



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
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Attachment 6 – Southwest Airlines Flight Operations Manual (Excerpts)

OPERATIONAL FACTORS

DCA19CA151

15.3 Turbulence

Revised: 07/21/2016

This section discusses turbulence limitations and policies, including how to prepare for turbulence and communicate with Passengers and Crew.

15.3.1 Turbulence Limitations and Policies

Revised: 07/21/2016

- L** Pilots will not intentionally conduct flight operations nor will flights be dispatched in areas of known or probable severe turbulence. A combination of forecasts, PIREPs, aircraft types, times, locations, and altitudes must be considered in determining known or probable severe turbulence.
- P** Pilots must remain on a filed mountain wave transit route. Coordinate any desired changes with Dispatch.
- P** Pilots must not accept an ATC reroute through active mountain wave areas that require planning mountain wave avoidance without first consulting the Dispatcher.

15.3.2 Turbulence Intensity

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The following are various levels of turbulence intensity:

- Smooth—no turbulence. There is no duration entry for smooth.
- Light chop—slight, rapid, and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude.
- Light turbulence—slight, erratic changes in altitude and/or attitude. Occupants may feel strain against seatbelts. Unsecured objects may be displaced slightly. Little or no difficulty walking.
- Moderate chop—rapid bumps or jolts without appreciable changes in aircraft altitude or attitude.
- Moderate turbulence—changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Occupants feel definite strain against seatbelts. Unsecured objects are dislodged. Walking is difficult.
- Severe—large, abrupt changes in altitude and/or attitude. Usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control. Occupants are forced violently against seatbelts. Unsecured objects are tossed about. Walking is impossible. Contact Dispatch; aircraft inspection is required.

- Extreme—aircraft is violently tossed about and practically impossible to control. Structural damage may result. Contact Dispatch; aircraft inspection is required.

15.3.3 Turbulence Duration

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- Occasional—less than $\frac{1}{3}$ of the time.
- Intermittent— $\frac{1}{3}$ to $\frac{2}{3}$ of the time.
- Continuous—more than $\frac{2}{3}$ of the time.

15.3.4 Turbulence Type

Revised: 07/21/2016

- Thunderstorm turbulence—turbulence associated within and in the vicinity of thunderstorms or cumulonimbus clouds. A cumulonimbus cloud with hanging protuberances is usually indicative of severe turbulence.
- Clear air turbulence—high level turbulence (above 15,000 ft) not normally associated with cumuliform cloudiness. Typically windshear turbulence even when in cirrus clouds.
- Mountain wave turbulence—turbulence as a result of air being blown over a mountain range or a sharp bluff causing a series of updrafts and downdrafts. Refer to [17.3.4 Turbulence and Mountain Wave Guidance](#) for details on mountain wave turbulence procedures.

15.3.5 Turbulence and Hazardous Weather Guidelines

Revised: 05/09/2018

WSI SIGMETs and Flight Plan Guidance (FPGs) are distributed both in text and on a chart provided in the weather package for each flight. The format focuses on turbulence and any other type of weather-specific hazards to flight. The plotting on the WSI SIGMETs is simple, and the degree of hazard is easily discernible.

Because some encounters with light-to-moderate turbulence are unavoidable and some turbulence is unpredictable, be prepared to reassure Passengers of their safety and, in some cases, to act quickly in preventing injuries to self and others. Pilots are expected to maintain awareness of all turbulence messages received via ACARS.

WSI SIGMET and FPG Chart Appearance and Contents

Hazardous weather phenomena are grouped into four levels of intensity:

- Occasional Moderate (OCNL MOD/MDT)—Isolated reports of or the forecast of turbulence that causes slight, rapid, and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude (FPG chart only).
- Moderate (MOD/MDT)—Multiple reports of or the forecast of turbulence that causes intermittent, rapid, and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude (WSI SIGMET and FPG charts).
- Occasional Severe (OCNL SVR)—Isolated reports of or the short-term forecast of turbulence that causes large, abrupt changes in altitude and/or

attitude and usually results in large variations in indicated airspeed. The aircraft may be momentarily out of control (WSI SIGMET chart only).

- Severe (SVR)—Multiple reports of or the short-term forecast of turbulence that causes large, abrupt changes in altitude and/or attitude and usually results in large variations in indicated airspeed. The aircraft may be momentarily out of control (WSI SIGMET chart only).

