

Log # 268A



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** December 20, 1996

**In reply refer to:** A-96-150 through -164

Honorable Linda Hall Daschle  
Acting Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

On December 20, 1995, at 1136, Tower Air flight 41, a Boeing B-747, veered off the left side of runway 4L during an attempted takeoff at John F. Kennedy International Airport (JFK), Jamaica, New York. The flight was a regularly scheduled passenger/cargo flight conducted under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121. Of the 468 persons aboard (451 passengers, 12 cabin crewmembers, 3 flightcrew members, and 2 cockpit jumpseat occupants), 24 passengers sustained minor injuries, and a flight attendant received serious injuries. The airplane sustained substantial damage. The weather at the time of the accident was partially obscured, with a 700-foot broken cloud ceiling, 1½ mile visibility, light snow, and fog.

The National Transportation Safety Board determined that the probable cause of this accident was the captain's failure to reject the takeoff in a timely manner when excessive nosewheel steering tiller inputs resulted in a loss of directional control on a slippery runway. Inadequate Boeing 747 slippery runway operating procedures developed by Tower Air, Inc., and the Boeing Commercial Airplane Group and the inadequate fidelity of B-747 flight training simulators for slippery runway operations contributed to the cause of this accident. The captain's reapplication of forward thrust before the airplane departed the left side of the runway contributed to the severity of the runway excursion and damage to the airplane.<sup>1</sup>

### **B-747 Slippery Runway Operating Procedures**

Because the Safety Board recognized that on a slippery runway, directional control of the B-747 could be lost rapidly by overcontrol of the tiller, it evaluated the existing procedures established by Tower Air and Boeing for operating the B-747 on slippery

<sup>1</sup> For more detailed information, read Aircraft Accident Report—"Runway Departure During Attempted Takeoff, Tower Air Flight 41, Boeing 747-136, N605FF, John F. Kennedy International Airport, New York, New York, December 20, 1995" (NTSB/AAR-96/04)

runways. As a result of the Tower Air procedure to guard the tiller during takeoff until 80 knots, the captain was ready to use the tiller during the beginning of the takeoff roll.

Tower Air and Boeing procedures urge pilots to use the rudder and rudder pedal steering during takeoff. However, B-747 procedural information produced by both the airline and the manufacturer permit the tiller to be used at the beginning of the takeoff. In its 1994 Standards Memo, Tower Air stated, "Use of the tiller is not recommended unless rudder pedal steering is not sufficient during the early takeoff roll." Boeing stated in its Flight Crew Training Manual for the B-747, "Do not use nosewheel tiller during takeoff roll unless required initially due to crosswind." The Safety Board is concerned that these procedures encourage use of the tiller at the beginning of the takeoff roll, during which the Safety Board's simulation study found the B-747 to be most susceptible to loss of control on slippery runways.

The Safety Board concludes that current B-747 operating procedures provide inadequate guidance to flightcrews regarding the potential for loss of directional control at low speeds on slippery runways with the use of the tiller. Therefore, the Safety Board believes that the FAA should require modification of applicable operating procedures published by Boeing and air carrier operators of the B-747 to further caution flightcrews against use of the tiller during slippery runway operations, including low-speed operations (for airplanes equipped with rudder pedal steering) and to provide appropriate limitations on tiller use during these operations (for airplanes not equipped with rudder pedal steering)

The Safety Board was informed by Tower Air after the accident that it had reevaluated and eliminated its standard procedure of guarding the tiller during the takeoff roll through 80 knots. The Safety Board concludes that this procedural change by Tower Air will make overcontrol of the tiller less likely for its own operations; however, other air carrier operators of the B-747 may need to make similar changes to their procedures. Consequently, the Safety Board believes that the FAA should issue a flight standards information bulletin (FSIB) to POIs assigned to air carriers operating the B-747, informing them of the circumstances of this accident and requesting a review and modification, as required, of each air carrier's takeoff procedure regarding pilot hand position with respect to the tiller.

The Safety Board recognizes that it may be a natural reaction for a pilot to persevere in a takeoff attempt when faced with an apparently minor hesitation of an airplane to respond to rudder input. However, the circumstances of this accident indicate that during takeoff in a B-747 on a slippery runway, the pilot must abort at the very first indication of a directional control loss.

