Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT

M99F0023

ENGINE-ROOM FIRE

THE SELF-UNLOADING BULK CARRIER "NANTICOKE" AT 39°20' N, 072°22' W, WESTERN NORTH ATLANTIC OCEAN

20 JULY 1999

Canada

Marine Investigation Report

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Summary

On 20 July 1999, while proceeding from Camden, New Jersey, towards Trois-Rivières, Quebec, the self-unloading bulk carrier "NANTICOKE" experienced an engine-room fire. The crew briefly fought the fire with portable extinguishers and water prior to the engine-room being evacuated. The fixed halon firefighting system was released and suppressed the fire. Despite damage to the steering power and control system wiring, the vessel proceeded to New York City under its own power for repairs.

Ce rapport est également disponible en français.

Other Factual Information

	"NANTICOKE"
Official Number	383534
Port of Registry	Toronto
Flag	Canada
Type	Self-unloading bulk carrier
Gross Tonnage[1]	21,870
Length	222.46 m
Draught	Forward: 8.2 m Aft: 9.4 m
Cargo	28,745 tons of petroleum coke
Built	1980, Collingwood, Ontario
Propulsion	2 x Crossley - Pielstick 10 cylinder model 4SA diesel engines 7,870 kW total. Single variable-pitch propeller.
Generator Engines	Three MAK 6M287AK (1979), 970 kW at 900 r/min
Number of Crew	25
Registered Owners	Canada Steamship Lines, Montreal, Quebec

History of the Voyage

The "NANTICOKE" departed Camden, New Jersey, USA, on 19 July 1999 at 1930,[2] loaded with 28,745 tons of petroleum coke and a small amount of trimming ballast. During the 1200-1600 engine-room watch the following day, the watchkeeping engineer cleaned the forward fuel filter on the port generator as part of the preventative maintenance routine. At 1500 the watchkeeping engineer started the generator and tested the filter for leaks. At 1515 the chief engineer entered the engine-room and inspected the generators. Finding all temperatures and pressures normal, he proceeded to the control room. Soon after, the general alarm was sounded for a fire drill, the watchkeeping engineer was then relieved by the chief engineer and proceeded to his fire station.

During the fire drill, the chief engineer and mechanical assistant on watch remained in the control room from where the generator flat could not be seen. The fire drill ended at 1600 and the crew prepared for a pollution drill. In the engine control room, the chief engineer noted a

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[1] Units of measurement in this report conform to International Maritime Organization (IMO) standards or, where there is no such standard, are expressed in the International System (SI) of units.

[2] All times are EDT (Coordinated Universal Time [UTC] minus four hours) unless otherwise stated.

high cooling water temperature alarm from port generator cylinder No. 1. The chief engineer left the control room to investigate and discovered that the engine-room was full of smoke and the port generator was on fire. Upon returning to the control room, the chief engineer immediately sounded the general alarm and called the bridge to inform them that there was a fire in the engine-room. He then proceeded to shut down the port generator and isolate its fuel supply. The chief engineer donned a 10-minute escape hood and attempted to locate the mechanical assistant. Failing to find the mechanical assistant (who had already left the engine-room) the chief engineer returned to the control room; however, the control room was not equipped with an emergency exit. As a result the chief engineer, wearing a 10-minute escape hood evacuated the smoke-filled engine-room by following handrails to the engine-room exit door on the main deck. The starboard generator was left running to supply power to the vessel.

On the bridge, the master transmitted a security call followed by a Mayday, both of which were received and acknowledged by the United States Coast Guard in New York City.

The fire parties were standing down from the drill and were in the process of removing their protective fire suits when the general alarm sounded. Two crew members suited up again and entered the engine-room through the steering flat using Scott air packs. They attempted to fight the fire with CO_2 extinguishers but were driven back by the intense heat. Subsequently, a second team, consisting of the head tunnelman and an ordinary seaman, entered the engine-room with a charged fire hose. Setting the nozzle on fog, they managed to extinguish much of the fire before they were ordered out of the engine-room. At 1640 following a head count and ensuring that all of the engine-room vents were closed, the chief engineer discharged the Halon extinguishing system. By 1722 the fire was out and shortly thereafter the gangway doors were opened to ventilate the engine-room while a fire party stood by to guard against a re-ignition.

