MARINE OCCURRENCE REPORT

EXPLOSION IN THE MAIN ENGINE EXHAUST SYSTEM OF THE PANAMANIAN CONTAINER SHIP "CAPE CHARLES" WHILE ALONGSIDE AT CERES CONTAINER TERMINAL, HALIFAX, NOVA SCOTIA

30 DECEMBER 1996

REPORT NUMBER M96M0178

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Explosion in the main engine exhaust system of the Panamanian container ship "CAPE CHARLES" while alongside at Ceres Container Terminal, Halifax, Nova Scotia

30 December, 1996.

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Summary

While preparing the vessel for departure, the main engine was pre-lubricated, blown through and started in the astern mode. As the engine fired, an explosion occurred in the upper section of the exhaust system. There was resulting damage to the economizer lower hopper and the main engine exhaust pipe rain-cap and a cloud of soot was ejected from the stack top. The exhaust pipe rain-cap landed on the upper deck of the vessel. The engine controls were immediately moved to the stop position following the explosion. There were no injuries, nor was there any pollution. Minor damage occurred to the vessel's main engine exhaust system and extensive damage occurred to the rain cap.

Ce rapport est également disponible en français.

Other Factual Information

Particulars of the Vessel

Name:	"CAPE CHARLES"
Port of Registry:	Panama City
Flag:	Panama
Official Number:	8601381
Type:	Container
Gross Tons:	41,843
Length:	236m
Built:	1986, Imabari Zonen K.K., Marugame, Japan
Propulsion:	1 x 8 cylinder, Mitsubishi-Sulzer RTA84 Diesel, 24,126kW
Owners:	Silvanus Shipholding S.A. Panama

The Mitsubishi-Sulzer RTA84 fitted to the "CAPE CHARLES" is a two stroke, uniflow-scavenged, crosshead-type diesel engine with a bore of 840mm and a stroke of 2400mm. The engine uses 380 cst (centistoke) fuel at sea and during manoeuvring.

The cylinder liner lubricating oil, called Texaco TARO Special cylinder lubricant, is supplied to cylinder lubricating quills. The lubricating quills are arranged around the upper part of each cylinder from a cylinder-lubricating pump driven by oil from the main bearing oil system.

Under emergency running conditions, oil from the cross-head bearing oil system may be used to drive the cylinder lubricating pump by opening and adjusting a valve which by-passes the flow-regulating valve. In this case, either the engine operation or oil flow to the pump may have to be regulated to ensure correct cylinder liner lubrication.

The by-pass valve was reportedly found to be leaking slightly during post-explosion examination of the engine by the vessel's engineers. It was also reported that the cylinder lubrication storage tank contained about 230 litres less than it should have when checked after the explosion.

Exhaust gas from each cylinder flows into the exhaust manifold from where it enters the turbochargers.

Upon exiting the turbochargers, the exhaust gas flows into the starboard side of the economizer lower hopper. This hopper is a fabricated, open-topped metal box, approximately 3890mm high, which is 5371mm long at the top and 4081mm long on the bottom, and is 2620mm wide on the top and 2284mm wide on the bottom. The side and bottom plating is 4.5mm thick. A drain is fitted in the bottom plating.

The exhaust gas enters the exhaust gas heat exchanger and travels upwards for a distance of 8440mm, passing across the tube banks. The top of the exhaust gas heat exchanger is covered with a shaped transition piece 825mm high leading into the circular exhaust pipe. From the top of the exhaust gas heat exchanger the exhaust gas passes directly upwards through the exhaust pipe to vent via the rain hood at the stack top.

While underway, steam generated using the exhaust gas heat exchanger is utilized to supply domestic heating

needs, heat the heavy fuel oil and drive a turbo alternator set. In port, an oil-fired boiler is used to supply domestic and fuel heating needs. Electrical power is supplied by diesel generator sets.

During a follow-up visit to the vessel, while it was loading and discharging containers, the temperature in the economizer was noted to vary between 154°C in the lower section and 109°C in the upper section.

On 30 December 1996, while preparing to depart the Ceres Container terminal for sea, the main engine was pre-lubricated and blown through. There were no reports of any liquid exiting the indicator cocks while blowing through. The main engine was started in the astern mode from the Bridge control station.

Very shortly after the engine was started, a sharp, loud, noise was heard by those on the bridge wing. This noise was followed by a crash as the exhaust pipe rain hood landed on the upper deck of the accommodation block amid a cloud of soot and dust.

Post occurrence examination of the exhaust system revealed the following items. No damage was reported to the exhaust trunking attached to the main engine, nor to the turbo chargers. No damage to the exhaust gas piping between the turbochargers and the lower economizer hopper was reported.

Some damage to the exterior of the lower economizer hopper was reported. A noticeable bulging of the forward and after sides of the hopper was evident, and also a general displacement of the sheet metal covered insulation panels. A bulging of the hopper plating on the forward, after and starboard faces on the inlet side above the exhaust gas inlet level was reported.