The Boeing B-747 Operations Manual and Tower Air B-747 Flight Manual direct pilots who are performing takeoffs on slippery runways to immediately reject the takeoff if deviations from the runway centerline cannot be controlled. While this accident demonstrates the soundness of this advice, the accident also indicates that the provisions

in these manuals are not adequately specific, particularly in their references to deviations that "cannot be controlled"

Tower Air's chief of flight standards suggested a criterion for rejecting takeoffs under slippery runway/crosswind conditions that may be useful for pilot decisionmaking in the future. He linked the takeoff rejection decision to the recommended procedure of limiting rudder pedal steering input to one-half full travel to get optimal cornering friction. He indicated it was clear that if a pilot could not control the airplane with one-half rudder pedal travel, the takeoff should be rejected.

This advice may be operationally useful for all B-747 pilots, if it can be verified by the FAA and aircraft manufacturer. The Safety Board concludes that current B-747 flight manual guidance is inadequate about when a pilot should reject a takeoff following some indication of a lack of directional control response. Consequently, the Safety Board believes that the FAA should require Boeing to develop operationally useful criteria for making a rapid and accurate decision to reject a takeoff under slippery runway conditions; then require that B-747 aircraft flight manuals, operating manuals, and training manuals be revised accordingly.

#### **Training Simulators for B-747 Slippery Runway Operations**

The air carrier and FAA pilots who participated in an August 8, 1996, simulation study conducted by the Safety Board believed that the Boeing engineering simulator had more realistic ground handling performance than the simulators Tower had provided for pilot training. The Board is concerned that air carrier B-747 pilots currently are not able to obtain needed training on slippery runway procedures, including proper tiller and rudder techniques, because training simulators have not incorporated the latest ground handling model (such as that implemented on the Boeing engineering simulator). Further, although existing flight test data on slippery runway handling characteristics are limited, the increasing use of high capacity FDRs and quick access maintenance recorders enables data on slippery runway handling to be obtained from actual line flying experience. Many B-747-400 models are equipped with these recorders.

The Safety Board concludes that improvements in the slippery runway handling fidelity of flight simulators used for B-747 pilot training are both needed and feasible. Consequently, the Safety Board believes that the FAA should evaluate B-747 simulator ground handling models and obtain additional ground handling data, as required, to ensure that B-747 flight simulators used for air carrier flightcrew training accurately simulate the slippery runway handling characteristics of the airplane. The Safety Board also believes that after completing this evaluation, the FAA should issue an FSIB urging POIs assigned to air carrier operators of the B-747 to enhance simulator training for slippery runway operations, including limitations on tiller use and instructions for rudder use during the takeoff roll.

## Galley Security

Service carts, galley containers, drawers and other galley items were not contained during the off-runway excursion. The most serious breach of galley security occurred in the aft galley complex, between the R4 and L4 exits. The two carts that came loose injured the R4 flight attendant and blocked the R4 exit.

The Safety Board could not determine whether the primary latching mechanisms were engaged on the carts that were released from the aft galley. However, the bending in the secondary latches indicated that those latches were engaged, but were not adequate to secure the carts. The Safety Board was unable to calculate the inertial loads imposed on N605FF during the crash sequence because of the malfunctioning FDR. However, the condition of the seats and the comments of the various occupants suggest that the airplane did not experience the loads specified in 14 CFR 25.561(b). Because the crash forces were not severe enough to have resulted in the failure of the latch material, the Safety Board concludes that the material or installation of secondary latches in the galleys of N605FF was inadequate. Consequently, the Safety Board believes that the FAA should develop certification standards for the installation of secondary galley latches; then use those standards to conduct an engineering review of secondary galley latches on all transport-category aircraft. Further, the FAA should require changes to existing installations as necessary to ensure that the strength of secondary latches and their installation are sufficient to adequately restrain carts.

