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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

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In Reply Refer To: M-95-13 through -17

Admiral Robert E. Kramek
Commandant
U. S. Coast Guard
Washington, DC 20593-0001

About 0930 on July 24, 1994, while bound for Dutch Harbor, Alaska, in the Aleutian Chain, the U.S. fish processing vessel ALL ALASKAN caught fire near the western end of Unimak Island, Alaska. The fire burned out of control for several days before burning itself out. One person died, and the vessel and cargo damage was estimated between $25.3 and $31 million.[1] The National Transportation Safety Board determined that the probable cause of the fire aboard the ALL ALASKAN was the failure to isolate heat tape from combustible rigid polyurethane (RPU) insulation and the lack of heat tape standards for fish processing vessels. Contributing to the severity of the fire was the lack of adequate firefighting (detection and suppression systems) standards. Contributing to the loss of life was the lack of formal firefighting training of the fire team.

The circumstances of this accident clearly show the hazards of firefighting and the need for fire team members who are to fight a fire to be thoroughly trained in the accepted procedures to follow. Such training in marine firefighting schools ashore is provided by professional and qualified instructors who answer student questions. Formal training is better than routine drills because fire theory is studied, hands-on and varied firefighting situations are enacted under controlled conditions, and proper firefighting procedures are followed.

[1]For more detailed information, read Marine Accident Report--*Fire on board U.S. Fish Processing Vessel ALL ALASKAN near Unimak Island, Alaska, Bering Sea, July 24, 1994* (NTSB/MAR-95/02).

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Deficiencies in the firefighting capabilities of the crewmembers who attempted to enter hold No.3 were apparent. Although the able seaman (AB) and deckhand felt the cargo hold door for heat, they either did not consider or were unaware of the insulating property of the RPU foam on the far side of the door. When the AB and deckhand opened the door leading down to the cargo hold, smoke and flames rushed out at them through the open doorway. This additional air entering hold No.3 when the door was opened had created a chimney effect.

The AB and deckhand attempted to enter the cargo hold without backup from other fire team members. Both carried a fire extinguisher and wore a firefighter coat with a self-contained breathing apparatus (SCBA). However, neither had SCBA training during actual smoke conditions. The burn pattern on the deckhand's face after his body was recovered indicated that he was wearing the SCBA face piece when he died. He was not wearing a harness to which a lifeline could be attached.

Title 46 Code of Federal Regulations [CFR] 28.205(e) requires SCBAs to provide a 30-minute minimum of air; however, the breathing rate of a person under exertion can deplete the air supply in less time. The breathing rate of the deckhand probably increased when he saw the flames and exerted himself while trying to escape. The AB stated that he had depleted the SCBA air supply shortly after leaving the cargo hold and he believed the deckhand may have exhausted his air supply either before or when he himself had because both had put on the SCBAs about the same time. The deckhand would have been overcome in seconds by the smoke once the SCBA air supply was exhausted.

The smoke seen coming from the hold No.3 door was quickly reported, but response was not in a manner normally recognized as acceptable for fighting fires aboard ship. The AB and deckhand after donning the SCBA gear and firefighter coats failed to receive instructions from the chief mate, who was in charge of the fire team, before attempting their firefighting operations. Their hurried unplanned response to check out the smoke from the closed freezer door not only lacked the methodical approach to investigate and to fight a fire but proved unsafe and ineffective, resulting in the deckhand's death. The team also never discussed what escape method, such as the use of lifelines, would be used should they become disoriented or whether charged hoses should be available as the door was opened. Had the fire in the hold been discovered in its beginning phase, hand-held equipment may have effectively extinguished it. The firefighters could not effectively fight the fire with the hand-held equipment when the seeping smoke was discovered however because of the magnitude of the fire from the rapid flame spread through the RPU foam insulation.

Had members of the fire team aboard the ALL ALASKAN received formal firefighting training in addition to shipboard fire drills, they would have been able to assess the fire and to coordinate their actions with a back-up fire team. They would have also known how to use lifelines with SCBAs to avoid being lost in smoke conditions. The AB testified that he had not received training in fire containment during the fire drills that were held as required. Although mock fires were simulated during drills, the AB had never used lifelines during drills, and, thus, his incomplete training did not prepare him for this situation. Therefore, Safety Board concludes

that because the AB and deckhand had no formal firefighting training, they were unable to properly assess the smoke conditions at the hold No.3 door that resulted in a more critical dilemma than before the door was opened.

