come first served” basis. Each consultation was estimated by the Senior Physician to take 15-20 minutes.

On February 12<sup>th</sup>, one passenger was brought to the medical centre by stretcher from Deck 10. This was done by the medical staff, and took some time, which delayed the treatment of passengers waiting to refill medications.

The possibility of a Gastro Intestinal (GI) outbreak was discussed at meetings on the bridge and extra precautions were taken. Non-catering staff drafted in to help with catering services were given special training. Further, gloves were worn. There were 12 cases of GI upset amongst passengers and 2 cases among the crew in 4 days. The medical staff indicated that this is a normal level for the vessel when operating on a regular cruise. Reports were made to the CDC and each case was investigated for any common symptoms. None were found. The housekeeping staff has a special cleaning routine, known as “GI Protocol”, when a GI case is reported and this was followed closely. Two cases of communicable disease were reported, one on the 13<sup>th</sup> and one on the 14<sup>th</sup> (Chickenpox) and these two passengers, unrelated, were isolated.

### **Guest Communications**

The Cruise Director is in charge of entertainment, singers, dancers, musicians, the daily newspaper and making all passenger announcements. Once the Alpha Team announcement was made on February 10<sup>th</sup>, the Cruise Director went to her assigned station at the bridge and stood by the intercom system ready to make passenger announcements. The Captain would make pertinent announcements, and then the Cruise Director would then repeat them in a clear English accent in order for all passengers to understand. Carnival’s Miami office directed the format of announcements, worded to avoid inducing panic into the passengers. Examples of actual announcements are as follows:

Shortly after the fire response;

*“Folks there is no need to be at the muster station, we do ask at this time that you proceed back to your state rooms, your cabins, as I said, there is a situation in the engine room control room, in the engine room, and everything is under control so we do ask that you please make your way back to your cabins at this time, there is no need to be waiting at the muster stations”*

Mid-morning on February 10<sup>th</sup>;

*“Some very important information folks on the toilet system here onboard, as you probably know by now the toilets are not flushing and its going to start causing a little bit of a problem in a short while so we have come up with a plan. So folks what we are going to do is we are going to deliver some red bags to all of the bathrooms onboard including*

*the stateroom bathrooms, your cabin bathrooms and we do need a number two, we ask that you deposit that into the red bags and we are going to put metal bins in the corridors on every deck on the ship and if you would be so kind as to drop them into the metal bins in the corridor that would be fantastic and if you do need to do a number 1 everybody instead of filling up the toilet bowls if you can do it in the shower that would be brilliant. I know that's not the best scenario folks but it seems like the best option we have right now"*

The Cruise Director remained on the bridge until after midnight on February 10th. She reported being in contact with the Carnival Miami office by Satellite (Iridium) phone, in conjunction with the Hotel Director and the Guest Services Manager. The Cruise Director was unaware of any contingency plans for her department. In her interview, she stated that she would direct any complaints regarding sewage to Guest Services. She indicated that vessels phone system was inoperable and indicated that additional radios would have helped. During her interview, she also indicated that when the vessel was moored at the terminal in Mobile, Alabama, after all passengers disembarked she was made aware by crew members that they couldn't really hear her announcements on the Lido deck.

### **Guest Services**

The Hotel Director is above all guest services, including food, beverage, casino, gift shop, concessions, bar, and the Cruise Director. Once the engine room situation became clear, and with the knowledge that there would be no power supply, the Hotel Director gave instructions to his department heads. In his post-casualty interview, he reported that these included:

- Start preparing lunch service for passengers
- Determine what can be prepared without power – salads, cold cuts, sandwiches, etc;
- Keep the staff looking after guests – the Guest Services office comprises 14 crew, the hotel department has 750 members; and
- Gift shop & bars remained closed.

On the evening of Sunday, February 10th, when it became clear that the vessel was expected to be without power for an extended period of time, an additional planning meeting was held, and the following resulted:

- Crew were assigned to supervise & monitor different decks;
- Crew were to relay passenger requests to guest services since the internal phone system was inoperable;
- Continual serving water and soft drinks to guests. It was determined that the vessel had 20,000 sodas aboard in storage plus the bar inventory; and
- Menu planning was made based on their capabilities.

It was discussed that passengers had begun blocking muster stations with mattresses, tables and chairs trying to escape the heat in their cabins. Crew members were assigned to clear these areas in event of emergency.



Bedding taken from cabins to Boat Deck.

