AC 121-2-5(Rev 0)
17 September 2018

Civil Aviation Authority of Singapore

Advisory Circular

PREVENTING INJURIES CAUSED BY TURBULENCE

GENERAL

Advisory Circulars (ACs) are issued by the Director-General of Civil Aviation (DGCA) from time to time to provide practical guidance or certainty in respect of the statutory requirements for aviation safety. ACs contain information about standards, practices and procedures acceptable to CAAS. An AC may be used, in accordance with section 3C of the Air Navigation Act (Cap. 6) (ANA), to demonstrate compliance with a statutory requirement. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

PURPOSE

This AC provides to demonstrate compliance with, and information for the AOC holder to develop SOPs, training programmes and other necessary measures to prevent injuries caused by turbulence.

APPLICABILITY

This AC is applicable to an AOC holder operating an aeroplane in accordance with ANR-121.

RELATED REGULATIONS

This Advisory Circular relates specifically to Regulations 21 and the Fourth Schedule of ANR-121.

RELATED ADVISORY CIRCULARS

- AC 121-2-1 Guidance on Operational Procedures for ANR-121 Operations
- AC 121-2-3 Standard Operating Procedures for Flight Crew Members
- AC 121-6-3 Acceptable Child Restraint Devices

CANCELLATION
This AC supersedes AC AOC-11.

EFFECTIVE DATE
This AC is effective from 1 October 2018.

OTHER REFERENCES
- ICAO Annex 3 Meteorological Service for International Air Navigation
- ICAO Doc 4444 Air Traffic Management
- ICAO Doc 9817 Manual on Low-level Wind Shear
- FAA Turbulence Information Website

1 INTRODUCTION

1.1 This AC provides guidance to AOC holder in developing SOPs and other measures to prevent injuries caused by turbulence. The AOC holder should incorporate these SOPs and measures into his operations manual including the training manual as appropriate.

1.2 This AC is based on strategies and practices consolidated by the industry and regulators together and is known to be effective in preventing injuries caused by turbulence. These include procedures for the avoidance of conditions that cause turbulence, and to help minimise risks when turbulence is encountered. These procedures are recommended for implementation in the operations and training of flight crews, cabin crew, flight dispatchers, and managers.

2 FUNDAMENTALS OF EFFECTIVE PRACTICES AGAINST INJURIES DUE TO TURBULENCE

2.1 **Turbulence Avoidance as corporate culture.** The first and most fundamental step is to avoid turbulence to the maximum extent possible as the first line of defence. Implementing a turbulence avoidance culture should include standard operating procedures (SOPs) for dispatch and flight operations to reroute around forecast and observed turbulence, and for observing standard clearances between thunderstorms and aircraft.

2.2 **Rerouting.** Modern aircraft automation, atmospheric modelling, and data display have enhanced forecast accuracy, data delivery, and AIREP subjectivity, improving the odds that a well-chosen rerouting would in fact avoid turbulence. Both at the planning stage and during flight, a corporate culture that accepts these changes in the interest of safety should be encouraged.

2.3 **Clearances between thunderstorms and aircraft.** SOPs should offer guidance to crew members in recommended distance away from thunderstorms. They should reflect the ICAO recommendations of industry standard clearances.

3 TRAINING OF CREW MEMBERS

3.1 **Take advantage of the training environment**. Crew members should be trained in standard operating procedures, including standard phraseology, and concepts that might promote crew members' adherence to those procedures during an encounter with turbulence. The training environment for cabin crew and flight crew affords an opportunity for lectures, scenarios and exercises designed to explore subjects such as evaluating risk, good and bad decision-making and the importance of crew coordination before, during and after an encounter with turbulence.

3.2 **Emphasise the importance of cabin crews personal safety.** As cabin crew spend more time in the passenger cabin unseated and therefore unbelted, their injury rates are disproportionately higher compared to other crew members and other cabin occupants. Effective training emphasises to cabin crews that:

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

(b) **You have tools available to increase your safety and the safety of your passengers**. Effective training shows cabin crew how to increase personal and passenger safety by identifying tools available to them during turbulence. Training should include the effective use of the passenger address system (PA) 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 minimal time.

