National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: Sep 24, 2001

In reply refer to: M-01-19 through -23

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The National Transportation Safety Board (Safety Board) is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

The recommendations address the following safety issues: the adequacy of inspection and maintenance procedures for electrical systems; the adequacy of management's safety oversight of maintenance procedures; and the adequacy of firefighting procedures. The recommendations are derived from the Safety Board's investigation of the fire on board the U.S. passenger ferry *Columbia* in Chatham Strait, near Juneau, Alaska, on June 6, 2000, and are consistent with the evidence we found and the analysis we performed.[1] As a result of this investigation, the Safety Board has issued five safety recommendations, all of which are addressed to the Alaska Marine Highway System (AMHS). The Safety Board would appreciate a response from you within 90 days addressing actions you have taken or intend to take to implement our recommendations.

About 1207, Alaskan daylight time June 6, 2000, a fire broke out in the main switchboard in the engine control room aboard the ferry *Columbia*. The ferry, with 498 people on board, was underway in Chatham Strait, about 30 nautical miles southwest of Juneau, on a regularly scheduled voyage from Juneau to Sitka, Alaska. About 1425, the fire was extinguished with the assistance of U.S. Coast Guard personnel from a responding Coast Guard cutter. Three passengers were evacuated by Coast Guard helicopter because of medical conditions that preexisted the fire. All of the other

[1] For further information, read: National Transportation Safety Board, *Fire On Board the U.S. Passenger Ferry* Columbia*, Chatham Strait, near Juneau, Alaska, June 6, 2000*, Marine Accident Report NTSB/MAR-01/02 (Washington, DC: NTSB, 2001).

passengers were safely transferred to another AMHS ferry and were returned to port without further incident. No injuries or deaths resulted from the fire. The AMHS estimated the damage to the *Columbia* to be about $2 million.

The Safety Board determined that the probable cause of the fire on the *Columbia* was the absence of an effective maintenance and inspection program for the electrical switchboards, resulting in a switchboard fire by arcing, most likely due to a faulty connection or a conductive object.

That mechanical vibrations and thermal cycling gradually loosen electrical connections is well known. However, investigators found no evidence that the integrity of the switchboard's electrical connections had been inspected during the last 5 years, despite the switchboard manufacturer's recommendation that an inspection be done, at a minimum, every year or during vessel overhauls. In addition, although vessel crewmembers had used an infrared thermographic inspection program to detect faulty electrical connections, they had never used the program to inspect the switchboard's internal electrical connections. Therefore, a faulty connection within the switchboard could have developed and remained undetected for a considerable period of time.

A faulty connection could also have resulted from prior work on the ship. Before the accident, during a shipyard overhaul, the *Columbia*'s main switchboard was modified to support the installation of new rescue boats. The work required that shipyard workers open the switchboard to add electrical connections and, in the process, disturb the connections that were already in place. The AMHS representative did not supervise this work or inspect it upon its completion. In addition, the ship's crew did not check the integrity of the electrical connections, either manually or thermographically. The modification work, therefore, could have created a faulty connection that would not have been detected by the owner's representative or the vessel's crew.

Another likely scenario is that a conducting object caused a short circuit connection between two phases in the distribution section of the electrical system. Any conductive object, such as a metal tool or a bolt, as well as a conductive liquid, such as seawater, could have created a conductive path. Electricians possibly inadvertently left a metallic object inside the switchboard during the last shipyard overhaul. Such a mistake would not have been detected because the owner's representative did not inspect the electricians' work. It is also possible that a conductive object had been left in the switchboard during some previous work period and remained undetected.

As mentioned earlier, the *Columbia*'s main switchboard had not been inspected thermographically during the past 5 years. Infrared thermographic inspection of electrical equipment is recognized as an important tool in locating improper connections and preventing switchboard fires. Infrared imaging of the switchboard could not be readily performed because its design arrangement prevented a full view of the electrical connections in the switchboard. Based on its findings, the Safety Board concluded that the use of suitably located access panels on the *Columbia*'s switchboards would facilitate infrared thermographic inspections and, therefore, help detect faulty electrical connections.

After the accident, the AMHS issued an engineering policy letter directing the crews of all vessels in its fleet to clean and tighten the electrical connections in the main and emergency switchboards not less than every other year. The switchboard manufacturer had recommended that such cleaning and tightening be performed, at a minimum, every year or during vessel overhauls. The Safety Board recognizes that the manufacturer's recommended inspection interval might be based on operating time and that the *Columbia* typically operates about 6 months a year. This means that it would take the ferry 2 calendar years to attain 1 year of operating time. During half of the year, however, the *Columbia* is taken out of service, which affords the AMHS ample time and opportunity to perform switchboard maintenance. The Safety Board, therefore, considers an annual examination consistent not only with the manufacturer's recommended inspection interval, but also the ferry's operation.

