# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** May 16, 2003

**In reply refer to:** A-03-17

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

**Precipitating Events**

**Lake Constance, Germany**

On July 1, 2002, about 2335 Central European Summer Time, a Boeing 757 (757) operated by DHL International Airways and a Tupolev 154M (Tu-154) operated by Bashkirian Airlines collided in flight near Lake Constance (Bodensee), Germany. The two-person flight crew of the 757 and the 71 crew and passengers on the Tu-154 were all killed and both airplanes were destroyed.[1]

Just prior to the collision, both airplanes were operating under instrument flight rules (IFR) and in communication with air traffic control (ATC) personnel at the Zurich, Switzerland, Area Control Center (ZUR ACC). One ZUR ACC controller was responsible for en route airspace in the eastern half of Switzerland, portions of southern Germany, and an approach control sector in the vicinity of Lake Constance[2] encompassing the Friedrichshafen Airport. About 2330, approximately 5 minutes prior to the collision, the controller was responsible for three airplanes: the two accident airplanes and an Airbus Industrie A320 approaching Friedrichshafen Airport. The controller had just handed two other aircraft over to other controllers and had just received the Tu-154. The A320 pilot was communicating with the controller on a different frequency than the accident airplanes and, due to a communication line outage, the controller was relaying messages to the Friedrichshafen tower through the Airbus pilot. The controller was using two different displays—one that covered a large range for en route aircraft and another focused on the Friedrichshafen airport area. The collision occurred in a

[1] The accident is currently under investigation by the German Bundesstelle für Flugunfalluntersuchung.

[2] Per international agreement between Germany and Switzerland, ZUR ACC provides ATC service in this portion of German sovereign airspace.

corner of the en route portion of ZUR ACC's airspace (that is, near the northeastern limit/boundary of the controller's area of responsibility).

The 757 was proceeding northbound and the Tu-154 was proceeding westbound. The ZUR ACC controller accepted a handoff on the Tu-154 from Munich ACC (the en route ATC facility in Munich, Germany) about 2330, when the airplane was level at flight level (FL) 360 and approximately 35 miles east of the collision point. The accident controller accepted a handoff on the 757 from Milan, Italy, ACC about 2320. After the 757 pilot reported on frequency, the accident controller provided clearances to climb to interim altitudes due to intervening airspace or traffic then, about 2323, authorized the 757 to climb to the requested altitude of FL 360. The 757 reached FL 360 about 2330, approximately 30 miles south of the collision point.

At 2334:49, when the airplanes were about 6.5 miles apart, the controller instructed the Tu-154 pilot to descend to FL 350.[3] Seven seconds later, the controller repeated the instruction and told the pilot to "expedite" because of "crossing traffic." At 2335:07, the Tu-154 pilot responded that he was descending. At the same time, radar data indicate the 757 began a descent. At 2335:19, the 757 pilot reported that he was descending as a result of a traffic collision avoidance system (TCAS)[4] advisory. The controller did not respond. At 2335:34, the airplanes collided.[5]

On the night of the accident, ZUR ACC was operating with reduced equipment capability. Due to scheduled maintenance, the primary ATC radar processing system was not available to the controllers, and a backup system[6] similar to the direct access radar channel (DARC) backup system in the United States was in use. As in U.S. airspace, the primary ATC radar processing system provides automated conflict alerts by monitoring aircraft course, speed, and altitude and by providing a visual and/or audio warning to controllers when aircraft are projected to come closer than allowed by prescribed separation minima (usually 5 nautical miles). Normally, this alert is generated 2 minutes before aircraft are projected to lose separation. The ZUR ACC backup system is not equipped to provide such automated conflict alert warnings to controllers.

In an ATC simulation of the circumstances leading up to the Lake Constance accident, the Federal Aviation Administration's (FAA) Technical Center demonstrated that—assuming the primary operating system was functioning—the FAA's en route ATC radar processing equipment

[3] The airplanes were converging at approximately 600 knots (10 miles per minute). Assuming a descent rate of 1,000 feet per minute (as recommended in the *Aeronautical Information Manual* and International Civil Aviation Organization guidance) and allowing reasonable time for crew response, the instruction to descend would have to have been issued a minimum of 1 minute earlier to maintain standard separation.

[4] TCAS is intended to provide flight crews with traffic advisory information and vertical command directives to enable them to maneuver aircraft to avoid imminent collision. According to Federal Aviation Administration (FAA) Advisory Circular 120-55 and an informational guide titled "Introduction to TCAS," published by the FAA in November 2000, TCAS is intended to be a safety net to ATC separation and right-of-way rules. ATC separation minima are much larger than those protected/addressed by TCAS, and no part of this letter implies that ATC use of conflict alert should interfere with flight crew response to TCAS advisories.