### Food and Beverage

Food service was restricted to Deck 9, the Lido Deck. There was consideration of service at Deck 3, but this was rejected due to a lack of lighting and air conditioning. Meals were served through extended time periods, with one pantry open 24 hours. Once the Alpha Team announcement was made on February 10th, all alcohol sales were prohibited. Four bars were opened to serve sodas and water. Initial food service was buffet style over the 2 days following the loss of power. However, due to hygiene and also waste issues, this was changed to a food service style. Hand sanitizer stations were set up in common areas to aid hygiene. It was housekeeping's responsibility to ensure that these remained filled.

The Hotel Director reported concerns from the Miami office over what was being done to look after the guests, feed and entertain them. Carnival Miami instructed the Hotel Director to open the bars to the passengers to serve only beer and wine. The Hotel Director required this be done only after the toilets were working. On Monday February 11<sup>th</sup> in the afternoon all public toilets and some cabin toilets were functional.

Passengers have a swipe card (FSS) used to record sales on the vessel, which also serves as the age verification system – ID's were requested to avoid serving minors alcohol as the FSS system required power and was inoperable. During the open bar evening, several staff members indicated in their interviews that quite a few passengers appeared to have had too much to drink. A few became obnoxious, and there were complaints that bathrooms were being messed up. The open bar had been intended to run from 15:30hrs through midnight, however, the Beverage Operations Manager made the decision to close down service early at 20:30 hours.

Early on February 10<sup>th</sup>, the Food Operations Manager met with his managers and evaluated the food situation. He also determined how to produce food and how to keep it safe. A determination was made of what food was suitable for immediate use. The Food Operations Manager was unaware of any predetermined plan for these circumstances. The plan devised by his staff was in response to immediate needs and was devised for a 7 day period.

The Food Operations Manager did not observe any flooding of the food areas. Rain was experienced and drains under the beverage stations overflowed, but these were attended to by housekeeping. No sewage was observed in the food service areas.

**\*\*Of note from the interview with the Food Operations Manager: when questioned regarding room service to disabled passengers, he replied that the Room Service department was evacuated early on February 10th due to smoke and then the phone system was out of service. There was not a true room service in operation. Given an hypothetical example of a wheelchair passenger on Deck 1 unable to get to Lido Deck 9 with no elevators in operation, the Food Operations Manager reported receiving a couple of requests, and if a guest requested assistance his department would take food but it was not “room service”.**

The Food Operations Manager walking around the ship did notice wet carpets “more like patches”. However, he did not recall seeing any bigger floods. His department placed buckets beneath water dripping from a ceiling on the Lido deck. These buckets were taken from a food service area, and were already soiled prior to being called into use for the dripping water. These bins were later a cause for concern for some of the passengers, as they believed they contained raw sewage. (The Investigation Team later determined that this was water dripping from machinery spaces above where the funnel fire sprinklers had caused some flooding).

### **Housekeeping/Sanitation**

The Hotel Director was aware of wet carpets and had assigned staff to soak water with towels. The Hotel Director was unaware of any widespread sewage issues. He was aware that the shower drains backed up with grey water and that in 3 cabins there were toilet overflows. Staff was assigned to clear these. Fecal odours were noted by the Beverage Manager outside the men’s bathroom on Deck 9 by the pool. It was noted that this was one of the busier bathrooms and housekeeping was informed.

The Housekeeping Manager held meetings with her staff for feedback morning, afternoon and evening at each change of shift. Once the toilet system was inoperative, housekeeping staff were instructed to be prepared to clean up based on passenger reports. A flood was experienced on deck 7 where a sprinkler broke. The Housekeeping Manager also reported floods on all decks due to the vessels list - she attributed these to some pipes burst, leaking sprinkler heads and the shower drains backing up. Water from overhead was noted to be fresh water, and that water from bathrooms was grey water from the shower drains. Once alleyway carpets became wet they started to smell.

Red bags were issued for guests to use as toilets. These were collected hourly by housekeeping into “poop stations”. Public restrooms were cleaned constantly. Once the toilet system was returned to operation, an aggressive cleaning practice was adopted in restrooms. The cabin stewards also assisted, and used disinfectant. Public areas of the vessel were cleaned every 4 hours. The Housekeeping Manager reported that floods were daily but that she received no complaints of sewage and that in cabins where toilets overflowed, the water was contained by the bathroom threshold and was cleaned by her department. Any toilet overflows were reported to plumbing.

\*\*Of note from the Housekeeping interview: Housekeeping is also in charge of special needs service. Cabin stewards were instructed to take care of special needs guests, especially those on Insulin and to assist any passengers to the medical centre. The Housekeeping Manager reported that Room Service serves meals to cabins, not housekeeping and that falls under Food and Beverage. Housekeeping was not requested to assist in any food service and her department is not trained to serve food.

\*\*Also of note, Housekeeping placed buckets on Deck 9 / Deck 10 stairwell where the deck head was leaking sprinkler water overflow from machinery spaces above.