Formal marine firefighting training provides an understanding of firefighting procedures and techniques as well as the classes of fire, the spread of fire, and extinguishing agents. This accident indicates that in addition to the fire drills aboard the ALL ALASKAN, formal training may have benefited the AB and deckhand. U.S. Coast Guard-approved basic and advanced firefighting training is available at various locations throughout the United States. However, the Coast Guard only requires licensed officers to have this training. The vessel crew is responsible for fire containment because a fishing vessel may be a great distance from shoreside firefighting assistance. The experience and training of the firefighting team can make the difference not only between extinguishing a fire and losing a vessel but also between personal safety and loss of life. About eight crewmembers on the ALL ALASKAN would need this formal training. Crew error is likely reduced when crewmembers on the firefighting team, in addition to the licensed officers, receive formal firefighting training. The Safety Board concludes that a Coast Guard requirement for formal marine firefighting training for crewmembers assigned to fire teams on fishing vessels is needed. Therefore, the Safety Board believes that the Coast Guard should amend 46 CFR 28 subpart C to require that people assigned to firefighting teams be trained in proper firefighting procedures and emergency equipment use and also that those assigned to fire watch duty be trained in proper fire detection procedures.

The fan motors on the evaporators aft, the heating pads on the drain collector pans under these evaporators, and the electric circuits (other than heat tape circuits) in hold No.3 and lighted tobacco materials were considered and eliminated as ignition sources. The burn pattern eliminated the first three items considered because the RPU insulation on the overhead and the cellular plastic foam insulation Rubatex on the piping were smoke damaged and charred but not destroyed. Had the ignition initially occurred in this overhead area, the insulation would have been destroyed, and the flame probably would not have spread down to the deck. In addition, the Rubatex, covering the drain pipe connected to the collector pan with the heating pad, was heat damaged but still in tact and not burned. Any discarded smoking material, such as a burning cigarette, was not considered a feasible ignition source because it would have had to smolder for 8 1/2 hours, which is a very unlikely possibility. Also, the odor was described as unusual, and a smoldering cigarette smell would probably have been recognized as such. Finally, Safety Board investigators found no evidence after the fire of smoking in the hold.

The burn pattern on the vessel indicated that the lowest point of the fire was in hold No.3 on the port side aft of the aft elevator. The plywood covering and the sprayed-on RPU insulation on the hull from the aft elevator to the aft bulkhead were completely burned away. The hold No.3 aft area was also where the "strange smell" was reported during various times in the 8 1/2 hours before the fire. Two potential ignition points were identified during the investigation in this area of the vessel as likely ignition sources, based on the burn pattern and other evidence.

The first potential ignition source for the fire was the heat tape on the 2-inch diameter vertical drain pipe from the number 1 evaporator in hold No.3. The Rubatex, the electrical insulation on the heat tape, and the semi-conducting material between the heat tape conductor wires were burned from the pipe. The heat tape bus wires remained spiraled around the pipe and were separated about 3 feet above the deck. A whitish area, consistent with a hot spot, was noted on the hull behind the pipe. The ends of the bus wires did not appear to have been cut but were severed and rounded consistent with electrical shorting and failure under power.

Because the end cap and all insulation were destroyed, the Safety Board could not determine whether the heat tape failed at the end cap. The proximity of the drain pipe to the loading and unloading activities near the elevator subjected it to possible mechanical damage and failure particularly because the plywood protection did not extend over the drain pipe. Because the drain line was insulated with Rubatex that was close to the RPU insulation, the fire could have easily spread into the foam.

The second potential ignition source was another heat tape in the port corner aft of hold No.3 that was wrapped on a 4.5-inch-diameter vertical pipe. The failure was behind a concrete barrier about 26 inches from the hull frame face forming a trough covered with plywood sheathing and about 14 inches below the plywood cover. The tape end cap and about 5 inches of the electrical insulation jacket above it were intact. Above this area, the bus wires were exposed and separated. Much of the Rubatex pipe insulation was still intact, although some insulation was burned. The electrical insulation and the heat tape matrix were burned away only at the failure site; however, about 2 inches above this failure, the heat tape spirals were undamaged. The failure appears to have taken place under power because the wire ends are beaded and metal beads/fragments were in the end cap. This failure site could have been the ignition source for the fire, although a number of factors suggest otherwise. First, the tape failed at the termination and did not progress for a complete turn around the pipe. Second, a 2-inch turn of heat tape above the failure site indicates that the fire did not spread upward, a typical mode of fire spread. The heat tape above the 2-inch spiral should have been burned if ignition had occurred here. Third, the Rubatex, which had to be removed to uncover the failure site, would have been consumed if the fire had started there. Fourth, except for the still-present Rubatex, the closest combustible material, the plywood, is about 14 inches above the failure site. Consequently, without direct fire spread upward to the plywood at this location, an easy route for the fire to spread into the RPU foam does not appear to exist.

