



National Transportation Safety Board

Washington, DC 20594

Safety Recommendation

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In reply refer to: A-15-1 through -8

The Honorable Michael P. Huerta
Administrator
Federal Aviation Administration
Washington, DC 20590

The National Transportation Safety Board (NTSB) has long been concerned about rapid recovery of recorded information to guide investigations, help determine accident causes, and develop recommendations to prevent recurrences. To focus attention on this issue, the NTSB convened its *Emerging Flight Data and Locator Technology Forum* on October 7, 2014, in Washington, D.C.¹ Forum discussions among government, industry, and investigative experts helped identify the following safety issues:

- The need for improved technologies to locate aircraft wreckage and flight recorders following an accident in a remote location or over water
- The need for timely recovery of critical flight data following an accident in a remote location or over water

This letter presents recommendations to address these safety issues and discusses open recommendations regarding cockpit image recorders and the need to protect flight recorder systems against intentional or inadvertent deactivation. The NTSB urges the Federal Aviation Administration (FAA) to take action on the safety recommendations issued in this letter.

Background

Cockpit voice recorder (CVR) and flight data recorder (FDR) data are some of the most important information sources available to help determine causes of aviation accidents. As such, recovering the recorders is an investigative priority at the crash site. Recent events have highlighted that recovering flight data can be costly and difficult when an accident occurs in a remote area, outside of radar coverage. For example, on June 1, 2009, Air France Flight 447, an Airbus A330, crashed into the Atlantic Ocean during a regularly scheduled flight from

¹ Documents and transcripts from the forum are available in the NTSB Docket Management System at <http://dms.nts.gov/pubdms/search/hitlist.cfm?docketID=56909&CFID=430399&CFTOKEN=77330661> (NTSB Accident ID: DCA14SS009).

Rio de Janeiro, Brazil, to Paris, France.² All 228 passengers and crew on board died. Although some wreckage was recovered during the first few days of search activity, it took almost 2 years and cost about \$40 million to locate and recover the flight recorders.³ When the recorders were finally recovered, the information they contained was essential to the French Bureau d'Enquêtes et d'Analyses (BEA) in issuing its findings and conclusions regarding the cause of the accident. Additionally, on March 8, 2014, Malaysia Airlines Flight 370 disappeared while on a scheduled flight from Kuala Lumpur, Malaysia, to Beijing, China, with 239 passengers and crew on board. According to the Malaysian Ministry of Transport's preliminary report, 26 countries have participated in the search effort using 82 aircraft and 84 vessels.⁴ To date, those participating in the search have analyzed and mapped more than 41,000 square kilometers of ocean floor without locating the aircraft's CVR, FDR, or any other wreckage.⁵ The investigation remains open.

Aircraft Position Reporting

When traveling within areas of radar coverage, aircraft transmit data to ground radar stations via transponders that allow position to be determined. When traveling outside of radar coverage, pilots periodically communicate the position of their aircraft with Air Traffic Organizations (ATO) and airline dispatchers via a variety of methods. For example, pilots can communicate their position via radio with ATOs when passing certain waypoints on their flight plan. Many large transport category aircraft are also equipped with a digital data link system. One common digital data link system is an Aircraft Communications Addressing and Reporting System (ACARS), which can be configured to automatically report aircraft position periodically to a ground station via satellite communications.⁶ Additionally, many aircraft are equipped with Automatic Dependent Surveillance-Broadcast (ADS-B) systems that periodically transmit their identification, current position, altitude, and speed to ATOs and other aircraft.⁷

During the 2 years before the Air France Flight 447 recorders were located and recovered, the BEA convened a working group to study flight data transmission, flight recorder technology, and wreckage localization technology.⁸ The working group consisted of more than 120 international members from investigative bodies, aircraft manufacturers, regulatory authorities, recorder manufacturers, and satellite service providers, including the NTSB, the FAA, and US industry representatives. The working group examined information relating an aircraft's rate of transmission of position to an accident impact location for 44 accidents of

² See Bureau d'Enquêtes et d'Analyses, *Final Report on the Accident to Air France Airbus 330-203 AF447 from Rio de Janeiro to Paris on 01 June 2009*, (France: Bureau d'Enquêtes et d'Analyses, 2012), which can be accessed at <http://www.bea.aero/docspa/2009/f-cp090601.en/pdf/f-cp090601.en.pdf>.

