

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



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OPERATIONAL FACTORS

Group Chair's Factual Report

April 15, 2024

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. OPERATIONAL FACTORS GROUP	3
C. SUMMARY	3
D. DETAILS OF THE INVESTIGATION	4
1.0 SPECIALISTS ACTIVITIES	4
E. FACTUAL INFORMATION.....	5
1.0 HISTORY OF FLIGHT.....	5
2.0 FLIGHT CREW INFORMATION	6
2.1 Captain.....	6
2.1.1 Captain's Pilot Certification Records.....	6
2.1.2 Captain's Training and Proficiency Checks	7
2.2 First Officer	7
2.2.1 First Officer's Pilot Certification Records	7
2.2.2 First Officer's Training and Proficiency Checks.....	8
3.0 AIRPLANE INFORMATION	9
4.0 METEOROLOGICAL INFORMATION	9
4.1 Accident Flight Operational Flight Plan.....	10
4.2 Turbulence Related ACARS Messages	10
4.3 Dispatcher Interviews.....	11
5.0 UNITED AIRLINES – GUIDANCE.....	12
5.1 Pre-Departure Briefing.....	12
5.2 Operating Priority and Efficiency.....	12
5.3 Turbulence PA Commands	13
5.4 Severe Turbulence.....	15
6.0 FAA GUIDANCE.....	15
6.1 FAA Turbulence Fact Sheet.....	15
6.2 Advisory Circular 120-88A.....	18
7.0 NTSB TURBULENCE STUDY	19
7.1 NTSB Turbulence Recommendations	19
F. LIST OF ATTACHMENTS	23

A. ACCIDENT

Location: Kelsey, NY
Date: February 10, 2024
Time: 1543 Eastern Standard Time (EST)¹
2043 Universal Coordinated Time (UTC)
Airplane: N788UA; United flight 1890, Boeing 777-222ER

B. OPERATIONAL FACTORS GROUP

Group Chair Shawn Etcher
 NTSB - AS-30 - Operational Factors
 Washington D.C.

Group Member James LaRosa
 Air Line Pilots Association (ALPA) - United
 Tysons Corner, VA

C. SUMMARY

On February 10, 2024, about 1543 eastern standard time (EST), United Airlines (UAL) flight 1890, a Boeing 777-222ER, N788UA, experienced moderate turbulence when descending to flight level (FL) 190 inbound to the Newark Liberty International Airport (EWR), Newark, New Jersey. Of the 280 passengers and crew, two flight attendants received serious injuries and one received a minor injury. The flight was conducted under the provisions of Title 14 *Code of Federal Regulations* Part 121 as a scheduled domestic passenger flight from Los Angeles International Airport (LAX), Los Angeles, California to EWR.

The first officer (FO) was the pilot flying and the captain was the pilot monitoring. The flight crew stated that the departure from LAX was uneventful and the flight leveled off at a cruise altitude of FL350. The FO stated that he was responsible for briefing the approach/arrival into EWR and in preparation for the brief, checked for potential turbulence using the Weather Services International (WSI) application (APP) and used the SkyPath APP to see if there were any reports of turbulence. Neither application revealed any significant indications of turbulence along their route. After the brief, the captain turned the onboard weather radar ON for the eventual descent into EWR.

The FO stated that while descending through about FL270, the captain announced via the passenger address (PA) system for the flight attendants (FA) to

¹ All times in this report will be EST unless otherwise noted. At the time of the event EST was UTC minus 5 hours. UTC can also be shown in reports as "Z."

prepare the cabin for landing. Following the announcement, the captain turned the seatbelt sign ON.

The FO stated that he observed an overcast layer of clouds ahead and below that the flight would penetrate on their descent to EWR. However, there was no indication of potential turbulence as nothing showed on the aircraft's weather radar or the SkyPath APP. Additionally, there were no reports of turbulence from ATC or dispatch.

The pilots reported that while descending through about FL210 in instrument meteorological conditions (IMC), the flight encountered moderate turbulence lasting a few seconds that caused unsecured items on the flightdeck to be thrown about. After the event, the captain immediately called the cabin crew and was informed of multiple injuries with one flight attendant sustaining a head laceration. Upon being notified of the injuries, the flight crew declared a medical emergency and requested paramedics meet the aircraft at the gate in EWR. Post-flight, two FAs were diagnosed with fracture injuries and a third was diagnosed with a sub-cranial bleed.

Postaccident examination of the weather in the area revealed a frontal boundary moving eastward across New York state. In addition, an upper-level jet stream maximum was located above the accident site. Satellite and weather radar imagery, along with lightning and surface data depicted strong cells in the vicinity of the flight. The U.S National Weather Service (NWS) had issued a Significant Meteorological (SIGMET) warning for embedded thunderstorms with tops reaching FL280 over the region.

D. DETAILS OF THE INVESTIGATION

1.0 SPECIALISTS ACTIVITIES

February 12, 2024 - The Operational Factors Specialist contacted United Airlines and requested pilot statement.

March 11, 2024 - The IIC requested and the Operational Factors Specialist formed an Operational Factors Group. Request were made to interview the dispatchers involved with the event flight, a meteorologist, and a SkyPath subject matter expert for United.

