
**A REPORT FROM THE
PORTABLE ELECTRONIC DEVICES
AVIATION RULEMAKING COMMITTEE
TO THE FEDERAL AVIATION ADMINISTRATION**

Recommendations on Expanding the Use of Portable Electronic Devices During Flight

September 30, 2013

Prepared for:

Associate Administrator for Aviation Safety
Federal Aviation Administration
Washington, DC

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PORTABLE ELECTRONIC DEVICES AVIATION RULEMAKING COMMITTEE MEMBERS



Kirk S. Thornburg, Co-Chair
Managing Director, Aviation Safety Assurance
Delta Air Lines



Timothy Shaver, Co-Chair
Designated Federal Official
Manager, Avionics Maintenance Branch (AFS-360)
Federal Aviation Administration



George Novak
Assistant Vice President, Civil Aviation
Aerospace Industries Association



Michael Childers
Chief Consultant Content & Media Strategy
Lufthansa Systems
Airline Passenger Experience Association



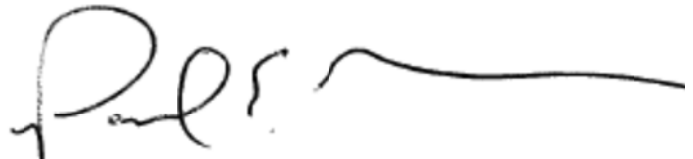
Richard J. Salter, Jr.
Chief Technical Officer
Lumexis Corporation
Airline Passenger Experience Association



Peter Anders
Certification Avionics/Electronics
Airbus



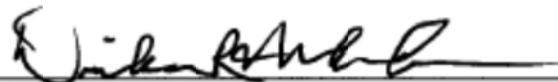
Captain Bill de Groh
Chairman, Aircraft Design & Operations Group
Air Line Pilots Association, Int'l



Paul Misener
Vice President, Global Public Policy
Amazon.com



Erik Miller
Senior Manager
Aircraft, Audio, Video, Voice, and Data Systems
Engineering
American Airlines



Dinkar R. Mokadam
OSHA Specialist
Air Safety, Health & Security Department
Association of Flight Attendants - CWA



David C. Hartz
Lead Engineer & AR/DER
Network Systems Engineering – Cabin Telecoms
The Boeing Company



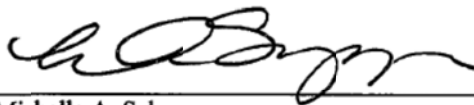
Billy M. Martin
Principal Engineer
Cessna Aircraft Company



Douglas K. Johnson
Vice President Technology Policy
Consumer Electronics Association

Member in concurrence, but unavailable for signature

Friedhelm Runge
Avionics System
European Aviation Safety Agency



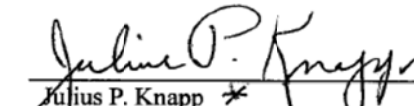
Michelle A. Schopp
Director, Flight Technical Programs
Executive Jet Management

Member of the Committee in attendance only

Nancy Sanchez
Attorney, Regulations Division
Office of the Chief Counsel, Policy and Adjudication
Federal Aviation Administration



David B. Walen
Chief Scientific and Technical Advisor – EMI
Federal Aviation Administration



Julius P. Knapp *
Chief, Office of Engineering and Technology
Federal Communications Commission

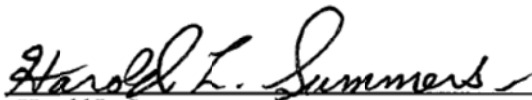
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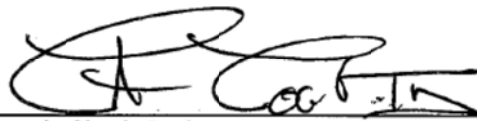
Member in concurrence, but unavailable for signature

Prat Patel
EMC Team Lead
Garmin

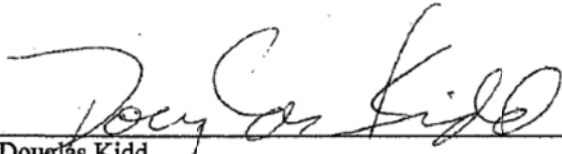
Gregory Bowles
Director, Engineering and Manufacturing
General Aviation Manufacturers Association



Harold L. Summers
Director of Flight Operations & Technical Services
Helicopter Association International



Captain Chuck Cook
Manager, Fleet Programs and Technology, Flight Operations
jetBlue



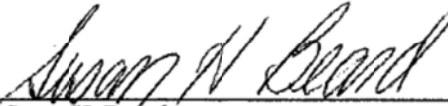
Douglas Kidd
Executive Director
National Association of Airline Passengers



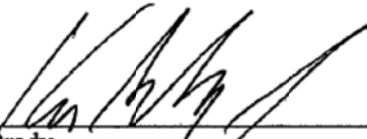
Nikki Cuban
V.P. Sales and Marketing
OnAsset Intelligence, Inc.



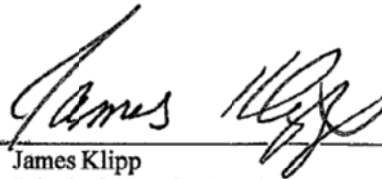
Stacey Bechdorf
Director, Safety & Technical Affairs
Regional Airline Association



Susan H. Beard
Principal Systems Engineer, CNS Systems & Support
Rockwell Collins



Ken Brady
Chief Design Engineer
Inflight Entertainment and Communications
Thales Avionics, Inc.



James Klipp
Principal Security Specialist
Office of Security Operations
Aviation Compliance Programs
Transportation Security Administration

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LETTER TO ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY

September 30, 2013

Ms. Margaret Gilligan
Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Dear Ms. Gilligan:

In August 2012, the FAA released a Federal Register notice request for comments about key areas of FAA policy and regulatory guidance that are used by an aircraft operator to expand portable electronic device (PED) use allowance. The PED Aviation Rulemaking Committee (ARC) was established on January 7, 2013 to provide a forum for the U.S. aviation community and PED manufacturers to review the comments received from the Federal Register notice. The Administrator also tasked the PED ARC to make recommendations to further clarify and provide guidance on allowing additional PEDs without compromising the continued safe operation of the aircraft.

After careful consideration of the data collected (including PED interference reports and passenger use survey results), the PED ARC developed a recommended path for operators to expand PED usage in flight. The PED ARC requested, and was granted an extension under a renewed Charter to complete two additional work tasks in order to finalize its recommendations. The PED ARC recommendations included in the enclosed report are the result of a collaborative review by the ARC members who represent multiple constituent groups including PED manufacturers and distributors, pilot and flight attendant groups, aircraft operators, passenger experience associations, airplane and avionics manufacturers, the FAA, and other U.S. and international regulatory authorities.

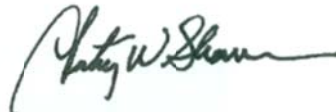
The PED ARC solicited input from Agency subject matter experts, aircraft manufacturers, PED manufacturers, and other aircraft operators during its deliberations. We are confident the ARC recommendations are based on a solid safety risk management foundation and SMS principles. In addition, the members believe that implementation of these recommendations will address passenger interest in expanded PED usage without compromising safety. The members stand ready to assist the FAA in the implementation of the recommendations contained in this report.

On behalf of the members, it has been a pleasure to participate on the PED ARC and assist the FAA in assessing and mitigating the risks associated with expanded use of PEDs. We appreciate the FAA's willingness to partner with industry stakeholders to consider solutions in furtherance of the goal of ensuring the safest possible operating environment for the flying public.

Sincerely,



Kirk Thornburg, Industry Co-Chair
Delta Air Lines



Timothy Shaver, Co-Chair & Designated Federal Official
Manager, Avionics Maintenance Branch
Federal Aviation Administration

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EXECUTIVE SUMMARY

On January 7, 2013, the Administrator of the Federal Aviation Administration (FAA) established the Portable Electronic Devices (PED) Aviation Rulemaking Committee (ARC) in order to provide a forum for the U.S. aviation community and PED manufacturers to review the comments received from the Notice of Policy/Request for Comments regarding PED policy and guidance published in the *Federal Register*. The ARC was tasked to make recommendations to further clarify and provide guidance on allowing additional PED usage without compromising the continued safe operation of the aircraft.¹ Under the Charter, the ARC was scheduled to terminate on July 31, 2013. At the request of the members, the FAA extended the ARC Charter until October 31, 2013.² The ARC has completed its review, and this report provides the results and its recommendation to the FAA.

Definition

In formulating its recommendations, the ARC developed and used the following definition of PED, which applies to all of the recommendations and supporting information included in this report:

Portable Electronic Device: A Portable Electronic Device (PED) is any piece of lightweight, electrically-powered equipment. These devices are typically consumer electronics devices functionally capable of communications, data processing and/or utility.³

Methodology

The ARC identified sources and methods for collecting objective data through presentations from subject matter experts (SMEs) and review of data submitted by the FAA, other federal agencies including the Federal Communications Commission (FCC), industry associations, and ARC members. The ARC also reviewed current guidance material and information on PEDs, including documents promulgated by the FAA, Radio Technical Commission for Aeronautics (RTCA), and FCC.

Identification of Key Issues

The ARC used the public comments received in response to the *Federal Register* notice to develop a list of key issues, which was used to assist the members in developing a roadmap for decision making. The key issues were tasked to individual subcommittees for further discussion. In using the key issues model, the members were asked to determine the relative priority of the issue, as well as the applicable subject area (technical, operational, or safety communications) for discussion.

¹ Appendix C, FAA Aviation Rulemaking Committee Charter: Portable Electronic Device Aviation Rulemaking Committee (Effective Date: 01/07/13) at ¶3. *See also*, 77 FR 53159 (August 31, 2012).

² Appendix C, FAA Aviation Rulemaking Committee Charter (Renewal): Portable Electronic Device Aviation Rulemaking Committee (Effective Date: 08/28/2013) at ¶3 (describing two additional Committee tasks).

³ For clarity, the ARC notes that the definition of PEDs is intended to encompass transmitting PEDs (T-PED).

Subcommittees & Working Groups

The ARC was tasked to focus on the technical, operational, and safety aspects of expanding PED usage on aircraft that are within the FAA's purview to address. In order to distribute the workload and provide the members an opportunity to debate issues in smaller groups, three subcommittees were each assigned key issues addressing these aspects of PED usage for consideration. The ARC recommendations submitted in this report were initially developed through the subcommittee process.

During the extension granted under the renewed Charter, the ARC requested the assistance of the FAA in forming two working groups ("Tiger Teams") to develop the safety risk assessment and a standardized PED stowage policy. The Safety Assessment and Stowage Standardization Working Groups were comprised of ARC members, as well as industry and FAA SMEs, and each working group was tasked to address an area of study and develop additional information for inclusion in this report.

Current Regulatory Framework

Under the current regulatory environment, the operator is still responsible for determining which PEDs may be used on its airplanes. Each operator's PED policy determines what types of devices may be used during which phase(s) of flight. Crewmembers are responsible for ensuring passenger compliance with an airplane operator's PED policy. Current guidance allows broad use of non-transmitting PEDs during non-critical phases of flight without detailed study of specific PEDs. However, if an operator wishes to expand its PED use allowance, FAA policy and guidance is in place to allow PED use, with the proper testing and analysis, during any phase of flight. Operators have been hesitant to deviate from current FAA guidance, as there has been no clear direction on methods to demonstrate an equivalent level of safety when expanding PED use into critical phases of flight.

FCC regulations also govern certain aspects of PED usage. The FCC has established rules for radio transmitters and consumer electronics to minimize the risk of harmful interference to other users of the airwaves. FCC rules, with a few notable exceptions, do not prohibit use of radio transmitters or consumer electronics aboard airplanes.

Notice of Policy and Request for Comments

On August 31, 2012, the FAA published a Notice of Policy, Request for Comment regarding Passenger Use of Portable Electronic Devices on board Aircraft in the *Federal Register*.⁴ The FAA sought comments on current policy, guidance, and procedures that aircraft operators use when determining if passenger use of PEDs may be allowed during any phase of flight on their aircraft. The comment period closed on October 30, 2012, and resulted in 162 formal submissions, 854 separate commenters, and a total of 1,062 discrete comments.

The PED ARC members reviewed the compiled comments and discussed the comments by each question category. From each category, specific key issues were identified and used to guide the discussion, narrow the issues presented, and formulate the ARC's recommendations.

⁴ 77 FR 53159 (Docket No. FAA-2012-0752).

Constituency Descriptions

In order to achieve a balance between the regulator, regulated parties, other industry stakeholders, and the flying public, the FAA selected ARC members across a broad spectrum of constituencies. ARC membership encompassed the following constituent groups representing stakeholders involved in all aspects of the PED use debate:

- PED Manufacturers and Distributors
- Pilot and Flight Attendant Groups
- Aircraft Operators
- Passenger Experience Associations
- Airplane and Avionics Manufacturers
- Federal Aviation Administration
- Other U.S. and International Regulatory Authorities including the Federal Communications Commission (FCC) and Transportation Security Administration (TSA)

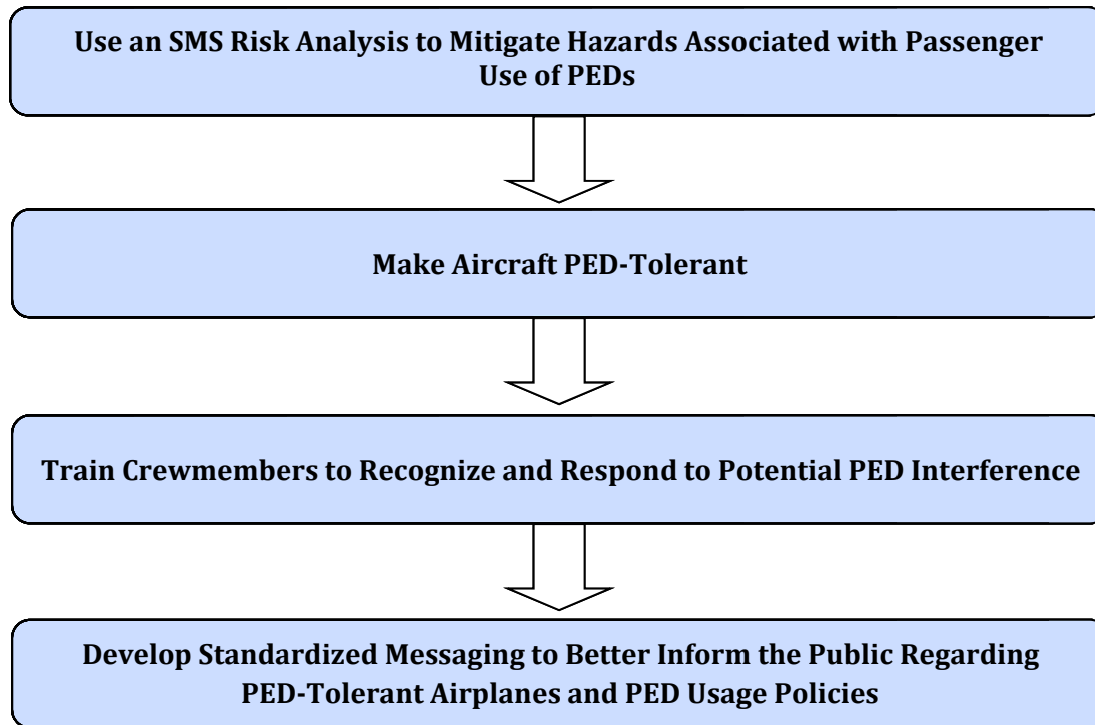
In addition, the ARC invited supplementary participation by FAA and other federal and international regulatory authorities to support the members' efforts as they collected information and data and debated recommendations.

Recommendations

The ARC sets forth a total of 29 recommendations on the expanded use of PEDs, including threshold recommendations, as well as recommendations addressing the technical, operational, and safety communications aspects of PED usage. The ARC members reached consensus on all of the recommendations with the exception of one aspect of Recommendation #10, as discussed below.

In creating a decision making framework for debating recommendations regarding the safe expansion of PED usage in flight, the ARC focused on an approach that lowers the risk of potential PED interference to an acceptable level.

The ARC recommendations are based on the following path:



Threshold Recommendations

The ARC noted that its recommendations in the technical, operational, and safety communications areas are all important to the universal acceptance of expanded allowance policies for PED usage in flight. The members determined that use of Safety Management System (SMS) methodology, harmonization of FAA and international policies, and standardization of the traveling experience for passengers were consistent themes across all of its recommendations. These core concepts were documented in a series of three threshold recommendations. (See Recommendations #1 – #3 below.)

Technical Recommendations

The ARC spent the majority of its time addressing the technical questions associated with expanding passenger use of PEDs to all phases of flight. The members reviewed data and related reports from a number of sources. The ARC also discussed the current standards for demonstrating PED-tolerance and various methods by which operators can demonstrate compliance with the applicable standards. The ARC deliberations resulted in four recommendations addressing airplane certification requirements for new airplanes. (See Recommendations #4 – #7 below.)

In discussing how to handle the existing fleet of airplanes, the members determined that a phased approach would be most appropriate to address legacy airplanes and avionics system(s) installations. The ARC also recognized the potential concerns associated with airplane certification requirements for airplanes currently in production and recommended a timeframe for compliance. (See Recommendation #8 below.)

The ARC developed two recommendations for enabling airplane operators (under 14 CFR Parts 91K, 121, and 135) to permit expanded passenger PED use to all phases of flight. (See Recommendations #9 & #10 below.) Five members of the ARC dissented to the Method 2 allowance as set forth in Recommendation #10, and their dissent position is included in this report.

In addressing technical issues, the ARC also noted the role of the FCC in addition to the FAA and recommended coordination between the agencies. (See Recommendation #11 below.)

Operational Recommendations

In addressing operational aspects of PED usage, the ARC discussed concerns raised by passengers about the differences between operators' policies and made recommendations regarding communication of and standardization among PED stowage policies. (See Recommendations #12 – #14 below.)

The members discussed the importance of training for airline personnel and developed recommendations to facilitate better awareness among flight and cabin crews with the expansion of PED use in flight. (See Recommendations #15 – #17 below.)

In addition, the ARC also proposed a standardized job aid to facilitate operator implementation of expanded PED usage policies. (See Recommendation #18 below.) The operational recommendations also address the importance of the FAA's role in providing guidance that will allow operators to pursue expanded PED usage policies. (See Recommendations #19 & #20 below.)

Safety Communications Recommendations

In the past, PEDs that transmitted or received radio frequency energy were a small subset of the larger population of PEDs. However, the consumer electronics market has evolved to where the majority of PEDs incorporate at least one, and frequently more than one, radio technology used for communication and data networking. The ARC has generated several recommendations that take into consideration the evolving marketplace for these devices. (See Recommendations #21 – #25 below.)

The ARC also emphasized the importance of effective communication with passengers, the public, and the aviation industry regarding PED policies and developed recommendations designed to work toward that goal. (See Recommendations #26 – #29 below.)

Summary of Recommendations

The ARC recommendations appear below, including a cross-reference to the detailed discussion in this final report:

Recommendation	Recommendation Area	Final Report Reference
Recommendation #1 —The ARC recommends that the FAA conduct an SMS risk assessment and engage safety experts on its staff and across industry to look for hazards associated with PED interference potential. While the PED ARC membership included some system expertise to identify hazards, it is suggested that a more focused group could develop a complete list of hazards that should be risk assessed to SMS standards. To support the expanded use recommendations proposed by the ARC, the members further recommend a safety risk assessment, as outlined in Appendix F of this report.	Threshold	6.1
Recommendation #2 —The ARC recommends that the FAA promote harmonized policy with international regulatory authorities, including EASA, such that the recommendations made in the ARC report are universally accepted by international regulatory authorities. The ARC encourages the FAA to use the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO) as forums to promote expanded PED usage policy within the recommended safety framework.	Threshold	6.2
Recommendation #3 —The ARC recommends that the FAA standardize the travelling experience for consumers such that they come to expect a consistent approach from air carriers regarding PED usage and stowage requirements.	Threshold	6.3
Recommendation #4—New Type Certificate Applications: The ARC recommends that the FAA require PED tolerant (i.e., RTCA DO-307 certified) airplane designs for all new type certificates issued for airplanes under 14 CFR Part 23 (commuter category only) or Part 25.	Technical	7.1
Recommendation #5—New Derivative Certificate Applications: The ARC recommends that the FAA require PED tolerant (i.e., RTCA DO-307 certified) airplane designs for all new derivative certificates issued for airplanes under 14 CFR Part 23 (commuter category only) or Part 25.	Technical	7.1

Recommendation	Recommendation Area	Final Report Reference
Recommendation #6—New Avionics, Major Changes in Type Designs: The ARC recommends that the FAA require new avionics system(s) installations that are considered major changes in type design (Supplemental Type Certificate [STC] or Amended Type Certificate [ATC]) with catastrophic failure classifications demonstrate PED tolerance (i.e., RTCA DO-307 certification) for those systems when certificated on airplanes under 14 CFR Part 23 (commuter category only) or Part 25. For new avionics system(s) installations that are considered major changes in type design (STC or ATC), where the systems are required by operating part or with major or hazardous failure classifications, and cannot demonstrate PED tolerance, a safety risk assessment (as discussed in Recommendation #10 below) must be accomplished for those systems.	Technical	7.1
Recommendation #7—The ARC recommends that associated FAA guidance documents, including AC 20-164 and AC 91-21.1B, be evaluated to incorporate alternative approach(es) to allow certification of individual systems for PED tolerance. Suggested revisions may also include changes to RTCA DO-294 guidance applicable to 14 CFR Part 119 certificate holders and considerations for the operating environment.	Technical	7.1
Recommendation #8—Newly Manufactured Airplanes: The ARC recommends that the FAA implement operational regulations that require all newly manufactured airplanes, which will be operated by 14 CFR Part 119 certificate holders under 14 CFR Parts 121 or 125, to be shown to be PED tolerant (i.e., RTCA DO-307 certified). This requirement would also apply to avionics system(s) installations that are considered major changes in type design (STC or Amended Type Certificate [ATC]) with catastrophic failure classifications, or equipment required by operating part, incorporate PED tolerant (i.e., RTCA DO-307 certification) designs when certificated on airplanes under 14 CFR Part 23 (commuter category only) or Part 25. For avionics system(s) installations that are considered major changes in type design (STC or ATC), where the systems are required by operating part or with major or hazardous failure classifications, and cannot demonstrate PED tolerance, a safety risk assessment (as discussed in Recommendation #10) must be accomplished for those systems. These regulations should have a compliance date no later than December 31, 2015. The FAA should grant petitions for limited extensions for operators introducing aircraft with extenuating circumstances, when justified.	Technical	7.2

Recommendation	Recommendation Area	Final Report Reference
Recommendation #9—The ARC recommends that the FAA modify AC 91-21.1B (and any associated guidance) to provide processes by which operators can demonstrate compliance with 14 CFR Section 121.306, 125.204, or 135.144, as applicable, in order to allow expanded use of PEDs to all phases of flight. Consideration should be given to maintaining cabin safety requirements (e.g. attention to safety announcements) when expanding PED usage.	Technical	7.3
Recommendation #10—The ARC recommends that in revising AC 91-21.1B (and any associated guidance), the FAA adopt the following methodology for expanding PED usage by passengers to all phases of flight. In particular, the FAA should immediately amend/revise current regulatory guidance documents to provide a methodology by which operators can permit PED usage by passengers during all phases of flight, using one of the following two methods: <u>Method 1.</u> The operator may perform PED tolerance testing, or the operator may document evidence of testing by an airplane manufacturer or other entity, that demonstrates airplanes are PED-tolerant in accordance with Sections 3 and 4 of RTCA DO-307. <u>Method 2.</u> The operator may validate that its airplane and operations meet the requirements and limitations of the safety risk assessment proposed by the ARC for adoption by the FAA (attached as <u>Appendix F</u> to this report) for the phases of flight (identified as Phases 1-8 in Figure 2 below) in which the operator wants to allow expanded passenger PED use. The ARC’s proposed FAA safety risk assessment addresses both back door and front door effects. Mitigations are supported by flight experience, analysis, and test data, and are provided for all failure condition classifications of Major and above, as well as for equipment required by operational rule. Back door effects are assumed to be covered by an airplane’s HIRF certification of critical systems. If an airplane is not HIRF-certified, or has not had other back door interference testing completed, additional analysis and systems testing may be required. <i>Note: Five members of the ARC dissented to the Method 2 allowance discussed above in Recommendation #10, and their dissent position is included in this report. (See Recommendation #10—Dissent Position below.)</i>	Technical	7.3
Recommendation #11—The ARC recommends that the FAA consult with the FCC with regard to Title 47 CFR parts that apply to airborne use of PEDs.	Technical	7.4

Recommendation	Recommendation Area	Final Report Reference
Recommendation #12 —The ARC recommends that the FAA and industry stakeholders develop standard content and timing for cabin and flight deck crewmember instructions to passengers on use and stowage of PEDs. The development process should include testing of the messaging with members of the traveling public.	Operational	8.1
Recommendation #13 —The ARC recommends that to support standardized industry best practices for stowage related to PEDs, the FAA update stowage policy and guidance documents to incorporate expanded use of PEDs as necessary.	Operational	8.1
Recommendation #14 —The ARC recommends that the FAA work with industry to develop a methodology by which exceptions can be granted to PED stowage requirements for passengers with special needs (so that they may use devices with adaptive or assistive technologies) without compromising safety.	Operational	8.1
Recommendation #15 —The ARC recommends that the FAA work with industry stakeholders to develop consistent and standardized training on the identification of PED interference effects so that flight crews are better able to mitigate risks to aviation safety and report possible incidents for further investigation as necessary.	Operational	8.2
Recommendation #16 —The ARC recommends that the FAA work with industry stakeholders to develop standardized processes for detecting/observing, reporting, evaluating, centralized data storing using existing systems if available, and summarizing of incidents, if any, involving adverse Electromagnetic Interference (EMI) effects on equipment, as well as passenger noncompliance with PED usage or stowage restrictions. Use of these tools should be part of enhanced employee training as proposed by the ARC.	Operational	8.2
Recommendation #17 —The ARC recommends that the FAA work with industry stakeholders to develop model frameworks for training programs targeting crewmembers and other affected operator personnel (including management), with minor but necessary variations owing to fleet size, airplane configurations and regulatory basis (i.e., part 135 vs. 121, etc.) utilizing standardized statements. This effort should involve initial and recurrent training for all employees, including cabin and flight deck crew, gate agents, and other customer service/contact personnel.	Operational	8.2
Recommendation #18 —The ARC recommends that the FAA work with industry stakeholders to develop a detailed job aid to lead an operator through key items of consideration. This job aid should be incorporated in the applicable FAA guidance documents.	Operational	8.3

Recommendation	Recommendation Area	Final Report Reference
Recommendation #19 —The ARC recommends that the FAA provide operators with policy guidance that institutes the approaches set up in the ARC for expansion of use as acceptable methods for compliance with PED use regulations.	Operational	8.4
Recommendation #20 —The ARC recommends that the FAA establish policy guidance for flight crew expectations. This policy should clearly define standardized roles and responsibilities for flight crews in the context of expanded PED usage allowance by the operator. These expectations should lessen the crew’s role in enforcing the PED usage policy.	Operational	8.4
Recommendation #21 —The ARC recommends that the terminology in FAA PED regulations, including 14 CFR 91.21, 121.306, 125.204, and 135.144, be updated to remove the outdated references to electronic devices. This terminology update should also be applied to all future policy and guidance documents.	Safety Communications	9.1
Recommendation #22 —The ARC recommends the FAA consider (and encourage operators to consider) using only the term PED when communicating information on operator policy to the public. Based on market data from CEA, most PEDs carried by passengers today incorporate one or more modes of wireless connectivity. With that in mind, distinguishing PEDs as Transmitting or Non-Transmitting may be confusing to the general public.	Safety Communications	9.1
Recommendation #23 —The ARC recommends that the FAA promote and encourage airplane operators to establish more stringent policy and guidance for PEDs that are not easily accessible to passengers or crewmembers during flight operation. Guidelines to PED manufacturers on the test requirements, satisfactory test data, and operational characteristics of these devices should be published in order to provide operators with an appropriate means to evaluate PEDs for use. Examples of these devices include, but are not limited to, some medical devices; asset tracking devices; data collection and monitoring devices; and devices for inventory management. (See Appendix E .)	Safety Communications	9.1

Recommendation	Recommendation Area	Final Report Reference
Recommendation #24 —The ARC recommends that the FAA promote and encourage airplane operators to develop a common device terminology (e.g., e-readers, smart phones, and tablet computers) when communicating to passengers about expanded usage policies. The ARC further recommends implementation of this recommendation be completed by November 30, 2013 to minimize confusion for the traveling public and allow the operator to clearly state which types of PEDs are allowed to be used onboard their airplanes and during which phase(s) of flight as outlined in the operator’s usage policy.	Safety Communications	9.1
Recommendation #25 —The ARC recommends that the FAA encourage airplane operators to provide to passengers lists of PEDs that may not be operated inflight, and make such information easily accessible through various media including printed material, websites, and audio or visual safety information.	Safety Communications	9.1
Recommendation #26 —The ARC recommends that the FAA and other stakeholders work together to develop messaging designed to better inform the public regarding why there would be restrictions on use of PEDs.	Safety Communications	9.2
Recommendation #27 —The ARC recommends that regulators, industry representatives and members of the public collaborate on the development of standardized information for travelers, which will be available in multiple, pre-tested formats at ticket purchase, in seat-pocket magazines, as well as distributed through various mass media outlets.	Safety Communications	9.2
Recommendation #28 —The ARC recommends that the FAA, in collaboration with the airline industry, explain to the public why there is a difference in PED usage policy for crewmembers versus passengers.	Safety Communications	9.2
Recommendation #29 —The ARC recommends that such collaborative efforts include programs designed to ensure the validity and efficacy of public messaging, using appropriate research, development, testing, evaluation, and feedback processes. In addition to the typical methods used for messaging to passengers (e.g., crewmember announcements, website and kiosk pop-ups, inflight magazines), the ARC further recommends that public information campaigns also leverage social media resources and applications to better anticipate and manage public perception and behavior, as well as counter misinformation as necessary.	Safety Communications	9.2

Conclusion

The ARC completed its tasking and prepared this report in accordance with its mandate to make recommendations to further clarify and provide guidance on allowing additional PED usage without compromising the continued safe operation of airplanes. In prioritizing its recommendations, the ARC noted that certain threshold recommendations were essential to establishing the initial framework and operating environment in which expanded PED usage could be implemented. The ARC organized the remaining recommendations around its tasking to address the technical, operational, and safety communications aspects associated with the expansion of passenger PED usage to all phases of flight. The ARC designed its recommendations to allow for phased implementation consistent with stakeholder capabilities, as well as sufficient opportunity to engage in a public education campaign concurrent with publication of updated/revised guidance and the allowance for expanded PED usage.

A Report from the Portable Electronic Devices Aviation Rulemaking Committee to the Federal Aviation Administration

Recommendations on Expanding the Use of Portable Electronic Devices During Flight

1.0 PORTABLE ELECTRONIC DEVICES AVIATION RULEMAKING COMMITTEE

In August 2012, the Federal Aviation Administration (FAA) published a Notice of Policy/Request for Comments on current policy, guidance, and procedures that aircraft operators (ranging from pilots of general aviation aircraft to operators) use when determining if passenger use of portable electronic devices (PEDs) may be allowed during any phase of flight on their aircraft.⁵ The FAA also sought comments about other technical challenges for addressing the problems associated with determining if and when PEDs can be used. In the Notice, the FAA indicated the desired outcome of the Request for Comments was to have sufficient information to allow operators to better assess whether more widespread use of PEDs during flight is appropriate, while maintaining the highest levels of safety to passengers and aircraft.

The FAA noted its intent to establish an Aviation Rulemaking Committee (ARC) to review the comments submitted and provide recommendations that might permit the more widespread use of PEDs. The FAA acknowledged the Federal Communications Commission (FCC) as a key partner in the FAA/industry collaboration to explore broader use of PEDs during flight.

The PED ARC provided a forum for the U.S. aviation community and PED manufacturers to review the comments received from the *Federal Register* Notice.⁶ The PED ARC made recommendations to further clarify and provide guidance on allowing additional PEDs without compromising the continued safe operation of the aircraft. This report includes the ARC's recommendations for allowing additional PED usage on airplanes.

The PED ARC membership included representatives from the FAA as well as members representing various stakeholder interests including PED manufacturers and distributors, pilot and flight attendant groups, aircraft operators, passenger experience associations, and aircraft and avionics manufacturers. The names of all ARC members, FAA participants and subject matter experts (SMEs), and other U.S. and international regulatory authorities are listed in Appendix A.

Under the Charter, the ARC was scheduled to terminate on July 31, 2013.⁷ At the request of the members, the FAA extended the ARC Charter until October 31, 2013.⁸ The ARC has completed its review, and this report provides the results and its recommendation to the FAA.

⁵ 77 FR 53159 (August 31, 2012).

⁶ PED ARC Charter at ¶3. *See also*, 77 FR 53159.

⁷ PED ARC Charter at ¶10.

⁸ *See* Letter Re: Request for Extension Portable Electronic Devices Aviation Rulemaking Committee (ARC) from K. Thornburg, Co-Chair, to M. Huerta, FAA Administrator, dated July 12, 2013. *See also*, PED ARC Charter (Renewed) at ¶3.

2.0 BACKGROUND

This chapter discusses background information relevant to the ARC's methodology and the development of its recommendations.

2.1 Overview

The PED ARC was established to provide a forum for the aviation community and PED manufacturers to review the 162 submissions (which included 1,062 discrete comments) received in response to the *Federal Register* Notice of Policy/Request for Comments.⁹ The ARC's main objective was to make recommendations to the FAA Administrator through the Associate Administrator for Aviation Safety (AVS-1) to further clarify and provide guidance on allowing additional PEDs without compromising the continued safe operation of the aircraft.¹⁰ The ARC was tasked to focus on the technical, operational, and safety aspects of expanding PED usage on aircraft that are within the FAA's purview to address.

In 1966, the FAA first published regulations to address the issue regarding the use of PEDs on aircraft.¹¹ The rulemaking was prompted after the 1958-1961 studies of PED interference concluded that portable frequency modulation (FM) radio receivers caused interference to navigation systems such as VHF Omni Range (VOR) navigation systems. The rulemaking concluded that the aircraft operator was best suited to determine which PEDs would not cause interference with the navigation or communication system on their aircraft. The rulemaking effort acknowledged the impracticality of requiring the FAA to conduct or verify tests of every conceivable PED, as an alternative to a determination made by the operator.

The potential for aircraft interference depends on the aircraft and its electrical and electronic systems, as well as the type of PED being used. Prior to fly-by-wire flight controls, the primary concern was the susceptibility of sensitive aircraft communication and navigation radio receivers to spurious radio frequency emissions from PEDs. Many of these aircraft using this older technology are still in service, and may be as susceptible today to interference as they were 45 years ago. When aircraft included fly-by-wire controls and electronic displays, the susceptibility of these aircraft systems also became a concern. Today's highly critical fly-by-wire controls and electronic displays are designed and certified to withstand interference from various radiated fields, including transmitting PEDs. However, not all aircraft electrical and electronic systems were designed to withstand these fields. These newer aircraft still have sensitive navigation, communication, and surveillance radio receivers that may be susceptible at certain frequencies to spurious radio frequency emissions from PEDs. Indeed, in some areas of the world, aerial navigation is conducted using ground-based radio navigational aids, such as VOR/DME, which may be as prone to interference as they were in the 1960s. Other ground-based navigational aids used for precision approaches, such as ILS, may also be at risk. PEDs have changed considerably in the past few decades and output a wide variety of signals. Some devices do not transmit or receive any signals, but generate unintentional low-power radio frequency emissions. Other PEDs, such as e-readers, are only active in this manner during the short time that a page is being

⁹ PED ARC Charter at ¶3. See also, 77 FR 53159.

¹⁰ PED ARC Charter at ¶3.

¹¹ See generally, PED ARC Charter at ¶2, Background.

changed. Of greater concern are intentional transmissions from PEDs. Most PEDs have Internet connectivity that includes transmitting and receiving signals wirelessly using radio waves, such as Wi-Fi, Bluetooth, and commercial mobile band technologies. These devices transmit higher powered emissions and can generate spurious signals at undesired frequencies, particularly if the device is damaged.

Since the initial rulemaking, the FAA has led four industry activities to study PEDs as the devices have evolved. In the early 1990s, the variety of PEDs had grown to the point that the industry had concerns about keeping up with the technology. The third industry effort was launched to review the overall risk of PED use. Those findings indicated that the probability of interference to installed aircraft systems from PEDs, singly or in multiples, is low at this time. However, the possibility of interference to aircraft navigation and information systems during critical phases of flight, e.g., takeoff and landing, should be viewed as potentially hazardous and an unacceptable risk for aircraft involved in passenger-carrying operations. Therefore, the Radio Technical Commission for Aeronautics (RTCA) recommended that the use of PEDs be restricted during certain critical phases of flight.¹²

The FAA agreed and developed Advisory Circular (AC) 91-21.1B, which outlined this guidance as an acceptable method of compliance for PED regulations.¹³ The guidance in AC 91-21.1B is still in use and serves as the basis for most operators' current policy allowing broad use of non-transmitting PEDs above 10,000 feet.

2.2 Scope

The ARC developed a definition of PED to provide context for the discussion and frame the recommendations included in this report. In discussing the scope of its tasking, the ARC also wanted to address certain discussions on topics related to the PEDs-on-aircraft debate but otherwise determined to be outside the scope of its tasking.

2.2.1 Definition of PED

In formulating its recommendations, the ARC developed and used the following definition of PED, which applies to all of the recommendations and supporting information included in this report:

Portable Electronic Device:

A Portable Electronic Device (PED) is any piece of lightweight, electrically-powered equipment. These devices are typically consumer electronics devices functionally capable of communications, data processing and/or utility.¹⁴

¹² RTCA DO-233, page 1, paragraph 5, prepared by SC-177, ©1996.

¹³ FAA AC 91-21.1B, Use of Portable Electronic Devices Aboard Aircraft (8/25/06).

¹⁴ For clarity, the ARC notes that the definition of PEDs is intended to encompass transmitting PEDs (T-PEDs).

Examples of PEDs include, but are not limited to, the following commonly manufactured devices: laptop computers; personal communication devices such as hand-held smart phones, tablet computers, media players, e-readers, and personal digital assistants; gaming and entertainment devices; medical and other healthcare assistive devices such as pacemakers and hearing aids; asset trackers; data collection and monitoring devices; inventory management and point-of-sale devices; wearable computers and other devices that may or may not incorporate wireless transmitters and receivers.

2.2.2 Issues Outside of Scope Considered/Discussed

The PED ARC discussed a number of issues in determining the scope of its recommendations. During the discussions, questions were raised as to the scope of the ARC Charter. As issues arose, the Designated Federal Official (DFO) coordinated guidance for the members on the FAA's tasking. In developing the recommendations in this report, the members noted two additional issues of concern—voice communication and malicious use of PEDs. While both issues were outside the defined scope of the ARC's tasking under its Charter, the members felt strongly that these issues need to be addressed.

With member consensus, the ARC believed it represented the constituencies needed to provide the FAA with recommendations surrounding the use of voice communication on airplanes. In the *Federal Register* Notice, the FAA invited comment on passenger perspectives on the use of PEDs specifically, "Should voice communications using other technologies such as voice over IP be limited or restricted"?¹⁵ While the FAA's intent may have been a review of the technical issues associated with voice communications, most of the respondents that commented referred in general to voice communications and provided a social argument whether it should be allowed or not. The PED ARC has been exposed to several surveys about voice communication in general. The results of the domestic surveys were consistent with the *Federal Register* commenters where 69 percent of the respondents did not desire cell phone usage (interpreted by the ARC to mean cell phone voice calls).¹⁶

The ARC has identified PED passenger compliance and onboard security events as being issues that should also be addressed in the context of the voice communication question. Voice communication in the small, confined space of an airplane cabin may become a concern when crewmembers are distracted from their other onboard duties by incidents involving interpersonal friction between two or more passengers.

¹⁵ 77 FR 53159, 53162.

¹⁶ An international survey, which included passenger responses regarding such services, resulted in 68% acceptance of onboard phone service..

As the voice communication issue is prevalent in the media, Congress, and in daily passenger operations, the ARC members felt these constituencies are expecting voice communication to be dealt with in concert with the PED ARC's tasking. Some members felt they could not go back to their constituencies ignoring this important part of the overall PED usage issue on airplanes. To document the member inputs, positions, and issues, the PED ARC has included these discussions in this report but has not made recommendations with regard to the voice communication issue. The members encourage the FAA to review the voice communication issue as discussed and consider whether actions should be taken when adopting or implementing the recommendations from the PED ARC.

Finally, there is one FCC regulation that prohibits cellular phones operating in the 800 MHz band from operating aboard airplanes in flight.¹⁷ While the ARC understands its tasking is specific to issues the FAA can regulate (or promulgate guidance on), the current FCC rule can create confusion because modern cell phones operate in many other frequency bands and also contain other types of transmitters such as Wi-Fi and Bluetooth. The ARC recognizes that the FAA and FCC have different responsibilities. However, the members have asked the FAA to consult with the FCC with regard to Title 47 regulations that apply to airborne use of PEDs. (See Recommendation #11 below.)

