National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 6, 2000

In reply refer to: A-00-66 through -71

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

In this letter, the National Transportation Safety Board recommends that the Federal Aviation Administration (FAA) take action to address the following safety issues related to runway incursions:[1] adequacy of ground movement safety systems and of air traffic control (ATC) procedures.

The Safety Board has issued numerous safety recommendations to the FAA since 1973 to prevent runway incursions and other airport surface incidents. On May 6, 1986, the Board issued a Special Investigation Report, titled "Runway Incursions at Controlled Airports in the United States."[2] In this report, the Board noted that the number of reported near-collision ground incidents had increased significantly and made several new safety recommendations to reduce the frequency of runway incursions. Several of these safety recommendations remained open when a fatal runway collision involving Eastern Airlines flight 111 (EAL111), a Boeing 727 (727), and N44UE, a Beechcraft King Air A100, occurred at Atlanta, Georgia, on January 18, 1990.[3] As a result, the Board placed airport runway incursions on its 1990 Most Wanted Transportation Safety Improvements List, and the issue has

[1] FAA Order 8020.11A, "Aircraft Accident and Incident Notification, Investigation and Reporting," defines a runway incursion as "any occurrence at an airport involving an aircraft, vehicle, person, or object on the ground, that creates a collision hazard or results in a loss of separation with an aircraft taking off, intending to take off, landing or intending to land."

[2] Special Investigation Report NTSB/SIR-86/01.

[3] N44UE was cleared for an instrument landing system (ILS) approach on runway 26R, and EAL111 was cleared for the same approach behind N44UE. Before N44UE was clear of the runway, EAL111 landed and struck N44UE. One person was killed, and one person was seriously injured.

remained on the list every year since then. Five fatal runway collisions have occurred since the EAL111/N44UE collision in 1990, killing a total of 62 people.[4]

The FAA tracks the number of runway incursions to measure the safety of runway operations. In the 1990s, the number of runway incursions per year in the United States ranged from a low of 186 in 1993 to a high of 325 in 1998. There were 321 reported runway incursions in the United States during 1999.[5] The number of incursions in 1999 was 71 percent greater than the number in 1993, and the incursion rate per 100,000 flight operations in 1999 was 56 percent greater than in 1993, despite a slight decrease in the number of runway incursions at the end of 1999. Between January 1 and May 31, 2000, there were 150 reported runway incursions in the United States, an average of 30 per month. If this trend continues, there will be approximately 360 runway incursions by the end of 2000.

In addition, the FAA expects aviation activity at FAA- and contract-towered airports to increase by more than 24 percent between fiscal years 1999 and 2010.[6] The Safety Board is concerned that the expected increase in air traffic activity may result in an increase in runway incursions. The Board is also concerned that runway incursions continue to occur despite the recommendations made in the Special Investigation Report, the inclusion of airport runway incursions on the Most Wanted Transportation Safety Improvements List for 10 years, and additional safety recommendations made as a result of the TWA427/N441KM and other fatal runway collision accidents. This letter summarizes the Board's rationale for issuing additional recommendations.

Background

Runway Incursions in 1999

The following are examples of serious runway incidents that occurred in 1999:

On April 1, 1999, about 0210 central standard time, Air China flight 9018 (CCA9018), a Boeing 747 (747), Chinese registration B2446, and Korean Air flight 036 (KAL036), a 747, Korean registration HL7493, were involved in a runway incursion on runway 14R at O'Hare International Airport (ORD), Chicago, Illinois. (Figure 1 shows a diagram of ORD with references to both airplanes' positions.) CCA9018, a cargo flight, had just landed and was rolling out on runway 14R when the ORD local controller instructed KAL036 to taxi into position and hold on runway 14R. After CCA9018 exited runway 14R at taxiway T10, the local controller cleared the flight to taxi to the cargo

[4] On December 3, 1990, Northwest Airlines flights 1482 and 299 collided at Detroit, Michigan. On February 1, 1991, USAir flight 1493 and Skywest flight 5569 collided at Los Angeles, California. On November 22, 1994, Trans World Airlines flight 427 (TWA427) and N441KM, a Cessna 441, collided at Bridgeton, Missouri. On November 19, 1996, United Express flight 5925 and N1127D, a Beechcraft A90, collided at Quincy, Illinois. On March 9, 2000, N79960, a Cessna 172, and N89827, a Cessna 152, collided at Sarasota, Florida. For more information, see Briefs of Accident DCA91MA010A/B, DCA91MA018A/B, CHI95MA044A/B, DCA97MA009A/B, and MIA00FA103A/B, respectively.

[5] The runway incursion statistics used in this letter were provided by the FAA's Air Traffic Resource Management Program—Planning, Information, and Analysis Branch.

[6] *FAA Aerospace Forecasts Fiscal Years 1999-2010*. U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy and Plans. March 1999. FAA/APO-99/1. Washington, DC.

ramp, and the flight crew acknowledged the instructions. The local controller then cleared KAL036 for takeoff. The flight crew of CCA9018 inadvertently deviated from its assigned taxi route and reentered runway 14R at taxiway M. As KAL036 approached rotation speed, the captain saw CCA9018 crossing the runway ahead. The KAL036 captain abruptly rotated the airplane, banking to the left. KAL036 reached 9º of left bank shortly after takeoff, passing directly over CCA9018 within 3 seconds and clearing CCA9018 by about 75 feet. The incident occurred in visual meteorological conditions (VMC) at night. No injuries were reported, and neither airplane was damaged.

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Figure 1. ORD Airport Diagram.