(c) **You need to recognise and avoid a denial reflex**. Cabin crews should be made aware of ways in which human psychology might play into a turbulence encounter, and how it might actually increase their risk of injury. For example, on a short flight, cabin crew might be less conservative regarding their personal safety than on a longer flight with less time constraints. Cabin crew can also increase risk and compromise their personal safety by trying to adhere to routine procedures normally accomplished on every flight, such as completing seat belt compliance checks, rather than by responding to the non-routine situation that a turbulence encounter presents.

3.3 **Promote communication and coordination**. Crew resource management (CRM) training for crew members and dispatch resource management (DRM) training for flight dispatchers should emphasise that the individual is part of a team and may include the following:

(a) **Address turbulence response in CRM training.** The AOC holder should develop and incorporate as part of CRM training, practices that encourages an effective coordinated crew response before, during and after a turbulence encounter.

(b) **Subtopics supporting CRM and DRM training to counter turbulence.** Effective team performance could be made clear by addressing topics such as:

- The importance of using standard phraseology.
- The importance of using standard operating procedures (SOPs).

- The importance of an effective pre-flight briefing that should include:
    - Potential of turbulence encounters during each leg.
    - Emphasis on the importance of keeping the flight crew members informed of cabin conditions.
    - Commitment to using standard operating procedures and phraseology during a turbulence encounter.
- The importance of maintaining communication during the flight, including communication with the aircraft dispatcher, as appropriate.
- The results of communication errors due to the use of vague, inaccurate descriptions and non-standard phraseology regarding turbulence.

Note: It is highly desirable to conduct joint CRM training including flight crew, cabin crew, and flight dispatchers. However, if joint training is not practical, each of these training populations should be made aware to other functions regarding turbulence through other training methods.

4 TRAINING FLIGHT DISPATCHERS

4.1 Flight dispatchers should be trained and current to maintain an awareness of weather products and services available from the ICAO World Area Forecast System (WAFS). Wind and temperature forecasts of flight levels and significant weather (SIGWX) forecasts are issued regularly four times per day by the two World Area Forecast Centres (WAFC), London and Washington and are disseminated to all users via the ICAO Aeronautical Fixed System (AFS).

4.2 Continual reinforcement of the AOC holder's turbulence avoidance policy should be evident in theory, in on-the-job training, and in practice. The flight dispatcher should:

(a) Ensure the weather briefing for the pilot includes known areas of turbulence.

(b) Select flight routings, including en route altitudes, taking due account of known thunderstorm and turbulence forecasts.

(c) Plan flights so they will not proceed through areas in which thunderstorms or turbulence of more than moderate intensities are known to exist.

5 OPERATING PROCEDURES.

5.1 **Crew members.** The AOC holder should refer to **Appendix A**, Turbulence Template, for suggested procedures for crew members developed by a broad collaboration of regulators.

5.2 **Passengers**. The AOC holder should develop and promulgate procedures promoting voluntary seat belt use and compliance with the Fasten Seat belt sign. These should include the following:

(a) **Flight crew to promptly and clearly communicate turbulence advisories** including specific directions to cabin crews and to passengers. Those advisories should include directions to be seated with seat belts fastened, and to secure cabin service equipment, as conditions may require.

(b) Cabin crew to effectively communicate directions to passengers to be seated with seat belts fastened.

(c) The proper use of child restraint device or an approved child restraint system (CRS) as guided in AC 121-6-3.

- Parents and guardians should ensure that children under the age of two, are properly secured by means of a child restraint device or if travelling with an approved CRS, **occupy the CRS any time the Fasten Seat belt sign is illuminated and are properly secured in their seats by safety belts.**

- Cabin crew should verify that the CRS is **properly secured** and that the child is properly secured in the CRS**.**

(d) **Encouragement for the passenger to comply with seating and seat belt instructions** from crew members such as:

- **Video presentations** incorporated as part of a cabin crew's safety demonstration to illustrate the benefits of using effective turbulence practices.

- **Information on safety information cards, articles in airline publications, pamphlets in seat back pockets or websites** to encourage passengers to engage in effective practices such as keeping seat belts fastened at all times.

- **Give prior notice that the Fasten Seat belt sign will be illuminated** when practicable, noting that any personal needs requiring movement in the cabin should be met within that time and emphasising the requirement to comply when the Fasten Seat belt sign is illuminated.

(e) **Highlighting of regulations that require passengers as individuals to comply with crew member instructions** regarding the Fasten Seat belt sign.

