Log 2545

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 28, 1995

In reply refer to: A-95-30 through -34

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Approximately 2202 central standard time on November 22, 1994, a collision occurred at the intersection of taxiway romeo and runway 30R at the St. Louis/Lambert International Airport, St Louis, Missouri. The St. Louis weather conditions were reported to be clear, with visibility at 25 miles. The accident involved a Cessna 441, N441KM, and a McDonnell Douglas MD-80, Trans World Airlines flight 427 (TWA427). TWA427 was operating as a scheduled domestic passenger service flight from St. Louis to Denver, Colorado, under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121. N441KM was operating under the provisions of 14 CFR Part 91, under an instrument flight rules clearance to Iron Mountain, Michigan. Both airplanes were in radio communication with the tower local controller at the time of the accident. As a result of the collision, N441KM was destroyed and TWA427 received substantial damage. The pilot and passenger aboard N441KM were fatally injured, and there were eight injuries on TWA427.

The Safety Board's investigation of the accident is continuing. Information obtained to date indicates that N441KM landed on runway 30R at St. Louis and taxied to the ramp at the north side of the airport. After unloading a passenger, the pilot requested and was issued a clearance to Iron Mountain. The ground controller then instructed its pilot to backtaxi on runway 31, which is parallel to runway 30R. The ground controller also instructed the pilot to hold in position on runway 31 and to advise the controller when he was ready for takeoff. A little more than 3 minutes later, the ground controller inquired if the pilot was ready for takeoff. After receiving an affirmative response, the ground controller instructed the pilot to monitor the tower local control frequency.

While the pilot of N441KM was on the ground control frequency, the flightcrew of TWA427 had received their takeoff clearance on runway 30R. About 38 seconds after they acknowledged their takeoff clearance, the pilot of N441KM advised the local controller, "and kilo mike's ready to go on the right side." The local controller advised the pilot that she could not clear him simultaneously, "with the uh traffic departing on the right just continue holding in

position . . . " About 11 seconds after the pilot of N441KM acknowledged this transmission, the airplane was struck by TWA427 which was on takeoff roll on runway 30R.

The Safety Board is focusing on many areas during its investigation and has not concluded that any specific communication was causal to the accident. Notwithstanding, the Safety Board believes that the Federal Aviation Administration (FAA) should take action to make certain that air traffic controllers and pilots clearly understand the intentions and expectations of one another. Also, the Safety Board believes that had previous actions taken by the FAA to reduce the risk of runway collisions received adequate support, this accident could have been prevented. While FAA statistics indicate that the number of runway incursions has decreased yearly since 1991, the Safety Board believes that this accident illustrates that there is no margin for error for either pilots or controllers and that unresolved errors can lead to catastrophic results.

The Safety Board's concern about the hazards of runway incursions dates back to 1972 following an accident at the Chicago O'Hare International Airport. Since that time, the investigation of other such accidents or incidents has prompted the Safety Board to issue 61 safety recommendations focused on the prevention of runway incursions. At present, this issue is included as a part of the Safety Board's "Most Wanted" Safety Recommendation Program.

Following a runway collision at the Atlanta Hartsfield International Airport that occurred on January 18, 1990, involving an Eastern Airlines Boeing 727 and a King Air A100,[1] the Safety Board recognized FAA efforts to explore and test several advanced concepts in automated airport surface traffic detection. One of those efforts, the Airport Movement Area Safety System (AMASS) was, at that time, undergoing proof-of-concept testing at the Pittsburgh International Airport. The AMASS system uses data available from the Airport Surface Detection Equipment (ASDE-3) and Automated Radar Terminal System (ARTS) to identify potential incursions and alerts the controller so that timely corrective action can be taken.

In testimony before congressional committees on March 6, 1990,[2] the FAA stated that it had entered into a contract with Norden Systems, a designer and manufacturer of electronic equipment for the Department of Defense (DOD) and the FAA, for development of AMASS. In testimony, the FAA and Norden acknowledged that while AMASS was conceptual and would require refinements, it would be able to function as a "backstop" to detect, and provide alerts in, at least 29 scenarios during which a runway incursion was most likely to occur (over 90 percent of possible incursion scenarios). FAA testimony noted that because the project had congressional interest, it would be "fast-tracked" and not totally confined to the cumbersome and time-

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[1]Aircraft Accident Report--Runway Collision of Eastern Airlines Boeing 727, Flight 111 and Epps Air Service Beechcraft King Air A100, Atlanta Hartsfield International Airport, Atlanta, Georgia, January 18, 1990 (NTSB/AAR-91/03).

