EVACUATION SLIDE AND SLIDE/RAFT RELIABILITY

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ABSTRACT

This paper will discuss the various issues involved with evacuation slide and slide/raft reliability including design, deployment intervals, maintenance practices, and FAA regulations. Several incidents and accidents that resulted in recent NTSB safety recommendations concerning evacuation slides and slide/rafts will also be discussed.

INTRODUCTION

The National Transportation Safety Board has recently investigated several incidents and accidents in which there were malfunctions involving evacuation systems. In developing safety recommendations for these events, NTSB staff performed a historical review of past accidents involving similar malfunctions. Included in this paper are descriptions for each of the accidents/incidents cited by the Safety Board in its recommendations to the Federal Aviation Administration (FAA) as well as summaries of subsequent correspondence between the NTSB and FAA concerning the recommendations.

ACCIDENT/INCIDENT SUMMARIES

San Juan, Puerto Rico (Airbus A300)

On July 9, 1998, about 1007 Atlantic standard time, an Airbus Industrie A300B4-605R, operated by American Airlines, Inc., (American) as flight 574, experienced a fire in the No. 1 (left) engine shortly after takeoff from San Juan, Puerto Rico. The flight crew declared an emergency, initiated the in-flight engine fire procedures, and returned to San Juan for an emergency landing. After the plane was stopped on the runway, the captain ordered an emergency evacuation. Of the 252 passengers and crewmembers on board, 28 passengers received minor injuries during the evacuation.

During the emergency evacuation, four of the eight exits were not used because of the engine fire or the emergency response vehicles that blocked the airplane's four left side exits. Flight attendants attempted to open the four right side exits; however, two of those exits (1R and 3R) did not operate as intended. The flight attendant at the 1R door said that when he attempted to open the door it only went "out one foot and forward a foot." He stated that he had "to pull it back again and then gave it a big push in order to unjam the slide [slide/raft] from the door. At that time the slide opened." Postincident

examination revealed that the power assist actuator did not function when the door was opened in the emergency mode.

The flight attendant at the 3R door stated that he tried to open the door but it did not fully open and the slide did not deploy. He said that he "pushed several times and it didn't budge." He explained that he "knew [the slide] was caught up" in the pack. Postincident testing conducted by the National Transportation Safety Board indicated that the malfunction might have been caused by a Velcro fastener that became hooked on a clip on the inside of the decorative cover.[1]

Exits 2R and 4R opened normally, but the 4R slide/raft was blown on its side by the wind and could not be used until it was stabilized by a person on the ground. Further, although the left side exits were not used during the evacuation, exit 1L was opened slightly by the purser to assess conditions outside the airplane. Postincident testing revealed that the power assist actuator for exit door 1L did not activate when the door was opened in the emergency mode.

The Safety Board is concerned that, of the four emergency exits that the flight attendants attempted to use during the emergency evacuation, two (1R and 3R) did not function as intended. Further, another door (1L) did not function as intended when it was partially opened to assess conditions on the left side of the airplane. The problems encountered in this evacuation are especially troubling because it is common during emergency evacuations for some exits to become unavailable for unforeseen reasons (such as a fire on one side of an airplane);[2] therefore, it is critical that all emergency exits and slide/rafts be capable of operating properly at all times.

Tampa, Florida (Boeing 727)

On November 6, 1986, a Pan American 727 was involved in a ground collision with a Piper PA23-150 in Tampa, Florida; two of the four floor level exits (1L and 2R) did not function as intended. The flight attendant at exit 2R was able to open the door only 9 inches. During the postaccident investigation, the door required eight separate pushes to be opened. Another flight attendant had difficulty opening exit 1L. The Safety Board's investigation revealed that decorative carpeting installed on the slide covers caused increased resistance that could prevent proper slide deployment.[3]

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[1]A photograph taken by a passenger shows an exterior view of exit 3R and the partially deployed slide. The Survival Factors Group conducted several tests to replicate the condition shown in the photograph. One test, in which a Velcro positioner on the evacuation slide was deliberately hooked around an aft retention clip on the evacuation slide's decorative cover, prevented the exit from opening fully and caused the slide pack to be positioned in a manner similar to that shown in the passenger's photograph. The retention clip was supposed to have been removed per Airworthiness Directive (AD) 92-10-06, which also required installation of "wear strip with rivets on both sides of decorative cover."