(f) **Encouragement of reasonable communication between cabin crew and the flight crew** regarding the use of the Fasten Seat Belt Sign. Cabin crew should feel free to request appropriate use of the seat belt sign, when, in their judgment, the sign should be illuminated or extinguished. Flight crew should be made aware of the reduced effectiveness of the sign when it is not appropriate to the conditions of flight.

5.3 **Flight dispatchers.** The AOC holder should incorporate the following into procedures for flight dispatchers:

(a) **Weather Briefings.** Pre-flight weather briefings, verbal or written, must include forecasts of turbulence and pilot reports of turbulence caused by thunderstorm activity, mountain wave activity, clear air turbulence, low altitude frontal wind shear and low altitude convective wind shear.

(b) **Keep communication channels open full-time.** Flight dispatchers and flight crews should communicate before, during, and after a flight, and should be encouraged to do so whenever necessary. Dispatchers should ensure flight crews are aware of known or forecast turbulence. Communication may resume at any time during or after flight using whatever means available to improve the flow of real-time information regarding turbulence.

6 UTILISING TURBULENCE REPORTING AND FORECASTING SYSTEMS

6.1 There have been significant improvements in turbulence reporting and forecasting. Major advances in data processing and delivery have allowed graphical depictions of weather to be delivered in near real-time, even to flight decks of suitably equipped aircraft. Advanced reporting, forecasting, and delivery of graphics have been promoted by regulator/industry partnerships and by leaders of various organisations.

6.2 **Use all applicable means to collate, compile and make available information**. Continued improvement in turbulence-related weather products requires better handling of real-time information on the state of the atmosphere at any given time. The most promising way to capture and convey this information is through a comprehensive programme of reports from aircrafts in flight. This programme would be founded on automated turbulence reporting supplemented by human reports (AIREPs). Air operators should promote real-time information handling described in the following paragraphs:

(a) Real-time information, airplane-to-ground. The AOC holder is recommended to:

(i) Improve the coverage and objectivity of atmospheric turbulence reports by installations of automated aircraft turbulence downlink systems on all ACARS-equipped aircrafts. The current International Civil Aviation Organisation (ICAO) standard metric for automated turbulence reporting is EDR (eddy dissipation rate).

(ii) Encourage additional reporting of AIREPs by flight crew through operator AIREP awareness campaigns and by training flight crews to follow ICAO established AIREP procedures (Reference ICAO Annex 3).

(iii) Establish communications links and encourage flight crews to deliver the operator “in-house” AIREPs to the ATS units as prescribed in ICAO Annex 3.

(b) **Efficient delivery of current information, ground-to-airplane.** In conjunction with improved turbulence reporting airplane-to-ground, the AOC holder may join industry groups and government organisations to develop faster processing and delivery of current turbulence information ground-to-airplane.

7 OTHER MEASURES

7.1 **Review its history of turbulence encounters and injuries.** Such a review by the AOC holder might shed light on root causes of these encounters and injuries and in turn, show ways to effectively prevent them.

7.2 **Systematically gather current information on turbulence encounters and injuries.** The AOC holder may gather information for review and analysis from a variety of sources such as turbulence reports from crew members, injury reports from cabin crew, post-encounter interviews and other processes.

7.3 Information useful for analysis should include:

(a) Type of aircraft, length, route and phase of flight.

(b) Time of year.

(c) Type of injuries received by passengers and/or crew.

(d) Adequacy of the AOC holder’s procedures, including crew communication and responses.

APPENDIX A TURBULENCE TEMPLATE

The Turbulence Template comprises of two parts:

1 STANDARD TERMINOLOGY FOR TURBULENCE.

May be based on time between two locations or over a single location. All locations should be readily identifiable.

- **DURATION**

  Occasional: Less than 1/3 of the time.

  Intermittent: 1/3 to 2/3 of the time.

  Continuous: More than 2/3 of the time.

- **INTENSITY**

  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 a slight strain against seatbelts. Unsecured objects may be displaced slightly. Food service may be conducted and little to no difficulty is encountered in 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. Food service and walking are difficult.

  Severe: Large, abrupt changes in altitude and/or attitude. Usually causes large variations of indicated airspeed. Aircraft may be momentarily out of control. Occupants are forced violently against seatbelts. Unsecured objects are tossed about. Food service and walking are impossible.