[5] According to preliminary information, the Tu-154 flight crew began responding to the controller's first instruction to descend promptly, which was contrary to the TCAS advisory to climb. The TCAS in both airplanes provided resolution advisories within 1 second of the controller's instruction.

[6] The backup processor at ZUR ACC is a Raytheon TRAC-View system.

would have detected the conflict and provided conflict alert warnings sufficiently in advance to have prevented the loss of separation. Conflict alert functionality, however, does not extend to ATC backup systems.

**Denver, Colorado**

On April 11, 2000, about 0226 mountain daylight time, loss of standard separation occurred about 55 miles east of North Platte, Nebraska, between Northwest Airlines flight 907, a Boeing 747, and US Airways flight 97, a Boeing 757. Both aircraft were operating under IFR and were in contact with Denver, Colorado, air route traffic control center (ARTCC).

The 757 was traveling eastbound at FL 390; the 747 was also at FL 390, traveling southwest. The controller was alerted to the loss of separation by the 747 pilot who reported that he was ascending in response to a TCAS alert. During the timeframe of the incident, the controller was responsible for about 17 airplanes, which she described as a moderate to busy workload. At the time of the incident, the primary ATC hardware/software system—the host/National Airspace System (NAS)—at the Denver ARTCC was shut down for maintenance, and controllers were using the DARC backup system. DARC is not equipped with conflict alert functionality. A Denver ARTCC supervisor interviewed after the incident estimated that if the primary host/NAS system had been operating, a conflict alert would have been generated when the airplanes were approximately 20 miles apart.

**Conflict Alert Capability In Backup Systems**

Normally, en route ATC radar processing equipment monitors the course, speed, and altitude of aircraft under ATC control and when it detects the potential for a loss of separation, it alerts controllers by issuing a conflict alert. ATC radar processing systems are designed to automatically issue such conflict alerts to compensate for potential error and/or inconsistency in controller scanning and the resulting possibility that controllers may not detect an impending loss of separation. In other words, the conflict alert function provides electronic redundancy so that the separation task is not completely reliant upon controller vigilance, which is subject to human error. In fact, conflict alert and related functions are one of the primary reasons for the existence of radar tracking processors.

According to the FAA, conflict alert availability in the various backup systems used depends upon which ATC facility, equipment, and failure mode is involved. For example, in the host/DARC backup mode to the host/NAS, in which the DARC software is taking over for a failure in the display computer, the host/NAS is still performing tracking and the conflict alert function is not lost. However, for the DARC/DARC backup mode, in which the host hardware or NAS software suffers a failure,[7] the DARC processor takes over *all* functions and the conflict alert function is lost. According to FAA automation specialists, the FAA had examined the possibility of adding conflict alert to DARC prior to the Lake Constance accident, but no actions to add conflict alert have been taken recently.

[7] A NAS failure may be an actual breakdown of equipment, a software crash, or either portion could be taken out of service for maintenance, software upgrades, etc.

Similarly, the availability of conflict alert functionality in the backup system for terminal radar approach control facilities is dependent upon what equipment and software is in use and the cause of the primary system failure. The Safety Board notes that, although the newer automated radar terminal system (ARTS) 2E and 3E "Common ARTS" systems are somewhat more sophisticated than the 3A system in that they are more resilient to radar site failures and can more easily integrate other sites, all versions of ARTS are susceptible to failure modes that leave conflict alert unavailable. Further, the standard terminal automation replacement system (STARS) currently being deployed by the FAA at some approach control facilities, which, like its predecessors, incorporates conflict alert functionality, has no conflict alert function in its backup mode.

In sum, conflict alert functionality is present in en route and approach control ATC facilities under primary system operation. Conflict alert availability under backup system operation, however, is largely dependent upon the facility, type of equipment, and software installed. The Safety Board recognizes that new systems currently being installed at approach control facilities are more robust, but they, too, fail to provide conflict alert functionality under backup system operation. The Board notes that there does not appear to be any obstacle in the computer software or hardware that would prevent ATC backup radar processing systems from providing conflict alert capabilities.

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

> Modify air traffic control radar data processing backup systems to provide conflict alert functionality to the greatest extent practicable. (A-03-17)

Chairman ENGLEMAN, Vice Chairman ROSENKER, and Members CARMODY, GOGLIA, and HEALING concurred with this recommendation.

*Original Signed*

By: Ellen G. Engleman
Chairman