NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 10, 2020

Group Chairman's Factual Report

OPERATIONAL FACTORS/HUMAN PERFORMANCE

DCA20CA043

Table Of Contents

A. ACCIDENT

Operator:	American Airlines
Location:	Disputanta, Virginia
Date:	December 18, 2019
Time:	1110 Eastern Standard Time (EDT)[1]
Airplane:	Embraer E190
Flight No.:	2247

B. OPERATIONAL FACTORS/HUMAN PERFORMANCE GROUP

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C. SUMMARY

On December 18, 2019, about 1110 EST, American Airlines flight 2247, E190, N959UW, during cruise descent, encountered moderate turbulence at FL180. The No. 1 flight attendant had fallen to the floor, injuring her foot. She was unable to complete her flight attendant duties and was transported to the hospital after landing. There were 2 pilot, 2 flight attendants,

[1] All times in the report will be Eastern Standard Time except as otherwise noted. At the time of the accident Greenwich Mean Time, also known as Zulu (Z) time, was 5 hours ahead of EST.
[2] Integrated Operations Center

and 44 passengers on board. The scheduled passenger flight was operating as a 14 *Code of Federal Regulations* Part 121 from LaGuardia Airport (LGA), Queens, New York, to Raleigh-Durham International Airport (RDU), Morrisville, North Carolina.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board (NTSB) Operational Factors investigator was assigned to the accident on December 18, 2019 and did not travel to the accident scene. The group chairman was briefed by the Investigator in Charge (IIC) on the events surrounding the accident.

The Operational Factors investigator requested manuals, statements, training records, and other various items for the investigation from the operator. Pilot certification information was obtained from the pilots, operator, and the Federal Aviation Administration (FAA). A human performance investigator was assigned to the accident on January 9, 2020.

On January 28, 2020, the Operational Factors/Human Performance Group convened at American Airlines North Simulator Building. The group interviewed the Technical Pilot for the American Airlines E-190 fleet.

On January 29, 2020, the Operational Factors/Human Performance Group reconvened at the American Airlines North Simulator Building. The group interviewed the accident dispatcher and American Airlines meteorologist and Turbulence Task Force (TTF) member.

On January 30, 2020, the Operational Factors/Human Performance Group reconvened at the American Airlines North Simulator Building. The group interviewed a Director of American Airlines Dispatch and the Lead Check Airman for the American Airlines E-190 fleet.

E. FACTUAL INFORMATION

1.0 History of Flight[3]

American Airlines flight 2247 had a scheduled departure time of 0959 and departed LGA at 0951. The flight's planned arrival time was 1141.

The flight was originally filed for FL180[4], due to "a strong Jetstream headwind at high altitudes." However, air traffic control assigned the flight a cruise altitude of FL200 and reported FL 200 as "smooth" and "no complaints" from other aircraft. The flight crew turned off the seatbelt sign and the flight attendants conducted their inflight service.

[3] Sources: Operational Factors/Human Performance Attachment 1 - Crew Statements

[4] A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Ease is stated in three digits that represent hundreds of feet. FL190 represent a barometric altimeter indication of 19,000 feet. Source: FAA Instrument Procedures Handbook (FAA-H-8083-16)

About 1100 the flight encountered a brief duration of “light to moderate chop” and illuminated the Seat Belt sign. The flight crew requested a descent to FL180.

According to the crew the skies were clear, a smooth ride, and no PIREP of turbulence. The seatbelt sign was extinguished after the flight reached FL180.

When the flight was near the Hopewell VOR[5] (HPW), Hopewell, Virginia, it encountered a “unexpected clear air turbulence event” which lasted for between 20 seconds and a minute.

According to the captain, the turbulence was classified as “light to moderate chop” and the sky was clear for the entire flight. After a second turbulence encounter, he looked at the TCAS since he thought it may have been wake turbulence. However, there was no other aircraft in their vicinity.

A non-revenue American Airline pilot passenger, seated in the cabin, in seat 8A, categorized the turbulence as moderate to severe. Prior to the encounter, he classified the turbulence as “occasional light turbulence.”

The flight crew received a call from the cabin advising them that a flight attendant had hurt her leg during the turbulence encounter. The captain, who was the pilot monitoring (PM) for the flight, transferred control of the radios to the first officer, who was the pilot flying (PF), and contacted the company.

According to a flight attendant statement the injured flight attendant was walking to the back of the aircraft, near the aft galley, when the flight encountered turbulence.

Once the flight crew received detailed information from the cabin about the severity of the injury, they declared a medical emergency with air traffic control. The flight was cleared directly to the final approach fix for runway 23R at RDU.

After landing at RDU, the flight taxied to the gate where paramedics met the aircraft, and subsequently removed the flight attendant from the flight.

2.0 Flight Crew Information

The accident crew consisted of 2 pilots and 2 cabin crew members. The first officer was the pilot flying (PF) on the accident flight and the captain was the pilot monitoring (PM).

[5] Very-high Omnidirectional Range

2.1 Captain

The captain was 49 years old and held an Airline Transport Pilot (ATP) certificate with a rating for airplane multiengine land and type ratings on the B737[6], DC-9[7], DHC-8, ERJ-170[8], and ERJ-190, and limitations included "Circ. Apch – VMC Only." He held an FAA first-class medical certificate dated September 19, 2019, with a limitation of "Must have available glasses for near vision." At the time of the accident he was based at Philadelphia International Airport (PHL), Philadelphia, Pennsylvania.

According to information provided by American Airlines, the captain had approximately 20,580 total hours of flight experience, of which 1,569 of those hours were in the ERJ-190, and 1,545 of those hours were as pilot in command (PIC) in the ERJ-190.

2.1.1 Captain's Training and Proficiency Checks Completed

A synopsis of the captain's recent training at American Airlines was as follows[9]:

Date of Initial New Hire Training at American	June 17, 1999
Upgrade to captain[10]	March 11, 2017
Most Recent Recurrent Ground School[11]	November 8, 2018
Most Recent Human Factors and Safety Training[12]	November 8, 2019
Most Recent Line Oriented Evaluation[13]	June 5, 2019

[6] 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 July 15, 2019.
[7] The Boeing Company DC-9-11, DC-12, DC-9-13, DC-9-14, DC-9-15, DC-9-15F, DC-9-21, DC-9-31, DC-9-32, DC-9-32F, DC-9-33F, DC-9-34, DC-9-34F, DC-9-41, DC-9-51, DC-9-81, DC-9-82, DC-9-83, DC-9-87, MD-88, MD-90-30, 717-200. Source FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[8] Embraer S.A. ERJ 170-100 STD, ERJ 170-100 LR, ERJ 170-100 SU, ERJ 170-100 SE, ERJ 170-200 STD, ERJ-170-200 LR, ERJ 170-200 SU, ERJ 190-100 STD, ERJ 190-100 LR, ERJ 190-100 STD, ERJ 190-100 LR, ERJ 190-100 IGW, ERJ 190-100 ECJ, ERJ 190-200 STD, ERJ 190-200 LR, ERJ 190-200 IGW, ERJ 190-300. Source: FAA Order 8900.1, Figure 5-88, dated July 15, 2019.
[9] American Airlines utilized the Advanced Qualification Program (AQP) which was based on a 36-month cycle and broken into 18-month periods with 9-month intervals.
[10] Upgrade training began with initial ground school on February 12, 2017 with computer based training and concluded March 11, 2017 with a LOE.
[11] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Recurrent Ground School was coded under the "Event" column as RGS and was reported as 3:15 in duration.
[12] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Recurrent Human Factors and Safety Training was coded under the "Event" column as RHF and was reported 90 minutes in duration.
[13] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Line Oriented Evaluation was coded under the "Event" column as RLE/RAD.

Most Recent Maneuvers Validation[14]	November 10, 2018
Most Recent Line Check	April 9, 2019
Hazardous Weather[15]	February 11, 2019

2.1.2 Captain's Flight Times

The Captain's flight times were based on American Airlines' provided documentation:

Total pilot flight time	20,580
Total E-190 flight time	1,569
Total E-190 PIC flight time	1,545
Total flight time preceding 24 hours[16]	5:03
Total flight time preceding 7 days	13:55
Total flight time preceding 30 days	60:00
Total flight time last 90 days	143:00

2.2 First Officer

The First Officer (FO) was 49 years old and held an ATP certificate with type ratings on the EMB-145[17], ERJ-170, and ERJ-190. He held a commercial pilot certificate for airplane single-engine land. He also held an FAA first-class medical certificate dated July 15, 2019, with a limitation of "Must wear corrective lenses." At the time of the accident he was based at PHL.

According to information provided by American Airlines, the FO had accumulated about 13,450 hours of total flight experience and had about 962 hours of total flight experience in the E-190.

2.2.1 First Officer's Training and Proficiency Checks

A synopsis of the FO's recent training at American Airlines is as follows[18]:

Date of Initial New Hire Training at American Airlines	August 22, 2017
Most Recent Recurrent Ground School[19]	April 23, 2019

[14] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Advanced Training and Maneuvers Validation was coded under the "Event" column as RVA/RAD.
[15] Accomplished via Distance Learning.
[16] Flight time includes the accident flight.
[17] 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 July 15, 2019
[18] American Airlines utilized the Advanced Qualification Program (AQP) which was based on a 36-month cycle and broken into 18-month periods with 9-month intervals.
[19] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Recurrent Ground School was coded under the "Event" column as RGS and was reported as 3:15 in duration.

