National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 10, 2007

In reply refer to: A-07-34

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On August 27, 2006, about 0607 eastern daylight time, Comair flight 5191, a Bombardier CL-600-2B19 (CRJ-100), N431CA, crashed during takeoff from Blue Grass Airport (LEX), Lexington, Kentucky.[1] The airplane had been cleared by air traffic control (ATC) for takeoff on runway 22, which is 7,003 feet long and equipped with high-intensity runway lights; however, the crew mistakenly taxied onto runway 26, which is 3,500 feet long and unlighted, and attempted to take off.[2] The airplane ran off the end of runway 26, impacted the airport perimeter fence and trees, and crashed. Of the 47 passengers and 3 crewmembers on board the airplane, 49 were killed, and one received serious injuries. The airplane was destroyed by impact forces and postcrash fire. The flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 and was en route to Hartsfield-Jackson Atlanta International Airport, Atlanta, Georgia.

During its investigation of this accident, the National Transportation Safety Board learned that a single air traffic controller was working in the tower at LEX when the accident occurred, and he had an unobstructed view of the hold-short areas for both runways 26 and 22. However, this air traffic controller did not become aware of the accident flight crewmembers' surface navigation error or their attempt to take off on the wrong runway until after the accident. The controller stated that, after completing the handoff of a previous departure he was monitoring, he turned around to face a center console in the tower and began counting flight progress strips for airplanes he had handled during his shift so that he could record hourly traffic counts. The evidence thus far in this investigation has presented a complex scenario in which to evaluate the extent to which various factors may have influenced controller actions as they related to the accident, and the Safety Board continues to evaluate the specific circumstances of this accident. The Board has investigated four other ATC-involved events, however, that highlight a safety

[1] The investigation of the accident is still ongoing and the National Transportation Safety Board has yet to determine the probable cause.

[2] Runway 26 was also restricted for use only in daylight visual flight rules conditions.

issue related to controller vigilance, judgment, and safety awareness that should be addressed.[3] These four events are described in more detail below.

Background

July 23, 2006, Chicago, Illinois[4]

On July 23, 2006, about 2201 central daylight time, an operational error occurred at Chicago O'Hare International Airport (ORD), Chicago, Illinois, when a local controller issued a landing clearance to Atlas Air flight 6972 (GTI6972), a Boeing 747 on approach to runway 14R, and subsequently issued a takeoff clearance to United Airlines flight 1015 (UAL1015), a Boeing 737 holding in position on intersecting runway 27L. During the takeoff roll, the flight crewmembers of UAL1015 saw GTI6972 just before the 747 entered runway 27L in front of the 737, and they rotated at a lower than normal airspeed, clearing the top of the 747 by less than 100 feet. A nearby controller was operating the electronic flight strip transfer system (EFSTS) and was required to monitor the local controller's frequency and assist the local controller to the extent possible.[5] However, neither controller noticed the conflict in time to affect the outcome of the event.

The local controller later recalled that, after he cleared GTI6972 to land, he forgot about the airplane while deciding how to sequence other airplanes that were waiting to depart. When the flight crewmembers of UAL1015, who he had already cleared into position on runway 27L, called to indicate that they were ready to take off, the controller recalled scanning runways 27L and 14R before issuing UAL1015's takeoff clearance, but he did not see GTI6972 rolling out on runway 14R. After reviewing radar replays of the incident, he stated that he believed a ground controller standing near him in the tower cab might have obstructed his view of GTI6972. The EFSTS controller did not detect the local controller's conflicting clearances because he did not have his headset plugged in and was not monitoring the operation. The EFSTS controller stated that, just before the incident, he noticed GTI6972 approaching runway 27L and wondered if it was going to turn off of runway 14R at the last taxiway before runway 27L and that he did not alert the local controller until he saw that GTI6972 was not going to turn.

[3] On December 12, 2006, as a result of the ongoing Comair investigation, the Safety Board issued two recommendations addressing flight crew procedures. Specifically, Safety Recommendation A-06-83 asked the Federal Aviation Administration (FAA) to "require that all 14 *Code of Federal Regulations* Part 121 operators establish procedures requiring all crewmembers on the flight deck to positively confirm and cross-check the airplane's location at the assigned departure runway before crossing the hold-short line for takeoff." Safety Recommendation A-06-84 asked the FAA to "require that all 14 *Code of Federal Regulations* Part 121 operators provide specific guidance to pilots on the runway lighting requirements for takeoff operations at night." Both recommendations are in an open status, awaiting initial response from the FAA.