[2]In addition, dual-aisle airplanes may be dispatched with an inoperative passenger door or slide/raft according to the airplane's minimum equipment list (in some cases, passenger-load restrictions may apply). Single-aisle airplanes may not be dispatched with an inoperative passenger door, slide, or slide/raft.

[3]As a result of this accident, the Safety Board issued Safety Recommendation A-87-26, asking the Federal Aviation Administration (FAA) to "alert the FAA principal maintenance inspectors of the operators with airplanes that have door-mounted evacuation slide containers to verify that any modified slide containers

Detroit, Michigan (Boeing 747)

On February 11, 1987, a United Airlines (United) 747 diverted to Detroit, Michigan, after receiving a bomb threat. An evacuation was initiated after landing. Problems were encountered at 2 of the 10 emergency exits. Exit 4R did not operate as intended because the door's pneumatic assist device failed to operate; it had to be opened manually. The slide/raft did not inflate automatically, and the flight attendant blocked that exit and redirected passengers to other exits. Exit 5R could not be used because a flight attendant inadvertently disconnected the slide/raft from the door.[4]

Romulus, Michigan (DC-9)

On December 3, 1990, a Northwest Airlines DC-9 was involved in a ground collision with a Northwest Airlines 727 in Romulus, Michigan. A fire ignited inside the DC-9 when the 727's right wing penetrated the right side of the DC-9 cabin. Of the DC-9's five emergency exits (two floor level exits, two overwing exits, and one tailcone exit), two right side exits were unusable because of severe structural damage and the tailcone exit malfunctioned and did not open. The bodies of a flight attendant and a passenger were recovered in the tailcone of the airplane. During the investigation, it was discovered that the internal tailcone release handle was broken, thereby preventing the tailcone from releasing and the slide from deploying.[5]

Guatemala City, Guatemala (Boeing 767)

On April 5, 1993, a Taca International Airlines 767 crashed while landing on a wet runway in Guatemala City, Guatemala. The airplane could not stop and it exited the runway, went through the perimeter fence, traveled down a hill, and struck several private residences before it came to rest. The airplane was successfully evacuated; however, the left overwing escape slide compartment did not open when the emergency exit hatch was opened by a passenger. The slide compartment did not open because one of the four latches that keeps the compartment closed was installed upside-down.[6]

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open freely and without resistance or interference." This recommendation was classified "Closed—Acceptable Action" on April 12, 1988.

[4]For more information read *Flight Attendant Training and Performance During Emergency Situations* Special Investigation Report NTSB/SIR-92/02.

[5]As a result of this accident, the Safety Board issued Safety Recommendation A-91-3, asking the FAA to "immediately require a fleet-wide inspection of all DC-9 tailcone assemblies…require detailed visual examinations of the interior and exterior tailcone release handles for broken or cracked shafts and for damage from contact with the lock cable ball-end fitting…and require that damaged handles be repaired or replaced." This recommendation was classified "Closed—Acceptable Action" on August 2, 1991.

[6]As a result of this accident, the Safety Board issued Safety Recommendations A-93-66 through -68. Safety Recommendation A-93-66 asked the FAA to "issue an emergency airworthiness directive to inspect all Model 767 and Model 747 series airplanes for improper installation of the off-wing escape slide compartments latches." It was classified "Closed—Acceptable Alternate Action" on October 11, 1994. Safety Recommendation A-93-67 asked the FAA to "issue an immediate revision to Airworthiness Directive 92-16-17 to include the additional information provided in Revision 1 to Service Bulletin [SB] 767-25A0174, which provides operators information on how to install the escape slide compartment door

East Granby, Connecticut (MD-83)