Most Recent Human Factors and Safety Training[20]	April 23, 2019
Most Recent Line Oriented Evaluation[21]	August 29, 2018
Most Recent Maneuvers Validation[22]	April 25, 2019
Most Recent Line Check	August 12, 2018
Hazardous Weather[23]	February 19, 2019

2.2.2 First Officer's Flight Times

The FO's flight times were based on American Airlines' provided documentation:

Total pilot flight time	13,450 hours
Total E190 flight time	962 hours
Total flight time preceding 24 hours [24]	5:03 hours
Total flight time preceding 30 days	46:00 hours
Total flight time last 90 days	105:00 hours

3.0 Airplane Information

Photo 1: Accident Airplane, N959UW (Courtesy of Flickr.com)

The accident airplane (Registration N959UW, Serial No. 166) was an Embraer 190AR (ERJ-190). The airplane was manufactured in 2008, registered to and operated by American Airlines, and held an airworthiness certificate dated April 18, 2008. The airplane was powered by two General Electric CF34-10E6 engines, each were rated at 18,500 pounds of thrust. The

[20] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Recurrent Human Factors and Safety Training was coded under the "Event" column as RHF and was reported 90 minutes in duration.
[21] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Line Oriented Evaluation was coded under the "Event" column as RLE/RAD.
[22] Source: Operational Factors/Human Performance Attachment 2 - Flight Crew Training Records. Advanced Training and Maneuvers Validation was coded under the "Event" column as RVA/RAD.
[23] Accomplished via Distant Learning.
[24] Flight Time includes the accident flight.

airplane was configured with 2 pilot seats, 1 cockpit observer seat, 3 flight attendant seats, and 99 passenger seats.

According to the accident flight's dispatch release there were no deferred maintenance items (MEL) at the time of departure.

3.1 Weight and Balance

The following weight and balance information was taken from the load closeout record. Limitations are indicated in **bold** type and taken from the American Airlines E190 Operating Manual Volume I, Chapter 2 "Limitations." All weights below are in pounds (lbs.).

Basic Operating Weight	64,249
Passenger Weight[25]	8,472
Cargo Weight	690
Total Payload	9,162
Zero Fuel Weight	73,411
Maximum Zero Fuel Weight	**90,150**
Fuel on Board[26]	12,260
Taxi Fuel	640
Ramp Weight[27]	86,951
Maximum Taxi and Ramp Weight	**114,500**
Takeoff Weight	86,311
Maximum Takeoff Weight	**114,150**
Planned Fuel Burn	6,941
Planned Landing Weight[28]	78,730
Maximum Landing Weight	**97,000**
Estimated Weight at the Time of the Event[29]	81,111

4.0 Accident Flight Dispatch Release and Weather Packet

The accident flight's filed route of flight was listed as direct to WHITE J209 to CYN[30] J37 CLASY J191 PXT[31] V213 HPW KAROO2 arrival into RDU.

[25] Passenger Weight was based on 44 total passengers of which 43 passengers were adults and 1 was listed as a child. The adult winter weights were 195 lbs. and the child weight was based on 87 lbs. All weights were based on FAA Advisory Circular AC 120-27E and American Airlines Weight and Balance Control Manual.
[26] Fuel on Board was the actual fuel weight on the load closeout sheet which was received by the flight crew at 0951 Local time. Source: Operational Factors/Human Performance Attachment 5 – Accident Flight Dispatch Paperwork.
[27] Included estimated taxi fuel burn
[28] Planned landing weight was a dispatch estimated weight based on an estimated takeoff weight.
[29] Source: American Airlines provided information via the NTSB Form 6120.1 (rev 9/2013).
[30] Coyle VORTAC
[31] Patuxent VORTAC

4.1 Weather and Flight Information

American Airlines weather and flight information for the accident flight, included departure and arrival airport weather, NOTAM, and field report information. Part of the weather information included enroute information that listed, in part, the following:

CAT[32] *SIGMEC NONE ISSUED*

TSTM SIGMEC NONE ISSUED

4.2 Accident Flight ACARS

The accident flight utilized ACARS to communicate with the flight's dispatcher. At 1124 the crew sent the following ACARS message to dispatch:

FI AA2247/AN N959UW
DT DDL RICV 181624 M96A
- OS KRDU /FTM
FA HURT IN TURB
MAYBE BRK ANKLE
NEED PARAMEDICS IN RDU
ETA1630
ALSO LET CREW SCHED
KNOW WE NEED NEW FA

At 1125 the dispatcher replied with the following response:

ACR N959 FTM
COPY
FD41 MATT

4.3 PIREPs

A review of archived PIREPs[33] throughout the national airspace system showed 521 PIREPs provided in the 2 hours prior and 1 hour after the accident flight's encounter with turbulence, there were 4 reports within about 100 miles of the accident location that indicated turbulence. The PIREPs were as follows:

DCA UA /OV GVE/TM 1500/FL260/TP A321/TB CONS LGT/RM FL240 OCNL LGT CHOP 38.156 -78.1658

RIC UA /OV RIC315007/TM 1558/FL220/TP B737/TB MOD/RM OUT OF IT AT 190 37.58319269 -77.41374058

[32] Clear Air Turbulence
[33] Source: Operational Factors/Human Performance Attachment 14 - Archived PIREPs

ORF UA /OV ORF270020/TM 1627/FL320/TP A321/TB MOD CHOP 36.90333 -76.55448136

CHO UA /OV GVE045030/TM 1651/FL280/TP CRJ9/TB CONS LGT OCNL MOD 38.46325438 -77.77505595

The reports in plain language taken from standard code and abbreviations, with altitudes in feet above mean sea level (MSL):

Ronald Regan Washington National Airport (DCA), Arlington, Virginia routine pilot report (UA); Over Gordonsville VORTAC[34] (GVE), Gordonsville, Virginia; Time – 1500Z (1000 EST); Altitude – FL260; Aircraft type – Airbus A-321; Turbulence – Continuous light; Remarks – FL240 occasional light chop at 38.156°N and 78.1658°W.

Richmond International Airport (RIC), Sandston, Virginia routine pilot report (UA); Over a point northwest of the RIC 7 miles; Time – 1558Z (1058 EST); Altitude – FL220; Aircraft type – Boeing B737; Turbulence – Moderate; Remarks – out of it at FL190 at 37.58319269°N and 77.4137058°W.

Norfolk VORTAC(ORF), Norfolk, Virginia routine pilot report (UA); Over a point west of the ORF 20 miles; Time 1627Z (1127 EST); Altitude FL320; Aircraft type - Airbus A-321; Turbulence – Moderate Chop at 36.90333°N and 76.55448136°W.

Charlottesville-Albemarle Airport (CHO); Charlottesville, Virginia routine pilot report (UA); Over a point northeast of the Gordonsville VORTAC (GVE), Gordonsville, Virginia 30 miles; Time – 1651Z (1151 EST); Altitude – FL280; Aircraft type- Bombardier CRJ-900; Turbulence – Continuous light occasional moderate at 38.46325438°N and 77.77505595°W.

5.0 American Airlines Personnel Interviews

In January of 2020, the Operational Factors/Human Performance group interviewed American Airlines personnel including the accident flight's dispatcher, technical pilot for the E-190 fleet, Weather Technology Manager, Director of the Integrated Operations Center, and the lead check airman on the E-190 fleet.[35]

The dispatcher provided the investigation with information about a normal workload and that on the day of the accident, he noticed the PIREP at FL220, which listed the turbulence as "moderate." He further stated that he gives about "2,000 feet separation" in altitude for any reported turbulence when he plans a route of flight. In addition, he will plan a flight with extra fuel to allow the flight to descend to a lower altitude if needed to avoid the turbulence. He further stated that he was made aware of the flight's encounter with turbulence when he received an

[34] Very-high Omnidirectional Range with Tactical Air Navigation system

[35] For a detailed transcript of those interviews reference Operational Factors/Human Performance Attachment 4 - American Airlines Personnel Interview Transcripts.

ACARS message from the flight. He stated the captain was "below 10,000 feet" and he looked at his WSI Fusion display and saw that the flight was around "7,000, 8,000 feet." He stated that he sent a "copy" message just so the crew knew that personnel in the IOC were aware of the situation, then he began making additional calls as required by company policy. He stated that he was "a little bit" surprised the flight encountered turbulence. He thought the flight may encounter "possible light" turbulence. When asked if he filed a PIREP for the turbulence encounter he stated he did not believe he did. Additionally, when asked if he used the RPM turbulence layer on WSI Fusion, he stated that he had used it occasionally but not on an everyday basis.

The Weather Technology Manager provided the investigation with information about the turbulence task force that he was part of, at American Airlines. He further stated that the goal of that task force was to reduce turbulence related injuries. He indicated the task force was analyzing data better than was done in the past. The task force also used automated TAPS[36] data, which allowed them to "do deep dives into these events" which allowed them to develop a process and provided them with better statistics. He also stated the task force had seen improvements in forecasting, communication, and objective data, however the state of the science needed to "bring all that together."

6.0 American Airlines Guidance

6.1 E190 Operating Manual Volume 1

The following guidance was provided to all E-190 flight crews. The current manual was listed as Revision Number 15, dated November 13, 2019.

6.1.1 Maximum Turbulence Penetration Speed

Section 1, Limitations, provided a maximum turbulent airspeed depending on the altitude the aircraft was operating when encountering turbulence. It provided a maximum turbulent airspeed when operating below 10,000 feet of 250 knots indicated airspeed (KIAS). When operating at or above 10,000 feet the airspeed was 270 KIAS or 0.76 Mach[37] whichever was less.

