LEAFLET NO. 29 GUIDANCE CONCERNING THE USE OF PORTABLE ELECTRONIC DEVICES ON BOARD AIRCRAFT

1 PURPOSE AND SCOPE

To safeguard operations, JAR-OPS 1.110 requires an operator "..... to take all reasonable measures to ensure that no person does use, on board an aeroplane, a portable electronic device that can adversely affect the performance of the aeroplane's systems and equipment".

Recognising the need to avoid differences between airlines in the manner in which portable electronic device (PED) usage is controlled, this leaflet provides information to assist understanding of the issues, and it establishes common operational policy consistent with the requirements of JAR OPS 1.110.

Although the primary target audience of this leaflet is the airline community, operators of business aircraft, and operators of light aeroplanes and rotorcraft need to be alert to the risks from PED interference. These operators are recommended to adopt equivalent precautions as promoted in this leaflet.

The certification of systems and equipment is outside the scope of this leaflet. Hence it does not apply to approved equipment permanently installed in the aircraft for the purposes of passenger entertainment, or to installed telephone systems approved as satisfying airworthiness standards and licensed for air-ground radio telephone. These systems and equipment will need to satisfy applicable certification requirements and related operating restrictions. Similarly, the leaflet does not apply to permitted medical equipment which meets applicable requirements.

2 DISCUSSION OF THE ISSUES

2.1 General

The use of portable electronic devices (PEDs) on board aircraft by flight crew, cabin crew and passengers presents a source of uncontrolled electro-magnetic radiation with the risk of adverse interference effects to aircraft systems. Given that a civil aircraft flying at high altitude and high speed in busy airspace is in an obviously hazardous environment, and given that many of the onboard systems are safety devices intended to reduce the risks of that environment to tolerable levels, then anything that degrades the effectiveness of those systems will increase the exposure of the aircraft to the hazards. Consequently, the aircraft operator needs to take measures that will reduce the risks to acceptable limits.

PEDs fall into two main categories; non-intentional transmitters and intentional transmitters. The first category includes, but is not limited to, computing equipment, cameras, radio receivers, audio and video reproducers, electronic games and toys, together with portable, non-transmitting devices intended to assist flight and cabin crews in their duties. Intentional transmitters are transmitting devices such as remote control equipment (which may include some toys), two-way radios, cellphones and satellite phones. In periods between transmissions, an intentional transmitter may radiate interference as a non-intentional transmitter.

2.2 Non-intentional transmitting PEDs

PEDs that are non-intentional transmitters will radiate emissions from internal oscillators and processor clocks, some types of motor, and power supply converters. The radio frequencies involved may fall in the bands used for aeronautical radio services, and emission levels may be sufficient to affect aircraft radio receivers through their antennas. Use of a PED on the flight deck presents a particular risk to those navigation systems having antenna systems located in the radome.

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2.3 Intentional transmitting PEDS

PEDs that are intentional transmitters may induce interference directly into aircraft equipment, wiring or components with sufficient power to adversely affect the proper functioning of aircraft systems. Many aircraft have non-metallic floors and internal doors that present no barrier to prevent the transmission from penetrating to the avionics equipment bays and to the flight deck. Tests (reference 8.6) have shown that demonstrated susceptibility levels of aircraft equipment, particularly equipment qualified to earlier standards, can easily be exceeded.

2.3.1 Cellphones

The rapid growth in cellphone[1] usage has presented the most significant risk to aircraft safety from PED interference. Cellphones are both non-intentional and intentional transmitting PEDs, operating on spot channel frequencies in the bands of approximately 415 MHz, 900 MHz or 1800 MHz. (Some regions of the world use slightly different bands). Most use digital modulation but analogue types are still in use. Their maximum transmitted power is in the range of typically 1 to 5 watts. The actual power transmitted at a particular time is controlled by the cellular network and may vary from 20mW to maximum rated power of the cellphone depending on quality of the link between the cellphone and the network. Even in standby mode, a cellphone transmits periodically to register and re-register with the cellular network and to maintain contact with a base station.