Attempts were made to get the vessel underway to New York City. However, due to damaged steering gear power and control electrical cables, no steering was available. The fire cut off power to the engine-room ventilation fans. The engine-room staff jury-rigged a temporary power supply to one steering motor and, using local control, managed to regain steering. As a consequence of the damaged ventilation fan wiring, the vessel proceeded on one engine, at reduced speed to New York City, arriving at 1500 on July 21.

At the time of the occurrence, the wind was from the northeast at 13 knots and seas were 1.5 to 2 m. Visibility was 8 nautical miles.

Generator Maintenance Work

The work performed on the port generator just prior to the fire was a 125-hour preventative maintenance routine. Included in this procedure was the requirement to disassemble and clean the secondary fuel filter, which had been in use during the past 125 hours of operation. In the case of the port generator, this was the forward filter.

The filter was cleaned without incident, and a new cover-sealing O-ring installed. However, the watchkeeping engineer encountered difficulty in obtaining a fuel-tight seal between the

cover and cover bolt. As no new spare copper washer gaskets were available on board, the existing copper washer was annealed and re-used.

Damage to the Engine-Room

Fire damage to the port generator was primarily to the upper front end in the area of cylinder heads Nos. 1, 2 and 3, secondary fuel filters, and accessories/wiring mounted on the front end of the engine. Electrical cables running in athwartships trays directly above the forward end of the port generator were extensively damaged, resulting in a loss of power to steering control, steering pumps, some ventilation fans, and engine-room lighting.

The fire damaged paintwork on the overhead directly over the port generator and on the port shell plating outboard adjacent to the port generator. The upper engine-room was extensively covered in soot.

Examination of the Port Generator

The port generator was examined by the TSB on the evening of July 21. The generator secondary fuel filters are located on the inboard forward end adjacent to valve cover No. 1. The generator secondary fuel filter selector cock was found in the forward filter position indicating that the forward fuel filter was in use at the time of the fire. Both the forward and aft filter bowls were extensively charred externally. The save-all under the fuel filters was full to within 3 cm of its upper edge with diesel oil. There was an indication that fuel had run down the starboard side of the engine under the filters.

Outboard of cylinder No. 1 are the exhaust collector pipes which lead to the turbocharger mounted on the forward end of the engine. No lagging or shielding was present on the exhaust pipes where they connected to the turbocharger. An indicator cock protruded from each cylinder head just forward and outboard of the valve covers.

A vertical, V-shaped soot pattern was present on the port generator exhaust uptake as well as a horizontal soot pattern on valve covers 1, 2 and 3, both originating in the vicinity of the exhaust manifold/turbocharger inlet area. Aft surfaces of the valve covers had been "shadowed" from the fire even though their top surfaces were burned and sooted. An area of "clean burn" damage was present on the cable tray directly above the fuel filters.

Aft Fuel Filter

Inspection of the aft filter revealed that the cover-retaining bolt was loose and that the cover could be moved vertically by 3 mm. The copper washer gasket used to seal the bolt/cover joint was stuck to the cover. Upon removing the aft filter cover, it was noted that the rubber O-ring, which seals the cover, had deformed plastic and had partially melted on the side facing the engine. Internally, the centre spindle rubber seal was partially distorted by heat, and the filter basket was discoloured, indicating it had been exposed to high temperature. The aft filter cover had a recess in its top surface into which the copper washer gasket fitted, a feature not noted on the forward filter cover.

Forward Fuel Filter

Inspection of the forward filter revealed that the cover was in place, with the centre retaining-bolt finger tight. The cover seal O-ring was melted for a distance of 3 cm on the side facing the engine, but was otherwise intact. Internally, the centre spindle rubber seal and filter basket were intact and showed no sign of heat damage. The filter bowl was two-thirds full of diesel fuel. File marks were present on the cover/bolt sealing surface and, unlike the aft filter, the cover/bolt surface was flat, with no recess.