6.1.2 Severe Turbulence

Section 3, "Adverse Weather Operations" provided the following guidance, in part:

> ***General.*** *Flight through severe turbulence should be avoided if at all possible. Use the Flight Plan/Dispatch Release turbulence index information and/or the weather radar's turbulence detection mode to circumvent severe turbulence areas.*

[36] Turbulence Auto-PIREP System

[37] Mach was defined as "*a decimal number (M) representing the true airspeed (TAS) relationship to the local speed of sound (e.g., TAS 75 percent (. 75 M) of the speed of sound where 100 percent of the speed of sound is represented as Mach 1 (1.0 M)).*" Source: FAA Advisory Circular 61-107B "Aircraft Operations at Altitudes above 25,000 Feet Mean Sea Level or Mach Numbers Greater Than .75," Section 1-4l, dated March 29. 2013.

Powerplant. *Flying in turbulence may cause engine inlet airflow distortion. This distortion combined with angle of attach changes, high altitude engine surge margins, etc. can result in engine surge(s) and/or flameout(s).*

Yaw Damper. *Use of the yaw damper, even though rudder control may be more active, considerable reduces structural loads on the tail.*

Turbulence Airspeed. *Turbulence airspeed give the best overall protection from inadvertent stalls and maintains substantial structural margins. The margin between present flight conditions and the onset of buffet is a function of load factor. A load factor margin of 0.5g is considered adequate for penetrating turbulence during cruise flight.*

Caution

When encountering moderate to severe turbulence, reduce altitude, if necessary to increase buffet margin.

Encountering Severe Turbulence. *If severe turbulence is encountered, accomplish the following:*

1. Autopilot.....Keep On
2. Autothrottles..... Disconnect
3. Thrust..... Maintain Turbulence Airspeed

• Note •

Do not allow airspeed to decrease and remain below the turbulent penetration speed, as buffet margin will be reduced and considerable time and fuel will be required to regain cruise speed.

Change thrust only in case of an extreme variation in airspeed. Do not chase airspeed or Mach. A transient speed increase is preferable to a loss of speed that decreases buffet margins and is difficult to recover.

- *250 knots below 10,000 feet*
- *270 knots/0.76M at or above 10,000 feet*

Manual Flight. *Trim the aircraft for Turbulent Airspeed, then do not change the stabilizer position. Control pitch with elevators using the attitude indicator as the primary instrument. Control attitude first, then make corrections for airspeed, altitude, and heading.*

In extreme up/down drafts, large altitude gains/losses may occur. Do not make sudden or large elevator control inputs, but rather smooth and deliberate inputs to regain the desired attitude. Altitude deviations are probable in severe turbulence and should be allowed to occur providing terrain clearance is adequate.

Flap Extension. *Delay flap extension as long as possible. The aircraft can withstand higher gust loads in the clean configuration. Consider diversion to another airfield if severe turbulence persists and/or is a better course of action.*

6.1.3 Non-Normals Methodology

Section 9, "Non-Normals" provided the following guidance on when the flightcrew should check on the Cabin Condition:

Following any incident affecting the cabin, the flightdeck crew should check on conditions in the cabin by interphone, as soon as possible, after completion of crew duties.

Assess the situation and make any necessary PAs to assist the flight attendants in calming and reassuring the passengers. Advise the arrival station of any assistance needed on landing.

Incidents requiring cabin investigation by interphone may include:

— depressurization
— turbulence
— evasive maneuvers
— smoke
— fire or fumes
— structural failure
— anything else that might have caused injury or alarm in the cabin

6.2 E190 Operating Manual Volume II

The following guidance was provided to all E190 flight crews. The current manual was considered a supplement to Operating Manual Volume I and provided information about aircraft and systems descriptions, expanded explanation of procedures, and other selected pertinent topics applicable to the E190 aircraft. The manual was effective April 8, 2015.

6.2.1 Weather Radar

The weather radar could be displayed on both the primary flight display (PFD) in the HSI[38] mode and on the multifunction display (MFD).

The airplane is equipped with the WU-880 weather radar system. The system is designed primarily for detection and analysis of the weather during flight and for ground mapping. The MFD handles the display of radar data and, in addition, provides virtual controllers for weather radar control.

[38] Horizontal Situation Indicator

The weather radar system consisted of an integrated receiver transmitter antenna (RTA) unit and two virtual weather radar controllers. The RTA unit is mounted in the nose of the airplane. The virtual controllers consist of the CCDs[39] and the weather mode information displayed on the MFDs.

Selection of weather data display was accomplished via the CCD actuating a soft key in the MFD to select the MAP menu and display the virtual controller on the MFD.

6.2.1.1 Weather Radar Functions

The following was information provided, in part, to E190 flight crews about the weather radar functions.

> ***Turbulence Detection (Turb) (WU-880 ONLY).*** *The radar processes return signals to determine if a turbulence signature is present. Areas of moderate, severe, or extreme turbulence are displayed in soft white. TURB may only be engaged in the WX mode ranges of 50 NM or less.*
>
> ***• Note •***
>
> *There is a possibility that the turbulence function annunciation in the MFD and PFD will remain displayed for ranges above 50 NM even though the function is deactivated. Range selections of 200 NM or greater always clear the turbulence function annunciation.*
>
> ***Antenna Stabilization.*** *The antenna is stabilized in pitch and roll using attitude information from the IRU. Momentarily selecting the STAB Off checkbox disables the antenna stabilization and causes an amber STAB to be displayed on the MFD.*
>
> ***Receiver Gain (Gain).*** *The GAIN control varies the RTA receiver gain. There are two modes: variable and calibrated. The normal preset is the calibrated mode and is used for weather avoidance. The system will be forced into calibrated gain when RCT or TGT is selected. The variable mode is useful for additional weather analysis and for ground mapping. In WX mode, variable gain can increase receiver sensitivity above the calibrated level to show weak targets or it can be reduced below the calibrated level to eliminate weak returns.*
>
> ***Range.*** *The range is set with the rotary knob on the CCD to the desired value (10, 25, 50, 100, 200, 300 NM). OVRG is displayed on the MFD when the range is selected above 300 NM.*
>
> ***Target Alert (TGT).*** *The TGT function monitors for weather beyond the selected range and 7.5° on each side of the aircraft heading. If weather is detected within the monitored*

[39] Cursor Control Device

heading, outside the selected range and up to a range of 200 NM, the TGT annunciation changes from a green-armed condition to an amber alert condition on the MFD. This annunciation advises the flight crew that potentially hazardous weather lies directly in front and outside of the selected range. When this warning is received, the flight crew should select greater ranges to view the questionable target. Note that TGT is inactive when hazards are within the selected range.

Selecting the TGT function forces the system to a preset gain and turns off the variable gain mode. Selection of ranges of 200 NM or greater automatically turns off the TGT function and allows the variable gain mode. TGT can only be selected in the WX mode.

• Note •

The TGT annunciation on the MFD may still be displayed when the range is increased to 200 NM or greater, even though the function is deactivated. In such cases, systems logic follows the TGT function annunciation and the gain is automatically preset. Selection of the 1000 NM range always clears the TGT annunciation.

Sector Scan (SECT). *The normal radar sweep is ± 60 degrees from the aircraft nose, at a rate of 12 sweeps per minute. Selecting the SECT push button reduces the angle of sweep to ± 30 degrees and increases the sweep rate to 24 sweeps per minute.*

Tilt. *The inner tuning knob on the CCD provides tilt control giving the pilot manual control of the antenna tilt angle. The CCD inner knob is a dedicated tilt knob if VAR Gain is not active. Tilt can be varied between 15 degrees up (clockwise rotation) and 15 degrees down (counterclockwise rotation).*

Altitude Compensated Tilt (ACT). *Automatically adjusts the antenna tilt according to the altitude and selected range. The TILT knob can be used for fixed offset corrections of up to 2.0 degrees.*

Rain Echo Attenuation Compensation Technique (REACT). *Automatically adjust sensitivity to compensate for attenuation losses as the radar pulse passes through weather targets on its way to illuminate other targets. The REACT compensation can be activated in all modes except the GMAP mode.*

WARNING

The cyan field indicates areas where further compensation is not possible. This is a warning indicating that attenuation is hiding possible severe weather and should be considered very dangerous.

6.2.1.2 Weather Radar on the PFD

The following was information provided to E190 flight crews about how the weather radar worked and was displayed on the lower half of the PFD.

