AC 121-2-7(Rev 0)
17 September 2018

Civil Aviation Authority of Singapore

Advisory Circular

MANAGEMENT OF LITHIUM BATTERIES IN THE AIRCRAFT PASSENGER CABIN

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 related to, the requirements on the management of the carriage of carry-on devices or portable electronic devices, (PEDs) containing lithium batteries and/or standalone lithium batteries in the passenger cabin and to address the serious possibility of in-flight fires involving these devices containing lithium batteries or standalone lithium batteries.

APPLICABILITY

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

RELATED REGULATIONS

This AC relates specifically to Regulation 21 of ANR-121.

RELATED ADVISORY CIRCULARS

- AC 121-2-1 Guidance on Operational Procedures for ANR-121 Operations
- AC DGR-2 Guidance for Carriage of Lithium Batteries by Air

CANCELLATION

This AC supersedes AC AOC-5.

EFFECTIVE DATE
This AC is effective from 1 October 2018.

OTHER REFERENCES
- Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods (Doc 9481) and CAAS AC DGR-2.

1 BACKGROUND

1.1 In recent times, the use of PEDs by passengers has exponentially increased with the worldwide relaxation of rules on PED use. Similarly, AOC holders, in light of the changes in regulations regarding PED use, can, with an approval from CAAS, provide PEDs to passenger for use as entertainment devices and to their crew for in-flight operational use.

1.2 The carry-on devices or PEDs brought on board flights which include laptop computers, some children's toys/games, mobile phones, portable electronic tablets, readers, point-of-service devices and games are mostly installed with lithium batteries and so by virtue of this symbiotic connection, there is concurrently an increase in the presence of lithium batteries in the passenger cabin. With this, it is important to acknowledge that the lithium batteries contained in these devices can pose a fire hazard and therefore could result in an increased risk of a battery fires.

1.3 The aim of this AC is to provide guidance to the AOC holder when developing procedures and training programmes with regard to the effective methods to manage the carriage of PEDs in the passenger cabin and to provide guidance with regard to developing means and procedures to deal with the possibility of in-flight fires caused by PEDs powered by lithium batteries.

2 MANAGEMENT OF THE CARRIAGE OF PORTABLE ELECTRONIC DEVICES IN THE PASSENGER CABIN

2.1 An AOC holder should establish and ensure the safe management of PEDs and incorporate safety policies and procedures in the operations manual. These procedures should include cabin crew responsibilities in normal, non-normal and emergency circumstances. The AOC holder should also inform the passengers of the precautions and limitations involving the use of PEDs.

2.2 Operator-Provided PEDs for Passenger and Crew Use

If the AOC holder intends to carry PEDs powered by lithium batteries as in flight entertainment devices or for crew's operational use, the AOC holder needs to ensure the safe use of such PEDs on their aircraft. The AOC holder should ensure that:

(a) CAAS' approval is sought for the use of such PEDs, (e.g. e-tablets) for operational needs such as the uploading of aircraft manuals, flight documents, service management, etc. and/or as part of in-flight entertainment for passengers' use.

(b) Approval conditions are adhered to and the AOC holder should update and seek CAAS' approval for any changes in implementation conditions of the approval as this may have an impact on the conditions of carriage and stowage especially if spare lithium batteries are carried.

(c) Both flight and cabin crew are briefed on all responsibilities and trained on the procedures for ensuring the safe use of PEDs.

(d) Safe stowage of these PEDs. There should not be more than 2 operator-provided e-tablets stowed at each enclosed location. This is to mitigate the possibility of consecutive thermal runaway of the lithium batteries powering the electronic devices.

(e) Each location must be certificated to be able to hold the weight of the e-tablets along with other contents intended to be stored at that location.

(f) The containers and/or drawers used to store multiple PEDs are able to contain a lithium battery fire that may be generated from PEDs.

(g) If operator-issued PEDs are protected with a sleeve or cover, the materials used for the fabrication of the sleeve or cover must be demonstrated to meet the flammability requirements (commonly known as 14 CFR 25.853 – Compartment Interiors or CS 25.853 – Compartment Interiors).

2.3 Carriage of Personal PEDs by Crew and Passengers

The AOC holder should ensure that all passengers and crew are aware of the conditions of carrying PEDs and their spare batteries. Generally, the AOC holder should:

(a) Ensure crew and passengers know that the spare batteries of their lithium battery-powered PEDs should not be packed in their check-in baggage and that spare batteries should be individually protected so as to prevent short circuits. For more information, refer to AC DGR-2.

