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National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: May 13, 1986

In reply refer to: A-86-30 through -43

Honorable Donald D. Engen
Administrator
Federal Aviation Administration
Washington, D.C. 20591

The collision of two airplanes operating on or near the same runway at an airport presents the potential for tremendous loss of life. The collision of two Boeing 747's on a runway at the Tenerife, Canary Islands, Spain, airport on March 27, 1977, caused 583 fatalities--more fatalities than in any other accident in the history of aviation. Fortunately, there have been few such ground collision accidents. However, there have been many close encounters, and the number of reported near-collision ground incidents has increased significantly in the past 2 years.

On March 31, 1985, two Northwest Airlines DC-10's nearly collided at the Minneapolis-St. Paul International Airport, Minneapolis, Minnesota. One airplane, flight 51, was taking off from a runway after having been cleared for takeoff by the local controller. The other airplane, flight 65, was taxiing across the same runway after having been cleared to cross the active runway by the ground controller. The captain of flight 51 averted a collision by rotating to a takeoff attitude and lifting off below the recommended takeoff speeds. Because of poor braking conditions and limited space in which to stop, he had no alternative. Flight 51 lifted off and overflew flight 65, reportedly clearing the other DC-10 by 50 to 75 feet. There were a total of 501 persons aboard the two airplanes. There were no reported injuries and neither airplane was damaged.

Because of the Minneapolis incident and the frequency and the potential severity of similar incidents, in July 1985 the Safety Board initiated a special investigation of runway incursion incidents and accidents. 1/ The purpose of the special investigation was to investigate selected runway incursions to determine their underlying causes and to recommend appropriate remedial actions.

1/ For the purpose of its special investigation, the Safety Board defined a runway incursion as any occurrence involving an aircraft, vehicle, person, object, or procedure that impedes the takeoff, intended takeoff, landing, or intended landing of an aircraft.

The Safety Board investigated 26 runway incursions for the special investigation. ^{2/} The Board selected the incidents on the basis of preliminary information and availability of investigative personnel. While the special investigation may not statistically represent all runway incursion incidents, the Board believes that the factors involved in these incidents are indicative of the causal factors in other incidents.

The FAA identified 17 of the incidents as controller-induced incursions and 9 as pilot-induced incursions. Despite the FAA categorization of incursions, the Safety Board determined that many incursions actually involved combinations of pilot and controller factors. The Board's special investigation included interviews with controllers, pilots, airport managers, airline management staff, and personnel from the Federal Aviation Administration's (FAA) Air Traffic and Flight Standards Services. A Board investigator led the investigation of each of the 26 incursions, aided by Board investigators specializing in air traffic control (ATC) and in human performance. The Board investigators were accompanied by FAA personnel in all of the investigations and by airline and pilot union representatives in selected investigations.

Of the 17 incidents attributed to controller error, 6 involved incomplete or misunderstood coordination between two controllers and 11 resulted from the actions of individual controllers. In seven incidents controllers stated they had forgotten about an aircraft or about previously effected coordination with other controllers. Six of the incidents involved a runway/taxiway crossing, four involved a single runway, three involved crossing runways, three involved an aircraft that had been given a "position and hold" clearance, and one involved a helicopter that started to cross a runway and conflicted with a fixed-wing aircraft.

Of the nine incidents attributed to pilot error, seven involved unauthorized runway crossing or entry for takeoff and two involved unauthorized takeoffs. In several of these incidents, runway and taxiway signs were missing or inadequate. In at least two incidents, pilots did not comply with controller clearances that the pilots had acknowledged receiving and understanding. The pilots contributed to some incursions by failing to communicate properly with ATC and failing to be vigilant and to scan runways and taxiways before moving their aircraft.

As part of the special investigation, Safety Board investigators visited the FAA's Mike Monroney Aeronautical Center (ATC Academy) at Oklahoma City, Oklahoma, where FAA controllers receive initial training. Board investigators also visited the United States Air Force ATC training center at Keesler Air Force Base, Mississippi, to compare the training of military controllers to the training of civilian FAA controllers. Board investigators examined policies and programs regarding FAA on-the-job training of controllers; human performance factors, including the effect of memory limitations; and the role of supervisory personnel in ATC towers. The FAA's runway incursion incident reporting and investigation programs also were examined.