On November 12, 1995, an American MD-83 landed short of the runway at East Granby, Connecticut, after contacting trees and an instrument landing system antenna during final approach. A flight attendant reported that after he opened the aft galley exit, the slide did not automatically inflate. He pulled the manual inflation cable and the slide inflated. During the investigation, the Safety Board found that the slide was misrigged and that the instructions for rigging the inflation cable contained in the McDonnell Douglas DC-9/MD-80 maintenance manual were ambiguous.[7]

Grand Rapids, Michigan (Boeing 737)

On November 18, 1996, a 737-222, operated by United as flight 422, was evacuated at Grand Rapids, Michigan, because of a possible fire in the No. 2 engine. Eighty-two passengers and five crewmembers were on board. A 79-year old passenger fractured her ankle during the evacuation. Of the airplane's four floor level exits, three (1L, 2L, and 2R) did not operate as intended.

When the 1L door was opened, the evacuation slide deployed but it did not inflate. The flight attendant pulled the slide's manual inflation handle but could not inflate the slide. The first officer also had difficulty pulling the manual inflation handle but, with about "80 pounds of pull," he was able to manually inflate the evacuation slide.

The flight attendant who attempted to open the 2L exit stated that the door handle was difficult to move and that after she called for help, a male passenger assisted her. She and the passenger each used their hands to rotate the exit door's handle, but they were unable to fully open the door. The 2L evacuation slide subsequently fully inflated inside the cabin, blocking exits 2L and 2R.

The flight attendant who opened the 2R exit stated that she rotated the door handle to the full-open position but had to push on the door about seven times before the door swung out and locked in its open position. When the slide did not inflate automatically after 3 to 4 seconds, she pulled the manual inflation handle; the slide immediately inflated, and she evacuated five to eight passengers from the 2R exit before she was forced to evacuate when the 2L slide inflated into the space at the 2R exit.

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latches properly." It was classified "Closed—Acceptable Action" on October 11, 1994. Safety Recommendation A-93-68 asked the FAA to "require Boeing to modify Model 767 and Model 747 escape slide compartment door latches to prevent the possibility of incorrect installation." It was classified "Closed—Unacceptable Action" on October 11, 1994.

[7]As a result of this accident, the Safety Board issued Safety Recommendation A-96-138, asking the FAA to "require all operators to inspect immediately all MD-80 and DC-9 floor level exits to ensure that the evacuation slides have been properly rigged," and Safety Recommendation A-96-139, asking the FAA to "require Douglas Aircraft Company to review and amend its MD-80 and DC-9 maintenance manuals so that terminology used in graphics and instructions pertaining to the installation and removal of evacuation slides are clear and consistent." Both recommendations were classified "Closed—Acceptable Action" on August 26, 1997.

The cause of the problems at exits 1L, 2L, and 2R was never conclusively determined. United conducted postevacuation testing (without Safety Board participation) and, based on those tests, attributed the difficulties in opening the doors to the Velcro material that was attached to the slide girts to hold the girt bar in position.[8] There is also some evidence that the difficulties in opening these doors might have been related to shrinkage of nylon webbing reinforcement on the slide girts. The slide girts at 1L, 2L, and 2R were constructed with stitched nylon webbing reinforcements that had shrunk from their original length, whereas the slide girt at exit 1R (which functioned properly) had been replaced with a girt with folded edge reinforcements.[9]

Honolulu, Hawaii (L-1011)

On August 7, 1997, a Delta Air Lines (Delta) Lockheed L-1011 performed a rejected takeoff in Honolulu, Hawaii. After the airplane came to a stop, a wheel/brake fire occurred in the left main landing gear, and an evacuation was initiated. Of the airplane's eight floor level exits, two (2R and 4R) did not function properly and could not be used. Further, two of the remaining exits (3L and 4L) were not used because of the fire on the left side of the airplane. Two hundred ninety-six passengers and 13 crewmembers evacuated. One passenger sustained a serious injury, and 56 passengers and 2 flight attendants sustained minor injuries during the evacuation.

Exit door 2R opened approximately 24 inches, which was not sufficient to eject the slide/raft pack from its compartment. The door's counterbalance was removed and returned to its manufacturer for a teardown inspection under Safety Board supervision; it was determined that the "unit had reduced output torque and ran rough throughout the entire cycle." Disassembly revealed that 1 of the 18 springs was broken, and the main bearing races were significantly worn.