Given the past infrequency of inspections, had the switchboard had faulty connections, they would have remained undetected until they became apparent through an equipment malfunction or fire. Had the main switchboard been subjected to thorough and timely inspections as part of an effective preventive maintenance program, any faulty connections or conductive objects would have likely been identified and corrected, and the fire might have been avoided. The Safety Board is aware that the AMHS is in the process of implementing a computer-based maintenance program that could address the problem of loose connections in the switchboards. In the Safety Board's opinion, the maintenance of switchboards should be included in this computer-based program.

Quality assurance is the planned and systematic pattern of actions, including inspections, performed by the vessel owner to determine whether a contractor has fulfilled contract obligations pertaining to the quality and quantity of work.[2] The AMHS included general quality assurance requirements in its agreements with contractors; the agency clarified the nature of the general requirements through individual specifications associated with each work item. Because the main switchboard is the central point for receiving and distributing all electrical power throughout a vessel, it is critical to the vessel's operation. Therefore, any contract work on the switchboard should be subjected to quality assurance inspections.

For unknown reasons, the AMHS did not include switchboard inspections in its contract with the shipyard. The AMHS had not required the shipyard to present the switchboard for inspection or required the vessel's crew or the agency's port engineering staff to inspect the work before the switchboard was returned to service. The shipyard's electrical foreman stated that he inspected his subordinates' work upon completion; however, he did not do so at the direction of the AMHS. Based on these findings, the Safety Board concluded that a thorough inspection of the interior of the switchboard by the AMHS and the port engineering staff before it was returned to service might have detected the presence of faulty connections and/or foreign objects and led to their correction and/or removal. A thorough inspection of the interior of the switchboard by the AMHS and the port engineering staff before it was returned to service might have

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[2] Adapted from the quality assurance definition at 48 CFR 46.101, "Federal Acquisition Regulations."

detected the presence of faulty connections and/or foreign objects and led to their correction and/or removal.

In this accident, the initial response to the fire by the shipboard engineers was appropriate. The Safety Board is concerned, however, that the crew's subsequent actions were somewhat haphazard and improvised as they went along. The crew's actions did not reflect the type of performance that would be expected from properly planning, training, and drilling for a fire in the control room.

The *Columbia*'s muster list designated the master as the person in charge from the bridge and the chief mate as the person in charge of the emergency squad on scene, but the list did not elaborate on their respective duties and responsibilities. The list indicated that the emergency squad consisted of unlicensed deck crewmembers on two hose teams and other unlicensed personnel providing backup and support. The list did not indicate that a separate emergency squad was to respond to engineroom fires or that engineroom personnel were assigned to hose teams. Further, the *Columbia* had not held a training drill featuring a response to an engineroom fire during the 2 years before the fire.

The muster list designated the chief engineer to be "in charge" of the engineroom and to supervise the release of the CO_2 system protecting the engineroom should such release be necessary. However, his role in responding to an engineroom fire was not spelled out in any detail. The other engineering officers were variously designated to tend bilge and fire pumps, operate sprinkler systems, and shut down ventilation systems, but were not listed as having any specific firefighting responsibility. The off-watch third assistant engineer and the off-watch junior engineer were the only engineering officers detailed to work with the emergency squad, and their roles were limited to bringing tools to the emergency locker.

According to the muster list, the emergency squad, under the command of the chief mate, should have fought the *Columbia*'s fire. However, the emergency squad was made up mainly of deck department personnel who were unfamiliar with the engineroom and who had never participated in a fire training drill in the control room. The lack of lighting and the presence of large quantities of black smoke, which reduced visibility in the control room to nearly zero, complicated their firefighting efforts. The engineers, on the other hand, were very familiar with the layout of the control room. They, logically, should have assumed the lead in fighting this fire. However, the lack of a comprehensive prefire plan detailing firefighting roles and responsibilities, coupled with the lack of a squad trained to fight engineroom fires, reduced the crew's capability to fight the fire effectively.

In response to the fire, the chief engineer sent the day third engineer without a lifeline into the control room to open the bus tie circuit breaker between the main switchboard and the emergency switchboard. Upon encountering difficult conditions, the day third engineer backed out in order to get a lifeline. He and the first assistant engineer then entered the control room to open the circuit breaker between the main and emergency switchboards and the circuit breakers between the ship's auxiliary generators and the main switchboard. Both men wore self-contained breathing apparatus borrowed

from the emergency squad, but neither wore protective clothing. In the Safety Board's opinion, sending crewmembers who were not properly clothed in protective gear into an active fire scene needlessly exposed them to serious injury and demonstrated poor decisionmaking on the part of the chief engineer.