April 15, 2024 -The Operational Factors Group Chair and Meteorology Specialist traveled to the United Airlines dispatch center near Chicago O'Hare International Airport to interview two dispatchers that were working the event flight.

April 16, 2024 - The Operational Factors Group Chair and Meteorology Specialist interviewed the manager of Flight Operations Navigation Database and a United Airlines Senior Meteorologist.

May 2, 2024 - The Operational Factors Group Chair and Meteorology Specialist discussed the SkyPath application via Zoom with the SkyPath developer.

E. FACTUAL INFORMATION

1.0 History of Flight

ACARS² data indicated that at 0817 Pacific standard time (PST) the passenger doors were closed and the cargo doors were closed 4 minutes earlier.

ADS-B data indicated that about 0831 PST the flight departed LAX to the west and subsequently turned to south while continuing to climb. About 0848 PST and after passing through 10,000 ft msl³, the flight turned towards the east and continued the climb FL350. After reaching FL350 the flight then proceeded on a northeasterly direction along its filed flight plan route. About 1300 EST the flight climbed to FL370.

About 1334, the flight crew sent a message via ACARS to their dispatcher stating that they were having a *"smooth ride past hour or so"* and then asking *"how's descent into EWR."* About one minute later the dispatcher replied, *"so far only complaint is a mod[erate] by an RJ⁴."* The flight, subsequently climbed to the cruise altitude of FL370. There was no other communication between the flight and the dispatcher until after the encounter with turbulence.

About 1437, the flight began a descent to FL350 where it remained for about 20 minutes. The flight then turned towards an easterly direction and began a descent to FL330.

About 1510, the flight began a descent to FL310 where it remained for about 17 minutes before beginning its descent for EWR. During the descent to FL190 the flight encountered *"mod[erate] turbulence⁵."*

About 1544, the flight leveled off at FL190 for about 3 minutes and then continued the descent into EWR.

About 1605, the flight landed on EWR's runway 22L, exited the runway and subsequently taxied to the gate. The flight arrived at the gate at 1610, where medical personnel met it.

² Aircraft Crew Alerting and Reporting System.

³ Mean sea level.

⁴ Regional Jet

⁵ Source: Operation Factors - Attachment 4 - "Accident Flight ACARS Messages [Excerpts]" pg. 29.

2.0 Flight Crew Information

The flight crew consisted of a captain and a first officer.

2.1 Captain

2.1.1 Captain's Pilot Certification Records

FAA Records of the captain indicated the following certificate history:

Commercial Pilot - Airplane Single and Multiengine Land, Instrument Airplane certificate was issued on August 25, 1989.

Commercial Pilot - Airplane Single and Multiengine Land, Instrument Airplane; L-188⁶ certificate was issued February 16, 1994.

Airline Transport Pilot - Airplane Multiengine Land; L-188, Commercial Privileges - Airplane Single-Engine Land certificate was issued September 10, 1994.

Flight Engineer - Turbojet Powered; Limitations: This Certificate is Subject to the Provision of Exemption #4901 certificate was issued March 20, 1995.

Flight Engineer - Turbojet Powered certificate was issued September 29, 1995.

Airline Transport Pilot - Airplane Multiengine Land, L-188, B757⁷, B-767, Commercial Privileges Airplane Single-Engine Land; Limitations: B-757 B767 Limited to the Purposes of 121.543(b)(3)(i) at United Airlines, B-757 B-767 Circ. Apch VMC⁸ Only certificate was issued May 14, 1999.

Airline Transport Pilot - Airplane Multiengine Land, B757, B-767, L-188, B-777⁹, Commercial Privileges Airplane Single-Engine Land; Limitations: B-757, B-767 Circ. Apch. VMC Only, B-757 B-767 Limited to the purposes of 121.543(B)(3)(i) at United Airlines certificate was issued May 23, 2005.

Captain's Training and Proficiency Checks

⁶ Lockheed Martin Corporation 188A, 188C. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

⁷ The Boeing Company 757-200 Series, 757-200PF Series, 757-200CB Series, 757-300 Series, 767-200 Series, 767-300 Series, 767-300F Series, 767-400ER Series. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

⁸ Circling Approach Visual Meteorological Conditions.

⁹ The Boeing Company 777-200 Series, 777-300 Series, 777-300ER Series, 777-200LR Series, 777F Series. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

2.1.2 Captain's Training and Proficiency Checks

The following training record information, for the captain, was provided by United Airlines:

Date of Hire with United Airlines	February 20, 1995
Initial IOE ¹⁰ in the B-777	June 3, 2005
B-777 Captain Upgrade Training	April 16, 2021
Captain IOE in the B-777 ¹¹	July 25, 2021
Most recent FAA Observations	July 24, 2021
Most Recent Maneuvers Validation	September 12, 2023
Most Recent Line Check	February 7, 2023
Most Recent Line Operations Evaluation (LOE)	December 9, 2022

2.2 First Officer

2.2.1 First Officer's Pilot Certification Records

FAA records of the First Officer indicated the following certificate history:

Private Pilot - Airplane Single-Engine Land certificate was issued April 19, 1994.

Private Pilot - Airplane Single-Engine Land, Instrument Airplane certificate was issued May 19, 1995.