The report of the special investigation discusses the issues that the Safety Board found most relevant to the runway incursion problem at controlled airports in the United States. The report includes a review of previous runway incursion incidents and accidents investigated by the Safety Board that led to recommendations to the FAA for remedial actions.

^{2/} For additional information, read Special Investigation Report--"Runway Incursions at Controlled Airports in the United States" (NTSB/SIR-86/01).

The Safety Board special investigation revealed that the magnitude of the runway incursion problem could not be measured because of both incomplete reporting and followup investigations by the FAA. Since the cause of most runway incursions could be understood by examining the human performance aspects of the incidents, the Board believes that all runway incursions should be investigated for both pilot and controller factors and for the determination of underlying causes. The result of such investigations should be analysed by means of a combined data base. Complete incident reporting and analysis also could generate timely and complete accident prevention programs.

The special investigation revealed a lack of controller supervision and redundancy in the tower cabs when runway incursions occurred. In the majority of the controller-induced runway incursions, the Safety Board found that even though facility staffing was sufficient to provide coverage for all operating positions, supervisors usually were not available in the tower cabs and cab coordinators were not always assigned or available to monitor controller performance. When a cab coordinator was assigned, the cab coordinator duties usually were combined with another operating position, preventing the cab coordinator from effectively providing assistance. The Board believes that supervision and position staffing are short-term problems that could be corrected by more effective facility management. However, the Board is concerned that a lack of supervision in the tower cab contributes to the runway incursion problem when no supervisor is available to monitor and assist controllers. As several incidents summarized in the report of the special investigation demonstrated, another controller or a supervisor dedicated to monitoring the activities of controllers, particularly at the local control position, should have discovered and corrected the controller's error in time to eliminate a risk of collision.

The special investigation also revealed deficiencies in the FAA's tower controller training program. These deficiencies are long-term and will require a dedicated effort on the part of the FAA to correct. The Safety Board believes that FAA controllers have not been afforded the best available training to prepare them for their tower duties. The Board finds that insufficient training is given in the coordination between control positions. Also, the Board believes that if the FAA would introduce "hands-on" dynamic tower cab simulation for use by the "tower option" student controllers at the ATC Academy, controllers would receive better training. Other benefits might include greater standardization of control techniques, the teaching of teamwork in a controlled environment, and the opportunity to present unusual but critical situations to which the controller might never be exposed during on-the-job training at the facility where controller training is eventually completed. The Board is convinced that if the training program included the practical application of ATC procedures through the use of tower cab simulation, new controllers would have better work habits, would have a better understanding of proper coordination and scanning techniques, and would transition more quickly to tower control positions.

Although the Safety Board believes that part of the long-term solution to the runway incursion problem involves the restructuring of the ATC Academy curriculum, the short-term solution involves improved supervision in the tower, broader use of cab coordinators, freeing supervisors and controllers-in-charge of control positions, and stressing standardized and complete coordination between control positions. The FAA should reexamine the on-the-job training controllers receive and review the qualifications of the instructor to ensure that on-the-job training is given, whenever possible, by experienced and motivated full performance level controllers rather than by developmental controllers or full performance level controllers who, while highly qualified, may not have had many hours of experience at a certain position.

Some runway incursions were found to be a combination of pilot and controller errors. Incidents could be prevented if controllers and pilots used proper phraseology and pilots acknowledged all ATC clearances, including taxi clearances. When acknowledging clearances, pilots should provide their aircraft call sign to assure tower personnel that the clearance was understood. When a clearance is not understood, pilots should ask for clarification.

To avoid runway incursions, pilots must be mentally alert when taxiing, taking off, or landing. Pilots also could reduce the risk of runway incursions by scanning the runway more effectively before taxiing onto active runways, by reducing taxi speed while approaching and preparing to cross any runway, and by delaying a request for clearance to cross until ready to cross the runway. The Safety Board also believes that runway and taxiway signing are effective runway incursion prevention tools whose use should be mandated by 14 CFR Part 139.