## Flight Attendant Communication

Several flight attendants acknowledged seeing or hearing things not associated with normal operations, such as *crunching and tearing noises*, engine separation, and significant spillage of carry-on luggage, during the airplane's off-runway excursion. However, only three of the 12 flight attendants on board the accident airplane shouted commands to passengers to "Grab Ankles! Stay Down!" during the impact sequence. Because these commands are important instructions that can prevent or reduce passenger injuries, the Safety Board is concerned that nine of the flight attendants did not shout any commands.

The Board recognizes that in the large cabin of the B-747, not all flight attendants had access to the same information about the event; therefore, flight attendants might have formed different opinions about the gravity of the situation. However, the Safety Board concludes that during this accident sequence, despite some ambiguity about the situation, there were ample indications in most parts of the passenger cabin to have caused a greater number of flight attendants to shout brace commands before the airplane came to a stop. The Safety Board believes that the FAA should issue an FSIB to POIs of 14 CFR Part 121 air carriers to ensure that flight attendant training programs stress the importance of shouting the appropriate protective instructions at the first indication of a potential accident, even when flight attendants are uncertain of the precise nature of the situation.

Further, the inconsistent pattern of the flight attendants' emergency commands before the airplane came to a stop, the large cabin layout of the B-747, and the large size of its cabin crew highlight the importance of communication among flight attendants. Communication was an issue in the cabin crew's actions immediately after the airplane came to a stop. While the decision not to evacuate the airplane (made independently by the flight attendants and the flightcrew) may have been appropriate, these decisions were made without adequate knowledge of the postaccident condition of the airplane. Flight attendants had vital information that they did not relay to the purser or the flightcrew. For example, flight attendants did not provide information to the flightcrew about the separation of the No. 4 engine, the severe floor disruption in the forward cabin, the smell of smoke and kerosene in the cabin, or the condition of the injured flight attendant.

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Normally, the PA and interphone systems provide effective means of communications among flight attendants and between the cabin and flight deck. In this accident, the purser was unaware that his PA announcements were only audible in the forward cabin, and thus passengers and flight attendants in the rear of the airplane did not receive any information about the decision not to evacuate. Further, the purser and three flight attendants attempted to use the interphone system without success. Flight attendants did not use megaphones as an alternative to these communications systems. The deadheading flight attendant went forward in the cabin to find out what was planned, but he did not return to the aft cabin to share the information with the other flight attendants.

The Safety Board's review of Tower Air flight attendant procedures revealed that no back-up procedures had been established for communicating or assessing conditions in the postaccident contingency of inoperative or unpowered PA and interphone systems. However, the likelihood of impact damage to PA and interphone equipment, as demonstrated in this accident, indicates that such back-up procedures are essential.

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The Safety Board concludes that the existing Tower Air flight attendant procedures provided inadequate guidance to flight attendants on how to communicate to coordinate their actions during and after the impact sequence. Further, because the Safety Board is concerned that the flight attendant procedures of other air carriers may also be inadequate, the Safety Board believes that the FAA should issue an FSIB requiring POIs of 14 CFR Part 121 air carriers to ensure that their air carriers have adequate procedures for flight attendant communications, including those for coordinating emergency commands to passengers, transmitting information to flightcrews and other flight attendants, and handling postaccident environments in which normal communications systems have been disrupted.

### **Flight Attendant CRM Training**

The circumstances of this accident imply that flight attendants (particularly those assigned to wide-body aircraft) would benefit from the opportunity to practice

communications procedures and coordination skills. CRM training can provide this opportunity.

While the FAA has issued guidance on this training, the Safety Board recognizes that the new requirements for flightcrew and flight attendant CRM training do not specify the specific form and content of this training. The communication and coordination issues raised by this accident, both among flight attendants and between flight attendants and flightcrew would be appropriately addressed in joint CRM training by providing experience and practice in a realistic, line-oriented setting. Therefore, the Safety Board believes that the FAA should issue an FSIB that encourages the use of this accident as a case study for CRM training.

### **Maintenance**

The Safety Board is concerned that Tower Air failed to recognize the results of the annual check of the FDR system of N605FF in a timely manner. Based on the results of this check, TWA notified Tower Air in a memorandum dated November 3, 1995, that the FDR system had six suspect data parameters. It was more than 1 month later, on December 4, 1995, when Tower Air responded to this notification by entering the discrepancy in the maintenance log of N605FF.