Commercial Pilot - Airplane Single-Engine Land, Instrument Airplane certificate was issued May 19, 1995.

Mechanic - Airframe, Powerplant certificate was issued August 30, 1994.

Notice of Disapproval - Commercial Pilot - Multiengine was issued on June 24, 1995.
Unsatisfactory item: Area of Operation 8. 1st disapproval.

Commercial Pilot - Airplane Single and Multiengine Land, Instrument Airplane certificate was issued on June 27, 1995.

Ground Instructor - Advanced, Instrument certificate was issued July 10, 1995.

Flight Instructor - Airplane Single-Engine certificate was issued July 12, 1995.

¹⁰ Initial Operating Experience. The captain's IOE was conducted as a first officer.

¹¹ Captain IOE included 29 hours and 16 minutes of flight experience which consisted of 7 flight segments and 6 landings.

Flight Instructor - Airplane Single-Engine, Instrument Airplane certificate was issued July 17, 1995. Reissued: July 29, 1997, July 13, 1999, June 18, 2001, May 28, 2003, July 13, 2005, July 19, 2007, July 27, 2009, July 12, 2011, July 18, 2013, July 11, 2015, June 23, 2017, June 29, 2019, June 9, 2021, and June 8, 2023.

Airline Transport Pilot - Airplane Multiengine Land, BE-1900¹², Commercial Pilot Privileges Airplane Single-Engine Land, Limitations: ATP Circling Approach- VMC Only, Beech 1900 Circling Approach - VMC Only, Beech 1900 Second-in-Command Required certificate was issued July 27, 2000.

Airline Transport Pilot - Airplane Multiengine Land, BE-1900 EMB-145¹³, Commercial Privileges, Airplane Single-Engine Land, Limitations: ATP/BE-1900 EMB-145 Circ. Appr - VMC Only, BE-1900 Second on [sic] Command Required certificate was issued January 24, 2002.

Airline Transport Pilot - Airplane Multiengine Land, B-737¹⁴, BE-1900, EMB-145; Commercial Privileges, Airplane Single-Engine Land; Limitations: English Proficient, BE-1900 EMB-145 Circ. Apch - VMC Only, BE-1900 Second in Command Required certificate was issued December 24, 2010.

Airline Transport Pilot - Airplane Multiengine Land, B-737, B-777, BE-1900, EMB-145; Commercial Privileges, Airplane Single-Engine Land; Limitations: English Proficient, B-777 BE-1900 EMB-145 Circ. Apch - VMC Only, BE-1900 Second in Command Required certificate was issued December 24, 2010.

2.2.2 First Officer's Training and Proficiency Checks

The following training record information, for the first officer, was provided by United Airlines:

Date of Hire with United Airlines	March 24, 2017
IOE in the B-777 ¹⁵	January 23, 2020
Most Recent Maneuvers Validation	September 19, 2023

¹² Textron Aviation Inc. 1900, 199C, 1900D. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

¹³ Embraer S.A. EMB-135ER, EMB-135LR, EMB-135KE, EMB-135KL, EMB-135BJ, EMB-145, EMB-145ER, EMB-145MR, EMB-145LR, EMB-145XR, EMB-145MP, EMB-145EP. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

¹⁴ The Boeing Company 737-100, 737-200, 737-200C, 737-300, 737-400, 737-500, 737-600, 737-700, 737-700C, 737-800, 737-900, 737-900ER, 737-8, 737-9. Source: FAA Order 8900.1, Figure 5-88, dated March 29, 2024.

¹⁵ IOE included 24 hours and 10 minutes of flight experience, which included 4 flight segments and 3 landings.

Most Recent Line Check ¹⁶	January 23, 2020
Most Recent Line Operations Evaluation (LOE)	February 5, 2023

3.0 Airplane Information

The airplane was a Boeing 777-222ER, manufacturing Serial Number 26942. The airplane was manufactured in 1997, delivered to United Airlines in July of 1997 and it held a transport category airworthiness certificate. The airplane was configured with 4 flight crew seats, 14 flight attendant seats, and 276 passenger seats.



Figure 1: Accident Airplane, N788UA (Courtesy of planespotters.net)

At the time of the event, the airplane had two deferrals from the Minimum Equipment List (MEL). Those deferrals were for the broadband antenna and the Autoland system. Neither of those would have contributed to this event.

4.0 Meteorological Information

For further meteorological information see the Meteorological Specialist Report located in the docket of this accident.

¹⁶ A first officer was not required to have annual line checks per *CFR* 121.440, a line check was required only when acting as a pilot in command. However, his most recent line check was conducted as part of his IOE.

4.1 Accident Flight Operational Flight Plan

The accident flight's operational flight plan was titled "RLSE 02"¹⁷ and had a filed routing from LAX to EWR via the DOTSS2 departure to CLEEE intersection to PKE¹⁸ J96 DRK¹⁹ to ALS²⁰ J102 LAA²¹ to HUSQA intersection to FOD²² to ALO²³ to BAE²⁴ to FNT²⁵ to BUF²⁶ to GEE²⁷ and the FLOSI4 arrival to EWR. The planned time enroute was 4:27.