With regard to questions surrounding malicious use of PEDs, ARC members were assured that this issue is being addressed by other governmental agencies in addition to remaining outside of the scope of the ARC. The ARC received briefings from the Department of Homeland Security (DHS), the FAA Office of Infrastructure Protection, and the FAA Aviation Special Operations & Security Division. Current and active Federal Government and private industry structure(s) in place for the appropriate disposition of these concerns include, but are not limited to:¹⁸

- Homeland Security Act of 2002, Section 871 (6 U.S.C. 451)
- Presidential Policy Directive (PPD) 21, Critical Infrastructure, Security and Resilience
- Homeland Security Presidential Directive 16, Aviation Security Policy
- Domestic Outreach Plan, National Strategy for Aviation Security
- National Infrastructure Protection Plan (NIPP)
- Transportation Systems Sector Government Coordinating Council (TSSGCC)

¹⁷ 47 CFR 22.295.

¹⁸ Presidential Policy Directive (PPD) 21, Critical Infrastructure Security and Resilience, February 12, 2013, identified 16 critical infrastructure sectors and designated the Department of Homeland Security (DHS) and DOT as the co-Sector Specific Agencies (SSA) of the Transportation Systems Sector (TSS). The Transportation Systems Sector Government Coordinating Council (TSSGCC) establishes sub-sector councils (aviation, highway, freight rail, mass transit, maritime and pipeline). TSSGCC membership consists of key Federal departments and agencies responsible for or involved in aviation security. The Aviation Government Coordinated Council (ASCC). The Critical Infrastructure Partnership Advisory Council (CIPAC) provides the operational mechanism for carrying out the sector partnership structure. CIPAC provides the framework for aircraft owner and operator members of ASCC and members of AGCC to engage in intra-government and public-private cooperation, information sharing, and engagement across the entire range of critical infrastructure protection activities.

2.2.3 Special Use Monitoring

In the public comments, the ARC noted at least one illustration of a case when a special needs passenger may require the use of a PED to enable communication or therapy.

With the advancement in technology, the industry has developed applications for tablets, smartphones, and other PEDs to assist passengers with special needs. The FAA received several comments from the public describing one particular use of these devices by passengers with autism. These devices can be used to help these passengers communicate or provide other types of support.

While the ARC understands and appreciates these concerns, the devices being used are still consumer off-the-shelf devices that present the same risks discussed in this report. The ARC notes that expansion of use of these devices for special needs must meet the same criteria for allowance of use of all other PEDs.

2.3 Methodology

The ARC identified multiple sources and methods for collecting objective data including presentations from subject matter experts (SMEs), as well as review of data submitted by the FAA, other federal agencies, industry associations, and ARC members.

2.3.1 Meetings

The ARC met six times and held twelve teleconferences. The meeting/teleconference schedule is included below.

Face-to-Face Meetings were held:

- January 15 – 17, 2013, in Washington DC
- February 26 – 28, 2013, in Washington DC
- April 23 – 25, 2013, in Washington DC
- June 4 – 6, 2013, in Washington DC
- July 9 – 11, 2013, in Washington DC
- September 24 – 25, 2013, in Washington DC

Teleconferences were held:

- January 31, 2013
- February 14, 2013
- March 14, 2013
- April 18, 2013
- May 16, 2013
- May 30, 2013
- June 13, 2013
- June 20, 2013
- June 27, 2013

- July 18, 2013
- July 25, 2013
- August 29, 2013

Members also received multiple logistical briefings on the Freedom of Information Act (FOIA) and guidance on how to respond to media inquiries regarding the work of the ARC during the pendency of its debate and discussions.

Finally, the Administrator and senior FAA officials from across the Agency also addressed the ARC in support of its efforts to find a path forward on expanding the use of PEDs during flight while maintaining the highest levels of safety.

2.3.2 Data Collection

Since the PED ARC had a diverse membership across multiple sectors of the aviation industry, as well as PED manufacturer representation, the members sought information and data from a variety of sources. The ARC received a number of informational briefings in its efforts to develop the recommendations contained in this report.

The members received briefings on the following topics from the FAA:

- Congressional Study on Cell Phone Use on Aircraft¹⁹
- Safety Management System (SMS) Philosophy, Guidance and Methodology
- RTCA DO-307 PED Tolerance Testing Procedures
- Electronic Flight Bag Use and Certification Guidelines
- Current PED Stowage/Use Policy and Survey of Cabin Inspectors

The members also received briefings on the following topics from other U.S. regulatory authorities and industry organizations:

- FCC Management of the Radio Spectrum and Radio Frequency (RF) Devices
- FCC Provisions for Wireless Medical Devices
- Cell Phone Use Survey Data (provided by members)
- Current Airplane PED Tolerant Design Status
- Consumer Research on PED Usage on Aircraft
- Use of DO-307 Process for Designing to T-PED Tolerance
- PED Interference Data Summaries (provided by members)

¹⁹ See 77 FR 54651 (September 5, 2012).

2.3.3 Informational Review

During its review of the issues related to PED usage, the ARC reviewed current guidance and information on PEDs, including:

- Current regulations and FAA guidance documents related to PEDs and operational allowance for PED usage by passengers
- SMS/Safety Risk Management (SRM) Decision making Methodology
- RTCA documents related to certification of aircraft/systems as PED-tolerant

2.3.4 Identification of Key Issues

The ARC used the public comments received in response to the *Federal Register* Notice to develop a list of key issues, which was used to assist the members in developing a roadmap for decision making. The key issues were tasked to individual subcommittees (described below) for further discussion. In using the key issues model, the members were asked to determine the relative priority of the issue as well as the applicable subject area (technical, operational, or safety communications) for discussion.

2.4 Subcommittees

The ARC formed three separate subcommittees to review the key issues raised in the ARC review of docket and member comments on the expansion of PED usage in flight. The key issues fell into technical, operational, and safety communications categories, and thus three subcommittees were each assigned the applicable group of key issues. The Subcommittee Chairs (as identified in [Appendix A](#)) were appointed to research each issue and propose potential recommendations to the plenary committee for consideration. Separating the key issues into three areas helped distribute the workload among the members and provided a forum for ARC members to debate issues in smaller groups aiding the overall ability to reach group consensus. The Subcommittee Chairs called in SMEs to provide additional information when needed.

2.4.1 Technical Subcommittee

The Technical Subcommittee focused on key issues surrounding airplane tolerance to PEDs, as well as PED power and transmission standards. The subcommittee used technical site visits to various system experts to gain knowledge to help disposition the key issues assigned. The subcommittee navigated across aviation, telecommunications, and PED industry design standards to form recommendations that met the expectations of each stakeholder group. This subcommittee provided initial recommendations, as the Operational and Safety Communications subcommittees needed direction on the technical path for expanded PED usage to be clarified as they debated key operational and safety communications recommendations.

2.4.2 Operational Subcommittee

The Operational Subcommittee focused on key issues surrounding the onboard management of PED device usage, crew communications, and the desire for standardized practices across operators. The subcommittee used member expertise in cabin and cockpit operations, PED device operation, and passenger adherence to current PED usage policies to inform its discussions. The subcommittee balanced the needs of a safe operational environment with the passengers' desire for connectivity for both entertainment and business functions. This subcommittee ensured that recommendations could be implemented across the spectrum of airplane operators, regardless of size or type of fleet. There were many types of operators represented on the subcommittee, including: general aviation, business jet, and scheduled and charter transport.

2.4.3 Safety Communications Subcommittee

The Safety Communications Subcommittee played a key role in addressing passenger desires and need for information within the ARC's recommendations. This subcommittee ensured that a series of technical and operational procedures would not be conceived without understanding the passengers' need for awareness, understanding, and ability to comply. This subcommittee was assigned key issues regarding boarding/pre-flight announcements, coordinated communications, understanding of PED operational modes, and how best to communicate to passengers (and the public) the potential interference risk to critical airplane systems.

2.5 Working Groups

As the conclusion of the initial charter period approached, the ARC worked to develop a recommended path for operators to expand PED usage in flight. The members believed that two areas required further assessment prior to finalizing the ARC's recommendations. Before accepting that the recommended path could be reliably implemented by operators, the ARC requested an extension of the initial PED ARC Charter and identified two additional work tasks.²⁰ During the extension granted under the renewed Charter, the ARC requested the assistance of the FAA in forming two Working Groups (Tiger Teams) to develop the safety risk assessment and a standardized PED stowage policy. The Working Groups were comprised of ARC members as well as industry and FAA SMEs, and each Working Group was tasked to address an area of study and develop additional information for inclusion in this report.

2.5.1 Safety Assessment Working Group

The PED ARC membership was concerned that operators needed more specific guidance on how to complete an adequate safety risk assessment when expanding PED use; particularly with regard to its effects to critical safety systems. Information from the FAA and aircraft manufacturers with respect to failure effect classification would be useful for the operator to determine effective mitigation. To support the use of a Safety

²⁰ PED ARC Charter (Renewed) at ¶3 (describing two additional Committee tasks).

Risk Assessment tool in expanding PED usage, the ARC members desired to review the work product of such a working group.

To support the members' request, the Safety Assessment Working Group comprised of PED ARC members, as well as industry and FAA SMEs was formed. This working group developed and documented an avionics system functional hazard risk assessment, which is included as Appendix F to this report.

2.5.2 Stowage Standardization Working Group

The PED ARC membership received briefings from the FAA on current PED stowage policy and guidance material, as well as actual operator PED stowage policy examples. The ARC membership was concerned that insufficient guidance exists in this area such that (1) operator stowage policy could negate an intended expanded passenger PED use policy if an uninformed view of projectile and egress risk from PEDs exists; and (2) passengers would be confused by conflicting stowage policies across the operator community.

The members noted that a recommended interim PED stowage policy guidance document would be of use to operators while the FAA considers action on Recommendation #13 in this report. The Stowage Standardization Working Group, consisting of informed PED ARC members as well as industry and FAA SMEs, developed the PED stowage policy assessment and considerations included in Appendix G of this report.

3.0 CURRENT REGULATORY FRAMEWORK

This chapter provides a discussion of the current regulatory framework applicable to airplane/equipment certification processes and operational allowance procedures in relation to the use of PEDs during flight.

Under the current regulatory environment, the operator is still responsible for determining which PEDs may be used on its airplanes. Each operator's PED policy determines what types of devices may be used during which phase(s) of flight. Crewmembers are responsible for ensuring passenger compliance with that airplane operator's PED policy. Typically, when a flight attendant observes a violation, he or she may request that the passenger turn off and stow the device. If the passenger remains non-compliant, depending on the operator's policies and procedures, the flight attendant may report the violator to the flight deck for a decision on whether to hold or divert the flight, and/or notify law enforcement.²¹

Current guidance allows broad use of non-transmitting PEDs during non-critical phases of flight without a detailed study of specific PEDs.²² However, if an operator wishes to expand its PED use allowance, FAA policy and guidance is in place to allow expanded PED use, with the proper testing and analysis, during any phase of flight.

Title 14 of the Code of Federal Regulations (14 CFR) §§ 91.21, 121.306, 125.204, and 135.144 establish the regulatory requirements for use of PEDs without the authorization of the airplane operator. These regulations are set up to prevent persons from using PEDs on civil airplanes unless the operator (or in the case of general aviation operators, the pilot) has determined that the device will not cause interference to the communication and navigation systems on the airplane. There are four specific devices that have been excluded from this requirement and they are listed below in 14 CFR 91.21 (cited as an example).

§ 91.21 Portable electronic devices.

(a) Except as provided in paragraph (b) of this section, no person may operate, nor may any operator or pilot in command of an aircraft allow the operation of, any portable electronic device on any of the following U.S.-registered civil aircraft:

- (1) Aircraft operated by a holder of an air carrier operating certificate or an operating certificate; or
- (2) Any other aircraft while it is operated under IFR.

(b) Paragraph (a) of this section does not apply to—

- (1) Portable voice recorders;
- (2) Hearing aids;
- (3) Heart pacemakers;
- (4) Electric shavers; or
- (5) Any other portable electronic device that the operator of the aircraft has determined will not cause interference with the navigation or communication system of the aircraft on which it is to be used.

(c) In the case of an aircraft operated by a holder of an air carrier operating certificate or an operating certificate, the determination required by paragraph (b)(5) of this section shall be made by that operator of the

²¹ The ARC noted multiple examples where enforcement of an operator's PED policy resulted in conflict between crewmembers and passengers, or passengers with other passengers. The ARC discussed situations where noncompliance with crewmember safety instructions on the use of PEDs resulted in passengers being removed from an airplane, and in some cases, in-flight diversions.

²² See AC 91-21.1B.

aircraft on which the particular device is to be used. In the case of other aircraft, the determination may be made by the pilot in command or other operator of the aircraft.

3.1 Regulatory History

In 1966, the FAA first published regulations to address the use of PEDs. The first regulation, 14 CFR § 91.19,²³ was later superseded by §§ 91.21, 121.306, 125.204, and 135.144 to specifically address commercial operations. These regulations also placed the onus for determining what devices could be used on the individual operator.

The rulemaking effort was prompted after the 1958-1961 studies of PED interference concluded that portable frequency modulation (FM) radio receivers caused interference to navigation systems such as VHF Omni Range (VOR) navigation systems.

During that rulemaking process, the FAA received comments on the subject of FAA involvement in authorization of PED usage. The public expressed concern that authorization of devices not specifically excepted in the rule (i.e., portable voice recorders, hearing aids, heart pacemakers, electric shavers) would subject operators to a considerable amount of “red tape.” The FAA agreed and concluded that the airplane operator was best suited to make the determination of which PEDs would not cause interference with the navigation or communication system on the airplane. The FAA further recognized that requiring the FAA to conduct or verify tests of every conceivable PED, as an alternative to a determination made by the operator, would place an excessive and unnecessary burden on the Agency.

3.2 Associated Regulations and Security Activity

As the design of airplane and engine control systems evolved to use more advanced electrical and electronic control, the FAA determined that standardized regulatory policy and guidance was necessary to ensure these systems were sufficiently protected from environmental conditions that could have a negative impact. Airplanes that included fly-by-wire controls and electronic display systems were of particular concern because failures for these systems could be catastrophic.

To address a known environmental threat, the FAA defined requirements for high-intensity radiated fields (HIRF) to provide assurance that newer airplanes with systems such as critical fly-by-wire controls and electronic displays will have sufficient protection to continue to operate safely when exposed to HIRF. The FAA began assigning special conditions to airplane and system installation in 1987. In 2007, the FAA promulgated 14 CFR § 25.1317 and companion regulations for the other airplane categories.²⁴

These regulations resulted in protection of such systems from spurious emissions from PEDs and intentional transmissions from transmitting PEDs that could cause interference by direct coupling to the system’s wiring and apertures. However, HIRF protection does not provide avionics received systems (e.g., instrument landing system (ILS) and global positioning system (GPS)) from spurious emissions of PEDs and intentional transmissions from transmitting PEDs.

²³ 14 CFR 91.19, Docket No. 7247; Amdt 91-35 (later superseded by §§ 91.21, 121.306, 125.204, and 135.144).

²⁴ See also, 14 CFR Parts 23, 27, and 29.

3.3 Operational Allowance

Today, the authority to allow the use of PEDs in flight rests with the operator under 14 CFR § 91.21. Further, AC 91-21.1B provides guidance to the operator to make the determination that the operation of PEDs will not interfere with the safe operation of the airplane. Generally, operators have adopted guidance in AC 91-21.1B.

Recommended Procedures for Operators

Prohibiting the operation of any PEDs during the takeoff and landing phases of flight. It must be recognized that the potential for personal injury to passengers is a paramount consideration, as well as is the possibility of missing significant safety announcements during important phases of flight. This prohibition is in addition to lessening the possible interference that may arise during sterile cockpit operations (below 10,000 feet).²⁵

Operators have been hesitant to deviate from the recommendations outlined in AC 91-21.1B, as there has been no clear industry/regulatory guidance on methods to demonstrate an equivalent level of safety when expanding PED use into critical phases of flight.

There is an additional burden on the airplane operator to insure that PEDs approved for use on board airplanes do not interfere with navigation and communication systems.

Recommended Procedures for Operators

Procedures for determining non-interference acceptability of those PEDs to be operated aboard its aircraft. Acceptable PEDs should be clearly spelled out in oral departure briefings and by written material provided to each passenger to avoid passenger confusion. The operator of the aircraft must make the determination of the effects of a particular PED on the navigation and communication systems of the aircraft on which it is to be operated. The operation of a PED is prohibited, unless the device is specifically listed in section 91.21(b)(1) through (4). However, even if the device is an exception from the general prohibition on the use of PEDs, an operator may prohibit use of that PED. The use of all other PEDs is prohibited by regulation, unless pursuant to section 91.21(b)(5). The operator is responsible for making the final determination that the operation of that device will not interfere with the communication or navigation system of the aircraft on which it is to be operated.²⁶

Each operator establishes a method by which this PED effects determination is made. A common method for making this determination is to compare each PED device against the current RTCA DO-160 standards for airborne equipment which has RF and Power emissions and transient allowances. As the consumer electronics industry has exploded in terms of device type and popularity, the requirement for each operator to fully evaluate each and every PED desired to be brought onboard an aircraft has become untenable.

3.4 FCC Regulations

The FCC has established rules for radio transmitters and consumer electronic equipment to minimize the risk of harmful interference to other users of the airwaves. The FCC rules, with a few notable exceptions, do not prohibit use of radio transmitters or consumer electronic equipment aboard airplanes.

²⁵ AC 91-21.1B at ¶6.F.

²⁶ AC 91-21.1B at ¶6.E.

The FCC standards for controlling interference from PEDs are essentially the same as those used elsewhere throughout the world. While these standards are not specifically designed to prevent interference from PEDs used on board airplanes, based on experience, there appears to be little risk of such interference from compliant devices.

Since 1991, 47 CFR 22.925 has prohibited the airborne use of 800 MHz cellular phones. The ban was put in place because of potential interference to cellular networks on the ground. In early 2005, the FCC proposed rulemaking to lift this ban.²⁷ In April 2007, the FCC terminated this proceeding, with the Commission noting that the “comments filed in this proceeding provide insufficient technical information that would allow the Commission to assess whether the airborne use of cellular phones may occur without causing harmful interference to terrestrial networks.”²⁸

Cell phones have recently been permitted by foreign carriers on international flights through use of pico-cells or miniature cellular base stations certified or approved for use aboard the aircraft. These pico-cells cease operation when the flight is over U.S. airspace, but there is growing interest in continuing operation when over the U.S. This raises the possibility that it may be appropriate for the FCC to again review its policies relative to cell phone use on planes, not only for international flights, but for U.S. domestic flights as well. Moreover, cell phone technology has advanced considerably since the last time the FCC reviewed the current rules, when usage was primarily focused on voice calls as opposed to the current widespread use of smart phones and devices for access to the Internet and various applications on board the airplane. These pico-cells cease operation when the flight is over U.S. airspace.

The FCC has approved rules that allow in-flight voice and data services, including broadband services using dedicated air-to-ground frequencies that were previously used for seat-back telephone service. Air-to-ground service providers offer in-flight services, such as Internet access for laptop computers via Wi-Fi systems that have been certified for use on aircraft. Because these air-to-ground services operate on frequencies that are dedicated to air-to-ground communications and are separate from those used for wireless services on the ground, they do not pose an interference risk to wireless networks on the ground.

Consumer devices using ultra-wideband technology are prohibited from operating on board airplanes due to the unique characteristics of this technology. This technology is not currently available in the form of PEDs. New Wi-Fi technology has been developed for the 60 GHz region of the spectrum. Such devices are currently prohibited from operating on board airplanes due to concerns about potential interference to radio astronomy. However, it is possible that this restriction may be revisited as 60 GHz devices may be introduced in the future for use in PEDs.

²⁷ 70 FR 11916 (March 10, 2005).

²⁸ 72 FR 20439 (April 25, 2007).

4.0 NOTICE OF POLICY AND REQUEST FOR COMMENTS

This chapter addresses the ARC's tasking to review the comments received from the *Federal Register* Notice.

4.1 Federal Register Notice

On August 31, 2012, the FAA published a Notice of Policy, Request for Comment regarding Passenger Use of Portable Electronic Devices on board Aircraft in the *Federal Register*.²⁹ The Agency sought comments on current policy, guidance, and procedures that aircraft operators use when determining if passenger use of PEDs may be allowed during any phase of flight on their aircraft.

4.2 Assessment of Federal Register Comments

The comment period closed on October 30, 2012, and resulted in 162 formal submissions, 854 separate commenters, and a total of 1,062 discrete comments. The FAA Comment Compilation Team sorted the comments into different areas based on the questions posed in the Notice. The final compilation also tracked each comment by the type of submitter (noting industry stakeholder comments, passenger comments, as well as other types of submitters).

The ARC members reviewed the compiled comments and discussed the results by each question category (or issue). From each category, the Chair gained consensus from the members as to when a potential key issue existed from which the ARC may desire to form/develop a recommendation. Thirty-two (32) specific key issues were identified and used to inform the ARC's deliberations.

The members used the 32 key issue areas to narrow the questions presented and formulate the ARC's recommendations. A summary of the comments (by question category) appears below:

- (a) Technical requirements exist to make airplanes tolerant from any interference effects from PEDs: Members noted that the work done by RTCA SC-202 laid an excellent foundation for establishing PED tolerant airplanes and a focused review. The Technical Subcommittee reviewed RTCA guidance documents DO-307, DO-294, and DO-160, as well as FAA AC 91-21.1B and AC 20-164 among other documents to determine ways to make airplanes PED tolerant using some mix of voluntary or mandatory methods. The ARC delineated three distinct categories of airplanes to consider: Airplanes that are 1) part of today's fleet; 2) being manufactured today or in the medium-term future under existing type certificates; and 3) being newly designed to be built under new type certificates.

²⁹ 77 FR 53159 (Docket No. FAA-2012-0752).

- (b) Comments from individuals identified as passengers (not associated with any particular industry group) indicate a growing belief that PED usage causes no harm to today's airplanes: Many respondents commented that they intentionally do not follow operator instructions when told to power off their PEDs. The respondents are convinced that there is absolutely no harm that can be caused by PEDs and that concerns are outdated and should have been dealt with long ago by the FAA. These and other passenger views prompted the ARC to focus one aspect of its work on safety communications recommendations that, regardless of the outcome of the expanded usage determination, will be integral to assuring passenger acceptance of and compliance with future operator and FAA PED usage policies.
- (c) Standards and consistency around PED stowage requirements: Passengers support stowing PEDs when they are assured it is necessary for safety from a projectile or egress perspective. Additionally, it is also clear that passengers desire to have a consistent flying experience as they travel.

- Domestically
- Internationally
- From Airline to Airline
- From Airplane to Airplane within an Airline

Further, there is a lack of guidance regarding passenger personal items that must be stowed for takeoff and landing (i.e., a hard cover book can be held by a passenger, while a purse must be stowed). The Safety Communications subcommittee considered this issue in detail in its recommendations.

- (d) Standards within the consumer electronics industry for airplane-friendly PEDs: Most commenters like this idea but committee discussions on this have surfaced how difficult this would be to implement. The members of the ARC who represent the PED manufacturing community indicate an openness to consider some type of expanded device testing and tagging to allow acceptable operator use; however, they note that their industry now increasingly displays such information electronically rather than with a physical device tag. Even if physical device tags were developed, they would have to be of sufficient size and brightness to be clearly visible to a crewmember in the aisle when held in a window seat, with some tamper- and counterfeit-resistant features. Also, today's PEDs typically combine multiple transmission modes (e.g., Bluetooth, cellular, Wi-Fi) with new modes envisioned for the near future, adding to the complexity of device tagging. Further, the committee observes that many passengers may be unaware of the communication mode used by their devices, and may therefore find it difficult to confirm that their device is in a "safe" operating condition; this would lead to unacceptable confusion and possible interpersonal friction during inflight operations.

- (e) Consistency in use with flight and cabin crew PEDs such as a cockpit Electronic Flight Bag (EFB) device(s): Airlines are proceeding to adapt PEDs for EFB and Cabin product use; restrictions on the use of such devices may differ from those applied to passenger devices today, or to future operator policies that allow for expanded PED use by passengers. The ARC recognizes that a mixed safety message potentially exists if an operator crew member is using a PED during a time when the operator has said a passenger device is not safe to operate. The ARC further notes that crewmember PEDs have been specifically authorized by the FAA for use in flight by crewmembers. The operational authorization is achieved by meeting specific FAA requirements that include restrictions on the type of software allowed to be used in flight.
- (f) Operational challenges of interference with passenger medical devices and impact on autistic passengers were identified: Medical devices on board an airplane may require continuous operation; however, the ARC has been unable to confirm that medical devices are tested against DO-160 equivalent emissions standards to verify compatibility for airborne operation. Autism was mentioned by a number of respondents who indicate autistic patients, especially children, may have negative behavioral reactions during takeoff and landing when their attention is not engaged by PEDs. The ARC notes that many operators already have a process in place to evaluate specific medical devices for special needs passengers, which involves evaluating each device on an individual basis.
- (g) SMS and other risk-based assessments were incorporated in ARC Recommendations: Many of the commenters requested that PED policies ensure airplane operational safety. This is a universal objective of all of the PED ARC committee members; however, balancing safety, economic impact, and passenger convenience is the challenge. To address this need, the PED ARC recommends adapting the SMS approach to develop a comprehensive risk-based assessment tool. Service Difficulty Report (SDR) data, Operator Interference data, and Manufacturer/Supplemental Type Certificate Installer test data are recommended inputs into the SMS model analysis. (See Section 6.1 of this report.) Further, operators have guidance on determining the severity of hazard from the ARC's work summarized in Appendix F, Avionics System Functional Hazard Risk Assessment.

5.0 CONSTITUENCY DESCRIPTIONS

This chapter describes the various constituencies that comprise the ARC membership. Each member or participant on the ARC was selected to represent an identified stakeholder group or industry segment, and because the member possessed the expertise and qualifications to speak for that constituency. The FAA wanted to achieve a balance between the regulator, regulated parties, other industry stakeholders, and the flying public.

As a result of the varied constituencies, the ARC was able to engage in meaningful debate on a sound, risk-based methodology for expanding the use of PEDs, and all of the constituencies contributed to the discussions on the technical, operational, and safety communications key issues. The ARC also invited additional participation by FAA and other federal and international

regulatory authority SMEs to support the members as they collected information and data and debated recommendations.

The membership encompassed seven constituent groups representing stakeholders involved in all aspects of the PED use debate.

5.1 PED Manufacturers and Distributors

The FAA invited Amazon.com and OnAsset Intelligence, Inc., as well as the Consumer Electronics Association (CEA) which represents 2,000 companies across the consumer electronics industry, to participate in the ARC. These PED industry representatives brought an important perspective to the ARC deliberations. They described their customers' experiences, observations, and questions about PED use aboard aircraft. They also discussed FCC-mandated testing and other testing required for PEDs, as well as industry practices regarding regulatory compliance. In addition, CEA was able to share consumer research survey findings specifically related to the in-flight use of PEDs, as well as a similar survey conducted ten years earlier.

5.2 Pilot and Flight Attendant Groups

The membership included representation from the Air Line Pilots Association, International (ALPA), the largest airline pilot union in the world, and the Association of Flight Attendants-CWA (AFA-CWA), the world's largest flight attendant union. These members were invited to participate to address crewmembers' safety concerns as they relate to expanded use of PEDs.

5.3 Aircraft Operators

The membership encompassed four 14 CFR Part 119 certificated air carriers and two industry associations. Delta Airlines, JetBlue Airways, American Airlines, Executive Jet Management, the Regional Airline Association (RAA) which represents North American regional airlines, and the Helicopter Association International comprised the operator contingent. These air carrier and industry association members were able to educate the other members on the current approval process(es) associated with PED usage policies, as well the practical challenges associated with demonstrating PED-tolerance to the FAA in order to obtain approval for the expanded use of PEDs.

5.4 Passenger Experience Associations

The membership included two passenger experience associations. The Airline Passenger Experience Association (APEX) is a network of the world's leading airlines, suppliers and related companies committed to elevating the level of the passenger experience. The National Association of Airline Passengers is a nonpartisan, nonprofit organization dedicated to preserving and protecting passenger rights and representing the passenger constituency.

5.5 Airplane and Avionics Manufacturers

The membership included three airplane manufacturers—The Boeing Company, Airbus, and Cessna Corporation, as well as two industry trade associations representing airplane manufacturers. The General Aviation Manufacturers Association (GAMA) represents 80 of the

world's leading manufacturers of general aviation airplanes and rotorcraft, engines, avionics, components and related services, and the Aerospace Industries Association (AIA) represents the nation's leading manufacturers and suppliers of civil, military, and business airplane, helicopters, unmanned airplane systems, space systems, airplane engines, missiles, materiel and related components, equipment, services and information technology. The ARC membership also included three avionics manufacturers—Garmin, Thales, and Rockwell Collins. The airplane/avionics manufacturer constituency spent a substantial amount of time educating the members on PED-tolerant airplanes and the testing required for an operator to obtain operational authorization for PED usage.

5.6 Federal Aviation Administration

FAA representation on the ARC included members from the Aircraft Maintenance Division (AFS-300), Office of the Chief Counsel (AGC), and the AVS Chief Scientific and Technical Advisor for Aircraft Electromagnetic Compatibility. In addition, several FAA subject matter experts participated in the ARC, including representatives from the Aircraft Engineering Division (AIR-100), Air Transportation Division (AFS-200), Office of Communications (AOC) and Office of Rulemaking (ARM). FAA members and participants supported the efforts of the ARC by facilitating discussion of the current regulatory framework for usage of PEDs; conducting briefings on a number of technical and regulatory issues; reviewing and cataloging comments submitted in response to the *Federal Register* Notice; and answering questions for the members.

5.7 Other U.S. and International Regulatory Authorities

In addition to the members and SMEs from the FAA, ARC members included representatives from the FCC and TSA. To the extent the work of the PED ARC overlapped areas within the authority of the FCC, the FCC member was available to clarify current FCC rules and discuss changes in the rules that the Commission has either proposed or may consider in the future. The FCC representative also briefed the members on developments in the use of the radio spectrum and radio frequency devices, including the advances in medical devices that are now and will in the future be carried by many passengers. The TSA representative was available to address the overlap between operational/technical considerations and the associated security concerns. At the outset of the ARC, members expressed a desire to harmonize its efforts with the international aviation community and requested that the FAA reach out to counterpart international safety organizations in Europe. A representative from the European Aviation Safety Agency (EASA) served on the ARC, and representatives from the United Kingdom Civil Aviation Authority (U.K. CAA) and Transport Canada (TC) participated on the ARC to discuss companion international efforts to harmonize PED usage policies.

6.0 THRESHOLD RECOMMENDATIONS

The ARC developed threshold recommendations to address the core concepts consistent across all aspects involved in expanding PED usage. These recommendations apply to the technical, operational, and safety communications recommendations that appear in later chapters of this report.

6.1 SMS Methodology

To support expanded PED usage on airplanes, the ARC studied the FAA SMS methodology as one method for risk mitigation.³⁰ The key elements of the SMS process involve identifying hazards associated with the introduction of any new system and determine the likelihood and most probable outcome of the existence of the hazard. The SMS approach forces a risk determination for each hazard and if the risk is found unacceptable, forces a review of actions that could be taken to mitigate the risk to an acceptable level.

The ARC endeavored to find as many data sources as possible to determine the number of confirmed occurrences of PED interference with aircraft systems. Several members studied data sources and compiled information that was presented to the ARC, including analysis of Service Difficulty Reports (SDR), ASRS Reports, operator reports, and information from multiple Supplemental Type Certificate (STC) holders (conducting new system certification testing). To the extent such information is not proprietary and/or could be de-identified, it is included in Appendix I of this report.

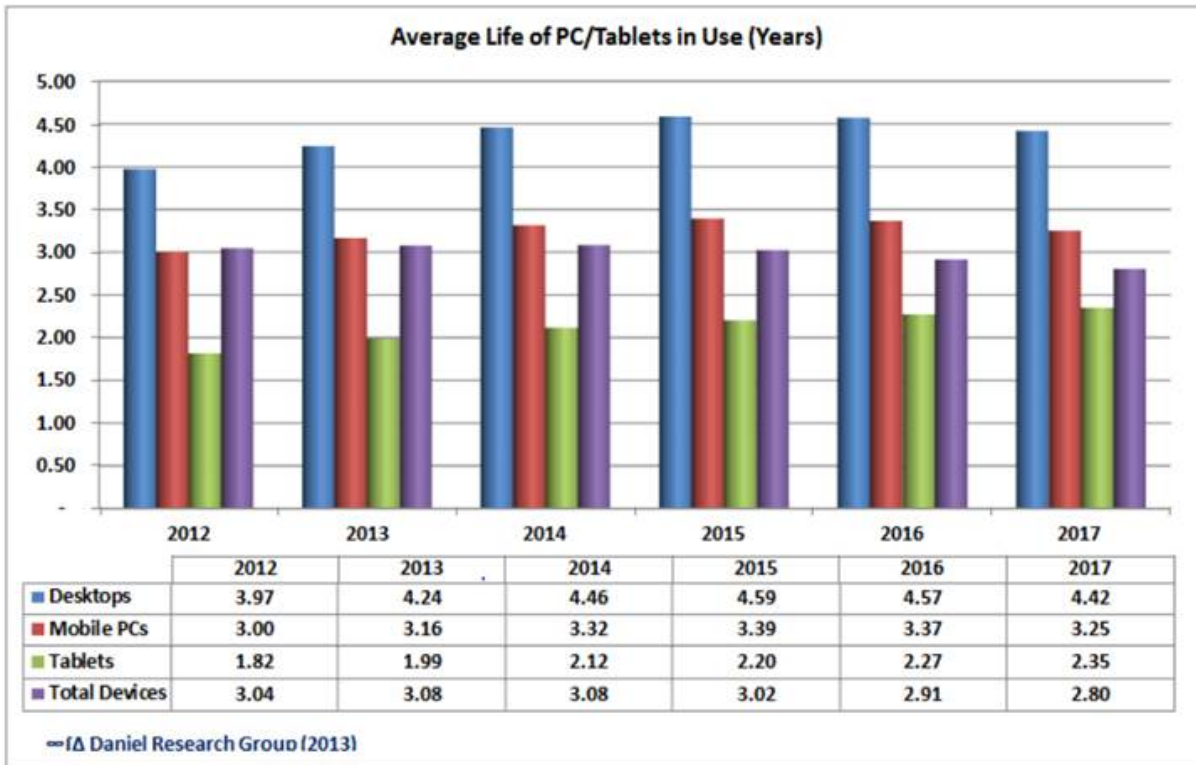
The ARC noted the difficulty that each of these sources had in confirming PEDs as a source of interference. However, each data set appeared to contain sufficient information to determine if an event was or was not related to PED interference. As there is difficulty in confirming PED interference across these data sources, the ARC recommends that an SMS risk assessment be conducted so that it captures some or all suspected PED interference events to obtain a conservative frequency of occurrence.

PED designs have also improved over time. Devices today emit much less power as manufacturers have sought to extend battery life.³¹ Transmitting PED designs have also been improved to insure devices stay within a tighter range of frequencies and transient noise envelopes. These factors have contributed to a PED population with much less potential to cause system interference. See *Figure 1* below.

³⁰ See generally, Federal Aviation Administration Office of Aviation Safety SMS Guidance at <http://www.faa.gov/about/initiatives/sms/>.

³¹ See Radio-Electronics.com (http://www.radio-electronics.com/info/cellulartelecomms/gsm_technical/power-control-classes-amplifier.php).

Figure 1 – Average Life of PC/Tablets in Use (Years)³²



For example, where devices such as portable FM radios, TV receivers, CD players and electronic hand-held games were popular years ago, today passengers are more likely to be carrying e-readers, tablet and laptop computers, music players, and smart phones that can operate in airplane mode. Many of these products have life-cycles of only a few years due to the rapid introduction of newer and better products. Accordingly, the specific device types that may have caused issues in the past may no longer be relevant today.³³

Recommendation #1—The ARC recommends that the FAA conduct an SMS risk assessment and engage safety experts on its staff and across industry to look for hazards associated with PED interference potential. While the PED ARC membership included some system expertise to identify hazards, it is suggested that a more focused group could develop a complete list of hazards that should be risk-assessed to SMS standards. To support the expanded use recommendations proposed by the ARC, the members further recommend a safety risk assessment, as outlined in [Appendix F](#) of this report.

As the SMS process is relatively new to the aviation community, the ARC also encourages the FAA to assign SMEs from the SMS Program Office to aid in the SMS risk assessment.

³² Daniel Research Group (2013) *June 2013: United States PC, Tablet, & Mobile Phone Market Size and Forecast*. Daniel Research Group.

³³ For example, portable FM radios included local oscillators that tended to generate significant spurious emissions on aeronautical frequencies, but such devices are no longer prevalent in the market.

6.2 Harmonization

Passengers worldwide must be comfortable and have sufficient knowledge to understand that airplanes are tolerant against PED emissions. Passengers are also looking for standardized, reasonable operator PED stowage requirements that balance societal expectations against projectile and egress risks. If a worldwide effective communication strategy is achieved, then the ARC believes the FAA will be positioned as a leader in international efforts to promote harmonization in this area.

Recommendation #2—The ARC recommends that the FAA promote harmonized policy with international regulatory authorities, including EASA, such that the recommendations made in the ARC report are universally accepted by international regulatory authorities. The ARC encourages the FAA to use the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO) as forums to promote expanded PED usage policy within the recommended safety framework.

The ARC notes that its recommendations in the technical, operational, and safety communications areas discussed below are all important to the universal acceptance of expanded allowance policies for PED usage in flight.

6.3 Standardization

The ARC encourages the FAA to set the standard for PED usage and stowage and encourage operators to only differ from a standard when absolutely necessary to mitigate an unacceptable risk condition. With regard to all article stowage standards, the ARC found that there has been very little policy, guidance, and analysis done with respect to what type of objects should be allowed to be out and in use during takeoff and landing. The FAA should use this opportunity to not only define what types of PEDs could be out and in use during takeoff and landing but define all article standards as well.

Recommendation #3—The ARC recommends that the FAA standardize the travelling experience for consumers such that they come to expect a consistent approach from air carriers regarding PED usage and stowage requirements.

The ARC received comments through the docket and our various constituencies that passengers do not like or understand why PED usage and stowage are different from air carrier to air carrier. Neither a lack of understanding of differences by passengers, nor an explanation by air carriers that it is “airline/operator policy” or “FAA required,” is an acceptable practice going forward.

Society has changed to where PEDs are an integral part of our everyday lives. The public expects and this ARC recommends that the FAA clearly articulate what is an acceptable risk with respect to device type and ensure confidence in the public that a proper risk assessment has been done.

7.0 TECHNICAL RECOMMENDATIONS

In addressing the technical questions associated with expanding passenger use of PEDs to all phases of flight, the ARC reviewed many data sources, and received many technical briefings, involving the RF characteristics of typical PEDs and of PED-tolerant airplanes, as well as the manner by which operators may demonstrate compliance with applicable standards. The technical recommendations were formulated to address airplane certification requirements as well as methods to enable airplane operators to allow expanded passenger PED use to all phases of flight.

7.1 Airplane Certification Requirements for New Airplanes

The ARC determined that, in order to ensure that airplanes are PED-tolerant, it would be appropriate to start with recommendations to address airplanes not yet produced (those for which a type certificate is required under 14 CFR Part 23 [commuter category only] or Part 25). In developing the recommendations associated with airplane certification, the ARC's intent was to apply the standards to new airplanes.

Recommendation #4—New Type Certificate Applications: The ARC recommends that the FAA require PED tolerant (i.e., RTCA DO-307 certified) airplane designs for all new type certificates issued for airplanes under 14 CFR Part 23 (commuter category only) or Part 25.

Recommendation #5—New Derivative Certificate Applications: The ARC recommends that the FAA require PED tolerant (i.e., RTCA DO-307 certified) airplane designs for all new derivative certificates issued for airplanes under 14 CFR Part 23 (commuter category only) or Part 25.

Recommendation #6—New Avionics, Major Changes in Type Designs: The ARC recommends that the FAA require new avionics system(s) installations that are considered major changes in type design (Supplemental Type Certificate [STC] or Amended Type Certificate [ATC]) with catastrophic failure classifications demonstrate PED tolerance (i.e., RTCA DO-307 certification) for those systems when certificated on airplanes under 14 CFR Part 23 (commuter category only) or Part 25. For new avionics system(s) installations that are considered major changes in type design (STC or ATC), where the systems are required by operating part or with major or hazardous failure classifications, and cannot demonstrate PED tolerance, a safety risk assessment (as discussed in Section 7.3 below) must be accomplished for those systems.

Recommendation #7—The ARC recommends that associated FAA guidance documents, including AC 20-164 and AC 91-21.1B, be evaluated to incorporate alternative approach(es) to allow certification of individual systems for PED tolerance. Suggested revisions may also include changes to RTCA DO-294 guidance applicable to 14 CFR Part 119 certificate holders and considerations for the operating environment.

