THE MERCHANT SHIPPING ACT, 1894

REPORT OF COURT

(No. 8022)

m.v. "Capetown Castle" O.N. 166402

In the matter of a Formal Investigation held at The Town Hall, Holborn, London, W.C.1, on the 20th, 21st, 22nd, 23rd, 24th, 28th and 29th days of November, 1961, before Kenneth Carpmael Esq., Q.C., assisted by J. R. C. Welch, Esq., I. J. Gray, Esq., and Dr. A. Thomas into the circumstances attending an explosion which occurred in the engine-room of the motor vessel "Capetown Castle" while she was approaching Las Palmas in the course of a voyage from Capetown to Las Palmas.

The Court having carefully inquired into the circumstances attending the above-mentioned shipping casualty, finds for the reasons stated in the Annex hereto, that the explosion may have occurred owing to an accumulation of oil in the air starting system of the port engine in or near to an air starting valve which oil was drawn by highly turbulent air into a cylinder where the mixture of oil and air ignited as a result of high temperature in the cylinder at some point remote from the starting air valve. The ignition first expelled a mixture of unburnt oil and air into the open line through the valve after which the flame accelerated and initiated a film detonation involving oil in the main air pipe lines. This conclusion is to a large extent conjectural.

The Court orders that the Minister of Transport do pay to Captain W. S. Byles the sum of seventy-five guineas being the expense to which he has been put by reason of this investigation.

Dated this 6th day of February, 1962.

KENNETH CARPMAEL, *Judge.*

We concur in the above report.

J. R. C. WELCH
IVOR J. GRAY } *Assessors.*
ALUN THOMAS

ANNEX TO THE REPORT

This Formal Investigation was held at the Holborn Town Hall on 20th, 21st, 22nd, 23rd, 24th, 28th and 29th November, 1961 into the circumstances in which an explosion occurred in the engine room of the British Motor Vessel "Capetown Castle" on 17th October, 1960.

Mr. Peter Bucknill, Q.C. and Mr. Robin Dunn (instructed by the Treasury Solicitor) appeared on behalf of the Minister of Transport.

The owners of the "Capetown Castle" (The Union Castle Mail Steamship Company Limited) her designated manager (Mr. Reginald James Bloxam) and her master (Captain W. S. Byles) had been made parties and were represented by Mr. J. Roland Adams, Q.C. and Mr. Gerald Darling (instructed by Messrs. Parker Garrett and Company).

Mr. R. F. Stone (instructed by Messrs. Ingledew, Brown, Bennison and Garrett) appeared on behalf of the Merchant Navy and Airline Officers Association representing the dependants of the late chief engineer (Mr. S. C. Logan), the late first engineer (Mr. J. C. Burton) and the late senior second engineer (Mr. D. H. E. Cameron) and upon request the Association was made a party.

Mr. George Beattie (instructed by Messrs. Clyde and Company) held a watching brief on behalf of the cargo interests.

Mr. C. McGregor (instructed by Messrs. Neil, Maclean and Company) held a watching brief on behalf of the National Union of Seamen.

1. The explosion the subject of this investigation occurred when the "Capetown Castle" was approaching Las Palmas in the course of a voyage from Capetown to Southampton and resulted in the loss of seven of the engine room staff and serious injuries to seven others. Those who died included the chief engineer and the senior second engineer (who were at the starboard and port engine controls respectively) and the first engineer and junior second engineer.

2. This tragic loss of life has naturally made the investigation of the explosion a difficult one and the conclusions the Court has made are to a considerable extent conjectural.

3. It is unnecessary to include in this report full particulars of the structure of the "Capetown Castle" but the details of her engines have to be examined in full.

4. The "Capetown Castle" is a steel twin screw motor vessel of 27,001.61 tons gross 702.9 feet in length and 82.5 feet in beam.

5. The twin screws are each coupled direct to a double acting two stroke cycle diesel engine of 10 cylinders, 660 m.m. bore and 1500 m.m. stroke; built by Harland and Wolff Limited, Belfast in 1938.

6. The main engines are arranged to operate on boiler oil, which, after passing through a system of heaters, purifiers and clarifiers, is raised to a temperature of about 180 degrees fahrenheit. Two fuel valves are situated at the ends of each cylinder and are supplied with fuel by a fuel pump, operated by a camshaft, chain driven from the main crankshaft through a clutch. At sea oil is delivered to the high pressure fuel pumps by an engine driven low pressure pump. For engine manoeuvring purposes on "stand-by" duty oil is supplied by an electric surcharge pump at about 35 pounds per square inch.