³ Bureau d'Enquêtes et d'Analyses, *Flight Data Recovery Working Group Report*, Technical Document, Issued December 22, 2009, <http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf>.

⁴ Office of the Chief Inspector of Air Accidents, Ministry of Transport, Malaysia, *MH 370 Preliminary Report Serial*, 03/2014, <http://www.dca.gov.my/MH370/Preliminary%20Report.pdf>.

⁵ Australian Transport Safety Bureau, *MH370 Progress Report*, <http://www.atsb.gov.au/mh370/progress-report.aspx>.

⁶ Examples of ground stations include ATOs and airline dispatch centers.

⁷ As specified in 14 CFR 91.225, all aircraft operating in certain US airspace will be required to carry ADS-B transmitters by January 1, 2020.

⁸ *Flight Data Recovery Working Group Report*, <http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf>.

transport category aircraft. In 95 percent of the cases, the working group determined that if these aircraft had been transmitting their position once every minute, the last reported position would have been within a 6 nautical mile (nm) radius of the point of impact.⁹ The International Civil Aviation Organization (ICAO) Flight Recorder (FLIREC) Panel was tasked with proposing recommendations that would aid in the recovery of data from flight recorders following an accident. The FLIREC Panel is using the BEA working group results to propose amendments that will better determine the position of an accident impact location. This work is ongoing.

In the case of Air France Flight 447, the ACARS system was configured to transmit the aircraft's position about once every 10 minutes. Given the aircraft's cruising speed and altitude, this resulted in a search area with a radius of 40 nm from its last reported position. Such a large area made the search much more challenging. If the aircraft had reported its position more frequently, the search area could have been significantly reduced.

As a consequence of the desire to more quickly and efficiently locate a downed aircraft, changes have been and are being made. In 2011, Air France modified the data link communications systems on its long-haul aircraft to report position once every minute under certain conditions.¹⁰ Further, at the October 2014 NTSB forum, the European Aviation Safety Agency (EASA) representative to the United States stated that the European Commission, assisted by EASA, is drafting additional performance-based regulatory material to improve aircraft tracking. Additionally, in May 2014, ICAO held a Multidisciplinary Meeting Regarding Global Flight Tracking to discuss the issues of aircraft tracking and accident location. ICAO established a framework for future efforts in this area, including an industry task force and the development of a flight-tracking concept of operations.¹¹ As a result, an ICAO working group has developed proposed requirements for a Global Aeronautical Distress and Safety System, which addresses tracking of aircraft during routine and abnormal flight conditions.¹² The NTSB supports the international efforts underway in this area and believes similar action should be taken in the United States. Therefore, the NTSB concludes that aircraft should broadcast sufficient information to facilitate a quicker identification of an accident location, a faster search and rescue response, and a more effective underwater search effort. Further, the BEA's working group analysis indicates that broadcasting an aircraft's location within 6 nm of the point of impact is realistically achievable with modern data link technology.

⁹ Bureau d'Enquêtes et d'Analyses, *Triggered Transmission of Flight Data Working Group Report*, Technical Document, Issued March 18, 2011, <http://www.bea.aero/en/enquetes/flight.af.447/triggered.transmission.of.flight.data.pdf>.

¹⁰ "Aircraft Tracking," working paper presented by France at the International Civil Aviation Organization Multidisciplinary Meeting Regarding Global Tracking in Montreal, Canada, May 12-13, 2014. Global Tracking 2014-WP/8 9/5/14, <http://www.icao.int/Meetings/GTM/Documents/WP.08.France.Aircraft%20tracking.pdf>.

¹¹ International Civil Aviation Organization, "Conclusions and Recommendations of the Multidisciplinary Meeting On Global Tracking" in Montreal, Canada, May 12-13, 2014, <http://www.icao.int/Meetings/GTM/Documents/Final%20Global%20Tracking%20Meeting%20Conclusions%20and%20%20Recommendations.pdf>.

¹² "Concept of Operations to Enhance Global Flight Tracking," working paper to be presented by the International Civil Aviation Organization Secretariat at the Second High-Level Safety Conference 2015, "Planning for Global Aviation Safety Improvement" in Montreal, Canada, February 2-5, 2015, HLSC/15-WP/2, http://www.icao.int/Meetings/HLSC2015/Documents/WP/wp002_en.pdf.