The ARC also believes that the FAA should periodically review RTCA DO-307 (Sections 3 and 4) and the document's capacity to provide guidance for the conditions above and work with the RTCA to amend DO-307 as appropriate.

7.2 Airplane Certification Requirements for Airplanes Currently in Production

In discussing how the FAA can establish requirements to allow operators to implement expanding passenger use of PEDs, the ARC acknowledged the concerns raised by operators about the cost of modifications and the importance of expanding PED usage to existing in-service airplanes. The ARC decided that a phased approach should be available for existing (legacy) airplanes. When reviewing how this policy could be implemented on airplanes currently being produced, the ARC determined that the recommendations provided in Section 7.3, below, will cover production airplanes or the operators of those airplanes that have obtained documentation indicating that those airplanes are PED tolerant.

Recommendation #8—Newly Manufactured Airplanes: The ARC recommends that the FAA implement operational regulations that require all newly manufactured airplanes, which will be operated by 14 CFR Part 119 certificate holders under 14 CFR Parts 121 or 125, to be shown to be PED tolerant (i.e., RTCA DO-307 certified). This requirement would also apply to avionics system(s) installations that are considered major changes in type design (STC or Amended Type Certificate [ATC]) with catastrophic failure classifications, or equipment required by operating part, incorporate PED tolerant (i.e., RTCA DO-307 certification) designs when certificated on airplanes under 14 CFR Part 23 (commuter category only) or Part 25.

For avionics system(s) installations that are considered major changes in type design (STC or ATC), where the systems are required by operating part or with major or hazardous failure classifications, and cannot demonstrate PED tolerance, a safety risk assessment (as discussed in Recommendation #10) must be accomplished for those systems.

These regulations should have a compliance date no later than December 31, 2015. The FAA should grant petitions for limited extensions for operators introducing aircraft with extenuating circumstances, when justified.

7.3 Enabling Airplane Operators to Permit Expanded Passenger PED Use

The ARC reviewed AC 91-21.1B and other available information and found that the FAA has sufficient information to revise AC 91-21.1B to allow airplane operators (under 14 CFR Parts 91K, 121, and 135) to permit expanded passenger PED use to additional phases of flight, noting that the incorporation of recommended safety risk management processes would enable operators to analyze whether to allow the expanded use of PEDs for the airplanes that they operate.

Recommendation #9—The ARC recommends that the FAA modify AC 91-21.1B (and any associated guidance) to provide processes by which operators can demonstrate compliance with 14 CFR Section 121.306, 125.204, or 135.144, as applicable, in order to allow expanded use of PEDs to all phases of flight. Consideration should be given to maintaining cabin safety requirements (e.g. attention to safety announcements) when expanding PED usage.

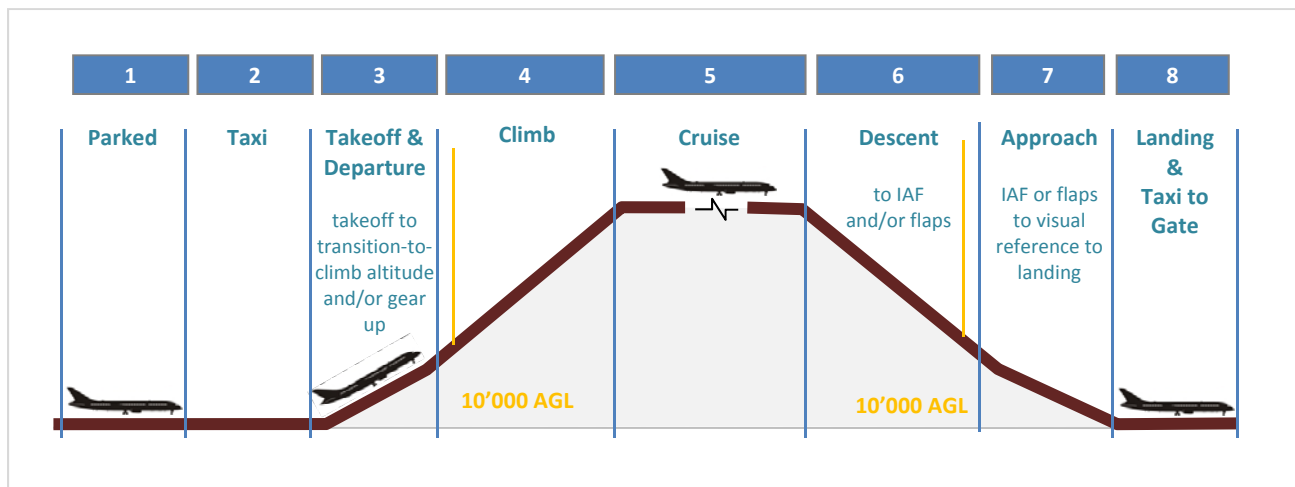
Recommendation #10—The ARC recommends that in revising AC 91-21.1B (and any associated guidance), the FAA adopt the following methodology for expanding PED usage by passengers to all phases of flight. In particular, the FAA should immediately amend/revise current regulatory guidance documents to provide a methodology by which operators can permit PED usage by passengers during all phases of flight, using one of the following two methods:³⁴

Method 1. The operator may perform PED tolerance testing, or the operator may document evidence of testing by an airplane manufacturer or other entity, that demonstrates airplanes are PED- tolerant in accordance with Sections 3 and 4 of RTCA DO-307.

Method 2. The operator may validate that its airplane and operations meet the requirements and limitations of the safety risk assessment proposed by the ARC for adoption by the FAA (attached as Appendix F to this report) for the phases of flight (identified as Phases 1-8 in *Figure 2* below) in which the operator wants to allow expanded passenger PED use. The ARC’s proposed FAA safety risk assessment addresses both back door and front door effects. Mitigations are supported by flight experience, analysis, and test data, and are provided for all failure condition classifications of Major and above, as well as for equipment required by operational rule. Back door effects are assumed to be covered by an airplane’s HIRF certification of critical systems. If an airplane is not HIRF-certified, or has not had other back door interference testing completed, additional analysis and systems testing may be required.

³⁴ Although Advisory in nature, AC 91-21.1B contains the statement that the operators PED usage program “should provide the following: ... f. Prohibiting the operation of any PEDs during the takeoff and landing phases of flight. It must be recognized that the potential for personal injury to passengers is a paramount consideration, as well as is the possibility of missing significant safety announcements during important phases of flight. This prohibition is in addition to lessening the possible interference that may arise during sterile cockpit operations (below 10,000 feet).” Operators will need updated guidance from the work done in this ARC and RTCA SC-202 in place of this language.

Figure 2 – Phase of Flight



Pursuant to this method, operators may permit passenger use of typical PEDs as follows:

- a) During any of the following phases:
 - 1 **Parked:** Passenger boarding and seating to door close.
 - 2 **Taxi Out:** Push back, taxi from gate to (but not including on) the runway.
 - 4 **Climb:** From ‘transition to climb altitude’ and/or gear retraction to en route altitude.
 - 5 **Cruise:** From en route altitude to beginning of descent with intent to land.
 - 6 **Descent:** From beginning of descent to the initiation of the approach.
 - 8 **Landing and Taxi to Gate:** Begins at airplane touchdown, and concludes when airplane is parked for passenger unloading.
- b) 3 **Take-off and Departure:** During this phase if a qualitative safety risk assessment is accomplished, and controls and mitigations are in place.
- c) 7 **Approach:** During this phase in visual approaches.
- d) 7 **Approach:** During this phase on instrument landings in visual meteorological conditions if a qualitative safety risk assessment is accomplished, and controls and mitigations are in place.
- e) 7 **Approach:** During this phase on instrument landings in CAT I conditions if qualitative safety risk assessment is accomplished, and controls and mitigations are in place.
- f) 7 **Approach:** During this phase on instrument landings in CAT II or CAT III conditions if testing and analysis shows that systems with Major, Hazardous, or Catastrophic failure conditions are determined PED tolerant.

The ARC recognizes and supports consistent application of expanded PED use policies across the aviation industry to reduce passenger confusion and inconsistency between different operator PED usage policies. Operators are encouraged to adopt standard usage profiles across flight phases to minimize passenger confusion. Operator decisions on expanded usage should take into account the goal of achieving stronger adherence to the usage policies.

Recommendation #10 Method 2: *Dissent Position*

Commercial air transportation is one of the safest modes of travel available. But it is in thinking about what could go wrong that makes it so. The PED ARC group that disagrees with the majority's Recommendation #10 above (aka, the Dissenting Group) include five individuals employed by the four organizations on the ARC that represent airline pilot; cabin crew; passenger; and entertainment, communications, IT and connectivity equipment issues: the Air Line Pilots Association, International; Association of Flight Attendants-CWA; National Association of Airline Passengers, and Airline Passenger Experience Association; respectively. The Dissenting Group supports expanded use of Portable Electronic Devices (PEDs), as long as such use is shown to be safe. However, it is the opinion of the Dissenting Group that a key recommendation contained within the majority's Recommendation #10, above, does not adequately satisfy this requirement.

According to Section 1.0 of this report, "In the Notice, the FAA indicated the desired outcome of the Request for Comments was to have sufficient information to allow operators to better assess whether more widespread use of PEDs during flight is appropriate, while maintaining the highest levels of safety to passengers and aircraft." It is important to note the desired outcome was not a guarantee that gate-to-gate use of PEDs would be the result, but only expanded use of PEDs while maintaining the highest levels of safety. Section 1.0 also states that the "PED ARC made recommendations to further clarify and provide guidance on allowing additional PEDs without compromising the continued safe operation of the aircraft."

Neither full nor general consensus³⁵ for all of the PED ARC recommendations was achieved; therefore, this section documents the dissenting position and provides an alternative to a key PED ARC recommendation to airline operators concerning so-called "legacy" aircraft; i.e., any aircraft not designed and manufactured, or otherwise determined to be, PED tolerant.

The regulatory history discussion in Section 3.1, above, notes that early studies of PED interference concluded that portable frequency modulation (FM) radio receivers caused interference to navigation systems such as VHF Omni-directional Range (VOR) navigation systems. While use of FM radio receivers seems unlikely today the VOR navigation system is

³⁵ FAA, *AVS Quality Management System: ARM Committee Process*, ARM-001-015, March 5, 2013. From Sec. 4.1 DEFINITIONS RELATED TO CONSENSUS: *Full consensus* means all members agree fully in context and principle and fully support the specific course of action; *General consensus* means that, although there may be disagreement, the group has heard, recognized, acknowledged, and reconciled the concerns or objections to the general acceptance of the group. Although not every member fully agrees in context and principle, all members support the overall position of the ARC and agree not to object to the proposed recommendation report; *Dissent* means a differing in opinions about the specific course of action. There may be times when one, some, or all members do not agree with the recommendation or cannot reach agreement on a recommendation. From 4.2.2.3 Dissenting Position: "If a member or members do not concur with one of the recommendations or the entire recommendation report, then this dissenting position is documented in the recommendation report."

still in use on most transport category aircraft. While many may feel that newer navigation systems such as GPS will make the VHF Omni-directional Range system obsolete, it may be of interest to realize that Ground Based Augmentation Systems (GBAS) that increase the accuracy of GPS for landing approach guidance will transmit correction signals to the GPS position via VHF radio transmissions.

While RTCA Special Committee SC-177 indicated that the probability of interference to installed aircraft systems from PEDs, singly or in multiples, is low at this time the Special Committee, nevertheless, stated, “However, the possibility of interference to aircraft navigation and information systems during critical phases of flight, e.g., takeoff and landing, should be viewed as potentially hazardous and an unacceptable risk for aircraft involved in passenger-carrying operations.”³⁶ This is the basis for the guidance material contained in Advisory Circular AC 91.21-1B, which states: “It must be recognized that the potential for personal injury to passengers is a paramount consideration, as well as the possibility of missing significant safety announcements during important phases of flight. This prohibition is in addition to lessening the possible interference that may arise during sterile cockpit operations (below 10,000 feet).”³⁷

This brings us to the recommendation regarding expanded PED use within the existing fleet of aircraft (as well as any near term future acquisitions of aircraft not yet determined to be PED tolerant) that is contained in Section 7.3, above; the Dissenting Group cannot agree with Method 2 of the majority’s Recommendation #10 as it is written. Currently, Method 2 of the majority’s Recommendation #10 allows an operator to use the Safety Risk Assessment (SRA) for the phases of flight in which the operator wants to allow expanded passenger PED use. As part of this SRA, mitigations have to be developed to address situations in which the risk is determined to be unacceptable. One of these mitigations would be to remove the threat by having passengers turn off their PEDs. But because this method allows the SRA to be conducted by phase of flight, such mitigation (passengers turning off PEDs) could be applied only for specific phases of flight in which the SRA has determined system severity to be Major, Hazardous, or Catastrophic. An example used in discussions was ILS CAT II approaches.

In this example, assuming the risk to the ILS CAT II approach system was determined to be Major or above, a suggested mitigation would be to have passengers turn off their PEDs when the weather was low enough to require the use of the ILS CAT II approach system. It was suggested that improved passenger compliance would result since passengers can “see” that the weather is poor. First, low visibility approaches that require use of the ILS CAT II system may be due to fog which may not be encountered until shortly before landing. In this case the passengers may only see sunshine and blue skies until just before landing. Second, making an announcement to turn off PEDs may unnecessarily scare some passengers. Third, this “phase of flight” approach will not afford the common passenger experience desired by the PED ARC.

³⁶ RTCA DO-233, page 1 Executive Summary

³⁷ AC 91.21-1B, paragraph 6.F.

Fourth, the safety of the aircraft should not be dependent on passenger compliance to turn off their PEDs; the passengers are not responsible for the safe operation of the aircraft.

Additionally, this recommendation allows an operator the opportunity to avoid doing anything, for any phase of flight, to achieve expanded PED use in its legacy fleet. The Dissenting Group supports expanded PED use for passengers as long as such expansion is shown to be safe and not merely “deemed” as such.

The argument has been made that requesting passengers turn off PEDs in the future will be no different than what is done today. However, the Dissenting Group believes that it is different since the current 10,000 ft. policy is being applied uniformly today. Under the PED ARC majority’s recommendation, compliance will be difficult to ensure consistently because it could be different from flight to flight.

The Dissenting Group is also of the opinion that any proposed change in policy regarding expanded use of PEDs should be transparent to the flight crew; i.e., that there should be no additional crew workload created by having to turn off landing navigational aids or make announcements to turn off PEDs during certain phases of flight and weather conditions. The flight crew’s job should be simply to fly the aircraft and manage safely its energy and trajectory. Ultimately, after allowing a reasonable period of time to accomplish a system-wide transition to “PED tolerant” aircraft, the Dissenting Group believes that if an airline operator needs to rely on passenger compliance with a crewmember’s instructions as a way to mitigate potentially major, hazardous or catastrophic conditions on a particular airplane, that airplane should be modified or otherwise be determined to be PED tolerant.

If operators choose, for any of their airplane configurations that are not already determined to be DO-307 compliant, to not perform PED tolerance testing or obtain evidence from an aircraft manufacturer or other entity demonstrating PED tolerance in accordance with Sections 3 and 4 of RTCA DO-307, the Dissenting Group recommends that these operators perform instead comprehensive Safety Risk Assessments, based on guidance from the FAA Safety Risk Management Panel, to identify hazards associated with expanded PED use to all communications, navigation, and surveillance equipment on those aircraft configurations. To expand the use of PEDs on these aircraft, an operator can use the SRA results to identify systems that are susceptible to PED EMI and ensure those systems comply with applicable sections of DO-307.

The PED ARC was tasked with looking into safely expanding the use of PEDs, which implies that the “status quo” is acceptable. To say it isn’t implies that today’s operations are unsafe. The Dissenting Group has concerns that the majority’s Recommendation #10, above, allows an operator to expand use of PEDs by “opting out” during certain flight phases. The Dissenting Group is of the opinion that if an operator wishes to expand the use of PEDs below 10,000 feet AGL then this means ALL operations below 10,000 feet AGL under all weather conditions (notwithstanding stowing items of mass for takeoff and landing).

The Dissenting Group alternative language for Recommendation #10 follows below. This alternative recommendation will enable 14 CFR Parts 91, 119, 121, and 135 aircraft operators the ability to allow expanded PED use on aircraft not otherwise fully PED tolerant. The ARC members reviewed AC 91.21-1B and other available information and found that the FAA has sufficient information to revise AC 91.21-1B, noting that the incorporation of DO-307 testing and/or recommended safety risk management processes will enable operators to allow the expanded use of PEDs for the aircraft that they operate.

Recommendation #10 Dissent Position—The ARC recommends that the FAA modify AC 91.21-1B (and any associated guidance) to provide methods by which operators can demonstrate compliance with PEDs during all phases of flight. By January 1, 2017 all operators will allow expanded use of PEDs during all phases of flight on all of their airplanes, consistent with the limits imposed by cabin item stowage policies as allowed by the FAA, through either of the following two methods:

Method 1: The operator may perform PED tolerance testing or properly document evidence from an aircraft manufacturer or other entity that demonstrates the airplane is PED-tolerant in accordance with Sections 3 and 4 of current version of RTCA DO-307.

Method 2: The operator may perform a Safety Risk Assessment (SRA) on each airplane model configuration in their inventory, following the process developed by the FAA Safety Risk Management Panel (SRMP) and attached in Appendix F. If the operator's SRA indicates a hazard class of CATASTROPHIC exists for a particular system, the risk must be controlled by compliance with the applicable sections of DO-307 (front door and back door, as applicable). If the SRA indicates a hazard class of MAJOR or HAZARDOUS for a failure mode of "misleading information" for a particular system, the risk must be controlled by the following process: a) Test the system to determine if it meets the standards in the applicable sections of DO-307 (front door and back door, as applicable), or an acceptable alternative; if not, b) Modify the system such that it meets the standards in the applicable sections of DO-307 (front door and back door, as applicable), or an acceptable alternative.

Before completing either Method 1 or Method 2 above for a particular airplane model configuration, an operator must continue to operate that specific configuration under existing PED usage policies, which include the turning off and stowing of PEDs below 10,000 feet Above Ground Level (AGL). In discussing how the FAA can implement changes to require that PED tolerance be demonstrated for all aircraft, the ARC acknowledges concerns raised by aircraft operators regarding the cost and operational impacts of aircraft testing and modifications, as well as the ability to transition their operations to system-wide,

expanded PED usage policies. To address these concerns, if an operator finds it difficult or cost-prohibitive to achieve full, expanded use of PEDs using either method above for one or more specific combinations of airplane model configuration and operation, the operator must prohibit PED usage below 10,000 feet AGL, or when the aircraft is “in-range” if cruising below 10,000 feet AGL.³⁸ This restriction only applies to those specific airplane model configurations/operations that the operator demonstrates to the FAA that implementation of a full-expanded PED usage policy is resource-prohibitive. Use of this restricted policy option is available only until January 1, 2017; beyond this date, all operators will ensure that all of their aircraft are determined to be PED-tolerant using either Method 1 or 2, above.

Since we have a dissenting opinion on Recommendation #10, our dissent also applies to Recommendation #19: We do not concur that all of the “approaches set up in the ARC for expansion of use as acceptable methods for compliance with PED use regulations” should be provided to operators as policy guidance. We also do not concur with use of the mitigation to turn PEDs off, which is included as an option in several parts of Appendix F, the Avionics System Functional Hazard Risk Assessment.

As mentioned at the outset, commercial air transportation is one of the safest modes of travel available, and the Dissenting Group believes adopting the above recommendations to safely expand the use of PEDs in flight will continue to ensure this.

³⁸ Note that this requirement to turn off and stow PEDs below 10,000 feet AGL is an operational risk-based limitation that will allow sufficient time for passengers to comply and crewmembers to perform compliance checks.

Recommendation #10 Method 2: ARC Position

The PED ARC spent considerable time debating the issues in *Table 1* that generated the dissent. The majority of the ARC membership voted to retain Recommendation 10, Method 2 and respond to the dissenting members' views as follows:

Operators should be free to develop an approved phase-of-flight approach to expanded use of PEDs.

The ARC majority believes the expanded use of PEDs should not be an all-or-nothing proposition. Operators should be free to develop an approved phase of flight approach in Recommendation 10, Method 2 above. Under the recommendations in this report, operators would have an opportunity to greatly expand the use of PEDs on board aircraft in almost all cases and phases of flight, which is a significant expansion and improvement over today's existing policy and practice. Dictating that expansion could only mean "all phases of flight" would deprive passengers of near-term expanded use opportunities on most phases of flight when operators could quickly demonstrate aircraft PED tolerance through a Safety Risk Assessment or DO-307. Further in response to the dissenters' views, expanded PED usage policies need not be transparent to the flight crews. The ARC majority believes it a reasonable workload request for flight crews to turn off navigation aids or make announcements. Operators would be free to establish these policies at any convenient point in the flight profile to ensure effective work flow in the cockpit. Finally, operators should be allowed to maintain the current policy without additional substantiation (i.e., use of PEDs only above 10,000 feet). The majority of ARC members believe that sufficient operational experience exists across the industry to support the current policy for PED use above 10,000 feet.

Mitigation of risk by switching off PEDs.

With the communication strategy outlined in Chapter 9.0 of this report, most ARC members believe instructions to switch off PEDs during certain critical phases of flight will remain an effective mitigation for both large and small commercial aircraft operators with the right messaging. The ARC majority believes that passengers are able to discern phase-of-flight restrictions when the reason is properly communicated and explained. Although passenger compliance with crewmember instructions is sometimes challenging, as seen with requirements for stowage, alcohol and seat belt use for example, passenger compliance with crewmember instructions is a core element of airplane travel today.

Market pressures rather than mandates should drive compliance with DO-307.

Operators' desired product offering in the marketplace should drive the decision to use the recommended tools –the Safety Risk Assessment and DO-307– to safely expand PED usage to the desired phases of flight. A Safety Risk Assessment and full certification to DO-307 are seen as potentially very impactful to operators. The possibility of failing any required testing or

discovering unacceptable risks presents unknown costs, recertification burdens and expenditure of resources to correct. In general, some aircraft types may be more complex and incur greater costs than others in order to comply with a Safety Risk Assessment and DO-307 in order to expand PED use to all phases of flight. Even in the cases where operators do not have DO-307-compliant aircraft, they should not be mandated to complete a Safety Risk Assessment. Given the costs and burdens involved, particularly for certain airlines and aircraft, it is best to avoid sweeping mandates that could harm operators and instead let market forces drive the decisions and related investments of resources.

Table 1: Summary of the Points of Disagreement

Issue	Dissenters' Position	ARC Position
Implementation of policy by phase of flight	To avoid passenger confusion, either current rules should remain in place, or expanded PED use should apply to all phases of flight.	Operators should be free to pursue the measures necessary to develop an approved phase-of-flight approach to expanded use of PEDs.
Mitigation of risk by switching off PEDs	The efficacy of switching off PEDs as an effective mitigation strategy will diminish significantly as usage expands	Flight Crew instructions to passengers is core to airline operations with each airline messaging properly to gain compliance. Passenger compliance to instructions to switch off PEDs will not diminish during the phase of flight approach with appropriate messaging.
Compliance with DO-307	Operators must comply with DO-307 or acceptable alternative by a specified date, which should be January 1, 2017.	There should be a market-oriented approach to compliance with DO-307 or acceptable alternative that is driven by the operator's own decision to safely expand the use of PEDs.

7.4 Coordination with the FCC

The ARC considered the overlap between FAA and FCC regulations and how expanded PED use by passengers might be limited by FCC rules. Generally, the FCC imposes emissions limits on PEDs and is principally concerned with protecting communications networks and other devices from harmful RF interference. In reviewing the information presented by FCC and FAA SMEs, the ARC noted that actual PED emissions are typically lower than required by the FCC, and generally below DO-160 limits.

The ARC also noted possible RF interference from airborne PEDs to ground-based networks and the relevant FCC rule, 47 CFR Section 22.925, which prohibits airborne use of PEDs operating in the 800 MHz band. The ARC determined that it would be appropriate for the FAA to ask the FCC whether its prohibition of 800 MHz cell phone use in airplanes remains current, given the sophistication of mobile phone networks and the apparent lack of air-to-ground RF interference incidents, and despite widespread ignorance of this rule, and whether airborne use of PEDs operating in other bands may be permitted.

Recommendation #11—The ARC recommends that the FAA consult with the FCC with regard to Title 47 CFR parts that apply to airborne use of PEDs.

8.0 OPERATIONAL RECOMMENDATIONS

The recommendations developed to address operational aspects of PED usage address the importance of standardization with regard to stowage of PEDs, enhanced training for airline personnel, creation of an effective job aid for operators, and regulatory action by the FAA.

8.1 Stowage of PEDs

In discussing concerns raised by passengers about the differences between operator policies, the ARC determined that standardization with respect to PED usage and stowage in the cabins of commercial airplanes is necessary to enhance the understanding and acceptance of, and compliance with, operator policies and federal regulations among passengers and airline/operator employees. Standardization will also help to manage crew workloads, such that they are not increased by any future changes to PED usage and stowage policies. Appendix G provides information for consideration when assessing the impact expanded PED use has on an operator's current stowage policies.

Recommendation #12—The ARC recommends that the FAA and industry stakeholders develop standard content and timing for cabin and flight deck crewmember instructions to passengers on use and stowage of PEDs. The development process should include testing of the messaging with members of the traveling public.

Recommendation #13—The ARC recommends that to support standardized industry best practices for stowage related to PEDs, the FAA update stowage policy and guidance documents to incorporate expanded use of PEDs as necessary.

Recommendation #14—The ARC recommends that the FAA work with industry to develop a methodology by which exceptions can be granted to PED stowage requirements for passengers with special needs (so that they may use devices with adaptive or assistive technologies) without compromising safety.

8.2 Airline Personnel Training

PED use on aircraft today is growing at an increasing rate. And while the regulations currently state that PEDs should be turned off during critical phases of flight, empirically we know that devices are being left on. While the majority of passengers say they follow clear and proper instructions on PED usage allowed prior to takeoff, the data from recent consumer research shows this is not always the case.³⁹

The following recommendations are provided to improve airline personnel training by facilitating better awareness among flight and cabin crews with the expansion of PED use in flight, thereby assisting in the validation activity associated with the proposed safety risk assessment.

Recommendation #15—The ARC recommends that the FAA work with industry stakeholders to develop consistent and standardized training on the identification of PED interference effects so that flight crews are better able to mitigate risks to aviation safety and report possible incidents for further investigation as necessary.

Recommendation #16—The ARC recommends that the FAA work with industry stakeholders to develop standardized processes for detecting/observing, reporting, evaluating, centralized data storing using existing systems if available, and summarizing of incidents, if any, involving adverse Electromagnetic Interference (EMI) effects on equipment, as well as passenger noncompliance with PED usage or stowage restrictions. Use of these tools should be part of enhanced employee training as proposed by the ARC.

Recommendation #17—The ARC recommends that the FAA work with industry stakeholders to develop model frameworks for training programs targeting crewmembers and other affected operator personnel (including management), with minor but necessary variations owing to fleet size, airplane configurations and regulatory basis (i.e., part 135 vs. 121, etc.) utilizing standardized statements. This effort should involve initial and recurrent training for all employees, including cabin and flight deck crew, gate agents, and other customer service/contact personnel.

Flight deck, cabin crew, and maintenance personnel should be given training on tools and procedures available to them to mitigate the risk of potential EMI. Flight attendants should be given training on how EMI can potentially interfere with airplane systems and why some

³⁹ CEA/APEX Survey Data showed 94% of passengers agree the instructions are clear, yet 59% say they always turn their devices completely off when asked to do so, with an additional 5% who say they sometimes turn their devices completely off. Almost one-third of passengers report they have accidentally left a PED turned on during a flight. 43% passengers incorrectly believe it is acceptable to use PEDs while taxiing to the runway, 32% while in the air before reaching the altitude where PEDs are approved for use and 26% while the plane is in its final descent. (See [Appendix H](#).)

restrictions are in place so that they are better prepared to communicate with the travelling public. Flight crews and maintenance personnel should be given training on a consistent way of reporting, through appropriate maintenance records entry, suspected EMI anomalies so that they may be properly diagnosed by maintenance and submitted by the operator to a centralized, de-identified database, which will benefit the industry and the public interest.

8.3 Creation of a Job Aid for Operators

The certification/approval path to achieving an expanded use of PEDs can involve the understanding and execution of many different RTCA documents, FAA regulations, and Inspector Checklists. This task can be overwhelming for an operator with limited resources or experience in completing such a large project. The use of a job aid that gives a checklist based approach to assist in the implementation of such a program could simplify the process and provide a standard way for separate operators to achieve the same approval. This proposed job aid would include sections addressing an assessment of airplane PED Tolerance, risks by phase of flight, applicable PEDs, and recommendations for implementing operational procedures and crew training.

Recommendation #18—The ARC recommends that the FAA work with industry stakeholders to develop a detailed job aid to lead an operator through key items of consideration. This job aid should be incorporated in the applicable FAA guidance documents.

8.4 Regulatory Action

The ARC's recommendations address various regulatory, policy and safety changes. To support these changes, the FAA should document its position on these issues and provide guidance for operators to standardize acceptable practices and procedures for operators to decide allowable passenger use of PEDs.

Many recommendations for expansion of use are based on technical determinations that determine an acceptable level of risk. Risk determinations can be controversial. There are also recommendations that could impact crew procedures, especially for flight attendants. To expand PED use, the roles, responsibilities, and assumptions for the flight crews, the operators and the regulators must be clearly defined.

The result of this activity should be coordinated with the international regulatory community to harmonize policy and regulations as much as possible. Any change(s) regarding the use of PEDs impacts operations not only in the U.S., but worldwide. Differences in policies will confuse the flying public and increase the potential for conflict and crew workload.

Recommendation #19—The ARC recommends that the FAA provide operators with policy guidance that institutes the approaches set up in the ARC for expansion of use as acceptable methods for compliance with PED use regulations.

Recommendation #20—The ARC recommends that the FAA establish policy guidance for flight crew expectations. This policy should clearly define standardized roles and responsibilities for flight crews in the context of expanded PED usage allowance by the

operator. These expectations should lessen the crew's role in enforcing the PED usage policy.

9.0 SAFETY COMMUNICATIONS RECOMMENDATIONS

In order to address current questions raised by passengers, as well as the questions that will likely arise as the operating environment for PEDs evolves, the ARC addressed several issues involving the safety communications aspect of expanded PED usage. These recommendations speak to the significance of PED terminology and the importance of effective messaging regarding PED usage policies.

9.1 PED Terminology

In the past, PEDs that transmitted or received radio frequency energy were a small subset of the larger population of PEDs. However, the consumer electronics market has evolved to where the majority of PEDs incorporate at least one, and frequently more than one, radio technology used for communication and data networking. The ARC has generated several recommendations that take into consideration the evolving marketplace for these devices.

Recommendation #21—The ARC recommends that the terminology in FAA PED regulations, including 14 CFR 91.21, 121.306, 125.204, and 135.144 be updated to remove the outdated references to electronic devices. This terminology update should also be applied to all future policy and guidance documents.

Recommendation #22—The ARC recommends the FAA consider (and encourage operators to consider) using only the term PED when communicating information on operator policy to the public. Based on market data from CEA, most PEDs carried by passengers today incorporate one or more modes of wireless connectivity. With that in mind, distinguishing PEDs as Transmitting or Non-Transmitting may be confusing to the general public.

Recommendation #23—The ARC recommends that the FAA promote and encourage airplane operators to establish more stringent policy and guidance for PEDs that are not easily accessible to passengers or crewmembers during flight operation. Guidelines to PED manufacturers on the test requirements, satisfactory test data, and operational characteristics of these devices should be published in order to provide operators with an appropriate means to evaluate PEDs for use. Examples of these devices include, but are not limited to some medical devices; asset tracking devices; data collection and monitoring devices; and devices for inventory management. (See [Appendix E](#).)

Recommendation #24—The ARC recommends that the FAA promote and encourage airplane operators to develop a common device terminology (e.g., e-readers, smart phones, and tablet computers) when communicating to passengers about expanded usage policies. The ARC further recommends implementation of this recommendation be completed by November 30, 2013 to minimize confusion for the traveling public and allow the operator to clearly state which types of PEDs are allowed to be used onboard their airplanes and during which phase(s) of flight as outlined in the operator’s usage policy.

Recommendation #25—The ARC recommends that the FAA encourage the airplane operators to provide to passengers lists of PEDs that may not be operated in flight, and make such information easily accessible through various media including printed material, websites, and audio or visual safety information.

The public comments also included a proposal to support the expanded use of PEDs during flight via a mark that would indicate device compatibility with in-flight usage. The commenter correctly recognized that manufacturers in the consumer electronics industry are moving to electronic labeling for regulatory compliance and certification marking on devices with displays. Under the recommended policy for expanding the use of PEDs during flight, differentiating acceptable versus non-acceptable devices with certification or compliance markings, whether electronic or not, may be difficult or impossible for crewmembers to observe and verify, and susceptible to counterfeiting as well, and would therefore not be useful.

Neither the FAA nor the FCC should mandate or otherwise encourage testing and/or labeling of PEDs as “safe” (from an EMI perspective) for use on airplanes.

Manufacturers of PEDs should not be prevented from marking or labeling PEDs, electronically or otherwise, to indicate compliance with requirements (i.e., DO-160) related to crew or passenger use of such PEDs on board airplanes.

9.2 Communication Regarding PED Usage Policies

Many passengers today do not understand the reasons for PED usage restrictions on board airplanes. For years, passengers have been asked to turn off devices below 10,000 feet. The industry should improve its communications to the traveling public such that the safety implications of PED usage in flight are clearly understood and accepted. Without standardized, consistent messages from the industry, passenger noncompliance will increase, confidence in the ability of the FAA and the operators to safely allow expanded use of PEDs will erode, and a nonstandard system of operator-dependent policies may emerge that further confuses the public.

Moreover, public comments indicate the traveling public is aware of PED use by crewmembers, which at times may differ from what is permitted for passengers. One example is crewmembers’ use of PEDs as Electronic Flight Bags (EFBs). Better understanding of why such differences exist would alleviate public confusion in this area. The FAA, operators and other industry stakeholders should collaborate to develop information to educate passengers on these differences, as well as develop recommendations for training provided to affected airline/operator employees.

Recommendation #26—The ARC recommends that the FAA and other stakeholders work together to develop messaging designed to better inform the public regarding why there would be restrictions on use of PEDs.

Recommendation #27—The ARC recommends that regulators, industry representatives and members of the public collaborate on the development of standardized information for travelers, which will be available in multiple, pre-tested formats at ticket purchase, in seat-pocket magazines, as well as distributed through various mass media outlets.

Recommendation #28—The ARC recommends that the FAA, in collaboration with the airline industry, explain to the public why there is a difference in PED usage policy for crewmembers versus passengers.

Recommendation #29—The ARC recommends that such collaborative efforts include programs designed to ensure the validity and efficacy of public messaging, using appropriate research, development, testing, evaluation, and feedback processes. In addition to the typical methods used for messaging to passengers (e.g., crewmember announcements, website and kiosk pop-ups, inflight magazines), the ARC further recommends that public information campaigns also leverage social media resources and applications to better anticipate and manage public perception and behavior, as well as counter misinformation as necessary.

10.0 CONCLUSION

The ARC developed and agreed to the recommendations presented in this report, which address expanding the use of PEDs during flight without compromising the continued safe operation of airplanes in the national airspace system (NAS). The ARC designed its recommendations to allow for phased implementation consistent with stakeholder capabilities, as well as sufficient opportunity to engage in a public education campaign concurrent with publication of updated/revised guidance and the allowance for expanded PED usage. The members reached consensus on 28 of the 29 recommendations included in this report. Five members of the ARC dissented to the Method 2 allowance for expanded use of PEDs as set forth in Recommendation #10 above, and the dissenting position follows the recommendation.

The ARC members and their respective organizations appreciated the opportunity to work with the FAA in studying the issue of expanding PED usage during all phases of flight and formulating recommendations. The ARC appreciates the cooperation and assistance of stakeholders from multiple sectors of the aviation industry, as well as the PED manufacturing industry, for providing information and data to the members. The members look forward to assisting the FAA in implementing the recommendations contained in this final report.

APPENDICES

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APPENDIX A: PED ARC MEMBERS

Co-Chairs

Mr. Kirk Thornburg, Industry Chair
[Delta Air Lines](#)

Mr. Tim Shaver, Designated Federal Official
Manager, Avionics Maintenance Branch (AFS-360)
[Federal Aviation Administration](#)

Members and Alternates

[Aerospace Industries Association \(AIA\)](#)

Mr. George Novak

Mr. Courtney Robinson, Alternate Member

[Airline Passenger Experience Association \(APEX\)](#)

Mr. Michael Childers, Lufthansa Systems

Mr. Rich Salter, Lumexis Corporation

[Airbus](#)

Mr. Peter Anders

[Air Line Pilots Association, International \(ALPA\)](#)

Captain Bill de Groh

Mr. Rick Kessel, Alternate Member

[Amazon.com](#)

Mr. Paul Misener, Technical Subcommittee Chair

[American Airlines](#)

Mr. Erik Miller

[Association of Flight Attendants-CWA](#)

Mr. Dinkar Mokadam

Mr. Christopher Witkowski, Alternate Member

[The Boeing Company](#)

Mr. David C. Hartze

Cessna Aircraft Company

Mr. Billy M. Martin

Consumer Electronics Association (CEA)

Mr. Douglas Johnson, Safety Communications Subcommittee Chair

European Aviation Safety Agency (EASA)

Mr. Friedhelm Runge

Mr. Julian Hall, Alternate Member

Executive Jet Management, (EJM)

Ms. Michelle A. Schopp

Federal Aviation Administration

Ms. Nancy Sanchez

Mr. Dave Walen

Federal Communications Commission

Mr. Julius Knapp

Garmin

Mr. Praf Patel

General Aviation Manufacturers Association (GAMA)

Mr. Greg Bowles

Helicopter Association International (HAI)

Mr. Harold Summers

JetBlue Airways

Captain Chuck Cook, Operational Subcommittee Chair

National Association of Airline Passengers

Mr. Douglas Kidd

OnAsset Intelligence

Ms. Nikki Cuban

Regional Airline Association (RAA)

Ms. Stacey Bechdolt

Mr. Scott Foose, *Alternate Member*

Rockwell Collins

Ms. Susan Beard

Thales Avionics, Inc.

Mr. Ken Brady

Transportation Security Administration

Mr. James Klipp

Mr. Lee Waller, *Alternate Member*

FAA Participants & Subject Matter Experts

Ms. Frankie Berry (AFS-300)

Ms. Andrea Copeland (ARM-200)

Ms. D.K. Deaderick (AFS-200)

Mr. Les Dorr (AOC-100)

Mr. Brian Hint (AFS-430)

Ms. Marci LaShells (AFS-320)

Mr. Lee Nguyen (AFS-130)

Mr. Steve Ramdeen (AIR-100)

Ms. Monalisa Tindall (AFS-360)

Mr. Ricky Chitwood (AFS-240)

Mr. Brian Verna (AFS-360)

Mr. Bob Warren (AFS-360)

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APPENDIX B: ABBREVIATIONS & ACRONYMS

Abbreviation/Acronym	Definition
14 CFR	Title 14 of the Code of Federal Regulations
A4A	Airlines for America
AC	Advisory Circular
AFA	Association of Flight Attendants
AFS-200	Air Transportation Division
AFS-300	Aircraft Maintenance Division
AGC	Office of the General Counsel
AGCC	Aviation Government Coordinated Council
AIR-100	Aircraft Engineering Division
ALPA	Air Line Pilots Association, International
AOC	FAA Office of Communications
APEX	Airline Passenger Experience Association
ARC	Aviation Rulemaking Committee
ARM	FAA Office of Rulemaking
ASCC	Aviation Sector Coordinating Council
AVS-1	FAA Associate Administrator for Aviation Safety
CAA	Civil Aviation Authority
CEA	Consumer Electronics Association
CIPAC	Critical Infrastructure Partnership Advisory Council
CWA	Communication Workers of America
DFO	Designated Federal Official
DHS	Department of Homeland Security
DOT	Department of Transportation
DVD	Digital Video Disc
EASA	European Aviation Safety Agency

<u>Abbreviation/Acronym</u>	<u>Definition</u>
EFB	Electronic Flight Bag
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FM	Frequency Modulation
FOIA	Freedom of Information Act
GAMA	General Aviation Manufacturers Association
GBAS	Ground Based Augmentation Systems
HAI	Helicopter Association International
HIRF	High-intensity Radiated Fields
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NIPP	National Infrastructure Protection Plan
PED	Portable Electronic Devices
PPD	Presidential Policy Directive
RAA	Regional Airline Association
RF	Radio Frequency
RTCA	Radio Technical Commission for Aeronautics
SDR	Service Difficulty Report
SIG	Bluetooth Special Interest Group
SME	Subject Matter Expert
SMS	Safety Management System

<u>Abbreviation/Acronym</u>	<u>Definition</u>
SRM	Single-Pilot Resource Management
SSA	Sector Specific Agency(ies)
TC	Transport Canada
TSA	Transportation Security Administration
TSS	Transportation Systems Sector
TSSGCC	Transportation Systems Sector Government Coordinating Council
VOR	VHF Omni Range
WLAN	Wireless Local Area Network

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APPENDIX C: PED ARC CHARTER



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Aviation Rulemaking Committee Charter

Effective Date: 1/07/13

SUBJECT: Portable Electronic Device Aviation Rulemaking Committee

- 1. PURPOSE.** This charter establishes the Aviation Rulemaking Committee (ARC) for Portable Electronic Devices according to the Administrator's authority under Title 49 of the United States Code (49 U.S.C.) 106(p)(5). This charter outlines the committee's organization, responsibilities, and tasks.
- 2. BACKGROUND.** In 1966, the Federal Aviation Administration (FAA) first published regulations to address the issue regarding the use of portable electronic device (PED) on aircraft. The rulemaking was prompted after the 1958-1961 studies of PED interference concluded that portable frequency modulation (FM) radio receivers caused interference to navigation systems such as VHF Omni Range (VOR) navigation systems. The rulemaking concluded that the aircraft operator was best suited to determine which PEDs would not cause interference with the navigation or communication system on their aircraft. It further recognized that to require the FAA to conduct or verify tests of every conceivable PED, as an alternative to a determination made by the operator, was impractical and would place an excessive and unnecessary burden on the Agency.