Additionally, one of the dispatchers for the flight included six remarks under the "Dispatcher Remarks" section of the release. Those remarks were:

PLANNED NORTH ROUTE FOR TURBC AVOID
MOD TB LAX to HOMER FL360/420 Planned FL350
LGT-MOD TB PKE to LANCY FL200/280
LGT-MOD TB VCNTY BAE FL350/420
LGT-MOD TB BUF TO EWR FL310/380
LGT-MOD TB EXTOL²⁸ TO EWR FL160/230

4.2 Turbulence Related ACARS Messages

Almost 2 hours prior to the turbulence encounter, the flight crew sent the following ACARS message "SMOOTH RIDE PAST HOUR OR SO HOWS DESCENT INTO EWR." About a minute later the dispatcher responded "SO FAR ONLY COMPLAINT IS A MOD BY AN RJ"

A turbulence PIREP²⁹ was sent to the flight via ACARS at 2041 UTC (1541 local) and reported "YOUR FLIGHT IS IN CLOSE PROXIMITY TO A MOD TURB PIREP EVENT REPORTED BY A B789 AT 2022 Z FL220 LOCATION HNK RMK TB MOD CHOP 220-190 YOU CLOSEST POINT TO EVENT AT 2041Z".

Additionally, at 1547, another ACARS message was sent to the flight crew which stated "YOUR FLIGHT ENTERS ATURBULENCE SIGMET AREAAT 2058Z

¹⁷ RLSE 02 was created due to "planned north route for turbc avoid." Source: Operational Factors - Attachment 3 - "Accident Flight Dispatch Release."

¹⁸ Parker VORTAC (very high omnidirection range with TACAN), Parker, California

¹⁹ Drake VORTAC, Prescott, Arizona.

²⁰ Alamosa VORTAC, Alamosa, Colorado.

²¹ Lamar VORTAC, Lamar, Colorado.

²² Fort Dodge VORTAC, Fort Dodge, Iowa.

²³ Waterloo VOR/DME (Distant Measuring Equipment), Waterloo, Iowa.

²⁴ Badger VORTAC, Milwaukee, Wisconsin.

²⁵ Flint VORTAC, Flint, Michigan.

²⁶ Buffalo VOR/DME, Buffalo, New York.

²⁷ Geneseo VOR/DME - Geneseo, New York.

²⁸ EXTOL was an intersection located on the FLOSI4 Arrival into EWR. It was east southeast of the GEE VOR approximately 50 miles and approximately 85 miles northwest of the accident location.

²⁹ Pilot Report

FL170LOCATION N4117.4 W07426.4ID TURB 30974ISSUED 10 FEB 1653ZVALID 10 FEB 1653ZTO 10 FEB 2100ZSIGMET AREA IS 70ESEAIR,15N SAX, 20ESEOWENZ,30SSE GVE,70ESE AIRMOVEMENT ENE AT 15KTSTYPE CATSEVERITY MODALTITUDE FL120 - FL180OUTLOOK NCDISCUSSION TURBULENCEREPORTED IN MID LEVELS OVER NEUS. "

At 1553 the accident pilots sent the following ACARS to United Airlines dispatch *"PLZ HAVE MEDICAL MEET US HIT HDAVY MOD TURB ON DESCENT THRU FL210 FA BLEEDING ANOTHER MAY BE CONCUSSED."*

About two minutes after the pilots sent the ACARS message, United Airlines responded with *"TWO FAS INJURED FROM TURB WILL HAVE EMS ON ARRIVAL."*

At 1611, ACARS indicated that the aircraft brake was set and two minutes later a passenger door was open.

At 1614, United Airlines dispatch sent the following message to the flightcrew *"WHEN ABLE PLEASE CALL DISPATCH."*

4.3 Dispatcher Interviews

During an interview with the flight's dispatchers, one had planned the flight earlier in the day; however, when her shift ended, she passed it to another dispatcher to monitor until it landed at EWR. The dispatcher that planned the flight recalled that on the day of the event they were responsible for releasing about 20 flights during their shift and that they were *"busy fine-tuning routes"*³⁰. She further provided that while a flight was airborne, they can monitor the progress in Fusion³¹. She utilized various function of the Fusion system including the FPG³² product, which provided turbulence forecast. Additionally, she stated that *"pretty much from the Midwest to the East Coast the RPM³³ data was showing turbulence."*³⁴ Prior to the end of her shift she had PIREPs being reported as moderate turbulence on descent along the east coast. She had alerted the flights she was monitoring about the turbulence prior to the end of her shift; however, the event flight *"was not even halfway across the U.S."*³⁵ when her shift ended and she briefed and transferred the monitoring of the event flight to another dispatcher.

³⁰ Source: Operational Factors - Attachment 2 - "United Airlines Personnel Interview Transcripts" pg. 76 line 22.

³¹ Fusion was a software program developed by The Weather Channel for global flight tracking, weather content, etc. Source: [Fusion: Global Aviation Management & Flight Tracking System](#)

³² Flight Plan Guidance

³³ Rapid Precision Model. Source: [The End of an Era -- RPM Weather Model Retired and Celebrated](#)

³⁴ Source: Operational Factors - Attachment 2 - "United Airlines Personnel Interview Transcripts" pg. 84 lines 11-12.