[8]United conducted and videotaped a series of slide deployment tests on aft cabin doors, the first of which revealed that in three of the five slide deployments, "the slide became jammed between the door and the bottom of the door opening. This did not allow the door to open fully and would not allow the slide to deploy." United concluded that "the Velcro [material] attached to the girt (to hold the girt bar in position) could contribute to jamming of the door" because it caused the girts to be more rigid and resistant to separating during slide deployment, and the Velcro made the girt thicker and possibly interfered with and/or jammed the door when attempting to open the door. The Velcro (which was part of the original slide design) was removed, and four subsequent tests resulted in normal deployment.

[9]In 1985, as a result of a 737 accident at Manchester, England, Boeing issued SB 737-25A1182, which stated that "[i]nvestigation has also disclosed that nylon webbing reinforcement installed on some slide girts may shrink. During door opening the shrunken girt may become taut before the latch assembly cable, thereby restricting further opening and preventing the deployment of the slide." As a result, the FAA issued AD 85-25-04, which required the inspection and modification and functional testing of 737-100, 200, and 300 escape slide containers and an inspection of the girt for nylon webbing reinforcement along forward and aft edges of girt. If webbing was noted, the AD required that the operator "replace the slide or replace the girt." Although United did not, at that time, replace the slides or girts that had such webbing, it did make several other modifications to the evacuation slides. The FAA issued United an Alternate Means of Compliance for AD 85-25-04.

Exit door 4R opened approximately 2 to 3 inches. It was found that the lower left corner of the slide packboard assembly was cracked and that a piece of the packboard had broken free along the edge of the girt bar retainer and prevented the door from opening. The investigation revealed that the door would operate normally in the emergency mode without the evacuation slide engaged in the girt assembly.

Manchester, United Kingdom (DC-10)

On March 8, 1998, a Continental DC-10 in Manchester, United Kingdom, was evacuated because of a fuel spill discovered as the airplane was taxiing to the runway. All eight doors were successfully opened, but only six of the evacuation slide/rafts deployed and inflated normally. Two slide/rafts (1R and 3L) did not operate as intended. The slide/raft at exit 1R had low inflation pressure, and ground personnel were required to assist at the bottom to maintain a usable slide/raft. According to the slide/raft manufacturer, the likely cause for the low inflation pressure was improper functioning of the regulator valve from one of the slide/raft's aspirators.

At exit 3L, the offwing slide/raft portion of the escape system did not inflate. The ramp portion (which inflates on top of the left wing) inflated normally. The cabin crewmember at that exit was not aware that the offwing slide/raft had not inflated and sent passengers onto the left wing ramp. After it was discovered that the offwing slide/raft had not inflated, passengers were reboarded from the left wing ramp and directed to other exits. According to the Air Accident Investigation Branch of the United Kingdom, the cause of the malfunction was an unconnected inflation cable.

Burbank, California (Boeing 737)

On March 5, 2000, about 1811 Pacific standard time, Southwest Airlines flight 1455, a Boeing 737-300, overran the departure end of runway 8 after landing at Burbank Glendale Pasadena Airport, Burbank, California. The airplane touched down at approximately 181 knots, and about 20 seconds later, at approximately 32 knots, collided with a blast fence and an airport perimeter wall and came to rest on a city street outside of the airport property. During the accident sequence, the forward service door (1R) slide inflated inside the airplane, the nose gear collapsed, and the forward flight attendant jumpseat, which was occupied by two flight attendants, partially collapsed. There was no postaccident fire. Of the 142 persons on board, 2 passengers sustained serious injuries; 41 passengers and 1 flight crewmember sustained minor injuries; and 94 passengers, 3 flight attendants, and 1 flight crewmember were uninjured. The airplane sustained substantial damage.

