

Log M-223  
SP-20

NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C.

ISSUED: October 12, 1983

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Forwarded to:

Mr. Peter Constas  
Vice-President  
Apex Marine Corporation  
2001 Marcus Avenue  
Lake Success, New York 11042

SAFETY RECOMMENDATION(S)

M-83-66 through -68

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On March 6, 1982, the 894-foot-long U.S. tankship SS GOLDEN DOLPHIN was en route in ballast from New Orleans, Louisiana, to Dubai, United Arab Emirates. Several crewmembers were replacing a section of the main deck steam piping; welding equipment and an oxygen-acetylene torch were used in the repairs. At the same time, five other crewmembers were cleaning one of the vessel's cargo tanks. About 1554, the first of several explosions occurred in the GOLDEN DOLPHIN's cargo tanks. An intense fire erupted and eventually engulfed the entire forward half of the vessel. On the following day, the vessel sank in the Atlantic Ocean about 900 nautical miles east of Bermuda. Nine of the vessel's 25 crewmembers died as a result of the explosions and fire. The GOLDEN DOLPHIN was valued at approximately \$29 million. 1/

The first explosion occurred while several crewmembers were repairing the deck steam piping at the No. 3 center tank. Shortly before the first explosion, one section of new 6-inch-diameter steam piping remained to be installed, and the 2-inch-diameter branch lines to the manifolds for the No. 3 tanks remained to be connected to that section of 6-inch-diameter piping. Since both an oxygen-acetylene torch and welding equipment were being used, it is evident that there were two possible sources of ignition. A Coast Guard expert concluded that the "most likely scenario" for the accident involved the filling of the main deck steam line through a leaking cargo tank steam line with a flammable gas mixture, the ignition of the flammable mixture by the oxygen-acetylene torch or welding arc, and the propagation of the resulting flame through the steam piping into a cargo tank. An expert hired by the vessel's operator believes that such a "continuous trail of flammable mixture" is "very difficult to accept on the balance of probabilities." However, numerous leaks in the GOLDEN DOLPHIN's steam heating coils had been found and repaired while the vessel was in a shipyard about 2 months before the accident. The large number of leaks in the steam heating coils, especially in the Nos. 1 and 2 tanks, attests to the deteriorated condition of the steam heating system. Although the initial leaks had been repaired, new leaks easily could have occurred after the vessel left the shipyard. Calculations performed by the Coast Guard expert show that a slight

1/ For more detailed information, read: "Marine Accident Report--Explosions and Fire on board the U.S. Tankship SS GOLDEN DOLPHIN in the Atlantic Ocean, March 6, 1982" (NTSB/MAR-83/07).

overpressure of a cargo tank as compared to the atmospheric pressure at the opening in the main deck steam piping would be sufficient to cause the tank atmosphere to flow into and fill the steam piping in a relatively short period of time. The tank temperature rise associated with the normal heating of a tank during the day would be sufficient to cause the slight tank overpressure. It is possible that an explosion occurred in this manner in any of the No. 1 and 2 cargo tanks. Since the 2-inch-diameter branch line to the No. 3 center tank manifold was to be connected to the main deck steam line, it is also possible that working on that branch line could have caused an explosion in the No. 3 center tank. Since the inert gas lines were open and easily could have been filled with a flammable mixture, it would have been possible for an explosion in one tank to propagate to any other tank containing a flammable mixture. It also would have been possible for explosions to propagate over the tank bulkheads when the pressure rise from one explosion lifted the main deck away from the bulkhead adjoining another tank. Explosions in adjoining tanks would not necessarily have been heard as distinct, individual sounds, so it is possible that the initial explosion was propagated by either or both of those mechanisms. Although possible sources of ignition existed both within the No. 4 center tank during the mucking operations and on the main deck at the No. 3 center tank during the steam piping repairs, the Safety Board concludes that the weight of the available evidence indicates that the initial explosion resulted from the ignition by a welding arc or oxygen-acetylene torch of flammable gases in the GOLDEN DOLPHIN's steam piping and the propagation of the resulting flame into a cargo tank.