7. Main and exhaust pistons are oil cooled from the same system as the lubricating oil, whilst the jackets are fresh water cooled. The engine has straight through scavenging by air at a pressure of about 2½ pounds per square inch delivered by independently driven blowers. The air is introduced to the cylinders through ports uncovered by the main pistons. Exhaust is controlled by exhaust pistons arranged to reciprocate together by eccentrics on the crankshaft.

8. Each cylinder unit is fitted with four fuel valves, two relief valves and two air starting valves.

9. The starting air system consists of a ring main of 5 inch bore solid drawn steel pipes connecting 4 air reservoirs, three of which are of 800 cubic feet capacity and one of 350 cubic feet capacity each being fitted with fusible plugs, pressure gauge, drains, relief and stop valves. These reservoirs are supplied from three motor driven 3 cylinder two stage air compressors delivering through a common 1½ inch bore line into the 5 inch ring main. These compressors are situated in the generator room. The pipe lines are then led aft between the main engines to their respective air stop valve.

10. A cross-over valve is fitted to a vertical loop joining the two pipes to the engines. From the engine air stop valves, air is led to an automatic valve and thence to two distribution pipes on each engine connecting with the top and the bottom cylinder air starting valves respectively. Operation of the automatic valves is controlled by the regulating levers at the engine platform which operate pilot valves. These vented the top of the automatic valve pistons to a silencer situated below the engine floor plates. Air is also admitted to the distributor valves thereby pressing their tappets on to the particular set of actuating cams, either ahead or astern, as determined by the position of the reversing lever. One or more of the cams are always in a position to allow air to pass from the distributor valve to the top of the pistons in the cylinder air starting valves so operating them and allowing air to enter the engine cylinders and causing the engine to revolve on air. Each branch from the ring main to the air starting valves is fitted with an emergency bursting disc.

11. Upon further advance of the regulating lever the pilot valve is tripped and pressure air is again admitted to the top of the automatic valve piston thereby closing the valve. Air in the cylinder air starting valve and distributor pipe lines is exhausted to the silencer and the distributor tappets lifted clear of the cams by means of springs. The further advance of the regulating lever also causes the fuel pumps to be set on the delivery position ready to be operated by their respective cams. Each cylinder has two automatic fuel valves top and bottom operated by the fuel pressure. At a pre-determined point the fuel is after-spilled at the fuel pump from the helical edge of the groove in the plungers. A separate fuel pump is provided for each end of each cylinder.

12. The system of draining the air distributor lines supplying the top and bottom cylinder air starting valves consists of separate drain pipes fitted to the bottom of the tee-piece castings forming the union between the engine air main and their branches to the starting valves. The top and bottom drain pipes are connected together through a four way branch piece. The bottom connection from this branch piece leads downwards to a shut off cock slightly above the lower engine platform level. A further extension or tail pipe is fitted. One leg of the four way branch piece was formerly used for drainage direct from the lower cylinder air starting valve, but at sometime in the past had been discarded. These drain pipes are of copper having an internal diameter of ⅛ inch.

13. As will be seen hereafter the drain pipes on the port engine were of considerable importance in the investigation of the explosion.

14. The air distributor camshaft is driven at engine speed from the main engine, the "ahead" or "astern" position of the camshaft being determined by the position of the reversing lever.

15. Air cross connections are also fitted in the auxiliary machinery room for starting the diesel generators and for charging two air bottles. These air bottles could also be charged by a steam driven emergency air compressor in the engine room. Air is also used to operate two Typhon whistles and one organ whistle and one or more air reservoirs are therefore always in use while the vessel is at sea.

16. The "Capetown Castle" left Capetown on 7th October, 1960 carrying 285 passengers and a crew of 359 with general and refrigerated cargo and mail and bullion.

17. The voyage towards Las Palmas appears in general to have been a normal one so far as the engine room was concerned. This is subject to comments hereafter in paragraphs 33, 35 and 36 with regard to clearing the starting air line drains described in paragraph 12 above.