The escape slides on Boeing 737 doors are restrained by a rigid plastic slide cover that is attached to the door by a hinge along the top edge and by two U-shaped slide cover latch brackets along the bottom edge. One of the brackets is attached to the slide cover, and the other is attached to the bottom edge of the door. The two brackets mate, and a latch connects and secures the brackets with pins. The slide therefore stays inside the slide cover when the cover is closed. The latch is connected to a girt bar by a stainless steel

chain. When the girt bar is inserted into its brackets ("armed" mode) and the door is opened, the chain pulls on the latch, releasing the pins, and the brackets separate. The brackets then disengage from each other, and the slide pack slips out of the slide cover and is suspended over the door sill. The weight of the slide pack tensions an automatic inflation lanyard, which discharges an inflation bottle that is contained in the slide pack, and the slide inflates.

The Safety Board's investigation revealed that the 1R slide cover latch had disengaged from the brackets, allowing the slide pack to slip out of the cover and onto the galley floor, and that the slide inflated inside of the airplane.[10] Flight attendants reported that the slide began inflating while the airplane was still moving. The investigation determined that the inflation most likely was triggered by the airplane swerving to the right during the hard braking phase of the accident sequence. The weight of the uninflated slide as it moved left during this swerve apparently exerted sufficient force on the inflation lanyard to discharge the inflation bottle and inflate the escape slide. Therefore, the slide cover latch must have disengaged from the brackets before the swerve. The inflated slide extended nearly across the entire width of the airplane, blocking the aisle from the passenger cabin to both forward door exits (1R and 1L) and preventing the two flight attendants seated on the forward jumpseat from assisting in the evacuation. The escape slide was not deflated until after the evacuation (using the overwing exits and the 2L door exit) was complete.

The Safety Board issued two recommendations asking the FAA to issue an airworthiness directive to replace the slide cover latch brackets on some Boeing 737 airplanes (A-01-12) and to require initial and periodic inspections of the brackets (A-01-13). The FAA responded by stating that a Notice of Proposed Rulemaking (NPRM) will be issued for an airworthiness directive and that the FAA is working with Boeing "to determine an appropriate course of action" to address recommendation A-01-13. Both recommendations have been classified as "Open – Acceptable Action" by the Safety Board.

Detroit, Michigan (Airbus A320)

On March 17, 2001, about 0708 eastern standard time, an Airbus Industrie A320-200, operated by Northwest Airlines as flight 985, ran off the runway and onto terrain during a rejected takeoff at the Detroit Metropolitan Wayne County Airport, Detroit, Michigan. The captain, copilot, 4 flight attendants, and 145 passengers were not injured. Three passengers reported minor injuries that occurred during the emergency evacuation. The airplane sustained substantial damage.

The flight crew reported that during the takeoff roll, at an airspeed of about 110 knots,[11] the nose of the airplane began to lift off the runway. The captain attempted to lower the nose and, because he believed that the airplane was unresponsive, reduced power on both

[10] Examination of the escape slide components revealed no anomalies with the 1R escape slide, slide cover, or deployment linkage.
[11] The rotation speed for this flight was 148 knots.

engines. The airplane then became airborne and climbed a few feet. As the airplane returned to the runway, the tail of the airplane struck the runway. The airplane traveled about 400 feet off the end of the 8,500-foot runway and came to rest in muddy terrain. An emergency evacuation was then performed.

During the evacuation, three of the four floor-level emergency exits operated as designed. However, the emergency evacuation slide/raft at door 2L separated from the airplane and fell to the ground when the flight attendant opened the door. The flight attendants then redirected passengers to door 2R.

Airbus Industrie A319, A320, and A321 airplanes that are over-water equipped, like the accident airplane, have a slide/raft at each floor-level emergency exit that is attached to the door by a packboard. Attached to the slide/raft are a fabric girt and telescopic girt bar. The telescopic girt bar enables the slide/raft pack to be removed from one floor-level exit's floor fittings and deployed outside the airplane from another door, if necessary, in the event of a ditching and emergency evacuation in the water.[12] When the door is "armed," the girt bar is attached to the floor fittings on the doorsill so that when the door is opened, the girt bar will pull on the slide/raft and initiate its deployment. When the door is "disarmed" and opened, the girt bar remains attached to and moves with the door, thereby preventing the slide/raft from deploying.