Further, although the company recorded in its maintenance records that the required FDR functional test had been performed on December 7, 1995, the Safety Board concludes, based on the limited amount of time between the rental of the test equipment and the movements of the airplane, that Tower Air did not perform the FDR functional test. If Tower Air had performed this test, it would have identified the malfunctioning CEU and DAU #3 units (as the Safety Board was able to do in its postaccident testing). Consequently, the Safety Board concludes that Tower Air's failure to conduct the FDR functional test resulted in the loss of FDR data related to the accident flight that were of critical importance to the Safety Board's investigation.

The FAA conducted a national aviation safety inspection program (NASIP) inspection at Tower Air from September 11-20, 1995. The inspection resulted in 34 findings, of which 23 were maintenance related and 11 were operational.

The executive summary of the NASIP inspection stated:

Findings documented during the inspection that are being investigated for possible non-compliance with [Federal Aviation Regulations] are: manuals and procedures, training records, passenger briefing cards, [Minimum Equipment List] usage, and life limited parts records.

A review of the FAA enforcement records for Tower Air indicated that 120 enforcement actions had been closed since the carrier's inception. As of January

1996, 17 cases were open. Two were operational and the others were maintenance related

As shown by the maintenance history of the FDR that failed to function during the accident sequence, as well as the findings of the FAA NASIP inspection, the installation of the landing gear without assuring it was appropriate for this airplane, and the inadequately documented "C" check, the Safety Board concludes that the Tower Air maintenance program deviated in significant ways from the procedures established in the company's GMM. Although these deviations were not related to the cause of this accident, they are cause for concern.

The Safety Board is equally concerned that the Tower Air continuing airworthiness surveillance and reliability programs, which are the carrier's internal audit and trend monitoring functions, failed to identify these deficiencies. The Safety Board concludes that the continuing airworthiness surveillance and reliability programs in the maintenance department of Tower Air were performing inadequately at the time of the accident. Consequently, the Safety Board believes that the FAA should review the structure and performance of the continuing airworthiness surveillance and reliability programs in the Tower Air maintenance department. Also, the Safety Board believes that the FAA should reassess inspectors' methods of evaluating maintenance work, focusing on the possibility of false entries through selective detailed analysis of records and unannounced work site inspections.

## Operations

In November 1995, revisions were made to the reporting relationships among managers in the Tower Air operations department. These revisions were significant because they left the director of operations (DO), who was assigned the responsibility for the proper conduct of flight operations under the General Operations Manual (GOM), without authority over the day-to-day operations of the airline, flightcrew training, or the activities of the chief pilot and flightcrews. This organizational change was rejected by the POI when it was finally submitted to him for approval following the accident, and the Safety Board concurs with this rejection.

Not only does an airline need individual managers who have appropriate technical qualifications, but the reporting relationships among managers must be such that the operational functions of the airline report through the DO, who has the responsibility for regulatory and procedural compliance in flight operations. Because Tower Air did not have this organizational hierarchy, the Safety Board concludes that it was operating with an inadequate management structure at the time of the accident. While the regulations contained in 14 CFR Part 119 outline the required technical qualifications for certain operational management positions at air carriers (including the DO), they do not specify the reporting relationships that provide the DO with the necessary authority. Consequently, the Safety Board believes that the FAA should revise 14 CFR Part 119 to

specify that the chief pilot and all operational functions under that position report through the DO.

The Safety Board is concerned that Tower Air failed to report significant management personnel and organizational changes to the POI before their implementation, even though this failure did not contribute to the accident. The carrier is responsible for maintaining the accuracy of its GOM, which specifies the company's operational management positions and reporting relationships. Tower Air failed to issue a revised GOM for more than 2 months following its implementation of changes in these areas. The fact that the FAA did not recognize this significant change in the company for this length of time is also disturbing.

### **FAA Surveillance**

The FAA POI and assistant POI assigned to Tower Air were also responsible for overseeing the certificate of Atlas Air. At the time of the accident, both companies were fast-growing B-747 operators engaged in worldwide flight operations.