As a result of its investigation of an accident at O'Hare International Airport, Chicago, Illinois, on December 20, 1972, 3/ the Safety Board issued the following safety recommendations to the FAA:

Establish and publish taxi routes for arriving and departing aircraft to be used during periods of restricted visibility on the order of 1/2 mile. (A-73-25) (issued May 17, 1973)

Require pilots to obtain the controller's approval before crossing a lighted runway during periods of restricted visibility on the order of 1/2 mile. (A-73-26) (issued May 17, 1973)

Require flight crews to report their aircraft position on the airport when establishing radio communications with controllers, and require the controllers to read back the reported aircraft position when it cannot be verified either visually or by means of radar. (A-73-54) (issued August 10, 1973)

Require flight crews to read back taxi clearances when operating in visibility of less than one-half mile. (A-73-55) (issued August 10, 1973)

The FAA did not take the recommended action in the first two recommendations, stating that the ever-changing traffic situation precluded use of a chart (A-73-25) and that a continuing controller requirement to approve each specific crossing of lighted runways would result in an intolerable communication problem and increase in controller workload (A-73-26). With regard to Safety Recommendation A-73-55, the FAA stated that sufficient instructions for communications between the controller and the pilot were in practice and that no further modification to communications procedures was necessary. The Safety Board classified Safety Recommendations A-73-25, A-73-26, and A-73-55 as "Closed--Unacceptable Action."

3/ Aircraft Accident Report--"North Central Airlines, Inc., McDonnell-Douglas DC-9-31, N954N, and Delta Air Lines, Inc., Convair CV-880, N8807E, O'Hare International Airport, Chicago, Illinois, December 20, 1972" (NTSB-AAR-73-15, issued July 5, 1973).

The FAA did conduct an in-depth study of aircraft position reporting during periods of reduced visibility, which resulted in General Notice 7110.322, issued November 29, 1983. This notice addressed "position verification" and required controllers to repeat an aircraft's reported position before issuing a taxi or takeoff clearance. The Safety Board classified Safety Recommendation A-73-54 as "Closed--Acceptable Action."

Following investigation of three runway incursion accident/incidents that occurred in 1978, the Safety Board issued the following safety recommendations on June 8, 1979, to the FAA :

Conduct a directed safety study, on a priority basis, to examine the runway incursion problem and to formulate recommended remedial action to reduce the likelihood of such hazardous conflicts. (A-79-42)

Alert all controller/pilot personnel that runway incursion mishaps represent a serious safety problem which requires their immediate attention. Special emphasis should be placed on the need for both groups to maintain greater visual surveillance in those taxi operations involving any runway crossing. (A-79-43)

In response to Safety Recommendation A-79-42, the FAA commissioned the Transportation Systems Center in Cambridge, Massachusetts, to conduct a study. The study was completed in April 1981 with a report titled "An Analysis of Runway-Taxiway Transgressions at Controlled Airports" (report No. FAA-EM-81-5). The study concluded that there "does not appear to be any pattern to the causes . . . other than human errors on the part of both air traffic controllers and pilots." The study also concluded that "more uniform communication and verification of messages between pilots and controllers could serve to reduce the chance of ambiguous or erroneous commands/actions." The report raised the question as to whether system reliability might be improved by increasing the reliability of the human element or by adding redundant elements. The study did not evaluate controller training or human performance issues. The study did suggest that incident reporting might be a part of the problem, since there were indications that all of the incidents were not reported, which precluded appropriate corrective measures. The report did not propose any corrective measures.

While the FAA did conduct the study on the runway incursion problem, the study did not result in developing remedial action to reduce or alleviate the problem. Because the FAA did not comply with the intent of the recommendation, and based upon the recommendations that resulted from this special investigation, the Safety Board classified Safety Recommendation A-79-42 as "Closed--Unacceptable Action/Superseded."

The FAA issued Advisory Circular (AC) 90-48C, Pilots' Role In Collision Avoidance on March 18, 1983, in response to Safety Recommendation A-79-43. This AC was published to alert all pilots to the potential hazards of midair collisions and near-midair collisions and to emphasize basic problem areas related to the human causal factors where improvement in pilot education, operating practices, procedures, and improved scanning techniques are needed to reduce conflicts. Paragraph 4.c, Clearing Procedures, of the AC emphasizes the importance of pilot scanning of runways before taxiing onto runways. The Safety Board classified Safety Recommendation A-79-43 as "Closed--Acceptable Action."

