



Bahamas Maritime Authority

**Report of the Investigation into
the Fire of a
Turbo Generator of
“NORWAY”
on
28 May 1999**

The Bahamas Maritime Authority investigates incidents at sea for the sole purpose of discovering any lessons which may be learned 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.

Date of Issue : 16 February 2001

Bahamas Maritime Authority
Latham House
16 Minories
LONDON
EC3N 1EH
United Kingdom

CONTENTS

1. **Summary**
2. **Particulars of Vessel**
3. **Narrative of events**
4. **Analysis**
5. **Conclusions**
6. **Recommendations**

Appendix:

- I. Chronology of fire fighting, crew and passengers activities and ship manoeuvres of the morning on Friday 28 may 1999

SUMMARY

- 1.1 During the final approaches to Barcelona, Spain, when a pilot was on board, a control oil pipe to the No 22 Turbo Generator, in the vessel's aft auxiliary engine room, cracked in such a manner that a jet of pressurised control oil sprayed onto the insulation of a "superheated steam" valve. The body of that valve, having a temperature of about 430° C, was considerably greater than both the flash point and the auto-ignition temperature of the oil, which therefore ignited.
- 1.2 The subsequent fire was quickly extinguished by the release of HALON into the space.
- 1.3 The vessel berthed at Barcelona where all passengers were safely disembarked.
- 1.4 The Master, Officers and crew responded to the fire alarm in accordance with the established Emergency procedures.
- 1.5 The fire was limited to the upper part of the "first floor" level of the aft auxiliary engine room before it was extinguished. Heat and soot damage to insulation, electrical starter systems, electrical cabinets, cabling and internal steel structures within the compartment, was apparent.
- 1.6 Neighbouring compartments, the deck above and below and the other areas of the same compartment were not effected.
- 1.7 The vessel remained at Barcelona while repairs were completed.
- 1.8 The report recommends that the managers of the vessel amend their procedures for repair of critical machinery.

PARTICULARS OF VESSEL

2.1 "NORWAY" is a passenger cruise vessel registered at Nassau, Bahamas, of welded steel construction having the following principal particulars:

- Official Number - 710763
- IMO Number - 5119143
- Length overall - 301.04 metres (1,035' 0")
- Length BP - 291.306 metres (953' 7")
- Breadth - 33.76 metres (110' 6")
- Depth - 16.99 metres (55' 9")
- Draught - 10.49 metres (35' 6")
- Gross Tonnage - 76,049 tons
- Net Tonnage - 45,886 tons
- Deadweight - 13,960 tonnes
- Call Sign - C6CM7

2.2 The vessel was built in 1961 at Chantier D'Atlantique, St. Nazaire, France and was formerly named "FRANCE." At the time of the incident she was owned and managed by the Norwegian Cruise Line of Miami, Florida, USA.

2.3 She is powered by two, single geared CEM steam turbine main engines that currently develop 29,983 kW (approximately 40,000 bhp.) These drive two fixed bladed propellers. Steam is generated from four Penhoet watertube boilers that have nominated working pressures of 71.5 bars and superheated steam temperatures of 500° C.

2.4 There are 14 main generators in four separate compartments. Six of these are steam turbine sets that are sited, three each, in the forward and aft auxiliary engine rooms; between the watertight bulkheads at frames 80 / 96 and 174 / 196. Those in the aft auxiliary engine room are numbered 20 (centre,) 21 (starboard) and 22 (port) and are fitted on an intermediate deck level, positioned about 5 metres above the tank top. Each generator is rated at about 2,200 kW. The aft auxiliary engine room forms the aft part of the No. 6 main vertical Fire Zone, which extends as far forward as frame 119 and includes the aft main engine room in which are fitted the two main steam turbine propulsion units. The aft auxiliary engine room also is fitted with two air conditioning units, Nos. 22 and 24.

2.5 Fixed Fire protection in the aft auxiliary engine room is provided by a fixed Halon gas system.

- 2.6 The vessel has a passenger certificate to carry 2,400 passengers and 900 crew, although the vessel is fitted to carry 2,560 passengers.
- 2.7 The vessel was first registered in the Bahamas in 1996 and was entered with Bureau Veritas Classification Society. At the time she complied with the all statutory and international requirements and certification.
- 2.8 "NORWAY" was subjected to a Bahamas Maritime Authority Annual Inspections at the Port of Southampton on 08 July 1998 and 12 July 1999. No relevant observations were made.

NARRATIVE OF EVENTS

All times noted in this narrative are given in the style of the standard 24 hour clock without additional annotation and in the Western European Summer Time zone, which is utc +2 hours. Any other timing is noted in brackets.

A similar fire to the subject incident of this report occurred on 16 March 1999 and is briefly described in the first part of this narrative, together with a summary of relevant details of a repair period in the April 1999.