The telescopic end of the girt bar is locked in the extended position by a spring-loaded trigger. (Figure 2 shows the telescopic end of the girt bar.) Squeezing the trigger causes the trigger locking mechanism to retract within the telescopic end of the girt bar, allowing it to slide into the stationary portion of the girt bar and shorten the overall length of the girt bar so that the slide/raft can be removed from the floor fittings. The stationary portion of the girt bar is designed to have a chamfer (beveled edge) that measures 0.50 millimeter (mm) on the horizontal surface by 0.50 mm on the vertical surface, +/- 0.10 mm, where the end of the trigger locking mechanism contacts this portion of the girt bar. In addition, the end of the trigger locking mechanism is designed to have a 7º cutback to provide for better contact with the stationary portion of the girt bar when it is locked in the extended position.

The girt bar is designed so that the exposed end of the trigger locking mechanism overlaps and will contact the stationary portion of the girt bar to prevent retraction. The Safety Board's investigation determined that the amount of chamfer on the stationary portion of the girt bar can directly impact the effectiveness of the engagement between the trigger locking mechanism and the stationary portion of the girt bar. Specifically, an increase in the amount of chamfer reduces the amount of overlap between the two surfaces and thus reduces the likelihood of a secure engagement between the two surfaces and increases the possibility of unintended retraction of the telescopic girt bar.

[12] Airbus Industrie A319, A320, and A321 airplanes that are not over-water equipped have slides and nonretractable girt bars.

Postaccident examination of the accident airplane's 2L telescopic girt bar[13] revealed that its chamfer was approximately 0.77 mm on the horizontal surface by 0.93 mm on the vertical surface instead of 0.50 mm by 0.50 mm. When the 2L door was opened in the "armed" mode, the force of the door opening apparently caused the trigger locking mechanism to slide over the improperly chamfered surface, which allowed the telescopic end of the girt bar to retract within the stationary portion of the girt bar. This retraction allowed the aft end of the girt bar to slip from its floor fitting and rotate forward. This movement and the weight of the slide/raft pulled the forward end of the girt bar from its floor fitting and caused the uninflated slide/raft pack to separate completely from the airplane and fall to the ground. Although the 1L and 2R doors opened and the slides/rafts deployed normally, the Safety Board's investigation also revealed the presence of improperly chamfered girt bars on those two doors.[14] The Board is concerned that the potential existed for slide/raft separations at these doors as well. If this had occurred, three of the four floor-level emergency exits on the accident airplane would have been unusable by passengers during the evacuation.

As a result of this ongoing investigation, the Safety Board has issued two recommendations to the FAA that airworthiness directives be issued to identify any girt bars that have been improperly manufactured.[15] Both the DGAC of France and the FAA have issued airworthiness directives to modify the girt bars as an interim measure as Airbus develops a long-term solution for this problem. Both recommendations are currently classified "Open – Acceptable Alternate Action."

[13] The accident airplane was equipped with telescopic girt bars and slides/rafts at doors 1L, 1R, 2L, and 2R.

[14] The chamfers of the 1L and 2R bars were approximately 0.32 mm on the horizontal surface by 0.69 mm on the vertical surface and 0.54 mm on the horizontal surface by 0.75 mm on the vertical surface, respectively.

[15] A-01-27 recommended that the FAA "immediately issue an emergency airworthiness directive to require operators of over-water equipped Airbus A319, A320, and A321 airplanes with manually chamfered girt bars to

(1) Ensure that the dimensions of the surfaces of the trigger locking mechanism and the stationary portion of the girt bars conform to the design specifications;

(2) Perform a reliable functional test to demonstrate the proper engagement of manually chamfered girt bars under realistic door opening conditions; and

(3) Repair or replace any girt bars that do not meet the dimensional requirements or do not pass the functional test, before the airplane is returned to service." A-01-28 recommended that the FAA "issue an airworthiness directive to require operators of over-water equipped Airbus Industrie A319, A320, and A321 airplanes with machine-chamfered girt bars to, by the next scheduled maintenance activity,

(1) Ensure that the dimensions of the trigger locking mechanism and the stationary portion of the girt bars conform to the design specifications;

(2) Perform a reliable functional test to demonstrate proper engagement of the girt bars under realistic door opening conditions; and

(3) Repair or replace any girt bars that do not meet the dimensional requirements or do not pass the functional test, before the airplanes are returned to service."

