log # M-87-47&48

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 21, 1987

In reply refer to: M-87-47 and -48

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President
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About 1030 on October 28, 1986, explosions and fires occurred in the engineroom and starboard fuel oil tanks of the 811-foot-long U.S. tankship OMI YUKON which was en route from Hawaii to South Korea for scheduled vessel repairs and biennial inspection by the U.S. Coast Guard. At the time of the explosions, the tankship was located in the Pacific Ocean about 1,000 miles west of Honolulu, Hawaii, and was not carrying any cargo. There were 24 crewmembers, 2 U.S. welders, and 11 Japanese workers employed in cleaning the cargo tanks aboard the vessel. Four persons were killed; the other 33 persons safely abandoned the vessel and were later rescued by a Japanese fishing vessel. The estimated damage to the OMI YUKON was $40 million. The vessel was towed to Japan and sold for scrap. 1/

The fuel oil sampling and testing procedures as practiced by OMI Corporation (OMI), Hawaiian Independent Refinery, Inc. (HIRI), Caleb Brett, U.S.A., Inc., and the OMI YUKON's two chief engineers were not adequate for preventing fuel oil with a flash point below 140° F from being loaded aboard the OMI YUKON. The Caleb Brett surveyor, who was aboard the OMI YUKON on October 23, testified that neither Caleb Brett nor OMI provided him with any verbal or written instructions regarding the sampling of the fuel oil. The Caleb Brett surveyor took one fuel oil sample at the beginning of the first load of fuel oil on October 23, and a second sample at the beginning of the second load. He did not sample near the end of either load nor was he required to take a sample near the end of each load where the fuel oil was probably contaminated with low flash point oil products. There is a need for standardized sampling procedures of fuel oils loaded aboard vessels that will ensure that the entire load of fuel oil is within required specifications.

Coast Guard regulations require that the chief engineer of a vessel obtain a half-pint sample of each load of fuel oil, but the regulations do not require that the sample be tested or specify how the fuel oil should be sampled. Coast Guard regulations only state that the chief engineer must obtain the flash point of the fuel oil as certified by the producer. In the case of HIRI, the refinery tested the fuel oil in their storage tank several days before loading of the OMI YUKON began. These test results were then given to the chief engineer as certification of the fuel oil's flash point. The test results of samples of fuel oil taken while it was loaded were normally not forwarded to the chief engineer until after the fuel oil was used. The fuel oil sample retained by the chief

1/ For more detailed information, read Marine Accident Report--"Explosions and Fires Aboard U.S. Tankship OMI YUKON in the Pacific Ocean about 1,000 Miles West of Honolulu, Hawaii, on October 28, 1986" (NTSB/MAR-87/06).

engineer and any test results of the fuel oil actually loaded were normally used to settle contract disputes after the fuel oil had been used and not to determine whether the fuel oil had a flash point above 140° F. The OMI superintendent engineer stated it was OMI's policy not to have the fuel oil samples tested before the fuel oil was used aboard its vessels because it took too long to obtain the results. Because of the contaminated fuel oil loaded aboard the OMI YUKON at HIRI in April 1986, the two OMI YUKON chief engineers had changed their practice from loading fuel oil directly into the fuel oil settler tanks to loading fuel oil into empty fuel oil storage tanks before transferring the fuel oil to the settler tanks. However, they still used the fuel oil before obtaining any test results from HIRI of the fuel oil samples taken during loading.

Testing of fuel oil samples for flash point can be done quickly. On December 1, 1986, when the chief engineer of the ASPEN questioned the fuel oil being loaded aboard his vessel at HIRI, HIRI tested samples of the fuel oil in about 4 hours. This accident indicates the need for improved testing practices for boiler fuel oil being loaded aboard vessels. The National Transportation Safety Board believes that the Coast Guard should require not only that samples be taken but also require that the samples be tested to ensure that the fuel oil actually loaded aboard vessels meets Coast Guard safety requirements. In addition, OMI should require that all fuel oil samples be tested before the fuel oil is burned on its vessels to ensure the fuel oil meets their specifications and is safe to use, and that HIRI should develop sampling and testing standards for all fuel oil loaded aboard vessels to ensure that the actual fuel oil loaded is not contaminated with other products.

The presence of an explosive hydrocarbon gas/air mixture above the fuel oil in the starboard fuel oil storage tank was the result of loading of fuel oil at the HIRI refinery, Barbers Point, Hawaii, on October 23, 1986, that had a lower viscosity than that ordered, some of which even had a lower flash point than permitted for No. 6 fuel oil. The testimony of the HIRI superintendent suggests that there were two processes that could explain how a grade of fuel oil other than ordered by OMI was loaded aboard the OMI YUKON. These two processes were inadequate blending of the fuel oil before loading and mixing of the fuel oil with the flush oil used to push the fuel oil through the pipeline during the loading.