On June 27, 1999, about 2149 eastern daylight time, Icelandair flight 614 (ICE614), a Boeing 757 (757), and Air France flight 6498 (AFR6498), a 747, were involved in a runway incursion on runway 22R at John F. Kennedy International Airport (JFK), Jamaica, New York. (Figure 2 shows a diagram of JFK with references to both airplanes' positions.) AFR6498 landed on runway 22L, and the JFK local controller instructed the flight crew to proceed via taxiway J and hold short of runway 22R. According to the ATC voice recording, the AFR6498 flight crew responded, "okay straight ahead on juliet and no hold short on 22 right," and then crossed runway 22R as ICE614 was departing.

ICE614 cleared AFR6498 by about 100 feet vertically. The incident occurred in instrument meteorological conditions (IMC) at night. No injuries were reported, and neither airplane was damaged.

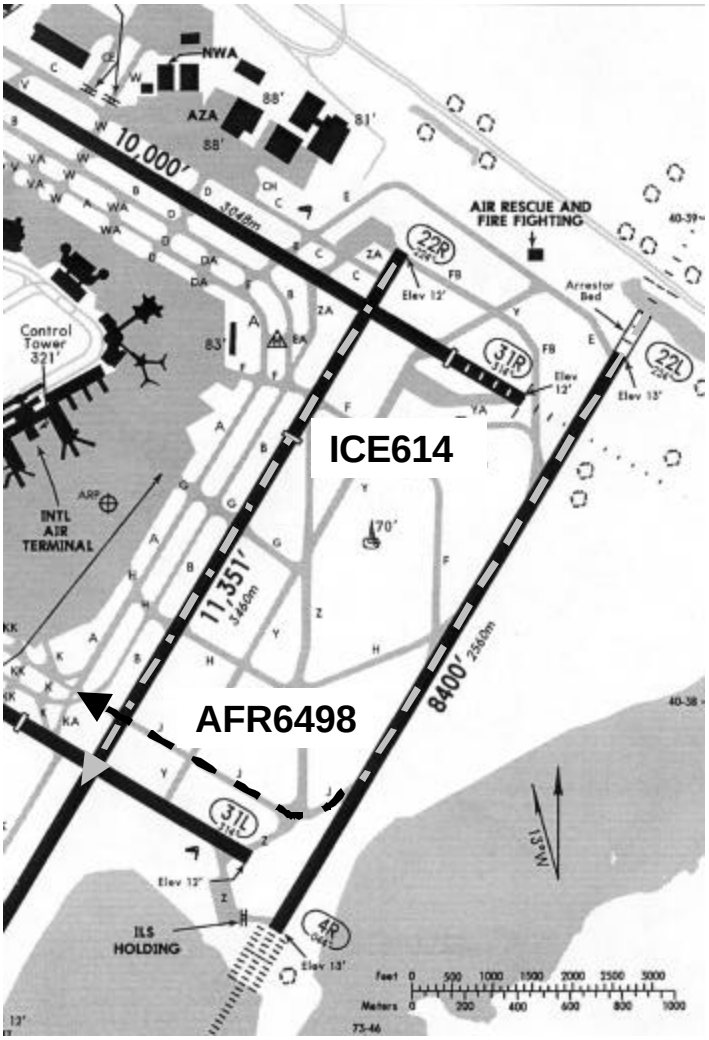

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Figure 2. JFK Airport Diagram.

On November 22, 1999, about 2236 Pacific standard time, Aeromexico flight 432 (AMX432), an MD-80, and United Airlines flight 204 (UAL204), a 757, were involved in a runway incursion on runway 25R at Los Angeles International Airport (LAX), Los Angeles, California. (Figure 3 shows a diagram of LAX with references to both airplanes' positions.) The LAX local controller cleared AMX432 to land on runway 25L. After the airplane landed, the controller instructed the flight crew to turn right on taxiway N and hold short of runway 25R so that UAL204 could depart. According to the ATC voice recording, AMX432 read back "November cross 25R." (In a postincident interview, the

controller stated that she thought that the flight crew read back "short 25R.") The controller stated that AMX432 turned on taxiway N but then accelerated toward runway 25R. The controller restated the hold short instruction, but UAL204 had already flown over AMX432 by about 100 feet. The incident occurred in VMC at night. No injuries were reported, and neither airplane was damaged.

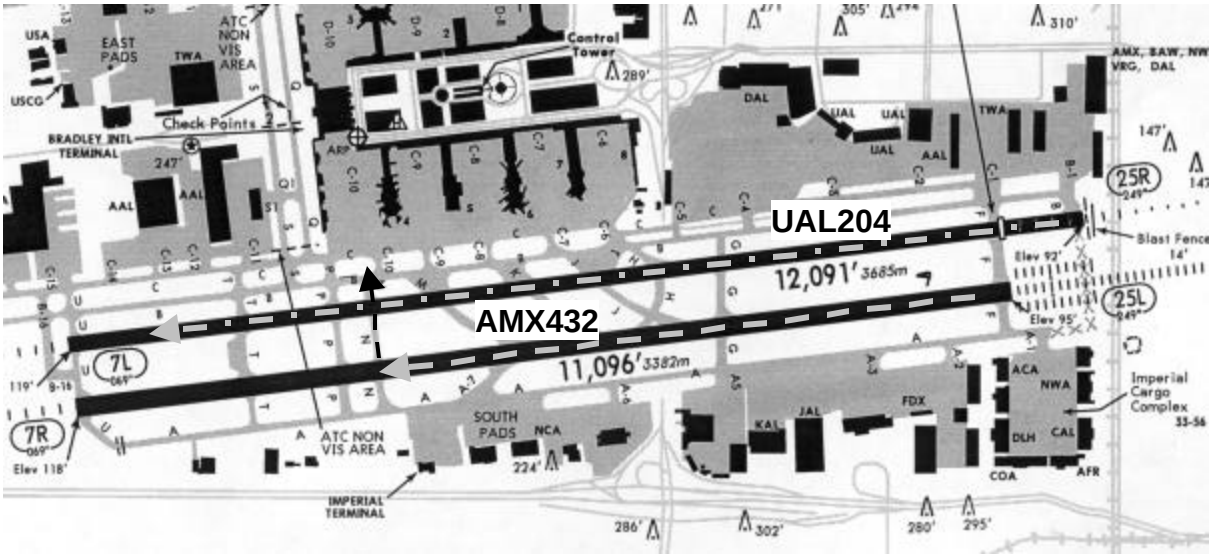

Figure 3. LAX Airport Diagram.