[4] A description of this incident, OPS06IA008, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[5] This requirement is documented in Section 4-2-7 of O'Hare Air Traffic Control Tower Standard Operating Procedures, ORD 7210.65E.

June 21, 2006, San Francisco, California[6]

On June 21, 2006, about 1429 Pacific daylight time, an operational error occurred at San Francisco International Airport (SFO), San Francisco, California, when the local controller issued takeoff clearances to United Airlines flight 726, a Boeing 757 departing from runway 1R; Skywest flight 6172, an Embraer E120 departing from runway 1L; and Five Star flight 322 (FIV322), a Cessna Citation 550 departing from runway 28R. All three aircraft were converging on the center of the airport until the local controller was alerted to the developing conflict by another tower controller. The controller instructed the crew of FIV322 to reject its takeoff, and that aircraft stopped before reaching runways 1R and 1L. The other two airplanes continued their takeoff rolls on runway 1R and 1L, departing safely.

The controller later recalled that he was operating under the mistaken impression that FIV322 was departing on runway 28R from a taxiway intersection that is west of runway 1L and would not have conflicted with departures on runways 1R and 1L. The aircraft was actually at the east end of runway 28R, the location indicated on the aircraft's flight strip. The controller had cleared FIV322 to taxi into position and hold on the runway 45 seconds before he cleared the airplane for takeoff. When he issued the takeoff clearance, the controller did not notice that the aircraft was not at the expected position west of runway 1L, nor did he notice that the aircraft was holding in position on the east end of runway 28R. The controller did not scan the runway and establish the position of FIV322 before issuing the takeoff clearance, an omission that could easily have resulted in an accident.

November 10, 2004, Santa Barbara, California[7]

On November 10, 2004, about 2200 Pacific standard time, N803ZG, a Piper PA32R, struck terrain just below the ridgeline of a mountain peak while on a visual flight rules flight from Meadows Field Airport, Bakersfield, California, to Santa Barbara Municipal Airport (SBA), Santa Barbara, California. The pilot and two passengers were killed, and the aircraft was destroyed. The airplane had been receiving radar flight-following service from Los Angeles Air Route Traffic Control Center (ZLA) in Palmdale, California.

As N803ZG approached the Santa Barbara area, the airplane descended to about 6,500 feet mean sea level (msl), and the ZLA controller began an automated handoff to SBA approach control. However, N803ZG was not visible to SBA's approach radar, and SBA did not accept the handoff. Soon thereafter, the airplane disappeared from radar when it impacted a 6,800-foot peak. The ZLA controller tried to reestablish radio contact with the airplane several times but was unsuccessful.

The ZLA controller was relieved from her position because she was nearing the end of her shift. Soon after, she was called back to respond to an inquiry from the SBA controller about the status of N803ZG. She told the SBA controller she had not terminated the airplane's service

[6] The FAA investigated this operational error and issued FAA Final Operational Error/Deviation Report Number SFO-T-06-E-001 on July 11, 2006.

[7] A description of this incident, LAX05FA032, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

but had just "lost radio and radar with him." The controller then left the facility without making further efforts to determine the status of N803ZG or briefing her supervisors about the disappearance of the aircraft. The 6,800-foot peak struck by the accident airplane was visible on a navigational chart displayed above the controller's workstation, but the controller later stated she was not aware of the peak. She stated that she had been providing radar flight-following service to N803ZG and explained that she did not think providing this service made her responsible for providing terrain-related safety alerts.

December 17, 2002, Agana, Guam[8]

On December 17, 2002, Philippine Airlines flight 110 (PAL110), an Airbus 330, struck power lines located on Nimitz Hill, near Agana, Guam, while executing a localizer approach to runway 6L at A.B. (Pat) Won Guam International Airport (GUM). The flight crew received a warning from the onboard ground proximity warning system (GPWS) and executed a missed approach, averting a collision with houses and terrain by about 30 feet. The aircraft incurred minor damage after striking several power lines. The flight crew initiated a go-around, completed a second approach, and landed at GUM.