The transmitted power and precise radio frequency of an operating cellphone is dependent on the traffic on the network, the distance of the cellphone from the nearest base station, and any obstacles or attenuation in the signal path. An aircraft on the ground at an airport is likely to be in close proximity to a base station resulting in a strong link between that station and an onboard cellphone. Under these circumstances, the cellphone would seek a free channel in the assigned communication band and its output power would be set by the network to a low level sufficient to maintain the link. Interference levels would, as a result, be low and probably harmless but this cannot be guaranteed. Closing of the aircraft doors increases attenuation in the signal path, and as the aircraft increases its distance from the base station, the output power setting of the cellphone is increased, eventually to its maximum rating. The risk of interference is then at its greatest. At altitude, the cellphone will transmit periodically attempting to register with the cellular network. The quality of the link is likely to be poor and the cellphone will radiate maximum power in these circumstances. Furthermore, since it is likely to be in line-of-sight range of multiple base stations, some degradation of the network operation may result[2] and actual communication may not be possible.

The effect of this type of functioning is that, when the aircraft is on the ground near a base station, the interference risk can be low but not negligible, and it will increase as the aircraft taxies and then climbs away from the network base stations.

The simultaneous use in an aircraft of several cellphones will result in transmissions at different radio frequencies leading to a more complex interference environment.

2.3.2 Private Mobile Radios

Private mobile radios conforming to the PMR 446 standard are now available to the general public for use as two-way radios without the need of a licence. These radios operate in the 446 MHz band and with sufficient power when transmitting to present an unacceptable interference risk in aircraft. Similarly, other types of two-way radios including those operating in the citizens' band present an unacceptable interference risk.

2.3.3 Wireless Area Networks

Wireless Local Area Network (WLAN) is an evolving technology offering wireless data communications, replacing Ethernet cables, for computing information exchange with a range of about 100 metres.

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[1] Cellphones are known also as mobile phones or portable phones.
[2] The telecommunications licensing authorities do not authorise cellphone use in aircraft because of the adverse effect on the ground network.

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Standards are being developed for WLAN such as the IEEE 802.11 and some future PEDs are likely to have this capability. WLAN uses radio transmissions of low power in the 2.4 GHz band with consideration being given to use of the 5 GHz band. WLAN transmissions do not need to be licensed.

Similarly, Wireless Personal Area Network (WPAN) is an emerging technology offering wireless data and audio communications, with a range of about 10 metres. "Bluetooth" is the name given to one example of a WPAN technology. WPAN also uses unlicensed, very low power radio transmissions in the 2.4 GHz band. Bluetooth will be incorporated into many classes of PED and passengers are likely to bring them on board aircraft expecting to use such devices during the flight. Studies (reference 8.10) have been completed which show that the interference risk in aircraft from PEDs with a Bluetooth transmitter is sufficiently low to permit their use during non-critical phases of flight i.e. Bluetooth devices need be subject only to the general restrictions applied to non-intentional transmitters.

The aviation authorities are monitoring WLAN and WPAN developments and will give further guidance where considered necessary.

2.4 In-seat Power Supplies

Many aircraft now offer, or are being modified to offer, an electrical supply at each passenger seat primarily for the purpose of operating laptop computers. These computers have safety devices to protect against over-charging of their re-chargeable batteries. Other types of PED may not have such protection and may be fitted (possibly incorrectly) with standard, non-chargeable batteries. Overcharging of batteries, or attempts to charge standard batteries, could cause them to fail in a dangerous manner with fire, smoke and fumes risks. It is the responsibility of the aircraft operator to ensure that PEDs connected to the in-seat supply do not present any additional hazard to persons on board the aircraft or to the aircraft itself. Safeguards include issuing passengers with information cards giving safety instructions for using the in-seat supplies and the restrictions for charging or handling batteries. The availability of a means to terminate and isolate such electrical supplies together with appropriate cabin crew procedures specified in the Operations Manual will be required as a condition of approval and use of in-seat power supplies.
Note: Guidance on in-seat power supplies may be found in JAA TGM No. 25-10 (reference 8.3).