On December 6, 1999, about 2035 eastern standard time, United Airlines flight 1448 (UAL1448), a 757, and Federal Express flight 1662 (FDX1662), a 727, were involved in an incident on runway 5R at Theodore Francis Green State Airport (PVD), Providence, Rhode Island. (Figure 4 shows a diagram of PVD with references to both airplanes' positions.) The PVD control tower is not equipped with Airport Surface Detection Equipment (ASDE).[7] Therefore, controllers must visually monitor aircraft and, during low-visibility and night operations, rely on pilot position reports (instead of a surface radar display) to locate aircraft. At the time of the incident, the reported visibility was 1/4 mile, and the runway visual range (RVR) was 1,400 feet.

[7] ASDE is a surface radar system designed to provide tower air traffic controllers at the busiest U.S. airports with position information on all aircraft and vehicles operating on airport runways and taxiways, especially during low-visibility and night operations. The FAA is installing 40 ASDE-3 systems at 34 U.S. airports. Of these 40 ASDE-3 systems, 38 are operational; the 2 remaining systems are expected to be in operation at LaGuardia Airport (LGA), Flushing, New York, in August 2000 and at Charlotte/Douglas International Airport, Charlotte, North Carolina, in January 2001.

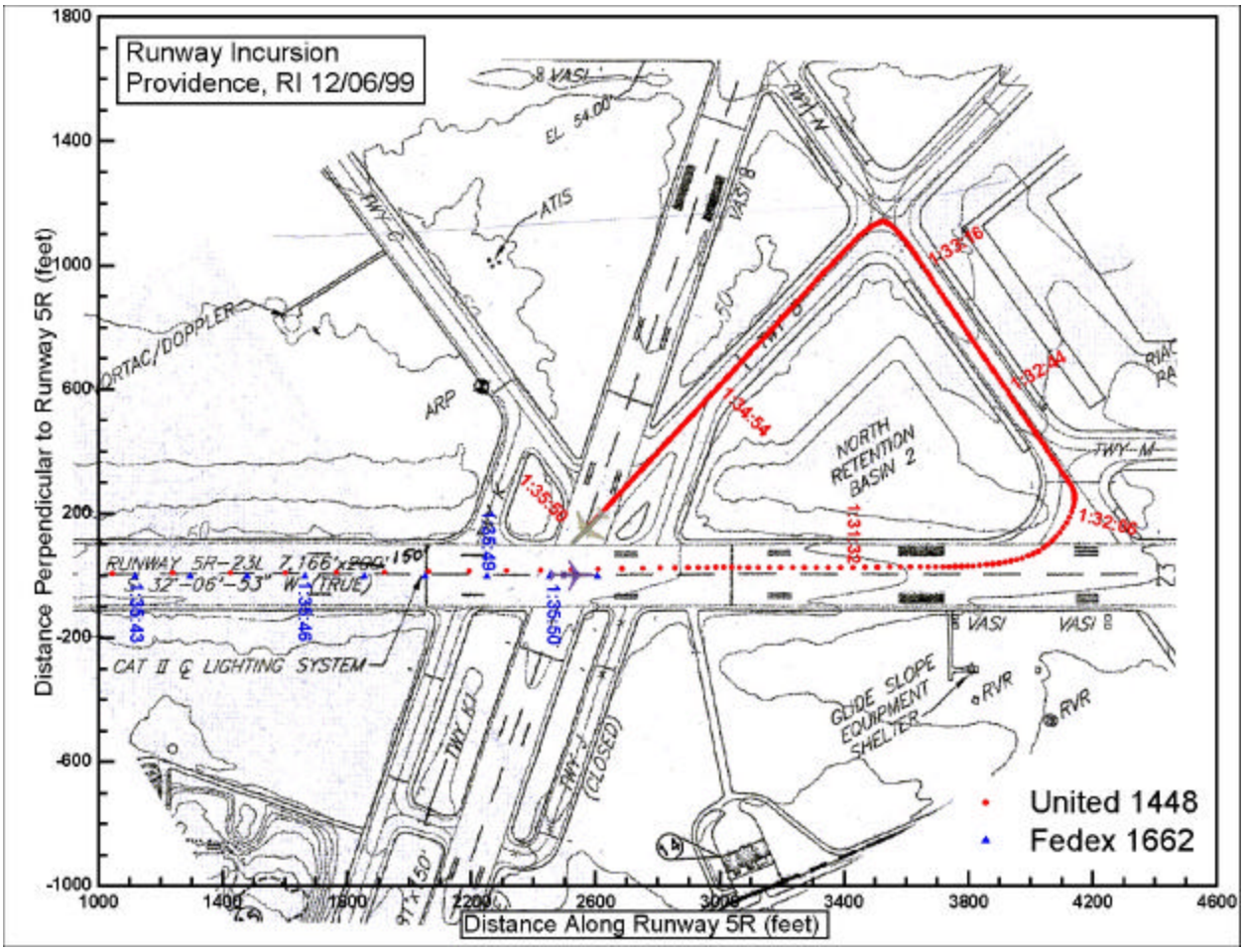

Figure 4. PVD Airport Diagram.