Discussions at the NTSB forum indicated that there are many technologies available that would enable broadcasting the location of an accident within 6 nm. Use of an emergency locator transmitter (ELT), whether as a stand-alone unit or as part of an automatically deploying flight recorder, could transmit the location of an accident; however, it must remain above water to function. In addition, frequent broadcast of an aircraft's position might establish the location of an accident within 6 nm. Currently, many aircraft are equipped with ELTs and many are also capable of automatically transmitting their position, speed, and other information. Although the primary goal of aircraft position reporting in the event of an accident is to reduce the search area to a radius of less than 6 nm, the NTSB recognizes there are complexities associated with issuing such a requirement and implementing the technology. Some operators have already modified their data link communications systems to report aircraft position every minute under certain conditions. Further, many other aircraft are already equipped with similar technology capable of automatically reporting aircraft position. The NTSB encourages the voluntary implementation of increased frequency of position reporting by operators as an interim measure to better establish accident location following an event.

The NTSB is most concerned about aircraft that fly extended overwater (EOW) operations outside of radar coverage because timely response and recovery are more challenging when an accident occurs in a remote area.¹³ Currently, aircraft that fly EOW operations must carry additional survival equipment, such as life rafts and survival-type ELTs, to mitigate the risks.¹⁴ The NTSB recommends that the FAA require that all aircraft used in EOW operations and operating under Title 14 *Code of Federal Regulations* (CFR) (1) Part 121 or (2) Part 135 that are required to have a CVR and an FDR, be equipped with a tamper-resistant method to broadcast to a ground station sufficient information to establish the location where an aircraft terminates flight as the result of an accident within 6 nm of the point of impact.

More Effective Location of Underwater Wreckage

The search for flight recorders submerged under water has traditionally been guided by an underwater locator beacon (ULB) affixed to each recorder. ULBs transmit an ultrasonic signal, or "ping," when submerged in water. Once activated by submersion in water, the device's batteries can power this signal continuously for at least 30 days. In some newer models, the batteries can power the signal for at least 90 days. The signal's detection range is generally limited to 1 to 3 nm depending on depth, underwater topography, and surrounding conditions. The detection range also can be greatly reduced if a ULB is covered or blocked by aircraft wreckage. Delays in locating a crash site and mobilizing underwater search assets have limited the available search time while the ULB batteries are still operational.

Following the Air France Flight 447 accident, SAE International formed a working group and developed Aerospace Standard AS6254, *Minimum Performance Standard for Low Frequency Underwater Locating Devices (Acoustic) (Self-Powered)*.¹⁵ Underwater locating devices (ULD) are beacons designed to be mounted to the fuselage structure and generate a

¹³ According to 14 CFR 1.1, an EOW operation occurs over water at a horizontal distance of more than 50 nm from the nearest shoreline.

¹⁴ See 14 CFR 121.339 and 14 CFR 135.167.

¹⁵ The working group participants included representatives from the NTSB, the FAA, foreign government agencies, and industry.

lower frequency signal than ULBs, which are smaller and are primarily used to aid in locating the recorders within the wreckage field. The lower operating frequency of ULDs increases signal detection range and improves signal transmissibility through any aircraft structure to allow main wreckage field identification. Another advantage of ULDs is that many private and military resources have receivers capable of detecting these low frequency signals, which increases the likelihood that resources capable of searching for aircraft wreckage would be in closer proximity to the search area. In 2012, the FAA issued a new Technical Standard Order (TSO), TSO-C200, “Airframe Low Frequency Underwater Locating Devices (Acoustic) (Self-Powered),” outlining the minimum performance standard for airframe low frequency ULDs based on the SAE International AS6254 standard. In 2012, ICAO adopted the SAE International standard for ULDs on aircraft that operate long distances over water. Although the NTSB is encouraged by the development of TSO-C200 and AS6254, both define the minimum operating life of a ULD to be 30 days. The NTSB believes a ULD minimum operating life should be at least 90 days. The NTSB concludes that airframe-mounted ULDs would improve the underwater search for aircraft wreckage because of their longer detection range and lower frequency signals. The ULD low frequency aids in locating the main wreckage field and supplements the use of a ULB, which has a shorter range but a higher frequency that provides a more precise location to identify recorder position. Therefore, the NTSB recommends that the FAA require that all aircraft used in EOW operations and operating under 14 CFR (1) Part 121 or (2) Part 135 that are required to have a CVR and an FDR, be equipped with an airframe low frequency ULD that will function for at least 90 days and that can be detected by equipment available on military, search and rescue, and salvage assets commonly used to search for and recover wreckage.