18. At about 3.0 a.m. 17th October 2 hours' notice of arrival at Las Palmas was given from the bridge to the engine room. At 4.41 a.m. the engines were rung "stand-by" followed by stop at 4.48 a.m. At 4.49 a.m. half astern on both engines was ordered and about half a minute later an explosion occurred in the engine room.

19. From a reconstruction afterwards of what happened the Court has come to the conclusion that following on the explosion a sheet of flame swept down the engine manoeuvring platform and elsewhere causing extensive burns which proved to be fatal to the chief engineer, the first engineer, the senior and junior second engineers, two junior engineers and a greaser.

20. After the explosion the vessel was brought to anchor and thereafter fires in the engine and

appliances. All fires were extinguished by 5 p.m. The injured men and all the passengers were disembarked during to forenoon.

21. On the following afternoon the "Capetown Castle" was taken into the inner harbour by tugs and moored alongside in berth.

22. That evening in circumstances of great difficulty owing to the state of the engine room with little lighting an inspection was started of the engine room by a Senior Engineer and Ship Surveyor of the Ministry of Transport and the head of the Research and Technical Department of the British and Commonwealth Shipping Company Limited (the holding company of the owners of the vessel) both of whom had flown out from England. It is fortunate that their presence on the spot had been made available because they were able to collect data which was very valuable in the reconstruction of events.

23. Within a few days after their arrival they had formed the definite conclusion that the explosion had started in the port engine and with this conclusion the Court concurs.

24. There were a number of factors leading to this result. In the first place much more damage occurred in the port engine than in the starboard engine. Many of the bursting discs had blown or ruptured on the port engine whereas none had gone on the starboard.

25. In these circumstances the Court thought it right to concentrate on an examination of the possible causes of the explosion as the experts had done.

26. It is clear from the damage that the main explosion must have happened outside the engine cylinders and was confined in the main to the air starting lines.

27. The difficulty throughout has been to isolate a cause or causes which could account for the initial explosion which must have been reproduced and magnified almost immediately afterwards along the whole starting air line range.

28. After a careful consideration the Court has come to the conclusion that the initial explosion must have been due to the presence of oil in quantity of four fluid ounces (half a teacup) upwards which had accumulated in the air line in or near an air starting valve.

29. There are four possibilities as to the nature of this oil:—

(*a*) Fuel oil.

(*b*) Compressor oil.

(*c*) Duplex valve lubricating oil, and

(*d*) Oil from a pressure pump which had been used to clear the drains as described hereafter.

30. There is no evidence that the engine moved when the control lever was put on to "start" on receipt of the astern movement order and as the engines had not been put on to fuel the Court considers that fuel oil (*a*) can be excluded.

duplex valves were open. These valves only open when the engine is put on "start," and remain open only for a matter of some seconds before they shut again when the engine is put on "Fuel." During this time air is rushing through the system and conditions do not seem suitable for any settling out of entrained oil. Certainly a blast of air which is mild enough to allow entrained oil to settle out on one occasion is unlikely to pick up that oil and carry it through to a cylinder on another occasion. Compressor oil is therefore excluded as a source of the initial explosion but it is clear that there must have been a film of oil in the air starting lines which had been drawn in from the compressors. It was stated by the experts that the presence of such oil in the lines was undesirable though difficult to prevent and with this opinion the Court agrees and steps have been taken after the disaster by the ship owners towards its elimination. Such oil however by itself would not have led to an explosion and only becomes of importance after the initial explosion as described later in paragraph 37.

32. With regard to (*c*) on the evidence there does not seem to have been enough oil admitted by lubrication of the automatic valves for it to have been responsible for the explosion unless there had been gross over lubrication, a finding of which would not be justified.

33. The Court was therefore forced to a conclusion that although there was no direct evidence that oil had got into the air lines through the use of a pressure pump there was evidence from which this could be inferred. Moreover there is nothing inherently improbable about this theory as there is with the other three suggestions just considered.

34. It is therefore necessary to consider the position with regard to these drain lines in some detail.

35. There is no doubt that they were liable to become choked due to deposits emanating from defective and leaking air starting valves. So much choking occurred that a routine for proving them clear was laid down in a watchkeeping work list for the northbound voyage. This routine does not appear to have been carried out regularly—indeed it appears to have been regarded by some of the junior engineers as only work which had to be completed by the end of the voyage.