\*\*Of note from the interview with the Hotel Director: when asked, he stated that he believed that the special needs passenger’s service was run by stateroom stewards under Housekeeping.

### **Entertainment**

Camp Carnival (children’s activities) was kept busy entertaining children. This was considered to have the secondary benefit that it would keep the parents happier.

### **Guest Security**

On February 10th during the fire response, the Security staff evacuated crew cabins off the marshalling area on Deck 0. During this time, the vessels internal phone system was operational. Passenger decks 1 and 2 were also evacuated, and those passengers were instructed to go to open decks.

Post-incident, separate rounds were made on all decks by crew teams for passenger needs, fire patrols and security patrols. Patrols wore lifejackets and carried flashlights to ensure visibility. Casino and photo studio staff assisted in patrols. The Security Director was aware of a single missing computer report, which was later recovered from an open deck where the owner had left it when preparations were being made for helicopter operations at the open area.

## APPENDIX II

### POST INCIDENT INVESTIGATION – GUEST INTERVIEWS

#### **Guest Interviews**

In order to prevent additional delays to the passengers on board, the Investigations Team developed a plan to board the ship at the sea buoy outside Mobile Bay. Prior to arriving at the ship, the investigations team developed a list of questions that would be asked of a sampling of the ships passengers. The passengers to be interviewed were also pre-selected by the Investigations Team, based on cabin location. Cabins were chosen from forward, mid-ships and aft sections of each passenger deck. Once the team was on board the ship and prepared, announcements were made requesting the occupants of the pre-selected cabins to report to the designated interview area.

In order to expedite the process, there were five interview tables set up, and at each table, a space was provided for a representative from the Flag State, US Coast Guard, NTSB and Carnival Cruise Lines. As each interviewee arrived, they were marked off from a roster. As we neared the end of the list of cabins, an assessment was made as to the level of response by the passengers. The team was able to determine which cabins chose not to be interviewed, and alternate cabins in those locations were selected. Passengers from a total of 41 cabins were interviewed during this time. Once the on-site portion of the investigation was completed, additional interviews were conducted based on gap-analysis of the investigation to that point.

#### **Sewage**

The investigations team received multiple reports of sewage overflowing from toilets once the ships power was out. Passengers reported sewage in the cabins, in the passageways and flowing down the bulkheads. The sewage system on the Carnival Triumph, as with most passenger vessels, is a vacuum flush system that is electrically powered.

#### **Improperly Stored Sewage**

The investigations team received reports of plastic bins of sewage sitting all around the ship. While the team was on board to conduct interviews, the lead investigator for the US Coast Guard was taken by a visibly very upset passenger to a bar area to see some of these bins. The investigator took pictures of the bin, which appeared to contain dirty water that was dripping from the overhead. Pictures of some of bins also appeared on the internet in the days after the ship docked in Mobile. During the course of the investigation, crew members were questioned as to the origin and content of those bins. Investigators were able to determine that those bins in the pictures and in the bar contained water that was leaking through the overhead from a machinery space above which was flooded when the sprinklers went off during the fire. It should also be noted that there is no sewage system piping in the overhead above where any of these bins were located.

## **Guest Waste Disposal**

In the days following the event, passengers were instructed by the Cruise Director to urinate in the shower and defecate in red bio-hazard bags that were provided to them. When the ship listed due to the water in the engineering spaces after the fire, this caused what should have been grey water to run out of the shower drains, and contributed to the perception by passengers that there was sewage running all over the floors, in the passageways and down the bulkheads. When the passengers were instructed to urinate in the shower, the water that then came out of the shower drains was now contaminated with urine instead of being strictly grey water.

## **Special Needs Guests**

The investigations team received multiple reports of concern that disabled passengers not properly attended to by staff during the event. With the loss of power on the ship, the elevators were out of service and passengers had to take the stairs from their cabins to access the food service lines which were on the Lido or 09 Deck. Passengers who were unable to walk up and down the stairs were dependent on others to provide food for them. Based on reports by passengers that the staff was not ensuring that the needs of disabled passengers were being met, the investigation team asked several crew members questions on this topic to determine whose responsibility it was to attend to the disabled passengers, and what their instructions were in that regard during the time that the power was out.

The Hotel Manager indicated in his statement that arrangements had been made for the cabin stewards to take food to the passengers who were on the ADA list, and that housekeeping was in charge of the cabin stewards.

The Housekeeping Manager was subsequently interviewed, and in her statement indicates that she had instructed the cabin stewards to make sure that they took care of the special needs guests because some of them were on medication. When asked specifically if her staff were bringing food to them, she indicated that room service, which falls under Food and Beverage and not Housekeeping, was responsible for that.

