Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Aid to Operators for the Expanded Use of Passenger PEDs	**AWB**	23-003	**Issue** :	2
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1. Applicability

This Airworthiness Bulletin (AWB) applies to operators that carry passengers in charter and regular public transport operations.

2. Purpose

This AWB provides guidance for operators in the management of the use by passengers of Personal Electronic Devices (PEDs) and is divided into three basic areas:

- The expanded use of PEDs in all phases of flight and it details:
  - The assessment of the suitability of an aircraft for passengers to use PEDs more broadly than the cruise phase of flight.
  - Guidance on establishing operational policy and procedures, and training of pilots and cabin crew on dealing with PEDs.
- Providing guidance on the treatment of PEDs as loose objects in the aircraft cabin.
- Providing guidance on the use of PEDs by passengers moving airside.

3. Background

CASA does not have a regulation that specifically prohibits the use of PEDs in an aircraft, but requires that the operator ensure that the aircraft is operated safely. With the expanded use of PEDs e.g. ebook readers, tablet computers etc. in virtually all sectors of the community, the demand to extend that use during flight has increased. This expansion has identified a need to evaluate potential issues with this increase and provide appropriate guidance.

In January 2013, the US Federal Aviation Administration (FAA) established an Aviation Rulemaking Committee (ARC) to provide a forum for the aviation community and government regulatory groups to review policy and guidance related to PEDs. The ARC was tasked with making recommendations on allowing passengers to operate PEDs outside the cruise phase of flight. In October 2013, the FAA published “Information for Operators” InFO 13010 on the subject of Expanding Use of Passenger Portable Electronic Devices (PED). InFO 13010 does not address the use of mobile telephones on aircraft. In December 2013, the European Aviation Safety Agency published similar guidance material.

In February 2014, the FAA published a supplemental document to InFO 13010 called InFO 13010SUP “FAA Aid to Operators for the Expanded Use of Passenger PEDS”. This supplement was published to assist operators to assess the ability of their aircraft to tolerate the low-power RF transmissions likely to be made by passengers’ PEDs.

The supplement presents a five-step process to be taken by US operators:

1. Aircraft PED Immunity
2. Analysis and Mitigation
3. Establish Expanded Use
4. Operational Policy & Procedure
5. Pilot & Flight Attendant Training.

The content of that supplement has been adapted for Australia in this AWB.

Experience in Australia and other countries has identified that PEDs can be a significant hazard if not secured in certain phases of flight or in cases of turbulence. Injuries have been reported by passengers being struck by PEDs during turbulence events.

Additional research has shown that the use of PEDs can be distracting. Guidance is provided in this AWB for those operators that require passengers to transit airside outside of terminal buildings.

4. Recommendations

It is recommended that operators of passenger-carrying services who wish to allow passengers to use PEDs more broadly than the cruise phase of flight should use this AWB to assess their aircraft and obtain guidance on what extra phases of flight might be available for passengers to use PEDs.

Operators should be aware that there are other important cabin safety and airside management issues that must be considered before final approval can be given to expand the use of passenger PEDs.

PED Weight Limitation

Paragraph 9.3 of Civil Aviation Orders (CAO) 20.16.3 specifies that solid articles must be placed in approved stowage at all times when seat belts are required to be worn. See Appendix B of this AWB for analysis supporting 1 kg as the maximum mass of PEDs that are safe to be secured. See Appendix A of this AWB for information on stowage of large items.

Appendix D provides guidance on the need for operational policies and procedures for the use of passenger PEDs whilst airside transiting to or from the terminal building.

Aircraft PED Immunity

There are two mechanisms by which PEDs may interfere with aircraft systems, these are:

a) Front-Door Interference Assessment

Front-door interference is interference caused by aircraft antennae absorbing electro-magnetic radiation from a PED.

b) Back-Door Interference Assessment

Back-door interference is interference caused by electro-magnetic radiation from a PED being absorbed by aircraft cables, wires or looms.

Aircraft PED Tolerance to Back-door Interference

Back-door interference is interference caused by electro-magnetic radiation from a PED being absorbed by aircraft cables, wires or looms.

Transmitting PEDs (T-PEDs) are widespread among passengers and crewmembers, take many forms, and have many functions. In many cases, the transmitting radio is embedded in a T-PED so that the operation of the radio transmitter is not apparent to the T-PED user. These T-PEDs operate in many frequency bands and with a wide range of transmitted RF power. Table 1 lists common T-PEDs and associated transmitting power.

COMMON T-PEDS AND ASSOCIATED POWER	
Device	**Transmitted RF Power**
Hand-held mobile phones	500 mW to 2 W
Wireless RF network transceivers	10 mW to 1 W
Consumer hand-held walkie-talkies	500 mW to 5 W
Wireless personal digital assistants	500 mW to 2 W
Hand-held amateur radio transmitters	500 mW to 7 W
Automobile keyless entry controllers	50 mW or less
Airline operations hand-held radios	1 W to 6 W

Table 1: Common T-PEDs and Associated Power

The aircraft RF environment produced by T-PEDs differs from the aircraft RF environment associated with High Intensity Radiated Fields (HIRF). The major differences are:

- Transmitting PEDs may operate very close to aircraft systems and wiring, within the aircraft cockpit, cabin, and baggage areas, while HIRF transmitters operate some distance outside the aircraft.

- Aircraft fly through the maximum HIRF RF levels in a few seconds, while the T-PEDs operate within the aircraft over a relatively long time frame.

HIRF transmitters are typically very high powered transmitters in specific geographic locations outside the aircraft, while T-PEDs may be operated in many locations within the aircraft, including the cabin, cockpit and baggage or cargo compartments.

What methods can be applied to address HIRF, PED and T-PED threats?

- The existing FAA regulations for HIRF, detailed in the United States Federal Aviation Regulations 23.1308, 25.1317, 27.1317 and 29.1317 were released in 2007. Current HIRF rules apply to systems that have potential failure conditions of Major, Hazardous and Catastrophic.

- The HIRF requirement is based on transmitters located outside the aircraft. Previous HIRF, special conditions only applied to systems whose failure or malfunction would prevent continued safe flight and landing of the aircraft. It should be noted, however, that the majority of aircraft certified since 1989, also were certified to the JAA/EASA special conditions, which required compliance to Major, Hazardous and Catastrophic failure conditions, in similar fashion to the existing rule.