(b) Provide supplementary information on the precautions and appropriate management of these PEDs powered by lithium batteries and/or general standalone lithium batteries. Information on the AOC holder's policy should be provided to the travelling public prior to flight, in flight, before/after landing.

(c) Establish procedures to ensure that passengers do not charge their PEDs during take-off and landing.

(d) Ensure that passengers are discouraged from leaving their PED unattended while it is plugged into the aircraft's electrical power supply for charging purposes. Unplugging the devices from the aircraft electrical power supply may help to minimise the risk from a battery overheat/fire that may be also exacerbated by charger fault.

(e) Ensure that passengers stow their PEDs properly so that inadvertent overheating and electrical shorting may be avoided. Crews are to be vigilant in their cabin checks to ensure PEDs are not stowed precariously so that the PEDs might inadvertently fall in between passengers' seats and get crushed during seat movement.

(f) Establish procedures that require:

(i) Ground staff and cabin crew to alert passengers to remove spare lithium batteries from their carry-on baggage before off-loading carry-on baggage that is too big to be stowed in the passenger cabin.

(ii) Whenever passengers inform cabin crew that they have spare lithium batteries in their checked baggage, cabin crew should immediately:

(1) Bring this to the attention of the ground staff, if the aircraft has not yet departed.

(2) Report the information regarding the spare lithium batteries to the flight crew, if the aircraft has been pushed back or is in flight.

(g) The AOC holder should develop safety procedures to manage the possibility of thermal runaway of the lithium batteries installed in the PEDs containing lithium battery(ies) or any standalone lithium battery(ies) that could lead to an on-board fire.

3 CHARACTERISTIC OF LITHIUM BATTERY FIRES

3.1 A failure of the PED's built-in over-charging protection features might lead to its lithium battery catching fire. While most PEDs have three levels of protection, multiple failures in the protection system are not completely impossible. Although the probability of such a fire in-flight is considered to be extremely low, it should be viewed as a potential risk and treated as a hazard to an aircraft during any phase of operation.

3.2 Batteries pose a unique hazard during transport because they contain stored energy, which if released through a short circuit, is capable of causing a fire. A battery may catch fire while not in use and if exposed contacts are connected or shorted by a conductive material such as a coin or key stowed in the same bag as the battery. Note that fires may re-ignite even after a lapse of time. Expansion of the battery and increase in its temperature are some warning symptoms of an impending battery fire.

3.3 Some devices such as laptop computers, e-tablets, mobile phones and video cameras use battery packs of multiple cells. During a fire involving such battery packs, the individual cell may catch fire over a period of several seconds rather than a simultaneous combustion of all cells.

3.4 Testing conducted by the FAAs Technical Centre has shown that halon is ineffective against lithium battery fires. Therefore, this type of fires requires a combined use of halon for flame suppression and the use of water or any non-flammable liquid to impede the heat promulgation capabilities of lithium batteries.

4 HANDLING LITHIUM BATTERY FIRES IN PASSENGER CABIN

4.1 If a battery fire does occur, there exists a harmful risk of excessive smoke inhalation by passengers and crew members. Additionally, panic can be expected among passengers from the sight of the fire or the smell of burning plastic.

4.2 When fighting a battery fire, one should be mindful that the fire may still be propagating from one cell to another. Hence, appropriate protective equipment should be worn.

4.3 A lithium battery-related fire should not be treated as a Class D (combustible metals) fire. Fighting a fire that contains lithium batteries requires the following considerations:

(a) If a battery fire is suspected, the power to ALL recharge points should be turned off as quickly as possible (preferably before deploying any fire extinguishers).

(b) As discussed in paragraph 3.4, although halon may not be effective by itself, the use of halon or FE-36 halon replacement extinguishers is more appropriate than using water alone for such fires and should be used first, if a choice is available. Halon will suppress fires around the surrounding flammable material and/or prevent its ignition.

(c) Besides the standard emergency procedures that are used to deal with on-board fires, the following steps should be considered particularly for lithium battery related fires:

(i) **Removal of External Electrical Power from Device (if applicable)** - This should be done in the earliest time possible as a battery is more likely to catch fire through thermal runway during or immediately following a charging cycle. By removing the external power supply from the device, it will be assured that additional energy would not be fed to the battery to promote a fire.