³⁵ Source: Operational Factors - Attachment 2 - "United Airlines Personnel Interview Transcripts" pg. 86 lines 14-15.

Following the outgoing dispatcher's briefing, the incoming dispatcher reviewed the flights he was responsible for, which included the event flight. He reviewed the turbulence on the west coast of the U.S. and also looked at the flights that were headed into EWR. He described the turbulence reports going into EWR as "*some light to occasional moderate*³⁶," which he characterized as a "*typical day*." After the event flight crew sent him an ACARS message about the turbulence and the flight attendant injuries, he began coordinating with emergency services to meet the flight upon arrival at EWR.

5.0 United Airlines - Guidance

5.1 Pre-Departure Briefing

The United Airlines Flight Operations Manual, Section 3.90.2 provided a list of briefing items to include. The list was composed of 11 bulleted items, two of those items were "*Weather*" and "*Turbulence/Cabin Communication*." Each bulleted item had some items to consider when briefing. The following were those respective items:

- **Weather** Review all weather of concern for the flight.
- **Turbulence/Cabin Communication** Review turbulence issues for the flight, to include approximately when the turbulence is expected (if known). If the weather requires the flight attendants to remain seated after takeoff or to be seated early on arrival, provide an estimate of the duration and the communication method to alert the flight attendants about when these concerns are valid or not valid. Review of Turbulence PA commands may be prudent.

5.2 Operating Priority and Efficiency

The United Airlines Flight Operations Manual, Section 4 "*Dispatch*," Section 10 "*Flight Planning Policy*" provided, in part, the following guidance on route and altitude selection:

All flights will be dispatched and operated along the least-cost routing, with consideration to ATC constraints and hazardous weather. The least-cost route and altitude profile provides the lowest total sum of fuel, time, delay, and overflight costs, while maximizing payload. If the route and/or altitude planned are not along the least-cost routing, the dispatcher must state the reason for the alternative altitude or route selection in the REMARKS section of the Release.

³⁶ Source: Operational Factors - Attachment 2 - "United Airlines Personnel Interview Transcripts" pg. 158, lines 9 thru 10.

Dispatch may add EXTRA fuel for altitude/lateral deviations, or adjust the planned altitude/routing to **avoid and/or mitigate hazardous weather threats**. Hazardous weather is defined as follows:

- Area of known/forecast continuous moderate or severe turbulence intensity as indicated by WSI SIGMET or Flight Plan Guidance (FPG).
- Area of broken convection (BKN) or greater coverage (SOLID) as indicated by WSI SIGMET or FPG.
- Elevated ozone concentrations (non-filtered aircraft only) as defined by WSI products or FPG.
- Areas of volcanic ash as defined by WSI SIGMET or FPG.

WSI is the FAA-approved controlling weather provider. A combination of WSI SIGMETs, Flight Plan Guidance and PIREPs (considering aircraft type, time, location and altitude) must be considered in verifying areas of continuous moderate or greater turbulence.

5.3 Turbulence PA Commands

The United Airlines Flight Operations Manual, Section 7.10 "Adverse Weather," dated September 22, 2023, provided the following guidance for public announcements that should be made over the public address system on board the airplane, in the event of turbulence. The guidance was broken down into two charts "Reported/Impending Turbulence of Moderate or Greater Intensity" and "Unexpected Turbulence of Moderate or Greater Intensity:"

TURBULENCE PA COMMANDS

Note: The turbulence intensity experienced on the flight deck may be considerably different than in the aft cabin. If time and duties permit, it is recommended to contact the aft flight attendants to assess the turbulence intensity in the aft of the aircraft when assessing the seat belt sign for turbulence.

Note: An interphone briefing may be accomplished and is encouraged if time permits, but when the flight attendants are to be seated for turbulence, the command **must** be given over the PA. This allows all flight attendants to hear the PA command simultaneously and informs the passengers that the flight attendants **must** be seated. See also Operating Information>Crew Information>Flight Attendant Briefing>Turbulence / Cabin Communication.

Reported/Impending Turbulence of Moderate or Greater Intensity			
Condition	Pilot Action	Reason	Flight Attendant Action
Turbulence of Moderate or Greater is Reported/ Impending	Make PA: "Flight attendants, take your jumpseats."	Flight attendants need to be in their jumpseats within 5 minutes.	Flight attendants will have up to 5 minutes to take their jumpseats.
	Make PA: "Flight attendants, take your jumpseats in X minutes."	Flight attendants need to be in their jumpseats sooner than 5 minutes (indicate the minutes in the PA announcement).	Flight attendants will take their jumpseats in the minutes indicated.
Turbulence Improves/ Subsides	Make PA: "Flight attendants, check in."	It is safe for flight attendants to leave their jumpseats and resume duties.	Flight attendants leave their jumpseats and resume duties. A call from the Purser/ designee to the flight deck is made once they have verified flight attendant, passenger, and cabin status.