Supplemental Methods to Recover Flight Data

The NTSB is also interested in ways to recover critical flight data in a more timely manner and that do not require immediate underwater retrieval of flight recorders. Locating and recovering flight recorders in over water accidents has been more problematic than those occurring on land.¹⁶

Once recovered, flight recorders have been highly reliable, and data have been successfully downloaded. However, there have been rare instances in which recorders have not been recovered or data were lost due to damage from exposure to severe fire or underwater conditions.¹⁷ Because of this, the NTSB issued Safety Recommendation A-99-17 to the FAA requiring the installation of dual combination flight recorders that include both cockpit voice and

¹⁶ See the Boeing presentation given at the NTSB *Emerging Flight Data and Locator Technology Forum*, October 7, 2014, which is available in the NTSB Docket Management System at <http://dms.nts.gov/pubdms/search/hitlist.cfm?docketID=56909&CFID=430399&CFTOKEN=77330661> (NTSB Accident ID: DCA14SS009). The average time for recovery of flight recorders in 27 over water accidents in the past 35 years was about 181 days. The 181-day average does not include the recorders from accidents dating back to 1987 that have yet to be recovered.

¹⁷ Some examples include the FDR from South African Airways Flight 295 (1987) and the CVR and FDR from Asiana Airlines Flight 991 (2011), which were never found. The CVR from Yemenia Airlines Flight 626 (2009) was damaged and some audio was lost. (See *Report of the Board of Inquiry Into the Loss of South African Airways Boeing 747 – 244B Combi Aircraft “Helderberg” in the Indian Ocean on November 28th 1987*; *Flight Data Recovery Working Group Report*; *Flight Data Recovery Working Group Report*, <http://www.bea.aero/en/enquetes/flight.af.447/flight.data.recovery.working.group.final.report.pdf>; Yemenia Airlines Flight 626 report, <http://www.bea.aero/docs/2009/70-j090629/pdf/70-j090629.pdf>).

flight data recording functionalities on board newly built aircraft.¹⁸ Although the NTSB continues to believe that dual combination recorders provide a very effective level of information redundancy, technology advances over the past several years have yielded alternate means to provide some degree of recorded flight data redundancy without the delays associated with a difficult underwater recovery.

Deployable recorders are a technology that can be used to recover flight data without the delay of a long and expensive underwater recovery. At the October 2014 NTSB forum, the Director of Air Programs at DRS Technologies Canada Ltd. stated that deployable recorders have been used in military and over water helicopter applications since the 1960s and are currently available from several manufacturers. These recorders combine traditional FDR and CVR functions into one unit and are capable of providing a comparable amount of flight data. They are designed to separate from the aircraft upon fuselage structural deformation or when submersed in water. If in water, they float indefinitely on the surface. These units are also equipped with ELTs that operate on the 121.5 megahertz (MHz) and 406 MHz frequencies for location and recovery. Standards already exist for automatically deploying flight recorders.¹⁹ The European Organization for Civil Aviation Equipment (EUROCAE) Document ED-112A, *Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems*, includes unique survivability criteria specific to the operational characteristics of deployable recorders with the goal of providing a comparable level of survivability to fixed flight recorders. Deployable flight recorders are subject to different impact and fire survivability requirements because they are designed to separate from an aircraft and come to rest outside of the primary wreckage field. The BEA Flight Data Recovery Working Group identified the installation of deployable recorders as a viable solution to supplement traditional flight recorders. At the NTSB forum, the Chief Product Security Officer at Airbus indicated the company's intention to study the application of deployable recorders for use in its aircraft. Installing deployable recorders, if combined with traditional onboard flight recorders, would provide an increased level of information redundancy.

Triggered flight data transmission is another promising technology, which was also studied by the BEA working group. This technology involves monitoring preselected aircraft parameters and triggering satellite transmission of critical flight data when the parameters deviate from their normal operating envelope. At the NTSB forum, the Director of Strategic Programs at FLYHT Aerospace Solutions Ltd., a manufacturer of flight data transmission technology, testified that triggered flight data transmission was not only feasible, but also already in service on some aircraft. Additionally, at this time, manufacturers and operators are equipping their aircraft with commercial satellite communications systems that can support broadband video, voice, and data transmissions. Commercial satellite systems on the market today are primarily used for passenger and crew connectivity and can support speeds of 200-400 kilobits per second (kbps). Higher speed capability is forthcoming. Such bandwidth would enable real-time parametric flight data transmission to begin after a triggering event as well as

¹⁸ See NTSB Safety Recommendation A-99-17 to the FAA, which is classified "Closed—Unacceptable Action." This recommendation letter and excerpts of associated correspondence are available via the NTSB safety recommendations database at <http://www.nts.gov/safety/safety-recs/layouts/nts-recsearch/RecTabs.aspx>.