The basic safety procedures to be observed while working on a tankship at sea are well established. Safety procedures are given in the International Safety Guide for Oil Tankers and Terminals (ISGOTT), Coast Guard publications, and the tank vessel regulations. However, the master and the chief mate did not follow numerous safety procedures which were applicable to the operations performed on the GOLDEN DOLPHIN during its last voyage. The tank vessel regulations require that the inert gas system on tankships such as the GOLDEN DOLPHIN be operated as necessary to maintain an inert atmosphere in the cargo tanks unless the cargo tanks are gas free. Since there was apparently no intent to gas free any tanks other than the Nos. 1 through 4 center tanks, the atmosphere in all of the other tanks should have been maintained inert. Although the master testified that he would not feel comfortable with men working in a tank adjacent to an inerted tank, adequate precautions to protect the crewmembers easily could have been taken. For example, the tank atmosphere could have been tested periodically for oxygen and hydrocarbon content, and the inert gas pressure could have been maintained slightly above the lower limit to minimize the possibility of leakage of inert gas through bulkhead cracks or defective pipelines or valves. Since the master wanted the Nos. 1 through 4 center tanks to be gas free while the hot work was in progress, the atmosphere in those tanks should have been tested periodically with a combustible gas indicator; alternatively, the tanks could have been inerted. Before commencing repairs to the main deck steam piping, the branch lines and steam heating coils should have been flushed with water or steam and should have been tested to ensure that they were gas free; alternatively, they could have been isolated from the main deck steam line with blanks. Since the inert gas system was not in use, the valves in the inert gas lines to each tank should have been closed to isolate the tanks from each other. If the master and the chief mate had followed these basic safety procedures, the accident might have been prevented.

The Code of Federal Regulations at Title 46, Chapter I, Subchapter D contains the U.S. Coast Guard regulations for tank vessels. Section 35.01-1 of the regulations indicates that repairs involving welding or burning on pipelines connected to cargo tanks must be preceded by an inspection to determine that the repairs can be undertaken with safety. In U.S. ports, the inspection is made by a marine chemist certificated by the

National Fire Protection Association (NFPA), and a "Marine Chemist's Certificate" is issued to indicate the condition of the spaces inspected and the requirements necessary to maintain safe conditions. At sea, the inspection is made by "the senior officer present" and, although an entry should be made in the vessel's logbook, no certificates are required to be issued. NFPA Standard No. 306, "Standard for the Control of Gas Hazards on Vessels to be Repaired," should be used as a guide in conducting the inspection. The standard provides minimum requirements and conditions to be used to determine if a space or area on a vessel is safe for hot work. The master testified that there was no copy of NFPA Standard No. 306 on board the GOLDEN DOLPHIN.

The ISGOTT contains recommendations for the safe operation of tankships. Subjects such as approval for hot work, gas freeing, and operation of the inert gas systems are thoroughly discussed. The ISGOTT indicates that consideration should be given to requiring "hot work permits" on tankships at sea to authorize the work to be done and to specify the area involved, the time permitted, the tools and equipment to be used, and the special precautions required. If the master of the GOLDEN DOLPHIN had been required to issue a hot work permit, he probably would have become more involved with the requirements for safely conducting the steam piping repairs. Additional safety measures might have been taken, and the accident might have been prevented.

Therefore, the National Transportation Safety Board recommends that Apex Marine Corporation:

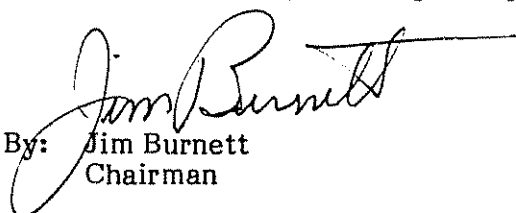
Require each officer assigned to an Apex Marine Corporation vessel to satisfactorily complete a formal training program which includes instruction in the operation and use of inert gas systems and crude oil washing systems and in the safety procedures to be followed when hot work is performed at sea. (Class II, Priority Action) (M-83-66)

Amend Apex Marine Corporation's "Vessel Instruction Manual" to require that the master issue a "hot work permit" specifying the work to be conducted and the requirements necessary to maintain safe conditions when hot work is to be conducted at sea. (Class II, Priority Action) (M-83-67)

Provide each Apex Marine Corporation vessel with at least one copy of the National Fire Protection Association Standard No. 306, "Standard for the Control of Gas Hazards on Vessels." (Class II, Priority Action) (M-83-68)

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" (P.L. 93-633). The Safety Board is vitally interested in any actions taken as a result of our safety recommendations. Therefore, we would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and ENGEN, Member, concurred in these recommendations. McADAMS and BURSLEY, Members, did not participate.

  
By: Jim Burnett  
Chairman