Unexpected Turbulence of Moderate or Greater Intensity			
Condition	Pilot Action	Reason	Flight Attendant Action
Unexpected Turbulence of Moderate or Greater	Make PA: "Flight attendants, be seated <i>immediately</i> , be seated <i>immediately</i> ."	Encountering unexpected turbulence of moderate or greater intensity.	Flight attendants will take their jumpseats, occupy the nearest available passenger seat or drop to the floor of the aircraft, whichever is closer.
Unexpected Turbulence of Moderate or Greater Subsides or Improves	Make PA: "Flight attendants, take your jumpseats."	Flight attendants are safe to return to their jumpseats, but not safe to resume duties.	Flight attendants will return to their jumpseats if not already there.
Turbulence Improves/ Subsides	Make PA: "Flight attendants, check in."	It is safe for flight attendants to leave their jumpseats and resume duties.	Flight attendants leave their jumpseats and resume service. A call from the Purser/ designee to the flight deck is made once they have verified flight attendant, passenger, and cabin status.

5.4 Severe Turbulence

The United Airlines Flight Operations Manual, Section 7.10 “Adverse Weather,” dated September 22, 2023 provided the following guidance on flight in areas of known severe turbulence:

Do not intentionally conduct flight through areas of known severe turbulence. If a chance of severe turbulence is forecasted for the route, be alert for PIREPs and other indications of actual severity of turbulence present. If informed of the presence of severe turbulence, consider the following action:

- *In the vicinity of the departure airport, seek departure routing that avoids the turbulent area, if possible, or delay departure until conditions improve.*
- *Enroute, change altitude and/or route in order to avoid the reported area.*
- *In the vicinity of the destination airport, seek a descent and approach path to avoid the reported turbulence area. If avoidance is doubtful, consider holding until the situation improves (PIREPs, LLWAS, TDWR, etc.) or consider diversion.*
- *Contact Dispatch for help in obtaining current weather and PIREPs.*

6.0 FAA Guidance

The FAA defines turbulence as: “air movement that normally cannot be seen and often occurs unexpectedly. It can be created by many different conditions, including atmospheric pressure, jet streams, air around mountains, cold or warm weather fronts or thunderstorms. Turbulence can even occur when the sky appears to be clear.”³⁷

6.1 FAA Turbulence Fact Sheet

The FAA provided the following guidance via the “Fact Sheets” titled “Turbulence” on March 28, 2023 on their website:³⁸

What is turbulence?

Turbulence is air movement created by atmospheric pressure, jet streams, air around mountains, cold or warm weather fronts or thunderstorms. It can be unexpected and can happen when the sky appears to be clear. Turbulence can give an airplane a sudden jolt that can injure passengers and flight crewmembers who aren't buckled in.

³⁷ Source: https://www.faa.gov/travelers/fly_safe/turbulence/

³⁸ Source: [Turbulence | Federal Aviation Administration \(faa.gov\)](https://www.faa.gov/turbulence/)

What should passengers do to avoid injuries?

Passengers can easily prevent injuries from unexpected turbulence by keeping their seat belt buckled at all times. The FAA's tips for staying safe:

- Listen to the pilots and flight attendants – FAA regulations require passengers to be seated with their seat belts fastened whenever the seat belt sign is illuminated during flight.*
- Pay attention to the safety briefing at the beginning of your flight and read the safety briefing card.*
- Use an approved child safety seat or device if your child is under two.*
- Prevent inflight injuries by adhering to your airline's carry-on restrictions.*

How is the FAA helping airlines avoid turbulence and prevent injuries?

The FAA has a long history of working to prevent turbulence injuries.

The agency developed guidance to help airlines avoid the conditions that cause turbulence and minimize the risks when airplanes do encounter it. Some of the material was based upon investigative work from the National Transportation Safety Board.

The FAA also encourages airlines to use operating procedures and training to prevent turbulence injuries, prioritize flight attendants' personal safety, and gather data and review the air carrier's history of turbulence encounters and injuries.

Part 121 Serious Turbulence Injuries 2009 to 2022

Year	Passenger	Crew	Total
2009	10	8	18
2010	2	10	12
2011	3	15	18
2012	2	12	14
2013	1	4	5
2014	0	6	6
2015	3	10	13
2016	2	11	13
2017	1	12	13
2018	3	7	10
2019	2	11	13
2020	0	5	5
2021	1	5	6
2022	4	13	17
Total	34	129	163

Source: National Transportation Safety Board (NTSB). The NTSB requires airlines to report serious injuries and fatalities. A serious injury is "any injury that (1) requires the individual to be hospitalized for more than 48 hours, commencing within seven 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 five percent of the body surface." The FAA tracks these reports, but not general incidents of turbulence.

6.2 Advisory Circular 120-88A

FAA Advisory Circular 120-88A "Preventing Injuries Caused by Turbulence" dated November 19, 2007 provided, in part, the following guidance:

Emphasize the Importance of F/A's Personal Safety. *F/A injuries occur at a disproportionately high rate compared to other crewmembers and other cabin occupants because F/As spend more time in the passenger cabin unseated and, therefore, unbelted. Effective training emphasizes to F/As that:*

(1) You are not invincible. The overlying objective throughout all crewmember training is to ensure that crewmembers are confident, competent, and in control while conducting their activities in the cabin. However, during a turbulence encounter, the most appropriate first response by a crewmember might be self-preservation. Training courseware can make crewmembers aware of their vulnerability in moderate and extreme turbulence. Effective training can incorporate video/digital media, real world scenarios and interviews with crewmembers who have experienced moderate and severe turbulence as a way to demonstrate that "turbulence can be stronger than you are."