  Extreme: Aircraft is violently tossed about, is practically impossible to control and structural damage may be caused.

- **TYPES OF TURBULENCE**

  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 (CAT): High level turbulence (above 15000 ft) not normally associated with cumuliform cloudiness, typically wind-shear 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.

2 ADOPTING EFFECTIVE PROCEDURES AGAINST TURBULENCE.

The following are suggested standard operating procedures for voluntary implementation by air operators.

- **MAXIMIZE INFORMATION ABOUT YOUR FLIGHT CONDITIONS.**

  - Inform ATC of turbulence at check in with new controller.
  - Inform company via ACARS or dispatch frequency so that following flights will be aware of the flight conditions or be prepared to plan for another route.
  - Inform/query other aircrafts operating in the area on a common frequency.

- **WHEN INFORMED OF TURBULENT FLIGHT CONDITIONS**.

  - Prior to departure, seek alternate routing avoiding the affected areas or delay departure until conditions improve.
  - Change en route altitudes or routes to avoid turbulence.
  - Reduce aircraft speed to the manufacturer's recommended turbulence penetration speed.
  - Prior to descent, seek alternate routing to avoid the affected areas or, if severity dictates, hold or divert to alternate.
  - Seek to avoid convective activity (CBs) en route by at least 20 nautical miles.

- **GENERAL TURBULENCE PROCEDURES AND INJURY AVOIDANCE**

  If flight into forecast turbulence is unavoidable, providing timely notifications to the cabin crew is crucial to their safety.

  Turbulence onset categories are:

  - **Expected Turbulence**: Advance notice exists for the Captain to brief the cabin crew either prior to the flight or in-flight via the interphone.

  - **Little Warning**: Sufficient warning exists to seat the passengers and for the cabin crew to perform their duties.

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

The briefing, prior to, or inflight, for expected turbulence must include:

- Actions the captain wants the cabin crew to undertake any time turbulence is expected.
- Intensity of turbulence expected.
- Methodology for communicating with the cabin the onset or worsening of turbulence, e.g., cabin interphone or PA.
- Phraseology for the cabin crew to communicate the severity of turbulence.
- Expected duration of the turbulence and how an “all-clear” will be communicated.

Utilise a positive signal of when cabin crew may commence their duties after takeoff and when they should be seated and secured prior to landing.

Passengers will be informed of turbulence via the PA system, not on the seatbelt sign alone.

Cabin crew will be informed of turbulence via the interphone.

If at any time the cabin crew experiences uncomfortable turbulence without notice from the flight crew, they must immediately take their seats and inform the flight crew. Similarly, when advised by the cockpit that turbulence is imminent, they must immediately take their seats.

Appropriate announcements from the captain should be made to inform the cabin crew of anticipated turbulence, using SOPs and standard phraseology to guide the cabin crew in their responses.

All service items must be properly stowed and secured when not in use.

APPENDIX B GOOD PRACTICES TO AVOID THUNDERSTORMS AND ATTENDANT TURBULENCE.

The North and South Asia Regional Aviation Safety Teams (NARAST/SARAST) have supported the following practices as measures to prevent thunderstorm penetrations and to mitigate effects of proximate thunderstorms, especially loss of control and turbulence that might cause injury.

These practices are included here for reference by managers and trainers of pilots operating transport category airplanes in commercial aviation, especially those carrying passengers and cabin crews.

These practices are comprised of clear and objective criteria to facilitate recognition of cues associated with severe convective activity and guidance to improve flight crew decision-making.

During flight, use any judicious means to avoid thunderstorms by at least –

- 20 nautical miles at or above flight level (FL) 230
- 10 nautical miles below FL 230

In order to minimise exposure to thunderstorm hazards **when approaching or departing an airport** in an area where thunderstorms are occurring or are forecast;

- Attempt to maintain visual meteorological conditions (VMC).
- Maintain at least 5 nautical miless separation from heavy rain showers.
- Avoid areas of high lightning potential, i.e. clouds within ± 5,000 ft of the freezing level.

Note : Approaches or departures may be accomplished when thunderstorms are within 10 nautical miles. The thunderstorms must not be producing hazardous conditions (such as hail, lightning, strong winds, gust fronts, heavy rain, wind shear, or microburst) at the airport, and must not be forecast or observed to be moving in the direction of the route of flight (to include the planned missed approach corridor, if applicable).