36. There does not appear to have been any settled practice as to how the work of clearing the lines was to be done and in consequence an improper practice had grown up in some cases of clearing the drains by means of a portable oil pressure pump. The primary use of this pump is in connection with an hydraulic jack for the tightening down of the main engine tie bolt nuts, lubricating oil being used as the pressure medium. The use of this pump for the purpose of clearing the drain pipes was never intended. Had these pipe lines been disconnected above and below where the pump was connected up no harm would have been done but the Court is satisfied that in some instances the pump must have been used in such a way that owing to the lower part of the line being blocked oil was forced upward by the pump into one or other of the air starting lines.

37. Having reached these conclusions the Court is of opinion that the following could be taken as a brief sequence of events which may have led to the explosion although as stated in paragraph 2 this opinion must be regarded as to a considerable extent conjectural.

Oil, in quantity of at least four fluid ounces (half a tea-cup) from the force pump that was used for clearing drain pipes was retained in the air starting system of the port engine, in or near to an air starting valve. When the port manoeuvring lever was moved to "start" the air start valve opened and highly turbulent air entrained the oil, sweeping it into the cylinder, acting to some extent like an air blast atomizer. The mixture of oil and air ignited as a result of high temperatures in the cylinder at some point remote from the starting air valve. This ignition first expelled a mixture of unburnt oil and air into the open line through the valve, then the explosion flame propagated from the source of ignition through the cylinder and out through the starting valve into the pipeline, there consuming the explosive mixture that had just been expelled. The flame accelerated and initiated a film detonation involving compressor oil in the main air pipe-lines (see paragraph 31). The detonation waves when reflected at the extremities of the system, or at T-junctions, produced very high instantaneous pressures (in some way akin to a "water-hammer" effect) and caused severe damage at these places. Rupture of the connections to the port aft air receiver caused the air in the receiver to be discharged directly at the back of the port engine, passing between the cylinders and swirling down over the manoeuvring platform. Flames associated with this discharge caused the casualties in the engine room. Fires in the generator room were likewise caused when the port forward air receiver connections were ruptured.

38. The theory which the Court has accepted as to the development of the original explosion by an "oil film" explosion was put forward by Dr. J. H. Burgoyne an expert on fires and explosions. He agreed with the way in which the initial explosion might have occurred as set out above.

39. The Court is of opinion that the explosion was of such a nature as is unlikely to recur.

40. There are however various precautions which should be taken:—

(*a*) Special steps should be taken to prevent the use of a pressure oil pump for clearing the drain lines.

(*b*) The drain lines might well be larger in diameter so as to prevent as far as possible their getting choked and extra drain lines should be fitted at points where there is any possible accumulation.

41. The phenomenon of film explosions or detonations is little understood and there are gaps in the information available on the subject. In particular further research appears to be desirable upon:—

(*a*) the conditions necessary for the initiation of such an explosion; and

(*b*) the extent to which the propagation of the explosion is influenced by the quality of the oil of which the film is composed.

42. The information at the disposal of the Court is insufficient to allow of any expression of opinion as

43. It is only necessary to add that temporary repairs were carried out at Las Palmas and the "Capetown Castle" left on 11th November, 1960 for Southampton where she arrived on 16th November, 1960. So well had the repairs been carried out that twenty-four hours after leaving Las Palmas it was found possible to re-start the port engine which remained in use for the remainder of the voyage.

QUESTIONS AND ANSWERS

Q. 1. (*a*) By whom was the m.v. "Capetown Castle" owned on the 17th October, 1960?

(*b*) How long has the vessel been so owned?

(*c*) Who was her designated manager on the 17th October, 1960?

A. (*a*) The Union Castle Mail Steamship Company Limited of 4 St. Mary Axe, London.

(*b*) Since she was built in 1938.

(*c*) Reginald James Bloxam of 4 St. Mary Axe, London.

Q. 2. (*a*) By whom was the vessel built?

(*b*) By whom were the engines designed, built and fitted?

A. (*a*) Harland and Wolff Limited of Belfast.

(*b*) Harland and Wolff Limited of Belfast.