(2) You have tools available to increase your safety and the safety of your passengers. Effective training shows crewmembers how to increase personal safety and passenger safety by identifying tools available to them in a turbulence encounter. Training can include the effective use of the passenger address (PA) system and other methods of communicating with passengers; the location of handholds throughout the airplane (or equipment that could be used as a handhold); and how to secure a service cart or an entire galley in minimum time.

(3) You need to recognize and avoid a denial reflex. Crewmembers can be made aware of ways in which human psychology might play into a turbulence encounter, and might actually increase their risk of injury. For example, on a short flight, with little time to complete a cabin service, crewmembers might be less conservative regarding their personal safety than on a longer flight with no time constraints. crewmembers can also increase risk and compromise their personal safety by trying to adhere to routine procedures normally accomplished on every flight, such as completing seatbelt compliance checks, rather than by responding to the nonroutine situation that a turbulence encounter presents.

It also provided the following guidance for imminent Turbulence or Turbulence Occurring:

Imminent Turbulence or Turbulence Occurring. Sudden, unexpected or imminent turbulence requiring immediate action to protect cabin crew and passengers.

- (1) Captain turns on seatbelt sign and makes a PA announcement, "F/As and passengers be seated immediately. Passengers please remain seated until this area of turbulence has passed and I have cleared you to move about the cabin."
- (2) Cabin crew take first available seat and secure themselves.
- (3) No compliance checks are performed and items are secured only if they present no delay in securing a person in a seat.
- (4) When conditions improve, captain makes PA announcement advising the cabin crew that they may resume their duties and whether or not the passengers may move about the cabin.

7.0 NTSB Turbulence Study

In 2020 and 2021 the NTSB conducted a yearlong safety study titled "*Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121*³⁹." The safety research report was adopted by the Board on August 10, 2021. As part of that study, the NTSB conducted 10 investigations of turbulence related accidents that occurred during Part 121 operations. The study identified four safety issues and made 18 new recommendations to the FAA, two recommendations to the National Weather Service, and one commendation to Airlines for America, the National Air Carrier Association, and the Regional Airline Association. In addition, the NTSB reiterated three recommendations to the FAA and one additional previous recommendation to the FAA was also reiterated but the classification was changed to "*Open - Unacceptable Response*."

7.1 NTSB Turbulence Recommendations

The safety study discussed in Section 7.0 above, issued the following safety recommendations, the current status of the recommendation, as of the date of this writing, by the NTSB is listed in **bold** following the recommendation number:

To the Federal Aviation Administration:

*Work with stakeholders to standardize the distribution of pilot weather reports (PIREPs) across and within air traffic control facilities to ensure they are disseminated to only those facilities and air traffic controller positions for which each PIREP applies. (A-21-25) **(Open - Acceptable Response)***

*As a condition of enhanced weather information system approval, require Title 14 Code of Federal Regulations Part 121 air carriers to disseminate all turbulence observations to the National Airspace System as pilot weather reports, as well as reports of smooth ride conditions. (A-21-26) **(Open - Acceptable Response)***

³⁹ Source: [Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121 \(ntsb.gov\)](https://www.ntsb.gov/investigations/reports/2021/2021-01-0001)

Determine how to harmonize current and future eddy dissipation rate algorithm performance in operational environments and publish the results of this determination. (A-21-27) (Open - Acceptable Response)

Incorporate the automatic dependent surveillance-broadcast weather capability in the next version of the automatic dependent surveillance-broadcast technical standard order. (A-21-28) (Open - Unacceptable Response)

After the automatic dependent surveillance-broadcast (ADS-B) technical standard order is revised as recommended in Safety Recommendation A-21-28, require that aircraft flown in Title 14 Code of Federal Regulations Part 121 air carrier operations be retrofitted with automatic dependent surveillance-broadcast weather capable ADS-B equipment. (A-21-29) (Open - Unacceptable Response)

Require automatic dependent surveillance-broadcast weather (ADS-B Wx)-equipped aircraft to broadcast ADS-B Wx information when operating in airspace requiring automatic dependent surveillance-broadcast capability as defined by Title 14 Code of Federal Regulations 91.225. (A-21-30) (Open - Acceptable Response)

In collaboration with the National Weather Service, modify airmen's meteorological information (AIRMET) advisory issuing practices to include graphical AIRMET advisories with higher granularity, taking into account the effect it would have on all National Airspace System users. (A-21-31) (Open - Acceptable Response)

NTSB Safety Research Report 65 Distribute graphical airmen's meteorological information advisories, significant meteorological information advisories, and center weather advisories to air traffic controllers as controller-selectable layers on current and future controller radar displays in air route traffic control centers and terminal radar approach control facilities. (A-21-32) (Open - Unacceptable Response)

Work with local safety councils to develop training on the use of the advisories developed for Safety Recommendation A-21-32. (A-21-33) (Open - Unacceptable Response)

In collaboration with the National Weather Service, operationalize a turbulence nowcast, such as the graphical turbulence guidance nowcast. (A-21-34) (Open - Acceptable Response)

Develop air traffic control guidelines for use of the turbulence nowcast operationalized in accordance with Safety Recommendations A-21-34 and A-21-44. (A-21-35) (Open - Acceptable Response)