Inspection of the centre and starboard generator engine secondary fuel filters revealed that the top covers were coated with diesel oil that appeared to have wept from the top cover bolt copper washer gasket.

Analysis

When a fire burns with high intensity, soot deposited on nearby surfaces is burned off, leaving a clean area. Such an area of "clean burn" was present on the bottom of the cable tray directly above and slightly inboard of port generator valve covers 1 and 2. The localized nature of the fire indicates that the most intense fire was centred in this area, which is also the general location of the fuel filters.

The vertical soot patterns on the exhaust uptake, the horizontal patterns on top of valve covers 4, 5 and 6, and the shadowing on the aft surfaces of the same valve covers, indicate a fire origin at the engine's port side, forward of cylinder head No. 1. The most probable high temperature ignition sources in this area are the indicator cock protruding from the cylinder head and the uncovered exhaust manifold connecting to the turbocharger.

Three sources of fuel were present in the vicinity of cylinder head No. 6. Lubricating oil was present beneath the valve cover. However, it was not under pressure and was contained by the cover itself. As the covers were intact and in place subsequent to the fire, lube oil can be ruled out as a source of fuel.

The two fuel oil filters mounted on the starboard upper side of the engine contain fuel under pressure of approximately one bar and are mounted on the same plane as the exposed exhaust manifold and indicator cock. Examination of the fuel filters indicated that the aft filter was extensively damaged internally. This indicates that the aft filter was not cooled by fuel flow and thus not in service at the time of the occurrence. It can, therefore, be ruled out as a source of fuel to the fire. Furthermore, the position of the fuel selector cock indicated that the forward filter was in service at the time of the occurrence.

At an unknown time before the occurrence, modifications had been made to the forward filter cover/bolt sealing surface, which removed the seating groove for the copper washer and left the sealing surface uneven and grooved with file marks. As a result, the watchkeeping engineer had experienced a problem obtaining a fuel-tight joint at the copper gasket sealing the cover to its securing bolt when he serviced the filter one hour before the fire. No new copper gaskets were available on board, so the existing copper gasket was annealed and re-used. Once a copper gasket has been deformed by use, it is more difficult to obtain a tight seal

for subsequent usage even if it has been annealed. The combination of the modified, uneven sealing surface and the re-use of the used gasket increased the risk of leakage once pressure was applied to the filter.

Under normal circumstances a liquid fuel would have to be above its flash point for vapours to form an ignitable mixture. However, in the case of spraying fuel, ignition can often occur at temperatures below the flash point provided a heat source above its ignition temperature is present. Therefore, the initial leak developed at the copper gasket and, due to the mounting position of the filter and lack of shielding between it and the engine, sprayed a fine mist of fuel onto the exposed indicator cock or exhaust manifold, both of which were above the ignition temperature of the fuel. As the fire progressed, it melted the main cover rubber O-ring on the forward filter, which then provided a large volume of pressurized fuel until the fire was discovered and the engine was shut down.

It is a common practice on merchant ships for the chief engineer to take over the engine-room watch during fire and emergency drills. This practice ensures continuity of watchkeeping during the drill and expeditious provision of emergency services (pumping, emergency power, electrical isolation) required by the emergency or drill.

During the drill, the chief engineer and mechanical assistant remained in the control room, the location of which does not provide a view of the port side of the engine-room including the port generator. Neither the chief engineer nor the mechanical assistant on watch had made a visual inspection of the engine-room between 1515 and 1600. As a result, the fire was able to establish itself well before being discovered.

