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National Transportation Safety Board

Preventing Turbulence-Related Injuries in Part 121 Air Carrier Operations

Nathan Doble Turbulence Impact Mitigation Workshop 4 November 10, 2021

About the NTSB

- Independent federal agency
- No regulatory authority only recommendations
- Investigates every US civil aviation accident and significant accidents in other modes
 - Highway, marine, rail, pipeline
- Conducts transportation safety research



Part 121 Turbulence Safety Research Report

- Published September 2021
- Issued 21 new safety recommendations
 - 18 to Federal Aviation Administration (FAA)
 - 2 to National Weather Service (NWS)
 - 1 to Airlines for America (A4A), National Air Carrier Association (NACA), and Regional Airline Association (RAA)
- Reiterated 4 recommendations to FAA

Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121



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Safety Research Report NTSB/SS-21/01 PB2021-100927



Why the NTSB Did This Research

- Turbulence-related accidents are the most common type of Part 121 accident
- From 2009 through 2018:
 - Turbulence accounted for 111 of 295 Part 121 accidents (38%)
 - All resulted in at least one serious injury



Part 121 Accident Types, 2009–2018



Research Methodology

- Literature review
- Data analysis
- Case studies
- Stakeholder interviews

• FAA

- Air traffic control (ATC)
- Air carriers
- Meteorologists and commercial weather information providers
- Pilot and flight attendant unions
- Aircraft and airborne radar manufacturers



Safety Issue Areas

- Insufficient submission and dissemination of turbulence observations
- Lack of shared awareness of turbulence risks
- Need for mitigation of common turbulence-related injury circumstances
- Need for updated turbulence guidance



- ATC procedures for processing pilot weather reports (PIREPs) are time-consuming and nonstandardized
 - FAA: work with stakeholders to standardize distribution of PIREPs across and within ATC facilities
 - FAA (reiteration): provide controllers with automated PIREP data-collection tools
 - FAA (reiteration): automatically populate PIREPs with data captured from controller displays
 - FAA (reiteration): provide a means of electronically accepting PIREPs
 - FAA (reiteration): encourage industry safety efforts to incentivize PIREP sharing



- Air carriers do not share all turbulence observations throughout the National Airspace System (NAS)
 - FAA: as a condition of enhanced weather information system (EWINS) approval, require Part 121 air carriers to disseminate all turbulence observations to the NAS



- Stakeholders lack access to important flight safety data because objective, in situ turbulence observations are not shared publicly to the greatest extent possible
 - FAA: incorporate automatic dependent surveillance-broadcast weather (ADS-B Wx) in the next version of the ADS-B technical standard order (TSO)
 - FAA: require that aircraft flown in Part 121 operations be retrofitted with ADS-B Wx
 - FAA: require ADS-B Wx equipped aircraft to broadcast ADS-B Wx information when operating in ADS-B airspace



- Methods are needed to translate between eddy dissipation rate (EDR) values calculated by different algorithms
 - FAA: determine how to harmonize current and future EDR algorithm performance in operational environments



Risk Awareness

- Due to their large size, AIRMETs are of limited value to Part 121 pilots and ATC
 - FAA & NWS: modify AIRMET issuing practices to include graphical AIRMETs with higher granularity





- Providing AIRMETs, SIGMETs, and center weather advisories (CWAs) on ATC displays would increase controller awareness of their locations
 - FAA: distribute graphical AIRMETs, SIGMETs, and CWAs as selectable layers on controller radar displays
- Lightning and hail information provide useful indicators for areas of convective turbulence
 - FAA: incorporate total lightning and hail information as selectable layers on controller radar displays
 - FAA: provide training to controllers on the use of lightning and hail information



- A turbulence nowcast would help pilots, dispatchers, and controllers respond tactically to turbulence
 - FAA & NWS: operationalize a turbulence nowcast, such as the Graphical Turbulence Guidance Nowcast (GTGN)
 - FAA: develop ATC guidelines for using a turbulence nowcast



Observation

Risk Awareness

- Having flight attendants seated earlier in the descent would reduce turbulence accidents and injuries
 - FAA: revise Advisory Circular 120-88A to include the phases of flight and altitudes at which flight attendants should be secured in their seats, including descent



Serious Injuries Sustained in Turbulence-Related Part 121 Accidents, 2009–2018



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Risk Awaren

Turbulence-Related Part 121 Accidents by Altitude and Phase of Flight, 2009–2018







- Assessing how aircraft accelerations from turbulence vary along the length of the aircraft would improve understanding of injury risk
 - FAA: conduct a study of how aircraft accelerations vary along the length of the aircraft during turbulence encounters, including differences among aircraft types operated by Part 121 air carriers



Estimated Load Factors During DCA16CA010 Accident (Boeing 737-900ER)





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- Wearing a seat belt reduces the risk of serious injury for all aircraft occupants during turbulence-related Part 121 accidents
- Researching factors that affect caregivers' decisions about using a child restraint system (CRS) would improve efforts to increase voluntary CRS use
 - FAA: conduct a study to determine the factors that affect CRS usage
 - FAA: use the study findings to direct FAA efforts to increase CRS usage
 - A4A, NACA, RAA: develop and implement a program to increase CRS usage, which should include data collection to determine the program's effectiveness



- Advisory Circular 120-88A (Preventing Injuries Caused by Turbulence) does not contain information about current available technologies and best practices for avoiding turbulence encounters and injuries
 - FAA: Revise AC 120-88A



Advisory Circular

AC No: 120-88A

Change:

 Subject:
 Preventing Injuries Caused by Turbulence
 Date: 1/19/06

 Initiated by: AFS-200

1. PURPOSE. This advisory circular (AC) provides information and practices that can be used to prevent injuries caused by turbulence. This AC highlights the data-driven methods of the Federal Aviation Administration (FAA) and its government and industry partners in identifying practices known to be effective against injuries caused by turbulence. Practices identified in the AC are suggested for crewmembers, aircraft dispatchers, managers, trainers, and others associated with flight operations under Title 14 of the Code of Federal Regulations (14 CFR) part 121. Those practices are suggested components of standard operating procedures (SOP) that can be followed in daily flight operations and continually reinforced in training.

2. RELATED REGULATIONS. These regulations are available online at: http://www.gpoaccess.gov/cfr/index.html.

a. 14 CFR part 121, §§ 121.311, 121.317, 121.417, 121.421, 121.427; part 125, §§ 125.211, 125.217, 125.287, 125.289, part 135, §§ 135.117, 135.128, 135.331, 135.349, and 135.351.

b. Title 49 of the Code of Federal Regulations (49 CFR) part 830, § 830.2.

3. DEFINITIONS. The following terms as they relate to this document are defined by the National Transportation Safety Board (NTSB).

a. Accident. An "accident" as in 49 CFR § 830.2 is "an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage."

b. Fatal Injury. "A fatal injury is any injury that results in death within 30 days of the accident."

c. Serious Injury. A serious injury is "any injury that (1) requires the individual to be hospitalized for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second-or third-degree burns, or any burns affecting more than 5 percent of the body surface."



For More Information

Report

- www.ntsb.gov » Safety Research » Safety Research Reports
- https://www.ntsb.gov/safety/safety-studies/Documents/SS2101.pdf
- Board meeting
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