During the interview with the Beverage Manager he stated that he did comply with requests to take drinks to disabled passengers. In the interview with the Food Operations Manager he states that there were a couple of requests to feed passengers that could not get to Deck 09, but room service was not making the deliveries. He stated that he brought food himself to guests on two occasions, but only as a result of a specific request.

## **Guest Information**

Many of the passengers indicated concerns that once the guests heard the announcement for Alpha Team, they were given no other information or instructions which caused concern/panic and some went to their muster stations anyway. The investigations team was able to locate a recording of an announcement by the Cruise Director at 0530 on the morning of the fire. The team is of the opinion that many people either didn't hear or didn't clearly understand what the situation was. There were many reports of frustration

with the lack of information that was passed, and the number of times that the information passed turned out to be incorrect. The investigations team, while understanding of the frustration of the passengers, also understands that most passengers have very little understanding of how maritime processes work. It is difficult for them to understand the length of time it takes to coordinate and facilitate the assistance required for the ship, and then for the assist vessels to transit from their current locations to the location of the ship. Finally, there were reports that passengers missed meal announcements and other announcements because they were not made in all spaces.

### **Sanitary concerns: food handling; and food hoarding**

The investigations team received multiple reports voicing concern over the food service lines. The issues ranged from passengers serving themselves and handling the serving utensils which increases risk of bacterial spread, additional non-food service personnel assisting with food service, and passengers taking large amounts of food back to their cabins, which was then wasted because there was no way to store it in the cabin. Based on interviews with the Hotel Director, Food Operations Manager and the Beverage Manager, it was clear that there is no plan in place to manage a long-term power outage on board the ship. The staff came up with a plan to deal with the situation to the best of their abilities, but it was clearly something they were doing as they went along. The team feels confident that the staff was well aware of the food safety frames and focused on food safety from the onset of the event. All food personnel are well-trained in the prevention of contamination and cross-contamination.

In his interview, the Food Operations Manager stated that on the first day, Sunday, the food was served buffet style under the sneeze guard and passengers did serve themselves. Starting the next day, all food was served by the ships crew using gloves, because by then they knew they would be there for a while longer. They did have personnel from other departments helping with the food service. These people were given basic food safety training and there were supervisors constantly monitoring to ensure that proper protocol was maintained.

The Food Operations Manager stated that at no time was there any sewage anywhere near the food service line, as had been reported by some passengers. He stated that there was some overflow of the drains in the beverage stations due to the melting ice, and that there were some wet carpets that smelled bad, but there was no sewage.

Regarding the food hoarding, the Hotel Director stated that passengers always take food back to their cabins, but in this case they did observe passengers taking an unusual amount of food back to their cabins, perhaps out of fear that there would be a food shortage.

The investigations team believes that the staff did an outstanding job with the food service and food safety management during the event. This is evidenced by the lack of GI outbreak on the vessel. According to the statement by the Senior Medical Officer, there were only 12 guests and 2 crew members with Gastrointestinal Distress during the four days the ship was without power, which is about the same number that would be seen on a typical voyage.

The investigations team is of the opinion that if the passengers were given more information, to include an announcement that there was plenty of food and that there was no danger that they would run out, it would alleviate the feeling that they needed to hoard food. The actual act of taking too much food and then letting it go to waste would in reality increase the possibility of a food shortage.

### **Meal service**

The investigations team discussed this with the Hotel Director and the Food Operations Manager. The Food Operations Manager indicated in his statement that there were four food stations in operation: one grand buffet with two lines, and two stations outside. He also stated that they kept the same serving times as they had before the event, since the passengers were accustomed to these times, and that they would also make announcements. In his statement he indicated that there was one food line that remained open 24/7, so there was always food available to the passengers.

### **Open bar event**

On the second evening after the fire, which would be Monday, Carnival gave instructions to provide free beer and wine to the passengers. In the interview with the Beverage Manager he indicated that the open bar was supposed to run from 3:30 pm until midnight that evening, but he closed the bars at approximately 8:30 because quite a few of the passengers had consumed too much alcohol and were becoming obnoxious and were also messing up the restrooms.

### **Guest Medical Needs**

The investigations team interviewed the Senior Medical Officer, the Head Nurse and the staff nurse in response to reports that the medical staff refused to fill prescriptions, that they did not have enough insulin or blood pressure medication, that there were very long waits to be seen, and that patients were turned away.