Incorporate total lightning and hail information as selectable layers on air traffic controller radar displays in air route traffic control centers and terminal radar approach control facilities. (A-21-36) (Open - Unacceptable Response)

After the action in Safety Recommendation A-21-36 is completed, provide training to air traffic controllers on the use of the controller-selectable total lightning and hail information. (A-21-37) (Open - Unacceptable Response)

Based on National Transportation Safety Board data on turbulence-related Title 14 Code of Federal Regulations Part 121 accidents, include in the revisions to Advisory Circular 120-88A, "Preventing Injuries Caused by Turbulence," in Safety Recommendation A-21-42 the phases of flight and associated altitudes at which flight attendants should be secured in their seats during Part 121 air carrier operations, including in particular the descent phase of flight. (A-21-38) (Open - Unacceptable Response)

Conduct a study of how aircraft accelerations vary along the length of the aircraft during turbulence encounters, including differences among aircraft types operated by Title 14 Code of Federal Regulations Part 121 air carriers, and publish the study findings. (A-21-39) (Open - Unacceptable Response)

Conduct a study to determine the factors that affect caregivers' decisions about the use of child restraint systems (CRSs) when traveling on a Title 14 Code of Federal Regulations Part 121 air carrier airplane with children under the age of 2 and to understand the challenges associated with using CRSs; publish the study findings. (A-21-40) (Open - Acceptable Response)

After the action in Safety Recommendation A-21-40 is completed, use the study findings to direct the Federal Aviation Administration's efforts to increase child restraint system usage. (A-21-41) (Open - Acceptable Response)

NTSB Safety Research Report 66 Revise Advisory Circular 120-88A, "Preventing Injuries Caused by Turbulence," to reflect current best practices and the findings of this research report, such as new turbulence forecasting and warning technologies; training methods; in-flight communications between pilots and flight attendants, procedures, and available information for predicting turbulence; and altitudes at which flight attendants should be secured in their seats. (A-21-42) (Open - Unacceptable Response)

To the National Weather Service:

Work with the Federal Aviation Administration to modify airmen's meteorological information (AIRMET) advisory issuing practices to include graphical AIRMET advisories with higher granularity, taking into account the effect it would have on all National Airspace System users. (A-21-43) (Open - Acceptable Response)

Work with the Federal Aviation Administration to operationalize a turbulence nowcast, such as the graphical turbulence guidance nowcast. (A-21-44) (Open - Acceptable Response)

To Airlines for America, the National Air Carrier Association, and the Regional Airline Association:

Coordinate with your member airlines to develop and implement a program to increase child restraint system (CRS) usage in airplanes; this effort should include collecting data to determine the program's effectiveness at increasing CRS usage. (A-21-45) (Open- Acceptable Response)

The safety study further reiterated the following safety recommendations:

To the Federal Aviation Administration:

Provide air traffic controllers with automated pilot weather report (PIREP) data-collection tools that incorporate design elements to prevent input errors, increase quantity, and improve the timeliness of PIREPs disseminated to the National Airspace System. (A-17-21) (Open - Acceptable Response)

Incorporate automation technology that captures data elements from air traffic controllers' displays, including aircraft type, time, location, and altitude, to automatically populate these data into a pilot weather report (PIREP)-collection and -dissemination tool that will enable controllers to enter the remaining PIREP elements and disseminate PIREPs through a common exchange model directly to the National Airspace System. (A-17-22) (Open - Acceptable Response)

Provide a reliable means of electronically accepting pilot weather reports directly from all users who are eligible to submit reports, and ensure that the system has the capacity to accept and make available all such reports to the National Airspace System. (A-17-26) (Open - Unacceptable Response)

The safety study also classified and reiterated the following safety recommendation:

To the Federal Aviation Administration:

Encourage industry safety efforts, such as the Commercial Aviation Safety Team and the General Aviation Joint Steering Committee, to identify, develop, and implement incentives for 14 Code of Federal Regulations Part 121, 135, and 91K operators and the general aviation community to freely share pilot weather reports (PIREPs), including braking action or runway condition reports filed as PIREPs, to the National Airspace System to enhance flight safety. (A-17-25) Safety Recommendation A-17-25 is classified "Open–Unacceptable Response"

In addition to the four previous mentioned reiterated safety recommendations the report also listed 27 additional recommendations that the Board issued beginning in 1990. Those additional recommendations were listed as follows:

- 1 "Closed - Unacceptable Action/Superseded"
- 5 "Closed - Unacceptable Action"
- 5 "Closed - Acceptable Action"
- 15 "Open - Acceptable Response"
- 1 "Closed - Unacceptable Response"

F. LIST OF ATTACHMENTS

Attachment 1 - Flight Crew Written Statements
Attachment 2 - United Airlines Personnel Interviews Transcripts
Attachment 3 - Accident Flight Dispatch Release
Attachment 4 - Accident Flight ACARS Messages [Excerpts]
Attachment 5 - United Airlines Flight Operations Manual [Excerpts]
Attachment 6 - Archived PIREPs
Attachment 7 - Operational Factors Group Member Party Form

Submitted by:

Shawn Etcher
Operational Factors Investigator