- “RTCA/DO-307: Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance” has been released by the RTCA and is referenced by FAA AC 20-164 “Designing and Demonstrating Aircraft Tolerance to Portable Electronic Devices”. CASA accepts these documents as appropriate guidance material for HIRF-related certification.

Demonstrated aircraft systems PED tolerance to back-door effects show that the installed electrical/electronic systems that perform Required, Major, Hazardous and/or Catastrophic functions are able to perform their intended functions in the presence of RF environment created by T-PEDs, during all non-critical phases of flight. This would allow for operators to treat T-PEDs the same as they would treat non-transmitting PEDs, in accordance with FAA AC 91-21.1B.

Assessment of Aircraft PED Tolerance to Back-door Interference

RTCA/DO-307 provides guidance that if the aircraft's electrical and electronic systems and wiring are separated from potential locations of T-PEDs by 1 metre or more, then RF susceptibility tests on the equipment or systems performed in accordance with RTCA/DO-160E Section 20 Category R, are considered acceptable procedures and test levels for this demonstration. If the aircraft electrical and electronic systems and wiring are separated from potential locations of T-PEDs by less than 1 metre, then RF susceptibility tests on the equipment or systems performed in accordance with RTCA/DO-160E Section 20 Category W, are considered acceptable procedures and test levels for this demonstration. The tests may exclude test frequencies above 8 GHz.

The following table is taken directly from Section 3 of RTCA/DO-307 and provides the back-door effects test requirements, based upon system criticality.

Classification of system	Distance between T-PED and system LRU > 20 cm	Distance between T-PED and system LRU < 20 cm
Catastrophic	ED-14E / DO-160E, Section 20, Cat. R	ED-14E/DO-160E Section 20, Cat. W, limited to 8 GHz
Hazardous	ED-14E / DO-160E, Section 20, Cat. R	ED-14E / DO-160E, Section 20, Cat. R
Major	ED-14E / DO-160E, Section 20, Cat. R	ED-14E / DO-160E, Section 20, Cat. R
Required by regulation	ED-14E / DO-160E, Section 20, Cat. R	ED-14E / DO-160E, Section 20, Cat. R

Table 2: RTCA/DO-307 Section 3 -Aircraft System RF Radiated Susceptibility Test Recommendations

Section 3 of RTCA/DO-307 discusses the relationship between HIRF protection requirements and PED tolerance to back-door interference effects. PED tolerance is accomplished by ensuring that all equipment that performs functions that are listed in the "Classification of system" column of the above table have been qualified by test/analysis to the requirements, given in the second and third columns. Both RTCA/DO-160E and the HIRF User's Guide[1] provide procedures that can be utilised for these types of tests. Note that RTCA/DO-160 is currently at version G.

[1] HIRF User's Guide, "Guide to Certification of Aircraft in a High-Intensity Radiated Field (HIRF) Environment" is available in SAE ARP 5583a. http://www.sae.org/technical/standards/ARP5583A

Level of HIRF Protection

The following process should be followed to determine the level of HIRF protection applied to your aircraft:

1. Find the Type Certificate Data Sheet (TCDS) for the make and model of aircraft being assessed.

2. Check the type Certification basis for the aircraft make and model.

   Does the certification basis include Amendment Nos. 23-57, 25-122, 27-42 or 29-49?

   YES – The aircraft incorporates the necessary HIRF certification levels. No further review is necessary unless the aircraft has been modified or repaired and the possibility exists that it no longer complies with the above amendment.

   NO – Proceed to step 3.

3. Search the TCDS for HIRF Special Conditions.

   Is there a HIRF Special Condition listed for your make and model?

   YES – Record the number of the Special Condition. Review the Special Condition to ensure it covers electrical and electronic systems. If it does, proceed to step 6. If not, proceed to step 5.

   NO – Proceed to step 4.

4. Is there a HIRF Special Condition applicable to aircraft electrical and electronic systems for your make and model of aircraft?

   YES – Record the number of the Special Condition and return to the TCDS for your make and model. Search the TCDS to verify that the Special Condition is listed for your aircraft. If it is, proceed to step 6. If not, proceed to step 5.

   NO – Proceed to step 5.

5. Is there a HIRF Special Condition applicable to a specific critical electrical or electronic system on your make and model of aircraft?

   YES – Record the number(s) of the Special Condition(s), and the system(s) covered. Proceed to step 6.

   NO – Proceed to step 7.

6. Review your critical aircraft systems to determine if any electrical or electronic system(s) was type-certificated with a Hazard Class (failure condition) of “Catastrophic”.

   Does a Special Condition cover your critical system(s)?

   YES – The critical systems are adequately covered for PED tolerance to back-door interference. No further review is necessary unless the aircraft has been modified or repaired and the possibility exists that it no longer complies with the above amendment.

   NO – Proceed to step 7.

7. The critical systems for your aircraft cannot be determined to be PED tolerant to back-door interference based on HIRF certification. Testing and analysis for critical systems (those certified with a catastrophic failure effect) to ensure PED tolerance to back-door interference must be (or have been) accomplished.

A. AIRCRAFT PED IMMUNITY

The following checklists (copied from FAA InFO 13010SUP) can be used to record the results of assessments of the aircraft's immunity to back-door and front-door interference. The results are to be used in section B "Analysis and Mitigation".

A.1 Back-door Interference Assessment

Back-door interference is interference caused by electro-magnetic radiation from a PED being absorbed by aircraft cables, wires or looms.

Describe HIRF certification basis and/or subsequent PED immunity demonstration. Check if YES. See "Level of HIRF Protection" above for the detailed process.

PED Tolerance Qualification		
☐	1. Aircraft that meet RTCA/DO-307 Section 3 *Aircraft System Tolerant to Intentionally Transmitting PEDs, Back- Door Coupling*	No further back-door analysis required.
☐	2. PED tolerance demonstration documented following testing associated with the installation of a wireless local area network – or – similar capability. • At installation, other systems may have received additional testing beyond that of a Hazard Classification of Catastrophic, but the documentation was not required for certification. • Back-door interference tolerance is provided for the frequency ranges tested. Significantly different frequency ranges require additional testing.	No further back-door analysis required.
☐	3. PED tolerance demonstration testing and analysis done using other acceptable methods. Test must be comprehensive and operator must have data to support the testing. • PED testing in support of previous PED use allowance determination, such as WiFi system of cell phone testing done to support in-flight use, may be acceptable. Must be supported by assessment of critical systems in the expanded phase of flight to ensure the previous testing covered these systems. • Back-door interference tolerance is provided for the frequency ranges tested. Significantly different frequency ranges require additional testing.	No further back-door analysis required.