Records show that OMI ordered about 8,000 barrels of No. 6 fuel oil with a viscosity of 380 centistokes. Industry standards require that No. 6 fuel oil have a flash point greater than 150° F and Coast Guard regulations require that fuel oil for boilers have a flash point greater than 140° F. According to the testimony and records, the fuel oil was blended during the night of October 17 and 18, 1986, by starting with a fuel oil of 169 centistokes in shore storage tank No. 307. This fuel oil was combined with a residual oil with a viscosity of 12,000 centistokes to obtain a fuel oil of about 380 centistokes as requested. American Society for Testing and Materials (ASTM) standard D 4057 states that a tank which contains in excess of 15 feet of oil should be sampled at three levels (top, bottom, and middle) to determine how well the blend has been mixed. In this case, the tank contained a little over 8 feet of oil. It is not clear from the testimony and records if samples were collected at three levels or if the viscosity of each sample was measured before loading the OMI YUKON. HIRI records show that the viscosity of the material in tank No. 307 on October 18, 1986, was 358 centistokes at 122° F and the oil had a flash point of 260° F. However, the fuel oil samples taken during loading on October 23, 1986, showed a viscosity of 192 centistokes and a flash point of 196° F. The fact that only a single value was recorded from tank No. 307 on October 18 strongly suggests that either three samples were combined or that only one sample was collected.

In either event, it cannot be established from these measurements how well the tank was blended. In fact, it appears that the HIRI superintendent relied mostly on past experience to determine the degree of mixing and not on measurements.

The second process that could have caused the lower viscosity fuel oil was contamination of the fuel oil with a material with a considerably lower flash point when the fuel oil was loaded through the subsea pipeline on October 23. The fuel oil was pushed through the 30-inch pipeline with a lower viscosity flush oil. Initially, the HIRI superintendent stated that the HIRI policy was to put an excess of about 4,000 barrels of fuel oil into the subsea pipeline (2,000 barrels on either end of the fuel oil to be loaded) as an interface to prevent contamination of the fuel oil with the flush oil in front of and behind the fuel oil. However, when it was pointed out that at the end of each of the two fuel oil loading stages on October 23, there was probably 500 barrels or less of fuel oil present as an interface, the superintendent stated that 500 barrels on either end was adequate to ensure that the fuel oil loaded aboard the tankship remained uncontaminated. However, the superintendent did not know of any pipeline studies that had been done to determine the extent of mixing of fuels when a high viscous fuel is pushed with a low viscosity flush oil.

The fuel oil and flush oil were miscible, that is, the viscous fuel oil was soluble in the flush oil. Due to this solubility, pushing a very viscous fluid (358 centistokes) with a relatively light weight solvent will lead to an ill-defined interface between the two fluids, and mixing of the fluids at their interface will occur. The 30-inch pipeline contained about one barrel of oil per foot of pipe. It is doubtful that 500 barrels, which is equivalent to about 500 feet of pipeline, was sufficient to provide fuel oil uncontaminated by flush oil unless the location of the interface was well known. In the HIRI loading system, the location of the interface was not known, except by gaugings at the storage tanks ashore and by visual observations as the fuel oil was loaded aboard the tankship. Consequently, the decision by the chief engineer to load fuel oil in the OMI YUKON's fuel oil storage tanks on October 23, was determined by observation of the oil's color, texture, and smell as the oil came aboard the tankship via the subsea pipeline. The chief engineer did not determine whether the oil being loaded near the end of the first stage of loading, at the beginning of the second stage, or at the end of the second stage was proper fuel oil. In addition, in this particular loading operation, because of gauging errors, the fuel oil remained in the pipeline longer than normal, and the loading was done in two segments with flush oil separating the segments thus increasing the chances of intermixing and contamination. The Safety Board believed that HIRI should establish written instructions regarding the minimum amount of fuel oil required to act as an interface between fuel oil and other products to prevent mixing of other products into the fuel oil during the loading of fuel oil for vessels.

Therefore, as a result of its investigation, the National Transportation Safety Board recommended that the Hawaiian Independent Refinery, Inc.:

> Establish written fuel oil sampling and testing practices to prevent improper fuel oil from being loaded aboard vessels at HIRI. (Class II, Priority Action) (M-87-47)
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> Establish written instructions regarding the minimum amount of fuel oil required to act as an interface between fuel oil and other products to prevent mixing of other products into the fuel oil during the loading of fuel oil for vessels. (Class II, Priority Action) (M-87-48)

Also, as a result of its investigation, the Safety Board issued Safety Recommendations M-87-28 through -37 to the U.S. Coast Guard, M-87-38 to the American Bureau of Shipping, M-87-39 through -46 to the OMI Corporation, M-87-49 to Caleb Brett U.S.A., Inc., M-87-50 to the American Petroleum Institute, and M-87-51 to the Federal Aviation Administration.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility ". . . to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-87-47 and -48.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in these recommendations.

By: Jim Burnett
Chairman