Q. 3. Where and when was the vessel built?

A. Belfast 1938.

Q. 4. Was the vessel disabled by an explosion in the main machinery space on the 17th October, 1960?

A. Yes.

Q. 5. If the answer to question 4 is in the affirmative, where was the vessel at the time of the explosion?

A. Approaching Las Palmas.

Q. 6. (*a*) When and where did the vessel last leave port before the explosion occurred?

(*b*) Was the vessel in good and seaworthy condition when she last left port?

A. (*a*) 2.30 p.m. G.M.T. 7th October, 1960 from Capetown.

(*b*) Yes.

Q. 7. (*a*) Did the life-saving and fire fighting appliances carried on the vessel comply with the statutory requirements and had they been properly maintained?

(*b*) What fire drills were carried out on the voyage?

A. (*a*) Yes.

(*b*) The normal fire drills were carried out.

Q. 8. Did the vessel carry a crew of 359 hands all told and 285 passengers?

A. Yes.

Q. 9. (*a*) How many persons lost their lives as a result of the explosion?

(*b*) How many persons were injured as the result of the explosion?

A. (*a*) Seven.

(*b*) Seven.

Q. 10. On notice of pending arrival in port being given to the engine room, what action was taken in the engine room?

A. Upon receipt of a two hour notice of arrival at Las Palmas as from 3.0 a.m. 17th October, 1960, Nos. 9 and No. 3 units starboard bottom air starting valve branch pipes were replaced. Telegraphs were tested and clocks corrected at 3.48 a.m. Cochran boilers were flashed up and steam raised to a pressure of 75 pounds per square inch.

Q. 11. At what time was "stand-by" rung in the engine room, and what action was taken in the engine room?

A. At 4.41 a.m.

The normal procedure of calling stand-by engineers and others and other normal action was taken.

Q. 12. Who was in command in the engine room at this time?

A. The chief engineer Mr. S. Logan.

Q. 13. Who were at the engine controls?

A. The chief engineer at the starboard engine controls and Mr. Cameron, senior second engineer, at the port engine controls.

Q. 14. What engine movements were ordered between the "stand-by" order and the explosion?

A. Half ahead at 4.43 a.m.

Slow ahead at 4.44 a.m.

Dead slow ahead at 4.46 a.m.

Stop both engines at 4.48 a.m.

Half astern both engines at 4.49 a.m.

Q. 15. At what time did the explosion occur?

A. About 4.49½ a.m.

Q. 16. Had the engine order of half astern at 4.49 a.m. been executed when the explosion occurred or if not what was the state of the engines?

A. No, but the order was in the course of being carried out.

Q. 17. Where did the explosion occur?

A. In the air starting system. This matter is developed in the Annex.

Q. 18. (*a*) What explosive media were involved?

(*b*) How did such explosive media come to be present?

A. (*a*) See Annex.

(*b*) See Annex.

Q. 19. (*a*) What was the means of ignition of such media?

(*b*) What was the nature of the propagation of the explosion?

(*c*) What was the cause of the explosion?

A. (*a*) See Annex.

(*b*) See Annex.

(*c*) See Annex.

Q. 20. Had the main engines of the vessel given satisfaction during the present and previous voyages?

A. In general yes.

Q. 21. Had any explosion similar to that which is the subject of the investigation occurred on board the vessel previously?

A. No.

Q. 22. (*a*) Did fires break out in the machinery spaces following the explosion?

(*b*) What steps were taken to extinguish the fires in the machinery spaces?

(*c*) Were these proper and adequate steps?

A. (*a*) Yes.

(*b*) Fire extinguishers were used as far as possible, small fires were damped out and finally the engine room spaces were sealed and C.O.2 was turned on.

(*c*) Yes.

Q. 23. (*a*) What steps were taken to assist the engine room personnel?

(*b*) Were these proper and adequate steps?

A. (*a*) and (*b*) All possible steps were taken to assist the engine room personnel.

Q. 24. (*a*) What steps were taken to ensure that no personnel were in the machinery space before C.O.2 was introduced therein?

(*b*) Were these proper and adequate steps?

A. (*a*) Searches and checks of the engine room personnel were carried out as far as possible.

(*b*) Yes.

Q. 25. Were the passengers transferred to the "Windsor Castle" and then ashore for the purpose of being carried on?

A. Yes.

KENNETH CARPMAEL, *Judge.*

We concur

J. R. C. WELCH
IVOR J. GRAY } *Assessors.*
ALUN THOMAS

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