In his statement, the Senior Medical Officer indicated that in only one case were they unable to provide either a refill or a suitable alternate for a medication, and that was for a particular narcotic that is not kept on board. In this case, the staff made arrangements for it to be called in to a pharmacy and it was waiting for her when she arrived in Mobile. They treated her with an alternative until that time. What the staff was doing, however, was managing the supplies they had on hand, so if a guest was not completely out of medication, they would not give them a refill to make sure that they had enough for patients who were actually out of medication. They had plenty of insulin, but they do not carry the insulin pens aboard, which is what some of the guests wanted. Instead, they were given a syringe with the required amount of insulin.

The guests were seen on a first-come, first-serve basis, which could account for the reports of long waits particularly on 2/12 when they had 125 guests visit the medical

centre. There was also at least one occasion where the medical staff was called to attend to a guest that had fallen, which would have increased their wait time as well. One such incident occurred on the 12th, which was also the day the most guests came to the medical centre.

### **Fire doors a danger to guests**

Investigators received report from the guests that the fire doors were confusing during the event, that some passengers did not know how to open them and that the fire doors on 01 Deck remained closed until they arrived in Mobile. Fire doors are not something normally encountered by cruise ship passengers, and there is no information provided to passengers in the safety brief about the doors. In fact, they open differently than the other doors that the passengers open normally. There is a handle that needs to be turned, and the door slides back, rather than pushing it outward or pulling it towards you. Even though there is a small sign on the doors with instructions, during the stress of the event there was confusion and some passengers were unable or found it difficult to open the fire doors. This could lead to a very dangerous situation.

**APPENDIX III****RECOMMENDATIONS BASED ON PASSENGER CONCERNS AND  
INVESTIGATIVE TEAM FINDINGS****1. ISSUE: Sewage**

The investigations team received multiple reports of sewage overflowing from toilets once the ship's power was out. Passengers reported sewage in the cabins, in the passageways and flowing down the bulkheads.

**Findings:**

There were most definitely instances where the toilets overflowed. The housekeeping manager indicates in her statement that there was flooding on all of the decks from the grey water coming up through the shower drains, the sprinklers and a couple of burst pipes. She also states that there were only a few toilets that overflowed, and that there was no sewage in the cabins or passageways other than the few toilets that overflowed, and those were addressed quickly by her staff. It is important to note that while these reports have been widely played in the media, there have been very few reports of illness that would naturally be associated with this type of contamination if it had not been properly addressed by the crew in a timely manner.

**Recommendations:**

This same issue has been reported on several other passenger vessels as well. The Investigation team recommends that Carnival explore some other type of back-up sanitation system.

**Actions being implemented by CCL**

Action already taken; additional power source for the sewage system is under installation as part of the approved vessel enhancement program in order to ascertain power for the system in all conditions

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**2. ISSUE: Passengers were instructed by the Cruise Director to urinate in the shower and defecate in red bio-hazard bags that were provided to them.****Findings:**

When the ship listed due to the water in the engineering spaces after the fire, this caused what should have been grey water to run out of the shower drains, and contributed to the perception by passengers that there was sewage running all over the floors, in the passageways and down the bulkheads. When the passengers were instructed to urinate in the shower, the water that then came out of the shower drains was now contaminated with urine instead of being harmless grey water.

The Investigators team recognises that in the circumstances, no suitable alternative was available.

**Recommendations:**

All human waste should be properly stored in bio-hazard containment.

**Actions being implemented by CCL**

Action already taken; additional power source for the sewage system under installation as part of the approved vessel enhancement program in order to ascertain power for the system in all conditions

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**3. ISSUE: The investigations team received multiple reports of concern that disabled passengers not properly attended to by staff during the event.****Findings:**

With the loss of power on the ship, the elevators were out of service and passengers had to take the stairs from their cabins to access the food service lines which were on the Lido or 09 Deck. Passengers who were unable to walk up and down the stairs were dependant on others to provide food for them. Based on reports by passengers that the staff was not ensuring that the needs of disabled passengers were being met, the investigation team asked several crew members questions on this topic to determine whose responsibility it was to attend to the disabled passengers, and what their instructions were in that regard during the time that the power was out.

The Hotel Manager indicated in his statement that arrangements had been made for the cabin stewards to take food to the passengers who were on the ADA list, and that housekeeping was in charge of the cabin stewards.

The Housekeeping Manager was subsequently interviewed, and in her statement indicates that she had instructed the cabin stewards to make sure that they took care of the special needs guests because some of them were on medication. When asked specifically if her staff was bringing food to them, she indicated that room service, which falls under Food and Beverage and not Housekeeping, was responsible for that.

During the interview with the Beverage Manager he stated that he did comply with requests to take drinks to disabled passengers. In the interview with the Food Operations Manager he states that there were a couple of requests to feed passengers that could not get to Deck 09, but room service was not making the deliveries. He stated that he brought food himself to guests on two occasions, but only as a result of a specific request.