Thunderstorms/WSI Thunderstorm (TSTMS) SIGMET coverage is defined as follows:

- Scattered (SCT)—When coverage is greater than 15 percent (FPG chart only).
- Scattered to Broken (SCT-BKN)—When coverage is greater than 30 percent (WSI SIGMET and FPG charts).
- Broken (BKN)—When coverage is greater than 50 percent (WSI SIGMET and FPG charts).
- Solid (SOLID)—When coverage is greater than 75 percent (WSI SIGMET chart only).

Icing is defined as follows:

- Occasional Severe (OCNL SVR)—Isolated reports of or short-term forecast of severe icing. Immediate flight diversion is necessary (WSI SIGMET chart only).
- Severe (SVR)—Multiple reports of or short-term forecast of severe icing. Immediate flight diversion is necessary (WSI SIGMET chart only).

Note: Severe icing is defined as the rate of accumulation at which deicing/anti-icing equipment fails to reduce or control the hazard.

WSI SIGMET

WSI SIGMET data indicates the need for caution, heightened awareness, and, in some cases, action to avoid areas of known turbulent conditions. The nature of turbulence (e.g., clear air, mountain wave, convective) and the intensity/availability of new data, with the degree of change expected over a given time period, dictates the frequency that WSI SIGMET turbulence messages are issued and updated. SIGMETs, other forecast products, and actual turbulence data may be used as secondary sources to enhance situational awareness; WSI SIGMET messages prevail over NWS SIGMETs when differences exist.

The WSI SIGMET chart includes en route hazards for the following:

- Moderate, occasional severe, and severe turbulence
- Scattered-broken, broken, and solid thunderstorms
- Occasional severe and severe icing

Table 15.1 ACARS WSI SIGMET Message Example

Menu Title for Turbulence	WSI SIG 28833
Turbulence Message	CN 28833 WSI SIGMET-TURB Valid: 20121018T1515Z until 20121018T1800Z Type: CAT Intensity: MOD/MDT Level: FL130-FL170 Movement: 67deg 10kt TURBC ASSOC WITH MID LVL SPEED/DIRECTIONAL WIND SHEAR. Area: 45ENEFLM 40WBKW 50NWVXV 30SSWIIU ID: 2883
Menu Title for Delete/Cancel	WSI DEL 28833
Delete/Cancel Message	CN 28833 DEL

FPG

The FPG chart includes forecast en route hazards for the following:

- FL 350 winds
- Jet stream
- Tropopause height
- Occasional moderate and moderate turbulence
- Scattered, scattered-broken, and broken thunderstorms

15.3.6 Turbulence Communication

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Turbulence Communication with Dispatch

Flight Deck Crews and Dispatchers will communicate known or potential turbulence before, during, and after flight. Dispatchers may use the Remarks section of the Dispatch Release to advise Flight Deck Crews of known or forecast turbulence. Flight Deck Crews must send turbulence PIREPs to Dispatch via ACARS, or by radio or telephone if ACARS is unavailable. When sending turbulence PIREPs, include the duration, intensity, altitude, and location of the turbulence.

Preflight weather briefings, verbal or written, must include forecasts of turbulence and PIREPs of turbulence caused by thunderstorm activity, mountain wave activity, clear air turbulence, low altitude frontal windshear, and low altitude convective windshear.

During flight, the Pilot and Dispatcher must communicate any changes in the forecast or actual turbulence conditions via ACARS or radio to pass real-time turbulence information to other flights.

Turbulence Communication with Flight Attendants

If flight into forecast turbulence is unavoidable, timely notification to the Flight Attendants is crucial to their safety. Anticipated turbulence must be part of the preflight briefing to the "A" Flight Attendant.

Remember the following when dealing with turbulence:

- Provide Flight Attendants with as much advance warning as possible before entering an area of turbulence. Discuss how much time will be required to discontinue cabin service and be seated.
- Ensure Flight Attendants are seated when directed. Require Flight Attendants to call as soon as seated and before getting out of their seats.
- Any turbulence-related communication with the Flight Attendants should use the following terminology: light, moderate, or severe. Whenever possible, show the WSI SIGMET chart to the Flight Attendants.
- Turbulence levels are not the same throughout the cabin. Intensity levels in forward sections may be lower than those in aft sections.
- Anytime Crew Members experience turbulence levels that have not been forecasted or communicated, take immediate action in response to conditions. Communicate between flight deck and cabin as soon as it is safe to do so.