At the time of the incident, PAL110 had been cleared for approach by Guam Combined Control Facility (CCF)[9] and was in communication with the ATC tower at Agana. When the CCF controller cleared PAL110 for approach, she also advised the flight crew that the instrument landing system (ILS) glideslope[10] was unusable. The controller then instructed the pilots of PAL110 to contact the tower, which they did, and the tower controller then cleared them to land. Radio recordings revealed that the CCF controller was handling a U.S. Air Force aircraft on approach to Anderson Air Force Base (AFB) while PAL110 was on approach and under the control of the Agana tower. Additional recorded data from the CCF facility indicated that a minimum safe altitude warning (MSAW) alert was triggered when PAL110 descended from 1,700 to 700 feet msl during the approach; its activation continued for 1 minute and 22 seconds until the flight crew initiated a climb in response to a GPWS alert. The CCF controller never issued a required safety alert to the flight crew or notified the Agana control tower that PAL110 was below the minimum safe altitude for the approach area.[11] Postincident, the controller reported that MSAW alerts occurred frequently, and she, therefore, paid them less attention.

When interviewed, the CCF controller initially explained her failure to react to the alert by saying that she was away from the control position conducting the shift traffic count and unaware that the MSAW system had activated. However, recorded communications between Guam CCF and the aircraft on approach to Anderson AFB showed that she was, in fact, at the

[8] A description of this incident, OPS03IA001, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[9] At the time of the incident, this facility was known as Guam Combined Center/Radar Approach Control but has since been renamed CCF.

[10] The glideslope is a component of an ILS that provides vertical guidance to aircraft. When it is out of service, pilots must compensate by complying with altitude crossing restrictions or, if so equipped, by using onboard vertical navigation equipment as a substitute for glideslope guidance.

[11] FAA Order 7110.65R, *Air Traffic Control*, Paragraph 2-1-6, "Safety Alerts," requires the issuance of a safety alert when a controller becomes aware that an aircraft is in a position that places it in unsafe proximity to terrain. It specifies that controllers are to issue the alert themselves or alert the appropriate controller.

control position during the alert. When questioned further, she attributed her lack of response to "bad judgment." Even with responsibility for two aircraft on approach to different airports, the controller evidently believed that occupation with administrative duties was a reasonable explanation for being unaware of PAL110's dangerous situation.

Discussion

These accident and incident investigations have raised human factors concerns in the areas of controller vigilance, judgment, and safety awareness. The local and EFSTS controllers at ORD demonstrated poor judgment and vigilance. The local controller failed to properly scan the runway or locate one of the airplanes. The EFSTS controller exercised poor safety awareness when he did not follow procedures to help the local controller by plugging in his headset and monitoring the operation. The SFO controller committed a vigilance error due, in part, to a lack of safety awareness when he failed to notice the location of FIV322 before clearing the airplane for takeoff. The ZLA controller demonstrated poor vigilance, judgment, and safety awareness when she failed to use available information to identify potential hazards for N803ZG and then made an insufficient effort to investigate the airplane's disappearance. The CCF controller demonstrated poor judgment and safety awareness when she decided not to issue a required safety alert or notify the Agana tower when she had reason to believe PAL110 was in danger of colliding with terrain. Controller performance shortcomings observed in these events are reminiscent of nontechnical[12] performance deficiencies that have been observed in flight-crew-involved accidents and incidents, including the failure to set appropriate priorities, inadequate monitoring, failure to use available information, and failure to follow required procedures.[13]

Paragraph 2-1-1, "ATC Service," in Federal Aviation Administration (FAA) Order 7110.65R, *Air Traffic Control*, provides guidance to controllers regarding how to prioritize their attention among various tasks and states the following:

> The primary purpose of the ATC system is to prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic. The ability to provide additional services is limited by many factors, such as the volume of traffic, frequency congestion, quality of radar, controller workload, higher priority duties, and the pure physical inability to scan and detect those situations that fall in this category. It is recognized that these services cannot be provided in cases in which the provision of services is precluded by the above factors. Consistent with the aforementioned conditions, controllers shall provide additional service procedures to the extent permitted by higher priority duties and other circumstances. The provision of additional services is not optional on the part of the controller, but rather is required when the work situation permits.