On the interior, tears in the hopper bottom, up to 300mm in length at some locations where the internal stiffeners join the side plating, were reported. Various other tears in the plating and a slight bending of the internal angle bar stiffeners on the sides and bottom were also reported.

The interior was evenly coated with soot and showed no signs of flame impingement.

No visible damage to the exhaust gas heat exchanger pipes was reported. A slight displacement of some of the sheet metal insulation panels on the sides of the heat exchanger was found throughout its height.

There was a slight distortion of the heat exchanger plating generally.

An internal examination of the tubes of the exhaust gas heat exchanger was conducted after the inspection covers had been removed. The examination reportedly revealed that at approximately 2/3 height the tubes were clean of all the light soot that had been noted elsewhere.

The soot blowers showed no damage and, when tested in the presence of the class surveyor, operated normally.

Severe damage occurred to the exhaust rain-hood as a result of being ejected from the stack top and landing on the upper deck. The exhaust rain-hood has a mass of approximately 800kg.

During the time alongside while loading and discharging, routine planned maintenance is carried out by the engine-room crew.

Examination of the main-engine injectors, carried out after the explosion, reportedly revealed no abnormalities.

The ship staff alleged that the origin of the explosion was in the exhaust trunk before the turbo-chargers due to the ignition of accumulated cylinder-liner lubrication oil.

In a case involving a similar-sized vessel, where an economizer fire occurred, it was noted that the engine manufacturer had stated in a service letter that oil-wetted soot may ignite at temperatures as low as 150°C.

Analysis

During the time that the vessel was secured at the container terminal working cargo, pre-heat was maintained on the engine. Jacket water was circulated through the engine. Lubricating oil was continuously circulated to the main and crosshead bearings and fuel oil was continuously circulated through the fuel oil system.

Cylinder liner lubrication is not in operation during shut-down periods, as oil flow to the hydraulic motor driving the cylinder liner lubricating oil pumps is regulated according to engine fuel demand.

Under emergency running-conditions, oil from the cross-head bearing oil system may be used to drive the cylinder-lubricating pump by opening and adjusting a valve which by-passes the flow regulating valve.

The by-pass valve was reportedly found to be leaking slightly during the post-explosion examination of the engine by the vessel's engineers. It was also reported that the cylinder-lubrication oil storage tank contained about 230 litres less than it should have when checked after the explosion.

With the by-pass valve leaking and the engine stopped, oil would have been supplied to the cylinder lubricators. Depending upon the position of the piston within the cylinder, oil could have accumulated on the piston crowns.

Prior to starting the engine, the normal procedure is to open the indicator cock on each cylinder head and turn the engine over with the turning gear. An accumulation of fuel, oil or water in the cylinders would be

indicated by a spray from the indicator cock as the engine was turned over.

There were no reports of any liquid being sprayed out of the indicator cocks. This evidence indicates that there was no significant accumulation of any liquid in any of the cylinders prior to starting the engine.

With the by-pass valve open and the engine running, excessive cylinder-liner lubrication oil would have been supplied to the engine during the voyage from Europe to Canada. Oil vapour carry-over into the exhaust system would have occurred.

Given that there was no damage nor indication of a fire in the exhaust trunk, no overspeed of or damage to the turbochargers, the slight bulging and tearing of the lower hopper and no damage to any of the tubes in the economizer, then the main force of the explosion appears to have taken the path of least resistance, travelling upwards, and dislodging the rain hood on its way.

The physical evidence and the damage observed would indicate that the explosion was initiated at or near the top of the exhaust gas heat exchanger. Furthermore, this area was reportedly clear of the light soot that was in evidence throughout the rest of the exhaust system.

The lack of light soot suggests that this area had been subjected to the most intense heat and therefore was the seat of the explosion.

It was not possible to positively determine the source of the inflammable vapours.

Given the loss of 230 litres of cylinder liner oil, and given that the injectors were reported to be in satisfactory condition, then it is possible that some of the cylinder liner oil carried over into the economizer while the engine was running.

Ignition was caused, in all likelihood, by a spark carried in the exhaust gas stream when the engine was started.

Findings

1. An explosion occurred in the upper section of the economizer in the main engine exhaust gas system when flammable vapours in the upper section of the economizer ignited after the engine was started.

2. The force of the explosion was sufficient to eject the rain hood from the stack top and cause damage to the lower hopper.

3. It was not possible to determine the type of combustible material present in the exhaust system which ignited.

Causes and Contributing Factors

The explosion in the exhaust system of the containership "CAPE CHARLES" resulted from the ignition of flammable gases in the upper section of the economizer.

Action Taken

To prevent a re-occurrence, Univan Ship Management Ltd. has issued instructions to all its vessels fitted with Sulzer RLA, RLB and RTA series of engines that the by-pass valve is to be fitted with a locking device and that the integrity of the valve is to be inspected from time to time to detect possible leakages.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 04 June 1998.