¹⁹ See the European Organization for Civil Aviation Equipment (EUROCAE) Document ED-112A, *Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems*, and FAA TSO-123c, "Cockpit Voice Recorder Equipment," and TSO-124c, "Flight Data Recorder Equipment."

transmission of a limited amount of stored flight data recorded before the triggering event.²⁰ For example, once triggered, each second of flight data between the triggering event and the end of the flight could be transmitted. Additionally, any available bandwidth not required for transmitting the real-time data could be used to transmit as much data as possible from prior to the triggering event.²¹

Either deployable recorder or triggered flight data transmission technologies, if used to supplement the mandatory onboard recorders, would provide investigators more timely access to information and offer valuable insight into the circumstances near the end of an accident flight. Access to the parametric flight data is available via both technologies.²² These data would provide information to help focus an investigation while the search for and recovery of recorders and wreckage is taking place at underwater crash sites. The NTSB concludes that supplemental methods of flight data recovery are feasible and would facilitate rapid identification of critical safety issues. Therefore, the NTSB recommends that the FAA require that all newly manufactured aircraft used in EOW operations and operating under 14 CFR (1) Part 121 or (2) Part 135 that are required to have a CVR and an FDR, be equipped with a means to recover, at a minimum, mandatory flight data parameters; the means of recovery should not require underwater retrieval. Data should be captured from a triggering event until the end of the flight and for as long a time period before the triggering event as possible.

The NTSB recognizes there are significant ongoing international industry and regulatory efforts to develop and adopt standards for enhanced aircraft position reporting and supplemental methods for recovering flight data. Achieving these goals on a global basis will demand a harmonized approach that addresses the needs of many stakeholders and ensures that domestic and foreign parties operate under equivalent standards. The NTSB concludes that the FAA should work closely with its international counterparts to ensure that regulations affecting both domestic and foreign parties are consistent. The NTSB believes that the current ICAO Standards and Recommended Practices address the intent of Safety Recommendation A-15-2 at the international level.²³ Therefore, the NTSB recommends that the FAA, concurrent with the implementation of Safety Recommendations A-15-1 and A-15-3, coordinate with other international regulatory authorities and ICAO to harmonize the implementation of the requirements outlined in Safety Recommendations A-15-1 and A-15-3.

²⁰ The highest data rate FDRs currently available—2,048 12-bit words per second (wps)—would require a data link with a minimum bandwidth of about 25 kbps to stream a complete set of real-time parametric flight data.

²¹ The majority of FDRs in use today have data rates of 128 or 256 wps. With these data rates, it is possible to transmit at least 61 seconds of flight data through a bandwidth of 200-400 kbps, which would provide 1 minute of data before a triggering event for every 1 second of data after a triggering event.

²² Mandatory flight data parameters are specified in 14 CFR 121.343 and 121.344 and 14 CFR 135.152.

²³ See International Civil Aviation Organization, *Operation of Aircraft, Part I, International Commercial, Air Transport—Aeroplanes*, International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Ninth Edition (Montreal, Quebec, Canada: International Civil Aviation Organization, July 2010, Amendment 38, November 13, 2014).

Previous Recommendations on Cockpit Image Recording Systems and Protection Against Intentional or Inadvertent Deactivation of Recording Systems