The first assistant engineer opened two circuit breakers by hitting them with his flashlight, which was an imprudent action. Considering the electrical arcing activity and the fire in the switchboard, the poor visibility within the control room, and his choice of tool for the job, only happenstance prevented his being seriously injured. In the Safety Board's opinion, the actions of the first assistant engineer indicated a lack of proper training in fighting a switchboard fire.

After the first assistant opened a third circuit breaker, he and the day third engineer backed out of the control room, and the chief engineer decided to manually shut down the No. 1 auxiliary generator, which was still powering the switchboard. In the Safety Board's view, manually shutting down the generator to remove electrical input to the switchboard was the course of action that should have been taken in the first place. Manually shutting down the generator is much safer than sending a person into a dark, smoke-filled room to open a bus tie circuit breaker.

Once the engineers had notified the bridge of the fire and the general alarm had been sounded, a firefighting team that was trained in the techniques of combating an electrical fire should have led the response to the fire in the control room. Such a team probably would have extinguished the fire more quickly and with minimum risk. This accident demonstrates that, because engineers have the specialized knowledge and expertise needed to effectively fight engineroom fires, they should be an integral part of a vessel's firefighting team.

As noted earlier, the *Columbia*'s muster list provided officers and other crewmembers with a quick guide to the emergency duty assignments; it did not go into any depth on individual roles and responsibilities or give details about policies, procedures, and plans for responding to shipboard fires. A comprehensive prefire plan, on the other hand, typically provides such vital information; however, prefire plans are not required by regulation, and not all vessels have developed such plans. The *Columbia* had a prefire plan, but it was not comprehensive. The *Columbia*'s plan merely provided a brief description of the vessel's firefighting resources and listed the locations of access doors and fire stations. The plan did not describe the vessel's firefighting organization or specify the crewmembers' firefighting roles and responsibilities. Moreover, the plan did not describe in detail how to fight fires in specific parts of the vessel.

A properly developed comprehensive prefire plan describes various fire scenarios in different spaces on the ship and how to fight the fire in each situation. The plan fully describes the roles and responsibilities of the emergency responders and establishes the chain of command for firefighting operations. Responsibility for strategic and tactical command is made clear and unambiguous for all foreseeable situations, including fires on the decks and in the engineroom. If necessary, separate and distinct organizations are created to respond to fires on deck and fires in the engineroom. In addition, the prefire

plan contains checklists for emergency actions, procedures for shutting down the electrical power and closing the ventilation to the various ship areas, as well as instructions for establishing fire boundaries and for maintaining watertight integrity. With a prefire plan, predetermined actions for responding to a fire in a given space or compartment are developed in a nonurgent atmosphere, where one is more likely to exercise good judgment. Then, if a fire develops, the officers in charge can refer to the plan and take appropriate action.

If the *Columbia* had had a comprehensive prefire plan that included procedures for fighting a control room fire and if the crewmembers had been properly trained and drilled in the execution of the plan, they would have known exactly what to do from the outset. If the firefighting roles and responsibilities of the various crewmembers had been predetermined and drilled, the main switchboard would have been electrically isolated quickly and completely, and the engineers would not have been sent into the control room without proper gear. The danger to firefighters would, thereby, have been diminished; and the fire might well have been extinguished sooner.

When fire and smoke forced the oiler and junior engineer to evacuate the control room, they were unable to alert the bridge immediately because the only telephone in the engineroom was in the control room and no manual fire alarms were in the engineroom. Having a single telephone with which to communicate from the engineroom to the bridge is inadequate to ensure communications during an emergency. Even though the telephone system on board the *Columbia* has since been upgraded, the main engineroom still has no means of communication outside of the control room.

The National Transportation Safety Board, therefore, makes the following safety recommendations to the Alaska Marine Highway System:

> Develop an annual switchboard inspection program that includes a thorough infrared thermographic inspection and physical examination of components. (M-01-19)
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> Include an annual switchboard inspection program in your computer-based maintenance planning system. (M-01-20)
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> Revise your procedures for accepting completed shipboard maintenance and repair work performed by outside contractors to verify that work has been done properly. (M-01-21)
>
> Develop comprehensive prefire plans for the vessels in your fleet that include procedures for fighting an engineroom fire and require the ships' crews to be thoroughly drilled in using the plans. (M-01-22)

Install a means of alerting the bridge of an emergency from the *Columbia*'s engineroom in case the telephone in the control room is inaccessible. (M-01-23)

In your response to the recommendations in this letter, please refer to M-01-19 through -23. If you need additional information, you may call (202) 314-6607.

Acting Chairman CARMODY and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Carol J. Carmody
Acting Chairman