HIRF Qualification			
☐	4.	Aircraft type certificated or system installed that meets FAA or EASA HIRF Regulations. (Follow decision flow chart in “Level of HIRF Protection” above.) *Meeting HIRF specifications, Special Conditions (e.g. 25-302-SC), or regulations* • Catastrophic systems have been tested at a minimum. • Operational Required equipment has not been tested. • At certification, other systems may have received additional testing but the documentation was not required.	No further back-door analysis required.
☐	5.	Aircraft Type Certificated or system installed prior to HIRF Regulatory Specifications in effect in 1987. *Aircraft certified prior to 1987 do not have verified RF immunity.* • Compliance to RTCA/DO-307 has not been met. • At certification, other systems may have received additional testing but the documentation was not required.	Back-door tolerance not demonstrated. Additional assessment or test required.

A.2 Front-door Interference Assessment

Front-door interference is interference caused by aircraft antennae absorbing electro-magnetic radiation from a PED.

Appendix F- *Functional Hazard Risk Assessment (FHRA)* of the FAA ARC report contains a safety risk assessment for operators to aid in assessing the avionics configuration of their fleet, and the failure modes associated with different types of communications and navigation equipment with respect to electromagnetic interference. The FHRA outlines mitigations and controls that the operator needs to adopt to expand PED use into various phases of flight.

☐	1.	Aircraft that meet RTCA/DO-307 Section 4 *Aircraft systems tolerant to unintentional emissions from PEDs, Front-Door Coupling*	No further front-door analysis required.
☐	2.	Aircraft system function with Catastrophic, Hazardous or Major failure condition (see risk assessment, “Hazard Class” column) documented to meet the interference path loss requirements of RTCA/DO-307/DO-294. *Documented system tolerance to unintentional emissions from PEDs, Front-Door Coupling*	No further front-door analysis required.
☐	3.	Aircraft system function with Catastrophic, Hazardous or Major failure condition (see risk assessment) **NOT** documented to meet the interference path loss requirements of RTCA/DO-307/DO-294.	Must mitigate risk and apply controls. Risk assessment actions required for Catastrophic.

B. ANALYSIS AND MITIGATION

The table below applies the results (from section A) of the assessment of both front-door and back-door PED tolerance and determines the phases of flight where PEDs can remain ON and be used. Step 1 uses answers to questions in the above section "Level of HIRF Protection".

STEP 1: Back-Door Tolerance Which questions in "Level of HIRF Protection" are checked YES?		**STEP 2: Front-Door Tolerance** Which rows in Section A 1.2, Front-Door interference, are checked YES?		**STEP 3: Acceptable Phases of Flight** Tally the results. A "YES" in STEP 1 and a "YES" in STEP 2 means that this phase of operations is permitted. **Check permitted phases below:**	
A "YES" to any of the Questions 1 – 4 results in a YES, below for all phases of operation:	A "YES" to ONLY Question 5 will require additional assessment or testing for certain phases of operation:	A "YES" to Questions 1 or 2 results in a YES, below:	A "YES" to ONLY Question 3 will require risk assessment, and mitigations/controls.		
Yes	Yes	Yes	Yes	**Parked:** Passenger boarding and seating to door close.	☐
Yes	Yes	Yes	Yes	**Taxi Out:** Push back, taxi from gate to (but not including on) the runway.	☐
Yes	No See Note 1	Yes	Yes	**Take-off & Departure:** Take-off transition to climb altitude/or gear-up.	☐
Yes	Yes	Yes	Yes	**Climb:** From 'transition to climb altitude' and/or gear retraction to through 10,000 ft AGL and onto cruise altitude.	☐
Yes	Yes	Yes	Yes	**Cruise:** (currently authorised)	☐
Yes	Yes	Yes	Limited See Note 2	**Descent:** From top of descent through 10,000 ft AGL to IAF and/or flaps.	☐
Yes	No See Note 1	Yes	Limited See Note 2	**Approach:** From IAF to visual reference or landing.	☐
Yes	Yes	Yes	Yes	**Landing & Taxi to Gate:** Begins at aircraft touchdown, and concludes when aircraft is parked for passenger unloading.	☐

Note 1: NO

Additional analysis and/or testing of avionics or electrical systems that have major, hazardous or catastrophic failure effects as certified must be done to address back-door PED tolerance.

Note 2: LIMITED

Examine the FAA AR report, Appendix F, and specifically the tables starting on page F-37.

1. Reference the 'Phase of Flight' column and look for a '6' or '7', 'Descent' or 'Approach' respectively.
2. Identify the Avionics Systems, the failure modes that have been presented with respect to EMI. Apply the necessary mitigations and controls as indicated, at a minimum for those items with a "Hazard Class" at certification of 'Catastrophic', 'Hazardous' or 'Major'.
3. For operations (such as CAT II or CAT III), where the Hazard Classification is 'Catastrophic', the listed Mitigations and Controls are mandatory.

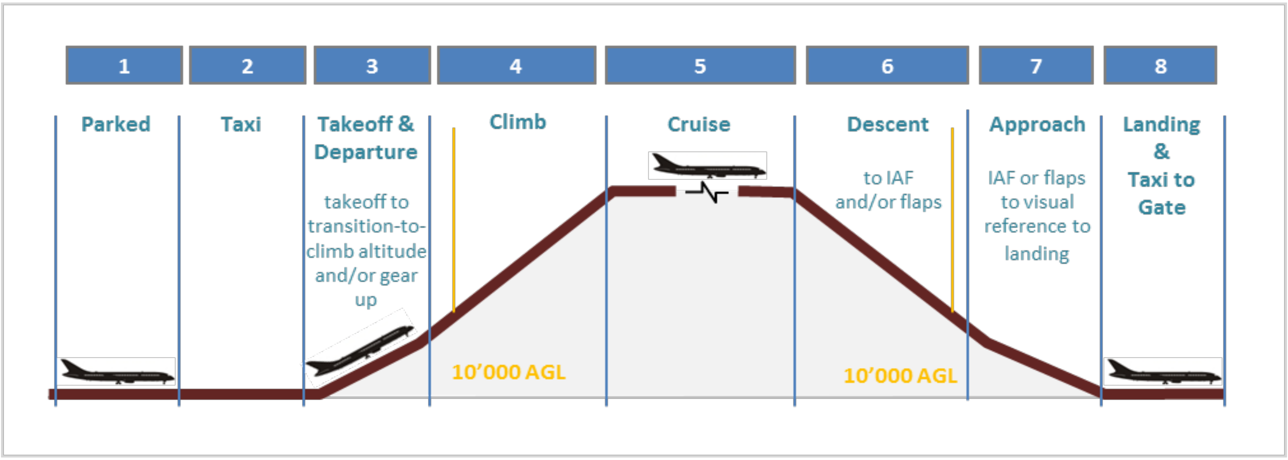

Table 3: Phase of Flight

C. OPERATIONAL POLICY AND PROCEDURES

The following checklist provides a list of key elements that should be present in an operator's policy and procedures in order to safely implement the expanded use of PEDs.