The NTSB also reviewed previously issued safety recommendations on cockpit image recording systems and protection against deactivation of recording systems. In April 2000, citing several accidents involving a lack of information regarding crewmember actions and the flight deck environment, including ValuJet Flight 592, SilkAir Flight 185, Swissair Flight 111, and EgyptAir Flight 990, the NTSB issued Safety Recommendations A-00-30 and -31 to the FAA.²⁴ In addition to recommending that the FAA require placing recorder system circuit breakers in locations the flight crew could not access, Safety Recommendation A-00-30 recommended that the FAA mandate that in-service aircraft operated under 14 CFR Part 121, 125, or 135 be equipped with a crash-protected cockpit image recording system. Safety Recommendation A-00-31 recommended similar action for newly manufactured aircraft that would be operated under 14 CFR Part 121, 125, or 135. In 2006, the NTSB reiterated Safety Recommendation A-00-30 as a result of its investigation of the October 19, 2004, accident involving Corporate Airlines Flight 5966, a BAE-J3201 aircraft, in Kirksville, Missouri.²⁵ The NTSB believes it is now appropriate to clarify the recommendations by separating the issue of recorder system circuit breaker accessibility from the issue of cockpit image recording systems and to update the recommendations by incorporating government and industry developments in cockpit image recording systems.

In response to Safety Recommendations A-00-30 and A-00-31, concerning circuit breakers, the FAA replied that the circuit protection for any electrical system that is active during flight should be accessible to the flight crew so that in the event of an in-flight electrical fire, the crew can quickly cut power to all electrical equipment in accordance with approved procedures. However, the NTSB notes that there are often circuit breakers on advanced aircraft to which flight crews do not have access. Further, some manufacturers currently install the flight recorder circuit breakers in a location that the flight crew cannot readily access. Therefore, the NTSB believes that it is possible to incorporate protections against disabling specific equipment while

²⁴ National Transportation Safety Board, *In-Flight Fire and Impact With Terrain, ValuJet Airlines Flight 592 DC-9-32, N904VJ, Everglades, Near Miami, Florida, May 11, 1996*, AAR-97/06 (Washington, DC: National Transportation Safety Board, 1997), <http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR9607.pdf>; National Transportation Safety Committee's *Aircraft Accident Report, SilkAir Flight MI 185, Boeing B737-3009V-TRF, Musi River, Palembang, Indonesia, December 19, 1997* (Department of Communications, Republic of Indonesia: Jakarta, December 14, 2000) available in the NTSB Docket Management System at <http://dms.ntsb.gov/pubdms/search/document.cfm?docID=377242&docketID=15358&mkey=11051>; Transportation Safety Board of Canada, *Aviation Investigation Report, In-Flight Fire Leading to Collision with Water, Swissair Transport Limited, McDonnell Douglas MD-11 HB-IWF, Peggy's Cove, Nova Scotia 5 nm SW, 2 September 1998*, Report Number A98H0003, <http://www.tsb.gc.ca/eng/rapports-reports/aviation/1998/a98h0003/a98h0003.pdf>; National Transportation Safety Board, *EgyptAir Flight 990, Boeing 767-366ER, SU-GAP, 60 Miles South of Nantucket, Massachusetts, October 31, 1999*, AAB-02/01 (Washington, DC: National Transportation Safety Board, 2002), <http://www.ntsb.gov/investigations/AccidentReports/Reports/AAB0201.pdf>; the NTSB recommendation letter for Safety Recommendations A-00-30 and -31 and excerpts of associated correspondence are available via the NTSB safety recommendations database at <http://www.ntsb.gov/safety/safety-recs/layouts/ntsb.recsearch/RecTabs.aspx>.

²⁵ National Transportation Safety Board, *Collision with Trees and Crash Short of the Runway, Corporate Airlines Flight 5966, BAE Systems BAE-J3201, N875JX, Kirksville, Missouri, October 19, 2004*, AAR-06/01 (Washington, DC: National Transportation Safety Board, 2006), <http://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0601.pdf>.

also meeting applicable regulations as well as the FAA's stated design philosophy. The NTSB concludes that flight crews may disable recording systems on current transport category aircraft, which could hinder the identification of safety issues during the investigation of serious events. Therefore, the NTSB recommends that the FAA require that all newly manufactured transport category aircraft incorporate adequate protections against disabling flight recorder systems.

The NTSB recognizes that retrofitting existing aircraft to incorporate protections against disabling recording systems may present significant challenges. Rewiring an aircraft would be difficult, but there may be other possible options to ensure that recording systems cannot be easily disabled. Some possible examples to help reduce accessibility include moving the circuit breakers to a different location or adding a protective cover. Despite the challenges with protecting recording system circuit breakers on existing aircraft, the NTSB concludes that identifying potential solutions to incorporate these protections is important because of the large number of aircraft that will remain in service for many years. Therefore, the NTSB recommends that the FAA identify ways to incorporate adequate protections against disabling flight recorder systems on all existing transport category aircraft.