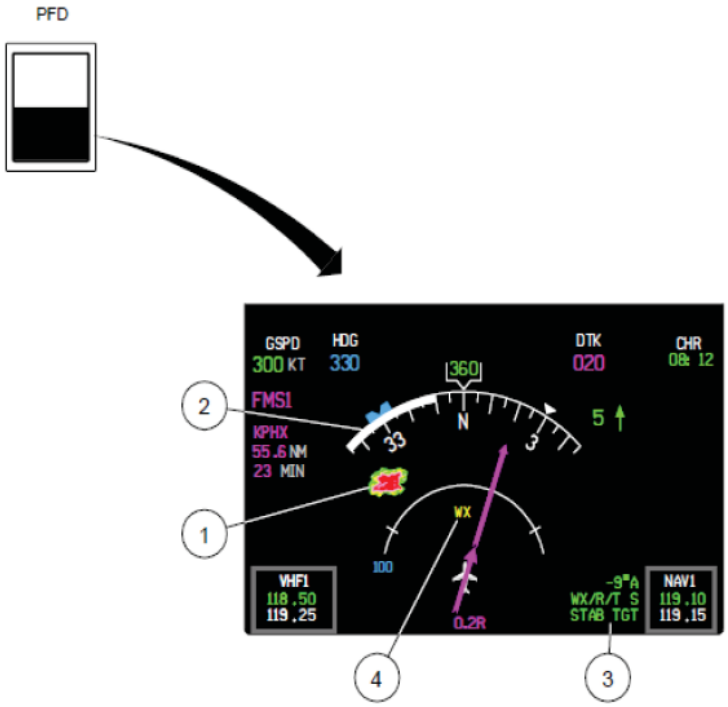

Figure 1: HSI Weather Radar Indications

(1) ***Weather Radar Returns***

Displays targets in color.
Modes:
WX: *the color indicates rain intensity in order of increasing intensity: green, yellow,*
red, and magenta
RCT: *attenuation is too high, hiding possible severe weather areas (cyan)*
GMAP: *color indicates surface information: black, cyan, yellow and magenta*
TURB: *(WU 880) only): areas of potentially hazardous turbulence (white)*

(2) ***Antenna Position Indicator***

Indicates that antenna scan is active.

(3) ***Weather Radar Annunciations***

First line:
CCD inner knob icon: *tilt angle is modifiable*
Tilt angle readout: *displays the tilt angle*
ACT annunciation: *ACT is an active submode*
Fault code data (entire line): *fault has been detected*
Second line:
Weather Radar Mode Annunciation:
GREEN (WX): *normal WX*
GREEN (WX/R): *normal WX with RCT*
GREEN (WX/T)*: normal WX with TURB*
GREEN (WX/R/T)*: normal WX with RCT and TURB*
GREEN (WX/TX): *weather transmitting but not selected for display on the PFD*
or
MFD
GREEN (GMAP)*: GMAP mode*
GREEN (FSBY): *forced standby*
GREEN (TEST)*: test mode and no faults*
AMBER (WX CTRL)*: invalid WX control bus*
AMBER (FAIL): *failure is detected*
AMBER (OVRNG): *MAP range greater than 300 NM*
WHITE (WX OFF): *WX is OFF*
WHITE (WAIT): *power up*
WHITE (STBY): *normal standby*
WHITE (S): *Slave mode is active*
Third line:
Stabilization annunciation: *radar stabilization is inhibited*
Target and gain mode annunciation.
GREEN (TGT): *TGT selected*
FLASHING AMBER (TGT): *TGT selected and alert condition*
AMBER (VAR): *variable gain selected*

④ ***Weather Radar Video Annunciation***

Indicates weather radar video failure.

6.2.1.3 Weather Radar on the MFD

The following was information provided to E190 flight crews about how the weather radar worked and was displayed on the MFD.

Figure 2: Weather Radar on the MFD

Controls & Indicators

Weather Radar Returns
Displays target in colors.

WX mode*: the color indicates rain intensity. In increasing order of intensity: green, yellow, red and magenta.*

***RCT mode**: attenuation is too high, hiding possible severe weather areas (cyan)*
***GMAP mode**: color indicates surface information: black, cyan, yellow and magenta*
***TURB mode**: areas of potentially hazardous turbulence (white)*

Target Alert Checkbox
Enables and disables the radar target feature. Can only be selected in the WX mode and at selected ranges of 200 NM or less.

Rain Echo Attenuation Compensation Technique Checkbox
Enables REACT function in all modes, except GMAP.

Altitude Compensated Tilt Checkbox
Enables automatic adjustment of the antenna tilt in relation to the altitude and selected range.

Turbulence Detection Checkbox
Enables the turbulence function only in the WX mode and at selected ranges of 50 NM or less.

Gain Indication Display
Indicates receiver sensitivity level from 0 to 100.

Receiver Gain Checkbox
Enables manual variation of the receiver sensitivity.

Antenna Stabilization Checkbox
Enables/disables automatic antenna stabilization.
A white STAB is displayed within the weather box when automatic antenna stabilization is disabled.

Sector Scan Checkbox
Enables the sector scan function for both pilots' displays.

Off Mode
Turns off the weather mode, provided OFF is selected in both weather radar virtual controllers.
In flight only, a single virtual controller selected to OFF operates in SLAVE mode.

Standby Mode
Selects the radar system into a standby mode, provided STBY is selected in both weather radar virtual controllers.
A green FSBY is displayed within the weather box when forced standby is active, on the ground.

Ground Mapping Mode
Enables ground mapping mode.

Radar Mode
In flight, activates the radar mode.

Forced Standby Override
Enables WX on the ground, when selected on both pilots' virtual control panel.

• Note •

Selection of Antenna Stabilization checkbox (STAB OFF) 4 times in less than 3 seconds enables the forced Standby Override function (FSBY OVRD).

Weather Radar Annunciations

First line:
CCD inner knob icon*: tilt angle is modifiable*
Tilt angle readout*: displays the tilt angle*
ACT annunciation*: ACT is active*
Fault code data (entire line)*: fault has been detected*

Second line:
Weather Radar Mode Annunciation*:*
GREEN (WX): *normal WX*
GREEN (WX/R)*: normal WX with RCT*
GREEN (WX/T): *normal WX with TURB*
GREEN (WX/R/T): *normal WX with RCT and TURB*
GREEN (WX/TX): *weather transmitting, but not selected for display on the PFD or MFD*
GREEN (GMAP): *GMAP mode*
GREEN (FSBY): *forced standby*
GREEN (TEST): *test mode and no faults*
AMBER (WX CTRL): *invalid WX control bus*
AMBER (FAIL): *failure is detected*
AMBER (OVRNG): *MAP range greater than 300 NM*
WHITE (WX OFF): *WX is OFF*
WHITE (WAIT): *power up*
WHITE (STAB): *STAB OFF function selected*
WHITE (STBY): *normal standby*
WHITE (S): *Slave mode is active Third line:*
Stabilization annunciation: *radar stabilization is inhibited*
Target and gain mode annunciation.
GREEN (TGT): *TGT selected*

FLASHING AMBER (TGT): *TGT selected and alert condition*
AMBER (VAR): *variable gain selected*

6.2.2 American Airlines Flight Operations Manual

The following guidance was provided to all American Airlines flight crews. The manual provided guidance for all American Airlines' fleet. The manual was effective December 10, 2019.

6.2.2.1 Turbulence Communication

The following turbulence communication guidance was provided to all American Airlines flight crews:

Expected.

"Ladies and gentlemen, this is Captain _____ speaking. I have instructed the flight attendants to take their seats and fasten their seat belts due to some turbulent air. Please ensure your seat belts are properly fastened. There is no cause for alarm. We simply want you to be aware that there may be a few bumps ahead. We will make every effort to minimize any effects we may encounter. Thank you for your cooperation."

In Progress or Imminent/No Warning.

"Flight attendants be seated immediately."

Limited Warning.

"Flight attendants stow the carts and take your seats."

Suspending Inflight Service.

"Ladies and gentlemen, we are experiencing rough air. The flight attendants are suspending the service and stowing the carts so they can take their seats. This is to prevent injury to our flight attendants and you, and we ask for your patience. Please keep your seat belt fastened and remain seated. When smoother flight conditions return, the service may be resumed."

Resuming Inflight service. *When conditions permit:*

"Ladies and gentlemen please remain seated. Flight attendant may resume your normal inflight duties."

6.2.2.2 Seatbelt Sign

The following seatbelt sign guidance was provided to all flight crews:

When not required inflight, extinguish the seatbelt sign to enhance passenger compliance and flight attendant awareness of turbulence.

Turn on the seatbelt sign:

- *prior to aircraft movement on the ground*
- *during takeoff and landing, initial climb-out, and descent below 18,000 feet MSL*
  - *when the aircraft is:*
    - *experiencing or is expected to experience moderate or greater turbulence*
    - *being maneuvered in the vicinity of thunderstorm activity*
- *at any other times the captain deems to be appropriate*

  Note: *If the seat belt sign is left on for an extended period, occasionally re-emphasize the important of seat belt use.*

6.2.2.4 Operations

*Operations through **known** severe or extreme turbulence are not authorized. If informed of the presence of severe or extreme turbulence, avoid the reported area and notify dispatch. If the reported area is:*

- *in the vicinity of the departure airport: see a departure routing that avoids the turbulent area or delay departure until conditions improve*
- *enroute: change altitude/route in order to avoid the reported area*
- *in the vicinity of the destination airport: seek a descent and approach to avoid the reported area; otherwise, hold until the condition improves or divert*

  Note: *Consider the size3 of reporting aircraft with PIREPs or ride reports.*

Dispatch

*Dispatch through **known** turbulence is authorized if the forecast indicates the turbulence will decrease to a level less than severe before the flight reaches that area. If the dispatcher has planned a route around turbulence for avoidance, it will be noted in the flight plan's RMKS. Consider contacting the dispatcher prior to accepting direct routing from ATC through that area.*

6.2.3 General Operations Weather – Procedures

6.2.3.1 Procedures

Terminal Area Turbulence Considerations

Consider weather impacts in the terminal area that will require flight attendants to remain seated after 10,000 feet AGL on departure or seated earlier during the descent before landing.