3.1 Fire on 16 March 1999

3.1.1 NORWAY was on passage from Miami, Florida to Phillipsburg, St. Maarten on the morning of 16 March 1999 when, in position 18° 15' N, 063° 32' W, at 0540 ship's time, a series of smoke detectors in the fire detection system became activated, all indicating activity in the aft auxiliary engine room.

3.1.2 Initial inspections and communication resulted in a fire fighter alarm and the coded fire alarm being broadcast throughout the vessel at 0542.

3.1.3 The first available fire team was assembled at 0546, were in direct contact with the seat of the fire by 0551 and, with the use of steam, powder and water, had it under control by 0553. The fire was logged as being extinguished by 0600 although still emitting a lot of smoke. Remedial preventative action was commenced resulting in the last fire team being stood down at 0754.

3.1.4 The cause of the fire was identified as being caused by a leaking 25 mm (external diameter) oil control pipe on the port turbo generator, No. 22, that soaked into the insulation of the superheated steam control valve, on the top of the turbine and which subsequently ignited.

3.1.5 A ship's technician welded a single 6 cm long bush externally over the area of the Control Oil Pipe that had been the initial cause of the leak and replaced it onto the turbo generator.

3.1.6 This event was reported to the United States Coast Guard, but not to the Bahamas Maritime Authority.

3.2 Dry Dock and Repair Period, Bremerhaven, Germany, April/May 1999

3.2.1 NORWAY underwent a period of maintenance and repair at Bremerhaven between 22 April and 16 May 1999. During this time three new diesel generators were installed, the two main propulsion turbines were overhauled and No. 22 steam Turbine Generator was overhauled and inspected.

3.2.2 The vessel arrived at Marseilles on 21 May 1999 and departed on a Western Mediterranean Cruise, with 1,527 passengers and 926 crewmembers on the following day.

3.3 Fire on 28 May 1999

A schedule of the events and announcements during the morning of Friday 28 May 1999 are attached as Appendix I.

- 3.3.1 During the morning of 28 May 1999 NORWAY was en route from Palma de Mallorca to Barcelona, Spain. The usual port arrival preparations, in accordance with established procedures, were taken when the two Barcelona Pilots boarded the vessel at 0601.
- 3.3.2 At 0605 the fire detection panel indicated that a fire was present in the vicinity of turbo generator No. 22 in the aft auxiliary engine room. This information was immediately telephoned to the engine room control room. The coded Officer and Fire fighter alarm signal was made within restricted areas thus mobilising the ship's fire fighting teams.
- 3.3.3 The watertight doors on the tank top were closed at 0610 and an electrical "blackout" occurred at 0611, taking all side thrusters out of service. One of the steering gears remained in operation and the emergency generator was immediately started. By 0612 the No. 2 fire team, allocated the task of the lead team in engine room fire fighting, was on station and commenced investigating the source of the fire. At 0619 the coded fire stations alarm: "Code BRAVO" was broadcast over the whole vessel followed by the general alarm at 0622 which was accompanied by announcements to the crew and passengers. The latter were then instructed to proceed to their lifeboat stations.
- 3.3.4 The aft auxiliary engine room was evacuated and sealed at 0627 when HALON was released. Other fire teams assembled at their stations as smoke escaped onto the International deck.
- 3.3.5 Members of the fire teams entered the aft auxiliary engine room to assess the effect of the HALON discharge and, by 0643, reported that there were no more flames but there was still a lot of smoke. The fire was confirmed to be extinguished at 0703. The process of ventilation was then started, firstly on the International deck and later in the aft auxiliary engine room. The passengers were permitted to return to their cabins and normal routines at 0722 and the crew, except for the immediate fire fighting parties, was stood down from emergency stations at 0735. Work opening up the aft auxiliary engine room was started at 0750.
- 3.3.6 In the mean time, four tugs had routinely made fast between 0620 and 0627 and the vessel was manoeuvred to its berth, the first mooring rope being secured at 0656. The tugs were dismissed at 0706 and the mooring process eventually completed at 0725.
- 3.3.7 Units of the Barcelona Fire department arrived at the pier by 0645 and ambulances at 0703, before the vessel was moored.
- 3.3.8 During the fire fighting process one passenger was taken ill and attended by ship's stretcher and medical team in the vicinity of No. 21 lifeboat on the

International deck. The passenger was eventually taken ashore to be treated in hospital. The diagnosis was Hypertension with a query of an Intracranial haemorrhage.

3.4 **Damage**

3.4.1 The initial inspection of the scene of the fire was made during the afternoon of 28 May 1999. There was heat and smoke damage to the following areas and components:

- Deck head in the aft port part of the aft auxiliary engine room.
- Light fittings and electric cables (melted.)
- Electrical starter control units of the Air Conditioning Units Nos. 22 and 24.
- Contactors and cables of the Auxiliary 440 volt switchboard.