Vessels built after 1 September 1984 are required to have the wiring for their duplicated steering power and control systems follow routes as widely separated as possible. This ensures that no “single point” damage can render the system completely inoperable. However, the “NANTICOKE” was built in 1980, before the new international regulations came into effect; the steering pump main power cables and the control wiring from the bridge ran together in a common cable tray past the port generator. Even though the fire was restricted to the area immediately surrounding the front of the port generator, routing the common cable tray that contained all of the steering systems resulted in the cables being destroyed. After the fire was extinguished, attempts were made to get the vessel underway to New York. However, due to fire damage to the wiring, no steering was available. This effectively disabled the vessel until an alternate source of electrical power was jury-rigged to the steering gear.

Findings

1. The bolt sealing surface on the forward fuel filter cover (port generator) had earlier been modified by removing the recess used to seat the copper washer. The surface was uneven and marred by file marks.

2. When the filter was serviced an hour before the fire, the copper washer was not renewed, as a spare was not available.

3. The port generator forward fuel filter was in service at the time of the fire.

4. The location of the forward fuel filter allowed leaking fuel to contact an adjacent, unshielded hot exhaust manifold and indicator cock.

5. No inspection rounds of the engine-room were made between 1515 and 1600, the time at which the fire was discovered.

6. Vessels built before 1 September 1984 were not required to have wiring for duplicated steering power and control systems in separated cable runs.

7. The fire extensively damaged the main power and control wiring for the vessel's duplicated steering systems, which ran together in a common cable tray above the generator.

Causes and Contributing Factors

The fire was caused by a leakage of fuel, which contacted an exposed exhaust manifold, from the forward fuel filter on the port generator. Contributing to the occurrence was the modification to the fuel filter cover, the re-use of the copper sealing gasket on the cover, the unshielded hot exhaust surfaces adjacent to the filter, and the less-than-adequate engine-room watchkeeping duty during the fire drill before the occurrence.

Safety Action

Safety Action by the Vessel's Owners

Notwithstanding that the "NANTICOKE" is the only vessel in the owners fleet with this model of generator, the owners have taken the following measures to prevent a recurrence:

- New top covers have been installed on all generator fuel filters.
- Metal shields have been installed between filters and adjacent hot exhaust surfaces to prevent contact in the event of filter leakage.
- The steering control and power wiring have been re-routed so that they do not pass over the generators' forward ends.
- An internal safety bulletin has been circulated to the entire fleet apprising them of the occurrence.

Safety Action Taken by the TSB

Marine Safety Advisory (MSA) 06/99 was sent to Transport Canada, Marine Safety (TCMS) indicating that, since 1 July 1999, four engine-room fires have occurred on board Canadian ships resulting from oil being exposed to hot exhaust surfaces. Although TCMS had previously issued information with respect to such occurrences (*Ship Safety Bulletin 13/85*), the risk of serious engine-room fires continues. Therefore, MSA 06/99 suggested that TCMS may wish to take additional measures to remind owners and operators of the dangers associated with combustible liquids near hot surfaces, and the importance of maintaining fuel/lube-oil and exhaust shielding/lagging in optimum condition.

In response, in June 2000 TCMS issued *Ship Safety Bulletin 8/2000* to the industry. The bulletin addresses the potential dangers that exist when equipment, (in particular fuel system components) is modified from its original configuration/specifications without the advice of the manufacturer or consideration of the hazards that may result from such modifications.

Safety Action Taken by Acomarit Canada Ltd.