Convective Weather. *Convective weather is the most common cause of injuries. Look for visual cues or use the radar to scan for hazards in the proximity to the airport. Clues/indications include:*

- *CB or TCU clouds, lightning, wind shear alerts or precipitation on ATIS information*
- *gusting or variable direction winds*

If able to update the iPad WSI application, look for cloud tops above 20,000 feet and/or active convective SIGMET warning area near your flight path.

Turbulence Reports. *Turbulence reports around the airport offer critical information. Look listen for PIREPs, TAPs reports, FPG areas, turbulence warning SIGMETs or RPM (model) turbulence on the vertical profile of the WSI application. Query the air traffic controller for information and ride reports. Listen for ride reports from the aircraft ahead on climb out and descent.*

Note: *If the WSI application shows a white circle around the terminal area, turbulence intensity has exceeded forecast expectations.*

Terrain. *Some airports, like DEN, with significant terrain features nearby, required special vigilance. When in doubt, assume conditions are turbulent.*

Preflight

During the preflight briefing with FA 1/purser, include knowledge of reported or potential turbulence along the route of flight using the terms: light, moderate, or severe turbulence.

Unsafe to Stand During Climb Out. *If there are conditions that are unsafe for flight attendants to be standing during climb (see Terminal Area Turbulence Considerations above), notify flight attendants to remain seated during climb out until the seat belt sign is turned off or until notified by flightdeck it is safe to move about the cabin. Also inform the passengers with an Expected turbulence PA when the flight attendants have been asked to remain seated for their safety.*

Enroute

Any crewmember can initiate the turbulence procedure communication to discuss the turbulence severity level. See also section 7w.1 Turbulence for flight crew actions.

Arrival. *During the arrival review and briefing (prior to BOD when possible), pre- brief flight attendants on the approximate time to have the cabin cleaned up and to be ready to be seated.*

Warning: *Notify flight attendants with an In Progress or Imminent/No Warning Turbulence PA prior to flying through and conditions that are unsafe for flight attendants to be standing.*

Inform the passenger with an Expected turbulence PA when the flight attendants have been asked to be seated for their safety.

Severity

Turbulence severity can also vary within the aircraft with turbulence intensities typically greater in the rear of the aircraft. Use the procedures associated with the worst level of severity in the aircraft.

Communicate to the FA 1//Purser. *When communicating with the flight attendants provide the:*

-turbulence severity level that will achieve the desired action by the flight attendants using only the following terms: light, moderate, or severe
-time available until the encounter is expected
Provide the flight attendants as much notification time as possible, keeping in mind normal flight attendant procedures for galley and cabin cleanup may take up to 20 minutes to complete.
-length of time expected to be in the turbulent environment
Emphasize that after the expected time has elapsed, the flight attendants are to remain in their seats until advised by the flightdeck.

Note: *Procedures dictate flight attendants remain seated until the flightdeck has provided clear communication that it is safe for them to get out of their seats.*

6.2.3.2 Turbulence Types

Thunderstorm. Turbulence and windshear within thunderstorms, or in the vicinity of thunderstorm tops and wakes, down bursts, and gust fronts.

Clear Air. Occurs in the free atmosphere away from visible convective activity. CAT includes high-level frontal and jet stream turbulence and strong vertical wind shear.

Mountain Wave. Produced in connection with mountain lee waves. It may include high amplitude mountain waves, rotors, turbulence in highly sheared layers near the tropopause and near the surface.

6.2.4 Turbulence – Communication

Communications are paramount to the safety of the passengers and flight crew. See also paragraph Turbulence for PA announcement examples.

Flight Attendants

For:

- *reported turbulence: notify flight attendants of newly reported or suspected turbulence as soon as possible using the interphone*
- *turbulence without notification: the flight attendants will take their seats and then contact the flightdeck*

Passengers

Inform passengers of routine turbulence via PAA. When it is necessary for flight attendants to be seated with seat belts fastened, convey this to the passengers.

Dispatch
Report turbulence to dispatch as soon as soon as conditions permit.

Note: *The captain's assessment is the final determinant of turbulence levels.*

Turbulence Index (TI). *The following table describes the flight planning system (FPS) turbulence index scale (found in the flight plan) and the flight planning system response to the turbulence index (TI).*

Level	TI Scale	FPS Action
NIL/Trace to Light		
Light to Occasional Moderate	3	
Moderate	4	
Moderate to Occasional Severe	5	Altitude/speed adjusted
Severe	6	Route blocked
Extreme	7	Route blocked
— End		

Table 1: Flight Planning System Turbulence Index Scale
(Source: American Airlines Flight Operations Manual)

6.2.4.1 Terminology

Turbulence vs Chop
Turbulence. *Appreciable amounts of pitch, roll or yaw are present.*
Chop. *Very little to no change in attitude/altitude occurs. Chop is referred to as light or moderate only.*
Note: *Chop is not an ICAO term and should not be reported outside the US.*

Turbulence Intensity

Smooth. *No bumpiness is experienced.*
Light Chop. *Some slight, rapid, rhythmic bumpiness without appreciable changes in altitude or attitude.*

Light Turbulence. *Bumpiness accompanied by slight erratic changes in altitude and/or attitude (pitch, roll, yaw). In a condition of light chop or light turbulence, occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may move slightly. Food service may be conducted. Little to no difficulty is encountered in walking.*

Moderate Chop. *Similar to light chop but of greater intensity. There are rapid bumps and jolts without appreciable changes in altitude or attitude.*

Moderate Turbulence. *Similar to light turbulence but of greater intensity. Altitude and attitude changes occur. Indicated air speed fluctuates. Positive control of the aircraft is maintainable at all times. In a condition of moderate chop or moderate turbulence, occupants feel a definite strain against seat belts or shoulder straps. Unsecured objects move. Food service and walking is difficult. An ACARS or radio report to dispatch is required.*

Severe Turbulence. *Large and abrupt changes in altitude and attitude. Indicated air speed fluctuates over a large range. Momentary loss of control may be experienced. Occupants are forced violently against seat belts and shoulder straps. Unsecured objects are tossed about. Food service and walking are not possible. A radio report to ATC and dispatch is required plus AML entry to ensure completion of required maintenance inspection.*

Extreme Turbulence. *Aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. A radio report to ATC and dispatch is required plus an AML entry to ensure completion of required maintenance inspection.*

Turbulence Duration

Term	***Chop or turbulence occurs ____ of the reported segment time.***
Occasional	*less than 1/3*
Intermittent	*from 1/3 to 2/3*
Continuous	*more than 2/3*

Table 2: Turbulence Duration Chart
(Source: American Airlines Flight Operations Manual)

6.2.4.2 Flight Crew Actions – Turbulence

Light Turbulence

Definition: *Turbulence that momentarily causes:*

- *momentarily slight, erratic changes in altitude or attitude (pitch, roll, yaw)*
- *slight, rapid, and somewhat rhythmic bumpiness without appreciable altitude/attitude changes (i.e., light chop)*

Inside Cabin Reaction:

- *occupants may feel a slight strain against seat belts*
- *liquids are shaking but not splashing out of cup*
- *little or no difficulty encountered in walking*

Flightdeck	Flight Attendant
Turn the seat belt sign on at captain's discretion.	– Make seat belt sign on announcement if necessary. – Continue service with caution.
Notify FA 1/purser **"Light Turbulence procedures are in effect."** Include expected duration if known.	If the seat belt sign is on
Provide ATC a PIREP (light turbulence or light chop as applicable).	– Discontinue service of hot liquids and remove hot liquids from carts. – Verify: • passenger seat belts are fastened and infants/children are secured in seats
- End -	

Moderate Turbulence

Definition: *Turbulence that is similar to:*

Flightdeck	*Flight Attendant*
– *Turn seat belt sign on.* – *Make PA instructing passengers and flight attendants to be seated.*	– *Make seat belt sign on announcement if necessary.* – *Discontinue service and seal hot liquids.* – *Stow and secure galley equipment and carts.* – *Sit down and secure seat belt.*
*Notify FA 1/purser "**Moderate turbulence procedures are in effect."** Include expected duration if known.*	
– *Provide ATC a PIREP (moderate turbulence or chop as applicable).* – *Notify Dispatch.*	
When service may be resumed	
– *Notify FA 1/purser service may be resumed.* – *Extinguish the seat belt sign at the captain's discretion.*	– *Check passengers/crew needing attention or assistance.* – *Notify captain of any injuries or interior cabin damage.*
- End -	

- *light turbulence but of greater intensity with altitude/attitude/airspeed changes but the aircraft remains in positive control at all times*
- *light chop but of greater intensity without appreciable altitude/attitude changes but rapid bumps or jolts occur*

Inside Cabin Reaction:

- *occupants feel definite strains against seat belts*
- *liquids are splashing out of cups*
- *difficulty encountered in walking*

Severe Turbulence

Definition: *Turbulence:*

- *that causes large and abrupt altitude/attitude/airspeed changes occur and the aircraft may be momentarily out of control*
- *in which the aircraft is violently tossed about and is practically impossible to control and possible structural damage*

Inside Cabin Reaction:

- *occupants forced violently against their seat belts*
- *items falling or lifting off surfaces*
- *walking is impossible*

<table>
<tr><th>Flightdeck</th><th>Flight Attendant</th></tr>
<tr><td>– Turn seat belt sign on.
– Make PA instructing passengers and flight attendants to be seated immediately.</td><td rowspan="3">– Make seat belt sign on announcement if necessary.
– Discontinue service and seal hot liquids.
– Stow and secure galley equipment and carts.
– Sit down and secure seat belt.