ADEQUACY OF EXISTING EMERGENCY EVACUATION SYSTEM MAINTENANCE PROGRAMS

All U.S. air carriers have an FAA-approved maintenance program for each airplane type that they operate. These programs require that the components of an airplane's emergency evacuation system be periodically inspected and/or serviced. An FAA principal maintenance inspector (PMI) approves the air carrier maintenance program based on guidance in the FAA Inspector Handbook 8300.10 and the Maintenance Review Board (MRB) report.[16] Maintenance programs may differ between airlines at the discretion of the PMI assigned to the air carrier.

Although most air carrier maintenance programs require that some percentage of emergency evacuation slides or slide/rafts be deployed on an airplane, the overall percentage of required on-airplane deployments is generally very small. For example, American's FAA-approved maintenance program for the A300[17] requires an on-airplane operational check of a total of four slides or slide/rafts (with the door in the armed/emergency mode) per year in the A300 fleet.[18] Delta's FAA-approved maintenance program for the L-1011 requires that Delta activate a full set of emergency exits and evacuation slides or slide/rafts every 24 months. United has an FAA-approved maintenance program that does not require that any slides be deployed on its 737 airplanes.

It should be noted that the FAA allows American to include inadvertent and actual emergency evacuation deployments towards accomplishment of its maintenance program; therefore, it is possible that American would not purposely deploy any slides or slide/rafts on an A300 to comply with the deployment requirement during any given year. The FAA also allows Delta to include inadvertent and actual emergency evacuation deployments towards accomplishment of its maintenance program.[19] The Safety Board is concerned that the FAA allows operators to include inadvertent and actual deployments to meet the deployment requirements found in their maintenance programs. Because inadvertent and actual deployments do not occur in a controlled environment, problems with, or failures in the system may be more difficult to identify and record, and personnel qualified to detect such failures may not be present. For example, in an inadvertent or actual slide or slide/raft deployment such things as the effectiveness of the power assist actuator, the timing of the slide or slide/raft inflation, and the slide or slide/raft inflation pressure most likely will not be observed or recorded. Therefore, the current practice of

[16]An MRB report "outlines the initial minimum maintenance/inspection requirements to be used in the development of an approved continuous maintenance program for the…components…of the (aircraft make, model, and series)."

[17]Per American's Maintenance Planning Document, "Engineering Specification Maintenance A300," page 25-9, Revision BF, December 17, 1998.

[18]American currently operates 35 A300 series airplanes. Therefore, American must perform an operational check on 4 out of 280 A300 slides or slide/rafts per year.

[19]The 1991 MRB report for the L-1011 recommended that operators activate (on the airplane) all L-1011 door evacuation systems (including slide/raft deployment) every time an individual slide/raft becomes due for an operational check, inspection, or repack, or at least every 3 years, whichever is earlier.

allowing inadvertent and actual slide or slide/raft deployments to be counted as part of maintenance programs does not provide adequate information about the interaction of the slide or slide/raft with the door or the effectiveness of power assist opening systems, nor does it provide feedback on the effectiveness of crew training mock-ups. Accordingly, the Safety Board recommended that the FAA should "discontinue the practice of allowing inadvertent and actual slide or slide/raft deployments to be used as a method of demonstrating compliance with an air carrier's Federal Aviation Administration-approved maintenance program." (A-99-99)