During the descent, Passengers are permitted to use large PEDs and tray tables until reaching 10,000 ft. When expecting turbulence, Pilots may direct the Flight Attendants to secure the cabin prior to 10,000 ft and be seated for their safety. Coordinate using the interphone and/or PA instead of the attend call button to allow Passengers to continue using large PEDs and tray tables until 10,000 ft.

Pilots should ensure Flight Attendants are allotted adequate time to secure galleys before entering areas of anticipated turbulence.

Table 15.2 Turbulence Communication with Flight Attendants

Pilot Responsibility	Flight Attendant Responsibility
Advise "A" Flight Attendant of expected or encountered turbulence, anticipated response time, and expected duration. Provide as much advance warning as possible so Flight Attendants can discontinue service and be seated.	Ensure other Flight Attendants are notified via interphone when turbulence is reported by Pilots. Advise Pilots if turbulence is disrupting cabin service. Flight Attendants may decide if conditions experienced in cabin are not suitable for continued service.
Turn on FASTEN SEAT BELT sign. Make PA to ensure Passengers and Flight Attendants are seated with seatbelts fastened when level of turbulence calls for it.	If Pilots do not make seatbelt announcement, make announcement. Make PA to ensure Passengers and other Flight Attendants are seated when level of turbulence calls for it. Notify Pilots when FASTEN SEAT BELT sign is on for extended periods without turbulence or if Passengers are disregarding sign.
Direct Flight Attendants to be seated when required.	When directed by Pilots to be seated, notify Pilots when all Flight Attendants are seated.
Notify Flight Attendants when safe to move about cabin and resume service.	Report any Passenger or Crew injuries to Pilots and complete an Irregularity Report.

When actual conditions in the cabin differ from the forecasted conditions, Flight Attendants must notify the Captain and take appropriate action.

15.3.7 Seatbelt Policy

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Communication between the flight deck and cabin is essential with regard to the severity and anticipated duration of the turbulence.

Passengers and Flight Attendants shall be seated when moderate or greater turbulence is anticipated or encountered. These areas may be indicated by WSI SIGMETs, radar images, cloud formations, PIREPs, or reports by ATC.

Safety data has shown that the majority of turbulence-related injuries occur during descent and in areas with occasional moderate turbulence.

15.3.8 Turbulence Action Table

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Table 15.3 Turbulence Action Table

Level Turbulence Type	Description	Pilot Action	Flight Attendant Action
Light	Slightly erratic in altitude and/or attitude. Occupants may feel strain against seat belt. Unsecured objects may dislodge slightly.	Ensure FASTEN SEAT BELT sign is on. Via interphone, advise Flight Attendants of anticipated type of turbulence and expected duration. If occasional moderate or greater turbulence is anticipated or encountered, advise the Flight Attendants to be seated. Make announcement reinforcing need for Passengers to remain seated.	Continue service with caution. Flight Attendants monitor compliance by visually checking Passengers are seated with seat belts fastened.
Moderate	Changes in altitude and/or attitude occur but the aircraft remains in positive control. It usually causes variations in indicated airspeed. Occupants feel definite strain against seat belts. Walking is difficult.	Ensure FASTEN SEAT BELT sign is on. Via interphone, advise Flight Attendants of anticipated type of turbulence and expected duration. Make announcement reinforcing need for Flight Attendants and Passengers to remain seated and service to be discontinued. Communicate with Flight Attendants as required. Refer to <i>B737NG AOM 10.5 Cruise Altitude Selection</i> or <i>B737MAX AOM 10.5 Cruise Altitude Selection</i> for guidance.	Stop all service. Stow all galley equipment. Secure self in a jumpseat as soon as possible using seat belt and shoulder harness (take nearest passenger seat if necessary). "A" Flight Attendant: - Communicate with other Flight Attendants to ensure Passengers and Flight Attendants are seated. - Notify Pilots when Flight Attendants are seated. - Communicate with Pilots on cabin, as required.

Level Turbulence Type	Description	Pilot Action	Flight Attendant Action
Severe	Large, abrupt changes in altitude and/or attitude.	Ensure FASTEN SEAT BELT sign is on. When operationally safe to do so: - Make announcement stating, "Flight Attendants and Passengers be seated immediately and fasten seat belts." - Make announcement to inform Flight Attendants and Passengers when turbulent conditions have subsided. After conditions subside, communicate with Flight Attendants as required.	Stop all service until turbulence is reduced. Secure self in the nearest available seat. If on jumpseat, use seat belt and shoulder harness. "A" Flight Attendant notifies Pilots when cabin is secure and Flight Attendants are seated. When safe to do so: - Stow all galley equipment. "A" Flight Attendant use PA to ensure Flight Attendants and Passengers are seated. - Check for injuries or damage. "A" Flight Attendant communicates with Flight Deck Crew on cabin conditions, as required.