1.	PED SECURING AND STOWAGE (See also Appendix B of this AWB) During take-off, landing and other critical phases of flight, the operator has policy and procedure to ensure PEDs are properly secured or stowed.	☐ Complete
2.	RISK MITIGATION: Suspected or Confirmed EMI event Operational procedures exist for a crew to recognize, respond and report transient or intermittent problems and suspected or confirmed EMI events. Note: As a minimum, record the time, effect on aircraft, aircraft location and phase of flight, suspected PED make, model, location, actions taken, and effect of action taken.	☐ Complete
3.	SAFETY PROGRAM DATA COLLECTION AND REPORTING: Operator has policy and procedure related to the reporting of events or anomalies associated with passenger PED use. Reportable items include but are not limited to passenger disruption, suspected or confirmed electromagnetic interference, and smoke or fire from a PED or battery.	☐ Complete
4	OPERATIONAL POLICY AND PROCEDURES (See Appendix C of this AWB) Operator has amended their operation manuals and associated documentation to reflect changed procedures in relation to the use of PEDs e.g. checklists, passenger safety cards, passenger briefing material, signage.	☐ Complete
5	OPERATIONAL POLICY AND PROCEDURES FOR PED USE WHILST AIRSIDE (See Appendix D of this AWB) Operators should also amend their existing procedures, considering the adequacy of facilities and safety devices used for the guidance and protection of passengers, before changing their policy to allow the use of PEDs while transiting to and from the aircraft.	☐ Complete

D. PILOT AND FLIGHT ATTENDANT TRAINING PROGRAM

The following checklist provides the key elements that should be present in an operator's training program in relation to airworthiness of the aircraft and Cabin Safety training requirements in order to safely implement the expanded use of PEDs.

The operator's training program for pilots and flight attendants should describe how to manage scenarios such as suspected or confirmed electromagnetic interference, smoke or fire from a PED or battery, and other similar scenarios.	☐ Complete
The operator has revised training programs to support the operational policy and procedure changes, and has ensured that crew and all other relevant personnel are adequately trained and proficient to perform their duties and responsibilities. This is evident in: • an initial training program • a recurrent training program • any other relevant training program which may specifically address these changes.	☐ Complete

5. References

http://www.faa.gov/about/initiatives/ped/

https://www.easa.europa.eu/personal-electronic-devices.php

RTCA/DO-294 "Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDs) on Aircraft"

RTCA/DO-307 "Aircraft Design and Certification for Portable Electronic Devices (PED) Tolerance"

FAA Advisory Circulars at http://rgl.faa.gov

6. Enquiries

Enquiries with regard to the content of the AWB should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

Airworthiness and Engineering Standards Branch
Standards Division
Civil Aviation Safety Authority
GPO Box 2005, Canberra, ACT, 2601

Appendix A

Securing and Stowing Passenger PEDs

PED – Stowed vs Secured

There is an important distinction that needs to be made between “stowing” and “securing” PEDs. If a PED is to be “stowed”, it must be placed into an approved carry-on stowage location. These locations have been designed and certified to comply with the requirements for retention of articles of mass during emergency landings. Approved carry-on stowage locations have specific weight and size limitations. When a PED is “secured”, it is restrained by a method which may not have been certified for retention of articles of mass to the emergency landing load limits. The following elements from the FAA PED ARC Stowage Policy Subcommittee identify several considerations for inclusion in an operator’s policy for stowing and securing PEDs:

1. Large PEDs (such as full-size laptop computers) must be stowed in an approved carry-on stowage location, and not present an undue hazard in the event of severe turbulence, crash forces or emergency egress. Large PEDs are those that the operator has determined have a mass more than 1 kg or are of a size that would impede egress. See Appendix B of this AWB for analysis supporting 1 kg as the maximum mass of PEDs that are not safely stowed in approved stowage locations.

2. Small PEDs must be stowed or secured at all times when seat belts are required to be worn. Passengers who do not wish to stow their PEDs should be encouraged to secure them on their person, such as in a garment pocket. Passengers may also secure small PEDs by placing them in seat pockets or holding them in their hands. A PED should not be left unsecured on an empty seat.

3. Seat back pockets are generally designed to hold a maximum of 1½ kg. The passenger safety card, magazines, other literature and air sickness bag account for approximately ½ kg. When an operator conducts a safety risk assessment to determine an acceptable weight limit for the seat pocket, these items should be taken into account. As a general “rule of thumb”, small PEDs and any other personal items placed in the seat back pocket should not exceed a total mass of 1 kg and should not protrude to the point of impeding egress. The FAA provides additional guidance for US air carriers in InFO 09018.

4. PED cords or accessories must not impede emergency egress.

5. PED policy must discourage passengers from getting up from their seats to access the overhead storage bins or other stowage areas at a point in time that would present a hazard to themselves or the passengers around them.

Appendix B

Solid Articles Analysis

Solid articles are required to be stowed at appropriate times as required by Section 9.3 of CAO 20.16.3. Operators are proposing to allow passengers to hold certain sized objects during takeoff and landing based on recently revised FAA guidelines. Of particular importance to the analysis is PEDs.

The following analysis uses simple techniques and literature reviews to draw conclusions about what may be an appropriate sized object to be hand-held for takeoff and landing based on acceptable injury potential. It is generally regarded that people cannot hold on to any size object during an accident or extreme turbulence due to the effect of their mass, flailing and startle. Therefore, this analysis concentrates on the injury potential of the loose object.

Alexander Radi, a Doctorate student from Monash University, conducted an analysis of human injury potential by Remotely Piloted Aircraft (RPA) for CASA in 2013. The analysis methodology is repurposed here for a solid article (PED) head strike that may occur during an aircraft impact sequence.