[2]Statement of FAA's Executive Director for System Development before the House Committee on Science, Space, and Technology, subcommittee on Transportation, Aviation and Materials, concerning runway incursions.

consuming acquisition hurdles of most projects, and as a result, it was anticipated that the project would be operational by 1992.

Following a preliminary design review during July 1991, work began on a pre-production prototype. This required input from staff from the FAA's Air Traffic Requirements Office, which provides operational requirements for new equipment. During October 1992, a "Demonstration/Validation" of the safety logic required for detecting the 29 situations during which a runway incursion could occur was provided to the air traffic requirements team. At that time, the system was capable of tracking 128 targets, but could be expanded to track 256 targets. During December 1992, live traffic testing began at the San Francisco International Airport. Concurrent with the decision for live traffic testing, the FAA's AMASS technical officer received a letter dated December 7, 1992, from the FAA's Director of Air Traffic Requirements. The letter outlined 30 modifications to AMASS hardware and software, 15 of which required substantial and additional funding, and would expand the time frame for the completion of the project. This letter also stated that additional requirement modifications would be forthcoming. Because a date for validation during April 1993 had been established, some changes that could be done quickly were accomplished. Ironically, most of the modifications were not associated with issues of increasing safety, but rather had to do with human [controller] interface. Some requirement changes went against the basic objective of the AMASS program; for example, one requirement called for the program to be able to inhibit specific targets from generating any type of alert, even though the target would normally qualify in an intrusion scenario. While it was envisioned initially that AMASS would be a virtual hands-off system for controllers, these, and other later modifications have created an AMASS system that may now be labor intensive, and could compromise its potential safety benefits.

During a December 1993 meeting which involved senior FAA staff associated with the AMASS project, the AMASS technical officer informed attendees that, of the new requirements submitted, eight could be accomplished with existing research and development (R&D) funds. The new requirements were accomplished and demonstrated at the Boston Logan International Airport, which had since received its ASDE-3 radar system. It was also noted that, of the eight new requirements, only one was safety related, and only one was applicable to those operations conducted at the Boston airport.

During February 1994, the AMASS project then transitioned from R&D funding to facilities and equipment (F&E) funding, which permitted the initiation of the formal specification review and formal acquisition process. This process dictated that the Air Traffic Requirements program manager submit a revalidated mission needs statement and operational requirements document, which enabled the AMASS program manager to set up the AMASS program for production. The mission needs and operational requirements document has not been received, and as a result, the AMASS program remains stalled.

Over $20 million has been spent so far on the AMASS project. At present, no AMASS systems are operational in the National Airspace System (NAS) at those airports envisioned to have the program before 1996. The Safety Board is concerned that progress of this important

project has been effectively paralyzed as a result of a succession of changes in operational specifications imposed from within the FAA's Air Traffic Service. Despite the involvement of staff from the Air Traffic Requirements office in every stage of the development and acquisition process, there appears to have been reluctance to establish firm and realistic requirements that would have kept the project on schedule. While the Safety Board recognizes that the input from the Air Traffic Requirements office is prudent and necessary, it would appear that factions within it are attempting to require that AMASS become something it was never intended to be. The Safety Board also believes that had this program continued, unencumbered by repeated requirement changes, AMASS would have been available for operational consideration during 1993. The Safety Board notes that AMASS hardware production continues, in anticipation of eventual installation.

The Safety Board believes that the AMASS project should move ahead immediately. Safety Board staff has observed the AMASS system in operation and is satisfied that it works. Of more concern is that the accident at St. Louis may have been prevented had AMASS been in use at that airport. On November 29, 1993, the FAA's National Runway Incursion Manager and members of his staff provided a briefing to Safety Board staff concerning the status of major FAA runway incursion initiatives. During this briefing, the FAA advised that while some problems had been encountered and some "slippage" had occurred, for the most part, all projects were on track and on target. The Safety Board is deeply concerned to learn that this has not been the case. The Safety Board also believes that the Air Traffic Service should provide a firm, finalized operational requirements document to the AMASS technical officer within 45 days from receipt of this letter. No further modifications should be implemented until after the first AMASS system is certified by the FAA as being ready for operation (commissioned).