After UAL1448 landed on runway 5R, the PVD local controller instructed the flight crew to exit the runway to the left, proceed to the ramp via taxiways N and T, and report when the airplane crossed runway 16. The UAL1448 flight crew became disoriented and turned back toward runway 5R. The flight crew then stopped the airplane, advised the PVD local controller of its position, and stated that it believed that the airplane was on an active runway. While UAL1448 was deviating from its assigned taxi route, FDX1662 departed from runway 5R, passing near UAL1448. (The sound of FDX1662's takeoff can be clearly heard in the background of the ATC recording of UAL1448's transmission of a position report.) Although the flight crew of UAL1448 reported its belief that the airplane was on an active runway, the PVD local controller cleared US Airways flight 2998, a Boeing 737 (737), for takeoff from runway 5R. The 737 flight crew declined the clearance because of its concern about UAL1448's position. The incident occurred in IMC at night. No injuries were reported, and neither airplane was damaged.

Pertinent Runway Incursion Safety Recommendations

The following four runway incursion safety recommendations are pertinent to the issues discussed in this letter:

On May 29, 1991, the Safety Board issued Safety Recommendations A-91-28 through -30 as a result of the EAL111/N44UE collision at Atlanta, Georgia.

Safety Recommendation A-91-28 asked the FAA to amend FAA Order 7110.65, "Air Traffic Control," to "preclude the issuance of multiple landing clearances to aircraft outside the final approach fix. Also, establish a numerical limit so that no more than two landing clearances may be issued to successive arrivals." The FAA ultimately decided not to implement the change, stating that doing so would increase workload, remove controller flexibility, and potentially compromise safety. On March 6, 1995, the Safety Board disagreed with the FAA's analysis and classified the recommendation "Closed—Unacceptable Action."

Safety Recommendation A-91-29 asked the FAA to "expedite efforts to fund the development and implementation of an operational system analogous to the airborne conflict alert system to alert controllers to pending runway incursions at all terminal facilities that are scheduled to receive Airport Surface Detection Equipment." On August 12, 1991, the FAA stated that it was addressing the intent of Safety Recommendation A-91-29 through its acquisition of the Airport Movement Area Safety System (AMASS).

AMASS is a ground movement safety system[8] that the FAA indicated was designed to prevent runway incursions. According to the FAA's AMASS project manager, AMASS is designed to generate an aural and visual alert to local controllers at ASDE-3-equipped airports when an aircraft or vehicle is occupying the runway and an arriving aircraft is 1/2 to 3/4 mile[9] from the runway threshold or when a departing aircraft on the runway is moving at 44 knots or greater and is predicted to conflict with another aircraft occupying the runway. These aural and visual alert parameters were empirically determined based on the information provided by San Francisco International Airport air traffic controllers using a prototype AMASS system and were not based on formal studies of human or aircraft performance.

During an October 6, 1999, briefing to the Safety Board on the National Runway Safety Program, the FAA stated that the focus of AMASS had been changed from the prevention of runway incursions to the prevention of runway collisions. The FAA also stated that human factors and operational issues related to the design of AMASS would be resolved by January 2001 and that

[8] In this letter, a ground movement safety system refers to any airport system (including a modified version of AMASS) that incorporates aircraft detection capabilities and safety logic that will prevent runway incursions. These systems may use technologies such as ground induction loops, magnetic sensors, marine X-band radar systems, and global positioning system (GPS) receivers.

[9] The actual distance is determined by the ATC facility.

all 40 systems would become operational between August 2001 and October 2002.[10] In its March 10, 2000, letter to the FAA, the Board stated that it was disappointed that more than 8 years had passed since Safety Recommendation A-91-29 (which requested expeditious action) was issued and that the FAA would not complete the work necessary to meet the intent of the recommendation for another 2 1/2 years. Because of the increased number of runway incursions and the need to take expeditious action to prevent incursions, the Board classified the recommendation "Open—Unacceptable Response."

Safety Recommendation A-91-30 asked the FAA to "conduct research and development efforts to provide airports that are not scheduled to receive Airport Surface Detection Equipment with an alternate, cost-effective system to bring controller and pilot attention to pending runway incursions in time to prevent ground collisions." On August 12, 1991, the FAA responded that it planned to fund a series of technological demonstrations in 1992 using magnetic loop sensors, infrared sensors, transponder systems, and GPS satellite technology.

The FAA also reported that the Massachusetts Institute of Technology's Lincoln Laboratory began a project to research the feasibility of runway status lights, with a demonstration planned to occur by December 1992. The FAA stated that the lights, positioned at the edge of the runway so that they would be visible from aircraft cockpits at the runway entrances, would be activated when sensors notified the system of aircraft on approach or aircraft accelerating and decelerating on the runway. The FAA also stated that additional lights would be placed where they would be visible to pilots of aircraft holding in departure positions and would operate without controller input, thus providing an autonomous warning capability to flight crews operating aircraft on or near runways.

On October 22, 1993, the FAA reported that it was evaluating several different technologies for monitoring airport surface movements at lower activity airports, including differential GPS, loop and magnetic sensors, and marine X-band radar systems. On December 21, 1995, this recommendation was classified "Closed—Acceptable Action" and was superseded by Safety Recommendation A-95-94,[11] which asked the FAA to "continue research and development efforts to provide airports that are not scheduled to receive Airport Surface Detection Equipment with an alternate, cost-effective system, such as the ground induction loop,[12] to bring controller and pilot attention to pending runway incursions in time to prevent ground collisions."