The simplified analysis technique contains limitations. Limited orientations of the PED striking the person will be assessed. Additionally only one injury mechanism will be evaluated; the risk of skull fracture resulting from the impact of the PED. Analysis using Transport category design standards will be employed. The results are equally applicable to General Aviation fixed wing and rotorcraft operations due to similar velocities changes used in design standards for Emergency Dynamic Landing conditions.

Recommendations regarding a maximum mass limit for solid articles will be made.

1. Reapplication of Human injury model for small unmanned aircraft impacts

Radi does not consider concussion or neck injuries in the head impact analysis which is a limitation for this purpose, as it rules out one measure of incapacitation that is likely to be critical for an evacuation. However, the focus on skull fracture is one of numerous appropriate injury measures. These calculations use Blunt Criterion (BC) as adopted by Raymond, et al., (2009) to measure head injury potential, developed for the design of non-lethal munitions. Where the impacting object has a contact area of less than $6cm^2$, it is likely to penetrate the skull rather than suffer compressive fracture. As the impactor moves from a small size (diameter) up to a larger size, the required force/energy to generate a skull fracture increases. Therefore, a flat plate represents the highest energy required to cause injury. The measure is a 50% chance of skull fracture which is an Abbreviated Injury Score (AIS) of 3 and represents an 11% chance of fatality.

Analysis conducted by Radi does not handle small impacting objects (penetrating injuries) which may be associated with an edge-on or corner PED strike. However, it is entirely appropriate for a flat sided strike by using the flat plate extension of the analysis.

For an inelastic collision, the Conservation of Momentum and Energy are required. Assuming the PED and head move together (or at similar speeds) after the collision, a fraction of the impacting object energy is converted into kinetic energy for both objects. The remaining energy is deformational energy, assumed to occur with the head (a PED is rigid and strong particularly edge on). The fractions of kinetic and deformational energy are related to the relative sizes of the impacting and hit objects.

$$p = m_1 V_1 = m_2 V_2$$

$$m_{ped} V_1 = (m_{head} + m_{ped}) V_2 \qquad \text{Equation 1}$$

$$E = E_1 = E_2$$

$$E_{kin1} = E_{kin2} + E_{def}$$

$$\frac{1}{2} m_{ped} V_1^2 = \frac{1}{2} (m_{head} + m_{ped}) V_2^2 + E_{def} \qquad \text{Equation 2}$$

Radi's head injury analysis predicts 76 Joules as the maximum tolerable deformation energy (E_{def}) during an impact with a flat surface (page 16). Similarly, an effective head mass of 6kg will be used. Initial velocity is based on a severe initial impact occurring equivalent to the transport aircraft design standard FAR §25.562(b)(2) 'Emergency Landing Dynamic Conditions' forward impact pulse of 44ft/s (13.4m/s). The resulting head velocity is not required to be known, so the above equations will be resolved for m_{PED}. Rearranging Equation 1 for V_2 and inserting into Equation 2:

$$\frac{1}{2} m_{ped} V_1^2 = \frac{1}{2} (m_{head} + m_{ped}) \left(\frac{m_{ped} V_1}{(m_{head} + m_{ped})} \right)^2 + E_{def}$$

$$\frac{1}{2} m_{ped} V_1^2 = \frac{1}{2} \frac{m_{ped}^2 V_1^2}{(m_{head} + m_{ped})} + E_{def}$$

$$\frac{1}{2} m_{ped} (m_{head} + m_{ped})\, V_1^2 = \frac{1}{2} m_{ped}^2 V_1^2 + (m_{head} + m_{ped}) E_{def}$$

$$\frac{1}{2} m_{ped} m_{head}\, V_1^2 = (m_{head} + m_{ped}) E_{def}$$

$$\frac{1}{2} m_{ped} m_{head}\, V_1^2 - m_{ped} E_{def} = m_{head} E_{def}$$

$$m_{ped} = \frac{m_{head} E_{def}}{\frac{1}{2} m_{head}\, V_1^2 - E_{def}} \qquad \text{Equation 3}$$

After the initial flailing, the occupant is stationary relative to the vehicle (whether or not it is still moving) and an airborne PED strikes the occupant in the back of the head. As per Figure 12 of the Radi analysis, a conclusion can be drawn for the critical weight of impactor (i.e. the PED). For a 13.4m/s impact velocity and a flat sided head strike, the critical PED mass is 0.98kg.

The above analysis assumes a direct strike on the occupant after initial flailing by the occupant, i.e. the occupant is at rest with respect to the vehicle and the PED is still at the initial pre-impact velocity. This may be an aggressive assumption. Reasons for a reduced impact velocity/energy include the PED release resistance from the owner's hands or bouncing off seat backs and overhead bins before the head strike. Equation 3 is graphically represented in Figure 1 of this Appendix and represents critical mass versus velocity. If an arbitrarily reduced impact velocity of 10m/s is assumed, the critical PED mass rises to 2.04kg.

However, edge and corner PED head strikes will inflict more severe injury (or similar injury at lower weights/velocities).

2. Investigation of Edge and Corner PED head strikes

A review of referenced journals in Radi's report reveals wider application for the BC to different shaped intermediate or heavy projectiles. Whilst the previous equation provides for flat plate impact energy; edge and corner strikes will require less energy to be injurious. However, defining the contact area is problematic. Sturdivan et al.(2004) state that where the diameter of the projectile is less than twice the body wall thickness, the diameter of the projectile is used in the BC rather than determining an impact or effective diameter. However, for small projectiles with a non-circular area of contact (A), again an effective diameter (D) is resolved and calculated by:

$$D = 2\sqrt{\frac{A}{\pi}}$$

——————— Equation 4

For the purposes of this analysis, it will be assumed that this criterion can be used for intermediate sized projectiles with small non-circular contact areas. Injury is assumed to occur once the body has been compressed to one wall thickness (T).

For PED edge strikes, a long thin indentation will occur with the contact area being dependent on the depth of penetration. Sturdivan et al.(2004), proposed for a torso impact with a flat plate that the thorax be simplified to a cylinder where the where the curvature of body part is used to calculate the area of contact.

$$A = 2H\sqrt{T(D' - T)}$$

——————— Equation 5

For the purpose of a PED edge contact, the formula can be applied where the height (H) of the flat plate is equal thickness of the PED. Given the length and breadth dimensions of a PED and radius of a human head, it can be conservatively assumed the length of the edge will always exceed the length of the impacting edge.