Based on analysis of the information obtained during the interviews, it would appear that there are no clear instructions or procedures for ensuring that disabled passengers have food delivered to them in the event that the elevators are out of service. It appears that each department thought a different department was taking care of delivering food to the disabled passengers, and that in fact, food deliveries were only made when the Food Operations Management received a specific request.

**Recommendations:**

Recommend that Carnival Cruise Lines develop and institute instructions for a team of people to be individually and wholly dedicated to the care and management of the special needs passengers for each voyage. This would include ensuring that meals are delivered to them, and that they are attended to on an established schedule in an emergency or other event such as the elevators are out of service for an extended period of time. A system should be put in place to verify that this is being done

**Actions being implemented by CCL**

Action already taken; Established procedure, dedicated persons assigned, specified in Hotel procedures

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**4. ISSUE: Lack of information; changing information, amount of time for decisions to be made; amount of time to get assistance; problems with assist tugs after they arrived on scene.**

**Findings:**

Many of the passengers indicated frustration with the lack of information that was passed, and the number of times that the information passed turned out to be incorrect. The investigations team, while understanding of the frustration of the passengers, also understands that most passengers have very little understanding of how maritime processes work. It is difficult for them to understand the length of time it takes to coordinate and facilitate the assistance required for the ship, and then for the assist vessels to transit from their current locations to the location of the ship.

**Recommendations:**

Recommend that in future emergency situations that will last more than 24 hours, the Captain hold briefings similar in style to the disembarkation briefing in a theatre type setting. In these briefings, the Captain or staff would fully explain the situation, what actions are being taken, articulate the complex nature of the logistics involved in resolving the situation, and any potential delays that may occur.

**Actions being implemented by CCL**

Action already taken; according to the new HESS Management System currently being rolled out, the Captain shall, considering the situation regularly brief the guests on all issues and particulars related to the incident

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**5. ISSUE: Sanitary conditions of food service lines; food hoarding and meal time arrangements.****Findings:**

The investigations team received multiple reports voicing concern over the food service lines. The issues ranged from passengers serving themselves and handling the serving utensils which increases risk of bacterial spread, additional non-food service personnel assisting with food service, and passengers taking large amounts of food back to their cabins, which was then wasted because there was no way to store it in the cabin. Based on interviews with the Hotel Director, Food Operations Manager and the Beverage Manager, it was clear that there is no plan in place to manage a long-term power outage on board the ship. The staff came up with a plan to deal with the situation to the best of their abilities, but it was clearly something they were doing as they went along. The team feels confident that the staff was well aware of the food safety frames and focused on food safety from the onset of the event. All food personnel are well-trained in the prevention of contamination and cross-contamination.

In his interview, the Food Operations Manager stated that on the first day, Sunday, the food was served buffet style under the sneeze guard and passengers did serve themselves. Starting the next day, all food was served by the ships crew using gloves, because by then they knew they would be there for a while longer. They did have personnel from other departments helping with the food service. These people were given basic food safety training and there were supervisors constantly monitoring to ensure that proper protocol was maintained.

The Food Operations Manager stated that at no time was there any sewage anywhere near the food service line, as had been reported by some passengers. He stated that there was some overflow of the drains in the beverage stations due to the melting ice, and that there were some wet carpets that smelled bad, but there was no sewage.

Regarding the food hoarding, the Hotel Director stated that passengers always take food back to their cabins, but in this case they did observe passengers taking an unusual amount of food back to their cabins, perhaps out of fear that there would be a food shortage.

The investigations team believes that the staff did an outstanding job with the food service and food safety management during the event. This is evidenced by the lack of GI outbreak on the vessel. According to the statement by the Senior Medical Officer, there were only 12 guests and 2 crew with GI distress during the four days the ship was without power, which is about the same that would be seen on a typical voyage.

The investigations team is of the opinion that if the passengers were given more information, to include an announcement that there was plenty of food and that there was no danger that they would run out, it would alleviate the feeling that they needed to hoard food. The actual act of taking too much food and then letting it go to waste would in reality increase the possibility of a food shortage.

The investigations team discussed this with the Hotel Director and the Food Operations Manager. The Food Operations Manager indicated in his statement that there were four food stations in operation: one grand buffet with two lines, and two stations outside. He also stated that they kept the same serving times as they had before the event, since the passengers were accustomed to these times, and that they would also make announcements. In his statement he indicated that there was one food line that remained open 24/7, so there was always food available to the passengers.

**Recommendations:**

- A) Recommend that in such emergencies the Hotel Director provides procedures and guidance for passenger meal times, taking into account the total loss of ships electrical power.
- B) Recommend that an announcement be made immediately and often that there is plenty of food available, and make sure the passengers have been made aware that there is no possibility of a food shortage.