The potential for aircraft interference depends on the aircraft and its electrical and electronic systems, as well as the type of PED being used. Prior to fly-by-wire flight controls, the primary concern was the susceptibility of sensitive aircraft communication and navigation radio receivers to spurious radio frequency emissions from PEDs. Many of these aircraft using this older technology are still in service, and are as susceptible today to interference as they were 45 years ago. When aircraft included fly-by-wire controls and electronic displays, the susceptibility of these aircraft systems also became a concern. Today's highly critical fly-by-wire controls and electronic displays are designed and certified to withstand interference from various radiated fields, including transmitting PEDs. However, not all aircraft electrical and electronic systems were designed to withstand these fields. These newer aircraft still have sensitive navigation, communication, and surveillance radio receivers that may be susceptible at certain frequencies to spurious radio frequency emissions from PEDs.

PEDs have changed considerably in the past few decades, and output a wide variety of signals. Some devices do not transmit or receive any signals, but generate low-power radio frequency emissions. Other PEDs, such as e-readers, are only active in this manner during the short time that a page is being changed. Of greater concern are intentional transmissions from PEDs. Most portable electronic devices have internet connectivity that includes transmitting and receiving signals wirelessly using radio waves, such as Wi-Fi, Bluetooth, and various other cellular technologies. These devices transmit higher powered emissions and can generate spurious signals at undesired frequencies, particularly if the device is damaged.

Since the initial rulemaking, the FAA has led four industry activities to study PEDs as they have evolved. In the early 1990s, the variety of PEDs had grown to the point that the industry felt it

Initiated By:AJM-232

could not keep up. The third industry activity was convened to review the overall risk of PED use. That study concluded that the risk of interference from non-transmitting PEDs such as tape or CD players and early personal computers was extremely low. The study determined that airlines could adopt a broad PED use allowance policy during phases of flight where the impact of interference would be low, but that PEDs should not be used during the critical phases of flight. The FAA agreed and developed an advisory circular which outlined this guidance as an acceptable method of compliance for PED regulations. This guidance is still in use and is the basis for most airlines' current policy allowing broad use of non-transmitting PEDs above 10,000 feet.

Under today's FAA regulation, the aircraft operator is still responsible for determining which PEDs may be used and during which phase of flight this utilization may occur. The operators' PED policy determines what types of devices may be used on board their aircraft and during which phase of flight. The responsibility for enforcing an aircraft operator's PED policy typically falls on the cabin crew. On occasion, enforcement of a commercial airline's PED policy results in a conflict between a flight attendant and a passenger. Noncompliance with crewmember safety instructions on the use of PEDs has resulted in passengers being removed from an aircraft, and in some cases caused in-flight diversions.

Current FAA regulations prohibit the use of PEDs during flight unless the aircraft operator has determined the device will not cause interference with the navigation or communication systems on the aircraft. Current guidance allows broad use of non-transmitting PEDs during non-critical phases of flight without detailed study of specific PEDs. However, if an operator wishes to expand its PED use allowance, FAA policy and guidance is in place to allow PED use, with the proper testing and analysis, during any phase of flight. The one exception is that Federal Communication Commission regulations prohibit the use of cellular devices while in-flight.

In August 2012, the FAA released a Federal Register notice request for comments (RFC) about key areas of FAA policy and guidance that are used by aircraft operators when they make these determinations.

3. **OBJECTIVES AND TASKS OF THE ARC.** The PED ARC will provide a forum for the United States aviation community and PED manufacturers to review the comments received from the Federal Register notice.

Recommendation Report. The PED ARC shall make recommendations to further clarify and provide guidance on allowing additional PEDs without compromising the continued safe operation of the aircraft.

The ARC will submit a report detailing recommendations for allowing additional PED usage.

4. **ARC PROCEDURES.**
 - a. The ARC advises and provides written recommendations to the Administrator through the Associate Administrator for Aviation Safety and acts solely in an advisory capacity. Once the ARC recommendations are delivered, it is within the discretion of the Administrator and the Associate Administrator for Aviation Safety to determine when and how the report of the ARC is released to the public.

- b. The ARC may propose additional tasks as necessary to the Administrator through the Associate Administrator for Aviation Safety for approval.
- c. The ARC will submit a report detailing recommendations by 7/31/2013, on the technical, policy and procedural guidance that the aircraft operators need to safely expand the use of various types of PEDs throughout the entire flight. The co-chairs of the ARC will send the recommendation report to the Administrator through the Associate Administrator for Aviation Safety and the Director of the Office of Rulemaking.
- d. The ARC may reconvene following the submission of its recommendations for the purposes of providing advice and assistance to the FAA, at the discretion of the Administrator provided the charter is still in effect.
- e. The committee will discuss and present information, guidance, and recommendations that the members of the committee consider relevant to disposing of issues.
- f. The Administrator through the Associate Administrator for Aviation Safety may jointly issue additional taskings, including deliverable dates.

5. ARC ORGANIZATION, MEMBERSHIP, AND ADMINISTRATION. The committee will consist of members from the FAA including members from the Air Transportation Division (AFS-200), Aircraft Maintenance Division (AFS-300), Aircraft Engineering Division (AIR-100), and the Chief Scientific and Technical Advisor for Electromagnetic Interference and Lightning. It will also consist of about 20 members, representing the following areas.

- PED Manufacturers and Trade associations
- Pilot and Flight Attendant Groups
- Airline Operators and Associations
- Passenger Representatives/Associations
- Aircraft Manufacturers and Associations
- Other U.S. and International Regulatory Authorities

Each member or participant on the committee should represent an identified aviation community or consumer electronics segment with the authority to speak for that segment. To promote discussions, membership on the committee will be limited. Active participation and commitment by members is essential for achieving the committee objectives and for continued membership on the committee. The committee may invite additional participants as subject matter experts to support specialized work groups.

The Administrator is the sponsor of the ARC and will select an industry chair(s) from the membership of the ARC and the FAA designated Federal official for the ARC. The FAA participation and support will come from all affected organizations within the agency.

- a. The ARC sponsor is the Administrator who:
 - 1. Appoints members or organizations to the ARC;
 - 2. Receives all ARC recommendations and reports through the Associate Administrator for Aviation Safety;
 - 3. Selects industry and FAA members; and

4. Provides administrative support for the ARC, through the Flight Standards Service.
- b. The industry chair(s) will:
 1. Coordinate required committee and work groups (if any) meetings in order to meet the ARC's objectives and timelines;
 2. Provide notification to all ARC members of the time and place for each meeting;
 3. Ensure meeting agendas are established and provided to the committee members in a timely manner;
 4. Keep meeting minutes;
 5. Perform other responsibilities as required to ensure the ARC's objectives are met; and
 6. Provide a status update in writing to the Administrator through the Associate Administrator for Aviation Safety at 3 months from the effective date of this charter.
6. **COST AND COMPENSATION.** The estimated conservative cost to the Federal Government is approximately \$50,000. Initial plans call for face-to-face meetings every other month. Bi-weekly telecons and/or polycoms will supplement these face-to-face meetings. Most meetings will take place in Washington, DC. All travel costs for Government employees will be the responsibility of the employee's organization. Non-Government representatives serve without government compensation and bear all costs related to their participation.
7. **PUBLIC PARTICIPATION.** ARC meetings are not open to the public. Persons or organizations outside the ARC who wish to attend a meeting must get approval in advance of the meeting from a committee co-chairperson or designated Federal official.
8. **AVAILABILITY OF RECORDS.** Consistent with the Freedom of Information Act, Title 5, U.S.C., section 522, records, reports, agendas, working papers, and other documents that are made available to or prepared for or by the committee will be available for public inspection and copying at the FAA Aircraft Maintenance Division, Avionics Branch (AFS-360), 950 L'Enfant Plaza, SW., Washington, DC 20024. Fees will be charged for information furnished to the public according to the fee schedule published in Title 49 of the Code of Federal Regulations, Part 7.

You can find this charter on the FAA Web site at:
http://www.faa.gov/regulations_policies/rulemaking/committees/documents/
9. **DISTRIBUTION.** This charter is distributed to director-level management in the Office of the Associate Administrator for Aviation Safety, and the Office of Aviation Policy and Plans.
10. **EFFECTIVE DATE AND DURATION.** This ARC is effective January 7, 2013. The ARC will remain in existence until July 31, 2013, unless sooner suspended, terminated or extended by the Administrator.

Issued in Washington, DC, on

NOV 8 2012

A handwritten signature in black ink, appearing to read "Michael P. Huerta", is written over a circular stamp.

Michael P. Huerta
Acting Administrator

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APPENDIX D: SAMPLE PASSENGER BRIEFING ANNOUNCEMENT

Appendix D includes the sample Passenger Briefing Announcement developed by the PED ARC Safety Communications Subcommittee.

The Safety Communications Subcommittee members suggested that the safety briefing for passengers that occurs before takeoff be standardized and that it include a statement(s) similar to the following, as applicable:

- “This aircraft has not yet been assessed to tolerate emissions from electronic devices. Please power them off until an announcement is made that it is OK to turn them back on again.”
- “This aircraft tolerates emissions from electronic devices for all phases of flight, except during certain instrument-only landings, at which time the pilot will restrict usage of electronic devices to ensure safety.”
- “This aircraft tolerates emissions from electronic devices for all phases of flight. Please note, however, that the pilot is authorized to restrict use of electronic devices as necessary to ensure safe operation of the flight.”

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APPENDIX E: SHOW COMPLIANCE STANDARD FOR INACCESSIBLE PEDS IN FLIGHT

In the case of PEDs that operate in the cabin or cargo areas of the aircraft and are not accessible by passengers or crewmembers during flight operation, PED manufacturers should provide satisfactory test data and documentation to operators for the determination on whether additional aircraft testing is needed.

Devices that are often not accessible during flight operations include but are not limited to: embedded medical devices; data collection and monitoring devices; asset tracking and inventory management; and other PEDs that often include connectivity (cellular, Wi-Fi⁴⁰, Bluetooth⁴¹, and radio frequency). For the purposes of this section, inaccessible PEDs do not include devices stowed by passengers in carry-on baggage intended for personal use.

The following satisfactory test data and operational characteristics should be provided by the PED manufacturer to show PED compliance and safety without the need for operator led electromagnetic compatibility testing:

- (1) Satisfactory test report from a properly accredited, independent laboratory for RTCA DO-160, Section 21 categories H radiated emissions testing. This testing must include the PED configured with any peripheral probes or other attachments that would be used during flight operation;
- (2) PED operational characteristics with automated and prolonged radio suspension in flight must include multiple modes of redundancy (“automatic airplane mode”) or verification that no radio transmitter is used;
- (3) Report containing the operational description, technical specifications, product label, and images of the PED and any peripheral attachments;
- (4) Failure Mode and Effects Analysis report (FMEA) of the PED and any peripheral attachments; and
- (5) Declaration of stringent design and production controls in place during PED manufacturing.

⁴⁰ Wi-Fi is defined as "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards". Wi-Fi is a trademark of the Wi-Fi Alliance.

⁴¹ Bluetooth is managed by the Bluetooth Special Interest Group (SIG). The SIG is the body that oversees the development of Bluetooth standards and the licensing of the Bluetooth technologies and trademarks to manufacturers. The SIG is a privately held, not-for-profit trade association founded in September 1998.

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APPENDIX F: AVIONICS SYSTEM FUNCTIONAL HAZARD RISK ASSESSMENT

Appendix F includes the complete Avionics System Functional Hazard Risk Assessment developed and documented by the PED ARC Safety Assessment Working Group, as submitted to the PED ARC on September 16, 2013.

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**Federal Aviation
Administration**

FAA/AFS-360
September 25, 2013

Portable Electronic Device (PED) Aviation Rulemaking Committee Avionics System Functional Hazard Risk Assessment

Summary
The ARC has determined that in order to expand PED use to certain phases of flight, an assessment of the risks must be made. To assist operators in making the safety determination, the FAA will develop a risk assessment based on the information and data available at this time. This paper outlines the approach used to establish the safety risk assessment, documents the assumptions and provides operators with a base lined risk assessment that they can use when developing their PED allowance usage policy.

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Appendix 1

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1. Background

- 1.1. During its deliberations, the ARC recommended that the FAA conduct a safety management system (SMS) risk assessment and engage safety experts on its staff and across industry to look for hazards associated with PED interference potential.
- 1.2. While the PED ARC membership included some system expertise to identify hazards, the ARC suggested that a more focused group could develop a complete list of hazards, assessed to SMS standards.
- 1.3. To support expanded PED use recommendations proposed by the ARC, this safety risk assessment was accomplished to assist the operators when determining if expanded use of PEDs is acceptable for their aircraft and operations.
- 1.4. This assessment looks at the technical risks associated with PED induced failures to avionics systems. It is intended to be used as a tool in conjunction with other operational considerations. Considerations such as PED stowage, crew and passenger education, or other operational issues must be addressed when expanding passenger use of PEDs to other phases of flight.
- 1.5. This assessment reviews the avionics systems and functions that were available and prevalent at the time of the review.

2. Acknowledgement

The ARC Chair thanks the numerous FAA and industry experts that performed initial research and contributed information for this study. Additionally, we would like to recognize the contributions of the following individuals who have volunteered their significant time and expertise to this effort:

Captain Chuck Cook, JetBlue
Richard Jennings, FAA
Rick Kessel, ALPA
Billy Martin, Cessna
Erik Miller, American Airlines

Michelle Schopp, EJM
Tim Shaver, FAA
Brian Verna, FAA
Dave Walen, FAA

3. System Functional Hazard Risk Assessment

This assessment is broken down into six basic areas of consideration.

- **Hazard identification** - Identify hazards and consequences
- **Risk analysis** - Analyze hazards and identify risks
- **Risk assessment** - Consolidate and prioritize risks
- **Likelihood Assessment** - Assess probability
- **Decision making** - Identify mitigations and controls; and
- **Validation** - Evaluate results for further action.

4. Hazard Identification

- 4.1. This assessment identifies and classifies functional failure conditions associated with the operation of the aircraft systems, with a hazard classification of major and above. These functional failure conditions are placed into two categories based on the types of interference coupling mechanisms to which the systems are susceptible. For the purpose of this assessment, those categories are “front door” coupling and “back-door” coupling to the susceptible systems.

To address these problems, in 2003 the FAA tasked RTCA⁴² with development of design certification standards to ensure that aircraft systems would tolerate PED emissions. These design standards ensure the coupling paths are at the level to ensure protection from both front door and back door emissions.

Assumption: ***Aircraft systems that comply with the design tolerance requirements established in RTCA DO-307 as discussed in FAA Advisory Circular (AC) 20-164 need no further systems level functional hazard safety risk analysis.***

4.2. Back Door Coupling

Intentional RF emissions from transmitting portable electronic devices have the potential to interfere with aircraft electrical and electronic systems by the emitted signal coupling to cables or directly into the aircraft system equipment. The potential for interference depends on the strength of the PED transmitted signal, and the aircraft system susceptibility at the specific frequency of the PED transmission.

- 4.2.1. Some aircraft electrical and electronic systems are protected against the effects of electromagnetic interference, particularly against high intensity radiated fields (HIRF), and both the direct and indirect effects of lightning. The system tolerance to RF fields depends on the system criticality and its location in the aircraft. The aircraft system HIRF and lightning protection provide sufficient immunity to the back door effects of PEDs⁴³.
- 4.2.2. Since 1986, the FAA has required compliance to the HIRF requirements, implemented through special conditions. This history of the application of HIRF requirements is explained in the preamble of the 2006 notice of proposed rulemaking⁴⁴. HIRF special conditions were applied to systems whose failure or malfunction would prevent continued safe flight and landing of the aircraft. The majority of aircraft certified since 1989 were also certified to the JAA/EASA special conditions, which required compliance to Major, Hazardous and Catastrophic failure conditions, in similar fashion to the existing rule.

⁴² RTCA DO-307 “Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance” and AC 20-164 “Designing and Demonstrating Aircraft Tolerance to Portable Electronic Devices”.

⁴³ See RTCA DO-307 “Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance”, paragraph 2.2.3 for further discussion.

⁴⁴ See Docket No. FAA-2006-23657, Notice No. 06-02 for full information. Available at www.regulations.gov

- 4.2.3. The risk analysis accomplished in Appendix 1 provides information about the protections provided by HIRF requirements and the residual risk factors for back-door interference.

Assumption: *Critical aircraft systems in the analysis included in Appendix 1 is assumed to meet the design High Intensity Radiated Field (HIRF) design criteria and therefore are not susceptible to Back-door interference. Refer to the aircraft Type Certificate Data Sheet (TCDS) for the certification basis at the original date of manufacture, a list of the applicable certification regulations, and Special Conditions compliance.*

- 4.2.4. Some aircraft have wireless connectivity systems installed for passenger use. During certification of these systems, specific tests were performed to ensure that back-door interference from PEDs communicating with the wireless connectivity system does not occur. Those tests are defined as part of an issue paper. See FAA AC 20-166 "Issue Paper Process" for more details on issue papers used during the wireless system certification. The tests use a portable wireless IEEE 802.11a/b/g/n transmitter emulator consisting of a signal generator, amplifier and transmitting antenna. The radiated power of the emulator is 36 dBm (4 watts) EIRP. The emulator antenna is positioned throughout the airplane cabin and flight deck including positions at cabin seats, aisles, galleys, crew rest areas, lavatories and the cockpit or flight deck. During the tests, all aircraft systems that are **Required** by regulations (such as flight/cockpit recorders), or have **Major, Hazardous** and/or **Catastrophic**, failure conditions (such as primary flight displays and electronic engine controls, etc.) are monitored to ensure proper performance. This emulation test does not take place of HIRF or DO-307 certification which requires testing across a much wider frequency spectrum. However, it ensures that the maximum expected power levels from the normal T-PED systems will not introduce back-door interference to the critical systems when operated. The operator must accomplish a review of the data used during wireless connectivity system certification and verify that the testing shows that the systems critical to the expanded phase of flight were PED tolerance tested. The operators may use that to support their PED allowance determinations for those flight phases.

Assumption: *Aircraft systems with major, hazardous and catastrophic failure conditions that have been tested during certification of wireless system installations and found to comply with backdoor interference requirement may use that testing in lieu of DO-307 certification as applicable.*

Note: *At the time of this writing, use of cellular technology is prohibited in flight per FCC regulations. If the operator intends to use cellular technology in flight, or if the operational environment changes in such a way that cellular use becomes prevalent, then additional testing of aircraft systems may need to be accomplished for back door interference effects.*

4.3. Front Door Coupling

- 4.3.1. This type of interference coupling mechanism occurs in the operational band of the avionics receivers. The spurious emissions from PEDs received by the aircraft radio receiver antennas can potentially interfere with aircraft radio receivers.
- 4.3.2. Current PED production specifications tend to increase front door effect safety margins (decrease probability of PED interference) due to a reduction in both power output and unintentional (spurious) emissions from PEDs. There are several reasons for this:
 - Miniaturization of the electronics to save power.
 - Large reduction in power consumption in the non-active state, driven primarily by the desire to extend battery life.
 - Current prevalent PED design incorporates multiple transmitters within the same unit, which requires isolation and drives a reduction of spurious emissions to ensure compatibility within the unit itself.
 - Typical consumer PED design tends to be characterized as ‘digital’, rather than ‘analog’, which reduces the broadband emissions when compared to older electronic devices. Devices that contain certain design elements like a motor or DC-DC converter (e.g. CD players, older robotic toys) could produce fairly significant emissions and introduce a front door coupling issues.

In addition, many of the same mitigations given for PEDs are also applicable to modern avionic systems, which are becoming much more digital in design. These systems (though still susceptible to front door effects, such as the broadband, spurious emissions prevalent in PEDs, that could possibly degrade or undermine the availability of the function) are much less susceptible to the front door effects that would result in “misleading information” which is generally accepted as the greatest threat presented by the PEDs to the safety of the aircraft.

- 4.3.3. This assessment establishes severity classifications based on the level required for system installation certification. The severity classifications provided in this analysis were established using the Functional Hazard Assessment (FHA) of several aircraft and avionics manufacturers, as well as other FAA operational safety assessments and FAA advisory circular guidance materials. These included both large transport airplanes certificated under 14 CFR Part 25 and smaller airplanes certificated in the normal and commuter categories.

A FHA is conducted at the beginning of the aircraft/system development cycle. It identifies and classifies the failure condition associated with the aircraft functions and combinations of aircraft functions. These failure condition classifications establish the safety objectives and are the means used by the manufacturers to define design requirements and develop a system architecture capable of meeting the requirements of 14 CFR 25.1309. The FHA process ensures that the required design features and operational aspects are provided in the finished aircraft or avionics system design.

A system level FHA is also a qualitative assessment which is iterative in nature and becomes more defined as the system evolves. It considers a failure or combination of system failures that affect an aircraft function

In order to make this approach applicable to as broad a range of applications as possible, the assessment accomplished in this report builds upon existing FHAs by reviewing the system failure modes with respect to a 'front door' interference event potentially introduced with the expansion of PED use, and assesses the operational effect of the failure mode in various phases of flight.

In general, broadband PED spurious emissions with noise-like characteristics increase the noise floor of the affected aircraft radio receivers, distorting low level desired signals until they are no longer usable. This effectively increases the level of the desired signal necessary for proper communication or guidance, decreasing the maximum operating range for the aircraft radio system. Narrow band spurious emissions from PEDs with continuous wave (CW) characteristics can also be received by the aircraft radio receivers and detected as a valid signal, resulting in erroneous responses from system receivers. Broadband spurious emissions are likely to be more of a threat than narrowband emissions which require a worst-case combination of conditions to affect the avionics receivers. Relevant avionics system failure modes can be classified into three basic categories.

- Denial of service – This failure condition prevents the avionics receiver system from receiving the desired signals rendering the system functionally inoperative.
- Degradation of service - This failure condition inhibits the avionics receiver system from optimal performance. In some instances the accuracy of the system may be degraded. In others, the system's receiver range may be degraded.
- Misleading information – This failure condition causes the system to provide misleading information without introducing a system failure and may not be obvious to the crew.

PED interference that introduces these failure modes are an occurrence whose origin is distinct from the airplane. These are produced as an unintended consequence of PED usage.

Note: ***The failure modes used in this analysis are not intended to cover intentional interference, malicious intent or sabotage.***

Each avionics receiver system has been evaluated to determine the impact these failures could have on the system. Like HIRF, system architecture such as placement of receiver system antennas, could result in common cause failures. These common cause events or failures can bypass or invalidate redundancy or independence of some systems. This analysis considers common cause failures when reviewing potential mitigation and controls.

4.3.4. Avionics Receiver System Analysis

4.3.4.1. ADF, HF and HF Datalink

The ADF, HF voice, and HF datalink radios, which operate at frequencies below 30 MHz, have been determined in RTCA DO-294 and DO-307 to have sufficient protection from PED emissions and does not require further analysis. This is because the physics of PED emissions in these frequency ranges preclude meaningful emissions at these frequencies. Since PEDs are physically small, they cannot radiate frequencies with wavelengths significantly larger than the dimension of the PED. For example, the wavelength of the upper frequency range of the HF voice transmitter (30 MHz) is 10 meters, resulting in a quarter wavelength of 2.5 meters and one-tenth wavelength (where radiators begin to act as transmission lines) of 1 meter, which is much larger than the typical PED.

4.3.4.2. Marker Beacon

The Marker Beacon system has been determined in RTCA DO-294 and DO-307 to have sufficient protection from PED emissions and does not require further analysis. This is because the statistical PED emissions reported in RTCA DO-307, Table 4-5 are already significantly lower than the aggregate receiver interference threshold. Thus, the Marker Beacon system is not affected by PED-induced spurious emissions.

4.3.4.3. Instrument Landing Systems (ILS)

- 4.3.4.3.1. **Localizer**⁴⁵ - The Localizer (LOC) provides a reference signal aligned with the runway centerline and deviation signals when the airplane is displaced left or right of the extended runway centerline. The linear coverage area for this signal is approximately 3 degrees either side of the extended runway centerline from a point emanating at the far end of the runway. The LOC data are displayed to the crew on the primary flight displays.

The localizer transmitter operates on one of 40 ILS channels within the frequency range of 108.10 to 111.95 MHz. The signal transmitted by the localizer consists of two vertical fan-shaped patterns that overlap, at the center. They are aligned with the extended centerline of the runway. The right side of this pattern, as seen by an approaching aircraft, is modulated at 150 Hz. The left side of the pattern is modulated at 90 Hz. The overlap between the two areas provides the on-track signal.

The width of the navigational beam may be varied from approximately 3° to 6°, with 5° being normal. It is adjusted to provide a track signal approximately 700 ft wide at the runway threshold. The width of the beam increases so that at 10 NM from the transmitter, the beam is approximately one mile wide.

⁴⁵ RTCA/DO-195, *Minimum Operational Performance Standards for Airborne ILS Localizer Receiving Equipment Operating within the Radio Frequency Range of 108-112 MHz*, Prepared by SC-153, November 17, 1986.

With special authorization, the localizer system can be also used for low visibility take-off guidance. Operators may be authorized takeoff minimums with a visibility of 300 feet runway visual range (RVR). For these operations, the airport ground localizer equipment must meet stringent requirements. The airport facility must also have certain equipment installed and operating. These include taxiway lead-on lights serving the takeoff runway; at least two RVR sensors and High Intensity Runway Lights (HIRL).

Note: *This assessment does not address low visibility localizer take-off operations. If an operator chooses to allow PED use during these operations, they must assess the associated risks. The failure modes for the localizer function remain the same as in this assessment, however the hazard levels for the failures were not available when this assessment was completed and must be determined.*

4.3.4.3.2. **Glide Slope**⁴⁶ The ILS glide slope provides a vertical flight path (nominally 3 degree descent angle) to a point in the landing zone of the runway. The vertical coverage is approximately 0.7 degrees on either side of the vertical reference path. The GS data is displayed to the crew on the primary flight displays. The GS signal is transmitted on a carrier frequency using a technique similar to that for the localizer. The center of the glide slope signal is arranged to define a glide path of approximately 3° above horizontal (ground level). The beam is 1.4° deep (0.7° below the glide-path center and 0.7° above).

The ILS glide slope is produced by a ground-based UHF radio transmitter and antenna system, operating at a range of 329.30 MHz to 335.00 MHz and is also modulated with 90 Hz and 150 Hz tones, with a 50 kHz spacing between each channel. The transmitter is located 750 to 1,250 feet (ft) down the runway from the threshold, offset 400 to 600 ft from the runway centerline.

The pilot (or the autopilot) controls the aircraft so that the glide slope indicator remains centered on the display to ensure the aircraft is following the glide path to remain above obstructions and reach the runway at the proper touchdown point (i.e., it provides vertical guidance).

⁴⁶ RTCA/DO-192, *Minimum Operational Performance Standards for Airborne ILS Glide Slope Receiving Equipment Operating within the Radio Frequency Range of 328.6 – 335.4 MHz*, Prepared by SC-153, July 19, 1986

4.3.4.3.3. **EMI Failure Modes** – Because of the type of signal transmitted by the ILS, the applicable failure modes are denial of service, degradation of service and misleading information. The operation of the ILS system usually requires the antennas for redundant systems (when installed) to be located in close proximity. Due to antenna placement, it is possible that redundant ILS systems may suffer simultaneous interference events (common mode failures).

Denial of service is similar to an inoperative localizer ground station. The interfering PED(s) would prevent the aircraft system from receiving the desired signal. The aircraft system would indicate or “flag” this failure to include blanking of the ILS indication of the displays.

Degradation of service is very similar to denial of service. The ILS system may or may not indicate a failure flag, and may appear as though the reference signal is too weak to be received (i.e. out of range). A momentary flag, or brief needle deflections, or both, may occur. This is similar to when obstructions or other aircraft pass between the transmitting antenna and the receiving aircraft.

Misleading information is when the aircraft system is affected by PED interference in such a way that the system displays the incorrect information. The ILS data is used by the flight director displays and autopilot to guide the aircraft on final approach. When used for a coupled autopilot approach, ILS signals autonomously control the flight path of the airplane. EMI induced dithering of ILS position data during coupled approach operations could cause erratic aircraft motion and/or the aircraft to be improperly positioned during the approach.

The localizer and glide slope receivers are susceptible to noise-like interference and to single-frequency continuous wave (CW) interference from PED emissions. The localizer and glide slope receivers detect signals in 90 and 150 Hz sidebands around the carrier frequency and provide guidance signals based on the amplitude ratio for the 90 and 150 Hz sidebands. Noise-like interference and CW interference result in errors in the indicated guidance signals. CW interference can also result in the receiver locking on to the interfering signal instead of the intended carrier signal, again resulting in indicated guidance signal errors.

4.3.4.3.1. **EMI Failure Effects** – The failure effects associated with ILS systems are listed in Appendix 2, table reference number 1.00. The failure condition classification (defined in section 4 of this document) of the ILS systems functions range **minor** effects to **catastrophic** effects depending on the usage and level of integration with other systems.

4.3.4.4. **VHF Omnirange⁴⁷ (VOR)**

4.3.4.4.1. A VOR is a ground-based electronic navaid transmitting 360° azimuth signals on assigned carrier frequencies ranging from 108.0 to 117.9 MHz. The VOR uses a reference signal and a variable signal to transmit the bearing information. The reference signal is a 30 Hz signal radiated omnidirectionally in 360 degrees of azimuth with a constant phase. The variable signal is also a 30 Hz signal which rotates around the ground station at a set speed (varies depending on type of VOR) and the signal phase varies with respect to direction of transmission.

In the composite VOR signal, the carrier is transmitted from one antenna and the sidebands are transmitted from a separate antenna. In space these two signals will produce an amplitude modulated signal. A 9960 Hz sub-carrier frequency is deviated by + or – 480 Hz at a 30Hz rate. Then the frequency modulated sub-carrier is amplitude modulated on the carrier. Radial information is derived from the difference in time between the two signals. The resulting phase difference is used by the airborne equipment.

The VOR function and display varies. An Omni-Bearing Indicator (OBI) is the traditional VOR indicator used in general aviation. It consists of a knob to rotate an "Omni Bearing Selector" (OBS), and the OBS scale around the outside of the instrument, used to set the desired course. The display's "course deviation indicator" (CDI) is centered when the aircraft is on the selected course, or gives left/right steering commands to return to the course. A TO-FROM indicator shows whether following the selected course would take the aircraft to, or away from the station. On electronic displays, the Horizontal Situation Indicator (HSI) combines heading information with the navigation display.

⁴⁷ RTCA/DO-196, Minimum Operational Performance Standards for Airborne VOR Receiving Equipment Operating within the Radio Frequency Range of 108-117.95 MHz, Prepared by SC-153, November 17, 1986

In addition to traditional en route and approach navigational functions provided by direct use of VOR, its use has also been incorporated into various flight management systems (FMS) as a method to update the position accuracy of these systems. The FMS Area Navigation (RNAV) function provides navigation display based on the system's navigation database. Typically, position updates from at least two VOR stations, or one VOR/DME station is required by these systems to indicate the aircraft position on a moving map, or display course deviation relative to a waypoint (virtual VOR station).

- 4.3.4.4.2. **EMI Failure Modes** – Because of the type of signal transmitted by the VOR, the applicable failure modes are denial of service, degradation of service and misleading information. The operation of the VOR system usually requires the antennas for redundant systems (when installed) to be located in close proximity. Due to antenna placement, common mode failures for this system are possible.

Denial of service is similar to an inoperative VOR ground station. The interfering PED(s) would prevent the aircraft system from receiving the desired signal. The aircraft system would indicate or “flag” this failure to include blanking of the VOR indication of the displays.

Degradation of service is very similar denial of service. The VOR system may or may not indicate a failure flag, and may appear as though the reference signal is too weak to be received (i.e. out of range). A momentary flag, or brief needle deflections, or both, may occur.

Misleading information is when the aircraft system is affected by PED interference in such a way that the system displays the incorrect information. The VOR data is used by the flight management system or traditional indicator to provide navigational direction to the pilots. EMI induced dithering of VOR position data during operation could cause the aircraft to be improperly position for navigation or non-precision approach.

The VOR receivers are susceptible to noise-like interference and to single-frequency continuous wave (CW) interference from PED emissions. The VOR systems detect the variation in signal phase and time to determine the correct course for the system. Noise-like interference and CW interference result in errors in the indicated guidance signals. CW interference can also result in the receiver locking on to the interfering signal instead of the intended carrier signal, again resulting in indicated guidance signal errors.

4.3.4.4.3. **EMI Failure Effects** – The failure effects associated with VOR systems are listed in Appendix 2, table reference 2.00. The failure condition classification (defined in section 4 of this document) of the VOR systems functions range **minor** effects to **hazardous** effects depending on the usage and level of integration with other systems.

4.3.4.5. **VHF Comm (including Voice and VDL Modes, 2 and 3)**

4.3.4.5.1. VHF Communication

Very High Frequency Communication is the standard civil aviation short range communication system. VHF Comm operates in the frequency band from 118.000 MHz to 137 MHz. VHF is used by ground control facilities and aircraft or by aircraft and other aircraft on one of 760 possible frequency channels with 25 kHz spacing between channels. Current International Civil Aviation Organization (ICAO) regulations require VHF channel spacing of 8.33 kHz. This expands the number of available VHF channels to 2280. Another VHF service available is weather information transmitted from ground stations.

VHF uses line of sight space wave transmissions with a theoretical range of 123 miles between an aircraft at a height of 10,000 ft and a ground station at sea level. In practice, however, useable range will also vary depending upon factors such as transmitter power, receiver sensitivity, atmospheric and temperature conditions, ground station geographical situation, and any obstruction in between aircraft and ground station (i.e. mountains, hills and trees). As a general rule, satisfactory two-way communication can typically be maintained up to 200 miles dependent on the aircraft height.

The principle operations of VHF voice and data systems are divided into three categories; Air Traffic Services (ATS), Aeronautical Operational Control (AOC), and Aeronautical Administrative Communications (AAC). ATS and AOC are services required for the safety and regularity of flight. AAC messages are associated with the airline commercial management communications.

VHF Voice Comm radio operations use amplitude modulation, predominantly, double sideband modulation of the assigned VHF carrier frequency for voice communication. Four VHF channels, 136.900, 136.925, 136.950, and 136.975 MHz are reserved for data communications worldwide.

VHF Digital Link (VDL) has defined standards for VDL Modes 2-4 which provide different capabilities. VDL Mode 2 operation is based on the Carrier Sense Multiple Access (CSMA) scheme to support data link compatibility. VDL Mode 3 allows simultaneous voice and data link capability using the Time Division Multiple Access (TDMA) architecture.

A VDL Mode 2 CSMA transmitter uses feedback from the receiver to determine whether another transmission is in progress before initiating a transmission. If a carrier is sensed, the station waits for the transmission in progress to finish before initiating its own transmission. The VDL Mode 2 uses a 25 kHz spaced VHF channel of a modulation scheme called Digital 8-Phase Shift Keying (D8PSK) providing a data rate of 31.5 kilobit/second. This is the highest data rate that can be achieved in a 25 kHz channel with a maximum range of 200 nautical miles. This required the implementation of VHF digital radios.

VDL Mode 3 uses the D8PSK modulation scheme and the TDMA media access control scheme. VDL Mode 3 allows for functionally simultaneous voice and data link.

4.3.4.5.2.

EMI Failure Modes – Because of the type of signal transmitted by the VHF Comm, the applicable failure modes are denial of service and degradation of service. Misleading information is not considered a viable failure mode. The VHF antennas are installed at various locations on the aircraft, typically not in close proximity. This significantly decreases the likelihood of common mode failures.

Denial of service for VHF Comm can occur in basically two ways. For voice communications, EMI can cause audible tone interference at a high enough level that desired communication voice reception may become completely unintelligible. For voice and data communications, the interfering signal can also block the receipt of the tuned channel.

Degradation of service is very similar to denial of service. For voice communications, EMI induced audible tone interference occurs at a lower level or intermittently at a higher level, rendering desired voice communication reception difficult. For data communications, the interfering signal can also block or corrupt the receipt of messages.

Misleading information is not considered a viable failure mode. VHF Comm voice and data services provide audible and visual data to the pilots. EMI interference cannot introduce audible or data communications that are contrary to what is intended. While it may be argued that loss of individual parts of a voice string or blockage of individual data messages could result in misunderstanding of the desired communication, these faults are caused by denial or degradation of the receipt of the intended signal, not as a result of introduction of misleading information.

- 4.3.4.5.3. **EMI Failure Effects** – The failure effects associated with VHF Comm systems are listed in Appendix 2, table reference 3.00. The failure condition classification (defined in section 4 of this document) of the VHF Comm systems functions range from **minor** effects to **major** effects depending on the number of communication systems are affected and the ability of the crew to select and use another communications system.

4.3.4.6. **Distance Measuring Equipment (DME)**

- 4.3.4.6.1. DME is a radio aid for short and medium-distance navigation. It is a secondary type of radar that allows several aircraft to simultaneously measure their distance from a ground reference (DME transponder). The distance is determined by measuring the propagation delay of a radio frequency (RF) pulse that is emitted by the aircraft transmitter and returned at a different frequency by the ground station.

The DME provides distance to a runway when the DME is collocated with an ILS station. En route or terminal area distance information is provided when a DME is collocated with a VOR.

DME equipped aircraft transmit encoded interrogating pulse pairs on the beacon's receiving channel. The beacon replies with encoded pulse pairs on the airborne equipment's receiving channel, which is 63 MHz apart from the beacon's channel. The DME transmits and receives in the range 962-1213 MHz. The transmitted pulses are paired 12 μ sec apart, each pulse lasting 3.5 μ sec. The pulse-pair repetition rate ranges from 5 to 150 pulse pairs per second.

The interval between the interrogation emission and the reply reception provides the aircraft with the slant range information from the ground station; this information displays on the cockpit indicator.

The aircraft's receiver receives and decodes the transponder's reply. Then it measures the lapse between the interrogation and reply and converts this measurement into electrical output signals. The beacon introduces a fixed delay, called the reply delay, between the reception of each encoded interrogating pulse pair and the transmission of the corresponding reply.

The transponder periodically transmits special identification pulse groups that are interwoven with the reply and squitter pulses; the aircraft decodes these special pulses as Morse tones keyed with the beacon code identification.

- 4.3.4.6.2. **EMI Failure Modes** – Because of the type of signal transmitted by the DME system, the applicable failure modes are denial of service and degradation of service. Misleading is not considered as a viable failure mode. The DME systems may be susceptible to both broad and narrow band PED interference emissions. The antennas for redundant systems (when installed) are usually located in close proximity. Due to antenna placement, common mode failures for this system are possible.

Denial of service is similar to an inoperative DME system. The interfering PED(s) would prevent the aircraft system from receiving the desired signal. The aircraft system would lose the distance indication and may or may not indicate or “flag” this failure.

Degradation of service shares some of the same failures denial of service. The DME system would experience data dropout and no replies to a portion of the interrogations. The PED interference may cause individual data dropouts caused by disruption to the received pulse signals. The system may or may not indicate an intermittent failure flag.

Misleading information is not considered a viable failure mode. The information used by DME systems consist of pulsed pairs that vary in both time and frequency. The aircraft’s receiver uses a stroboscopic technique to recognize the replies to its own interrogations among the many other pulses transmitted by the beacon. Each reply to a DME interrogation is offset in time by 50ms. The distance to the station is then derived by determining the signal in space transmission time between the interrogation and the reply paired pulses. In order for a PED EMI to cause misleading information, it would have to introduce a random combination of pulses that are the same shape and frequency of the intended signal. The introduced pulse then would have to be timed with the receipt of the interrogation replay. Finally, the timing of the pulsed paired separation would have to correlate with the specific equation that would cause the system to indicate consistent distance information. The probability for this type of failure to occur is so extremely low that this failure mode is not considered viable.

- 4.3.4.6.3. **EMI Failure Effects** – The failure effects associated with DME systems are listed in Appendix 2, table reference 6.00. The failure condition classification (defined in section 4 of this document) of the DME systems functions are **minor** effects.