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[10] The AMASS installation schedule had been changed several times before. On May 5, 1992, the FAA reported that the first delivery of an operational AMASS to a field facility was planned for November 1994. On October 26, 1995, the FAA reported that all 40 contracted systems would be installed and operational by 2000. On April 6, 1999, the FAA stated that the final delivery date for the 40 contracted systems would be August 2000.

[11] The Safety Board issued Safety Recommendation A-95-94 as a result of the fatal runway collision involving TWA427 and N441KM at Bridgeton, Missouri, on November 22, 1994. During its takeoff roll on runway 30R, TWA427 collided with N441KM, which was positioned on runway 30R awaiting takeoff clearance. (The N441KM pilot mistakenly believed that his assigned departure runway was runway 30R, rather than runway 31.)

[12] A ground induction loop is an electrical conductor (installed in runways and taxiways) that senses aircraft and vehicles passing over it. Loop arrays can provide data to a processing unit, which displays the speed, size, and direction of the aircraft (or vehicle) for the local controller.

On October 26, 1995, the FAA reported that RTCA, Inc., had issued standards in April 1994 for the use of surface sensors for airport lighting control and surveillance. The FAA also reported that none of the vendor proposals that incorporated these standards were acceptable because they failed to account for airborne aircraft approaching the runway. The FAA further reported that it was continuing to field test runway status lights and was planning, in 1996, to install and test low-cost ASDE systems[13] at Salt Lake City International Airport, Salt Lake City, Utah, and General Mitchell Field Airport (MKE), Milwaukee, Wisconsin. The FAA's letter noted that the FAA's efforts were limited by budget constraints.

On July 14, 1997, the FAA stated that it was planning to evaluate a low-cost ASDE system at Norfolk International Airport (ORF), Norfolk, Virginia, later that year. On March 23, 1998, the FAA reported that it was continuing research and development of low-cost ASDE alternatives, including a marine X-band radar system installed at MKE and a phased-array radar system installed at ORF. The FAA stated that it was also investigating the use of ground induction loops for aircraft detection and was collaborating with the National Aeronautics and Space Administration to test and demonstrate an integrated surface movement management system. On September 28, 1998, the Safety Board classified Safety Recommendation A-95-94 "Closed—Acceptable Action," based on the FAA's continuing research activities. However, as of June 2000, all of these systems remained under development, and none had been commissioned for full operational use at any U.S. airport.

Recent FAA Action

In October 1999, the FAA established a National Runway Safety Program to reduce the number of surface accidents and incidents by (1) decreasing ATC operational errors and deviations, (2) increasing flight standards investigation and analysis of pilot deviations, and (3) increasing airport emphasis on the prevention of vehicle and pedestrian deviations. According to the FAA, the Runway Safety Program Director serves as the agency's focal point for all activities associated with runway safety, provides strategic direction, and ensures timely execution of runway safety initiatives.

Since January 2000, the FAA has conducted 630 runway incursion safety seminars for pilots throughout the United States; 300 more seminars were expected to be conducted by the end of June 2000. In March 2000, the FAA announced new runway safety initiatives, including more in-depth investigations of runway incursions and regional awareness meetings for pilots, airport managers, and controllers. In April 2000, the FAA established the Runway Incursion Information and Evaluation Program to gather information from pilots involved in runway incursions and determine the causes of the incursions. In addition, the FAA conducted a runway safety summit in June 2000.

Department of Transportation Testimony on Runway Incursions

[13] The low-cost ASDE is now referred to as ASDE-X. Specifically, ASDE-X is a lower-cost surveillance system being developed for use at smaller and midsized airports where adverse weather conditions pose a threat to safe and efficient operations.

According to March 2000 congressional testimony by the Department of Transportation's Inspector General (DOT/IG), the FAA's actions to reduce runway incursions have not been fully implemented or have not been effective, and the agency's efforts must be improved. The DOT/IG testified that the FAA set a goal in 1997 to reduce the number of runway incursions to 41 by the end of 2000 and that the FAA revised that goal in 1998 to 248 runway incursions, an increase of more than 500 percent. The DOT/IG also testified that the FAA is not likely to reach its revised goal by the end of 2000.

Ground Movement Safety Systems

As previously indicated, in its August 12, 1991, letter to the Safety Board, the FAA stated that it would address the intent of Safety Recommendation A-91-29 (to prevent runway incursions) with the development of AMASS. However, the FAA later announced that AMASS would no longer be designed to prevent runway incursions but rather would be designed to prevent runway collisions. Thus, AMASS, as currently designed, will alert the local controller of a potential collision only after a situation is already in progress, thus reducing the amount of time available to prevent a potential collision. A system designed to prevent runway incursions will allow the tower controller (and the flight crew) more time to react and prevent an incursion from becoming a collision. The Board is disappointed that AMASS is no longer being designed to prevent runway incursions.

On May 26, 1999, the Safety Board requested that the FAA conduct a simulation of AMASS response time using data from an actual runway incursion, specifically, the CCA9018/KAL036 incident at ORD. The simulation showed that AMASS would have generated both aural and visual collision warnings 6 seconds before KAL036 passed over CCA9018. These warnings would have occurred when KAL036 was approximately 1,850 feet from CCA9018 and was moving at 172 knots and CCA9018 was entering runway 14R at taxiway M. AMASS would have highlighted both aircraft targets on the monitor, showed a warning message, and announced through the voice alerting system, "warning, runway one four right departure occupied runway." In the 6 seconds after the generation of the AMASS warning, the controllers would have needed to detect the warning, determine the nature and location of the problem, identify the necessary action, and contact the flight crews of both airplanes. The flight crews would then have needed to execute the proper maneuver to avert a collision. Six seconds does not provide sufficient time for controllers and flight crews to respond appropriately in this type of scenario.