In its final report on the Air France Flight 447 accident, the BEA cited difficulties in reconstructing critical instrument panel indications that were available to the flight crew. Consequently, the BEA recommended that ICAO require public transport flights with passengers be equipped with a cockpit image recorder that can record the instrument panel and also that guidelines be established to guarantee the confidentiality of recordings.

On September 3, 2010, a Boeing 747-44AF, operated by United Parcel Service (UPS), crashed while attempting to return to Dubai International Airport following an in-flight cargo fire. Some critical information, such as flight instrument indications, switch positions, and aircraft system conditions, could not be confirmed with the available evidence. The final report, prepared by the United Arab Emirates General Civil Aviation Authority in accordance with ICAO Annex 13, specifically cited the lack of cockpit imagery as a detriment to the timeliness of the investigation and delivery of critical safety recommendations.²⁶

In the SilkAir and EgyptAir crashes, the CVR and the FDR recordings provided limited information about crew actions and the status of the cockpit environment. Further, in the Air France and UPS crashes, the accident aircraft were equipped with FDRs that greatly exceeded the minimum parameter requirements. However, in these accidents, critical information related to the cockpit environment conditions (for example, crew actions and visibility), instrument indications available to crewmembers, and the degradation of aircraft systems was not available to investigators. The NTSB concludes that image recordings would provide critical information about flight crew actions and the cockpit environment that has not been provided by CVRs and FDRs, and would enhance accident investigations and identification of safety issues. Further, the FAA has addressed this in TSO-C176a, "Cockpit Image Recorder Equipment," which outlines the minimum performance standard for cockpit image recorder systems based on the EUROCAE Document ED-112A.

²⁶ General Civil Aviation Authority of the United Arab Emirates, Air Accident Investigation Sector Final Air Accident Investigation Report, *Uncontained Cargo Fire Leading to Loss of Control Inflight and Uncontrolled Descent into Terrain, Boeing 747-44AF, N571UP, Dubai, United Arab Emirates, 03 September 2010*, Case Reference 13/2010.

Equipment approved under TSO-C176a could accommodate flight data, cockpit voice, and cockpit image recording functions in a single combination recorder. To maximize the potential for recorder survivability and information regarding the cockpit environment, one combination recorder providing these functions would be installed as close to the cockpit as practicable and another as far aft as practicable. The NTSB recommends that the FAA require that all newly manufactured aircraft operated under 14 CFR Part 121 or 135 and required to have a CVR and an FDR also be equipped with a crash-protected cockpit image recording system compliant with TSO-C176a or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457. Additionally, the NTSB recommends that the FAA require that all existing aircraft operated under 14 CFR Part 121 or 135 and currently required to have a CVR and an FDR be retrofitted with a crash-protected cockpit image recording system compliant with TSO-C176a or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457.

Safety Recommendations A-15-5 through -8 recommend similar actions to Safety Recommendations A-00-30 and -31; however, they separately address safeguarding against disabling flight recorders and requiring cockpit image recorders. Issuing TSO-C176a was a good first step; however, after 15 years the FAA still has not mandated installing cockpit image recorders or incorporating protections against the flight crew disabling flight recorder systems. Therefore, Safety Recommendations A-00-30 and -31 are classified “Closed—Unacceptable Action/Superseded.”

Recommendations

Therefore, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

Require that all aircraft used in extended overwater operations and operating under Title 14 *Code of Federal Regulations* (1) Part 121 or (2) Part 135 that are required to have a cockpit voice recorder and a flight data recorder, be equipped with a tamper-resistant method to broadcast to a ground station sufficient information to establish the location where an aircraft terminates flight as the result of an accident within 6 nautical miles of the point of impact. (A-15-1)

Require that all aircraft used in extended overwater operations and operating under Title 14 *Code of Federal Regulations* (1) Part 121 or (2) Part 135 that are required to have a cockpit voice recorder and a flight data recorder, be equipped with an airframe low frequency underwater locating device that will function for at least 90 days and that can be detected by equipment available on military, search and rescue, and salvage assets commonly used to search for and recover wreckage. (A-15-2)

Require that all newly manufactured aircraft used in extended overwater operations and operating under Title 14 *Code of Federal Regulations* (1) Part 121 or (2) Part 135 that are required to have a cockpit voice recorder and a flight data recorder, be equipped with a means to recover, at a minimum, mandatory flight data parameters; the means of recovery should not require underwater retrieval. Data should be captured from a triggering event until the end of the flight and for as long a time period before the triggering event as possible. (A-15-3)