As a result of its study of the ATC system in 1983, 4/ the Safety Board issued Safety Recommendation A-83-38 on May 19, 1983, which recommended that the FAA:

Institute air traffic control directives and procedures to require, when the assigned first-line supervisor is occupied working a control position, that there is appropriate and adequate direct supervision to ensure the detection and reporting of all controller errors or deviations, the detection and monitoring of fatigue and/or stress, and the control of each controller's workload.

On July 3, 1985, the FAA issued Change 5 to the Facility Operation and Administration Manual (7210.3G). This change required facility managers, to the extent possible, to avoid scheduling area supervisors for nonoperational duties during periods of known heavy traffic. Because the Safety Board's special investigation found that most runway incursion occurrences happen during relatively light traffic, the Board has requested that the FAA ensure that there is appropriate and adequate direct supervision at all times. The Board classified Safety Recommendation A-83-38 as "Open--Acceptable Action."

Following its investigation of an accident at Anchorage, Alaska, on December 23, 1983, 5/ the Safety Board issued Safety Recommendation A-84-98 on August 23, 1984, which recommended that the FAA:

Require that airports certificated for air carrier operations install signs at all runway and taxiway entrances, exits and intersections that indicate the identity of the runway or taxiway.

In its letter of November 30, 1984, the FAA stated that it concurred with this recommendation and was developing a Notice of Proposed Rulemaking (NPRM) which would address the proper identification of runways and taxiways. The NPRM, which proposes to revise 14 CFR Part 139 was published in the Federal Register in October 1985. If adopted as proposed, the rule would contain several provisions that are related to runway incursions. These include:

- (1) airfield marking and signing, including holding position markings;
- (2) limiting access to the airfield to those ground vehicles necessary for air operations;
- (3) requiring that vehicle operators be familiar with the airport's rules; and
- (4) requiring the airport certificate holder to make available records of vehicle accidents.

4/ Special Investigation Report--"Followup Study of the United States Air Traffic Control System" (NTSB/SIR-83/01).

5/ Aircraft Accident Report--"Korean Air Lines McDonnell Douglas DC-10-30, HL 7339, South Central Air Piper PA-31-350, N35206, Anchorage, Alaska, December 23, 1983" (NTSB/AAR-84/10, issued August 9, 1984).

The FAA does not expect to issue the final rule until late in 1986. Pending the FAA's final action on this rulemaking effort, the Safety Board has classified Safety Recommendation A-84-98 as "Open--Acceptable Action."

As a result of two accidents ^{6/} and one incident involving ground vehicle operations on active runways, the Safety Board issued the following safety recommendations on February 22, 1985, to the FAA:

Develop a mechanical/aural/visual (or combination thereof) alert device and require its use by local and ground controllers to coordinate their activities when a vehicle has been cleared to operate on the active duty runway for an extended period such as in snow removal operations. (A-85-15)

Periodically emphasize in the training of air traffic control personnel providing airport advisory services the proper application of runway usage procedures stressing positive coordination between control positions. (A-85-16)

Periodically emphasize in the training of air traffic controller personnel the requirements contained in the Air Traffic Control Handbook 7110.65D, March 1984, for restricting vehicle and aircraft operations in the ILS critical areas when the ILS is being used for approach/landing guidance and the reported ceiling, visibility or runway visual range are below the specified levels. (A-85-17)

In response to Safety Recommendation A-85-15, the FAA developed and issued an order directing facility managers to develop and use an aural and/or visual display method to indicate when vehicles are operating on a runway. This order was distributed on March 7, 1986. The Safety Board requests that the FAA provide additional information on the types of devices developed by the facility tower managers, controller reactions to the use of these devices, any measurable improvement in controller coordination, and the facilities in which these devices have been installed. Pending its review of this information, the Board has classified Safety Recommendation A-85-15 as "Open--Acceptable Action."

In response to Safety Recommendations A-85-16 and -17, the FAA stated that current training practices and procedures sufficiently addressed runway usage and proper communication/coordination between local and ground controllers. This response is counter to the findings of the Safety Board's special investigation. The Board has classified Safety Recommendations A-85-16 and -17 as "Open--Unacceptable Action."