The Blunt Criterion is:

$$BC = \ln\left(\frac{E}{W^{1/3}TD}\right)$$

——————— Equation. 6

Expanding Equation 6 for kinetic energy and rearranging for determination of critical mass:

$$m = \frac{2W^{1/3}TDe^{BC}}{V^2}$$ Equation. 7

As used in the previous analysis, Raymond et al.(2009) determined a 50% chance of skull fracture is represented by a BC of 1.61. Additionally their values of skin thickness (T) for the head of 0.7 cm will be used. Whilst this study looked at temporo-parietal (side of head) impacts, due to a lack of appropriate studies, it is assumed to be broadly applicable to occipital (back of head) impacts. From the Radi analysis, the same assumptions of an effective head mass (W) of 6kg, and head diameter (D') of 18cm, will be used. Velocity (V) again will use FAR §25.562(b)(2) forward impact velocity change of 13.4m/s. With respect to the dimensions of the PED, the device of most concern is a 'tablet' style computer. Whilst their dimensions vary greatly, a typical thickness of 1.0cm for a 10" tablet will be used. Thinner devices will have a lower critical mass due to reduced contact area but 1cm thickness is typical.

Resolving Equations 5, 4 and 7 results in the solutions of an impact area (A) of 6.96cm2, effective projectile diameter (D) of 2.98cm2, and maximum PED mass (m) of 0.21kg.

As before, if some arbitrary energy dissipation is assumed to occur and the velocity is reduced from 13.4m/s to 10m/s, the critical PED mass increases to 0.38kg. The graphical presentation of critical mass versus velocity is given in Figure 1 for a PED edge strike.

Determining the effective diameter for a PED corner strike is problematic for this kind of analysis as the effective diameter is highly dependent on penetration distance. This type of analysis is not appropriate for a highly tapering impactor.

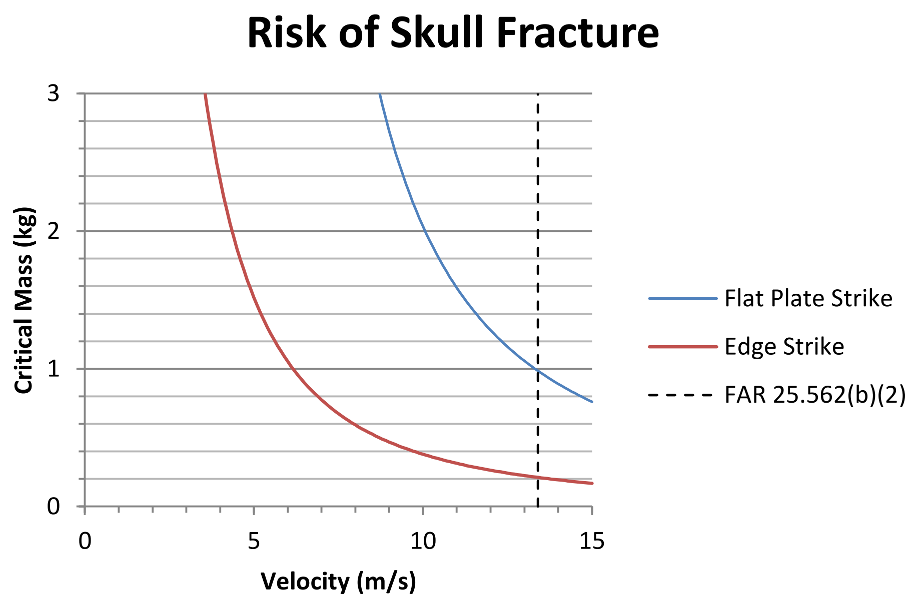

Figure 1 – Graphical representation of Equations 3 and 7

3. QF460 scenario

On 8 November 2013, QF460 on approach to Sydney entered extreme turbulence. After two attempts to land, the aircraft was diverted to Newcastle. One passenger suffered a minor injury (not hospitalised) due to an iPad2 striking their head, reportedly coming from three rows in front. Another passenger was hospitalised after being struck in the head by a laptop falling from an overhead locker. A second passenger was hospitalised by an injury outside the scope of this analysis.

Assuming a turbulence gust of +2.5g applying for the entire period and a 1m fall by the laptop, the velocity of the laptop at the time of striking the passenger's head might be:

$$V_2^2 = V_1^2 + 2as$$

$$= 0^2 + 2 \times (2.5 \times 9.8) \times 1$$

$$V_2 = 7.0 \text{ m/s}$$

Whilst CASA has little details of this incident, it is safe to assume that the person didn't suffer a skull fracture given it was reported the injured passengers were only admitted overnight. However, for this incident, given a similar laptop mass and slightly lower velocity, the fact that the person was hospitalised goes someway to validating the assumptions of this analysis.

4. Limitations

The following limitations apply to this analysis:

1. Only head injury was assessed. It does not consider neck injury or injury to other body parts.

2. The analysis considers skull fracture as the only injury mechanism. It does not consider concussion or other forms of head injury which may be more critical. Due to lack of data, side of head fracture data has been used.

3. It assumes the PED strikes the passenger with its flat side or edge on. Corner strikes have not been assessed. The analysis assumes a strike perpendicular to the head and not a 'glancing blow'.

4. The analysis assesses the consequences of a direct strike to the head by the PED. A second indirect strike scenario was derived for both assessments using loose assumptions.

5. This analysis only determines the outcome of an injury event. The likelihood of the event occurring is not determined and so does not rationalise the risk.

5. Conclusion

This analysis has shown that a 2 kg device could be injurious during times of turbulence. This is backed up by service history. A loose 1 kg device is injurious with an impact speed of 13.4 m/s which is of similar severity to the aircraft design standard FAR §25.562. Calculations show in a worst case scenario, a 210 g PED has the potential to be injurious during an impact sequence.

6. Recommendations

1 kg is considered the maximum mass limit for solid articles. This provides protection from PED edge head strike scenarios during turbulence events and is tolerable for flat sided head strikes during accidents equivalent to aircraft ultimate load design standards.

7. References

Civil Aviation Order 20.16.3, Air service operations — carriage of persons. Civil Aviation Safety Authority. 2004,
http://www.comlaw.gov.au/Series/F2005B00797

Radi, A. 2013, *Human injury model for small unmanned aircraft impacts*. Civil Aviation Safety Authority /Monash University.

Raymond, D., Van Ee, C. & Bir, C. 2009, 'Tolerance of the skull to blunt ballistic temporo-parietal impact', *Journal of Biomechanics*, vol. 42, pp. 2479-2485.