To assist controllers in preventing runway incursions, the control tower monitors will display hold bars, or red lines, at runway/taxiway intersections when AMASS detects a departing aircraft traveling at least 44 knots on a runway. According to the FAA simulation of the CCA9018/KAL036 incident,[14] the hold bars displayed on the tower monitor would have activated 36 seconds before the incident. At that time, CCA9018 was turning onto taxiway M and had not yet reentered runway 14R.

[14] On June 9, 2000, the FAA advised Safety Board staff that the AMASS software had been revised and that this revision might affect the timing of the warning.

If AMASS had the ability to activate stop bars[15] at runway/taxiway intersections, for example, CCA9018's flight crew would have been provided with a direct warning not to proceed onto runway 14R.[16] This direct warning to the flight crew of CCA9018 would have occurred 30 seconds before the simulated conflict warning activated in the tower. A datalink[17] is another method to provide the flight crew with a direct warning of a potential incursion.

According to the simulation, AMASS, as currently designed, would not have prevented the ORD incident. Although simulations of the JFK and LAX incidents were not conducted, it appears that AMASS would not have prevented those incidents because, as with the ORD incident, the unauthorized aircraft entered the runway after the departing aircraft had started its takeoff roll.

The FAA originally developed AMASS to prevent runway incursions; however, because the FAA was unable to develop an acceptable predictive warning system, AMASS' focus was changed to prevent runway collisions. Further, the current system does not appear to be able to provide sufficient warning time to prevent even some runway collisions. Providing warnings only to air traffic controllers unnecessarily increases the time to alert flight crews of a potential runway incursion or collision, as a significant amount of time is required for the controller to detect the warning, identify the nature of the problem, and determine the necessary action before attempting to establish radio contact with the flight crew (which may or may not be possible). Of course, the flight crew will require additional time to react and take evasive action.

On the basis of its investigation of the incidents described in this letter, the Safety Board concludes that an acceptable ground movement safety system should be able to provide direct warnings to flight crews and other vehicle operators of potential incursions through means such as runway edge lights and stop bars located at all runway/taxiway intersections, or by other means, such as a datalink.[18] Further, the Board concludes that some type of ground movement safety system should be installed at all airports providing scheduled passenger service[19] because passengers flying into and out of lower

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[15] Stop bars consist of a series of red lights in the pavement that alert the flight crew of the need to stop at the end of a taxiway before entering an active runway. When the stop bars are extinguished by the controller, the flight crew (or vehicle operator) is cleared to enter the runway. If a discrepancy exists between the stop bars and the verbal clearance from the controller, the flight crew should stop the aircraft.

[16] During March 2000, Safety Board staff traveled to the following airports to review runway incursion prevention equipment and discuss ATC procedures in use at those airports: Heathrow Airport, London, United Kingdom; Munich Airport, Munich, Germany; and Gardermoen Airport, Oslo, Norway. These airports are equipped with stop bars at all runway/taxiway intersections, which are in use during hours of darkness and periods of reduced visibility. These stop bars reinforce hold short instructions by providing pilots with direct warnings of taxiway/runway intersections. All of the air traffic managers stated that, because of the airports' runway configuration and stop bar use, runway incursions have been virtually nonexistent.

[17] A datalink is a radio channel that provides for the exchange of digital information primarily between ATC and aircraft (or surface vehicles).

[18] The Safety Board notes that stop bars and datalinks are not the only means to provide a direct warning to the flight crew.

[19] According to the FAA's Office of Airport Planning and Programming, in 1998, there were 433 U.S. airports with scheduled passenger service (2,500 or more scheduled passengers per year). Approximately 320 of those airports had FAA or contract towers.

activity airports (such as PVD, Quincy Municipal Airport, or Sarasota Bradenton International Airport) should be afforded the same level of safety as those using the busiest U.S. airports.[20] Therefore, the Safety Board believes that the FAA should require, at all airports with scheduled passenger service, a ground movement safety system that will prevent runway incursions; the system should provide a direct warning capability to flight crews. In addition, the FAA should demonstrate through computer simulations or other means that the system will, in fact, prevent incursions.

ATC Procedural Issues

The Safety Board has identified four ATC operating procedures that may contribute to runway incursions and other airport surface incidents. First, 14 Code of Federal Regulations (CFR) Section 91.129(i), "Takeoff, Landing, Taxi Clearance," states:

> No person may, at any airport with an operating control tower, operate an aircraft on a runway or taxiway, or take off or land an aircraft, unless an appropriate clearance is received from ATC. A clearance to "taxi to" the takeoff runway assigned to the aircraft is not a clearance to cross that assigned takeoff runway, or to taxi on that runway at any point, but is a clearance to cross other runways that intersect the taxi route to that assigned takeoff runway. A clearance to "taxi to" any point other than an assigned takeoff runway is clearance to cross all runways that intersect the taxi route to that point.

This regulation does not mention the possibility of a hold short instruction. Unless air traffic controllers specifically issue an instruction to hold short, runway crossings are implicitly approved. Thus, a pilot who fails to hear or understand an ATC clearance containing a hold short instruction will believe that he has authorization to cross an active runway. In the JFK and LAX incidents, the flight crews believed that they were authorized to cross an active runway, even though the local controllers had not issued clearance to cross the runway.[21]

ATC procedures should require specific clearances, rather than rely on implied clearances, for aircraft to cross runways. This requirement would reduce the chance of a runway incursion because pilots would have to obtain an explicit clearance before crossing any runway; without such a clearance, the pilot would be required to hold short. The Safety Board recognizes that this requirement would increase the workload of the controllers, possibly resulting in reduced capacity; however, the Board is confident that the benefits to safety would outweigh any potential problems caused by the requirement. Therefore, the Safety Board believes that the FAA should amend 14 CFR 91.129(i) to require that all runway crossings be authorized only by specific ATC clearance and should ensure that U.S. pilots, U.S. personnel assigned to move aircraft, and pilots operating under 14 CFR Part 129 receive adequate

[20] The Safety Board notes that the November 19, 1996, runway collision at Quincy, Illinois, demonstrates the need for such a system at untowered airports.

