



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

Date: APR 10 1997

In reply refer to: M-97-12 and -13

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On June 10, 1995, the Panamanian passenger ship *Royal Majesty* grounded on Rose and Crown Shoal about 10 miles east of Nantucket Island, Massachusetts, and about 17 miles from where the watch officers thought the vessel was. The vessel, with 1,509 persons on board, was en route from St. George's, Bermuda, to Boston, Massachusetts. There were no deaths or injuries as a result of this accident. Damage to the vessel and lost revenue, however, were estimated at about \$7 million.<sup>1</sup>

The National Transportation Safety Board determines that the probable cause of the grounding of the *Royal Majesty* was the watch officers' overreliance on the automated features of the integrated bridge system, Majesty Cruise Line's failure to ensure that its officers were adequately trained in the automated features of the integrated bridge system and in the implications of this automation for bridge resource management, the deficiencies in the design and implementation of the integrated bridge system and in the procedures for its operation, and the second officer's failure to take corrective action after several cues indicated the vessel was off course.

Contributing factors were the inadequacy of international training standards for watchstanders aboard vessels equipped with electronic navigation systems and integrated bridge systems and the inadequacy of international standards for the design, installation, and testing of integrated bridge systems aboard vessels.

The performance of the watch officers during the voyage and the circumstances leading to the grounding were linked to several error-inducing deficiencies in the design of the integrated bridge system and to an inefficient layout of system displays on the bridge. For example, although the *Royal Majesty* was equipped with multiple position receivers, the navigation and command system (NACOS) 25 autopilot was not configured to compare position data from

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<sup>1</sup> For more information, read Marine Accident Report—*Grounding of the Panamanian Passenger Ship Royal Majesty on Rose and Crown Shoal near Nantucket, Massachusetts, June 10, 1995* (NTSB/MAR-97/01).

multiple independent position receivers, such as the 920 global positioning system (GPS) and the 780 Loran-C receivers. Given the *Royal Majesty's* frequent proximity to land and the expected reasonable accuracy of the Loran-C in that area, the NACOS 25 could have recognized the large discrepancy between the GPS and the Loran-C positions as the vessel approached Nantucket Shoals had it been able to compare them. The Safety Board concludes that had the autopilot been configured to compare position data from multiple independent position receivers and had a corresponding alarm been installed that activated when discrepancies were detected, the accident may have been avoided. The safety benefits associated with the redundancy of such critical systems as position receivers would help prevent such single-point catastrophic failures as occurred on the *Royal Majesty*. The Safety Board believes, therefore, that STN Atlas should design its integrated bridge systems to incorporate multiple independent position receivers, comparison of position data from those receivers, and related crew alerts regarding changes in position receiver accuracy, selection, and mode.

The NACOS 25 central console provided efficient access and display of most information needed to conduct a passage when the GPS was fully operational. However, where various sources of position information were possible (i.e., GPS, Loran-C, or dead reckoning [DR]), as with the NACOS 25 autopilot, it was important to delineate clearly which mode was in use. On the *Royal Majesty*, because the NACOS 25 could not detect the GPS's change to DR mode, the central console display switched from GPS to DR-derived positions without changing its display in any perceivable way or notifying the crew. The integrated bridge system, as configured, did not indicate to the officers at the central console that the navigation system had defaulted to the DR navigation mode.

The failure of the NACOS 25 autopilot to recognize the GPS data as invalid and to sound an alarm helped result in a single-point, "silent" failure mode on the *Royal Majesty*. Aeronautical and aerospace design safety practices typically require the analysis of potential failure modes via failure modes and effects analyses (FMEAs). FMEAs of the *Royal Majesty's* integrated bridge system could have highlighted the need for multiple independent comparisons of positioning systems for discrepancies between systems, the need for removal of the DR input to the Raytheon 920 GPS receiver, and the need for interrogation of the National Marine Electronics Association 0183 *valid/invalid* position data bits by the NACOS 25. The Safety Board concludes that FMEAs of the *Royal Majesty's* integrated bridge system would probably have disclosed the shortcomings of the system's components. Consequently, the Safety Board believes that STN Atlas should recommend that all of its customers have final FMEAs for their installations, because overall integrated bridge system and peripheral device installation details frequently vary from installation to installation.

Therefore, the National Transportation Safety Board recommends that STN Atlas Elektronik GmbH:

Design integrated bridge systems to incorporate multiple independent position receivers, comparison of position data from those receivers, and related crew alerts regarding changes in position receiver accuracy, selection, and mode. (M-97-12)


Recommend that all its customers have final failure modes and effects analyses for their integrated bridge system installations. (M-97-13)

The Safety Board also issued Safety Recommendations M-97-1 through -4 to Majesty Cruise Line; M-97-5 through -11 to the U.S. Coast Guard; M-97-14 and -15 to Raytheon Marine; M-97-16 through -18 to the National Marine Electronics Association; M-97-19 and -20 to the International Electrotechnical Commission; M-97-21 through 26 to the International Council of Cruise Lines; and M-97-27 and -28 to the International Chamber of Shipping and to the International Association of Independent Tanker Owners. The Safety Board also reiterated Safety Recommendations M-93-18 and -19 to the U.S. Coast Guard.

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 interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-97-12 and -13. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By:

  
Jim Hall  
Chairman