As a result of its investigation of the near-collision of the two Northwest Airlines DC-10's at Minneapolis on March 31, 1985, the Safety Board made the following safety recommendations on April 19, 1985, to the FAA:

^{6/} For more information read Aircraft Accident/Incident Summary Reports--"Sioux Falls, South Dakota, December 20, 1983," (NTSB/AAR-85/01/SUM, issued September 30, 1985).

Issue a General Notice (GENOT) directing the management of all terminal air traffic control facilities to immediately brief all traffic controllers on the importance of complete and accurate coordination between local and ground controllers before taxiing airplanes on or across an active runway. (A-85-32)

Develop and implement, on a priority basis, specific procedures and standards, and specify responsibilities to be used during direct face-to-face and/or interphone coordination between local and ground controllers regarding requests and approvals to clear airplanes to taxi across an active runway. (A-85-33)

In its letter of July 12, 1985, the FAA advised the Safety Board that it had issued a GENOT which emphasized the importance of complete and accurate coordination between local and ground controllers. Additionally, the FAA issued a letter to tower facility managers which directed them to conduct an analysis of local procedures which address runway crossings and local and ground controller coordination. Several other initiatives to improve traffic awareness and local and ground controller coordination were also proposed. The Board has classified Safety Recommendations A-85-32 and -33 as "Closed--Acceptable Action" and "Open--Acceptable Action," respectively.

As a result of a runway incursion incident at Washington National Airport on September 24, 1985, the Safety Board issued the following safety recommendations on January 15, 1986, to the FAA:

Establish standardized departure/arrival routes for helicopter traffic arriving and departing Washington National Airport. (A-86-7)

Design, publish, and require the use of a chart depicting visual flight rules helicopter routes for civilian and military helicopter operations throughout the Washington, D.C. metropolitan area, which would include the standardized departure and arrival routes to and from Washington National Airport. The chart should include graphic and narrative descriptions of the selected routes. (A-86-8)

Study the feasibility of establishing standard visual flight rules helicopter routes and arrival and departure procedures at major airports throughout the National Airspace System. (A-86-9)

Require the inclusion of visual flight rules helicopter control procedures, in using standard routes, in both classroom and on-the-job training of local controllers. (A-86-10)

Examine the administration of the Technical Appraisal Program at Washington National Airport tower to confirm compliance with all directives pertaining to Air Traffic Control Specialist Proficiency Requirements. (A-86-11)

Require that on-the-job training at specified control positions be given only by controllers who are qualified instructors and who have current (in the last 6 months) performance evaluations of on-the-job training ability and current (in the last 6 months) performance evaluations at the specified control position. (A-86-12)

6

The FAA responded to these recommendations in its letter of April 10, 1988. The FAA informed the Safety Board that it had published a new chart for helicopter traffic arriving and departing Washington National Airport, which depicts the Washington, D.C. area as well as Washington National Airport, and provides helicopter routes to be used. The Board has classified Safety Recommendations A-86-7 and -8 as "Closed--Acceptable Action."

In response to Safety Recommendation A-86-9, the FAA informed the Safety Board that it has begun a study of the feasibility of establishing standard visual flight rules helicopter routes and arrival and departure procedures at major airports. Pending its review of the results of this study and subsequent FAA action, the Board has classified Safety Recommendation A-86-9 as "Open--Acceptable Action."

With regard to Safety Recommendation A-86-10, the FAA stated that the ATC Academy was revising the classroom portion of the training program to include simulation of airport ground and local control situations involving helicopter operations, and that the on-the-job training portion requires the demonstration of the use of standard arrival and departure route procedures prior to position certification. Pending further information from the FAA on the status of revising the tower controller training program, the Safety Board has classified Safety Recommendation A-86-10 as "Open--Acceptable Action."

In response to Safety Recommendation A-86-11, the FAA stated that an evaluation had found Washington National Airport to be in full compliance with the Technical Performance Appraisal Program and that every effort would be made to ensure that the program is properly administered in the future. However, there was no indication of the actions taken to achieve this result. Therefore, the Safety Board requests that the FAA provide additional information as to the actions taken to correct the discrepancies found during the investigation. The Board has classified Safety Recommendation A-86-11 as "Open--Acceptable Action."