[21] The Safety Board is aware of at least three similar incidents that occurred in 2000: on January 6 at Midway Airport, Chicago, Illinois; on March 25 at Melbourne, Florida; and on April 23 at North Las Vegas, Nevada.

notification of the change. Further, if aircraft need to be cleared to cross multiple runways, controllers should issue an explicit crossing instruction for each runway after the previous runway has been crossed. This procedure would preclude controllers from authorizing aircraft to cross more than one runway at a time. Therefore, the Safety Board believes that the FAA should amend FAA Order 7110.65, "Air Traffic Control," to require that, when aircraft need to cross multiple runways, air traffic controllers issue an explicit crossing instruction for each runway after the previous runway has been crossed.

Second, FAA Order 7110.65, paragraph 3-9-4, "Takeoff Position Hold," authorizes air traffic controllers to allow aircraft to taxi into position and hold on a runway pending resolution of traffic conflicts or other issues that preclude immediate issuance of a takeoff clearance. Controllers are required to advise the holding aircraft of the closest arrival traffic that is approaching the same runway and are prohibited from allowing aircraft to hold on the runway at an intersection between sunset and sunrise or at any time that an intersection is not visible from the tower.

On January 3, 1999, United Airlines flight 38 (UAL38), a 757, and American Trans Air flight 1308 (AMT1308), a 757, were involved in an incident on runway 24L at LAX during the hours of darkness. AMT1308 was holding in position for departure at the approach end of runway 24L when UAL38 was cleared to land on runway 24L. The UAL38 flight crew questioned the LAX local controller about the holding airplane, but the local controller stated that no airplane was on the runway. (The local controller, in a postincident interview, admitted that he forgot that he had placed AMT1308 on the runway.) As UAL38 approached the runway, the flight crew initiated a go-around maneuver and overflew AMT1308 by about 150 feet.

On December 2, 1998, US Airways flight 1290 (USA1290), a 737, and N300FL, a Beechcraft BE-90A, were involved in a runway incursion at LGA during the hours of darkness. The local controller instructed the pilot of N300FL to taxi into position and hold on runway 31. Shortly afterward, the local controller advised the USA1290 flight crew of aircraft arriving on runway 22 and then cleared USA1290 to land on runway 31. USA1290 subsequently landed over N300FL; the vertical separation between the airplanes was estimated to be about 50 feet.

On February 27, 1995, American Airlines flight 2351 (AAL2351), an MD-11, and Lone Star Airlines flight 1219 (LS1219), a Swearingen SA227, were involved in a runway incursion at Dallas/Fort Worth International Airport, Dallas, Texas, during the hours of darkness. The local controller cleared AAL2351 to land on runway 35R and, shortly thereafter, instructed LS1219 to "taxi into position and hold on runway 35R." Both clearances were acknowledged by the flight crews, but neither one heard the other's clearance. AAL2351 flew over LS1219, touching down approximately 1,200 to 1,500 feet beyond the approach threshold; radar data indicated that the vertical separation between the airplanes was 35 feet.[22]

[22] The Safety Board is aware of at least three similar incidents that occurred in 2000: on February 25 at Detroit, Michigan, and on May 20 and May 31 at Midway Airport, Chicago, Illinois.

The Safety Board is concerned that the current practice of holding departing aircraft on active runways during nighttime or when low ceiling and visibility conditions exist increases the potential for a runway incursion. The Board recognizes that discontinuing this practice would increase the workload of the controllers, possibly resulting in reduced capacity; however, the Board is confident that the benefits to safety would outweigh any potential problems. Therefore, the Safety Board believes that the FAA should amend FAA Order 7110.65, "Air Traffic Control," paragraph 3-9-4, "Takeoff Position Hold," to discontinue the practice of allowing departing aircraft to hold on active runways at nighttime or at any time when ceiling and visibility conditions preclude arriving aircraft from seeing traffic on the runway in time to initiate a safe go-around maneuver.

Third, landing clearance procedures contained in FAA Order 7110.65, paragraph 3-10-6, "Anticipating Separation," allow controllers to issue multiple landing clearances before ensuring that the runway is clear. The paragraph states the following:

> Landing clearance to a succeeding aircraft in a landing sequence need not be withheld if you observe the positions of the aircraft and determine that prescribed runway separation will exist when the aircraft cross the landing threshold. Issue traffic information to the succeeding aircraft if not previously reported.

As previously discussed, the Safety Board issued Safety Recommendation A-91-28, asking the FAA to preclude the issuance of landing clearances to multiple arriving aircraft. The Board disagreed with the FAA's decision not to implement the recommendation and classified it "Closed—Unacceptable Action." The Board maintains its position that the use of the multiple landing clearance procedure should be eliminated.

On February 9, 1998, American Airlines flight 1340 (AAL1340), a 727, landed short of the runway 14R threshold while attempting a Category II ILS approach at ORD and then slid off the side of the runway.[23] The local controller did not notice that AAL1340 had crashed, leaving debris on the runway, and had not cleared the runway in a normal manner. The local controller continued to clear arriving aircraft to land on runway 14R without ensuring positive separation from AAL1340. After the accident, one airplane completed a landing with debris on the runway, and a second airplane touched down on the runway momentarily while executing a go-around maneuver.[24]

The AAL1340 accident demonstrates the potential hazard of issuing multiple landing clearances. The airplanes following AAL1340 should not have been cleared to land on runway 14R until the air traffic controller was certain that AAL1340 had safely exited the runway. If the spacing between aircraft creates uncertainty about runway separation, a landing clearance should be withheld until separation has been ensured. Even if the spacing between aircraft indicates that runway separation is

[23] The weather at the time of the accident was overcast at 100 feet, with 1/2-mile visibility in freezing fog. The RVR was 1,400 feet variable to 1,800 feet.