3 INTERFERENCE LEVELS AND EFFECTS

3.1 Aircraft Equipment Qualification

To qualify for approval, equipment to be installed in aircraft has to demonstrate that it is not susceptible to prescribed levels of radiated interference irrespective of the source, and that it will not radiate unacceptable interference. The levels were originally set to ensure equipment could co-exist in the aircraft without mutual interference. For example, for an equipment susceptibility test prior to 1985, the maximum field strength of radiated interference was set at only 0.1 volts per metre. The risk of an uncontrolled interference source within the aircraft was not addressed by earlier standards. Recognising the inadequacy of the earlier standards, the tests have become progressively more severe primarily to protect against external threats such as broadcast transmitters, radars, and satellite uplinks. For critical equipment, the susceptibility tests now involve field strengths of 200 volts per metre or more. However, even the latest standards permit a low level of immunity for some equipment. Many aircraft, including newly manufactured aircraft, still have systems and equipment qualified to earlier standards.

3.2 Interference Levels

Studies have confirmed that the levels and radio frequencies of radiated interference from non-intentional transmitters are such that aircraft radio receivers can be affected. Over the years, many reports have been received by the authorities concerning such interference.

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For an intentional transmitter such as a cellphone, an obvious risk is recognised even though the cellphone is not transmitting in the aeronautical frequency band. Applying fundamental principles, the maximum field strength E in volts per metre of the transmission at a distance D from a cellphone transmitting P Watts of radio frequency power in a free, unobstructed space, can be estimated using the equation[3];

$$E = 7\sqrt{P} \text{ divided by the distance } D$$

Thus, for a 2 watt cellphone, the maximum field strength in free space at one metre distance is approximately 10 volts per metre, and at 100 metres distance, approximately 0.1 volts per metre.
However, in the confines of a metallic aircraft fuselage, complex propagation paths arise due to reflections from the metallic structure which can lead to signal cancellation or re-inforcement at different locations in the aircraft. Although the free space equation does not give reliable results under these conditions, tests have shown that the field strength of the interfering cellphone transmission, at maximum power, will exceed by a significant margin the levels used in susceptibility tests for avionic equipment qualified to earlier standards. Similarly, these tests have shown that interference levels would vary by relatively small changes of location of a cellphone and that persons obstructing the transmission path reduce the interference.

3.3 Effects

Reports of interference are increasing but it has been difficult to positively confirm in all cases that a PED has been the actual cause of a problem. This is due to the difficulty in replicating the conditions that existed at the time of the occurrence due to the multiple factors involved (e.g. geographical location of the aircraft, system operating modes, interference frequency and intensity, source location in the aircraft, and path attenuation). Cellphones have been positively identified as the cause of degraded communications and of false baggage compartment smoke warnings. Cellphones have been strongly implicated in other spurious cockpit warnings, corrupted instrument displays, and pressurisation system malfunctions.

Although the total number of reports is relatively low considering the aircraft flight hours involved, the potential severity of the effects of interference means that the problem cannot be ignored.

As a general conclusion, interference can result in:

- Malfunctioning of multiple systems;
- False warnings of unsafe conditions;
- Increased work load for the flight crew and the possibility of invoking emergency drills;
- Reduced crew confidence in protection systems which may then be ignored during a genuine warning;
- Distraction of the flight crew from their normal duties[4];
- Noise in the flight crew headphones;
- Hidden failures of safety systems with loss of protection.