Sturdivan, L., Viano, D. & Champion, R. 2004, 'Analysis of injury criteria to assess chest and abdominal injury risks in blunt and ballistic impacts', *The Journal of Trauma, Injury, Infection, and Critical Care*, 56(3), pp. 651-663.

Appendix C

Operational Policies and Procedures for use of Passenger PEDs

C.1 Background

Both technical and operational conditions must be addressed when expanding the use of PEDs. This Appendix provides guidance to operators who intend to expand the use of PEDs in operations. An operator seeking to allow the expanded use of PEDs on board its aircraft should carry out a review of their operations to determine if expanded PED use is appropriate, and develop policy and procedures to address the use of the devices.

C.2 Operational policy and procedures

In accordance with an operator's Safety Management System (SMS), a risk assessment on the expanded use of PEDs should be conducted to identify safety related risks, and a means to mitigate those risks. This assessment should form the basis for the operators PED policy, and the development of processes and procedures to manage the expanded use.

The following considerations should be included in the development of operational policies and procedures related to expanded use of PEDs:

- types of PEDs that can be used, and at what stages of flight
- limitations on use
- procedures during normal, abnormal and emergency situations e.g. refuelling, turbulence, PED smoke/fire events
- suspected or confirmed Electromagnetic Interference (EMI) event
- securing and stowage
- passenger information and education
- PED distraction and the receipt of passenger safety information
- passenger non-compliance with PED policy
- training programs
- staff use of personal and company issued PEDs
- management of wireless services
- international operations and foreign regulations
- PED event reporting as part of the safety assurance program.

C.2.1 Documentation and Training

Operators will need to amend operation manuals and associated documentation to reflect changed procedures in relation to the use of PEDs e.g. checklists, passenger safety cards, passenger briefing material, signage.

Training programs will also require revision to support the changes, and ensure that crew and other relevant personnel are adequately trained and proficient to perform their duties and responsibilities.

In relation to passenger care and crew response the following should be considered:

- Describe the communications methods used to teach the passengers about the new policy.
- Describe techniques that may be used to deal with passengers that are using their PEDs in a disruptive or unsafe way (use of PED speakers instead of headphones, loud voice communications, etc.).
- Explain how the passengers will be kept informed as to when it is OK to use PEDs and when/how they should secure or stow them appropriately.

CASA will require operators to provide details of revisions to procedures and training programs as part of their submission for expanded use of PEDs.

C.3 Enquiries

Enquires with regard to the content of this Appendix should be made via the direct link email address: cabinsafety@casa.gov.au

C.4 References

It is intended that the following reference material be used in conjunction with this document:

- Regulation 254 of the *Civil Aviation Regulation 1988,* Exits and passageways not to be obstructed, http://www.comlaw.gov.au/Details/F2014C00614/Html/Volume_3#_Toc386785216
- Civil Aviation Order 20.16.3, Air service operations – carriage of persons, http://www.comlaw.gov.au/Details/F2009C00628
- A Report from the Portable Electronic Devices Aviation Rulemaking Committee to the Federal Aviation Administration, 30/09/13 – *Recommendations of Expanding the Use of Portable Electronic Devices During Flight* http://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information?documentID=1502
- FAA Notice 8900.240, 31/10/13 – *Expanded Use of Passenger Portable Electronic Devices (PED)* http://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/1022366
- FAA Information for Operators (InFO) 13010, 31/10/13 – *Expanding Use of Passenger Portable Electronic Devices (PED)*

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2013/InFO13010.pdf

- Supplement to FAA InFO 13010, 31/10/13 – *FAA Aid to Operators for the Expanded Use of Passengers PEDs*
  http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2013/info13010sup.pdf

Appendix D

Operational Policies and Procedures for use of Passenger PEDs whilst airside

D.1 Background

The purpose of this Appendix is to provide information on the use of PEDs by passengers whilst airside.

Passengers transiting to or from an aircraft can experience cognitive distraction from mobile phone or other PED use. This reduces situational awareness, increases unsafe behaviour, and puts the passenger at greater risk of accidents.

Hazardous conditions that may need to be considered include other aircraft movements in close proximity and ground service or fuelling vehicles. Night operations at remote aerodromes without adequate airside lighting may also present hazards that should be considered.

Research into the flammability of aviation turbine fuel due to a non-related airborne incident demonstrated ignition requires a significant amount of energy to be applied. In addition the fuel air mix must be at the correct stoichiometric ratio for ignition to occur. PEDs in normal operation cannot transmit that level of energy to cause ignition.

Paragraph 4.4.3 of CAO 20.9, states in part that:,

> A person shall not, and the pilot in command and the operator shall take reasonable steps to ensure that a person does not, during fuelling operations:
>
> (b) except in the case of aircraft, operate an internal combustion engine or *any electrical switch, battery, generator, motor or other electrical apparatus* within 15 metres (50 ft) of the aircraft's fuel tank filling points or vent outlets, and ground fuelling equipment unless the engine, switch, generator, motor or apparatus complies with the provisions of Appendix I to this Order and has been inspected.

Appendix 1 of CAO 20.9 further defines electrical equipment as:

> All fixed and portable electrical equipment (other than vehicular) shall be of the same requirements as the SAA requirements as for equipment operated in Class 1, Division 2 locations, as specified in the SAA Wiring Rules, Part 1, except that arc-producing devices such as switches, contactors, etc., which are not operated during fuelling or defuelling operations need not to conform to the requirements for this class of equipment. The controls of all arc-producing devices which do not meet the requirements for Class 1, Division 2 locations shall be clearly labelled so that there is no doubt that they are not to be operated during fuelling operations.

Mobile phones, iPods, tablets etc are not dealt with under the Standards Australia Association (SAA) wiring rules. This Standard applies specifically to domestic and commercial electrical installations at 240 and 415V AC.

The greatest risk to a person using a PED is distraction or inattention and the consequences of that distraction or inattention. The pilot and airport operator are jointly responsible for establishing the policy for PED use airside.

In addition, the refuelling organisation will have well developed safety requirements that are applied during aircraft refuelling. Again, CAO 20.9 provides adequate guidance in this matter.

D.2 Operators policy and procedures

Operators should also consider the adequacy of existing procedures, facilities and safety devices used for the guidance and protection of passengers, before changing their policy to allow for the use of PEDs while transiting to and from the aircraft. In circumstances where the operator is not confident of the level of protection provided by procedures, facilities and safety devices, they should consider restricting the use of PEDs.

D.3 Reporting

Australian operators should report any issues through the normal Service Difficulty Reporting (SDR) system.