4.3.4.7. Transponder Systems

The avionics transponder systems include Mode A/C Transponder Receiver; Mode S Transponder Receiver systems; Universal Access Transceiver (UAT) and Automatic Dependent Surveillance Broadcast (ADS-B)

- 4.3.4.7.1. **Mode A/C Transponder** - The Mode A/C Air Traffic Control Radar Beacon System (ATCRBS), is a secondary surveillance radar system developed for use within the air traffic control system for more precise position reporting of planes. It is used in conjunction with the primary radar, to determine the presence of planes in the airspace. ATCRBS supplements this positional information with positive identification and altitude information, allowing controllers to track each plane more precisely and efficiently.

The ATCRBS system is an interrogation-based system that is comprised of a ground-based interrogator and an on-plane transponder. On the ground, an ATCRBS sensor sends out an interrogation signal (using the 1030 MHz frequency band) from a rotating antenna to aircraft flying in its sector. Aircraft that are equipped with transponders receive these interrogations and send back a reply (using the 1090 MHz band). There are two primary types of interrogations; Mode A interrogations are used for plane identification information, and Mode C interrogations are used for altitude information.

- 4.3.4.7.2. **Mode S Transponder** - The Mode S transponder provides the functions of existing ATCRBS transponders; (Modes A and C; identification and altitude reporting) but because of its design characteristics, is able to do so in a more efficient manner.

Each interrogation contains the unique address of the aircraft for which it is intended. A Mode S transponder receiving an interrogation examines it for its own address. If the address corresponds, the transponder generates and transmits the necessary reply; all other aircraft ignore the interrogation.

This type of interrogation management ensures that no overlapping replies arrive at the interrogator's antenna and prevents random replies from interrogators with overlapping areas of coverage. This technique improves Secondary Surveillance Radar (SSR) performance and increases system capacity.

The operation of Mode S transponders by the flight crew is identical to conventional transponders (ATCRBS). The Mode S transponder is required for TCAS II operation.

- 4.3.4.7.3. **Universal Access Transceiver** - A Universal Access Transceiver (UAT) refers to a data link that operates on a frequency of 978 MHz intended to serve the majority of the general aviation community. UAT system supports Automatic Dependent Surveillance Broadcast (ADS-B), Flight Information Service – Broadcast (FIS-B) and Traffic Information Service - Broadcast (TIS-B).

UAT will allow aircraft equipped with "out" broadcast capabilities to be seen by any other aircraft using ADS-B In technology as well as by FAA ground stations. Aircraft equipped with ADS-B In technology will be able to see detailed altitude and vector information from other ADS-B Out equipped aircraft as well as FIS-B and TIS-B broadcasts. The FIS-B broadcast will allow receiving aircraft to view weather and flight service information.

The UAT system is specifically designed for ADS-B operation. UAT is also the first link to be certified for "radar-like" ATC services in the United States. UAT is the only ADS-B link standard that is truly bidirectional: UAT users have access to ground-based aeronautical data (FIS-B) and can receive reports from proximate traffic (TIS-B). UAT equipped aircraft can also observe each other directly with high accuracy and minimal latency.

- 4.3.4.7.4. **ADS-B Transponders**– ADS-B-equipped aircraft exchange information on one of two frequencies: 1090 or 978 MHz. ADS-B extends the message elements of Mode S with additional information about the aircraft and its position. This is known as the extended squitter and is referred to as 1090ES.

ADS-B enhances air traffic controllers' ability to identify and guide aircraft. It can also provide coverage in areas where radar is not possible, like the Gulf of Mexico or remote regions of Alaska.

ADS-B enables properly equipped aircraft to broadcast their identification, position, altitude, and velocity to other aircraft and to ATC. By 2020, all aircraft operating within designated ADS-B airspace will be required to comply with the equipment performance requirements of ADS-B Out.

- 4.3.4.7.5. **EMI Failure Modes** – Because of the type of signal transmitted by the transponders, the applicable failure modes are denial of service and degradation of service. Misleading is not considered as a viable failure mode. The antennas for redundant systems (when installed) may be located in close proximity. Depending on antenna placement, common mode failures for this system are possible.

Denial of service is similar to an inoperative transponder system. The interfering PED(s) would prevent the aircraft system from receiving the desired signal. The aircraft system would indicate or "flag" this failure.

Degradation of service is very similar denial of service. The transponder system may or may not indicate a failure flag, The PED interference may cause individual data dropouts caused by disruption to the received pulse signals.

Misleading information is not considered a viable failure mode. The information used by transponder systems consist of digital framing pulses. Each reply to a transponder consisted of a framing pulse, some combination of the possible data pulses, and another framing pulse. The typical pulse transmit duration is approximately 20ms. In order for a PED EMI to cause misleading information, it would have to introduce a random combination of pulses, synchronized in time with the receipt of the interrogation reply, that is formatted with the exact pulse amplitude and duration that correlates with the transponder desired information. The probability for this type of failure to occur is so extremely low that this failure mode is not considered viable.

- 4.3.4.7.6. **EMI Failure Effects** – The failure effects associated with ILS systems are listed in Appendix 2, table reference 4.00. The failure condition classification (defined in section 4 of this document) of the transponder systems functions are **major** effects.

- 4.3.4.8. **Traffic Alert and Collision Avoidance System (TCAS) Interrogator Receiver**

- 4.3.4.8.1. TCAS is a system that is designed to alert a flight crew to the potential of conflicts with other aircraft within the area. The system uses the existing ATCRBS system and the capabilities of Mode S transponders to coordinate with other TCAS equipped aircraft. TCAS II provides two types of advisories to the flight crew; a traffic advisory which informs the flight crew that there are other aircraft in the vicinity, and a resolution advisory that advises the flight crew a corrective or preventative action is required to avoid an intruder aircraft.

TCAS system processes used to accomplish this function are organized into several elements. First, the system surveillance sensors collect information about the intruder aircraft (e.g., its relative position and velocity) and pass the information to the computer to determine whether a collision threat exists. If a threat is identified, the system threat-resolution computations determine an appropriate response. If the intruder aircraft also has TCAS, the response is coordinated through a data link to ensure that each aircraft maneuvers in a compatible direction.

Collision avoidance maneuvers generated and displayed by TCAS are treated as advisories to flight crews, who then take manual control of the aircraft and maneuver accordingly. Pilots are trained to follow TCAS advisories unless doing so would jeopardize safety.

Surveillance of the air traffic environment is based on air-to-air interrogations broadcast once per second from antennae on the TCAS aircraft using the same frequency (1030 MHz) and waveform as ground-based air traffic control sensors. Transponders on nearby intruder aircraft receive these interrogations and send replies at 1090 MHz. Two types of transponders are currently in use: Mode S transponders, which have a Mode S address, and older ATCRBS transponders, which do not have unique addressing capability. To track ATCRBS intruders, TCAS transmits “ATCRBS-only all-call” interrogations once per second; all ATCRBS aircraft in a region around the TCAS aircraft reply. In contrast, Mode S–equipped intruders are tracked with a selective interrogation once per second directed at that specific intruder; only that one aircraft replies.

The antennas used by TCAS include a directional antenna that is mounted on the top of the aircraft and either an omnidirectional or a directional antenna mounted on the bottom of the aircraft. Most installations use the optional directional antenna on the bottom of the aircraft. In addition to the two TCAS antennas, two antennas are also required for the Mode S transponder. One antenna is mounted on the top of the aircraft while the other is mounted on the bottom. These antennas enable the Mode S transponder to receive interrogations at 1030 MHz and reply to the received interrogations at 1090 MHz.

4.3.4.8.2. **EMI Failure Modes** – Because of the type of signal transmitted and received by the TCAS system, the applicable failure modes systems are denial of service and degradation of service. Misleading is not considered as a viable failure mode. The TCAS uses antennas installed on the top and the bottom of the aircraft fuselage. However, since it is a single system, common mode failure is not relevant in this case.

Denial of service is similar to an inoperative TCAS system. The interfering PED(s) would prevent the aircraft system from receiving the desired signal and associated messages. The aircraft system would indicate or “flag” this failure.

Degradation of service is very similar denial of service. The TCAS system may or may not indicate a failure flag, The PED interference may cause individual data dropouts caused by disruption to the received pulse signals.

Misleading information is not considered a viable failure mode⁴⁸. The information used by TCAS systems consist of digital framing pulses. Each reply to a TCAS interrogation consisted of a framing pulse, some combination of the possible data pulses, and another framing pulse. In order for a PED EMI to cause misleading information, it would have to introduce a random combination of pulses, synchronized in time with the receipt of the interrogation reply. Each pulse has very tight specifications for position, width, and rise and fall times. The transponder signal is complex and is difficult to create accidentally. The probability for this type of failure to occur is so extremely low that this failure mode is not considered viable.

- 4.3.4.8.3. **EMI Failure Effects** – The failure effects associated with TCAS systems are listed in Appendix 2, table reference 5.00. The failure condition classification (defined in section 4 of this document) of the transponder systems functions are major effects.

- 4.3.4.9. **Global Positioning System (GPS)/Global Navigation Satellite System (GNSS)**

- 4.3.4.9.1. GPS (GNSS) Provides accurate, worldwide navigation capability with a high degree of availability. GPS navigation information is used to supply the aircraft three-dimensional position, velocity, track data, time, and other information to other aircraft subsystems for use in that system's navigation, guidance or performance computations. GPS systems used for precision navigational operations, such as approach and landing have been developed to take into account GPS system outages.

GPS signal data is modulated onto several carrier frequencies. Broadcast in the 1559-1610 MHz frequency range is called L1. Broadcast the 1164-1215 frequency band is called L5 (or E5) is an aeronautical navigation band.

The signal data is a binary-coded message that contains basically three parts. The first part contains the GPS date and time, plus the satellite's status and an indication of its health. The second part contains orbital information called ephemeris data and allows the receiver to calculate the position of the satellite. The third part, called the almanac, contains information and status concerning all the satellites; their locations and PRN numbers.

GPS outages are a normal operating condition and can occur anywhere in the NAS due to unintentional interference. The aircraft-level effect from losing GPS positioning, velocity, and timing is a complex problem that depends on the GPS equipment design and the degree of integration with other systems. GPS outputs are being integrated into a variety of functions beyond

⁴⁸ See discussion "False TCAS Advisories and PEDs" at http://asrs.arc.nasa.gov/publications/callback/cb_321.htm

traditional navigation data. For example, GPS data is being used for Terrain Awareness Warning Systems (TAWS); synthetic vision systems; ADS-B; and as sensors in air data attitude heading reference system (ADAHRS) inputs to electronic primary flight displays. There are a wide range of integrations from legacy aircraft with self-contained GPS navigation units and a simple autopilot interface to new production aircraft with digital cockpits using integrated modular avionics providing the advanced functions mentioned above and more (including potential GPS time applications).

Satellite Based Augmentation System (SBAS): This system is designed for Category I precision approach. GPS/WAAS and European Geostationary Navigation Overlay Service (EGNOS) are examples of these systems.

Ground Based Augmentation System (GBAS): This system uses ground-based pseudolite emitting signal having similar characteristics of GPS. An example is GPS/Local Area Augmentation System (LAAS), designed for Category II/III precision approach.

- 4.3.4.9.2. **EMI Failure Modes** – Because of the type of signal transmitted by the GPS system, the applicable failure modes systems are denial of service and degradation of service. Misleading is not considered as a viable failure mode. The antennas for redundant systems (when installed) may be located in close proximity. Depending on antenna placement, common mode failures for this system are possible.

Denial of service is similar to GPS system outage. The interfering PED(s) would prevent the aircraft system from receiving the desired signal. This would result from an increase in the carrier to noise ratio (CNR) at the aircraft's system antenna. The aircraft system would indicate or "flag" this failure. For GPS, the type and extent of aircraft system status varies depending on the navigational performance level the system was designed to provide. GPS system user interfaces (displays or control input devices) simply provided "No Computed Data", or "System Fail" warnings. Some systems indicate the number of satellites tracked. GPS systems designed for precision navigation include indication of GPS signal availability and accuracy information. Specific system documentation provides information about how GPS data is used by the aircraft systems and how to determine degradation of GPS signal reception.

Degradation of service is similar to denial of service. The GPS system may or may not indicate a failure flag, by raising the CNR, reception of individual satellites may be prohibited. As the number of received satellites decreases, GPS system performance is affected.

Misleading information is not considered a viable failure mode. In order for a PED EMI to cause misleading information, it would have to introduce an error on the binary-coded messages from all of the received satellites. The probability for this type of failure to randomly occurring is so extremely low that this failure mode is not considered viable.

- 4.3.4.9.3. **EMI Failure Effects** – The failure effects associated with GPS systems are listed in Appendix 2, table reference 7.00. The failure condition classification (defined in section 4 of this document) of the GPS systems functions are **major** effects.

- 4.3.4.10. **AMS(R)S SATCOM**

SATCOM is a long range radio communication system that provides both voice and data communication capabilities. These systems are primarily used when the aircraft is out of range of VHF communication system. The phase of flight that these systems are used is during cruise. Since the cruise phase of flight PED usage allowance is a long time accepted practice, no additional analysis of SATCOM was accomplished in the report. If an operator uses SATCOM during other phases of flight, the system criticality must be evaluated to determine if expanded PED use during that flight phase maintains an acceptable level of risk for that operation.

- 4.3.4.11. **Radio Altimeter and Weather Radar** - The 4 GHz radio altimeter, the 5 GHz weather radar, and the 9 GHz weather radar systems have been determined in RTCA DO-294 and DO-307 to have sufficient protection from PED emissions to not require further analysis. Each of these systems use a very directional antenna, limiting the coupling between the PED emission and the receiver. Furthermore, PED-induced increases in the receiver noise floor only affect receiver outputs at the far limits of coverage where the impact of such effects has minimal operational impact. Critical operation of such systems, e.g., wind shear detection or decision height determination only occur at close ranges where the received signal level is sufficient to overcome PED-induced increases in the noise floor.

- 4.3.4.12. **Microwave Landing System (MLS)** – At the time of this analysis, there were no active MLS systems in the US public airspace system. If an operator uses a MLS system as part of their operations, a risk assessment similar to this one must be accomplished to determine the failure modes PED interference could introduce to the system and associated hazards. This must be evaluated before use of PEDs on aircraft using MLS systems can be expanded into the approach and landing phases of flight.

5. Risk Analysis

5.1. Failure Condition Classifications.

For the purpose of this assessment, the failure condition classification provided by FAA Advisory Circular (AC) 23.1309-1E⁴⁹ is used. To meet the objectives of this document, a failure condition is defined as a condition that can have an effect on either the airplane or its occupants, or both, either direct or consequential, which is caused (or attributed to) by the associated PED interference failure mode. Failure conditions are classified according to their severity as follows:

- 5.1.1. No safety effect. Failure conditions that would have no effect on safety (that is failure conditions that would not affect the operational capability of the airplane or increase crew workload).
- 5.1.2. Minor. Failure conditions that would not significantly reduce airplane safety and involve crew actions that is within their capabilities. Minor failure conditions may include a slight reduction in safety margins or functional capabilities, a slight increase in crew workload (such as routine flight plan changes), or some physical discomfort to passengers or cabin crew.
- 5.1.3. Major. Failure conditions that would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be a significant reduction in safety margins or functional capabilities. In addition, the failure condition has a significant increase in crew workload or in conditions impairing crew efficiency; or a discomfort to the flight crew or physical distress to passengers or cabin crew, possibly including injuries.
- 5.1.4. Hazardous. Failure conditions that would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions to the extent that there would be the following:
 - A large reduction in safety margins or functional capabilities;
 - Physical distress or higher workload such that the flight crew cannot be relied upon to perform their tasks accurately or completely; or
 - Serious or fatal injury to an occupant other than the flight crew.
- 5.1.5. Catastrophic. Failure conditions that are expected to result in multiple fatalities of the occupants, or incapacitation or fatal injury to a flight crewmember normally with the loss of the airplane.

Notes: The phrase “are expected to result” is not intended to require 100 percent certainty that the effects will always be catastrophic. Conversely, just because the effects of a given failure, or combination of failures, could conceivably be catastrophic in extreme circumstances, it is not intended to imply that the failure condition will necessarily be considered catastrophic.

⁴⁹ This AC was used to expand the failure condition categories to include “hazardous” failures . FAA Advisory Circular (AC) 25.1309-1A - System Design and Analysis may also be used.

6. Likelihood Assessment

6.1. Likelihood assessments can be quantitative, qualitative or include portions of both.

6.1.1. **Quantitative Assessment:** A quantitative assessment is an analytical process that applies mathematical methods to assess system and airplane safety. Quantitative assessments are often used in certification of systems to determine the acceptable probability for failure. This drives aircraft design and system reliability to ensure that the failure rates meet the assessed probability. Aircraft systems are designed to be fail-safe and use a combination of methods such as design integrity and quality; redundant systems, back-up systems, component reliability, service experience and margins of safety to ensure these systems meet the necessary criteria.⁵⁰ For typical aircraft certification quantitative assessment, the rate of failure of systems resulting in a catastrophic event must be shown to be extremely improbable. This means that the likelihood of occurrence must be less than 1 in 1,000,000,000 (10^{-9}) flight hours for the particular aircraft model in the phase of flight that the function that the system performs is used. Since passenger PED use varies greatly and is not measured in any fashion, it makes justification of PED use based on quantifiable operational experience very difficult. This is especially true for those phases of flight, such as take-off and landing, where operators currently ask passengers to turn PEDs off.

6.1.2. **Qualitative assessment:** Qualitative assessments are analytical processes that assess system and airplane safety in a subjective, non-numerical manner. These assessments use processes such as analysis of system failures and the effect they have on the system's function, as well as the expected response. These processes depend on the technical data for the system operation and are based on engineering experience and operational judgment.

6.2. In this assessment, the likelihood for interference from PEDs includes both quantitative (where possible) and qualitative assessments using a systematic, deductive, high-level examination of potential PED introduced failures. This assessment includes a review of operational service experience (service difficulty reports, aviation safety reporting system data and other operator specific data), evaluation of known PED spurious emissions, a review of existing technical studies accomplished in the various RTCA PED activities and a review of the current PED industry statistics.

For the purpose of this assessment, the evaluation of likelihood associated with the failure conditions use definitions as follows:

6.2.1. Probable failure conditions are those failure conditions anticipated to occur one or more times during the entire operational life of each airplane.

6.2.2. Remote failure conditions are those failure conditions that are unlikely to occur to each airplane during its total life but that may occur several times when considering the total operational life of a number of airplanes of this type.

⁵⁰FAA Advisory Circular (AC) 25.1309-1A - System Design and Analysis

- 6.2.3. Extremely remote failure conditions are those failure conditions not anticipated to occur to each airplane during its total life but which may occur a few times when considering the total operational life of all airplanes of this type.
- 6.2.4. Extremely improbable failure conditions are those failure conditions so unlikely that they are not anticipated to occur during the entire operational life of all airplanes of one type.

7. Risk Acceptance

- 7.1. In the development of the risk assessment criteria, the acceptability of risk was evaluated using the risk matrices of Appendix 1 and 2, and considers three initial levels of acceptability. The standard SMS color scheme is included in this document in the following manner: Acceptable (green), Acceptable with mitigation (yellow), and Unacceptable (red).
 - 7.1.1. Unacceptable. Where combinations of avionics system failure effect severity and likelihood cause risk to fall into the 'red area', the risk has been assessed as unacceptable. Systems with catastrophic failure effects are considered to have an unacceptable level of risk and therefore, a more structured qualitative assessment is required using the RTCA DO-307 path loss measurement procedure to ensure that the system meets the latest criteria for PED tolerance.
 - 7.1.2. Acceptable with Mitigation. Where the risk assessment falls into the 'yellow area', the risk may be accepted under defined conditions of mitigation. An example of this scenario would be an assessment of the impact of an inoperative aircraft component redundant to other aircraft systems or operational controls that constitute a mitigating action that could make an otherwise unacceptable risk acceptable, as long as the other systems are available and the defined procedure is implemented. These situations also require continued special emphasis during the operator's safety management system continuous improvement safety evaluation function (or equivalent).
 - 7.1.3. Acceptable. Where the assessed risk falls into the 'green area', expanded PED use is accepted without further analysis. The objective in risk management should always be to reduce risk to as low as practicable regardless of whether or not the assessment shows that it can be accepted as is. This is a fundamental principle of continuous improvement.
- 7.2. Residual risk considers the possible controls and mitigations that may be established to reduce the initial assessed risk, based on failure effect severity and likelihood, to an acceptable level. For this to occur, the operator must determine that the controls and mitigations identified are appropriate for their aircraft and operational profile, that the risk control and/or mitigation technique has been implemented and has been validated to be effective. See also Sections 8 and 9.

8. Decision Making

- 8.1. The assumptions and the failure effects for interference established in Section 3, Hazard Identification, established the baseline for setting the mitigations and controls for each system function. The mitigation and controls that are identified in Appendix 2 consider the effect of the PED interference on the function of the avionics system(s). The recommended controls listed identify operational procedures, operator PED allowance policy or aircraft system testing to address the hazard classification of the failure effect.
- 8.2. The following residual risks are listed in Appendix 2 and are based on the mitigations and controls as follows:
- 8.2.1. **Acceptable** – When the hazard level associated with the effect was established to be minor, the mitigation necessary to address the failure mode is already addressed as part of standard practices or operating procedures.
- 8.2.2. **Acceptable with mitigation** – Depending on the hazard level and the effect, this mitigation could be handled as part of standard practices or operating procedures; could have requirements for additional aircraft systems to be used as a cross check of independent systems; prohibition of PED allowance; or collection of data that determines PED use is acceptable. In order to use this assessment as basis for allowing expanded PED use, an operator must determine that the controls and mitigations identified are appropriate for their aircraft and operational profile, that the risk control and/or mitigation technique has been implemented and has been validated as specified in Section 9.
- When mitigation involves dependency on other system functions, the operator must assess and address any changes required to their minimum equipment list (MEL) allowance for that system as well as the non-normal procedures for the operations involving those systems. For example, if an operator mitigates the impact of misleading information during an ILS coupled approach by cross referencing the aircraft position by using the aircraft's position based on GPS position, then GPS function is required for that operation. The operator should revise the MEL to reflect the inoperative GPS functions impact on the ability to perform that operation.
- 8.2.3. **Acceptable only with listed mitigations** – In instances where the failure mode could result in a catastrophic condition, the mitigation and controls listed are the only acceptable means to address the failure mode. In order to allow expansion of PED use during these operations, the system must be tested to ensure that the interference path loss requirements for front door interference given in DO-294 or DO-307 have been met. The operator must possess the data to support this determination. Until that data is obtained, the operator must prohibit the use of PEDs during the listed avionics system function or alternatively, prohibit the use of the listed flight operation.

9. Validation

- 9.1. A vital part of any safety management system approach is to continuously monitor the performance of the changed functions and measure its performance against planned goals. When an operator expands of use of PEDs into new phases of flight, they should adopt the principles of safety assurance to validate those operations.
- 9.2. Three important aspects of safety assurance are safety performance monitoring measurement and review; management of change; and continuous improvement of the safety system.
 - 9.2.1. Safety performance monitoring and measurement should be the process by which the safety performance is verified in comparison to its safety policies and objectives. This process should include:
 - 9.2.1.1. Safety reporting - Train flight crews to report intermittent or transient avionics problems that they notice during these operations. This should not focus on the PEDs as a suspected cause, but rather reporting all anomalies.
 - 9.2.1.2. Safety reviews including trending of data – Operators should incorporate reviews of problem and trends as part of their reliability process.
 - 9.2.1.3. Safety audits – Operators should conduct safety audits of their operations to ensure crew compliance with company procedures. This should include evaluation of the level of competency and training of their crews.
 - 9.2.2. Management of change should be a formal process that identifies how expansion of use of PEDs may affect their established processes and procedures. The affect, and the process or procedures used to address that affect should be documented.
 - 9.2.3. Continuous improvement of the safety system should rectify situations identified through safety assurance activities, paying particular attention to critical systems. The operator should assess any problems with expected performance and their implications in operational safety. Take necessary actions to address these problems.

Note: *If a problem is identified that has been confirmed to be caused by PED use, that information should be shared with the aviation industry via one of the available reporting mechanisms. Provide as much detail as possible on how the interference was attributed to PED operation and include details such as type of device and location in the aircraft where device was operated.*

10. Conclusion

- 10.1. This assessment concluded that the two types of PED interference coupling mechanisms can be addressed to provide an acceptable level of safety for expanded PED use. For back-door interference (as discussed in section 3.2), system protection is provided in several ways including meeting certain HIRF and wireless system installation design requirements. For front door interference (as discussed in section 3.3), there are several mitigations available.
 - 10.1.1. PED Tolerance – The best mitigation for front door interference is to obtain data to show the system meets the interference path loss requirements for interference as shown in DO-294 or DO-307 have been met. This is a requirement for systems that have a catastrophic failure condition.
 - 10.1.2. Operational Mitigations – For systems that have major or minor failure conditions, the mitigations are handled as part of standard practices or operating procedures. Hazardous effects require additional aircraft systems to be used as a cross check of independent systems. This may involve additional crew training to heighten the awareness of these requirements.
 - 10.1.3. Operational Limitations – If an operator opts not perform a function described in the safety assessment, then that function does not have to be considered as part of their safety assessment. However, if the operation such as CAT II or CAT III was previously approved, the operator must surrender that FAA operational authorization (operations specification) when applying this operational limitation as a mitigation.
 - 10.1.4. PED use prohibition – If an operator chooses to use this mitigation, they must assess their current PED crew and passenger instructions and make necessary changes to convey the appropriate information. There is a hypothesis that once passengers are allowed to use PEDs in various phases of flight, they will be hesitant to follow crew instruction to shut off the devices when asked. The operator will need to reinforce the importance of passenger cooperation should the crew request that devices be turned off. This could be either during a phase of flight that passenger PED use is not allowed by the operator or in an instance when the crew has detected an anomaly which they believe is caused by a PED. In either case, it is a regulatory requirement⁵¹ that the passengers will follow crew instructions. Therefore it is imperative that the instructions provided by the crew are clear and understandable to the passengers and convey the appropriate information to allow them to understand the reason for the requirement.
- 10.2. This assessment reviewed the avionics systems certification hazard classification and functions that were available and prevalent at the time of the review. The assessment provides an example methodology that can be replicated to assess the impact of PED use on other avionics functions as they are adopted, or as changes to the systems performing the functions occur.
- 10.3. To address this problem in the future, all new avionics systems that perform ‘major’ and above functions should be assessed during certification to ensure that they address the PED interference environment and adopt PED tolerant design criteria

⁵¹ See Title 49 – Transportation. Subtitle VII - Aviation Programs PART A – Air Commerce and Safety, Subpart iv - Enforcement and Penalties

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Appendix 1 – Predicted Residual Risk – Transmitting PED “Back Door” Interference

The risk analysis provides information about the protections provided by HIRF requirements and the residual risk factors for back-door interference, as described in paragraph 4.2:

Predicted Residual Risk - Transmitting PED “Back Door” Interference			
Aircraft That Meet No HIRF Regulations	Aircraft That Meet FAA Special Conditions	Aircraft That Meet FAA or EASA HIRF Regulations	Aircraft That Meet RTCA/DO-307 Section 3
CATASTROPHIC FAILURE CONDITIONS	CATASTROPHIC FAILURE CONDITIONS	CATASTROPHIC FAILURE CONDITIONS	CATASTROPHIC FAILURE CONDITIONS
HAZARDOUS FAILURE CONDITIONS	HAZARDOUS FAILURE CONDITIONS	HAZARDOUS FAILURE CONDITIONS	HAZARDOUS FAILURE CONDITIONS
MAJOR FAILURE CONDITIONS	MAJOR FAILURE CONDITIONS	MAJOR FAILURE CONDITIONS	MAJOR FAILURE CONDITIONS
Aircraft certified prior to 1987 do not have verified RF immunity.	Aircraft certified by FAA but not by JAA/EASA.	Aircraft certified after 1987 by JAA/EASA or after 2007 by FAA.	Aircraft that meet requirements in RTCA/DO-307 Section 3
Example: Boeing/McDonnell-Douglas/Douglas DC-9/MD-80 series airplanes. This fleet was initially certified before there were any HIRF special conditions or regulations.	Example: Boeing 737-600/700/800/900 series airplanes. Many systems meet HIRF special conditions, but some systems retained from the earlier Boeing 737 models do not meet FAA and JAA/EASA HIRF special conditions		
DC-9/MD-80 US Flight hours from 1995 to 2002: 21,645,272	737-600/700/800/900 US Flight hours from 2001 to 2010: 21,370,664		
Airworthiness Directives related to RF interference: None	Airworthiness Directives related to RF interference: None	Airworthiness Directives related to RF interference: None	Airworthiness Directives related to RF interference: None
US Accident, SDR or NASA ASRS reports: Catastrophic: None Hazardous: None Major: 32 ASRS reports 1995 – 2002	US Accident, SDR or NASA ASRS reports: Catastrophic: None Hazardous: None Major: 8 ASRS reports 2001 – 2010	US Accident, SDR or NASA ASRS reports: Catastrophic: None Hazardous: None Major: None	US Accident, SDR or NASA ASRS reports: Catastrophic: None Hazardous: None Major: None

(continued)

Residual Risk – Catastrophic: Low, with some uncertainty No catastrophic events linked to PEDs. Therefore rate is less than $1/21,645,272$ or 5×10^{-8} per flight hour. This condition has low residual risk, but is not specifically quantified, and has some uncertainty because the fleet hours are less than 1×10^9 .	Residual Risk – Catastrophic: Low No catastrophic events linked to PEDs. All systems with catastrophic failure conditions meet RF immunity levels significantly higher than expected transmitting PED RF field strengths.	Residual Risk – Catastrophic: Low No catastrophic events linked to PEDs. All systems with catastrophic failure conditions meet RF immunity levels significantly higher than expected transmitting PED RF field strengths.	Residual Risk – Catastrophic: Low No catastrophic events linked to PEDs. All systems with catastrophic failure conditions meet RF immunity levels significantly higher than expected transmitting PED RF field strengths.
Residual Risk – Hazardous: Low No hazardous events links to PEDs. Therefore rate is less than $1/21,645,272$ or 5×10^{-8} per flight hour. Events with Hazardous consequences should be extremely remote occurrences, or less than once in 10,00,000 flight hours (1×10^{-7} per flight hour). Therefore this condition has low residual risk.	Residual Risk – Hazardous: Low No hazardous events links to PEDs. Therefore rate is less than $1/21,370,664$ or 5×10^{-8} per flight hour. Events with Hazardous consequences should be extremely remote occurrences, or less than once in 10,00,000 flight hours (1×10^{-7} per flight hour). Therefore this condition has low residual risk.	Residual Risk – Hazardous: Low No hazardous events linked to PEDs. All systems with hazardous failure conditions meet RF immunity levels significantly higher than expected transmitting PED RF field strengths.	Residual Risk – Hazardous: Low No hazardous events linked to PEDs. All systems with hazardous failure conditions meet RF immunity levels higher than expected transmitting PED RF field strengths.
Residual Risk – Major: Low 32 ASRS reports from 1995 to 2002. $32/21,645,272$ or 1.5×10^{-6} per flight hour. Events with Major consequences should be remote occurrences, or less than once in 100,000 flight hours (1×10^{-5} per flight hour). Therefore this condition has low residual risk.	Residual Risk – Major: Low 8 ASRS reports from 2001 to 2010. $8/21,370,664$ or 4×10^{-7} per flight hour. Events with Major consequences should be remote occurrences, or less than once in 100,000 flight hours (1×10^{-5} per flight hour). Therefore this condition has low residual risk.	Residual Risk – Major: Low No major events linked to PEDs. All systems with major failure conditions meet RF immunity levels higher than expected transmitting PED RF field strengths.	Residual Risk – Major: Low No major events linked to PEDs. All systems with major failure conditions meet RF immunity levels higher than expected transmitting PED RF field strengths.

(continued)

1	Hazard ID	Transmitting PED Interference
2	Hazard Description	Transmitting Portable Electronic Devices (PEDs) such as cell phones interfere with an aircraft system with potential catastrophic, hazardous, or major failure conditions.
3	Causes	The radio frequency power transmitted by the PED, such as a cell phone, couples to wiring or into enclosure for electrical or electronic equipment that are part of a system whose failure leads to catastrophic, hazardous, or major consequences.
4	System State	The aircraft electrical or electronic system performs a function that has potential failures that could lead to catastrophic, hazardous, or major consequences
5	Existing Controls	Existing high intensity radiated fields (HIRF) regulations and associated special conditions require that aircraft electrical or electronic system that performs functions that have potential failures that could lead to catastrophic consequences must be protected against adverse effects due to RF fields. The RF field strengths in the HIRF requirements are significantly higher than the field strengths associated with transmitting PEDs. Electrical and electronic systems that perform functions with failures that could lead to catastrophic consequences must also meet requirements for system integrity and availability (such as 14 CFR 25.1309). The physical separation tends to limit common effects to redundant channels from discrete devices such as cell phones. Most air carriers prohibit use of transmitting PEDs during aircraft operations, except taxi-in.
6	Existing Control Justification/ Supporting Data	14 CFR sections 23.1308, 25.1317, 27.1317, and 29.1317. Multiple special conditions such as 25-302-SC have been issued since 1987 for aircraft electrical and electronic system installations with failures that could lead to catastrophic effects. Aircraft certified prior to 1987 have a limited number of electrical and electronic systems that have catastrophic failure conditions. 14 CFR 91.21, 121.306, etc. prohibit use of PEDs unless the aircraft operator has determined that their use is acceptable. Multiple aircraft tests have been performed on existing aircraft models to determine if there are adverse effects due to specific transmitting PEDs such as cell phones and WiFi devices, with very few effects noted, and those have not been proven to contribute to catastrophic failures.
7	Effects	Potential catastrophic failures could lead to loss of the aircraft and fatalities. Potential hazardous or major failures could lead to multiple serious injuries; fatal injury to a relatively small number of persons (one or two); or a hull loss without fatalities.
8	Severity	Catastrophic, hazardous, or major
9	Severity Rationale	The aircraft safety assessment process categorizes the functions performed by systems and the potential failures associated with the systems and functions. There may be systems with functions whose failure or malfunction could lead to catastrophic, hazardous, or major consequences.
10	Likelihood	Extremely improbable
11	Likelihood/ Rationale	The RF immunity requirements associated with the HIRF regulations are higher than the RF field strength that transmitting PEDs can generate, so it is unlikely that these will generate effects that result in catastrophic effects. Aircraft certified prior to 1987 have limited number of electronic systems with catastrophic failure conditions, are operated daily with exposure to high RF fields in the airport area, and have not demonstrated adverse effects due to these RF fields.
12	Initial Risk	Low
13	Safety Requirements	The existing HIRF regulations and associated special conditions require that aircraft electrical or electronic system that performs functions that have potential failures that could lead to catastrophic consequences must be protected against adverse effects due to RF fields.
14	FAA Organization Responsible	AIR-100/AFS-360

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Appendix 2 – Systems Hazard Assessment by Phase of Operations

AFS-360: PED ARC Avionics System Functional Hazard Risk Assessment, Revision – Original – September 16, 2013

Note: Appendix2 has been formatted for electronic viewing and may also be printed on 11" x 17" paper.