4 POLICY

4.1 Restrictions on use of PEDs by Passengers

If an operator permits passengers to use PEDs on board its aircraft, procedures will need to be in place to control their use. It is the responsibility of the operator to ensure that all aircraft crew and ground agents are trained to enforce the restrictions on this equipment consistent with these procedures. The Operations Manual should include, as a minimum, procedures to ensure that:

[3] The strengths of electric and magnetic fields that exist in close proximity to the transmitting antenna (i.e. distances less than one wavelength and known as the near field) are not considered in this simple explanation.
[4] Crew distraction is a factor in altitude busts and runway incursions.

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4.1.1 Cellphones and other transmitting devices are not used and are switched OFF from the time at the start of the flight when the passengers have boarded and all doors have been closed until the end of the flight when a passenger door has been opened.

Notes: 1. At the Commander's discretion, the use of cellphones may be permitted when the aircraft is stationary during prolonged departure delays provided that sufficient time is available to check the cabin before the flight proceeds. Similarly, after landing, the Commander may authorise cellphone use in the event of a prolonged delay for a parking/gate position (even though doors are closed and the engines are running).

2. This paragraph does not apply to a PED where the sole means of transmission is identified as a low power transmitting device compliant with the "Bluetooth" Standard.

4.1.2 PEDs that are not transmitting devices are disconnected from any in-seat electrical power supply, switched off and stowed during taxi-ing, take-off, approach and landing, and during abnormal or emergency conditions.

Notes: 1. This restriction does not apply to permitted medical equipment.

2. This restriction applies to equipment carried on by the passenger or loaned to the passenger by the aircraft operator.

3. In the case of a PED where the sole means of transmission is identified as a low power "Bluetooth" transmitter, it may be considered as a non-intentional transmitter and may be used during non-critical phases of flight as permitted by this paragraph.

4.1.3 Necessary announcements are made both prior to and during boarding of the aircraft so that passengers may be reminded of the restrictions applicable to cellphones and other transmitting devices before fastening their seat belts. Passengers will need to be advised of the restrictions on all PEDs in the pre-departure passenger safety briefing required by JAR-OPS 1.285.

4.1.4 Cabin crew monitor passenger use of equipment during the flight and, where necessary, ensure suspect equipment is switched off. The cabin crew should be particularly alert to passenger mis-use of equipment which has a built-in cellphone. Furthermore, if turbulence is encountered and the crew determine that loose items could present a hazard, instructions will be given that these should be stowed.

4.1.5 Appropriate flight crew to cabin crew co-ordination exists to deal with interference or other PED safety related problems.

4.1.6 Crew are aware of the proper means to switch off in-seat power supplies used for PEDs.

4.1.7 Check in and ground handling staff as well as flight and cabin crews are aware of the safety issues and restrictions concerning PEDs.

4.1.8 Occurrences are reported to the responsible authority of suspected or confirmed interference which has potential safety implications. Where possible, to assist follow-up technical investigation, reports should describe the offending device, identify the brand name and model number, its location in the aircraft at the time of the occurrence, interference symptoms, and the results of actions taken by the crew.

Note: The cooperation of the device owner should be sought by obtaining contact details.

4.2 Restrictions on use of PEDs by Cabin Crew

4.2.1 PEDs provided to assist cabin crew in their duties must be switched off and stowed during taxi-ing, take-off, approach and landing, unless tests have been performed which confirm that these PEDs are not a source of unacceptable interference or other safety hazard.

4.2.2 Cabin crew must observe the same restrictions for cellphone usage as applicable to passengers.

4.3 Restrictions on use of PEDs by Flight Crew

4.3.1 PEDs provided to assist the flight crew in their duties will need to be used in compliance with the procedures and conditions stated in the Operations Manual of the aircraft operator. Such equipment will need to be switched off and stowed during all phases of flight unless:

(a) tests have been performed which confirm that these PEDs are not a source of unacceptable interference or distraction;

(b) the PEDs do not pose a loose-item risk or other hazard, and;

(c) the conditions for their use in flight are stated in the Operations Manual.