Additionally, the Safety Board recommended that the FAA, "for a 12-month period, should require that all operators of transport-category aircraft demonstrate the on-airplane operation of all emergency evacuation systems (including door opening assist mechanisms and slide or slide/raft deployment) on 10 percent of each type of airplane (minimum of one airplane per type) in their fleets. These demonstrations should be conducted on an airplane in a controlled environment so that the entire evacuation system can be properly evaluated by qualified personnel. The results of the demonstrations (including an explanation of the reasons for any failures) should be documented for each component of the system and should be reported to the FAA." (A-99-100) The Safety Board also believes that the FAA should revise the requirements for evacuation system operational demonstrations and maintenance procedures in air carrier maintenance programs to improve the reliability of evacuation systems on the basis of an analysis of the demonstrations recommended in Safety Recommendation A-99-100. (A-99-101)

The FAA responded to recommendation A-99-99 in a December 4, 2000 letter stating that "slide/raft deployments, inadvertent or otherwise, are not used as maintenance program compliance demonstrations." The Safety Board disagreed with the FAA on this point and provided a copy of one carrier's maintenance manual that states, for several of the different types of aircraft in the operator's fleet, that "inadvertent deployment[s] may be utilized in satisfying this requirement."

In response to A-99-100, the FAA formed an emergency evacuation system response team composed of FAA/industry representatives to examine ten years of service difficulty reports (SDRs) with evacuation systems and analyze the data. The December 4, 2000 letter stated that the "plan currently being implemented calls for the development of a new operations specifications paragraph entitled "Emergency Evacuation Systems Maintenance Program Requirements," a handbook bulletin, and AC… The FAA anticipates issuing the AC in February 2001."

The Safety Board disagrees with the use of SDRs for this purpose. The Safety Board is aware that the Service Difficulty Report system is currently in place as a mechanism for air carriers to report failures, malfunctions, and defects of airplanes; however, the Safety Board is concerned that the current requirements to report evacuation equipment failures through the SDR system may not be adequate to identify recurring failure modes. During the investigation of the American Airlines A-300 incident in San Juan, Puerto Rico, Safety Board staff reviewed SDR reports for many accidents and incidents listed above and found that the explanations for some problems are misleading or inaccurate. For

example, the SDR entry for the Honolulu, Hawaii, L-1011 rejected takeoff reports a "slide malfunction" at the 4R door. It states, "Four right door did not open and the slide did not deploy during evacuation. Found 'T' handle not fully deployed, Ops. Check normal." The SDR entry fails to mention that a piece of the slide/raft's packboard had broken off and prevented the door from fully opening. The Safety Board has also found, on numerous occasions, that the SDR system is substantially incomplete and has previously issued Safety Recommendations A-93-61 through -64 to address this issue.[20]

CONCLUSION

Because of the continued malfunctions that occur on all airplane types during actual emergency evacuations,[21] it is apparent that current maintenance practices and operational checks do not adequately ensure that emergency evacuation systems will operate as intended in the event of an actual emergency evacuation. Therefore, the Safety Board believes more aggressive measures are needed by the FAA to identify and correct potential malfunctions in emergency evacuation systems before those systems are needed in an actual emergency evacuation.

[20]On June 3, 1993, the Safety Board issued Safety Recommendations A-93-61 through -64. Safety Recommendation A-93-61 asked the FAA to "establish standardized reporting formats...that include the capability for electronic submission." It was classified "Open—Acceptable Response" on February 7, 1996. Safety Recommendation A-93-62 asked the FAA to "encourage all persons or organizations that operate under 14 C[ode of] F[ederal] R[egulations] Parts 43 and 91 to submit Malfunction or Defect Reports and provide appropriate guidance to improve the quality and content of the general aviation service difficulty database." It was classified "Closed—Acceptable Action" on February 16, 1994. Safety Recommendation A-93-63 asked the FAA to "ensure that prompt analysis of service difficulty reports and dissemination of alerting information is being accomplished." It was classified "Closed—Acceptable Action" on February 16, 1994. Safety Recommendation A-93-64 asked the FAA to "encourage foreign regulatory agencies to provide service difficulty data from resident operators and manufacturers to the FAA for incorporation into the FAA service difficulty database." It was classified "Closed—Acceptable Action" on February 16, 1994.

[21]For more information, please read NTSB/SS-00/01 "Safety Study: Emergency Evacuation of Commercial Airplanes"