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
1.00	ILS (Localizer and Glideslope) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.01	Loss of ILS function during non-precision approach. Not coupled to autopilot and flight director flags appear.	XS/DS	This could cause the crew to transition a visual approach or execute a missed approach procedure. This would result in a slight increase in crew workload as they plan for an alternate approach procedure.	MIN	6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
1.02	Loss of ILS function during non-precision approach. Coupled to autopilot. Flight director flags appear and autopilot disengages.	XS/DS	The crew would take manual control of the aircraft and transition to a visual approach or execute a missed approach procedure. This would result in a slight increase in crew workload as they plan for an alternate approach procedure	MIN	6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
1.03	Misleading information during non-precision approach. Not coupled to autopilot.	ML	This could cause the crew to transition to visual a approach or execute a missed approach procedure. This would result in a slight increase in crew workload as they plan for an alternate approach procedure	MIN	6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
1.04	Misleading information during non-precision approach. Coupled to autopilot.	ML	The crew would take manual control of the aircraft and transition to a visual approach or execute a routine missed approach procedure. This would result in a slight increase in crew workload as they plan for an alternate approach procedure	MIN	6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certificated)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.05	Loss of ILS function during CAT I precision approach. Not coupled to autopilot and flight director flags appear.	XS/DS	This would cause the crew to execute a routine missed approach procedure. This would result in an increase in crew workload.	MAJ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (Green) Possess data that shows system compliance.	Adoption of the mitigations provide an acceptable level of risk for allowing operation of PEDs during this operation. The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Aircraft system and pilot function, such as: A. Crew cross checks using the radio altimeter and altimeter validates that the aircraft height at the final approach fix is correct. B. Use of TAWS (EGPWS) based alerting would alert the pilots to terrain and obstacles (as equipped). C. Crew cross checks using a FMS and/or GPS display of the desired track (lateral position) for the aircraft. Improper function of an ILS system would result in the aircraft not being on course, and the FMS and/or GPS display would show the discrepancy. D. Crew cross checks using VOR radial to cross check lateral position on approach. E. Monitoring other information sources, including but not limited to, marker beacon, DME, timing from fixes, etc. to validate position on approach.	Acceptable with mitigation: (Yellow) Operator has procedures and equipment to assess aircraft position along course of approach.	
						Option 4. Do not allow CAT I approaches.	Acceptable: (Green) Remove CAT I operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certificated)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.06	Loss of ILS function during CAT I precision approach. Flight director flags appear and autopilot disengages.	XS/DS	The crew would assume manual control of the aircraft and execute a routine missed approach procedure. This would result in an increase in crew workload.	MAJ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (Green) Possess data that shows system compliance.	Adoption of the mitigations provide an acceptable level of risk for allowing operation of PEDs during this operation. The mitigations for denial of service, degradation of service and misleading information are driven the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Aircraft system and pilot function, such as: A. Crew cross checks using the radio altimeter and altimeter validates that the aircraft height at the final approach fix is correct. B. Use of TAWS (EGPWS) based alerting would alert the pilots to terrain and obstacles (as equipped). C. Crew cross checks using a FMS and/or GPS display of the desired track (lateral position) for the aircraft. Improper function of an ILS system would result in the aircraft not being on course, and the FMS and/or GPS display would show the discrepancy. D. Crew cross checks using VOR radial to cross check lateral position on approach. E. Monitoring other information sources, including but not limited to, marker beacon, DME, timing from fixes, etc. to validate position on approach.	Acceptable with mitigation: (Yellow) Operator has procedures and equipment to assess position along course of approach.	
						Option 4. Do not allow CAT I approaches.	Acceptable: (Green) Remove CAT I operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.07	Misleading information during CAT I precision approach. Not coupled to autopilot.	ML	May result in no action taken by the crew until visual conditions were obtained. This would require crew to initiate a go-around procedure. This would result in an increase in crew workload and a reduction in safety margin.	MAJ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (Green) Possess data that shows system compliance.	Adoption of the mitigations provide an acceptable level of risk for allowing operation of PEDs during this operation. The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Aircraft system and pilot function, such as: A. Crew cross checks using the radio altimeter and altimeter validates that the aircraft height at the final approach fix is correct. B. Use of TAWS (EGPWS) based alerting would alert the pilots to terrain and obstacles (as equipped). C. Crew cross checks using a FMS and/or GPS display of the desired track (lateral position) for the aircraft. Improper function of an ILS system would result in the aircraft not being on course, and the FMS and/or GPS display would show the discrepancy. D. Crew cross checks using VOR radial to cross check lateral position on approach. E. Monitoring other information sources, including but not limited to, marker beacon, DME, timing from fixes, etc. to validate position on approach.	Acceptable with mitigation: (Yellow) Operator has procedures and equipment to assess position along course of approach.	
						Option 4. Do not allow CAT I approaches.	Acceptable: (Green) Remove CAT I operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.08	Misleading information during CAT I precision approach. Coupled to autopilot.	ML	May result in no action taken by the crew until visual conditions were obtained. The crew would assume manual control of the aircraft and initiate a go-around procedure (or initiate an auto-pilot TO/GA). This would result in an increase in crew workload and a reduction in safety margin.	HAZ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (Green) Possess data that shows system compliance.	Adoption of the mitigations provide an acceptable level of risk for allowing operation of PEDs during this operation. The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Aircraft system and pilot function, such as: A. Crew cross checks using the radio altimeter and altimeter validates that the aircraft height at the final approach fix is correct. B. Use of TAWS (EGPWS) based alerting would alert the pilots to terrain and obstacles (as equipped). C. Crew cross checks using a FMS and/or GPS display of the desired track (lateral position) for the aircraft. Improper function of an ILS system would result in the aircraft not being on course, and the FMS and/or GPS display would show the discrepancy. D. Crew cross checks using VOR radial to cross check lateral position on approach. E. Monitoring other information sources, including but not limited to, marker beacon, DME, timing from fixes, etc. to validate position on approach.	Acceptable with mitigation: (Yellow) Operator has procedures and equipment to assess position along course of approach.	
						Option 4. Do not allow CAT I approaches.	Acceptable: (Green) Remove CAT I operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certificated)	Phase of flight		Residual Risk: (See section 8.0) and Recommended Controls	Remarks
						Mitigations		
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.09	Loss of ILS function during CAT II/III precision approach. Not coupled to autopilot and flight director flags appear.	XS/DS	This would cause the crew to execute go-around procedure. This would result in an significant increase in crew workload and decrease in safety margin.	MAJ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (See remarks) (Green) Possess data that shows system compliance.	The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation. (See table reference numbers 1.11 and 1.12)
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (See remarks) (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Do not allow CAT II/III approaches.	Acceptable: (See remarks) (Green) Remove CAT II/III operation from OPS Spec.	
1.10	Loss of ILS function during CAT II/III precision approach. Flight director flags appear and autopilot disengages.	XS/DS	The crew would assume manual control of the aircraft and execute a go-around procedure. This would result in an significant increase in crew workload and decrease in safety margin.	MAJ	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable: (See remarks) (Green) Possess data that shows system compliance.	The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation. (See table reference numbers 1.11 and 1.12)
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with mitigation: (See remarks) (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Do not allow CAT II/III approaches.	Acceptable: (See remarks) (Green) Remove CAT II/III operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0)	Remarks
							and Recommended Controls	
1.00	ILS (continued) 4.3.4.3	4.3.4.3.3	4.3.4.3.4					
1.11	Misleading information during CAT II/III precision approach. Not coupled to autopilot.	ML	May result in no action taken by the crew until visual conditions were obtained. This may not provide the crew sufficient time to initiate a go-around or cause the aircraft to blunder in its approach. This would result in an significant increase in crew workload and significant decrease in safety margin.	CAT	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable with only the listed mitigations: (Green) Possess data that shows system compliance.	The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with only the listed mitigations: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Do not allow CAT II/III approaches.	Acceptable with only the listed mitigations: (Green) Remove CAT II/III operation from OPS Spec.	
1.12	Misleading information during CAT II/III precision approach. Coupled to autopilot.	ML	May result in no action taken by the crew until visual conditions were obtained. The crew could emergency disconnect the autopilot, assume manual control of the aircraft (or initiate an auto-pilot TO/GA) and may not provide the crew sufficient time to initiate a go-around or cause the aircraft to blunder in its approach. This would result in an significant increase in crew workload and decrease in safety margin. This would result in an significant increase in crew workload and significant decrease in safety margin.	CAT	6, 7	Option 1. Front door path loss must be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable with only the listed mitigations: (Green) Possess data that shows system compliance.	The mitigations for denial of service, degradation of service and misleading information are driven to the most severe hazard classification for that operation.
						Option 2. Do not allow the use of PEDs during these approaches.	Acceptable with only the listed mitigations: (Yellow) Operator procedures to have passengers shut off devices.	
						Option 3. Do not allow CAT II/III approaches.	Acceptable with only the listed mitigations: (Green) Remove CAT II/III operation from OPS Spec.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certificated)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
2.00	VOR 4.3.4.4.	4.3.4.4.2	4.3.4.4.3.					
2.01	Loss of all VOR radio navigation information accompanied by VOR indication.	XS/DS	During non-precision VOR approach, the crew would respond to this by executing a routine missed approach procedure. This would result in a slight increase in crew workload as they plan for an alternate approach procedure.	MIN	3, 4, 6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
2.02	Display of hazardously misleading VOR radio navigation information to both pilots.	ML	During non-precision VOR approach, crew could unknowingly lose accurate information relevant to the aircraft's location and flight path. This could result in disorientation near the ground and cause a considerable workload increase for the crew.	HAZ	3, 4, 6, 7	Option 1 - Hazardous system classification is only applicable to aircraft that use VOR as primary navigation source and possess no other navigation reference. - Front door path loss may be assessed to ensure the system meets requirements of DO-294/DO-307 for the LOC and GS systems.	Acceptable with mitigation: (Yellow) Operator procedures to have passengers shut off devices. (Green) Possess data that shows system compliance	
				MIN	3, 4, 6, 7	Option 2. For aircraft equipped with other navigational references, the hazard is minor.	Acceptable: (Green) No additional controls required due to classification of failure. Pilot will follow appropriate procedures	
3.00	VHF Voice Comm, VDL Modes 2&3 4.3.4.5.	4.3.4.5.2	4.3.4.5.3.					
3.01	XS/DS- Loss of primary communications radio, with secondary VHF COM functioning properly	XS/DS	Communications must be transferred through an alternate radio that uses a different antenna location. The crew workload may slightly increase until the problem is solved.	MIN	2, 3, 4, 6, 7, 8	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
3.02	Loss of all primary communications radios	XS/DS	When the flight crew realizes communication has been lost, the appropriate procedure will be followed to a safe landing. This would result in a significant increase in workload to the crew.	MAJ	2, 3, 4, 6, 7, 8	Pilot will follow appropriate procedures. No additional mitigation required due effect of failure.	Acceptable with mitigation: Pilot will follow appropriate procedures. No additional controls required due effect of failure.	
3.03	Loss of data linked communications	XS/DS	Crew obtains data via voice or other comm methods. Slight increase in crew workload.	MIN	2, 3, 4, 6, 7, 8	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
3.04	Loss of Controller-Pilot Data Link Communications (CPDLC)	XS/DS	Loss of CPDLC capability would result in use of contingency procedures established in the applicable geographic region. Slight increase in flight crew workload due to reversion to voice communication.	MIN	2, 3, 4, 6, 7, 8	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	

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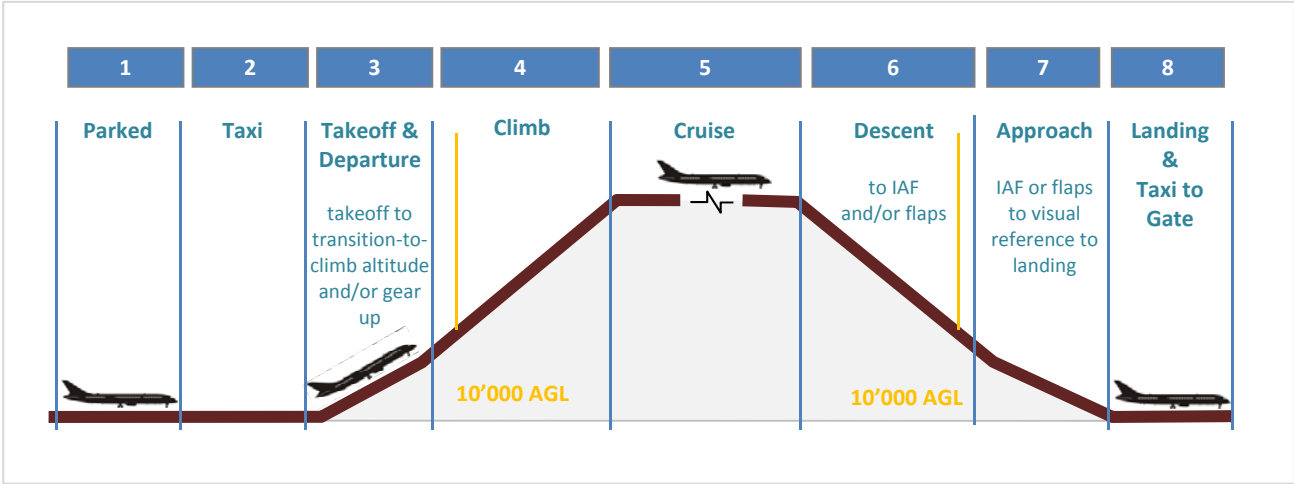
Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
4.00	ATC SSR Xpndr, Mode S, UAT and ADS-B 4.3.4.7	4.3.4.7.5	4.3.4.7.6					
4.01	Intermittent loss of transponder	DS	Intermittent loss of transponder function would result in lapse of altitude information, aircraft position/track, aircraft identification information and other required information vital to air traffic controllers. Often, the transponder is integrated with ADS-B and that functionality would also be intermittently lost. Intermittent reporting of aircraft position information, if lapse exceeds limits of air traffic automation, could require communication with ATC to re-establish identification. Intermittent TCAS "off" indications could also occur. Crew and ATC workload would increase.	MIN	2, 3, 4, 6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
4.02	Complete loss of transponders	XS	Loss of all transponder function would result in loss of altitude information, aircraft position/track, aircraft identification information and other required information vital to air traffic controllers. Often, the transponder is integrated with ADS-B and that functionality would also be lost. Aircraft position information would be lost to other aircraft in the vicinity using TCAS and Traffic Information Services-Broadcast (TIS-B). With loss of ADS-B, the flight crew would have to avoid Class A, class B, and class C airspace, or require special handling from ATC. Significant increase in crew workload and decrease in safety margins.	MAJ	2, 3, 4, 6, 7	Pilot will follow appropriate procedures. No additional mitigation required due effect of failure.	Acceptable with mitigation: Pilot will follow appropriate procedures. No additional controls required due effect of failure.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and Recommended Controls	Remarks
5.00	TCAS 4.3.4.8	4.3.4.8.2	4.3.4.8.3					
5.01	Loss of TCAS when in an advisory situation	XS/DS	TCAS does not alter or diminish the pilot’s basic authority and responsibility to ensure safe flight. Since TCAS does not respond to aircraft which are not transponder equipped or aircraft with a transponder failure, TCAS alone does not ensure safe separation in every case. Loss of TCAS functionality will result in a slight decrease in safety margins. The crew must rely on visual separation if operating under VFR conditions or ATC provided separation if operating IFR under IMC conditions.	MIN	3, 4, 6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	
6.00	DME 4.3.4.6	4.3.4.6.2	4.3.4.6.3					
6.01	Loss of DME information during approach. No data or erratic data displayed.	XS/DS	DME issued to provide distance to touchdown for ILS approaches. When specified in an the approach procedure, DME is used in lieu of the outer marker, can be used as a back course final approach fix, and is used to establish other fixes on the localizer course. This would result in a slight increase in crew workload.	MIN	6, 7	No additional mitigation required due to classification of failure. Pilot will follow appropriate procedures.	Acceptable: No additional controls required due to classification of failure. Pilot will follow appropriate procedures.	

(continued)

Table Ref.	Avionics System Function	Failure Mode Codes	Effect of PED interference on aircraft operation	Hazard Class (As certified)	Phase of flight	Mitigations	Residual Risk: (See section 8.0) and	Remarks
							Recommended Controls	
7.00	GNSS (L1/L5/E5) 4.3.4.9	4.3.4.9.2	4.3.4.9.3					
7.01	Loss of all GPS navigation information for terminal area navigation (including departures) and nonprecision Approach (e.g. LNAV or RNP <1, RNAV SIDs)	XS/DS	Loss of GPS navigation information during this operating phase could result in flight crew discontinuing GPS approach and potentially required missed approach. Loss of GPS function during departure would not significantly impact the RNAV SID operations because the selection of ground based NAV aids, the navigation system accuracy would not degrade to an unacceptable level within the time frame of the departure. The crew may resort to other navigational systems if available. This would result in a reduction in safety margin, and a increase in crew workload.	MAJ	2, 3, 4, 6, 7	Pilot will follow appropriate procedures. No additional mitigation required due effect of failure.	Acceptable with mitigation: Pilot will follow appropriate procedures. No additional controls required due effect of failure.	
7.02	Loss of all GPS navigation information during nonprecision approach with Vertical Guidance (LNAV/VNAV)	XS/DS	Loss of GPS navigation information during this operating phase occurs prior to the final approach waypoint (FAWP), the approach should not be completed since GPS may no longer provide the required accuracy. The crew may resort to other navigational systems if available. This would result in a significant reduction in safety margin, and a significant increase in crew workload.	MAJ	6, 7	Pilot will follow appropriate procedures. No additional mitigation required due effect of failure.	Acceptable with mitigation: Pilot will follow appropriate procedures. No additional controls required due effect of failure.	
7.03	Loss of all GPS navigation information during LP/LPV and GNSS Category I/II approaches.	XS/DS	Loss of GPS navigation information during this operating phase occurs prior to the final approach waypoint (FAWP), the approach should not be completed since GPS may no longer provide the required accuracy. If the flag/status annunciation appears after the FAWP, the missed approach should be executed immediately. This would result in a significant reduction in safety margin, and a significant increase in crew workload.	MAJ	6, 7	Pilot will follow appropriate procedures. No additional mitigation required due effect of failure.	Acceptable with mitigation: Pilot will follow appropriate procedures. No additional controls required due effect of failure.	



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APPENDIX G: PED STOWAGE POLICY ASSESSMENT & CONSIDERATIONS

Appendix G includes the PED Stowage Policy Assessment and Considerations Report as amended by the PED ARC on September 25, 2013.

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**Federal Aviation
Administration**

September 25, 2013

Portable Electronic Device (PED) Aviation Rulemaking Committee PED Stowage Policy Assessment and Considerations

Summary
The PED ARC has determined the need for a Portable Electronic Device (PED) stowage policy assessment on aircraft used in commercial passenger air transportation. The ARC tasked a working group to present considerations to assist commercial aircraft operators in developing a PED stowage policy that would work in concert with an expanded PED use policy. This paper summarizes FAA relevant regulations and guidance, evaluates current industry PED policies, and provides considerations to standardize industry best practices for stowage of PEDs as appropriate.

Portable Electronic Device Aviation Rulemaking Committee PED Stowage Policy Assessment and Considerations

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1. Background

1.1. Purpose

The Federal Aviation Administration (FAA) Portable Electronic Devices Aviation Rulemaking Committee (PED ARC) is tasked to make suggestions to further clarify and provide guidance on allowing additional PED use by passengers in the cabin without compromising the continued safe operation of the aircraft. The PED ARC stowage policy working group was established to evaluate PED policies in use today by Title 14, Code of Federal Regulations (14 CFR) Part 119 certificate holders. Since a migration to “PED tolerant” airplanes will allow passengers’ devices to remain powered on throughout flight, the team was also asked to consider expanding the windows of time that passengers may use their electronic devices, without adversely affecting cabin safety.

1.2. Applicability & Scope

This document, PED Stowage Policy Assessment and Considerations is a product of the Portable Electronic Device Aviation Rulemaking Committee based on the evaluation conducted by the PED Stowage working group. This report serves as suggested guidance for those 14 CFR 119 certificate holders that desire to allow passengers to utilize PEDs in any phase of flight on their aircraft. The air carrier is ultimately responsible for passenger safety. Procedures may vary due to differences in air carrier operations and aircraft. The scope of this document is limited to passenger PED stowage as related to carry-on baggage policies. The use of the terms “aircraft operator(s)” and “operator” throughout this document is applicable to operations conducted under 14 CFR parts 91k, 121, 125 and 135.

The working group’s efforts included contacting and working with the FAA Office of Aerospace Medicine (AAM-600) and Cabin Safety Inspectors (CSI), Airlines for America (A4A), the Association of Flight Attendants-CWA (AFA), the National Business Aviation Association (NBAA), the National Air Transportation Association (NATA), the Association of Professional Flight Attendants (APFA), the Regional Airline Association (RAA), and other interested stakeholders.

1.3. Charter

The PED ARC Stowage Working Group will recommend guidance to enable operators to develop a PED stowage policy that would work in concert with an expanded PED usage policy.

1.4. Definitions

A **Portable Electronic Device (PED)** is any piece of lightweight, electrically-powered equipment. These devices are typically consumer electronic devices functionally capable of communications, data processing and/or utility.

To stow an item, according to one dictionary definition, is “to put (something that is not being used) in a place where it is available, where it can be kept safely, etc.”⁵²

Stowage, therefore, is simply a “space especially on a ship or airplane for stowing things.”⁵³ For purposes of this report, a stowage location on an airplane is generally one that is approved for stowage by the operator, and placarded with a maximum weight restriction. If an item is located in a place that lacks formal operator approval or a maximum weight placard, but where it is considered, in the judgment of the operator, that in a survivable incident (e.g., severe turbulence during a critical phase of flight) the item is unlikely to threaten any occupant’s safety (e.g., restricting egress from a seat during an emergency evacuation) or lead to one or more injuries, this report refers to that item’s condition as “**secure**”. Some factors that help determine the relative safety of a secure location include the size, shape, and weight of the passenger’s item, as well as the holding properties of the location itself.

⁵² Hyperlink: Merriam-Webster online dictionary [<http://www.merriam-webster.com/dictionary/stow>] Accessed September 19, 2013.

⁵³ Hyperlink: Merriam-Webster online dictionary [<http://www.merriam-webster.com/dictionary/stowage>] Accessed September 19, 2013.

2. Current FAA Regulations and Guidance

The following sections summarize and discuss current FAA regulatory, policy, and guidance documents relevant to stowage of passenger items in the cabin.

2.1. Regulations

Pertinent parts of the applicable regulations have been excerpted here for this discussion. Footnotes have been provided to link to the full regulatory language.

2.1.1. Portable Electronic Devices (14 CFR § 121.306)

Portable electronic devices regulation 121.306 gives operators the authority to determine whether particular devices may be used on board their aircraft:⁵⁴

§ 121.306 Portable electronic devices.

(a) Except as provided in paragraph (b) of this section, no person may operate, nor may any operator or pilot in command of an aircraft allow the operation of, any portable electronic device on any U.S.-registered civil aircraft operating under this part.

(b) Paragraph (a) of this section does not apply to—

(1) Portable voice recorders;

(2) Hearing aids;

(3) Heart pacemakers;

(4) Electric shavers; or

(5) Any other portable electronic device that the part 119 certificate holder has determined will not cause interference with the navigation or communication system of the aircraft on which it is to be used.

(c) The determination required by paragraph (b)(5) of this section shall be made by that part 119 certificate holder operating the particular device to be used.

⁵⁴ Hyperlink: §121.306 Portable electronic devices [<http://www.ecfr.gov>]; Accessed September 19, 2013.

2.1.2. Carry-on Baggage (14 CFR § 121.589)

14 CFR § 121.589 paragraphs (b) - (f) specify requirements for ensuring that cabin items are properly secured during takeoff and landing operations:⁵⁵

§ 121.589 Carry-on baggage.

** * * **

(b) No certificate holder may allow all passenger entry doors of an airplane to be closed in preparation for taxi or pushback unless at least one required crewmember has verified that each article of baggage is stowed in accordance with this section and § 121.285 (c) and (d).

(c) No certificate holder may allow an airplane to take off or land unless each article of baggage is stowed:

(1) In a suitable closet or baggage or cargo stowage compartment placarded for its maximum weight and providing proper restraint for all baggage or cargo stowed within, and in a manner that does not hinder the possible use of any emergency equipment; or

(2) As provided in § 121.285 (c) and (d); or

(3) Under a passenger seat.

(d) Baggage, other than articles of loose clothing, may not be placed in an overhead rack unless that rack is equipped with approved restraining devices or doors.

(e) Each passenger must comply with instructions given by crewmembers regarding compliance with paragraphs (a), (b), (c), (d), and (g) of this section.

(f) Each passenger seat under which baggage is allowed to be stowed shall be fitted with a means to prevent articles of baggage stowed under it from sliding forward. In addition, each aisle seat shall be fitted with a means to prevent articles of baggage stowed under it from sliding sideward into the aisle under crash impacts severe enough to induce the ultimate inertia forces specified in the emergency landing condition regulations under which the airplane was type certificated.

** * * **

⁵⁵ Hyperlink: §121.589 Carry-on baggage [\[http://www.ecfr.gov/\]](http://www.ecfr.gov/); Accessed September 19, 2013.

2.1.3. Stowage Compartments (14 CFR § 25.787)

14 CFR § 25.787 paragraphs (a) and (b) specify the design requirements for approved stowage compartments:⁵⁶

§25.787 Stowage compartments

(a) Each compartment for the stowage of cargo, baggage, carry-on articles, and equipment (such as life rafts), and any other stowage compartment must be designed for its placarded maximum weight of contents and for the critical load distribution at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of § 25.561(b), except that the forces specified in the emergency landing conditions need not be applied to compartments located below, or forward, of all occupants in the airplane. If the airplane has a passenger seating configuration, excluding pilots seats, of 10 seats or more, each stowage compartment in the passenger cabin, except for underseat and overhead compartments for passenger convenience, must be completely enclosed.

(b) There must be a means to prevent the contents in the compartments from becoming a hazard by shifting, under the loads specified in paragraph (a) of this section. For stowage compartments in the passenger and crew cabin, if the means used is a latched door, the design must take into consideration the wear and deterioration expected in service.

* * * *

⁵⁶ Hyperlink: §25.787 Stowage compartments [\[http://www.ecfr.gov\]](http://www.ecfr.gov); Accessed September 19, 2013.

2.1.4. Part 25, Subpart C – Structure, General (14 CFR § 25.561)

14 CFR § 25.561 paragraph (b) lists specific inertia forces experienced during emergency landing conditions on land or water:⁵⁷

§ 25.561 General.

* * * *

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when—

(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward, 3.0g

(ii) Forward, 9.0g

(iii) Sideward, 3.0g on the airframe; and 4.0g on the seats and their attachments.

(iv) Downward, 6.0g

(v) Rearward, 1.5g

* * * *

2.2. Guidance

This section lists several FAA policy and guidance documents that expand on and clarify existing regulations and generally provide one means, although not the only means, for complying with those regulations. Relevant portions of these documents are excerpted in the following sections:

2.2.1. Carry-On Baggage (AC 121-29B)

Advisory Circular (AC) 121-29B “provides information about features that the ... FAA ... recommends be included in air carriers’ carry-on baggage programs [and] provides clarification to air carriers about how to comply with FAA’s carry-on baggage regulations.”⁵⁸ The following portions of the AC address issues relevant to stowage of PEDs:

⁵⁷ Hyperlink: §25.561 Structures, General [<http://www.ecfr.gov>]; Accessed September 19, 2013.

⁵⁸ Hyperlink: FAA AC 121-29B Carry-On Baggage [<http://rgl.faa.gov>]; Accessed September 19, 2013.

Excerpt - FAA Advisory Circular 121-29B:

4. What should your FAA-approved carry-on baggage program address?

...

d. Explain how you intend to stow carry-on baggage properly. This part of the program depends on the type of aircraft covered by the program, including cabin configuration and other space factors. Your stowage program should ensure that:

(1) Carry-on baggage does not obstruct passenger movement to, from, or across the aisle;

...

e. Describe your procedures to verify that each article of baggage is properly stowed in an approved compartment or other specifically approved area before flight attendants close the passenger entry doors on each flight. The FAA recommends that you task a specific crewmember, such as the lead flight attendant, with verifying proper stowage. Your description should include:

(1) Methods to ensure carry-on baggage and cargo do not exceed the FAA-approved weight limitations or load limits for the specific place they are stowed, including the restraints used to secure them. ...

i. Establish procedures for informing travelers and travel agents about the specific carry-on requirements of your flights. You may accommodate travelers with special baggage problems, provided you can stow the baggage safely. ...

j. Include information about your carry-on baggage program in the appropriate parts of the crewmembers' manual. You should cover all of the elements listed above, especially crewmember responsibility for verifying that baggage is stowed properly and will not hinder the availability and use of emergency equipment; and other pertinent information that the principal operations inspector determines should be in the crewmembers' manual.

k. Provide training to appropriate ground personnel and to all crewmembers regarding your approved carry-on baggage program. The training should include at least carry-on baggage limitations; baggage scanning; processing of carry-on baggage that you cannot accommodate in any of the passenger compartments; proper stowing of carry-on baggage, cargo and unusual items in the cabin; crew coordination; applicable passenger information; types of and limitations on stowage provisions; verification that carry-on baggage is stowed so it does not interfere with emergency equipment; and how to handle carry-on baggage during an emergency.

2.2.2. Use of Portable Electronic Devices Aboard Aircraft (AC 91-21.1B)

Advisory Circular 91-21.1B provides aircraft operators with information and guidance that are one means, but not the only means, for complying with 14 CFR § 91.21.⁵⁹

Excerpt - FAA Advisory Circular 91-21.1B:

6. RECOMMENDED PROCEDURES FOR THE OPERATION OF PEDs ABOARD AIRCRAFT. If an operator allows the use of PEDs aboard its aircraft, procedures should be established and spelled out clearly to control their use during passenger-carrying operations. The procedures, when used in conjunction with an operator's program, should provide the following:

a. Methods to inform passengers of permissible times, conditions, and limitations when various PEDs may be used. This may be accomplished through the departure briefing, passenger information cards, captain's announcement, and other methods deemed appropriate by the operator. For air carrier operations conducted under 14 CFR part 121 or part 135, the limitations, as a minimum, should state that use of all such devices (except certain inaccessible medical electronic devices, for example, heart pacemakers) are prohibited during any phase of operation when their use could interfere with the communication or navigation equipment on board the aircraft or the ability of the flightcrew to give necessary instructions in the event of an emergency.

...

f. Prohibiting the operation of any PEDs during the takeoff and landing phases of flight. It must be recognized that the potential for personal injury to passengers is a paramount consideration, as well as is the possibility of missing significant safety announcements during important phases of flight. This prohibition is in addition to lessening the possible interference that may arise during sterile cockpit operations (below 10,000 feet).

⁵⁹ Hyperlink: FAA AC 91-21.1B Use of Portable Electronic Devices Aboard Aircraft [\[http://www.faa.gov\]](http://www.faa.gov); Accessed September 19, 2013.

2.2.3. Passenger Safety Information Briefing and Briefing Cards (AC 121-24C)

Advisory Circular 121-24C provides aircraft operators with “information regarding the items that are required to be, or should be, covered in oral passenger briefings and on passenger briefing cards.”⁶⁰

Excerpt - FAA Advisory Circular 121-24C:

1. ORAL BRIEFINGS. The pretakeoff oral briefing should be given so that each passenger can clearly hear it and easily see required demonstrations. ...

...

a. Pretakeoff. Before each takeoff, the operator must ensure that all passengers are orally briefed on each of the following:

...

(9) Portable Electronic Devices. Except as provided in § 91.21, no part 119 certificate holder or pilot in command may operate or allow the operation of portable electronic devices on any U.S.-registered aircraft operated by the certificate holder. Passengers should be informed of permissible times, conditions, and limitations when various portable electronic devices may be used.

c. Prelanding. A prelanding briefing is recommended and should include the following: seatbelts must be securely fastened; smoking materials must be extinguished; tray tables must be secured in their stowed position; seat backs must be in a fully upright position; food, beverages, or tableware must be picked up; and carry-on baggage and movie/video screens must be properly stowed for landing.

...

e. Crewmember Procedures. Each oral briefing provided by a carrier or commercial operator for its passengers must be explained and described in appropriate manuals. The manuals should also contain a description of flight attendant tasks and coordination procedures to ensure passenger compliance with information signs and flight attendants' safety instructions. This description should include the stipulation that flight attendants should notify the pilot in command anytime a passenger is not complying with safety instructions. Flight attendants should neither be assigned nor perform nonsafety-related duties during the safety briefings if those duties could obstruct the view of the passengers or distract them from listening.

⁶⁰ Hyperlink: FAA AC 121-24C Passenger Safety Information Briefing and Briefing Cards <http://rgl.faa.gov/>;
Accessed September 19, 2013.

2. PASSENGER SAFETY BRIEFING CARDS. Oral briefings must be supplemented with briefing cards, which must be pertinent only to that type and model of aircraft and consistent with the airline's procedures. The information on the cards should be consistent with the information contained in the air carrier's manuals. When aircraft equipment is substantially different, even within the same model of aircraft, the air carrier should provide information cards specific to that aircraft. ...

...

c. Content. Safety briefing cards that provide information to passengers should include:

...

(14) Portable Electronic Devices. The cards should inform passengers of permissible times, conditions, and limitations when various portable electronic devices may be used.

(15) Supplemental Information. The cards may contain supplemental instructions. For example, for takeoff and landing, carry-on baggage and tray tables must be properly stowed, galley service items must be collected from passengers and stowed, and seat backs must be placed in their fully upright position.

2.2.4. Stowage of Items in Seat Pockets (InFO 09018)

Information for Operators (InFO) 09018, Stowage of Items in Seat Pockets, dated November 12, 2009, provides clarifying guidance for air carriers about the stowage of items in seat pockets.⁶¹

The intent of the carry-on baggage regulation, Title 14 of the Code of Federal Regulations (14 CFR) part 121, section 121.589, is to prevent carry-on items from slowing an emergency evacuation and to prevent injury to passengers by ensuring items are properly restrained. Seat pockets have been designed to restrain approximately 3 pounds of weight and not the weight of additional carry-on items. Seat pockets are not listed in the regulation as an approved stowage location for carry-on items. If a seat pocket fails to restrain its contents, the contents of the seat pocket may impede emergency evacuation or may strike and injure a passenger.

If small, lightweight items, such as eyeglasses or a cell phone can be placed in the seat pocket without exceeding the total designed weight limitation of the seat pocket or so that the seat pocket does not block anyone from evacuating the row of seats; it may be safe to do so.

The requirements of the carry-on baggage regulation are applicable to take-off and landing. Nothing in the carry-on baggage regulation prohibits a passenger from taking out small personal items from an approved stowage location and placing them in the seat pocket after takeoff and stowing them in approved locations prior to landing. Crewmembers may still direct a passenger to stow carry-on items in an approved stowage location, during flight should they pose a hazard, such as in the case of turbulence.

Existing FAA policy in Order 8900.1, Volume 3, Chapter 33, Section 6, Operations—Cabin Safety,⁶² states that carry-on baggage programs should:

- *Prohibit the stowage of carry-on baggage and other items in the lavatories and seat pockets (the only items allowed in seat pockets should be magazines and passenger information cards)*
- *Provide specific crewmember assignments for the verification that carry-on baggage is properly stowed*
- *Address procedures in appropriate manuals*
- *Provide crewmember training on carry-on baggage, and*
- *Ensure that information is available to the public about the air carrier's carry-on baggage program*

⁶¹ Hyperlink: FAA InFO 09018 [<http://www.faa.gov>] Accessed September 19, 2013.

⁶² Hyperlink: Order 8900.1, Volume 3, Chapter 33, Section 6, Operations, Cabin Safety [<http://fsims.faa.gov>] Accessed September 19, 2013.

2.2.5. Transport Airplane Cabin Interiors Crashworthiness Handbook (AC 25-17A)

Passenger PEDs that are sufficiently thin may slide out from under-seat stowage locations into aisles,⁶³ creating tripping hazards and/or obscuring emergency path lighting, given the gap allowed beneath under-seat restraints as noted on page 156 of AC 25-17A:⁶⁴

(G) The bottom of the restraint system should be no more than 2 1/2-inches above the floor level of the airplane. The top of the system should be no less than 3-inches above the floor level of the airplane. (Amendment 25-32).

2.2.6. Corded Electrical Devices Used in the Passenger Cabin (ANM-02-115-20)

FAA Policy Statement No. ANM-02-115-20, dated November 21, 2002, consolidates and clarifies “certification policy for addressing potential hazards associated with the installation of corded electrical devices used in the passenger cabin.”⁶⁵ Specific sections of 14 CFR Part 25 design regulations are cited that require passageways leading from main aisles to various types of exit doors, between individual passenger areas, and cross aisles between main aisles, be unobstructed.

⁶³ Excerpt and Hyperlink: From [FAA Order 8900.1, Volume 3, Chapter 33, Section 6, Operations—Cabin Safety](#), 3-3548. STOWAGE OF NON-COLLAPSIBLE FLEXIBLE TRAVEL CANES: “The FAA requires that passenger seats, under which baggage is allowed to be stowed, must be equipped with under-seat restraints sufficient to prevent articles of baggage, including flexible travel canes and other thin profile items of baggage, from sliding forward.” Accessed September 19, 2013.

⁶⁴ Hyperlink: FAA AC 25-17A Transport Airplane Cabin Interiors Crashworthiness Handbook [\[http://www.faa.gov\]](http://www.faa.gov); Accessed September 19, 2013.

⁶⁵ Hyperlink: FAA Policy Statement No. ANM-02-115-20 Corded Electrical Devices Used in the Passenger Cabin [\[http://www.airweb.faa.gov\]](http://www.airweb.faa.gov); Accessed September 19, 2013.

3. Survey of Current Industry Stowage Policies

3.1. Background

The PED stowage working group developed a survey to request information from various aviation industry stakeholders about current operator policies related to stowage of PEDs. Surveys were emailed to, and completed by, FAA Certificate Management Office (CMO) staff, Part 121 operators, flight attendants, and one aircraft manufacturer. In all, 41 completed surveys were returned.

3.2. Survey Questions and Summary of Responses

The table below includes the full text of all survey questions, as well as numbers of responses in each category. Respondents were asked to answer Yes or No to each question, and to leave items blank if unsure. However, many of the participants did not always follow this guidance. For purposes of the summary table, in most cases, alternate responses were converted to Yes, No, or blank following inspection, although a small number were categorized as “OTHER” when the other three options could not be applied. Detailed results are provided in Appendix 1.

#	Question	Response			
		Yes	No	Blank	Other
1	Does your aircraft operation have a policy requiring stowage of some or all passenger PEDs at any point during a flight? If Yes, please answer questions 1a-h, and attach text of policy, if possible.	38	3	0	0
1a	Does the policy require stowage of passenger PEDs under some flight conditions and/or phases of	36	4	1	0
1b	Does the policy treat different sizes and/or weights of passenger PEDs differently?	21	17	2	1
1c	Does the policy allow passenger PEDs to be stowed in seat pockets?	25	15	1	0
1d	Does the policy limit the weight of items, including passenger PEDs, stowed in seat	28	6	6	1
1e	Does the policy limit seat pocket stowage to ensure that passengers can egress safely during an emergency?	34	4	3	0
1f	Does the policy specifically restrict the use/stowage of wired headsets?	7	30	3	1
1g	Does the policy specifically restrict the use/stowage of wireless headsets?	10	25	5	1
1h	Does your aircraft operation have crewmember reports of incidents involving passenger Non-compliance with PED stowage requirements? If Yes, please attach examples, if	19	7	15	0
2	Do any of your aircraft have seat power plugs installed for passenger use? If Yes, please answer questions 2a-b.	15	24	2	0
2a	Can passenger PEDs be connected to seat power during all phases of flight?	4	12	25	0
2b	Can cabin crewmembers disable seat power? If Yes, please answer questions 2c-d.	11	4	25	1
2c	At individual seats?	2	12	26	1
2d	In separate sections of the airplane?	8	6	26	1
3	Are crewmembers (pilots and/or flight attendants) required to make announcement(s) to passengers related to stowage of PEDs? If Yes, please attach text of announcement(s), if possible.	33	8	0	0
4	Does your aircraft operation require crewmembers (pilots and/or flight attendants) follow specific procedures to enforce its passenger PED stowage policies? If Yes, please attach details, if possible.	25	13	3	0
5	Does your aircraft operation have reports of passenger PEDs thrown about the cabin due to turbulence, hard landing, or sudden stop acceleration/deceleration? If Yes, please attach redacted copies or summaries of incident reports, if possible.	1	26	14	0

3.3. Discussion of Survey Results

The stowage policies survey results tabulated above provide responses of operator policies across domestic passenger air transport operations. Participants were drawn from FAA Certificate Management Office personnel, Part 121 operators both directly and anonymously through the trade association Airlines for America (A4A), Association of Flight Attendants-CWA (AFA) safety committee chairpersons, one other air carrier union, and one aircraft manufacturer.

Some general perspectives on current stowage policies and practices may be observed. First, it is clear from responses to questions 1 and 1a, in which 93% and 88% of all participants, respectively, answered yes, that most operators appear to require that passenger PEDs be stowed at some point during a flight, which conforms to the guidance in InFO 09018. The responses to 1b suggest that only about half of operators (51% Yes) have policies that distinguish between different sizes/weights of PEDs. The responses to 1c and 1d suggest that about two-thirds of operators allow the use of seat pockets as stowage for PEDs and/or restrict the weight of items stowed in seat pockets (61% and 68% Yes, respectively). The responses to 1e suggest that most operators (83% Yes) consider safe egress during an emergency in their seat pocket stowage policies, although the responses to 1f suggest that most do not consider wireless headsets to be an egress issue (73% No). Responses to 1g suggest that most operators do not place restrictions on use or stowage of wireless headsets (61% No). Responses to 1h suggest that about half of operators receive reports of passenger non-compliance with PED stowage policies (46% Yes).

Question 2 asked about seat power plugs; responses suggest that most operators (37% Yes, 59% No) at this time do not have this option available to passengers. Responses to 2a suggest that most operators today who have power plugs do not allow unrestricted use of them during all phases of flight (10% Yes). Responses to 2b suggest that cabin crew can generally disable seat power if necessary (27% Yes); responses to 2c suggest that very few of these systems can be disabled at individual seats (5% Yes), although responses to 2d suggest that power can often be disabled in individual sections of the cabin (20% Yes).

The remaining survey questions asked about crew announcements, stowage policy enforcement, and reports of injury incidents involving PEDs. The responses to question 3 indicate that operators, in general, require crewmembers to make announcements that relate to stowage of PEDs (80% Yes), while the responses to question 4 suggest that somewhat fewer operators (61% Yes) require that crewmembers follow specific procedures to enforce stowage policy restrictions on PEDs. Responses to question 5 suggest that few operators have reports of passengers being struck by PEDs during inflight incidents; only one responder definitively answered yes to this question, while 34% were unsure.

4. PED Stowage Considerations

The ARC report recommends that FAA and industry stakeholders develop standard content and timing for cabin and flight deck crewmember instructions to passengers on use and stowage of PEDs.

The ARC report further recommends to support standardized industry best practices for stowage related to PEDs, the FAA update stowage policy and guidance documents to incorporate expanded use of PEDs as necessary. The information in this section provides ideas for operators to consider when reviewing their stowage policies.

4.1. Key Issues to Consider

The Stowage Policy working group debated various issues related to stowage and securing of loose items in order to develop specific recommendations to the FAA for future research and development of guidance to operators. The issue that received the greatest attention: How to balance the desire of many passengers to use their PEDs during the critical takeoff and landing phases of flight while maintaining or even elevating existing levels of operational and occupant safety. Other issues explored included the effect of PED use on passenger attention to crewmember instructions during the pre-takeoff and pre-landing phases as well as emergency incidents; options for designating seat pockets as approved stowage locations without damaging their structural integrity, adversely affecting egress, and increasing projectile risks; safe use and stowage of corded devices (e.g., headphones, power adapters); management of under-seat stowage to prevent PEDs from becoming tripping or projectile hazards or obscuring emergency path markings; content and timing of crew announcements in combination with appropriate procedures and training to encourage passenger compliance with stowage policies and adequate management of loose item risks; and content, formats and media options for disseminating information to travelers that explain operator stowage policies in ways that maximize understanding and acceptance of restrictions.

Roughly in parallel with these internal Stowage Policy working group discussions, research scientists in the FAA Office of Aerospace Medicine, Civil Aerospace Medical Institute (CAMI), Protection and Survival Research Laboratory (AAM-630) also assessed options for expanded PED usage policies. The AAM-630 Memorandum in Appendix 2 of this document considers the relationship of PED usage to post-crash emergency evacuation; reviews literature on the adverse effects of distractions on passenger safety awareness and National Transportation Safety Board (NTSB) recommendations to counter historic declines in passenger attention to safety information; reviews accident data showing that take-off and landing are critical phases of flight for accidents and fatalities; praises the benefits of mandatory evacuation drills for all passengers on cruise ships; and supports the need for a clean cabin environment during pre-flight briefings and critical phases of flight.

The AAM-630 memorandum also considers the issues of projectile injury risks from unsecured items of mass, items in seat pockets, and items held in a cabin occupant's hand. AAM-630 research scientists state in the memorandum that it is the unexpected nature of events such as turbulence and emergency landings that makes it unlikely a passenger would be able to hold onto an object during an incident, even if it is small and light. The memorandum also comments on the lack of evidence for any increased occupant injury risk posed by PEDs when compared to "any other object (e.g., a hard cover book) of similar weight, size and stiffness." (p. 4 of Appendix 2)

The AAM-630 memorandum concludes with a discussion of dynamic testing of airplane seats with 3 lbs of paper, approximately 1.25 inches thick, stowed in a seat pocket during the seat qualification process. The memorandum response suggests that "dynamic tests show that the seat can carry the additional weight of the literature without structural failure, but do not ensure that the literature is retained throughout the entire dynamic event" (reference Appendix 2, pages 4-5).

This last observation referenced in the AAM-630 memorandum, which concerns the lack of testing to ensure that contents in seat pockets are retained, is supported by a summary of one aircraft manufacturer's policy related to dynamic seat testing obtained by a member of the Stowage Policy working group. This testing policy, which conforms to applicable sections of SAE Aerospace Standard 8049B (referenced in footnote 29 of the AAM-630 memorandum) may be summarized as follows:

- Dynamic Testing of the passenger seats is to validate that the seat can take the weight of its occupant plus the weight of a 3 lb. object stored in the seat pocket.
- Dynamic Testing does not prove that the 3 lb. object stays in the seat pocket, there are no requirements for this.
- There is no requirement that defines the size of the object to be used during the testing....just that it weigh 3 lbs.
- Prior to the testing, the seat pocket is "taped" shut so the 3 lb. object remains in the pocket during the test.