(ii) **Removal of Power to Remaining Electrical Outlets** - By doing this, the aircraft's system is assured to be free of faults, especially if the device was previously plugged in when the incident of smoke or fire happened. Additionally, if there is a malfunctioning aircraft system, it will not contribute to additional failures of other passengers' portable electronic devices.

(iii) **Douse Device with Water (or other Non-Flammable Liquid)** - This is required to cool the cells and prevent adjacent cells from overheating and igniting. This could cause the battery pack to further reignite multiple times due to the heat transfer to other cells in the pack. Monitor the battery for re-occurrence and continually cool the device with non-flammable liquids. The following should be considered:

(1) When attempting to cool the device, DO NOT cover the device with ice as this would only insulate the device increasing the overheating of it and resulting in thermal runway.

(2) Caution should be exercised by the crew not to use liquids on, or in the immediate vicinity of any other piece of electrical equipment.

(iv) **Do Not Move Device -** Do not pick up and attempt to move a burning device or a device that is emitting smoke as flames may suddenly ignite or reignite multiple times as heat is transferred to other cells in the battery pack within the device. It is advisable to cool the device using water (or other non-flammable liquid); injuries may occur if the device reignites while it is being moved.

(v) **Collate Information** – Procedures should be established for the crew to provide as much information as possible that may be required for thorough investigation to the incident. As a guide, the following should be the type of initial information that could be collated by the crew:

(1) What was the manufacturer and model number of the device?

(2) Was the battery pack supplied by the device manufacturer or a third party?

(3) Was the device repaired recently and was it by an authorised repair facility?

(4) Was the battery being charged when the fire started?

(5) Was the charging cable supplied by the airline or the passenger?

4.4 The AOC holder should assign pre-landing responsibilities and procedures for both their flight and ground staff with regard to the management of an in-flight fire involving a PED.

4.5 The AOC holder should also develop post-incident procedures for the handling of the PED or lithium battery that has been involved in a fire or smoke event. In developing the procedures, the AOC holder should consider whether a device involved in a fire or smoke incident, under certain conditions, could be returned to the passenger in flight and/or be allowed to continue on the flight with the passenger (owner) or that it should be removed from the aircraft at the first point of landing, the reason being that some battery cells that were damaged may still be charged and affected and could potentially go into thermal runaway again. AOC holders should also note the following when developing post-incident management procedures:

(a) Some authorities may require the device to be placed in quarantine while awaiting the arrival of investigative authorities. Hence, considerations should be made to retain the affected device until all investigations have been completed by the investigative authorities.

(b) The device manufacturer may also require the device so that they can conduct a failure analysis to determine the cause if it was so determined by the investigation.

5 CREW TRAINING

5.1 The AOC holder should re-emphasise the procedures and processes to all flight and cabin crew members. In managing the use of PEDs in the passenger cabin, there should be the particular highlight of preventive measures such as vigilance and thorough cabin checks before take-off and before landing as well as thorough in-flight cabin checks ensuring devices powered by lithium batteries are not being improperly charged, covered under blankets or placed precariously on chair-tables or seats.

5.2 The AOC holder should emphasise in their crew training that fires related to PEDs or stand-alone lithium batteries differ from other types of fires and require specific crew responses to safely manage them. The fire-fighting procedures and processes should include specific aspects for the management of PED fire/smoke occurrences, including how cabin crew should handle and stow the affected devices.

6 ACTION BY THE AOC HOLDER

6.1 The AOC holder may refer to information provided in this AC when developing procedures for crew in the management of the carriage of PEDs in the passenger cabin

6.2 For information on the types and quantities of lithium batteries permitted to be carried by crew and passengers in their baggage, the AOC holder may refer to CAAS AC DGR-2 – Guidance for the Carriage of Lithium Batteries by Air as well as the *Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods (Doc 9481)* when developing procedures in handling of fires involving any PED or standalone lithium batteries.

6.3 Report to CAAS of events or anomalies related with the use of lithium battery(ies) and/or standalone lithium battery(ies) in the passenger cabin during any phase of flight.

7 CONTACT INFORMATION

7.1 Should you have any queries relating to the above, please contact CAAS at CAAS_AFO_Infocenter@caas.gov.sg.