Note: FA 1/purser will notify flightdeck crew when all flight attendants are seated.</td></tr>
<tr><td>Notify FA 1/purser "Severe turbulence procedures are in effect." Include expected duration if known.</td></tr>
<tr><td>– Provide ATC a PIREP (severe or extreme turbulence as applicable).
– Notify Dispatch</td></tr>
<tr><td colspan="2">When service may be resumed</td></tr>
</table>

– *Notify FA 1/purser service may be resumed.* – *Extinguish the seat belt sign at the captain's discretion.* – *Make AML severe turbulence entry*	– *Check passengers/crew needing attention or assistance.* – *Notify captain of any injuries or interior cabin damage.*
- End -	

6.2.4.3 Electronic Flight Bag – Operations

WSI Pilot Brief
iPad EFB connectivity during flight must never become a distraction to the safe operation of the aircraft. The Company recommends the pilot monitoring perform iPad WSI downloads during flight.

> ***Downloaded Data.*** *iPad EFB data downloaded/displayed during flight remains secondary to the primary navigation displays and onboard weather radar. iPad EFB information is intended to enhance situational awareness and strategic decision making.*
>
> *Due to the inherent latency of internet weather data, never use iPad EFB data to tactically maneuver the aircraft. Proper visual and radar usage techniques must remain the primary tool to avoid in-close weather cells.*
>
> ***Substitution.*** *iPad EFB WSI weather may not be used to satisfy an aircraft MEL or a substitute for required aircraft weather radar equipment.*
>
> ***Reporting Anomalies/Feedback.*** *Submit pilot debrief or Flightdeck WiFi feedback form in myMobile365 for poor connectivity. Many factors may cause slow or no WiFi signal in the flightdeck. Do not make a logbook writeup unless the entire IFE system is inoperative*

6.3 Inflight Manual

The following information was provided to cabin crew in the Inflight Manual, Revision 3.1 dated September 7, 2017.

6.3.1 Seatbelt Compliance Checks

Immediately after the Fasten Seatbelt Sign is illuminated, all FAs must coordinate responsibilities for verifying all customers are seated with their seatbelts fastened in each cabin.

In the event of turbulence that would compromise FA safety, only deliver the Fasten Seatbelt PA. Conduct compliance checks once it is safe to move about the cabin.

To conduct seatbelt checks

- *FA 1/Purser delivers Fasten Seatbelt PA*
  - *exception on night flights between 10:00 PM and 6:30 AM*
- *Ensure all customers have seatbelts fastened*
  - *use flashlight if needed*
- *If Fasten Seatbelt Sign is illuminated during a beverage or meal service, FAs must momentarily stop service to perform compliance checks*
  - *carts cannot be left unattended - FAs alternate conducting seatbelt checks and manning cart*

6.3.2 General Turbulence Guidelines

- *Customers are requested to keep seatbelts fastened while seated at all times and are required to keep seatbelts fastened when the Fasten Seatbelt sign is on*
- *Do not jeopardize personal safety during turbulent conditions*
- *Turbulence severity is communicated using the categories found in the Turbulence Procedure Tables, the categories are:*
  - ***Light:** Bumpiness and momentary changes in altitude/attitude*
  - ***Moderate:** Rapid bumps or jolts; changes in altitude/attitude*
  - ***Severe:** Large, abrupt changes in altitude/ attitude*
- *The cabin is prepared according to the level currently being experienced as defined on the Turbulence Procedures Tables*
- *There can be different levels of turbulence intensity relative to location in the aircraft. The cabin is prepared according to the highest level on the Turbulence Procedure Tables*

6.3.2.1 Turbulence Procedure Tables

Flightdeck and flight attendants must comply with the communication and action outlined in the following Turbulence Procedures Tables

Light Turbulence Procedures

Moderate Turbulence Procedures

Severe Turbulence Procedures

Light Turbulence Procedures

Definition

- *Turbulence that momentarily causes slight, erratic changes in altitude or attitude*

OR

- *Turbulence that causes slight, rapid and somewhat rhythmic bumpiness with minimal changes in altitude or attitude*

Inside Cabin Reaction

- *Occupants may feel a slight strain against seatbelts*
- *Liquids shaking but not splashing out of cup*
- *Little or no difficulty encountered in walking*

Flightdeck Actions

- *Seatbelt sign on at captain's discretion*
- *Notify FA 1/Purser that Light Turbulence Procedures are in effect and expected duration*

Flight Attendant Actions

- *Deliver Seatbelt Sign ON announcement, if not made by flightdeck*
- *Continue service with caution*
- *Discontinue service of hot liquids and remove hot liquids from carts*
- *If seatbelt sign is on, verify that passenger seatbelts are fastened, infants/children are secured in seat and lavatories unoccupied*
- *Submit a CERS, if applicable*

Moderate Turbulence Procedures

Definition

- *Changes in altitude or attitude occur but the aircraft remains in positive control at all times. Usually causes variations in airspeed*

OR

- *Causes rapid bumps or jolts with minimal change in aircraft altitude or attitude*

Inside Cabin Reaction

- *Occupants feel strains against seatbelts*
- *Liquids splashing out of cups*
- *Difficulty in walking*

Flightdeck Actions

- *Turn on Fasten Seatbelt Sign*
- *Deliver PA instructing passengers and FAs to be seated*
- *Notify FA 1/Purser that Moderate Turbulence Procedures are in effect and expected duration*
- *Notify FA 1/Purser when service may be resumed. Extinguish Seatbelt sign at captain's discretion*

Flight Attendant Actions

- *Deliver Seatbelt Sign ON or Turbulence announcement, if necessary*
- *Discontinue service, deliver Turbulence Discontinue Service announcement*

> ***Exception*** *- On night flights (2200- 0630), when a cabin check is not possible, deliver PAs.*

- *Secure hot liquids while returning cart to galley*
- *Stow carts and secure galleys*
- *Sit down and secure seatbelt*
- *Remain seated until notified by the flightdeck or the seatbelt sign has been turned off Check for passengers/crew needing assistance. Ensure lavatories are vacant. Inform flightdeck of any injuries or interior cabin damage*

- *Submit a CERS*

Severe Turbulence Procedures

Definition

- *Causes large, abrupt changes in altitude or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control*

OR

- *Aircraft is violently tossed about and is practically impossible to control. It may cause structural damage*

Inside Cabin Reaction

- *Occupants forced violently against seatbelts*
- *Items falling or lifting off surface*
- *Walking is impossible*

Flightdeck Actions

- *Seatbelt sign turned on*
- *Deliver PA instructing passengers and FAs to be seated immediately*
- *Notify FA 1/Purser that Severe Turbulence Procedures are in effect and expected duration*
- *When severe turbulence is no longer in effect, notify FA 1/Purser when service maybe resumed. Seatbelt sign is turned off at captain's discretion*

FA Actions

- *Deliver Seatbelt Sign On or Turbulence PA, if possible*
- *Discontinue service, deliver Turbulence Discontinue Service PA*

Note: On night flights (2200-0630), when a cabin check is not possible, deliver PAs

- *If cart is in aisle, secure cart by wedging cart between aisle seats*
- *Set brakes on all carts in present location*
- *Remove hot liquids from cart by placing in cart (if room available) or on floor*
- *Sit down immediately in nearest seat and secure seatbelt or sit on floor and secure self*
- *Remain seated until notified by flightdeck or seatbelt sign is turned off*
- *Check for passengers/crew needing attention or assistance. Ensure lavatories are vacant. Inform captain of any injuries*
- *Submit a CERS*

6.3.3 Turbulence Communication

- *Maintaining communication with the flightdeck and other flight attendants is essential to avoiding turbulence injuries*
- *Reported or potential turbulence during flight is conveyed by the flightdeck during the crew briefing with the FA 1/Purser*

- *During flight, flightdeck notifies FAs of newly reported or suspected turbulence as soon as possible*
- *Flightdeck and FAs communicate the severity of turbulence using light, moderate and severe turbulence verbiage*
- *If FAs experience turbulence, with no prior notification from the flightdeck, FA calls flightdeck to request the seatbelt sign to be turned on*
- *Flightdeck communicates to the FAs the length of time expected to be in turbulence, if known*
- *if advised, the FAs remain seated until advised by the flightdeck. FA 1/Purser delivers Seatbelt Sign On or Turbulence announcement*
- *if extended period time, with no update from the flightdeck, the FA calls for an update*

6.3.4 Unexpected Turbulence

- *Dependent on intensity, immediately take nearest seat or jumpseat and fasten seatbelt, including shoulder harness if in jumpseat*
- *If cart is in aisle, secure cart by wedging cart between aisle seats*
- *Set brakes on all carts in present location*
- *Remove hot liquids from cart by placing in cart (if room available) or on floor*
- *Communicate with other FAs and advise to secure themselves*
- *Remain seated until notified by the flightdeck that it is safe to resume duties*
- *FA 1/Purser delivers Turbulence announcement*
- *Advise flightdeck of any injuries or cabin interior damage*

6.4 Dispatch Procedures Manual

The following guidance was provided to all American Airlines IOC personnel. The manual provided operations policies, procedures, Federal Regulations, and American Airlines operations specifications which govern American Airlines flight operations. According to the Corporate Operations Policy within the Dispatch Procedures Manual, the manual was to be used by dispatchers in conducting safe and efficient flight operations and the policies were intended to ensure operating integrity and standardization.