[12] "Nontechnical" refers to skills that foster improved situation awareness, communication, teamwork, task allocation, and decision-making within a comprehensive framework of standard operating procedures. See Advisory Circular 120-51E, "Crew Resource Management Training."

[13] E.L. Wiener, B.G. Kanki, and R.L. Helmreich (Eds.), *Cockpit Resource Management*. New York, NY: Academic Press, Inc. (1993); see also National Transportation Safety Board, *A Review of Flightcrew-Involved Major Accidents of U.S. Carriers, 1978 Through 1990*, Safety Study NTSB/SS-94/01 (Washington, D.C.: NTSB, 1994).

Further, Paragraph 2-1-2, "Duty Priority," in Order 7110.65R states that a controller shall "[g]ive first priority to separating aircraft and issuing safety alerts." The task of issuing safety alerts is, therefore, identified as being a priority on par with the responsibility to ensure the separation of aircraft. However, Paragraph 2-1-6 in the order provides a narrow description of the circumstances requiring a safety alert, as shown below:

> Issue a safety alert to an aircraft if you are aware the aircraft is in a position/altitude which, in your judgment, places it in unsafe proximity to terrain, obstructions, or other aircraft. Once the pilot informs you action is being taken to resolve the situation, you may discontinue the issuance of further alerts. Do not assume that because someone else has responsibility for the aircraft that the unsafe situation has been observed and the safety alert issued; inform the appropriate controller.

The above guidance provides a relatively narrow definition of the kind of situation that requires the issuance of a safety alert.

Under existing FAA policy, tasks that do not serve to ensure the separation of traffic or the issuance of mandatory safety alerts have secondary duty priority. Paragraph 2-1-2, "Duty Priority," states, "Good judgment shall be used in prioritizing all other provisions of this order based on the requirements of the situation at hand." A note in the same section expands on this guidance as follows:

> Note: Because there are many variables involved, it is virtually impossible to develop a standard list of duty priorities that would apply uniformly to every conceivable situation. Each set of circumstances must be evaluated on its own merit, and when more than one action is required, controllers shall exercise their best judgment based on the facts and circumstances known to them. That action which is most critical from a safety standpoint is performed first.

This passage implies that the relative priority of secondary tasks will be readily apparent based on a controller's judgment. Although many controllers routinely demonstrate good judgment in this area, the accidents and incidents described above indicate that this is not the case for all controllers at all times. Some controllers may not recognize the critical importance of their efforts to provide a redundant safety protection against unexpected flight crew errors and other threats to flight safety.

Recognizing the frequent involvement of nontechnical performance deficiencies in flight-crew-involved accidents, the Safety Board has long encouraged the development of resource management training for flight crews. The Board first formally recommended the development of flight-deck resource management training programs in 1979.[14] Such training is now required for all flight crewmembers operating under 14 CFR Part 121.[15] It has been widely endorsed by

[14] National Transportation Safety Board, *United Airlines, Inc., McDonnell-Douglas DC-8-71, N8082U, Portland Oregon, December 28, 1978*, Aircraft Accident Report NTSB/AAR-79/7 (Washington, D.C.: 1979).

[15] Title 14 CFR 121.404 states "After March 19, 1998, no certificate holder may use a person as a flight crewmember, and after March 19, 1999, no certificate holder may use a person as a flight attendant or aircraft

flight crews[16] and has been credited with enhancing flight crew performance and safety in emergency situations.[17] Crew resource management (CRM) training has evolved considerably since the 1970s, from simple classroom indoctrination training to customized line-oriented simulation training programs involving hazard assessment and error management. Training programs for controller nontechnical skills have not reached a comparable stage of maturity.

The FAA has developed some resource management training for air traffic controllers.[18] Locally developed resource management training programs, known as controller awareness and resource training, were implemented in 1988 at several air traffic facilities and continued until 1993. However, these programs were derivatives of airline CRM training and may not have been well suited to the ATC environment.[19] In the mid-1990s, the FAA developed a new national program to improve controller resource management called Air Traffic Teamwork Enhancement (ATTE) training. Although commendable for its intent, a national panel on human factors in ATC found the program to be lacking in several important ways. The program was not based on an analysis of empirical data regarding controller attitudes and nontechnical performance deficiencies, it was not budgeted or mandated at the national level, it was not integrated with formal controller training and evaluation, its impact was not systematically evaluated, it was delivered as a single training event without recurrent training, and it did not provide non-jeopardy simulations that would allow controllers to practice nontechnical behaviors in realistic situations and receive feedback on their performance. Currently, the FAA offers a voluntary 28-hour ATTE facilitator training course at the FAA Academy in Oklahoma City, Oklahoma.