Australian Government

Civil Aviation Safety Authority

Instrument number CASA EX102/14

I, TERENCE LINDSAY FARQUHARSON, Acting Director of Aviation Safety, on behalf of CASA, make this instrument under regulation 11.160 of the *Civil Aviation Safety Regulations 1998*.

Terry Farquharson
Acting Director of Aviation Safety

17 August 2014

Exemption — carriage of portable electronic devices during flight

1 Duration

This instrument:

(a) commences on the day of registration; and

(b) expires at the end of July 2017, as if it had been repealed by another instrument.

2 Application

This instrument applies to the carriage of a portable electronic device (***PED***) by a passenger on an Australian registered aircraft engaged in charter or regular public transport operations.

3 Definitions

In this instrument:

large PED means a PED with a mass of 1 kg or more.

small PED means a PED with a mass of less than 1 kg.

PED means a portable electronic device, such as a mobile phone, music player, e-reader, tablet computer, laptop computer, portable video game console or camera, that has no sharp edges or protrusions.

4 Exemption

For the stowage of small PEDs, the operator and pilot in command of an Australian registered aircraft are exempt from complying with paragraph 9.3 of Civil Aviation Order (***CAO***) 20.16.3.

5 Conditions

The exemption is subject to the conditions set out in Schedule 1.

Schedule 1 Conditions

1 A small PED may be carried by a passenger during take-off, landing or other critical phases of flight whenever seat belts are required to be worn in accordance with paragraph 4.1 of CAO 20.16.3.

2 A small PED carried by a passenger in accordance with clause 1 must be secured by the passenger. For that purpose, it may be held by the passenger, or secured in the pocket of a garment worn by the passenger or the magazine pocket on the back of a seat, but it must not be left unattended.

3 A small PED must not be secured so that it or its accessories could impede emergency egress.

4 Large PEDs or PEDs that could impede emergency egress must be placed in an approved stowage for solid articles in accordance with paragraph 9.4 of CAO 20.16.3.

5 Operators who engage in charter or regular public transport operations must have documented processes and procedures in place that cover the requirements associated with the stowing and securing of PEDs.

Note In spite of this exemption, the pilot in command may, under regulation 309A of the *Civil Aviation Regulations 1988*, require passengers to stow small PEDs in an approved stowage for solid articles when he or she considers it necessary in the interests of the safety of air navigation.

Explanatory Statement

Civil Aviation Safety Regulations 1998

Exemption — carriage of portable electronic devices during flight

Legislation
Subsection 98 (1) of the *Civil Aviation Act 1988* (the ***Act***) provides that the Governor-General may make regulations for the Act and in the interests of the safety of air navigation.

Under subregulation 235 (7) of the *Civil Aviation Regulations 1988* (***CAR 1988***), CASA may give directions with respect to the method of loading of persons and goods (including fuel) on aircraft.

Paragraph 9.3 of Civil Aviation Order (***CAO***) 20.16.3 is made under subregulation 235 (7) and states that solid articles must be placed in approved stowage at all times when seat belts are required to be worn in the cabin in accordance with paragraph 4.1 of CAO 20.16.3. Paragraph 9.4 sets out details of what constitutes approved stowage of solid articles.

Exemption
The exemption excludes from paragraph 9.3 the stowage of small portable electronic devices (***PEDs***) carried on an Australian registered aircraft.

CASA is satisfied that strict compliance with paragraph 9.3 is not necessary in the case of small PEDs which are defined as PEDs with a mass of less than 1 kg.

The exemption is subject to a number of conditions in order to avoid the risk of injury or damage. A small PED may be carried by a passenger when seat belts are required to be worn. It must be secured by the passenger, by being held, or secured in the pocket of a garment worn by the passenger or the magazine pocket on the back of a seat. It must not be left unattended or impede emergency egress.

Large PEDs or PEDs that could impede emergency egress must be placed in an approved stowage for solid articles in accordance with paragraph 9.4 of CAO 20.16.3.

Operators who engage in charter or regular public transport operations must have documented processes and procedures in place that cover the requirements associated with the stowing and securing of PEDs.

In addition, the pilot in command retains the right to issue directions under regulation 309A of CAR 1988 for the stowage of small PEDs in approved stowage, when he or she considers it necessary for the safety of air navigation.

Subsection 98 (5AA) of the Act states that an instrument issued under paragraph (5A) (a) is a legislative instrument if it applies to a class of persons or a class of aircraft. This exemption was issued under that paragraph and applies to a class of aircraft and so is a legislative instrument.

Consultation
CASA has consulted with a number of regular public transport operators in relation to the issue of the exemption. The terms of the exemption have been agreed to without any objections. CASA has also published guidance for industry on the use of PEDs to align the Australian legislative and policy requirements as far as practicable with those of other

major aviation agencies, including the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA). The terms of the exemption provide relief against the existing Australian legislative requirements to facilitate the implementation of an internationally harmonised standard for the use of PEDs.

Legislative Instruments Act

Subsection 98 (5AA) of the Act states that an instrument issued under paragraph (5A) (a) is a legislative instrument if it applies to a class of persons or a class of aircraft. This exemption was issued under that paragraph and applies to a class of aircraft and so is a legislative instrument.

Statement of Compatibility with Human Rights

A Statement of Compatibility with Human Rights is at Attachment 1.

Making and commencement

The exemption has been made by the Acting Director of Aviation Safety, on behalf of CASA, under subsection 73 (2) of the Act.

The instrument commences on the day of registration. It expires at the end of July 2017, as if it had been repealed by another instrument.

[Instrument number CASA EX102/14]

Attachment 1

Statement of Compatibility with Human Rights

Prepared in accordance with Part 3 of the
Human Rights (Parliamentary Scrutiny) Act 2011

Exemption — carriage of portable electronic devices during flight

This legislative instrument is compatible with the human rights and freedoms recognised or declared in the international instruments listed in section 3 of the *Human Rights (Parliamentary Scrutiny) Act 2011.*

Overview of the legislative instrument

The instrument enables passengers on Australian registered aircraft to carry small portable electronic devices without complying with paragraph 9.3 of Civil Aviation Order 20.16.3.

The primary purpose of the legislative instrument is to relax restrictions on the carriage of the portable electronic devices where they weigh less than 1 kg.

Human rights implications

This legislative instrument does not engage any of the applicable rights or freedoms.

Conclusion

This legislative instrument is compatible with human rights as it does not raise any human rights issues.

Civil Aviation Safety Authority