6.4.1 Responsibilities

An American Airlines' Flight Dispatcher is an airman who holds an Aircraft Dispatcher Certificate. Each Dispatcher shall operate in accordance with applicable regulations and company policy listed in 14 CFR 121, Flight Operations Manual, this Dispatch Procedures Manual, FAA Operations Specifications, and other company policy references.

The Dispatcher is jointly responsible, with the pilot in command, for the preflight planning, delay, and dispatch release of assigned flights. The Dispatcher is responsible for monitoring the progress of the flight, issuing information or instructions necessary for the safety of the flight, and canceling or redispatching the flight (amending the release) if considered necessary for the safety of the flight (by either the Dispatcher or pilot in command).

Except when an airplane lands at an intermediate airport specified in the original dispatch release and remains there for not more than one hour, no person may start a flight unless an aircraft dispatcher specifically authorizes that flight. No person may continue a flight from an intermediate airport without redispatch if the airplane has been on the ground more than six hours

The Dispatcher shall provide the pilot-in-command all additional available information of meteorological conditions (including adverse weather phenomena such as CAT, thunderstorms and low level wind shear) as well as irregularities of facilities and services that may affect the safety of flight. Flights may not be dispatched or operate through areas of reported or forecast hazardous weather unless these hazards can be avoided by:

- *Changing routing or altitude*
- *Delaying takeoff or landing*
- *Holding or landing at an alternate*

When planning a flight to specifically avoid hazardous weather, the flight plan should be locked out to discuss the planned route and avoidance strategy with the Captain so that he/she does not accept an ATC reroute into the area being avoided. This is particularly important with turbulence avoidance, therefore, it is mandatory that the flight plan be locked out when avoiding an area of moderate to severe (or greater) turbulence (indicators 5 or greater on the flight plan) to discuss the area fully with the Captain before departure.

A Dispatcher may conduct a pre or inflight redispatch (amended release) by recording the amendment on oral tape and in writing. The Captain may accept a pre or in-flight amendment over a radio by reading back the dispatch release message, recording the message in writing (including the Dispatcher's name/initials) noting the date and time and signing the entry.

Critical phases of flight include all ground operation up to 10,000ft (sterile flight deck period). Non-essential, non-operational related company communication is not authorized during the sterile flight deck period. To protect the sterile flight deck period, crew reassignment messages may not be sent within 20 mins of the estimated ON time.

The Dispatcher has the authority to release, defer and cancel flights in accordance with regulations and company policies. With this authority comes responsibility and accountability for all decisions.

6.4.2 Reporting Potential Inflight Hazards

Flight Crews are required to notify Dispatch of encounters with potentially hazardous weather conditions such as Moderate/Severe Icing or turbulence. Crews are also

required to notify ATC whenever they have encountered an irregularity in a ground facility or Navaid. If unable to relay this irregularity to the controlling ATC facility in a timely manner, the Crew may request that the Dispatcher relay the information to ATC for them.

6.4.3 Flight Plan Review

Each Dispatcher is required to make a final review, upon calculation, of the operational parameters used in building the Dispatch Release / Flight Plan. These parameters include ensuring each airport planned in the Dispatch Release is open and/or has personnel available at the expected time of arrival. Each crewmember is required to review the flight plan/release, attached messages and TPS.

The Captain and Dispatcher will independently analyze information necessary for the operation of each American Airlines' flight, however, the Dispatcher must lock out the flight plan to discuss any routing changes purposely done for moderate to severe (or greater) turbulence avoidance (where turbulence indicators of 5 or greater would appear on flight plan).

Both are required to sign the Dispatch Release / Flight Plan prior to departure. The Dispatcher's and Captain's (electronic) signatures certify that, in the judgment of each, the flight can be made safely as planned.

6.4.4 Enhanced Weather Information Systems – EWINS

The Weather Company forecasts and products are outlined in the AA EWINS Manual. Turbulence products include:

- *Turbulence Indicators*
- *Flight Planning Guidance*
- *SIGMETs*
- *PIREPS*
- *TAPS*
- *Turbulence Advisories (TBCA)*
- *RPM Turbulence*

6.4.4.1 Flight Plan Turbulence Indicators

AA uses a numerical indicator system to describe turbulence either through the flight plan or by a PIREP:

- *0 - Smooth (PIREP only)*
- *1 - Ocnl Light (PIREP only)*
- *2 - Cont Light (PIREP only)*
- *3 - Light Ocnl Moderate*

- *4 - Moderate*
- *5 - Moderate Ocnl Severe*
- *6 - Severe*
- *7 - Extreme*

ACARS Numerical Turbulence values are reported as a numerical value preceded with the letters TB. Ex, TB2 = (Continuous light)

Flight plans will display numerical values 3 and above in the main body and in the wind summary sections. These indices are derived based on forecast Flight Planning Guidance and SIGMET plotting done by TWC meteorologists.

Note:

1. When planning a flight to avoid moderate to severe (or greater) turbulence, (turbulence
indicators of 5 or greater), the flight plan must be locked out to discuss the avoidance area with the Captain. This discussion will ensure that the Captain will not accept an ATC reroute into the turbulent area.

2. 0, 1 and 2's are replaced with a - (dash) since no flight planning is required for those indices. Awareness of those areas should be derived from Optima or Fusion during the flight planning phase.

6.4.4.2 Flight Planning Guidance

Flight planning areas are manually drawn by The Weather Company (TWC) meteorologists to depict forecast areas of potential light or light to moderate turbulence. When converted to text, these areas can have more points than can be manually plotted. Because of this, do not send FPG areas that contain more than 6 defining waypoints via ACARS as it is difficult to impossible for crews to plot. If you want to send an FPG area with more than 6 defining waypoints, manually describe the area as it relates to the flight plan.

Turbulence forecasts from The Weather Company (FPG's and SIGMETS) take into account the significant wind and temperature gradients associated with turbulence near a sharp tropopause break.

<u>Tropopause Overview</u>

The tropopause is a thin layer forming the boundary between the troposphere, characterized by decreasing temperature with height by and the stratosphere, where temps are either steady or slightly warm with height. Tropopause height varies from around 65,000 feet over the Equator to around 20,000 feet near the poles. The

tropopause is not continuous but generally descends in steps (occurring in "breaks") from the Equator to the poles.

The strongest jet core winds often occur near sharp breaks between the Tropical tropopause and the Polar tropopause. These jet cores are associated with sharp temperature, wind speed gradients and possibly turbulence. If flight plan tropopause heights indicate significant changes in tropopause height over a relatively short distance and there are wind speed changes in direction and/or intensity, the flight path is likely in or near a jet core. When weather patterns are relatively quiet, it is quite likely that significant breaks do not exist.

6.4.4.3 Turbulence SIGMETS

Turbulence SIGMETs (SIGnificant METeorological advisory) can be issued by either a government agency such as the National Weather Service or The Weather Company for clear air turbulence (including Low Level Wind Shear and Mountain Wave episodes). Although Dispatchers must be aware, and consider, non-EWINS forecasts and reports of hazardous weather, EWINS approved weather sources (TWC) are controlling when considering enroute hazardous weather advisories. As such, applicable TWC SIGMETs must be relayed to all affected flights.

6.4.4.4 Turbulence Advisories (TBCA)

The EWINS manual describes the Turbulence Advisory (TBCA) as a short-term advisory to warn users that something unexpected has been reported. This is also a trigger for TWC to review the immediate area for SIGMET consideration.

A. TBCA boundaries

TBCA's are typically 50NM and +/- 1000ft around the event that triggered the advisory (TAPS or PIREP). The advisory default is for 30minutes but can be manually extended by TWC to 60 minutes if more time is needed to determine if a forecast change is needed (issue SIGMET, FPG, etc.)

B. TBCA Triggers

TCBA's are automatically triggered based on a turbulence event which is one turbulence category higher than the corresponding FPG or SIGMET. For example, if an FPG area is published for Light and a TAPS report of Moderate is detected, TWC software will automatically issue the TCBA. The EWINS manual specifically defines various scenarios.

C. TBCA Flight Planning Guidance

Since TBCAs are advisory based on a PIREP or TAPS event, it is not required to avoid any TBCA. Sending a TBCA via ACARS is optional but CFR 121.601 states that it is required to send all available current reports of meteorological conditions (including

adverse weather phenomena, such as clear air turbulence, thunderstorms, and low altitude wind shear). This means that if the TBCA is not sent, the TAPS report or PIREP that generated it should be.

6.4.4.5 RPM Turbulence

RPM (Rapid Precision Mesoscale) turbulence is an automated forecast product which depicts areas of turbulence on either Fusion or Optima. The forecast is updated every 6 hours and provides up to 18 different altitude options.

As with The Weather Company forecasting (FPG's and SIGMETS), RPM turbulence forecasts have the diagnostics to detect turbulence associated with significant wind and temperature gradients associated with turbulence near a sharp tropopause break.

Using the Time and Altitude Sliders, you can adjust the layer depiction. A setting in My Preferences controls what altitude is set when the altitude slider is not used.

6.4.5 Turbulence Auto PIREP System (TAPS)

Turbulence Auto PIREP System (TAPS) is a process that turns suitably equipped aircraft (B737-NG, B757 and B767) into turbulence reporting platforms. The objective of the program is to:

+ Augment subjective PIREPs with objective and precise turbulence measurements

+ Improve timeliness from 30-45 minutes to near real-time

+ Improve frequency from once per event to continuous until event passed.

+ Improve location from nearest waypoint on flight plan to actual geospatial coordinate.