Recognizing the important safety role of nontechnical skills, the FAA's Air Traffic Safety Services Organization has developed a new 1-day training course called "Crew Resource Management (CRM): Human Factors for Air Traffic Controllers." The intent of this course is to foster a culture of teamwork designed to help the controller detect and correct controller and pilot mistakes before they result in operational errors or collisions. Topics include approaches to improving individual performance and teamwork and strategies for threat and error management. Vigilance, judgment, and safety awareness are addressed. This new training course has been provided at air traffic facilities located at several major U.S. airports since November 2006, and the training will also be provided at three en route centers in 2007. The FAA is developing follow-up action plans to encourage the institutionalization of concepts advocated in this training program at the facilities where training has been conducted but it does not currently plan to offer formal recurrent training. In addition, the FAA is creating a DVD based on the CRM training

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dispatcher unless that person has completed approved crew resource management…or dispatcher resource management…initial training, as applicable, with that certificate holder or with another certificate holder."

[16] R.L. Helmreich and H.C. Foushee, "Why Crew Resource Management?" *Empirical and Theoretical Bases of Human Factors Training In Aviation* (1993); see also E.L. Wiener, B.G. Kanki, and R.L. Helmreich (Eds.) (1993). *Cockpit Resource Management*. (New York, NY, Academic Press, Inc.: 1993).

[17] S.C. Predmore, *Microcoding of Communications in Accident Investigation: Crew Coordination in United 811 and United 232* (1991). In R.S. Jensen (Ed.) *Proceedings of the Sixth International Symposium on Aviation Psychology*, Columbus Ohio: The Ohio State University.

[18] Controller resource management training programs have also been developed by Eurocontrol and other air traffic service providers.

[19] C.D. Wickens, A.S. Mavor, and J.P. McGee, (Eds.). *Flight to the Future: Human Factors in Air Traffic Control*, (Washington, D.C., National Academy Press: 1997).

course that will be distributed to facilities that are not scheduled to receive classroom training, and it has proposed the development of a CRM training course for new controllers to be delivered at the FAA Academy.

The Safety Board commends the FAA's efforts to develop a new resource management training program for its controllers. This training is based on a modern philosophy of threat-and-error management, which has been highly influential among developers of flight crew resource management training programs. The training program has the potential to address deficiencies in controller nontechnical skills observed in recent accidents and incidents and provide important safety benefits if it can overcome some of the disadvantages of past efforts.

The Safety Board is encouraged by the FAA's deployment of its new CRM training program for controllers at some major air traffic facilities. Ensuring that this training reaches all controllers, including those at smaller facilities and those receiving indoctrination training at the FAA Academy, is essential and should not be delayed. To provide explicit examples of the importance of nontechnical skills, such training should include detailed examinations of recent accidents and incidents that demonstrate breakdowns in controller resource management, as well as incidents demonstrating best practices in this area; such a component is viewed as highly valuable in many airline resource management training programs.

In addition, it is important that such training be provided in a way that will promote retention. The FAA distributed self-study materials addressing shift work and fatigue to all air traffic control specialists in 2002.[20] Interviews conducted by the Safety Board during investigations of operational errors at the ORD tower facility in 2006, however, indicated that controllers recalled little from these training materials, which suggests that the dissemination of self-study materials may not be an effective means of training controllers in nontechnical subjects.

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

> Require all air traffic controllers to complete instructor-led initial and recurrent training in resource management skills that will improve controller judgment, vigilance, and safety awareness. (A-07-34)

[20] P.S. Della Rocco and T.E. Nesthus, "Shift Work and Air Traffic Control: Transitioning Research Results to the Workforce." In B. Kirwan, M.D. Rodgers, and Dirk Schaefer (Eds.), *Human Factors Impacts In Air Traffic Management*. Aldershot, UK: Ashgate (2005).

Please refer to Safety Recommendation A-07-34 in your reply. If you need additional information, you may call (202) 314-6177.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with this recommendation.

[*Original Signed*]

By: Mark V. Rosenker
Chairman