Concurrent with the implementation of Safety Recommendations A-15-1 and A-15-3, coordinate with other international regulatory authorities and the International Civil Aviation Organization to harmonize the implementation of the requirements outlined in Safety Recommendations A-15-1 and A-15-3. (A-15-4)

Identify ways to incorporate adequate protections against disabling flight recorder systems on all existing transport category aircraft. (A-15-5) (Supersedes Safety Recommendation A-00-30)

Require that all newly manufactured transport category aircraft incorporate adequate protections against disabling flight recorder systems. (A-15-6) (Supersedes Safety Recommendation A-00-31)

Require that all existing aircraft operated under Title 14 *Code of Federal Regulations* (CFR) Part 121 or 135 and currently required to have a cockpit voice recorder and a flight data recorder be retrofitted with a crash-protected cockpit image recording system compliant with Technical Standard Order TSO-C176a, “Cockpit Image Recorder Equipment,” TSO-C176a or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457. (A-15-7) (Supersedes Safety Recommendation A-00-30)

Require that all newly manufactured aircraft operated under Title 14 *Code of Federal Regulations* (CFR) Part 121 or 135 and required to have a cockpit voice recorder and a flight data recorder also be equipped with a crash-protected cockpit image recording system compliant with Technical Standard Order TSO-C176a, “Cockpit Image Recorder Equipment,” or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457. (A-15-8) (Supersedes Safety Recommendation A-00-31)

The National Transportation Safety Board also classifies the following previously issued recommendations to the Federal Aviation Administration “Closed—Unacceptable Action/Superseded”:

Require that all aircraft operated under Title 14 *Code of Federal Regulations* Part 121, 125, or 135 and currently required to be equipped with a cockpit voice recorder (CVR) and digital flight data recorder (DFDR) be retrofitted by January 1, 2005, with a crash-protected cockpit image recording system. The cockpit image recorder system should have a 2-hour recording duration, as a minimum, and be capable of recording, in color, a view of the entire cockpit including each control position and each action (such as display selections or system activations) taken by people in the cockpit. The recording of these video images should be at a frame rate and resolution sufficient for capturing such actions. The cockpit image recorder should be mounted in the aft portion of the aircraft for maximum survivability and should be equipped with an independent auxiliary power supply that automatically engages and provides 10 minutes of operation whenever aircraft power to the cockpit image recorder and associated cockpit camera system ceases, either by normal shutdown or by a loss of power to the bus. The circuit breaker for the cockpit image recorder system, as well as the circuit breakers for the CVR and the DFDR, should not be accessible to the flight crew during flight. (A-00-30) (Superseded by Safety Recommendations A-15-5 and -7)

Require that all aircraft manufactured after January 1, 2003, operated under Title 14 *Code of Federal Regulations* Part 121, 125, or 135 and required to be equipped with a cockpit voice recorder (CVR) and digital flight data recorder (DFDR) also be equipped with two crash-protected cockpit image recording systems. The cockpit image recorder systems should have a 2-hour recording duration, as a minimum, and be capable of recording, in color, a view of the entire cockpit including each control position and each action (such as display selections or system activations) taken by people in the cockpit. The recording of these video images should be at a frame rate and resolution sufficient for capturing such actions. One recorder should be located as close to the cockpit as practicable and the other as far aft as practicable. These recorders should be equipped with independent auxiliary power supplies that automatically engage and provide 10 minutes of operation whenever aircraft power to the cockpit image recorders and associated cockpit camera systems ceases, either by normal shutdown or by a loss of power to the bus. The circuit breaker for the cockpit image recorder systems, as well as the circuit breakers for the CVRs and the DFDRs, should not be accessible to the flight crew during flight. (A-00-31) (Superseded by Safety Recommendations A-15-6 and -8)

Acting Chairman HART, and Members SUMWALT and WEENER concurred in these recommendations.

The NTSB is vitally interested in these recommendations because they are designed to prevent accidents and save lives. We would appreciate receiving a response from you within 90 days, as required by 49 *United States Code* section 1135, detailing the actions you have taken or intend to take to implement them. When replying, please refer to the safety recommendations by number and submit your response electronically to correspondence@ntsb.gov.

[Original Signed]

By: Christopher A. Hart,
Acting Chairman