**Actions being implemented by CCL**

Action already taken. The procedure sets out frequent announcements and flyers on food timing and sufficient quantities, However, CCL consider buffet style is preferable

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**6. ISSUE: Open bar event was not a good idea.**

**Findings:**

On the second evening after the fire, which would be Monday, Carnival Corporation gave instructions to provide free beer and wine to the passengers. In the interview with the Beverage Manager he indicated that the open bar was supposed to run from 3:30 pm until midnight that evening, but he closed the bars at approximately 8:30 because quite a few of the passengers had consumed too much alcohol, the consumption of alcohol tends to decrease inhibitions and self-control.

**Recommendations:**

The investigations team would recommend against this practice in the future. Alcohol tends to inflame tensions that are already on the rise, and in this case clearly exacerbated an already difficult situation.

**Actions being implemented by CCL**

Action already taken. No alcohol service during emergency situations. Also stated in flyers

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**7. ISSUE: Passengers were turned away by medical staff; long waits to be seen; prescriptions not filled****Findings:**

The investigations team interviewed the Senior Medical Officer, the Head Nurse and a Staff Nurse in response to reports that the medical staff refused to fill prescriptions, that they did not have enough insulin or blood pressure medication, that there were very long waits to be seen, and that patients were turned away.

In his statement, the Senior Medical Officer indicated that in only one case were they unable to provide either a refill or a suitable alternative for a medication, and that was for a particular narcotic that is not kept on board. In this case, the staff made arrangements for it to be called in to a pharmacy and it was waiting for her when she arrived in Mobile. They treated her with an alternative until that time. The medical staff were making every effort to manage the supplies they had on hand, so if a guest was not completely out of medication, they would not give them a refill to make sure that they had enough for patients who were actually out of medication. They had plenty of insulin, but they do not carry the insulin pens onboard, which is what some of the guests wanted. Instead, they were given a syringe with the required amount of insulin.

The guests were seen on a first-come, first-serve basis, which could account for the reports of long waits particularly on 2/12 when they had 125 guests visit the medical centre. There was also at least one occasion where the medical staff was called to attend to a guest that had fallen, which would have increased their wait time as well. One such incident occurred on the 12th, which was also the day the most guests came to the medical centre.

The investigations team could find no indications that guests were turned away from the medical department. We believe that if the guests came to medical for a refill of a prescription, but were not completely out, and the staff did not give them additional medication because they wanted to ensure that they had enough for guests who were completely out, that the guest may have interpreted that as being turned away when in fact the medical staff was just rationing out their medical supplies.

**Recommendations:**

- A) The investigations team believes that this could have been managed much more efficiently, such as having them come down and sign up for an appointment and come back at their scheduled time rather than sit in the hallway, or some other system that would avoid having large numbers of guests in line, particularly ones that are ill. With no air-conditioning and the medical centre being located on Deck 0, the heat would just add to the discomfort and agitation of the guests.
- B) The investigations team recommend that Carnival's emergency procedures not only include a head count for all departments, but due consideration be given to additional passenger needs and subsequently reported to the bridge.
- C) Recommend that a first aid station be situated in a suitable guest lounge, in the event of such an emergency to alleviate the load on the medical centre for simple first aid requirements.

- D) Recommend that prescription refill requests be made on forms issued from the first aid station, which could then be reviewed by medical staff and appropriately managed based on passenger need and medicine availability before the passenger reports to the medical centre.

**Actions being implemented by CCL**

Current procedures will be updated accordingly.

We confirm that we perform head count, however for us we cannot do it by Department as crewmembers are reporting to different areas based on their duties. The medical Staff reports to the Infirmary and with the new upcoming procedure must report to Command and Control to confirm gathering

Locate first aid station in suitable guest lounge.

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**8. ISSUE: Fire doors were confusing during the event, some passengers did not know how to open them; Fire doors on 01 Deck remained closed until they arrived in Mobile.**

**Findings:**

Fire doors are not something normally encountered by cruise ship passengers, and there is no information provided to passengers in the safety brief about the doors. In fact, they open differently than the other doors that the passengers open normally. There is a handle that needs to be turned, and the door slides back, rather than pushing it outward or pulling it towards you. Even though there are signs on the doors with instructions, during the stress of the event there was confusion and some passengers were unable or found it difficult to open the fire doors. This could lead to a very dangerous situation.

**Recommendations:**

- A) Recommend that instructions on the fire doors be included in the safety briefing, and in the safety information given to passengers in their boarding packages.