Dispatchers are required to notify Flight Crews when turbulence (greater than light) is expected. TAPS Event reports are an appropriate source of ride/turbulence data to communicate expected in-flight conditions to the Flight Crew.

6.4.5.1 TAPS Alerting

A TAPS equipped aircraft transmits two kinds of messages: HEART-BEAT and TAPS Events. The events are based on certain thresholds represented by Root Mean Square/G-force (RMS/G) values. Each turbulence reporting level (Ride Quality, Light, Moderate or Severe) are associated with specific RMSG values. These events are sent down via ACARS and processed by WSI and displayed on Fusion.

- *RMS/G VALUE - The avionics on board the aircraft determine turbulence in relation to G-force and report it as an RMS/G value. Each event is transmitted from the aircraft to a ground based program that computes a comparable turbulence value and sends the interpreted report to Fusion for display and alerting.*

- *HEARTBEAT MESSAGES - These messages are sent every 20mins at any altitude. A Heartbeat message is sent whether an aircraft is in turbulence or not. It is an instantaneous report of conditions being experienced at the moment the message is transmit- ted. Heartbeats reports are a good indicator of no (or very light) turbulence.*
- *TAPS EVENTS - TAPS events are generated when the aircraft is at/above 10,000ft (except a severe event will generate at any altitude). Once turbulence is detected the aircraft will send a TAPS Event report and will continue to send an event every 30 seconds until the turbulence decreases below the RMS/G value for Ride Quality (basically the ride becomes Smooth).*

6.4.5.2 RMS/G Value

The following table indicates the relationship of RMS/G values to more common turbulence indicators such as Smooth, Light, Moderate or Severe. Ride Quality is representative of a ride not quite smooth, but not considered Light Turbulence. It's more of a nuisance chop.

Intensity	Hazard RMS/G Value	WSI Enroute Turb Index	Aircraft Reaction	Inside Aircraft
Smooth	<0.075g	No SIGMET or FPG Guidance TI = 0	No Turbulence	No impact
Ride Quality	0.075g to <0.1G	No SIGMET or FPG Guidance TI = 1 OCNL LGT	Causes little of no airspeed or altitude adjustment	Discomfort if exposed for more than 15mins.
Light	0.1g to <0.2g	No SIGMET or FPG Guidance TI = 2 LGT TI = 3 LGT OCNL MDT	Momentarily causes slight, erratic changes in altitude or attitude	Pax may feel slight strain against seat-belts.
Moderate	0.2g to <0.3g	SIGMET and FPG Guidance TI = 4 MDT TI = 5 MDT OCNL SVR	Similar to LGT turb but of greater intensity. Changes in altitude/attitude occur but air-craft in positive control	Definite strain against seatbelt. Food service and walking difficult. Objects are dislodged.
Severe	>0.3g	SIGMET and FPG Guidance TI = 6 SVR TI = 7 EXTM	Causes large, abrupt changes in altitude/attitude Causes large variations in airspeed. Air-craft may become out of control	Pax forced violently against seatbelts. Objects are tossed around. Food Service and walking not possible.

Table 3 RMS/G Values (Source: American Airlines Dispatch Procedures Manual)

6.4.5.3 TAPS Report to Flight Crews

TAPS events higher than RMS/G of 0.26 will automatically send a message to the aircraft which reported the Event. This message will indicate the flight information, location of the event, RMS value, maintenance flag threshold, and the range of the G value. It is important to note that the TAPS Event severity classification is different from the maintenance threshold in that the TAPS threshold relates to an RMS/G value and only correlates to the AIM description of turbulence. The maintenance threshold directly relates to G value and the aircraft manuals definition of severe turbulence which would require an inspection. It is possible to have a severe TAPS Event which does not exceed the maintenance flight threshold and vice versa.

All messages will indicate the Flaps down maintenance threshold because the G load parameter is more conservative than the flaps up threshold. The flaps down g-load threshold are 2.0g/+0.0g.

This message is intended to assist the Captain in determining if a severe turbulence inspection is required. It is the Captain determination and entry in the logbook of a severe turbulence encounter which is controlling for the maintenance inspection.

Dispatch receives a copy of this message via Screen Printer.

> *FLIGHT AA1234 RPTS SEVERE TAPS EVENT.*
> *A/C: B752 REPORTED: 27/0019Z LOCATION: 50SSE ORL ALTITUDE: FL100*
> *RMS LOAD: 0.33*
> *FLAPS DOWN MX FLAG THRESHOLD: NOT EXCEEDED PEAK LOADS: PLUS 1.358*
> */ PLUS 0.417*

7.0 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."*[40]

7.1 FAA Turbulence Fact Sheet

The FAA provided the following guidance titled "Fact Sheet – Turbulence" on August 1, 2019, on their website:[41]

What is turbulence?

[40] Source: https://www.faa.gov/travelers/fly_safe/turbulence/
[41] Source: https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20074

Clear air 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.

What should passengers do to avoid injuries?

Flying is the safest way to travel. 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 flight attendants. Pay attention to the safety briefing at the beginning of your flight and read the safety briefing card.*
- *Buckle up. Keep you and your family safe by wearing a seat belt at all times.*
- *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.*

What do airlines do to avoid turbulence and prevent injuries?

Working together through the Commercial Aviation Safety Team (CAST), the FAA developed guidance material to help air carriers and other operators prevent turbulence injuries. CAST develops an integrated, data-driven strategy to reduce the commercial aviation fatality risk in the United States and promotes government and industry safety initiatives throughout the world. Some of the material responds to investigative work from the National Transportation Safety Board. The focus of the material (see additional reading) is to help air carriers avoid the conditions that cause turbulence and minimize the risks when airplanes do encounter it. This impacts the operations and training of flight crews, flight attendants, dispatchers and managers.

The FAA recommends that air carriers:

- *improve dispatch procedures by keeping communication channels open full-time;*
- *include turbulence in weather briefings;*
- *promote real-time information sharing between pilot and dispatcher;*
- *reinforce the air carrier's turbulence avoidance policy through dispatcher training;*
- *consider rerouting using automation, atmospheric modeling, and data displays; and*
- *use all applicable weather data as well as reporting and forecasting graphics.*

The FAA also encourages air carriers to use operating procedures and training to prevent turbulence injuries, emphasize the importance of flight attendant's personal safety, promote communication and coordination, and gather data and review the air carrier's history of turbulence encounters and injuries.

How many people have been injured during turbulence?

Year	*Passenger*	*Crew*	*Total*
2009	*74*	*27*	*101*
2010	*35*	*23*	*58*
2011	*4*	*25*	*29*
2012	*4*	*19*	*23*
2013	*2*	*4*	*6*
2014	*19*	*9*	*28*
2015	*11*	*16*	*27*
2016	*29*	*13*	*42*
2017	*9*	*8*	*17*

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.

7.2 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.

7.3 FAA Advisory Circular AC 00-30C Clear Air Turbulence Avoidance

FAA AC 00-30C "Clear Air Turbulence Avoidance,", dated March 22, 2016, section 5.1 defines Clear Air Turbulence (CAT) as "*sudden severe turbulence occurring in cloudless regions that causes violent buffeting of aircraft…includes turbulence in cirrus clouds, within and in the vicinity of standing lenticular clouds and, in some cases, in clear air in the vicinity of thunderstorms."* The AC further went on to state *"CAT is a recognized problem that affects all aircraft operations. CAT is especially troublesome because it is often encountered unexpectedly and frequently without visual clues to warn pilots of the hazard."* The AC, in section 7 "Modern Turbulence Reports and Forecasts" goes on to stated *"Automated turbulence reporting systems are common on many commercial aircraft using the Aircraft Meteorological Data Relay*

(AMDAR) system. Airline pilot reports are now being relayed to others by the airline's aircraft dispatchers and by meteorologists working wat the Federal Aviation Administration's (FAA) air route traffic control centers (ARTCC).

AMDAR reports turbulence in terms of Eddy Dissipation Rate (EDR) which was the International Civil Aviation Organization (ICAO) standard dimension for automated turbulence reporting. EDR was a state-of-the-atmosphere measure rather than a state-of-the-aircraft measure and thus makes it independent of aircraft type.

In-flight weather advisories such as SIGMET and AIRMET are used to disseminate important information on atmospheric turbulence, both convective and CAT. In-flight weather advisories in the contiguous United States are issued by the Aviation Weather Center (AWC) as well as 20 Center Weather Service Units (CWSUs).

F. LIST OF ATTACHMENTS

Attachment 1: Crew Statements
Attachment 2: Flight Crew Training Records [Excerpts]
Attachment 3: Flight Crew Schedules
Attachment 4: American Airlines Personnel Interview Transcripts
Attachment 5: Accident Flight Dispatch Paperwork
Attachment 6: Accident Flight ACARS Transmissions [Excerpts]
Attachment 7: American Airlines Operations Manual Vol 1 and 2 [Excerpts]
Attachment 8: American Airlines Flight Operations Manual [Excerpts]
Attachment 9: American Airlines Flight Operations Bulletin 17-007B
Attachment 10: American Airlines Inflight Manual [Excerpts]
Attachment 11: American Airlines Dispatch Procedures Manual [Excerpts]
Attachment 12: American Airlines Weight and Balance Manual [Excerpt]
Attachment 13: American Airlines Postaccident Weather Review
Attachment 14: Archived PIREPs
Attachment 15: Operational Factors/Human Performance Group Party Forms

Submitted by:

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Operational Factors	Human Performance

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