log# M-339

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 21, 1987

In reply refer to: M-87-50

Mr. Charles J. DiBona
President
American Petroleum Institute
1220 L Street, N.W.
Washington, D.C. 20005

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 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 Hawaiian Independent Refinery, Inc. (HIRI), 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 Corporation (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,

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).

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 that occurred 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 if 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 laboratory test results of the fuel oil samples taken from the OMI YUKON's midship manifold, fuel oil piping leading to the fuel oil storage tanks, and fuel oil manifold in its lower engineroom after the explosions support the hypothesis that some of the fuel oil was most likely contaminated with the flush oil used for pushing the fuel oil. The fueloil samples collected from the deck piping system had a flash point of 22° F at the amidships manifold and 73° F at the after port fuel oil connection. These samples, especially the one at the amidship location, would be unaffected by the fire because of

the distance from the fire and the fact that the fuel oil remained in a closed system. Consequently, the high-vapor fraction of the fuel oil that accounts for the low flash point would have remained and not have been lost by vaporization into the atmosphere even if the pipe temperature increased from the fire. The fuel oil samples collected from the fuel oil tanks most likely had a lower flash point before the explosion and fires. The high vapor fraction of this fuel oil would have been burned off by the fires or driven off by the heat. Consequently, the samples taken from the fuel oil tanks were not representative of the fuel oil at the time of the explosion. Nevertheless, the fuel oil in the port settler tank had a flash point of 152° F as compared to a value of 196° F reported from the composite of two samples taken during loading. Thus, it is likely that the flash point of the fuel oil in the OMI YUKON's fuel oil storage tanks was below 150° F at the time of the explosion. The Safety Board believes that the American Petroleum Institute should publicize the danger of low viscosity oil mixing with high viscosity fuel oil during loading of fuel aboard vessels.

Therefore, as a result of its investigation, the National Transportation Safety Board recommended that the American Petroleum Institute:

> Publicize the danger of low viscosity (higher volatile) oil mixing with high viscosity (lower volatile) fuel oil during loading of fuel oil aboard vessels. (Class II, Priority Action) (M-87-50)

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 througoh -46 to the OMI Corporation, M-87-47 and -48 to the Hawaiian Independent Refinery, Inc., M-87-49 to the Caleb Brett, U.S.A., Inc., 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 recommendation in this letter. Please refer to Safety Recommendation M-87-50.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in this recommendation.

By: Jim Burnett
Chairman