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The procedures for turbulence avoidance are based on forecast and/or observed areas of turbulence, and are used both for flight planning and while en route. Due to the transient nature of turbulence, there are times when it is unavoidable. Dispatchers and Flight Deck Crews should remain vigilant and take extra precautions to ensure the safety of the flight when conditions are conducive to turbulence.

A combination of WSI SIGMETs, FPGs, Turbulence Auto PIREP System (TAPS) reports, Turbulence Advisories, and Pilot Weather Reports (including aircraft type, location, and altitude) must be used to determine whether known or probable turbulence exists. If greater-than-light turbulence is expected to impact the flight, the Dispatcher considers additional contingency fuel and, depending on the level of turbulence, selects a different altitude and/or route and advises the Flight Deck Crew. Dispatchers do not plan any flight into areas of known or probable severe turbulence.

Turbulence Data

Turbulence data indicates the need for caution, heightened awareness, and, in some cases, action to avoid areas of known turbulent conditions. The nature of turbulence (i.e., clear air, mountain wave, or convective), the intensity, the availability of new data, and the degree of change expected over a given time period dictate the frequency at which WSI SIGMET messages are issued and updated. NWS SIGMETs, AIRMETs, other forecast products, and actual turbulence data may be used as secondary sources to enhance situational awareness; WSI SIGMET messages prevail over NWS SIGMETs when differences exist. Refer to [15.3.5 Turbulence and Hazardous Weather Guidelines](#).

Mountain Wave Turbulence

Mountain wave areas are depicted as either moderate, occasional severe, or severe, based on expected level of turbulence that has been or may be encountered. Flights must be planned with the most appropriate mountain wave route that avoids altitudes or areas of greater-than-moderate turbulence.

Mountain Wave Transit Route

Mountain wave transit routes are planned routes through active mountain wave areas where moderate or greater turbulence can be expected.

Dispatchers plan a mountain wave transit route, if available, when the flight route transits an active moderate or severe mountain wave area. Additionally, Dispatchers plan to avoid any altitude forecast or known to have greater-than-moderate turbulence.

A note in the Remarks section of the Dispatch Release indicates when a mountain wave transit route is planned. Many of these routes are coded in the SWIFT flight planning database with MWD after the six-letter city pair code (e.g., DTWLASMWD). As the navigational database reference cycle is updated, the mountain wave transit routes coded in the SWIFT flight planning database reflect MWT after the six-letter city pair code (e.g., DTWLASMWT).

Mountain Wave Avoidance Altitude

If no mountain wave transit route exists, Dispatchers may plan flights on normal routes through mountain wave areas as follows:

- Avoiding any altitude forecast or known to have greater-than-moderate turbulence.
- If no such altitude exists, choosing a route that avoids the entire area.

- Noting in the Remarks section of the release when avoidance altitudes are planned.

Mountain Wave Avoidance Routes

Mountain wave avoidance routes are routes used to remain clear of an active mountain wave area where greater-than-moderate turbulence can be expected.

Dispatchers plan a mountain wave avoidance route to avoid areas where greater-than-moderate turbulence is indicated and neither a mountain wave transit nor a more efficient avoidance altitude transiting the area is available.

A note in the Remarks section of the Dispatch Release indicates when a mountain wave avoidance route is planned. Many of these routes are coded in the SWIFT flight planning database with MWA after the six-letter city pair code (e.g., DTWLASMWA).

Mountain Wave Policy

While transiting a hazard area on a filed mountain wave route, Pilots must remain on the filed route at an altitude that avoids any turbulence known or forecast to be greater than moderate. While outside of a hazard area, deviations off the filed mountain wave route are acceptable if the flight remains clear of the hazard area and the deviation is beneficial to flight efficiency and/or comfort.

This policy is not designed to override the Captain's authority. Once the flight has entered the hazard area, deviations should be of immediate necessity (e.g., thunderstorm avoidance, severe turbulence) as determined by the Captain. If an immediate deviation is necessary, contact Dispatch as soon as practical.

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