[24] The local controller realized that there was a problem with AAL1340 just as the second airplane arrived, so the pilot of that airplane was instructed to go around.

likely, the air traffic controller should still not issue the landing clearance to the following airplane until the preceding airplane has crossed the runway threshold or cleared the runway.[25]

The Safety Board notes that International Civil Aviation Organization (ICAO) Document 4444-RAC/501, "Procedures for Air Navigation Services—Rules of the Air and Air Traffic Services," recommends in paragraph 15.2 that controllers wait to issue a landing clearance to a following aircraft until the preceding aircraft has crossed the runway threshold. The Board recognizes that this procedure may occasionally result in a pilot performing a go-around maneuver, but the procedure ensures that airplanes will be properly separated on a runway. Therefore, the Safety Board believes that the FAA should adopt the landing clearance procedure recommended by ICAO Document 4444-RAC/501, "Procedures for Air Navigation Services—Rules of the Air and Air Traffic Services," Part V, "Aerodrome Control Service," paragraph 15.2.

Fourth, the Safety Board notes that the ORD (CCA9018/KAL036), JFK (ICE614/AFR6498), and LAX (AMX432/UAL204) runway incursion incidents involved flight crews whose primary language was not English. ICAO Document 4444-RAC/501 includes standard international phraseology for airport surface operations; however, ICAO Member States are not obligated to follow ICAO procedures, and the FAA has elected to use different ATC phraseology. For example, ICAO recommends that the phrase "line up and wait" be used when instructing a pilot to enter a runway and stop while awaiting takeoff clearance.[26] The equivalent U.S. instruction in FAA Order 7110.65, paragraph 3-9-4, is "taxi into position and hold."

The standard international ATC phraseology[27] was established in part to reduce the opportunities for confusion and misunderstanding as flight crews operate across national boundaries; however, U.S. controllers' use of different ATC phraseology may create confusion and misunderstanding for foreign pilots flying into the United States. These pilots may also have difficulty comprehending ATC instructions that are not communicated at reasonable speech rates. Therefore, the Safety Board believes that, to minimize opportunities for misunderstanding instructions, the FAA should amend FAA Order 7110.65, "Air Traffic Control," to require the use of standard ICAO phraseology (excluding conditional phraseology) for airport surface operations and should periodically emphasize to controllers the need to use this phraseology and to speak at reasonable rates when communicating with all flight crews, especially those whose primary language is not English.

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[25] The Safety Board is aware of at least two similar incidents that occurred recently: on March 17, 2000, at Denver, Colorado, and on July 22, 1999, at Atlanta, Georgia.

[26] In addition to "line up and wait," other standard ICAO phrases are "request backtrack"; "vacate runway"; "cross runway [number] report vacated"; "cleared for takeoff runway [number]"; "takeoff immediately or vacate runway"; "takeoff immediately or hold short of runway"; "hold position, cancel, I say again cancel takeoff"; and "stop immediately [call sign] stop immediately." The FAA has equivalent instructions for these ICAO phrases.

[27] Some ICAO phrases include a circumstantial condition, such as "behind landing aircraft" and "after departing aircraft." ICAO Document 4444-RAC/501, Part X, Section 2.4, indicates that, under certain circumstances, a conditional phrase is to be given that consists of the aircraft identification, the specific condition, and the clearance. The Safety Board notes that FAA procedures do not permit the use of such conditional phraseology in the United States. According to the FAA's Program Director for Air Traffic Planning and Procedures, the Air Traffic System is based on a specific separation standard that maintains positive control; conditional clearances do not fall within those parameters.

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

Require, at all airports with scheduled passenger service, a ground movement safety system that will prevent runway incursions; the system should provide a direct warning capability to flight crews. In addition, demonstrate through computer simulations or other means that the system will, in fact, prevent incursions. (A-00-66)

Amend 14 Code of Federal Regulations (CFR) Section 91.129(i) to require that all runway crossings be authorized only by specific air traffic control clearance, and ensure that U.S. pilots, U.S. personnel assigned to move aircraft, and pilots operating under 14 CFR Part 129 receive adequate notification of the change. (A-00-67)

Amend Federal Aviation Administration Order 7110.65, "Air Traffic Control," to require that, when aircraft need to cross multiple runways, air traffic controllers issue an explicit crossing instruction for each runway after the previous runway has been crossed. (A-00-68)

Amend Federal Aviation Administration Order 7110.65, "Air Traffic Control," paragraph 3-9-4, "Takeoff Position Hold," to discontinue the practice of allowing departing aircraft to hold on active runways at nighttime or at any time when ceiling and visibility conditions preclude arriving aircraft from seeing traffic on the runway in time to initiate a safe go-around maneuver. (A-00-69)

Adopt the landing clearance procedure recommended by International Civil Aviation Organization Document 4444-RAC/501, "Procedures for Air Navigation Services—Rules of the Air and Air Traffic Services," Part V, "Aerodrome Control Service," paragraph 15.2. (A-00-70)

Amend Federal Aviation Administration Order 7110.65, "Air Traffic Control," to require the use of standard International Civil Aviation Organization phraseology (excluding conditional phraseology) for airport surface operations, and periodically emphasize to controllers the need to use this phraseology and to speak at reasonable rates when communicating with all flight crews, especially those whose primary language is not English. (A-00-71)

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

Original Signed

By: Jim Hall
Chairman