3.4.2 Sea water had been used as a means of cooling during the fire fighting. These areas had been hosed down with fresh water as soon as time permitted, in order to dilute and disperse the salt water.

3.4.3 Seven bottles of HALON had been discharged during the fire fighting. Five originated from the aft end of the main engine room and two were positioned on the port side of the aft auxiliary engine room. The latter had self released, because of the local heat, during the fire.

4.1 Cause of the Fire

- 4.1.1 A broken 25 mm (external diameter) oil control pipe, that carried lubricating oil into the top of the turbine steam inlet valve of the No. 22 (port side) turbo generator was identified. It was inferred that a spray of hot oil from this pipe had ignited on the hot body of the turbo generator and further leaking lubricating oil had provided the fuel to feed the fire as it spread to the immediate surrounding area.
- 4.1.2 A similar fire that occurred in March 1999 that was identified as being caused by a leakage of lubricating oil from a fracture of the same pipe that soaked into the insulation of the superheated steam control valve, on the top of the turbine.
- 4.1.3 In that case, after the fire had been extinguished, a ship's technician welded a single 6 cm long bush externally over the area of the oil control pipe that had been the initial cause of the leak and replaced it onto the turbo generator. There is no evidence to infer that this incident was brought to the attention of the vessel's Classification Society or that they approved the repair.

4.2 Lubricating Oil

- 4.2.1 The lubricating oil that sprayed from the fractured pipe had two primary function with respect to No. 22 turbo generator. As well as acting as a lubricant and heat distribution medium it was also part of the speed control system of the superheated steam inlet valve. The oil in use was "TRO-MAR T" Petroleum Lubricating Oil manufactured by the Exxon Company, USA. The "Material Safety Data Sheet" indicated the following properties of the oil that are relevant to this fire:

Name	TRO-MAR T
Category	Petroleum Lubricating Oil
Product Code	338010 - 01203
Hazardous Materials Identification System (HMIS)	Health = 1, Flammability = 1
National Fire Protection Association (NFPA) Hazard Identification	Health = 1, Flammability = 1
Minimum Flash Point (Cleveland open cup – ASTM D 92)	224° C
Auto-ignition temperature	Greater than 260° C
Handling Precaution	Use product with caution around heat, sparks, pilot lights, static electricity and open flames.

- 4.2.2 The fracture of the control oil pipe occurred very close to the welded seam at the end of the bush that had been fitted after the previous fire. Visual examination indicated that either the composition or hardness of the steel pipe had changed or that there had been residual tension forces in the pipe after it had been refitted.
- 4.2.3 One or a combination of the above properties, combined with lubricating oil pressure of eight bars had resulted in the crack that formed and initiated a spray of oil onto the insulation and around the Superheated Steam Control Valve. The temperature of that steam, and therefore of the metal fabric of the valve, was about 430° C. That temperature is over 200° C greater than the Flash point of the oil and significantly greater than the lower range of the self ignition temperature.
- 4.2.4 The lubricating oil and the residual high temperatures in an open natural air atmosphere are sufficient to initiate an intense fire. The lubricating oil, held in the saturated insulation, formed an ideal reservoir in addition to the oil spray to sustain the fire while it spread to other areas close to the turbo generator.
- 4.3 **Fire Fighting**
- 4.3.1 The discovery of the fire followed by the assembly of the fire teams occurred in an acceptably short time. The No. 2 Fire Team were in position, preparing their equipment outside the aft auxiliary engine room within six minutes of the alarm that was initially only raised in the crew quarters. Two men from that team entered the aft auxiliary engine room a further eight minutes later but returned within one minute (as recorded.) Preparations were then made to make the HALON release.
- 4.3.2 The Master then commenced a series of warnings and communications with key personnel charged with passenger care before sounding the General alarm and passing instructions for all passengers to proceed to their lifeboat stations. Thereafter regular communication was passed to the passengers who remained calm and informed.
- 4.3.3 During that whole process, the vessel was manoeuvred to her berth with the assistance of four tugs, which were already engaged to participate with the berthing. As a result the vessel was moored without any apparent delay and the fire fighting efforts were satisfactorily completed before the Barcelona Fire Department had an opportunity to board the vessel.
- 4.3.4 The time taken between the fire being detected and being extinguished was 58 minutes.