The ASDE-3 and AMASS are interconnected. AMASS is not capable of being a stand-alone system. During the investigation of the accident at St. Louis, Safety Board investigators learned that the hard drive on the ASDE-3 system had failed, but because it had not been commissioned it did not receive priority for logistical support to implement timely repair.

During September 1989, the ASDE-3 was installed at the Pittsburgh International Airport, Pittsburgh, Pennsylvania, to become the first system in the NAS. Since that time, 23 sites, including St. Louis, have received the ASDE-3. The Safety Board is aware that the ASDE-3 has experienced some problems since it was first introduced. One of the earlier problems, which has since been resolved, was delamination of the antenna. Another problem was site specific where it was learned that the pedestal on which the antenna is mounted was improperly installed. Another problem that has been encountered, primarily at the Atlanta Hartsfield International Airport, has been a phenomenon called "multi-path," which is the generation of false targets from intense reflectivity from buildings or other natural obstructions on the surface of the airport. When augmented with AMASS, the generation of false targets could trigger false alerts in specific areas of the airport. However, this problem has been mitigated through the use of icons superimposed over the radar target of known aircraft. Almost all problems have either been corrected or resolved in some manner, although it is acknowledged that the system is not perfect.

At the time of this accident, the Safety Board learned that of those sites that have the ASDE-3, only one airport, the Seattle/Tacoma International Airport, in Seattle, Washington, had a commissioned system. This airport was selected by the FAA to be the premier facility for low visibility operations. Since this accident, Safety Board staff has learned that six other airports with the ASDE-3 system have been commissioned.

For the controller workforce, probably the most contentious issue surrounding the ASDE-3 system has been the design of the zoom feature on the ASDE-3 display, in which the target of the airplane may appear as several targets when magnified. It is analogous to looking at printed letters with the naked eye, in which the letters will appear to be a solid line, but when magnified, the print is broken into pixels (dots). This is not a design flaw, but rather a natural feature of high resolution radar such as the ASDE-3. While this impasse is not delaying the installation of ASDE-3 at those airports slated to get the system, the controversy over this issue has possibly served as the impetus for not commissioning those systems. However, it must be recognized that for those facilities that currently have the system in place, those controllers must operate with a substandard ground-based radar system or without the benefit of any surface detection system because commissioning has not occurred.

The Safety Board believes that unless there are compelling reasons not to commission those currently installed ASDE-3 radars, the FAA should do so immediately. Safety Board investigators note that the weather conditions that prevailed at St. Louis would not have, under current procedures, required that the ASDE-3 be operational; however, had it been, it is conceivable that the local controller would have been able to confirm the position of N441KM when advised, "ready to go on the right side." As stated earlier, had the ASDE-3 been augmented with AMASS processing, an alert would have been generated. The Safety Board believes that the FAA should require that the ASDE-3 be operational between sunset and sunrise, regardless of weather, and once AMASS processing is commissioned, it should operate 24 hours a day.

With regard to the St. Louis accident, the Safety Board notes that, after receiving his clearance to taxi, the pilot of N441KM did not read back his runway assignment during any subsequent transmissions, nor was he required to. When the pilot of N441KM advised the local controller that he was, "ready to go on the right side," it seems that this transmission should have prompted the local controller concern, since her next transmission also referred to, "on the right." This was the first indication to the local controller that the pilot of N441KM was in position on the wrong runway; however, at that moment, it is doubtful that there was time to clear runway 30R. Her failure to perceive the significance of his initial transmission may have been a result of her being advised by the ground controller that the pilot of N441KM had been instructed to expect to take off on runway 31 and her resultant expectation that the pilot was in position on the adjacent, parallel runway. In addition, the pilot, after being advised by the local controller, "I can't roll you simultaneously with the uh traffic departing on the right," did not realize that he had taxied into position on the wrong runway.

The intersection at which the pilot of N441KM entered runway 30R is about 2,000 feet from the departure end of runway 30R, where the flightcrew of TWA427 was initiating their takeoff roll. The communication from the pilot of N441KM to the local controller that he was, "ready to go on the right," may have been perceived by the flightcrew of TWA427 as a routine communication in that another pilot was advising the tower that he was ready to depart, in sequence, on runway 30R.