The assistant POI acknowledged that neither he nor the POI had sufficient time to conduct routine surveillance of Tower Air. The only en route inspections he performed were those that were also required for a new captain's certification during IOE. The POI conducted one en route check from October 1, 1994, through December 31, 1995.

Because the POI and assistant POI were not able to perform routine surveillance of Tower Air, this surveillance was dependent on the support of geographic inspectors from other FAA offices. Although inspectors involved in geographic support probably would notify an air carrier POI immediately if they detected a gross violation, these inspectors would not necessarily recognize deviations from procedures specific to the airline. Further, they would be unable to recognize trends in inspection findings. Therefore, the success of the FAA's geographic inspection program depends on the POI's review and integration of the inspection results.

The POI assigned to Tower Air acknowledged that his primary source of feedback from geographic surveillance was from reviews of the reports filed in the FAA PTRS data base, which he attempted to review quarterly. However, he stated that he had been unable to review these reports during the 6 months before the accident because of workload.

Further, the Safety Board is concerned that the POI and assistant POI were so burdened with certification activities involving their two carriers that they were unfamiliar with significant, inappropriate management changes occurring at Tower Air. Although these changes were eventually recognized and rejected by the POI, he was unable to detect the change until the formal notification was submitted for his signature.

Based on the POI's dependence on geographic inspections for routine surveillance, his inability to review the findings of these inspections in a timely manner, and his inability



to recognize and correct an inadequate operational management structure at Tower Air in a timely manner, the Safety Board concludes that the POI and assistant POI assigned to Tower Air were overburdened, and the FAA program for routine surveillance of the operational functions of Tower Air was inadequate. Consequently, the Safety Board believes that the FAA should immediately implement its plan to assign the Tower Air certificate to a POI and assistant POI who do not have oversight responsibility for any other carriers. Further, based on the circumstances of this accident and Tower Air's recent accident history, the Safety Board believes that the FAA should develop, by December 31, 1997, standards for enhanced surveillance of air carriers based on rapid growth, change, complexity, and accident/incident history, then revise national flight standards surveillance methods, work programs, staffing standards, and inspector staffing to accomplish the enhanced surveillance that is identified by the new standards.

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### **Runway Contamination Evaluation**

In this accident, the airport personnel completed a runway friction test of runway 4L at 0933 and obtained a reading that, by their own procedures, required a report to the control tower. Although the airport personnel claimed that the report was made, there was no documentation of a timely report in their records; the only such record was of a postaccident entry in the operations office computer. The control tower was required by FAA Order 7110.65J to advise pilots of runway friction readings when they were received from airport management, but the control tower personnel claimed that they did not receive these reports. The Safety Board was unable to determine whether the runway friction measurement data were sent or received. However, the Safety Board concludes that the failure of the PNY&NJ or FAA air traffic control tower personnel to provide these data to the pilots of flight 41 did not contribute to this accident.

Although the guidance currently provided by the FAA on runway friction measurement and reporting may be helpful to airport operators, it is incomplete because friction coefficient measurements of various types are not correlated with braking performance of different airplane types or configurations. The International Civil Aviation Organization (ICAO) Guidance Material Supplementary to Annex 14, Volume I, 6, includes a table of friction coefficient measurements correlated with descriptive values, i.e., good, medium, poor. However, this table is provided for informational use only, and it, too, does not establish clearly defined parameters applicable to airplane types.

The FAA has made considerable progress in providing and implementing procedures for airport operators to perform friction measurements during periods of ice/snow and slush contamination. However, such measurements are still not required, and there is no standardization of the equipment currently being used. Further, there are no means to compare measurement standards or translate the data into aircraft performance. A key issue is that no significant progress has been made in correlating stopping distance data from airplane manufacturers' flight tests and calculations with the friction values obtained from measuring devices. An outcome of these correlations could be the establishment of objective standards for air carrier operations on slippery runways,

perhaps extending to the establishment of appropriate minimum runway friction levels for operational use

The Safety Board concludes that the circumstances of this accident indicate that the issue of correlating airplane stopping performance with runway friction measurements should be revisited by the Government and the air transportation industry. Consequently, the Safety Board believes that the FAA should require the appropriate Aviation Rulemaking and Advisory Committee to establish runway friction measurements that are operationally meaningful to pilots and air carriers for their slippery runway operations (including a table correlating friction values measured by various types of industry equipment), and minimum coefficient of friction levels for specific airplane types below which airplane operations will be suspended.