Note: It is outside of the scope of this leaflet to define the characteristics, functionality and performance necessary for a PED to assist the flight crew in their duties.

4.3.2 Flight and cabin crews should avoid using cellphones and other transmitting devices during critical pre-flight procedures (e.g. when loading route information into navigation systems or when monitoring fuel loading). Otherwise, flight crews and other persons involved in dispatching the aircraft will need to observe the same restrictions as passengers.

Note: This restriction does not preclude use of a cellphone by the flight crew to deal with an emergency although reliance should not be predicated on a cellphone for this purpose.

4.4 Other Precautions

4.4.1 Except for items which do not pose a loose item risk, PEDs together with any accessories such as spare batteries or cables, carried on board an aircraft for crew or passenger use, will need to be provided with suitable stowage facilities.

4.4.2 Where in-seat electrical power supplies are available for passenger use, information cards giving safety instructions should be provided.

5 RECOMMENDATIONS

5.1 Aircraft operators should consider installing detectors in their aircraft, which together with suitable procedures, can assist the cabin crew to detect unauthorised transmissions from commonly used types of cellphone.

5.2 Aircraft operators should seek the assistance of airport operators for the display of safety notices at aircraft boarding points reminding passengers to switch off cellphones and other transmitting devices.

6 IMPLEMENTATION

Aircraft operators should take action to amend their procedures and, where necessary, to update their Operations Manual, passenger safety cards and video briefings, leading to early implementation of the policy stated in this leaflet.

7 FURTHER INFORMATION

Further information should be requested from the responsible authority in the state where the principal place of business of the operator is located.

8 REFERENCE DOCUMENTS

8.1 JAR OPS 1.110: *Portable Electronic Devices*.

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8.2 JAR OPS 1.285 *Passenger Briefing.*

8.3 JAA TGM No. 25-10: *Guidance Material Regarding the installation of in-seat Power Supply Systems for Portable Electronic Devices;* June 2001.

8.4 FAA Advisory Circular AC 91.21-1A; *Use of Portable Electronic Devices Aboard Aircraft;* 2nd October 2000.

8.5 Association of European Airlines: *Policy on mobile phone use in aircraft*; TOC/54, Rome, September 22nd, 2000

8.6 UK Civil Aviation Authority: *Interference Levels In Aircraft at Radio Frequencies used by Portable Telephones*; report 9/40:23-90-02, May 2nd, 2000.

8.7 RTCA Inc: *Portable Electronic Devices carried on board Aircraft;* document DO-233, August 20th, 1996.

8.8 EUROCAE: *Environmental Conditions and Test procedures for Airborne Equipment*; document ED-14D, July 1997, Section 20. (ED-14D is technically equivalent RTCA document DO-160D).

8.9 International Civil Aviation Organisation: *Preparation of an Operations Manual;* document 9376-An/914, 2nd Edition-1997, (paragraph 8.5.2).

8.10 Intel Mobile Architecture Lab Technology & Research Labs: *Safety Evaluation of Bluetooth Class ISM Band Transmitters on board Commercial Aircraft;* Revision 2, December 2000.

9 AVAILABILITY OF DOCUMENTS

JAA documents are available from Information Handling Services (IHS). Information on prices, where and how to order, is available on the JAA web site (www.jaa.nl) and on the IHS web sites www.global.ihs.com and www.avdataworks.com.

EUROCAE documents may be purchased from EUROCAE, 17 rue Hamelin, 75783 PARIS Cedex 16, France, (Fax : 33 1 45 05 72 30). Web site: www.eurocae.org.

FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325, USA.

RTCA documents may be obtained from RTCA Inc, 1828 L Street, NW., Suite 805, Washington, DC 20036, USA, (Tel. 1 202 833 9339, Fax. 1 202 833 9434), Web site: www.rtca.org.

ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organisation, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: 1 514 954 6769, or
e-mail: sales_unit@icao.org) or through national agencies.

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