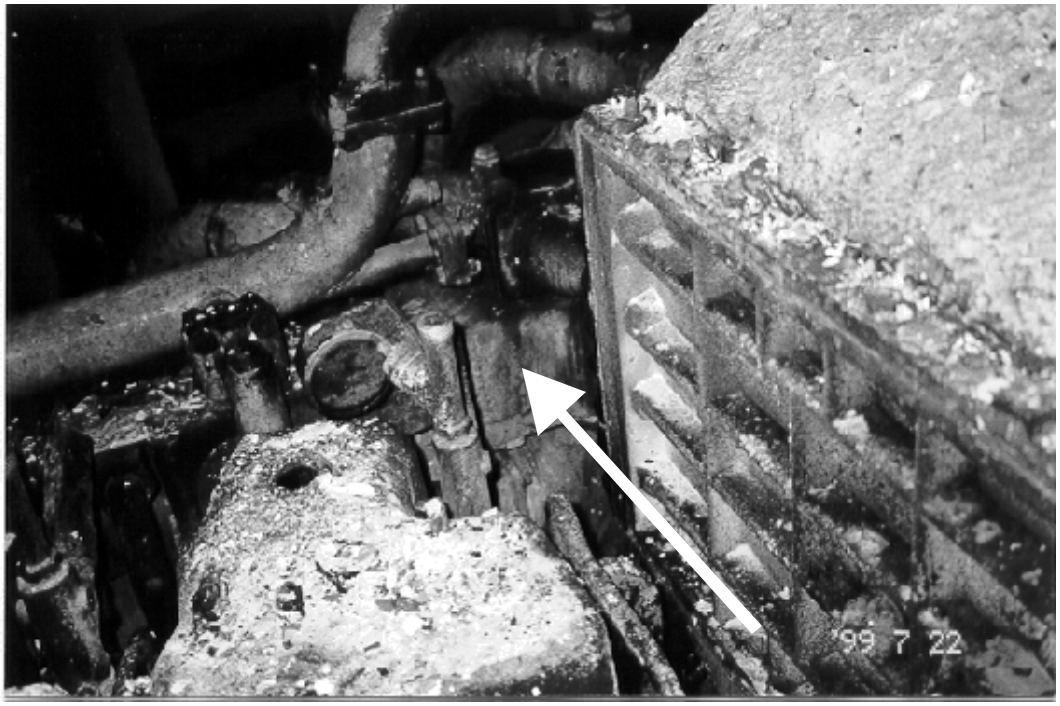
Subsequent to the occurrence, Acomarit Canada Ltd., the ship management company that is contracted to manage the Canada Steamship Lines fleet, circulated a letter to all chief engineers within the fleet stressing the importance of frequent engine-room rounds, including during drills.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 31 August 2000.