CONCLUSIONS

- 5.1 During the final stages of approach and entry in Barcelona, a fire broke out on the No. 22 Turbo Generator (Port side) of the aft auxiliary engine room.
- 5.2 After an initial inspection by the Fire Team, the fire was extinguished with the use of the vessel's fixed HALON system for that compartment and thereafter boundary cooling was completed with water hoses. The time taken between the fire being detected and being extinguished was 58 minutes.
- 5.3 A partial electrical "Blackout" occurred but the harbour tugs were already in attendance and so the berthing of the vessel continued without delay while the fire fighting operations continued.
- 5.4 The passengers were assembled at their emergency stations as a precautionary exercise. There were no injuries although one passenger was taken ill during the emergency and later sent to hospital. This illness was not related to or caused by the fire or the subsequent emergency procedures.
- 5.5 The fire was caused by the failure of a previous repair to a 25 mm steel pipe that carried control lubricating oil to the superheated steam control valve of No. 22 steam turbo generator. Oil from that pipe saturated into local insulation and sprayed onto the hot metallic body of the control valve where it ignited.

RECOMMENDATIONS

- 6.1 The Managers are recommended to review their procedures to ensure that any repairs to critical machinery are permanently made good to Classification Society approval.

APPENDIX I

**Chronology of fire fighting,
crew and passengers activities
and ship manoeuvres of the
morning on Friday 28 may 1999**

CHRONOLOGY OF FIRE FIGHTING, CREW AND PASSENGERS ACTIVITIES AND SHIP MANOEUVRES Friday 28 May 1999			
Time	Fire Fighting	Passenger and Crew Announcements and Events	Ship Manoeuvres
0000			
0601		En route from Palma de Mallorca to Barcelona, Spain.	
0605	Arrival preparations, according to established procedures. Two Barcelona Pilots boarded		
0605	Fire detection panel indicated a fire in the vicinity of turbo generator No. 22 in the aft auxiliary engine room. Engine room control room immediately informed.		
0606	Coded “Officer and Fire fighter” alarm signal made within restricted crew areas thus mobilising the fire fighting teams. Hotel Director warned to prepare his staff.		
0610	Watertight doors on the tank top closed.		
0611	Electrical “blackout.” All side thrusters out of service. Emergency generator started. One steering gear remained operable.		
0612	No. 2 fire team, acting as the lead team in engine room fire fighting, at station.		
0615	Fans to aft auxiliary engine room stopped.		
0619	Coded fire stations alarm: “Code BRAVO” broadcast over the whole vessel.		
0620	Two fire fighters enter aft auxiliary engine room.		1 st tug fast aft.
0621	Fire fighters withdrawn from the aft auxiliary engine room in preparation for releasing HALON gas.		
0622	The general alarm sounded over whole vessel.		2 nd tug pushing forward.
0623		Hospital briefed.	
0624		Cruise Director briefed.	
0625		Captain informed crew about the fire.	
0626		Passengers instructed to proceed to lifeboat stations.	
0627	Aft auxiliary engine room confirmed to be evacuated and sealed. HALON released. Other fire teams assembled at their stations. Smoke escaped onto the International deck.		3 rd tug fast forward and 4 th tug pushing aft.
0635		Smoke seen on “International” deck.	
0639	Fire team members inside aft auxiliary engine room.	Captain advised passengers, over the P.A. system, that the situation was under control.	

CHRONOLOGY OF FIRE FIGHTING, CREW AND PASSENGERS ACTIVITIES AND SHIP MANOEUVRES Friday 28 May 1999			
Time	Fire Fighting	Passenger and Crew Announcements and Events	Ship Manoeuvres
0640		Smoke on “International” deck reduced.	
0643	Fire teams members entered aft auxiliary engine room to assess the effect of the HALON discharge. No more flames reported but there still a lot of smoke.		
0645	Units of the Barcelona Fire department arrived at the pier.		
0650	Fire reported to be under control.	Captain announced that “Fire under control. Passengers to remain at stations. Code “ALPHA” (Medical team) called to, International deck.	
0656			1 st mooring rope ashore.
0702		Passengers on International deck remain very calm. Medical team attending to one passenger at lifeboat station No. 21.	
0703	Fire extinguished. Ventilation process started, firstly on the International deck and later in the aft auxiliary engine room.	Ambulances arrived at the pier	
0706			Tugs dismissed.
0708	Evacuation doors on International deck opened to ventilate.		
0709		Captain informed passengers that fire was extinguished and that vessel was safely moored.	
0713		Passengers remained at International deck while smoke was cleared from corridors and staterooms.	
0722		Captain announced that passengers could stand down from their emergency stations, thanking them for their co-operation.	
0725			Mooring completed.
0735	Crew, except for the immediate fire fighting parties, was stood down from emergency stations.		
0750	Commence work opening up the aft auxiliary engine room.		
0845		One passenger sent ashore to hospital.	
1200	Aft auxiliary engine room hosed down with fresh water to minimise damage to electrical components.		