4.2. Key Questions

The Stowage Policy working group reviewed the regulatory and guidance material in Section 2 and the policy survey responses in Section 3, along with the Appendix 2 memorandum prepared by AAM-630. As a result of this review, the following questions arose:

- What are the impact injury risks, assessed qualitatively and quantitatively, from typical PEDs of less than 3 pounds, in the event of a survivable impact on takeoff or landing?⁶⁶ Are PEDs any different than books or magazines, in terms of occupant injury risks, considering such factors that could include, but are not limited to, weight, form factor, hardness, and quantity?
- Is there an acceptable size/weight limitation for PEDs that could allow stowage in seat pockets during critical phases of flight? Is 3 lbs an acceptable weight constraint? Should the allowable weight account for an operator's existing seat pocket contents (i.e., magazines, safety briefing cards, and airsickness bags)? Figure 1 shows one possible concept for a seat pocket PED sizing card – would such a concept be useful in tandem with an operator's stowage policy?
- How can operators further improve cabin safety policies so that the expansion of PED use during all phases of flight does not adversely affect the safety of the travelling public?
- Would the allowed use of PEDs through all phases of flight impact cabin safety? (Refer to Figure 2 below) If safety were affected, how should operators update policy to mitigate any reduction of safety?
- How can the use of seat power receptacles be managed with an expansion of PED usage? Can a PED adversely restrict egress in an emergency evacuation if plugged into aircraft power receptacles?
- Can a PED adversely restrict egress in an emergency evacuation if stowed in a seat pocket – assuming all items in seat pocket do not exceed 3 lbs.? If so, is there an acceptable maximum device size?
- Can a PED with thin form factors (e.g., tablets, laptops) adversely restrict egress in an emergency evacuation if stowed under a seat outside of a bag?
- In the event of tarmac delays or runway holds when the airplane is not moving, should flight deck crewmembers authorize that passenger PEDs (including larger devices such as laptops) be used?

⁶⁶ Static inertial forces as specified by 14 CFR § 25.561(b)(3).
Hyperlink: §25.561 Structures, General <http://www.ecfr.gov/>; Accessed September 19, 2013.

Figure 1. Stowage Policy Example for a PED Size Check Box

Sample dimensions and PED weight limits are one way (but not the only way) for passengers to quickly determine if their device is permitted by an operator's policy. Aircraft operators would determine appropriate values based on their fleet composition and best judgment.

- Specific dimensions and stowage policy (e.g., FAA approved carry-on baggage program which includes personal items, and/or personal items policy for those carriers that do not have an FAA approved carry-on baggage program) to be developed by the aircraft operator and approved by the geographic responsible FAA certificate oversight office.
- The aircraft operator is ultimately responsible for the specifics of what is displayed on the PED gate sizing box. There will be some variance based on the uniqueness of the air carrier's operations and aircraft.

NOTE: FAA InFO 09018 – *Stowage of Items in Seat Pockets*, explains seat pockets have been designed to restrain approximately 3 pounds of weight and not the weight of additional carry-on items. The PED weight limit should take into consideration aircraft conformity items in the seat pocket e.g. briefing card, air sickness bag, inflight magazine (which contains safety and compliance information for passengers), headset that plugs into the armrest.

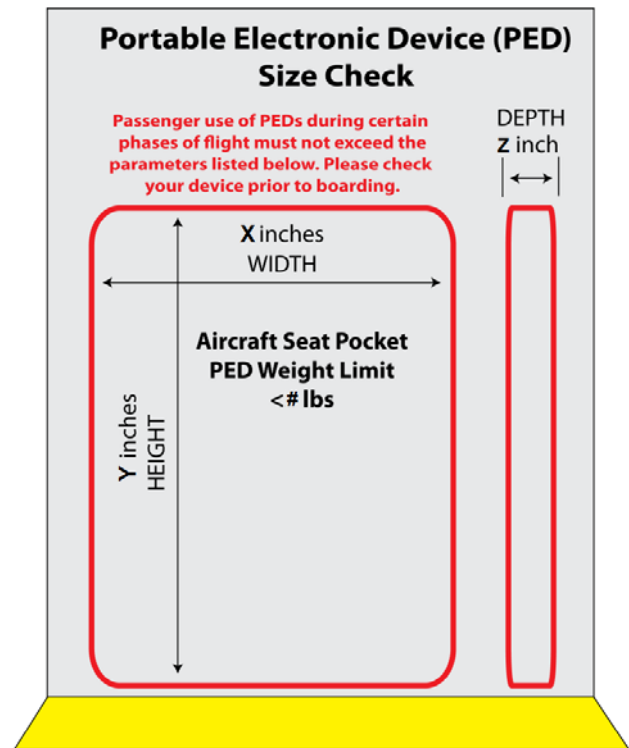
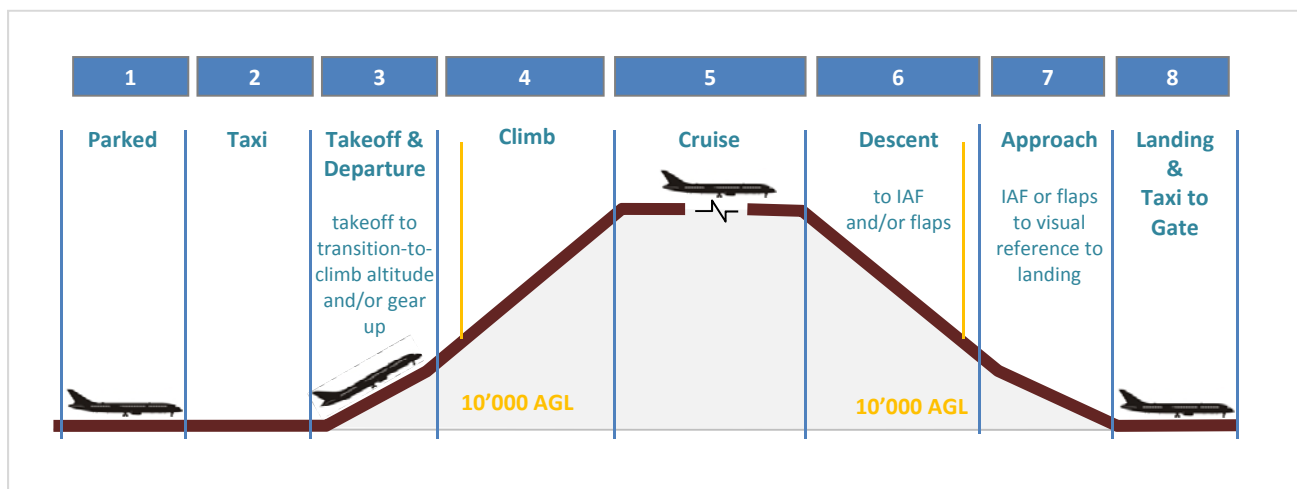


Figure 2. Phases of Flight



4.3. Minimize Variability of Stowage Policies

The variability of PED stowage policies between operators should be minimized, in order to maximize passenger understanding and acceptance of the rules, as well as compliance with crewmember instructions.

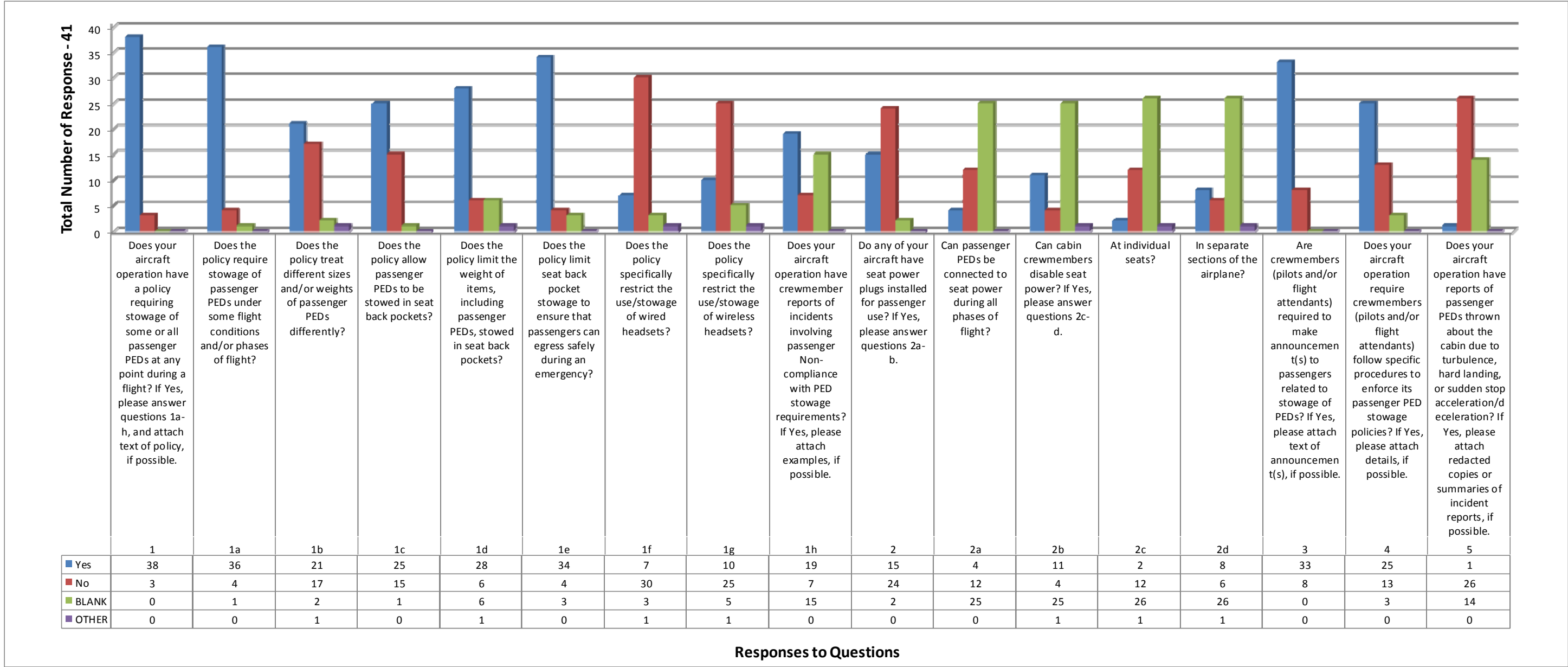
4.4. Develop a Public Messaging Strategy

The information to the traveling public on cabin stowage policies should be easy to understand, concise, and be widely disseminated through various forms of media.

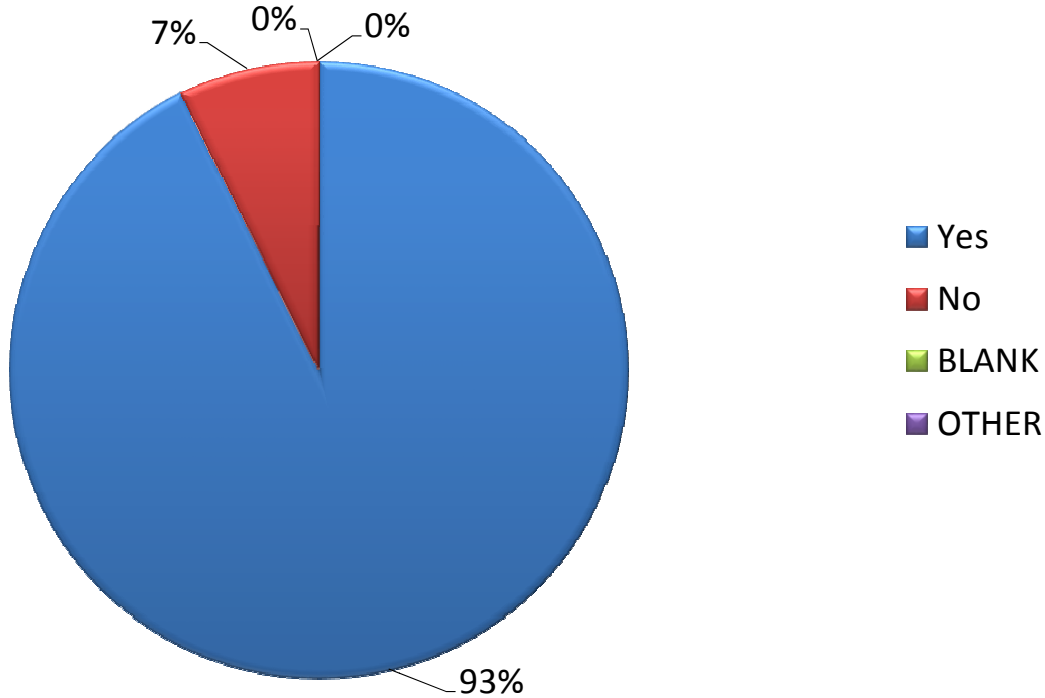
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Appendix 1: PED Stowage Survey Responses

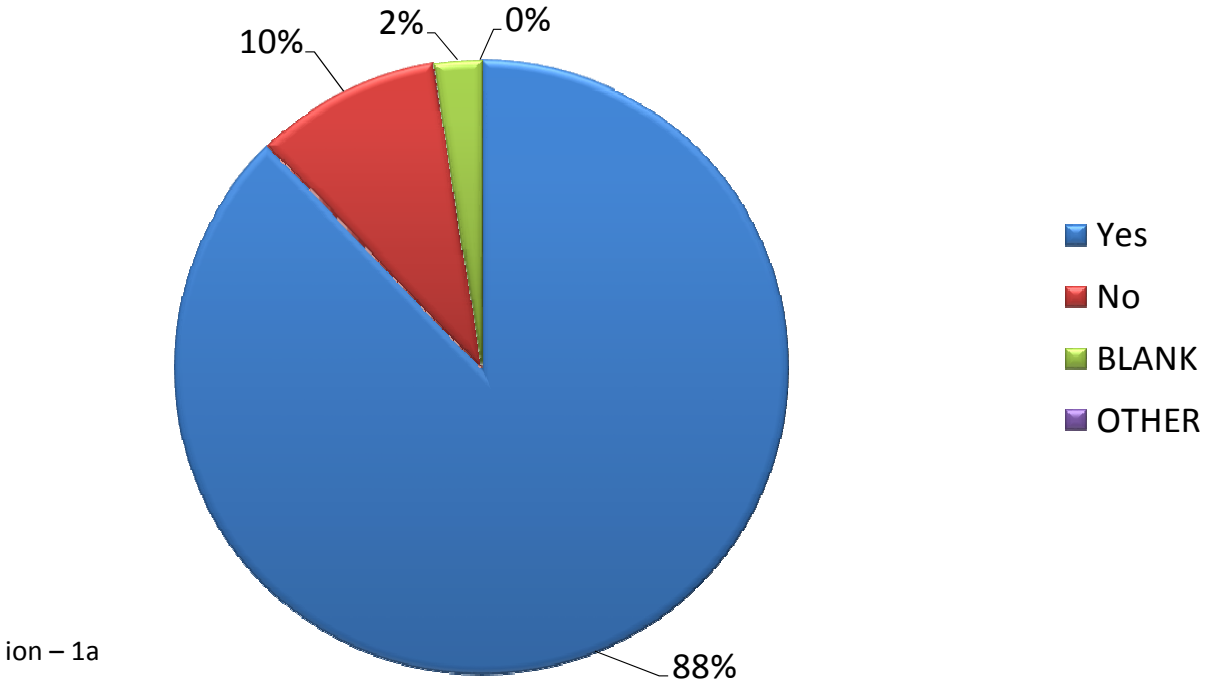
Note: Appendix 1 has been formatted for electronic viewing and may also be printed on 11" x 17" paper.



Does your aircraft operation have a policy requiring stowage of some or all passenger PEDs at any point during a flight?

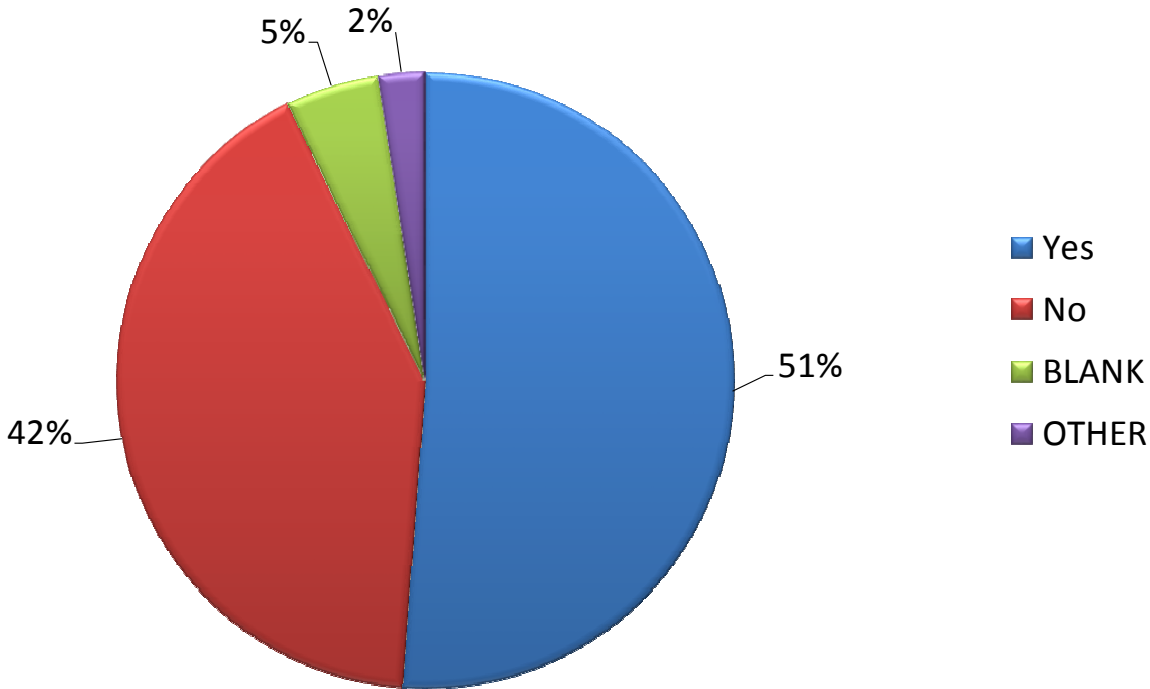


Does the policy require stowage of passenger PEDs under some flight conditions and/or phases of flight?

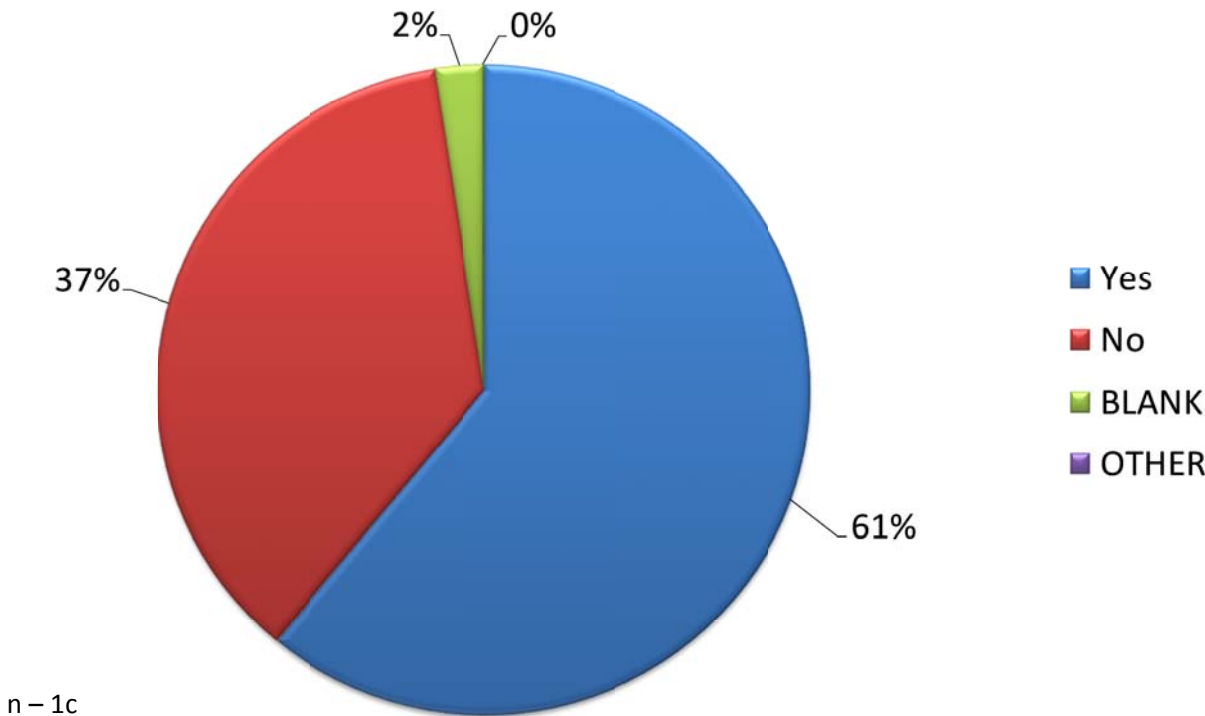


ion – 1a

Does the policy treat different sizes and/or weights of passenger PEDs differently?

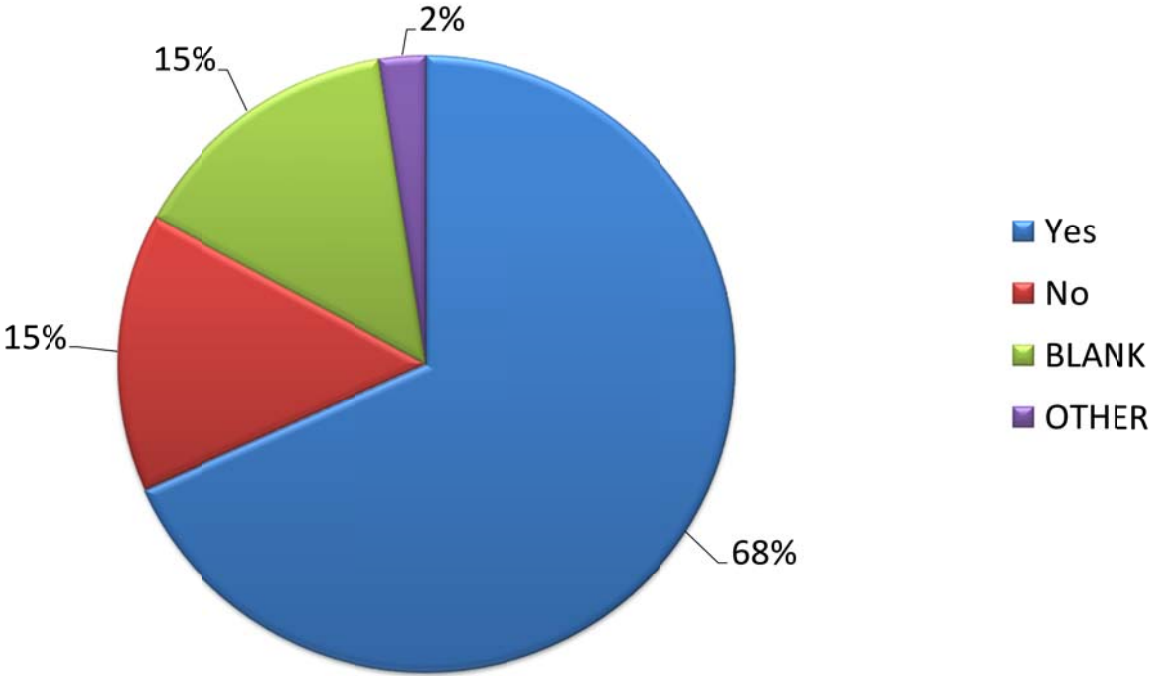


Does the policy allow passenger PEDs to be stowed in seat back pockets?

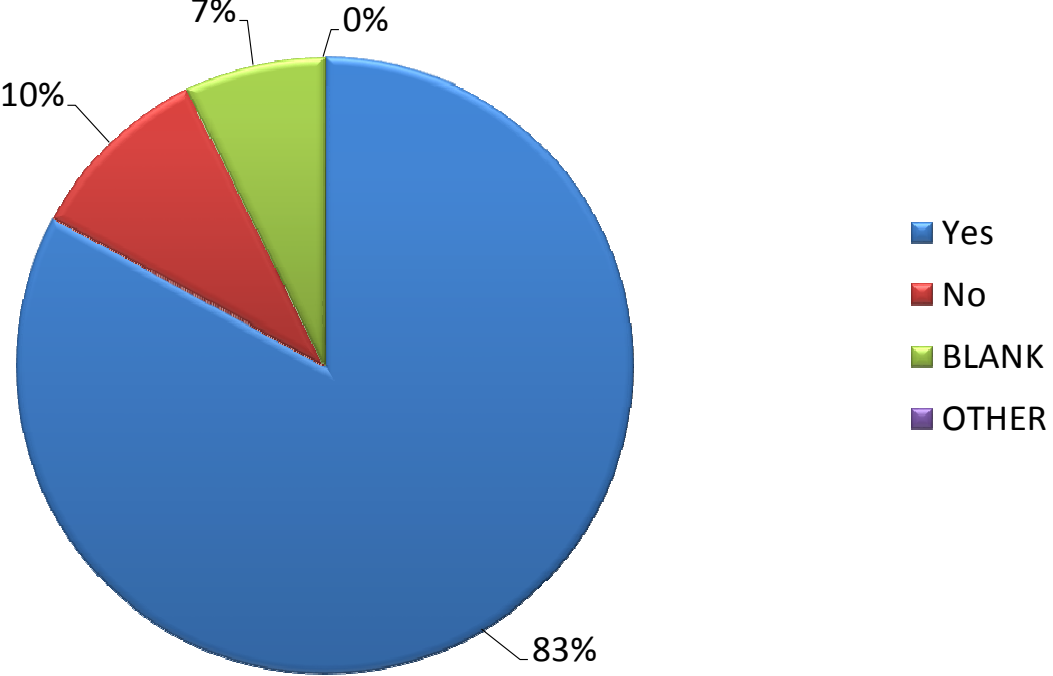


n – 1c

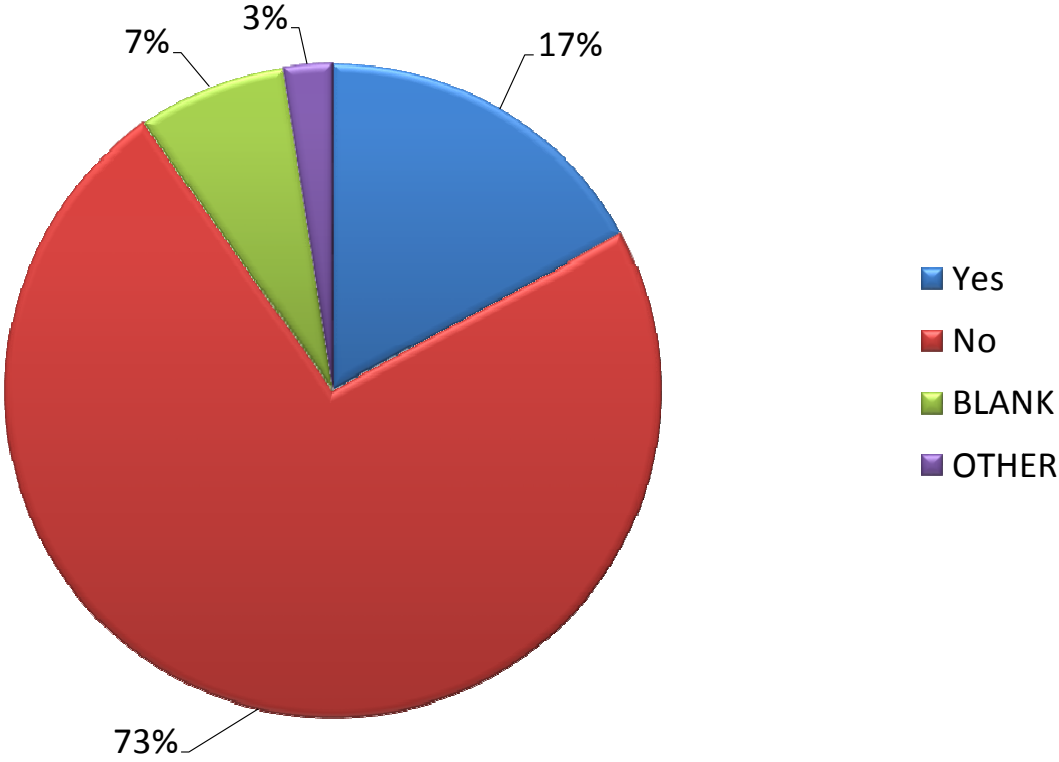
Does the policy limit the weight of items, including passenger PEDs, stowed in seat back pockets?



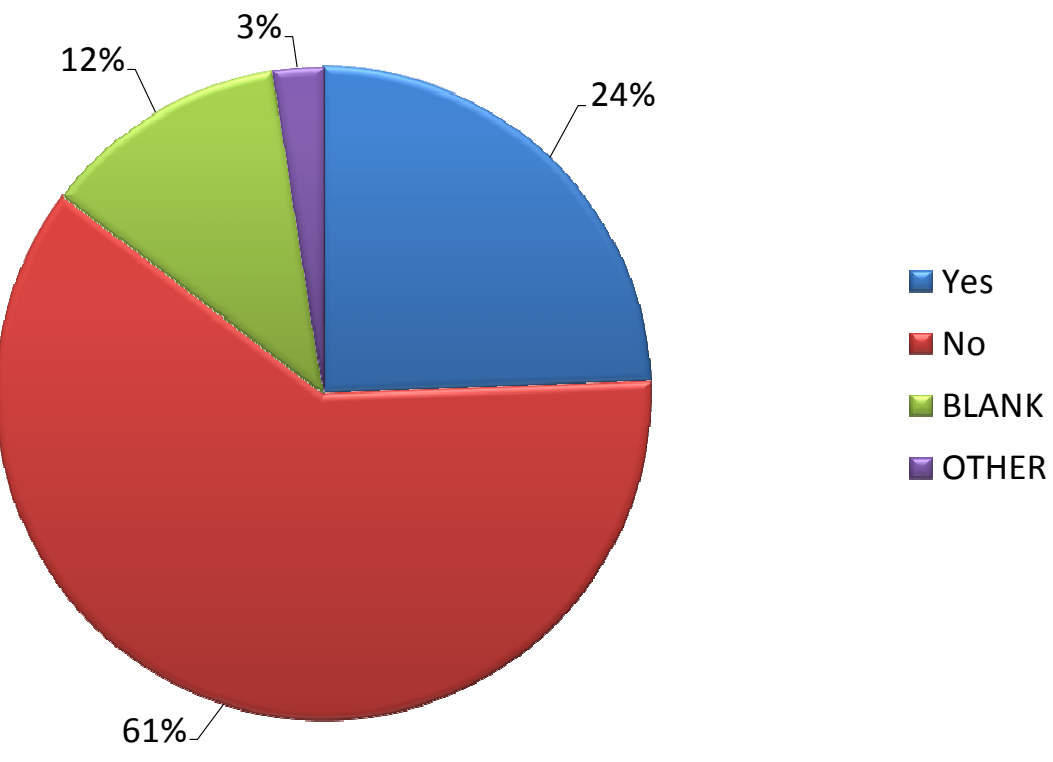
Does the policy limit seat back pocket stowage to ensure that passengers can egress safely during an emergency?



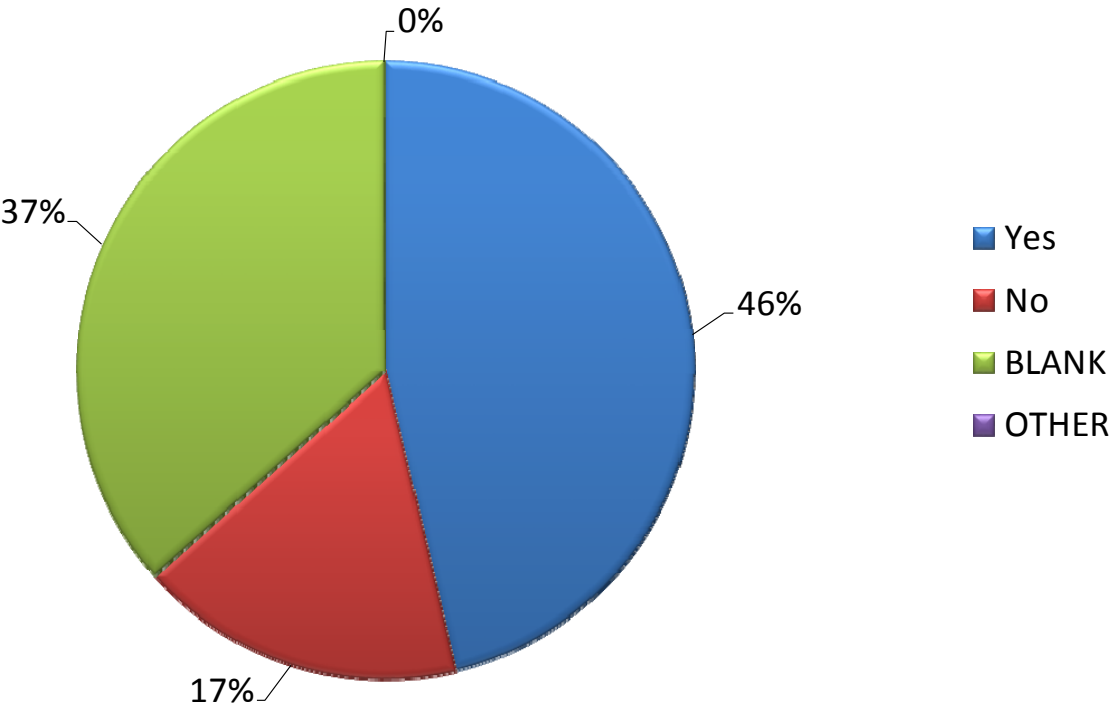
Does the policy specifically restrict the use/stowage of **wired** headsets?



Does the policy specifically restrict the use/stowage of **wireless** headsets?

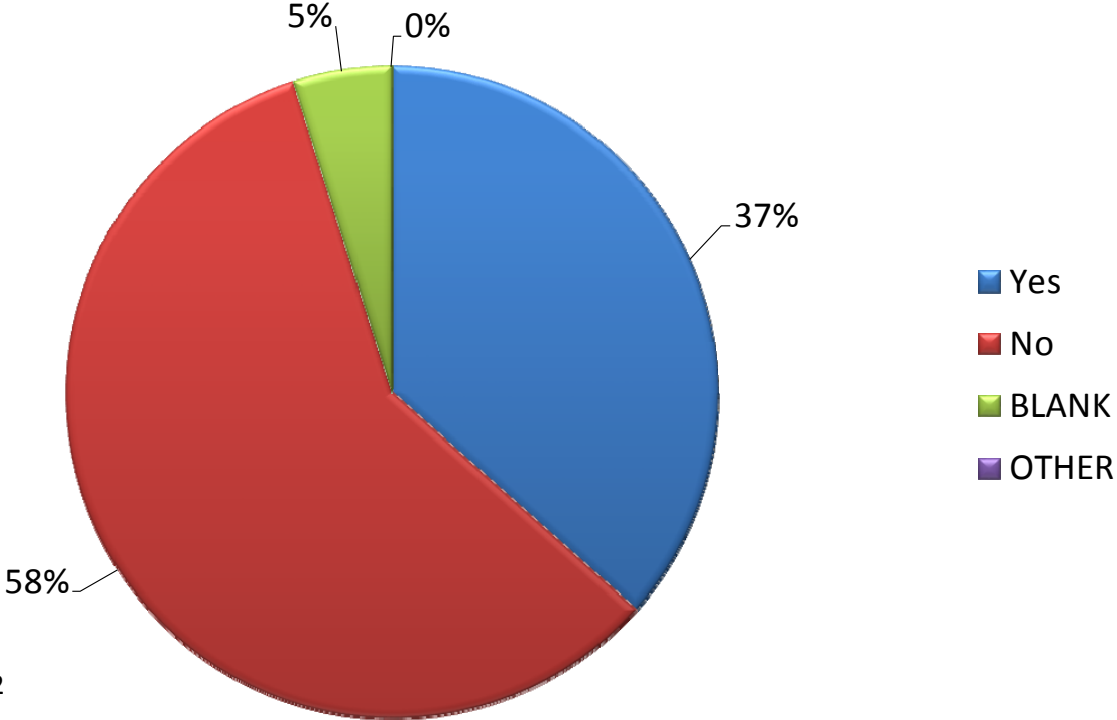


Does your aircraft operation have crewmember reports of incidents involving passenger Non-compliance with PED stowage requirements?



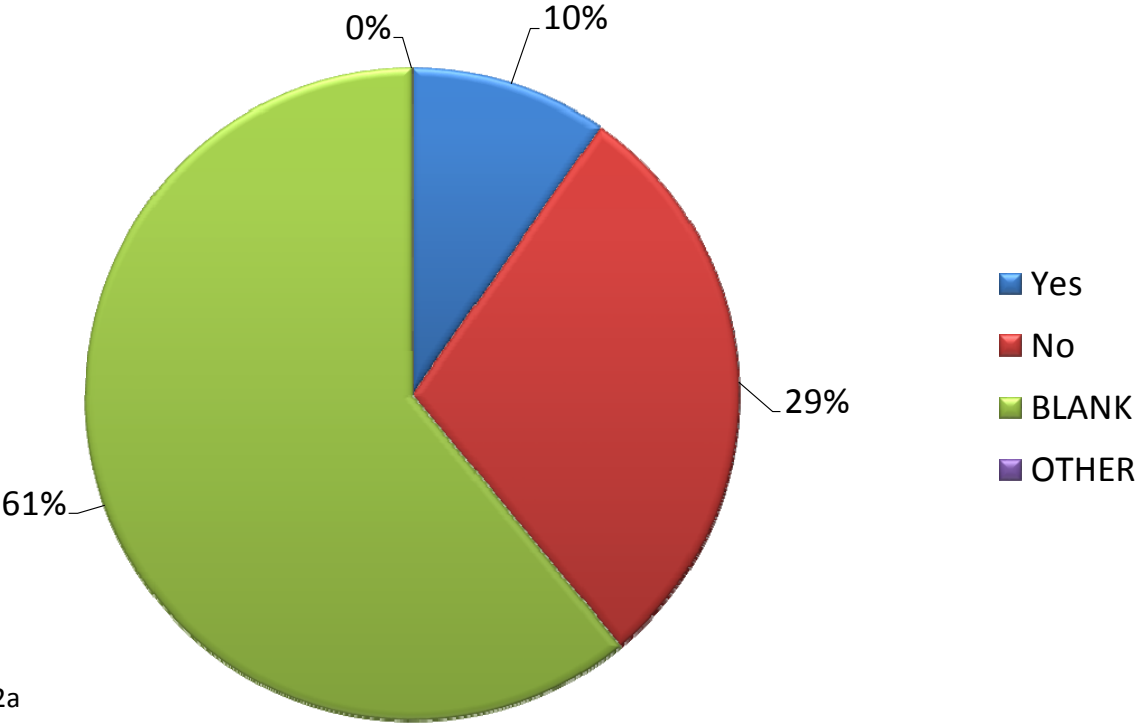
Question – 1h

Do any of your aircraft have seat power plugs installed for passenger use?



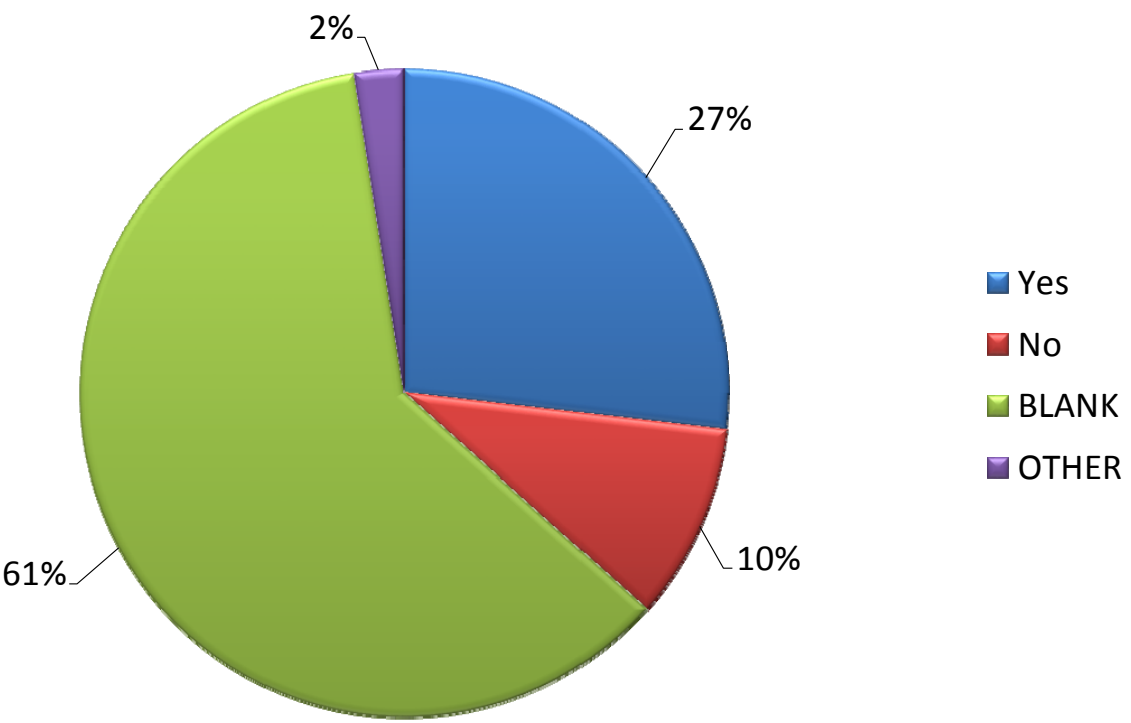
Question – 2

Can passenger PEDs be connected to seat power during all phases of flight?