With regard to Safety Recommendation A-86-12, the FAA's letter did not indicate that any action had been taken to correct this situation. The Safety Board has classified Safety Recommendation A-86-12 as "Open--Unacceptable Action" pending further correspondence on this issue.

As a result of its special investigation of runway incursions at controlled airports in the United States, the National Transportation Safety Board reiterates Safety Recommendations A-83-38, A-84-98, A-85-16, and A-85-33. Also, the Safety Board recommends that the Federal Aviation Administration:

Revise the current tower training curriculum at the ATC Academy to include more emphasis on practical standardized "hands-on" tower training using dynamic laboratory and simulation facilities. (Class II, Priority Action) (A-86-30)

Establish a program for improved supervision of tower controller performance in which scanning, coordination, and use of proper phraseology is emphasized and which includes retraining of controllers who are deficient. (Class II, Priority Action) (A-86-31)

Establish an ad hoc task force, including controller and human performance expertise, to develop effective memory aids that would reduce incidents of air traffic controllers forgetting traffic, and to incorporate a description of these memory aids and how they should be used in the ATC Academy controller training syllabus and in the tower facility training program. (Class II, Priority Action) (A-86-32)

Require controllers to obtain a readback for all hold, takeoff, or crossing clearances and for clearances onto an active runway. (Class II, Priority Action) (A-86-33)

Emphasize in operational bulletins, the Airman's Information Manual, general aviation seminars, and pilot training programs, the importance of reading back taxi, hold-short, runway crossing, and takeoff clearances in proper phraseology; the importance of reporting when unable to promptly cross, take off from, or clear a runway when so cleared; and the need to scan properly before entering or crossing a runway. (Class II, Priority Action) (A-86-34)

Emphasize in operational bulletins, the Airman's Information Manual, and pilot training programs that a good operating practice for pilots of single-pilot airplanes is to monitor only assigned air traffic control communication frequencies after a clearance onto an active runway for departure, until flight from the airport traffic area is completed, or after receipt of clearance for landing, until the landing and taxi across all active runways is completed. (Class II, Priority Action) (A-86-35)

Revise controller phraseology for use when issuing takeoff and landing clearances to include the runway number (for example: "American 75, runway 36, cleared for takeoff"). (Class II, Priority Action) (A-86-36)

Issue a General Notice directing the management of all terminal air traffic control facilities to brief all controllers on the dangers of attempting to expedite traffic departing or crossing runways in order to accommodate arrival and departure traffic. (Class II, Priority Action) (A-86-37)

Issue an Advisory Circular delineating both the pilot and controller roles and responsibilities in the prevention of runway incursion incidents. (Class II, Priority Action) (A-86-38)

Revise the near-midair collision reporting and investigating program to clarify the intent that near-collisions on or near the airport surface constitute an occurrence which must be investigated as a near-midair collision. (Class II, Priority Action) (A-86-39)

Revise and enforce the requirements to report and to investigate operational errors, pilot deviations, and near-midair collisions that involve aircraft on the ground as well as in the air, and develop a combined data base for comprehensive procedural and human performance causal analyses of runway incursion incidents. (Class II, Priority Action) (A-86-40)

Issue an air carrier operations bulletin to require air carrier inspectors to review air carrier training and operations manuals and pilot training programs to ensure that they contain specific standardized information and guidance to pilots concerning their role in the prevention of runway incursions. (Class II, Priority Action) (A-86-41)

Disseminate copies of the Safety Board's Special Investigation Report on Runway Incursions at Controlled Airports in the United States to all terminal control facilities and to the ATC Academy for use in their training programs. (Class II, Priority Action) (A-86-42)

In cooperation with terminal air traffic managers, airport managers, airline representatives, and pilot groups, determine the most effective signs, markings, and procedures, from an operational and human performance perspective, to prevent pilot-induced runway incursions and issue an Advisory Circular to disseminate the information to airport managers and pilot organizations. (Class II, Priority Action) (A-86-43)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.


By: Jim Burnett
Chairman