**Actions being implemented by CCL**

Based on the new HESS Management System currently being rolled out, the Captain having assessed the actual situation shall repeatedly inform the guests on the operation of the fire doors

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**9. ISSUE: Most passengers heard announcement for Alpha Team, but were given no other information or instructions which caused concern/panic and some went to their muster stations anyway.**

**Findings:**

The investigations team was able to locate a recording of an announcement by the Cruise Director at 0530 on the morning of the fire. The team is of the opinion that many people either didn't hear or didn't clearly understand what the situation was.

**Recommendations:**

- A) Recommend that any instructions or information given during an event such as this be given multiple times over the public address system.
- B) Recommend that staff members be stationed as needed in high traffic areas to assist passengers as necessary.

**Actions being implemented by CCL**

The new Corporate HESS Management System currently being rolled out mandates announcement all over the ship in order to make sure all crew members can be reached. Such announcement shall be followed up with second guest announcement explaining the situation and the actions taken

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**10. ISSUE: There were reports that passengers missed meal announcements and other announcements because they were not made in all spaces.**

**Findings:**

This could be an issue with either the improper engagement of the circuits by the person making the announcement, or a problem with the circuit board itself.

**Recommendations:**

A full test of the Public Address system.

**Actions being implemented by CCL**

The system is regularly tested and corrective actions taken as needed

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**11. ISSUE: The 01 and 02 Decks were affected by smoke; no announcement was made but the crew did evacuate these decks. Upper decks near the funnel were also smoky, but those decks were not evacuated or given any information.**

**Findings:**

The investigations team found a self-closing door which isolates the aft port stairwell from Deck 0 to passenger cabins on Deck 01, which did not close completely during the event. The opened door allowed smoke to penetrate to passenger accommodation spaces from Deck 0.

**Recommendations:**

Recommend all fire doors that are required to self-close be inspected and adjusted as necessary to ensure proper operation. (Door closing device on Fire Doors)

**Actions being implemented by CCL**

Action already implemented. The doors are regularly inspected and tested and repaired as needed

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**12. ISSUE: Passengers were concerned about the ships list and were not given adequate information to allay their concerns.**

**Findings:**

The investigations team determined that the ship did experience a 5 degree list after the fire. This was partially due to the amount of water that accumulated in the Aft Engine Room centre and starboard bilges following the failure of a fire hydrant forward on the starboard bulkhead of the centre compartment, allowing water to flood into the bilges, unknown to the fire teams. Wind and inoperable stabilizers also added to the list. The investigations team has determined that at no time was the ship in any danger of capsizing due to the list, but it is understandable that the passengers would have such a concern.

**Recommendations:**

An announcement by the Captain explaining why there was a list and that they were in no danger would have preventing the passengers from undue stress and concern over this issue.

**Actions being implemented by CCL**

Included in the Emergency Response Procedure of the new HESS Management System currently being rolled out (Captain shall give all essential information to the guests).

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**13. ISSUE: Passengers were very concerned that the muster stations and fire doors were blocked by mattresses and personal belongings once people moved out on deck after the power outage.**

**Findings:**

The Hotel Manager was questioned on this topic during his interview by the investigations team. He also had concerns about access to the muster stations, but they did not want to make the passengers move since they were just trying to make the best of the situation and get as comfortable as possible. He stated that this situation was discussed by several of the department heads, and they decided to have people from housekeeping assigned with clearing the area in the event that there was a need to access the muster stations.

The investigations team believes that most passengers do not understand the importance of clear access to the muster stations and fire doors.

**Recommendations:**

Recommend that the Captain make an announcement that conveys the importance of keeping those areas clear, and that if people choose to place items in those areas, to understand that they will be immediately moved and could be lost in the event of an emergency. It is imperative that the crew and passengers have unrestricted access to the muster stations. Fire doors should never be blocked. It is the responsibility of the ship's crew, particularly under the circumstances of such events, to convey to the passengers the importance of maintaining clear access to those areas.

**Actions being implemented by CCL**

Included in the Emergency Response Procedure of the new HESS Management System currently being rolled out

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**14. ISSUE: Interior cabin emergency lighting**

**Findings:**

The vessel's interior cabins do not have any emergency lighting, in event of a blackout the cabins without external light sources such as windows or balconies are completely dark. This was reviewed and verified by the investigating team and total disorientation is experienced in a short time. Passengers are unfamiliar with the layout of ship board accommodation, notably in way of raised door sills and this poses a severe risk of injury.

**Recommendations:**

Recommend that Carnival Corporation investigate the installation of emergency lighting in the passenger cabins.

**Actions being implemented by CCL**

CCL has already investigated and will provide feed-back once final decisions have been taken. The ships have been already supplied with flash lights.

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