At present, voice communication is the primary interface between the controller and pilots, and common human performance failures make it one of the most vulnerable to error. Under the circumstances of this accident, it cannot be determined what the pilot of N441KM heard or understood. As a result of its 1986 study of airport runway incursions,[3] the Safety Board issued Safety Recommendation A-86-33, which asked the FAA to "require controllers to obtain a read back for all hold, takeoff, or crossing clearances and for clearances onto an active runway." The FAA reluctantly agreed to amend the ATC Handbook to require that controllers receive a readback of all runway hold short clearances. The FAA's primary concern was that this change would create additional frequency congestion during peak traffic periods. In 1993, the FAA informed the Board that during low visibility conditions, controllers would be required to obtain a readback from pilots to confirm an airplane's movement to cross or take off from an active runway. Based on this action, the Board classified Safety Recommendation A-86-33 "Closed--Acceptable Action." The Safety Board maintains that this change is responsible, in part, for the decrease in runway incursion incidents. However, this most recent accident demonstrates that additional measures are required.

At many airports in the United States, multiple runway configurations are used for arriving and departing aircraft. The Safety Board believes that for those airports that employ multiple runway configurations, to alleviate any misunderstandings or miscommunications, pilots should confirm their runway assignment when initially issued, by stating fully the runway assignment and any other instruction that requires the pilot to taxi on, near, or to a runway. Following any subsequent frequency changes, this procedure should again be employed until the flight is airborne. The Safety Board believes that the benefit of receiving an explicit confirmation of runway assignment from the pilot before receiving takeoff clearance will provide an extra measure of safety in that this procedure will allow the controller to eliminate those errors where a pilot has misunderstood his runway assignment and will enhance situational awareness on the part of other flightcrews that are landing or are to take off on that specific runway.

The FAA has two primary tools through which pilots can quickly be provided with fundamental flight information and air traffic control procedures. These are the Airman's Information Manual (AIM) and an Administrator's Letter to Airmen. Because clear and concise communications are the backbone to safety during ground operations, the Safety Board believes that the FAA should issue an Administrator's Letter to Airmen and should amend the AIM to

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[3]National Transportation Safety Board, Runway Incursions at Controlled Airports in the United States, NTSB/SIR-86/01.

encourage pilots to read back their runway assignment during ground operations until receiving their clearance for takeoff. The rationale for this procedure should be provided, in conjunction with specific examples of appropriate phraseology.

For air traffic controllers, FAA Order 7110.65, "Air Traffic Control," should be amended to require that controllers receive full acknowledgement of runway assignment and any clearance associated with the runway assignment when multiple runway configurations are employed. Under current procedures, the possibility that miscommunication may occur is greater because there is no requirement for the pilot to fully acknowledge such clearances. The Safety Board believes that during busy traffic periods, it is imperative that the controller receive confirmation that his instructions have been clearly understood. In addition, by having specific confirmation of the runway assignment and the pilot's actions stated on the radio frequency, the information becomes available to other flightcrews to enhance their situational awareness in a manner not otherwise available under current procedures.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Within 45 days of receipt of this letter, require that the Air Traffic Service provide a firm, finalized mission needs and operational requirements document for the Airport Movement Area Safety System. No further modifications should be implemented until after the first Airport Movement Area Safety System is commissioned. (Class II, Priority Action)(A-95-30)
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> Within 60 days of receipt of this letter, provide to the Safety Board a firm schedule to commission those Airport Surface Detection Equipment-3 radar systems that have been installed and adhere to that schedule. (Class II, Priority Action)(A-95-31)
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> For those air traffic control terminal facilities that commission the Airport Surface Detection Equipment-3, require that it be operational between sunset and sunrise. When the Airport Movement Area Safety System is commissioned, require that it be operational 24 hours a day. (Class II, Priority Action)(A-95-32)
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> Issue an Administrator's Letter to Airmen that directs pilots to read back, in full, their runway assignment upon receiving taxi instructions and before receiving their takeoff clearance when operating at airports that employ more than one runway. Also, revise the Airman's Information Manual to reflect this procedure. (Class II, Priority Action)(A-95-33)
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> Amend FAA Order 7110.65, "Air Traffic Control," to require that air traffic controllers receive confirmation of runway assignment from pilots after issuing

taxi instructions. Require that this procedure be used at those airports which employ more than one runway during operations. (Class II, Priority Action)(A-95-34)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in these recommendations.

By: Jim Hall
Chairman