Because the concrete barrier and the plywood cover protected the heat tape from mechanical damage, it is probable that the tape failed at its end cap, which most likely occurred from salt water leakage into the end cap. The x-ray analysis of the end cap showed copper beads and broken wires, and the electrical tape wrapped at the end seal indicates that a repair was made to the heat tape or end seal. The use of electrical tape, according to the 1990 Raychem Corporation *Auto-Trace "R" Heat-Tracing Systems for Ordinary and Hazardous Division 2 Locations; Installation and Maintenance Guide*, is not an appropriate method of repair. From this evidence, an improper repair and/or installation of the end cap appears to have allowed sea water to enter the end cap, which led to the failure.

Furthermore, the tape seems to have failed while the end cap and a short length of the tape were under water. This supposition would explain the unburned end cap, unburned electrical tape, and short length of good electrical insulation with the semi-conducting heat matrix burned away. The experimental results of tape taken from the vessel and a new tape show that when the bus wires arc to the matrix, the matrix heats up and the system ignites. Water had accumulated on the aft port side of the vessel at various times. The chief steward testified that ice had to be chipped out after fish processing cleaning procedures and that he believed the water came down the elevator shaft. Thus, salt water most likely accumulated around the drain pipe and entered the end cap leading to an electrical failure. This evidence shows that the tape had failed some time earlier and, thus, was not the ignition source for this fire.

All evidence indicates that the fire originated in hold No.3. The RPU foam insulation in contact with the pipe insulation and heat tape on the 2-inch diameter vertical drain pipe allowed the fire to spread directly into the RPU foam. Thus, the Safety Board concludes that the ignition source for the fire was the failure of the heat tape on the 2-inch diameter vertical drain pipe in hold No.3 on the port side aft. In addition, had the RPU foam insulation in hold No.3 been physically separated from the heat tape failure by a noncombustible material, the fire may not have occurred. Therefore, the Safety Board believes that the Coast Guard should amend 46 CFR 28 subpart D to require that equipment using heat tape be physically separated from RPU foam and other organic combustible material insulations by a noncombustible material.

The testing laboratory that performed the U.S. Consumer Product Safety Commission studies on residential heat tapes concluded that a ground fault circuit interrupter (GFCI) provided reliable protection against fire from failed shielded heat tapes. The distribution circuits on marine vessels are generally designed to be ungrounded. On a steel-hulled ship that uses an ungrounded distribution system (no neutral conductor) a solid grounding of either heating tape conductor may not cause the circuit-over-current protecting device to disconnect and, ironically, is more likely if the electrical system is in good condition. However, should the system have poor electrical insulation or another accidental ground on the appropriate conductor anywhere in the ship, sufficient conductivity to the steel hull may exist for the over current device to disconnect the heating tape circuit.

The installation of a GFCI to supply heating tapes with an ungrounded electrical system aboard a steel-hulled ship may or may not provide additional protection against fires. The following scenarios are possible:

a. If heating tape conductors do not touch ground and the arc does not result in sufficient current flow, a fire may start because the over-current protecting device may not disconnect. Additionally, the heating tape circuit supplied from a GFCI will not disconnect the circuit because a GFCI functions only when the protected circuit sustains a loss of current to ground.

b. If either heating tape conductor touches the hull, the results will resemble the scenario above, except if unintended electrical grounds already exist, the GFCI will cause an opening of the electric circuit at very low leakage currents. The GFCI to that extent may reduce the probability of fire incidence; however, it is not a predictably reliable protection from fires caused by heat tape failures.

A GFCI would, therefore, not be reliable in preventing a heat tape-initiated fire. Because no standards or regulations regarding the use of heat tape on vessels have been provided and fires aboard vessels using heat tape have occurred, the Safety Board concludes that a national marine safety standard for vessels on the safe use of heat tape is needed. Therefore, the Safety Board believes that the Coast Guard and the National Fire Protection Association (NFPA) should establish, in cooperation, a national marine safety standard on the safe use of heat tape, heat tape insulation, and methods to detect heat tape failure on vessels.

The Coast Guard Navigation and Vessel Inspection Circular (NVIC) No. 8-80 (Fire Hazard of Polyurethane and Other Organic Foams) states that when organic foam is exposed to fire or heat, it may ignite and burn with rapid flame spread, high temperatures, toxic gases, and voluminous quantities of smoke. When RPU foam insulation is properly installed and protected by a noncombustible material, according to NVIC No. 8-80, it is no more of a fire hazard than other combustible materials. This NVIC also provides guidance on the proper protection of RPU insulation.

