4. Recommendations

As a result of the investigation of the USAir flight 427 accident, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

Require that all existing and future Boeing 737s have a reliably redundant rudder actuation system. (A-99-20)

Convene an engineering test and evaluation board to conduct a failure analysis to identify potential failure modes, a component and subsystem test to isolate particular failure modes found during the failure analysis, and a full-scale integrated systems test of the Boeing 737 rudder actuation and control system to identify potential latent failures and validate operation of the system without regard to minimum certification standards and requirements in 14 Code of Federal Regulations Part 25. Participants in the engineering test and evaluation board should include the Federal Aviation Administration (FAA); National Transportation Safety Board technical advisors; the Boeing Company; other appropriate manufacturers; and experts from other government agencies, the aviation industry, and academia. A test plan should be prepared that includes installation of original and redesigned Boeing 737 main rudder power control units and related equipment and exercises all potential factors that could initiate anomalous behavior (such as thermal effects, fluid contamination, maintenance errors, mechanical failure, system compliance, and structural flexure). The engineering board's work should be completed by March 31, 2000, and published by the FAA. (A-99-21)

Ensure that future transport-category airplanes certificated by the Federal Aviation Administration provide a reliably redundant rudder actuation system. (A-99-22)

Amend 14 Code of Federal Regulations Section 25.671(c)(3) to require that transport-category airplanes be shown to be capable of continued safe flight and landing after jamming of a flight control at any deflection possible, up to and including its full deflection, unless such a jam is shown to be extremely improbable. (A-99-23)

Revise Airworthiness Directive 96-26-07 so that procedures for addressing a jammed or restricted rudder do not rely on the pilots' ability to center the rudder pedals as an indication that the rudder malfunction has been successfully resolved, and require Boeing and U.S. operators of Boeing 737s to amend their Airplane Flight Manuals and Operations Manuals accordingly. (A-99-24)

Require all 14 Code of Federal Regulations Part 121 air carrier operators of the Boeing 737 to provide their flight crews with initial and recurrent flight simulator training in the "Uncommanded Yaw or Roll" and "Jammed or Restricted Rudder" procedures in Boeing's 737 Operations Manual. The

training should demonstrate the inability to control the airplane at some speeds and configurations by using the roll controls (the crossover airspeed phenomenon) and include performance of both procedures in their entirety. (A-99-25)

Require Boeing to update its Boeing 737 simulator package to reflect flight test data on crossover airspeed and then require all operators of the Boeing 737 to incorporate these changes in their simulators used for Boeing 737 pilot training. (A-99-26)

Evaluate the Boeing 737's block maneuvering speed schedule to ensure the adequacy of airspeed margins above crossover airspeed for each flap configuration, provide the results of the evaluation to air carrier operators of the Boeing 737 and the National Transportation Safety Board, and require Boeing to revise block maneuvering speeds to ensure a safe airspeed margin above crossover airspeed. (A-99-27)

Require that all Boeing 737 airplanes operated under 14 Code of Federal Regulations Parts 121 or 125 that currently have a flight data acquisition unit be equipped, by July 31, 2000, with a flight data recorder system that records, at a minimum, the parameters required by Federal Aviation Administration Final Rules 121.344 and 125.226, dated July 17, 1997, applicable to that airplane plus the following parameters: pitch trim; trailing edge and leading edge flaps; thrust reverser position (each engine); yaw damper command; yaw damper on/off discrete; standby rudder on/off discrete; and control wheel, control column, and rudder pedal forces (with yaw damper command; yaw damper on/off discrete; and control wheel, control column, and rudder pedal forces sampled at a minimum rate of twice per second). (A-99-28)

Require that all Boeing 737 airplanes operated under 14 Code of Federal Regulations Parts 121 or 125 that are not equipped with a flight data acquisition unit be equipped, at the earliest time practicable but no later than August 1, 2001, with a flight data recorder system that records, at a minimum, the parameters required by Federal Aviation Administration Final Rules 121.344 and 125.226, dated July 17, 1997, applicable to that airplane plus the following parameters: pitch trim; trailing edge and leading edge flaps; thrust reverser position (each engine); yaw damper command; yaw damper on/off discrete; standby rudder on/off discrete; and control wheel, control column, and rudder pedal forces (with yaw damper command; yaw damper on/off discrete; and control wheel, control column, and rudder pedal forces sampled at a minimum rate of twice per second). (A-99-29)