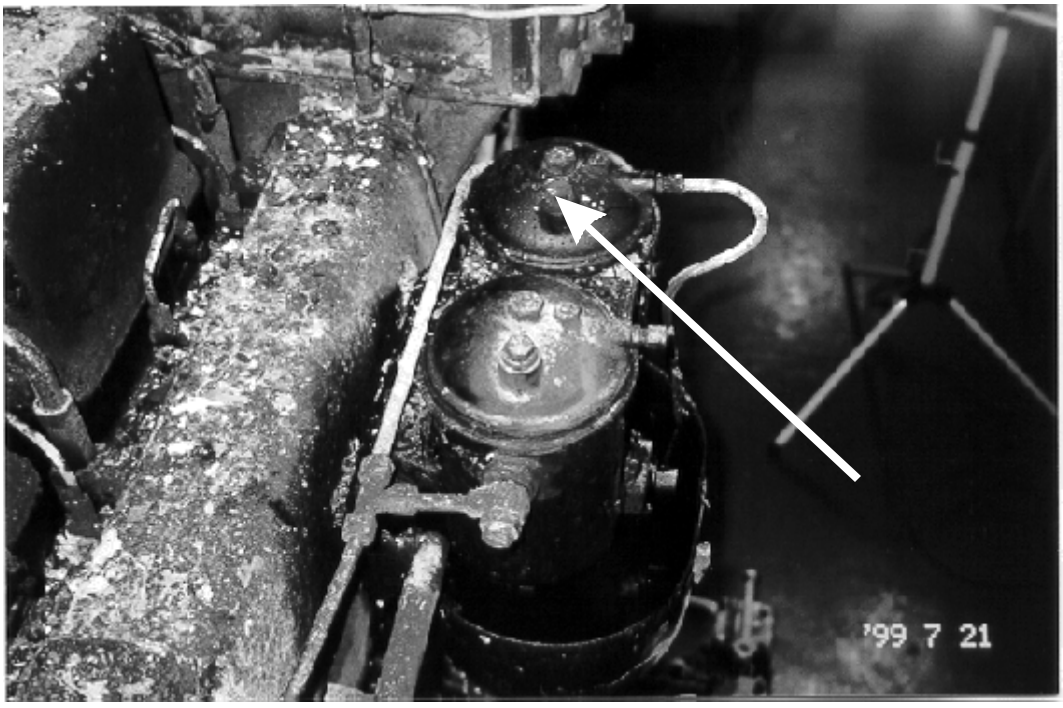
Appendix A - Photographs

HORIZONTAL CHARRING PATTERN POINTING TOWARDS
THE SEAT OF THE FIRE AT THE EXPOSED EXHAUST PIPING

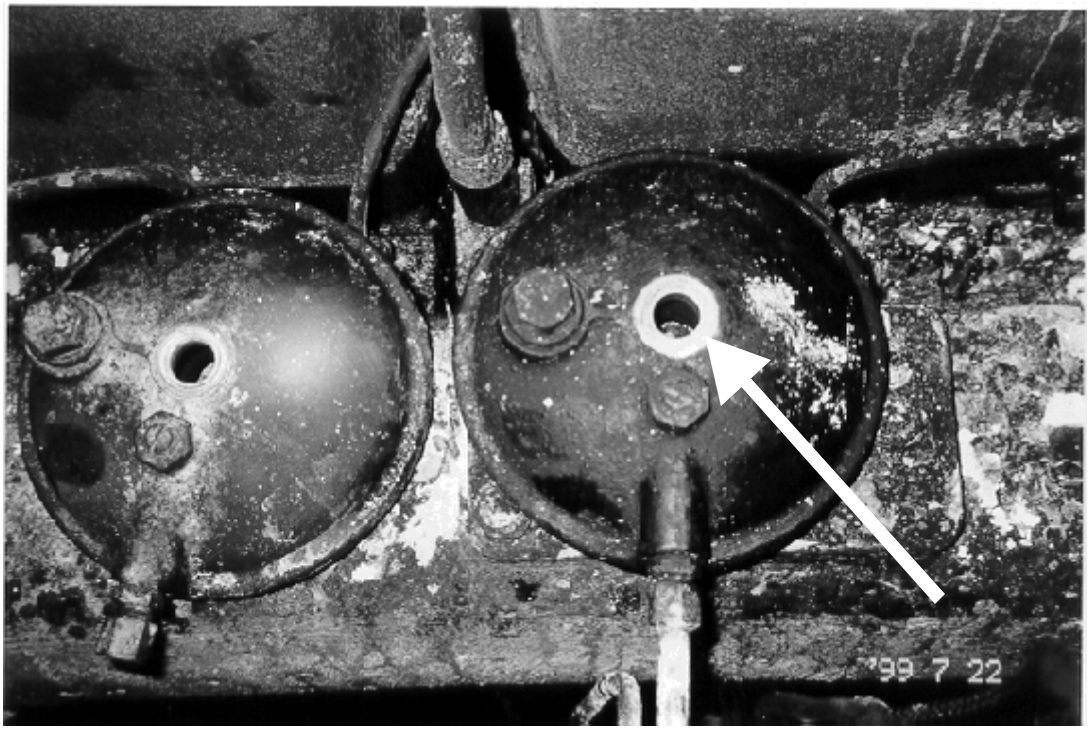
VERTICAL SOOT PATTERN INDICATING THE SEAT OF FIRE
NEAR EXHAUST MANIFOLD AT INLET TO TURBO-CHARGER



EXPOSED EXHAUST MANIFOLD ADJACENT NO. 1 CYLINDER HEAD



SECONDARY FUEL FILTERS ADJACENT NO.1 CYLINDER HEAD
ARROW POINTS TO INITIAL LEAKAGE POINT



COVER FROM FORWARD FUEL FILTER (RIGHT)
MODIFIED BY REMOVAL OF THE GASKET MOUNTING GROOVE