Therefore, as a result of this investigation, the National Transportation Safety Board recommends the following to the Federal Aviation Administration:

Require modification of applicable operating procedures published by the Boeing Commercial Airplane Group and air carrier operators of the B-747 to further caution flightcrews against use of the tiller during slippery runway operations, including low-speed operations (for airplanes equipped with rudder pedal steering) and to provide appropriate limitations on tiller use during these operations (for airplanes not equipped with rudder pedal steering). (A-96-150)

Issue a flight standards information bulletin to principal operations inspectors assigned to air carriers operating the B-747, informing them of the circumstances of this accident and requesting a review and modification, as required, of each air carrier's takeoff procedure regarding pilot hand position with respect to the tiller. (A-96-151)

Require the Boeing Commercial Airplane Group to develop operationally useful criteria for making a rapid and accurate decision to reject a takeoff under slippery runway conditions; then require that B-747 aircraft flight manuals, operating manuals, and training manuals be revised accordingly. (A-96-152)

Evaluate Boeing 747 simulator ground handling models and obtain additional ground handling data, as required, to ensure that B-747 flight simulators used for air carrier flightcrew training accurately simulate the slippery runway handling characteristics of the airplane. (A-96-153)

After completing this evaluation, issue a flight standards information bulletin urging principal operations inspectors assigned

to air carrier operators of the Boeing 747 to enhance simulator training for slippery runway operations, including limitations on tiller use and instructions for rudder use during the takeoff roll (A-96-154)

Develop certification standards for the installation of secondary galley latches, then use those standards to conduct an engineering review of secondary galley latches on all transport-category aircraft. Require changes to existing installations as necessary to ensure that the strength of secondary latches and their installation are sufficient to adequately restrain carts. (A-96-155)

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Issue a flight standards information bulletin to principal operations inspectors of 14 CFR Part 121 air carriers to ensure that flight attendant training programs stress the importance of shouting the appropriate protective instructions at the first indication of a potential accident, even when flight attendants are uncertain of the precise nature of the situation. (A-96-156)

Issue a flight standards information bulletin requiring principal operations inspectors of 14 CFR Part 121 air carriers to ensure that their air carriers have adequate procedures for flight attendant communications, including those for coordinating emergency commands to passengers, transmitting information to flightcrews and other flight attendants, and handling postaccident environments in which normal communications systems have been disrupted. (A-96-157)

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~~Issue a flight standards information bulletin that encourages the use of this accident as a case study for crew resource management training (A-96-158)~~

Review the structure and performance of the continuing airworthiness surveillance and reliability programs in the Tower Air maintenance department. (A-96-159)

Reassess inspectors' methods of evaluating maintenance work, focusing on the possibility of false entries through selective detailed analysis of records and unannounced work site inspections. (A-96-160)

Revise 14 CFR Part 119 to specify that the chief pilot and all operational functions under that position report through the director of operations (A-96-161)

Immediately implement the plan to assign the Tower Air certificate to a principal operations inspector (POI) and assistant POI who do not have oversight responsibility for any other carriers. (A-96-162)

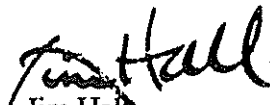
Develop, by December 31, 1997, standards for enhanced surveillance of air carriers based on rapid growth, change, complexity, and accident/incident history; then revise national flight standards surveillance methods, work programs, staffing standards, and inspector staffing to accomplish the enhanced surveillance that is identified by the new standards. (A-96-163)

Require the appropriate Aviation Rulemaking and Advisory Committee to establish runway friction measurements that are operationally meaningful to pilots and air carriers for their slippery runway operations (including a table correlating friction values measured by various types of industry equipment), and minimum coefficient of friction levels for specific airplane types below which airplane operations will be suspended. (A-96-164)

Also as a result of its investigation, the Safety Board issued Safety Recommendation A-96-165 to Tower Air, Inc.

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

By:

  
Jim Hall  
Chairman