The commercial uninspected fishing industry vessel regulations permit combustible insulation in cargo spaces and refrigerated service spaces and have no requirement about the type of foam (fire retarding or not) or other combustible insulation used in these spaces or how it should be installed and protected. The regulations do not specify smoke and fire detectors or fixed fire extinguishing systems for these spaces. No requirement stipulates what constitutes a proper installation for owners, inspectors, or accepted organizations to follow when a combustible material, such as RPU foam insulation, is used.

The Coast Guard NVIC No. 5-86 (Voluntary Standards for U.S. Uninspected Commercial Fishing Vessels) recommends the use of smoke or fire detectors in galleys, accommodations, and other high fire risk spaces as well as the use of a fixed carbon dioxide fire extinguishing system to protect cargo spaces with a high fire risk. However, what constitutes a high fire risk is not defined. The Safety Board has determined that large spaces insulated with RPU foam should be considered a high fire risk and that smoke or fire detectors should be used within these high fire risk spaces. The Coast Guard does require a fixed fire extinguishing system in cargo holds if the holds carry explosives, combustible liquids, or automobiles. However, it does not require this system be installed in the spaces insulated with combustible construction material in which people work at sea. These spaces should also be required to be protected by a fixed fire extinguishing system. The above items should be included in a national marine safety standard when combustible insulation material is used in cargo spaces.

After the Commercial Fishing Industry Vessel Safety Act of 1988 was enacted, the Coast Guard developed regulations for the fishing industry vessels. Despite the applicable details of NVIC No. 8-80 and NVIC No. 5-86 and the warnings in the 1990 Worcester [Massachusetts] Polytechnic Institute *Unclassed Fish Processing Vessel Study* concerning foam (combustible insulation) and its hazards, requirements were not incorporated into 46 CFR part 28 when published on August 14, 1991. These regulations should have requirements about combustible insulating materials installation and protection in cargo holds and other service spaces.

The U.S. model building codes (shoreside) recognized and effectively dealt with the fire problem associated with cellular plastics almost 20 years ago. Unfortunately, this shoreside approach to fire safety has not been translated into fishing industry vessel fire safety codes and regulations. Should Coast Guard regulations continue to permit RPU foam or other organic combustible material insulations to be used in cargo holds and service spaces, the requirements for these combustible materials should be revised using the land-based fire protection standards to establish similar fire safety standards (construction and structural fire protection and fixed firefighting system) for fishing industry vessels. These requirements should include covering the combustible insulation with a noncombustible material, physically separating heat-taped equipment from combustible insulation with a noncombustible material/insulation, and installing smoke and fire detectors and a fixed fire extinguishing system in spaces equipped with these materials. The Safety Board concludes that a national marine fire safety standard for the safe use of RPU foam and other organic combustible material insulation on vessels is needed. Therefore, the Safety Board believes that the Coast Guard and the NFPA should establish, in cooperation, a national marine fire safety standard on the safe use of rigid polyurethane foam and other organic combustible material insulation on vessels.

Therefore, the National Transportation Safety Board recommends that the U.S. Coast Guard:

> Amend 46 Code of Federal Regulations 28 subpart C to require that people assigned to firefighting teams be trained in proper firefighting procedures and emergency equipment use and also that those assigned to fire watch duty be trained in proper fire detection procedures. (Class II, Priority Action)(M-95-13)
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> Amend 46 Code of Federal Regulations 28 subpart D to require that equipment using heat tape be physically separated from rigid polyurethane foam and other organic combustible material insulations by a noncombustible material. (Class II, Priority Action)(M-95-14)
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> Establish, in cooperation with the National Fire Protection Association, a national marine safety standard on the safe use of heat tape, heat tape insulation, and methods to detect heat tape failure on vessels. (Class II, Priority Action)(M-9-15)

Establish, in cooperation with the National Fire Protection Association, a national marine fire safety standard on the safe use of rigid polyurethane foam and other organic combustible material insulation on vessels. (Class II, Priority Action)(M-95-16)

Publicize the circumstances of this accident to the fishing industry. (Class II, Priority Action)(M-95-17)

Also, the Safety Board issued Safety Recommendations M-95-18 through -22 to the All Alaskan Seafoods, Inc.; M-95-23 to the Commercial Fishing Industry Vessel Safety Advisory Committee; and M-95-24 and -25 to the National Fire Protection Association. If you need additional information, you may call (202) 382-6860.

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in these recommendations.

By: Jim Hall
Chairman