



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

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**Date:** May 14, 2001

**In reply refer to:** M-01-12

Mr. Robin Bradley  
Permanent Secretary  
International Association of Classification Societies  
5, Old Queen Street  
London SW1H9JA  
United Kingdom

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The National Transportation Safety Board is an independent Federal agency charged by the Congress of the United States 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 recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses the adequacy of engineering systems design. The recommendation is derived from the Safety Board's investigation of the fire on board the Liberian Passenger Ship *Ecstasy* near Miami, Florida, on July 20, 1998, and is consistent with the evidence we found and the analysis we performed.<sup>1</sup> As a result of this investigation, the Safety Board issued twelve safety recommendations, one of which is directed to the International Association of Classification Societies. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

The fire on board the *Ecstasy* started in the main laundry and migrated through the ventilation system to the aft mooring deck, where mooring lines ignited, creating intense heat and large amounts of smoke that damaged deck areas in the aft two main vertical zones of the ship. The affected areas included the stern thruster room, an air conditioning room, an electrical equipment room, and the steering gear room. The fire and the heat that it generated caused the partial or complete failure of several engineering and emergency systems, including propulsion. Although the loss of propulsive power did not ultimately endanger the ship and its passengers in this accident, the potential threat to vessel safety from the failure of such a vital system is significant. Hazardous situations that may result from a ship losing propulsive power include vessel grounding, inability to avoid severe weather conditions, and passenger evacuation at sea.

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<sup>1</sup> For further information, read: National Transportation Safety Board, *Fire On Board the Liberian Passenger Ship Ecstasy, Miami, Florida, July 20, 1998*, Marine Accident Report NTSB/MAR-01/01 (Washington, DC: NTSB, 2001).

The *Ecstasy* had been built to Lloyds Register of Shipping (LR) regulations, which stipulate the need to provide independent and isolated power supplies to essential components of the vessels engineering systems, such as propulsion. The *Ecstasy's* propulsion system had many redundant features and isolated components designed to provide reliability. However, the auxiliary voltage to the high-speed breakers for the starboard and the port propulsion systems was routed through the same distribution panel, which was in an electrical equipment room on the deck above the mooring station. The auxiliary voltage was essential to the operation of both propulsion systems. When the distribution panel sustained heat damage, both systems failed.

The propulsion system was designed and manufactured by ABB, a subcontractor to Kvaerner Masa, the shipbuilder. The integration of the propulsion system into the ship's other systems, notably the electrical distribution system, was the responsibility of Kvaerner Masa's designers. ABB's specifications to the shipbuilder list the required voltage and current supplying the propulsion system. The specifications do not indicate that the voltage supply should be provided by independent sources. Kvaerner Masa routed the auxiliary voltage for both high-speed breakers through a single external interface.

As part of the agency's investigation, Safety Board staff contacted ABB regarding the reviews and examinations of the propulsion system that were conducted before and during the construction of the *Ecstasy*. ABB officials stated that they did not do a qualitative failure analysis<sup>2</sup> of the propulsion system for the Fantasy class ships, including the *Ecstasy*, because it was not required by the *International Convention for the Safety of Life at Sea, 1974* (SOLAS 74) standards and LR regulations. In addition, the ship owner did not require that a system failure analysis be conducted.

Safety Board staff wrote LR asking the classification society to provide its interpretation of Part 6, Chapter 2-1, "Electrical Installations—Equipment and Systems Design," of the 1987 LR Rules, which states, in part, that the wiring for "essential services," that is, those services necessary for the propulsion and safety of the ship, should be duplicated. The Board also asked to what extent the rule applied to the electrical arrangement for the auxiliary voltage supply to the propulsion system's high-speed breakers.

In its response, LR wrote:

The details of these internal connections were not provided to LR during LR's plan approval, and LR's surveys of the vessel's construction. Therefore, LR was not aware, prior to this casualty, that if these cables were burnt through propulsion would be lost.

LR receives "design" plans for consideration at or before the time of construction of the vessel. It is these plans that our surveyors review and stamp "approved" against applicable classification requirements. Upon completion of construction "as built" plans are forwarded to LR for record purposes.

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<sup>2</sup> A common systems analysis tool used by engineers is the failure modes and effects analysis, or FMEA.

We have checked the *Ecstasy* design plans approved by LR at the time of construction and the “as built” plans forwarded to us for record purposes. Neither shows the detailed matters referred to in your letter.

A qualitative failure analysis can identify potential failures and rank them according to the probability of occurrence, the severity of effects, and the probability of detection. System failure analyses are widely used in many other industries as part of the overall movement toward quality improvement in processes and products. In addition, the International Maritime Organization now requires that a failure analysis be performed during the design of navigation equipment and bridge systems. The U.S. Coast Guard (Coast Guard) has required the use of qualitative failure analysis techniques in evaluating the reliability and safety of vital system automation on U.S. flag vessels since 1988. In proposing the regulatory requirement that designers, manufacturers, and/or shipyards perform and submit system failure analysis, the Coast Guard stated that the use of advanced automation technologies such as electronics and microprocessors made it increasingly difficult, “at times impossible, for the Coast Guard, ship owners/operators, and classification societies to evaluate safety.”

Despite the fact that vital automation systems are becoming even more complex and difficult to evaluate, classification societies have not seen the need to require failure analyses on these systems. If a qualitative failure analysis of the *Ecstasy's* propulsion system had been performed during its design phase, the failure probability of the single power source may have been rated low. However, the high severity of the failure effect, that is, the total loss of the propulsion system, should have led the designers to implement design modifications. The Safety Board is convinced that a qualitative failure analysis can be an important technique to maximize the reliability and safety of a system before it is built, when changes can be easily made.

The Safety Board, therefore, makes the following recommendation to the International Association of Classification Societies:

Recommend that your members require systems designers, manufacturers, and/or shipyards to perform and submit qualitative failure analyses to ensure the fail-safe operation of propulsion systems on new passenger ships. (M-01-12)

The Safety Board also issued safety recommendations to the U.S. Coast Guard, American Classic Voyages, Carnival Corporation, Inc., Carnival Cruise Lines, Crystal Cruises, Disney Cruise Line, Norwegian Cruise Line, Orient Lines, P&O Princess Cruises International, Ltd., Radisson Seven Seas Cruises, Regal Cruises, Renaissance Cruises, Inc., Royal Caribbean Cruises, Ltd., Royal Olympic Cruises, and Silversea Cruises, Ltd., and ABB, Inc. In your response to the recommendation in this letter, please refer to M-01-12. If you need additional information, you may call (202) 314-6607.

Acting Chairman CARMODY and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

*Original Signed*

By: Carol J. Carmody  
Acting Chairman