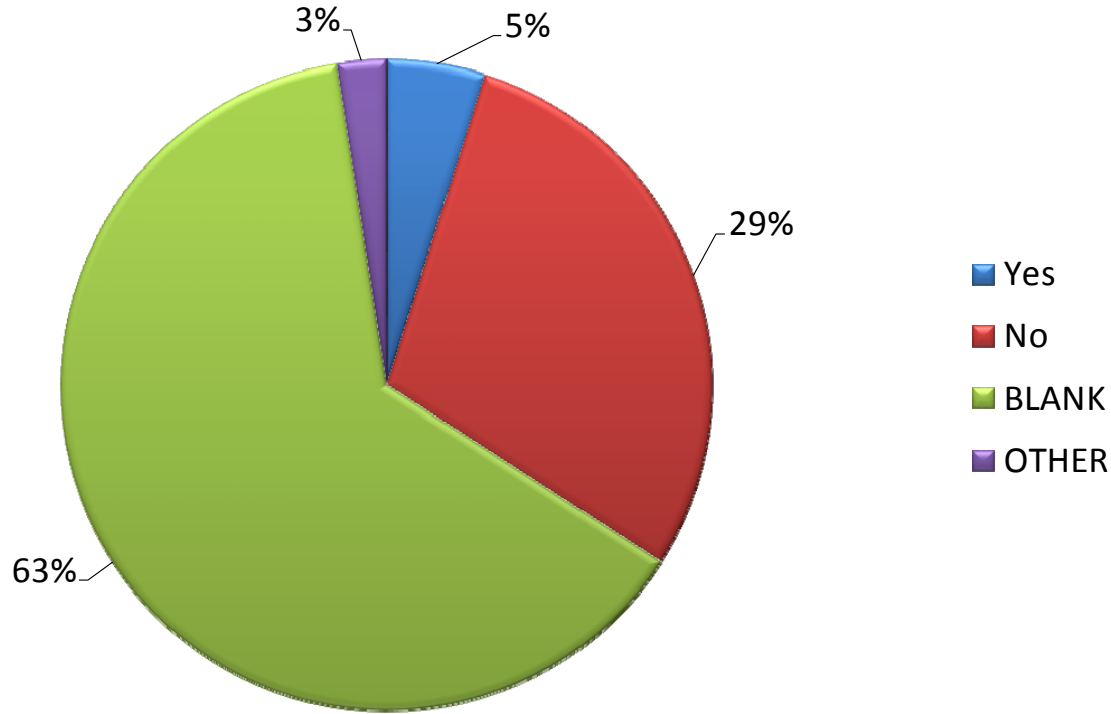
Question – 2a

Can cabin crewmembers disable seat power?

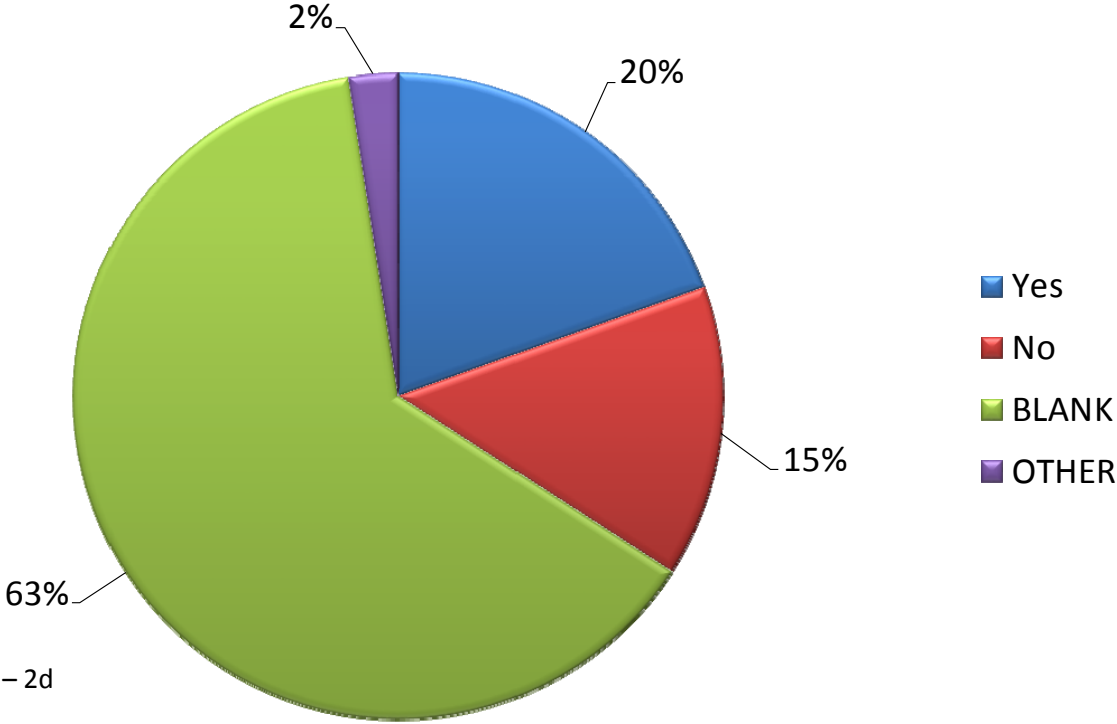


Question – 2b

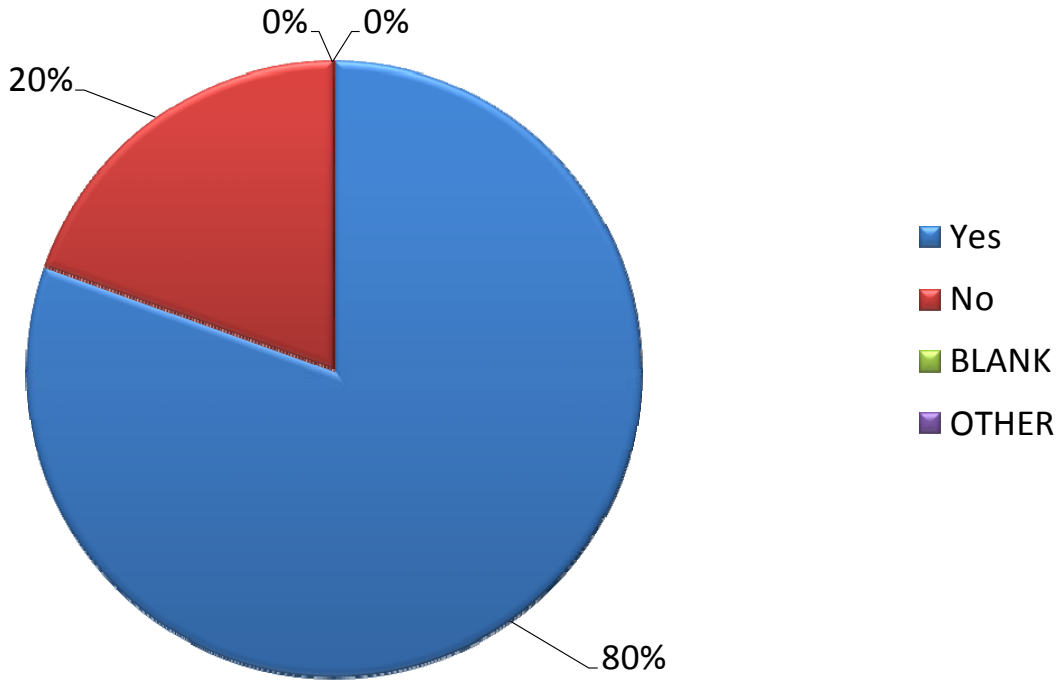
Can cabin crewmembers disable seat power at individual seats?



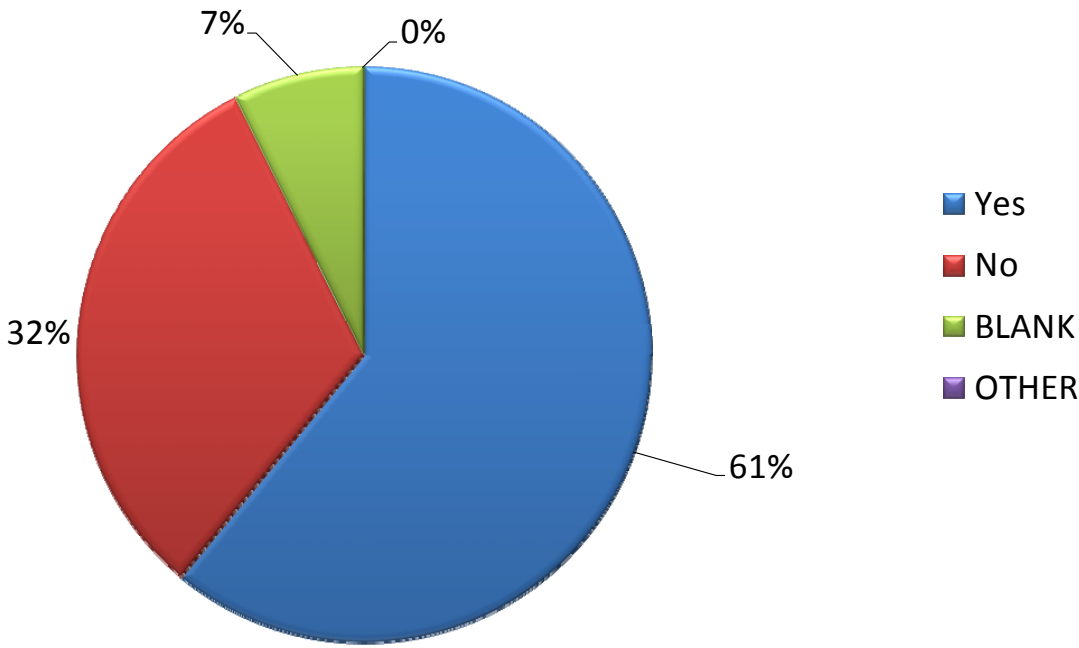
Can cabin crewmembers disable seat power in separate sections of the airplane?

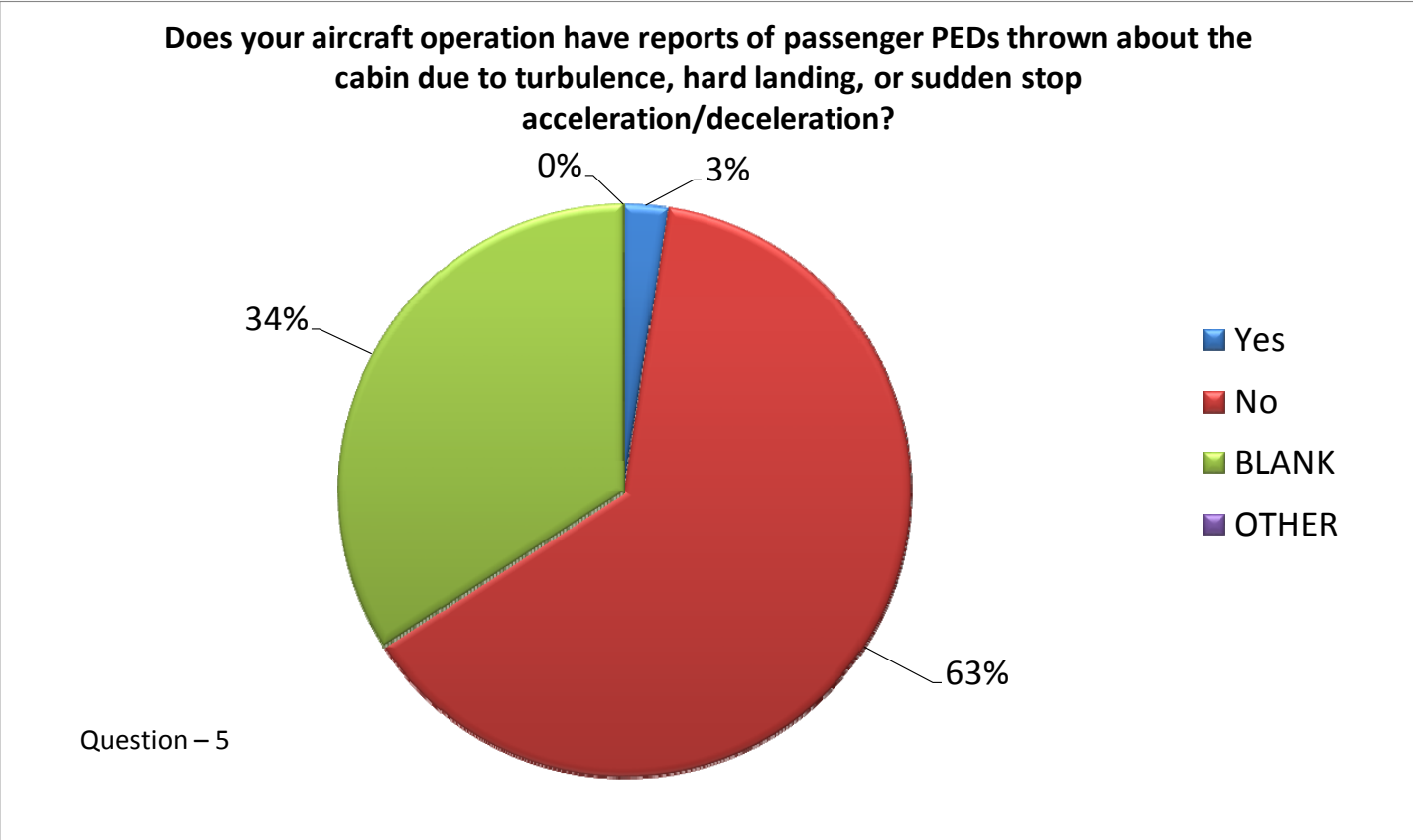


Are crewmembers (pilots and/or flight attendants) required to make announcement(s) to passengers related to stowage of PEDs?



Does your aircraft operation require crewmembers (pilots and/or flight attendants) follow specific procedures to enforce its passenger PED stowage policies?





Appendix 2: AAM-630 Memorandum, Recommendations for PED Usage Onboard Airliners



Federal Aviation Administration

Memorandum

Date: September 18, 2013
To: Portable Electronic Device (PED) Aviation Rulemaking Committee (ARC)
From: Manager, Protection and Survival Research Laboratory, AAM-630
Subject: Recommendations for PED Usage Onboard Airliners

Cabin Safety research scientists in the FAA Office of Aerospace Medicine, Civil Aerospace Medical Institute (CAMI, AAM-630) have assessed the options for an expanded portable electronic device usage policy being considered by the Portable Electronic Device (PED) Aviation Rulemaking Committee (ARC) and its Stowage Policy Working Group, using data from aviation accident investigations, aviation human factors research, and the general literature for context. Of particular importance is the relationship of PED usage to post-crash emergency evacuation.

When an emergency evacuation is required, passengers must engage in rapid and appropriate behaviors under stressful conditions. In what has become the seminal analysis of airplane accident survival factors, Snow, Carroll and Allgood¹ concluded:

Within a few seconds, [a passenger] must make a perilous journey from seat to sanctuary through fire, smoke and a maze of physical and human barriers... [survival] depends largely upon the number and location of exits, which of these are blocked by flame or impact damage, the human help he receives along the way and the intensity of the fire and smoke within the cabin. ***But in addition to these extrinsic factors, his chance of survival is also influenced by physical and mental attributes of his own that may enable, or prevent, his effective exploitation of the short time he has remaining*** (emphasis added).

Their study implicates informative preflight briefings, combined with positive direct crew assistance throughout the evacuation, as important to post-crash passenger survival. Since providing detailed information and specific instructions to people before and during an emergency has been shown to prompt action, reduce stress, and support the problem solving process, it is clear that passenger knowledge and awareness are key factors in determining how they will respond in the event of an accident (Baddeley², Chertkoff & Kushigian³, Fritz & Marks⁴, Quarantelli⁵).

¹ Snow, CC, Carroll, JJ, & Allgood, MA (1970). *Survival in emergency escape from passenger aircraft* (AM 70-16). Washington, DC: Office of Aerospace Medicine.

² Baddeley, AD (2001). Selective attention and performance in dangerous environments. *Human Performance in Extreme Environments*, 5, 86-91.

³ Chertoff, JM & Kurshigian, RH (1999). *Don't Panic: The Psychology of Emergency Egress and Ingress*. Wesport, CT: Praeger.

⁴ Fritz, CD & Marks, ES (1954). The NORC studies of human behavior in a disaster. *Journal of Social Issues*, 10, 26-41.

⁵ Quarantelli, EL (1954) The nature and conditions of panic. *American Journal of Sociology*, 60, 267-275.

The airplane passenger who has paid attention to the safety information available, and has developed a plan for what she or he would do to get out of an airplane in a hurry, is better able to handle an emergency situation without becoming confused or panicked (Hodson⁶, Johnson^{7,8,9}, Leach¹⁰, Pronko & Leith¹¹).

In a three-part study of passenger safety awareness from 2000 to 2006 by Corbett and McLean¹², 60% of the participants reported that they did not attend to preflight safety information. Although the other 40% of the study participants claimed to engage preflight safety information, they did not know any more than the non-attenders, suggesting that while passengers may say they attend to safety information, in actuality they may not be learning or remembering it later. Multiple distractions are likely to be a large part of that shortcoming.

In a follow-up to the passenger safety awareness study, Corbett¹³ analyzed the NTSB questionnaire and interview responses from the passengers of US Airways Flight 1549, which made a water landing in the Hudson River in January, 2009. Seventy percent of those passengers reported that they took more than 6 flights per year; 50% reported that they watched NONE of the preflight safety presentation; 89% did not read the safety information card at all; and using the same criteria from the previous study to classify them as attenders/non-attenders, 94% of the passengers were categorized as NON-attenders. Thirty-six percent reported that they were reading, sleeping, listening to music, or distracted by other people during the briefing. It should not be surprising, then, that the passengers did not know what "brace for impact" meant, nor did they retrieve their flotation seat cushions or life preservers, nor could they properly don a life preserver they were given, nor did they realize that the overwing exits were not so-called "ditching" exits, nor did they realize that the evacuation slides aft of the wings were not "boats". The NTSB survival factors report makes clear that the passengers were mostly uninformed and unprepared to function effectively in that emergency situation¹⁴.

In its safety studies and accident investigations, the NTSB continues to find that passenger attention to safety information is declining, and recommends that the FAA require operators to implement creative and effective methods of overcoming passenger inattention, and to conduct research to explore creative and effective methods that use state-of-the-art technology to convey safety information to passengers (A-74-113¹⁵, A-85-101¹⁶, A-00-86¹⁷, A-10-86¹⁸). In response, the FAA has suggested that "One way to increase passenger motivation [to focus on the safety information] is to make the safety briefings and cards as interesting and attractive as possible," encouraging "operators to be innovative in their approach in imparting such information" (AC 121-24C; 2003¹⁹).

Safety procedures on modern day cruise ships should be exemplars for safety training for passengers²⁰. At the start of each cruise, ALL passengers must become familiar with the procedure for evacuation of the ship in the event of a fire or collision. The International Convention for Safety of Life at Sea (SOLAS Regulation III/19) requires that all passengers on commercial vessels, no matter the number of times they have cruised, simulate an on-board emergency, retrieve life jackets, and proceed to life boats and/or muster stations in a training exercise known as a

⁶ Hodson, M (2000, August 13). How to survive an air crash. The London Sunday Times, p. Travel 10.

⁷ Johnson, DA (1979). *An investigation of factors affecting aircraft passenger attention to safety information presentations*. Washington, DC: DOT. (NTIS No. AD A082358)

⁸ Johnson, DA (1984). *Just in Case: A Passenger's Guide to Airplane Safety and Survival*. New York: Plenum.

⁹ Johnson, DA (1997). How people behave in aircraft accidents. *Human Performance in Extreme Environments*, 2, 71-80.

¹⁰ Leach, J (1994). *Survival Psychology*. Washington Square, NY: New York University Press.

¹¹ Pronko, NH & Leith, WR (1956). Behavior under stress: A study of its disintegration. *Psychological Reports*, 2, 205-222.

¹² <http://www.fire.tc.faa.gov/2007Conference/files/Evacuation/WedAM/CorbettPassSafetyAware/CorbettPassSafetyAwarePres.pdf>

¹³ http://www.fire.tc.faa.gov/2010Conference/files/Cabin_Safety_I/CorbettAwareness1549/CorbettAwareness1549Pres.pdf

¹⁴ <http://dms.nts.gov/pubdms/search/hitlist.cfm?docketID=47230&CFID=81828&CFTOKEN=71811991>

¹⁵ http://www.nts.gov/doclib/recletters/1974/A74_105_114.pdf

¹⁶ http://www.nts.gov/doclib/recletters/1985/A85_93_104.pdf

¹⁷ http://www.nts.gov/doclib/recletters/2000/A00_72_91.pdf

¹⁸ <http://www.nts.gov/doclib/recletters/2010/A-10-062-086.pdf>

¹⁹ [http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/list/AC%20121-24C/\\$FILE/AC121-24C.pdf](http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/list/AC%20121-24C/$FILE/AC121-24C.pdf)

²⁰ <http://seniortravel.about.com/od/cruises/a/What-To-Expect-At-The-Lifeboat-Drill.htm>

passenger boat drill. Further, a passenger's role is not simply to "do as you are told," but often to help organize the other passengers for a fast and efficient evacuation. Passengers are also instructed to be familiar with at least 2 evacuation routes from cabin to life boat.

CAMI Cabin Safety researchers recognize the attraction of "PED-tolerant" airplanes, including the allure of allowing these devices to operate during all phases of flight. However, in addition to the aforementioned scientific data and analysis pertinent to maintaining a "clean cabin environment," accident data show that takeoff/initial-climb and final-approach/landing are critical phases of flight for accidents and fatalities. The Boeing Company has published reports, e.g., *Statistical Summary of Commercial Jet Aircraft Accidents*, which show that 17% of accidents occurred during takeoff and initial climb and 54% occurred during final approach and landing for the period of 1992 through 2001²¹, and for fatal accidents in the period of 2003 through 2012²², the accident/fatality numbers are 16% and 41%, respectively. Combined, the research and accident statistics indicate that added distractions (e.g., usage of PEDs) during critical phases of flight would unnecessarily increase risk, discount passenger safety, and disregard the many serious efforts to rectify the shortcomings related to passenger safety awareness.

In particular, use of PEDs should continue to respect the clean cabin environment during the pre-flight briefing and critical phases of flight, since the focused attention of passengers to PEDs creates competition for passenger mental capacity. People can selectively attend to only one thing at a time. This limitation on attention is the reason states have cited to outlaw cell phone usage while driving²³, and while the results of passenger inattention to safety information on airliners would typically not be as dramatic, except in an emergency, it seems inexplicable to promote PED usage during the very times when passengers might need to engage that safety information the most. One might argue that other modes of public transportation do not demand such passenger engagement, but as cited above, the public transportation mode with the most comparable risk profile – cruise ships – does in fact mandate hands-on safety equipment briefings and emergency escape planning when all passengers have first come on board.

Whatever minimal loss in PED usage time caused by requiring a clean cabin environment during preflight briefings and the critical phases of flight can be mitigated effectively by immediately accessible (e.g., seatback pocket) PED stowage provisions. Such provisions would allow timely access when appropriate and mitigate evacuation delays or trip hazards caused by errant power cables and related accessories. Perhaps just as importantly, the message is sent that safety is an important concern that passengers need to embrace.

The circumstances surrounding the cabin safety aspects of PED usage onboard airliners have previously been made clear, and there is little additional information in this regard that needs to be garnered via laboratory research.

Biodynamics research scientists in the FAA Office of Aerospace Medicine, Civil Aerospace Medical Institute (CAMI, AAM-630) have assessed the options for an expanded portable electronic device usage policy being considered by the Portable Electronic Device (PED) Aviation Rulemaking Committee (ARC) and its Stowage Policy Working Group. The issues addressed are related to the injury risk from unsecured objects, and stowage of items in the seat back pocket.

Items of mass can become projectiles in the event of a sudden deceleration as could be experienced during a maximum performance landing, rejected takeoff, turbulence, or a severe but survivable crash landing. FAA regulations require that seats and restraint systems installed in newly manufactured airliners provide the occupants protection from serious head injuries during emergency landing conditions²⁴. The impact scenarios used to verify this protection are a horizontal deceleration, as could result from a landing overrun, and a combined horizontal/vertical deceleration as could occur during a landing undershoot.

²¹ http://www.oaviao.com/oaviao_novo/diretorio_aero/seguranca_voo/Boeingaccidentstatsum59-01.pdf, page 17

²² <http://www.skybrary.aero/bookshelf/books/2418.pdf>, page 20

²³ <http://www.distraction.gov/download/811737.pdf>

²⁴ <http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=19b36f76bf3e2ea97a7613c5435a19b8&r=SECTION&n=14v1.0.1.3.11.3.169.63>

While hanging onto a small object exposed to the inertial forces that could be imposed during turbulence or an emergency landing is possible, it is the unexpected nature of these events that make it more likely that a passenger would lose control of even a light object. During a turbulence event, the most likely initial trajectory of a loose item is vertical. During an emergency landing, the initial trajectory will depend on the impact direction, with the forward and downward directions being the most likely. The relative velocity that a loose item can attain is related to the inertial force applied and the distance it travels. The presence of nearby seatbacks and walls in a typical aircraft cabin tends to limit the distance that an object can travel, thereby limiting its velocity. The impact risk to passengers posed by a loose object is related to its mass (weight), size, stiffness, and its velocity. There is no evidence that PEDs pose any more risk of injury to occupants than any other object (e.g., a hard cover book) of similar weight, size and stiffness.

One means to control the risk of impacts from loose objects is to store them during phases of flight where the risk of unexpected deceleration is most likely i.e. takeoff, turbulence, and landing. Since the seat back pocket is readily accessible, using it as a stowage compartment to store small items during critical phases of flight is one way proposed to ensure safety on a "PED tolerant" aircraft.

The amount of mass placed in literature pockets during aircraft seat dynamic tests and interpretation of the results of those tests are defined in multiple FAA documents, and industry standards. FAA regulations require that seats and restraint systems installed in newly manufactured airliners successfully complete dynamic tests and FAA guidance concerning conduct of those tests calls for the mass of baggage, life vests, and literature pocket contents be installed at each seat place²⁵. An FAA Information Bulletin further states that "Seat pockets have been designed to restrain approximately 3 pounds of weight and not the weight of additional carry-on items"²⁶. An SAE Aerospace Recommended Practice qualifies the 3 lb. specified by reducing the mass in proportion to the literature pocket width relative to the overall seat back width.²⁷ FAA regulations also require that cargo in the passenger compartment be positioned so that if it breaks loose it will be unlikely to cause direct injury to occupants²⁸. The latest version of the SAE performance standard for aircraft seats provides additional detail concerning retention of literature pocket contents during dynamic tests.²⁹ This standard states in Section 5.3.5.1 that "Items 0.15 kg (0.33 lb) or greater carried by the seat that do not affect the dynamic performance of the seat may be representative masses, but the production means of attachment must be on the test article." It also states in Section 5.3.9.15 that "Detachment of an item should be assessed to determine the effect on the seat or egress. The time when the item became detached relative to the time when the seat achieved peak reaction loads should be determined. If the item in question was retained until after the seat achieved peak reaction loads, the seat structure carried the total seat weight through the peak dynamic load and no retest of the structure or reduction of the tested seat weight is required due to the loss of the item. If the item detached prior to the seat achieving peak reaction loads, any item (or all items if more than one detached) exceeding 3% of the empty weight of the seat (i.e., without occupants, baggage, life vests, literature, etc.) will require a retest or a reduction in the tested seat weight. In both cases, the means of restraint should be improved and substantiated."

Meeting these requirements can be demonstrated by placing a 3 lb. item, simulating literature pocket contents in each seat back pocket during the dynamic qualification tests. If the pocket is narrower than the seat back, then a proportionally lighter item may be used. Since the primary purpose of including the literature weight in the dynamic tests was to substantiate overall seat strength, the SAE standard permits detachment of items after the time of peak loading. This means the dynamic tests show that the seat can carry the additional weight of the literature without structural failure, but do not ensure that the literature is retained throughout the entire

²⁵ [http://www.airweb.faa.gov/Regulatory and Guidance Library/gAdvisoryCircular.nsf/0/808324BF7790FDA3862571010075BCBF?OpenDocument](http://www.airweb.faa.gov/Regulatory%20and%20Guidance%20Library/gAdvisoryCircular.nsf/0/808324BF7790FDA3862571010075BCBF?OpenDocument)

²⁶ http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2009/InFO09018.pdf

²⁷ SAE Aerospace Recommended Practice 5526C, Aircraft Seat Design Guidance and Clarifications, 2011-05, <http://www.sae.org>

²⁸ [http://www.ecfr.gov/cgi-bin/text-](http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=130c1ff8c8c03c27d83459ecdd19494c&rgn=div8&view=text&node=14.1.0.1.3.11.3.169.62&idno=14)

[idx?c=ecfr&SID=130c1ff8c8c03c27d83459ecdd19494c&rgn=div8&view=text&node=14.1.0.1.3.11.3.169.62&idno=14](http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=130c1ff8c8c03c27d83459ecdd19494c&rgn=div8&view=text&node=14.1.0.1.3.11.3.169.62&idno=14)

²⁹ SAE Aerospace Standard 8049B, Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft, 2005-01, <http://www.sae.org>

dynamic event. For full width seat pockets, if the operationally required content of the literature pocket weighs only 1 lb., then an item weighing 2 lb. could be placed in the pocket and not exceed the weight for which the seat has been qualified. The exact size of the simulated contents is not specified in the guidance material, but they are typically made up of 3 lb. of 8.5 x 11 inch paper (which is a stack about 1.25 inches tall).

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APPENDIX H: PASSENGER USE SURVEY DATA

Appendix H includes passenger use survey data reviewed by the PED ARC during its deliberations. The following information was compiled and prepared for publication by the member organization listed.

- Airline Passenger Experience Association & Consumer Electronics Association, *Portable Electronic Devices on Aircraft Study* (March 2013)
- Consumer Electronics Association, *CEA Comparison Summary Report - Portable Electronic Devices on Aircraft - 2003 vs. 2013* (April 2013)
- Delta Air Lines, *Customer Service Data* (October 2012)

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Portable Electronic Devices on Aircraft



**Joint study created in collaboration with
the Airline Passenger Experience Association
and the Consumer Electronics Association (CEA)®**

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Methodology

The report described herein was designed and formulated jointly by the Consumer Electronics Association (CEA) ® and the Airline Passenger Experience Association (APEX). This report presents the findings of a telephone survey conducted among two national probability samples, which, when combined, consist of 1,629 adults, 815 men and 814 women 18 years of age and older, living in the continental United States. Interviewing for this CARAVAN® Survey was completed on December 14-18, 2012. 1,093 interviews were from the landline sample and 536 interviews from the cell phone sample.

The margin of sampling error at 95% confidence for aggregate results is +/- 2.43%. Sampling error is larger for subgroups of the data. As with any survey, sampling error is only one source of possible error. While non-sampling error cannot be accurately calculated, precautionary steps were taken in all phases of the survey design, collection and processing of the data to minimize its influence.

During the fielding of this study, Consumer Electronics Association (CEA) ® and the Airline Passenger Experience Association (APEX) employed the services of Opinion Research Corporation (ORC) to conduct telephone interviewing. The telephone interviewing employed industry standard random-digit dialing and computer assisted telephone interviewing (CATI).

Sampling

ORC's CARAVAN® landline-cell combined sample is a dual frame sampling design. This means that the sample is drawn from two independent non-overlapping sample frames—one for landlines and one for cell phones.

Land Line Sample

ORC's Random Digit Dial (RDD) telephone sample is generated using a list-assisted methodology.

Cell Phone sample

The MSG Cellular RDD database is constructed quarterly utilizing Telecordia's LERG product.

As is common practice in survey research, the data was weighted to reflect the known demographics of the population under study. In this survey, weights were applied to cases based on gender, age, race and geographic region. As a result, this data can be generalized to the entire U.S. adult population. The bases shown on all charts and tables are weighted bases. All percentages in the text, charts and tables included in this report are also based on weighted data.

The Consumer Electronics Association is a member of the Marketing Research Association (MRA) and adheres to the MRA's Code of Marketing Research Standards.

CEA and APEX designed this study in its entirety and is responsible for all content contained in this report. Any questions regarding the study should be directed to CEA Market Research staff at info@CE.org.



Background and Research Objectives

The Federal Aviation Administration (FAA) has policies in place that permit the usage of specified portable electronic devices (PED) that the aircraft operator has determined will not interfere with the safe operation of the aircraft. These regulations generally prohibit the use of all PEDs during taxiing, take-off and landing. However, with the recent proliferation of PEDs such as smartphones, tablets and e-Readers into travelers' Internet-connected lives, many passengers, along with various industry groups and associations, are leading initiatives asking for greater usage of PEDs while on aircraft.

The objectives of this study are to gauge consumer awareness and usage of PEDs on aircraft by:

- Assessing current consumer awareness and perceptions of the safety of PEDs on aircraft
- Evaluating existing and future usage of PEDs on aircraft

Executive Summary

- Nearly all (94%) U.S. adult airline passengers have brought at least one PED with them onto an aircraft while traveling in the past 12 months, either in their checked baggage or as a carry-on item.
 - The majority of PEDs brought on aircraft are carried-on. The most common PEDs carried-on include smartphones, notebook or laptop computers and basic cellphones, while the most frequently checked PEDs include notebook or laptop computers, smartphones and portable digital audio or MP3 players.
- Seven in ten (69%) PED carrying passengers report they used their device(s) during the flight, with the most commonly used devices being smartphones, notebook or laptop computers, tablet computers or digital audio or MP3 players.
 - During their flight, passengers most often use their PEDs for entertainment purposes: listening to music, playing games, reading books or magazines and watching movies, TV or videos. There are also a number of passengers who work while in-flight by working offline, reading email, sending email or working online.
- While on the ground, either prior to take-off or after landing, communication appears to be key. More than eight in ten (85%) passengers reported they used their PED(s) prior to take-off or after landing, the majority of use being of smartphones and basic cell phones.
 - Sending text messages is the number one activity conducted by passengers while on the ground, followed by reading email, listening to music, connecting to Wi-Fi (if available), sending email and playing games.
- In addition to their own PED usage on airplanes, four in ten (42%) passengers report their travel companions, such as family members, have also used PED(s) during flight(s) in the past 12 months.
 - Smartphones and tablet computers are the PEDs most commonly used by these travel companions, devices likely used for entertainment purposes such as playing games, listening to music, reading books or magazines or watching movies, TV or videos.
- Four in ten (43%) passengers indicate they would like to be able to use PEDs during all phases of flights, including take-off and landing.
- However, six in ten (61%) airline passengers believe that making cell phone calls should be restricted during flights, mainly due to the potential distractions it could cause for other passengers.
- Six in ten (61%) passengers feel it is important to be able to use their PEDs when flying for personal reasons. Interestingly, a considerably lower 43% feel the same is true for business travel, and about half (51%) feel it is important to be able to use PEDs when flying for business and personal purposes combined, suggesting that PED usage for entertainment purposes is more important than usage for work-related purposes.
- The importance of actually being able to connect PEDs to the Internet is considerably lower than the importance of having the device while traveling, further supporting the notion that PED usage for entertainment purposes is more important than usage for work-related purposes. Approximately four in ten agree it is important to be able to connect their PEDs to the Internet while traveling for personal (39%), combined business and personal (37%) and business purposes (35%) alike.
- While the majority of passengers say they follow clear and proper instruction on allowed usage of PEDs prior to take-off, the data shows this is not always the case. More than nine in ten (94%) passengers agree the instructions are clear, yet only six in ten (59%) say they ***always*** turn their

devices completely off when asked to do so, with an additional 5% who say they sometimes turn their devices completely off.

- Almost one third (30%) of passengers report they have accidentally left a PED turned on during a flight. Smartphones, the most common PEDs carried onto passenger planes, are also the most common PED to be accidentally left turned on.
 - Basic cellphones, tablet computers and digital audio/MP3 players are also accidentally left on occasionally.
- Additionally, many passengers do not have a clear understanding of specifically when their PEDs can be used on an aircraft. Four in ten (43%) passengers incorrectly believe it is acceptable to use PEDs while taxiing to the runway, 32% while in the air before reaching 10,000 feet and 26% while the plane is in its final descent.
- Six in ten passengers are concerned about the potential for interference caused by PEDs powered on during both take-off (60%) and landing (58%).
 - Passenger concern is not nearly as high for devices powered on while in-flight or for devices left in airplane mode.
 - Reasons for this concern vary, but mainly center around interference and safety in general.
- More than half (57%) of passengers express interest in in-flight Wi-Fi services, while one-third (34%) are not interested.
 - Notebook or laptop computers, smartphones and tablet computers top the list of devices passengers would like to be able to connect to the Internet during flight.
- Passengers are more likely to purchase Wi-Fi when on longer flights. If available on a flight and reasonably priced, passengers are most likely to purchase Wi-Fi in-flight if the flight is over three hours in length (57% likely). Conversely, they are least likely to purchase if the flight is less than three hours long (32%). The purpose of the trip, business versus personal versus combined, does not make much of a difference in likelihood to purchase, as approximately four in ten would purchase for any of said travel purposes.

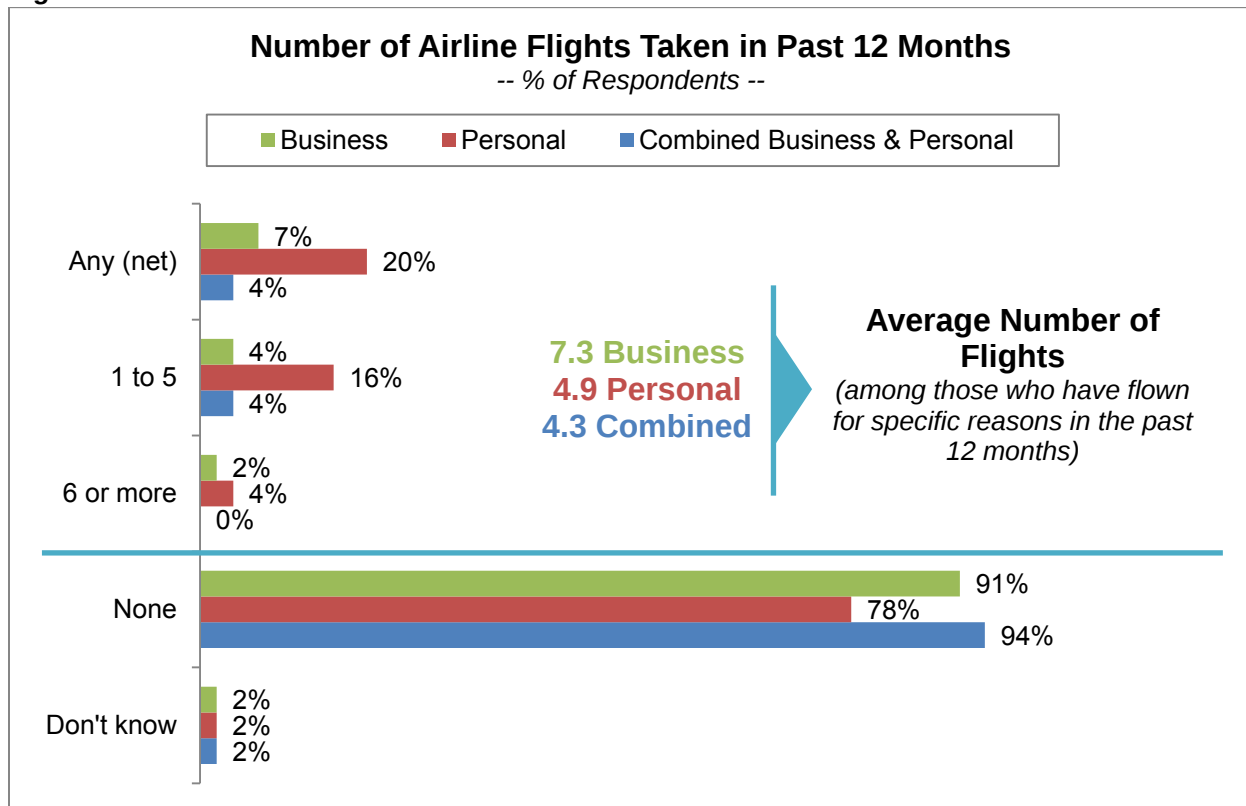
Detailed Findings

Airline Travel and Portable Electronic Device Usage

One in five (20%) U.S. adults have taken a flight for personal reasons in the past 12 months. An additional 7% have flown for business purposes and 4% for combined business and personal purposes.

Passengers who flew for business took an average of seven flights in the past 12 months. Looking specifically at those who flew for personal reasons, five flights were taken in the past 12 months, while combined business and personal flyers averaged four flights. Females are more likely than males to have taken personal flights, while males and passengers ages 35-54 are more likely to have taken business flights.

Figure 1

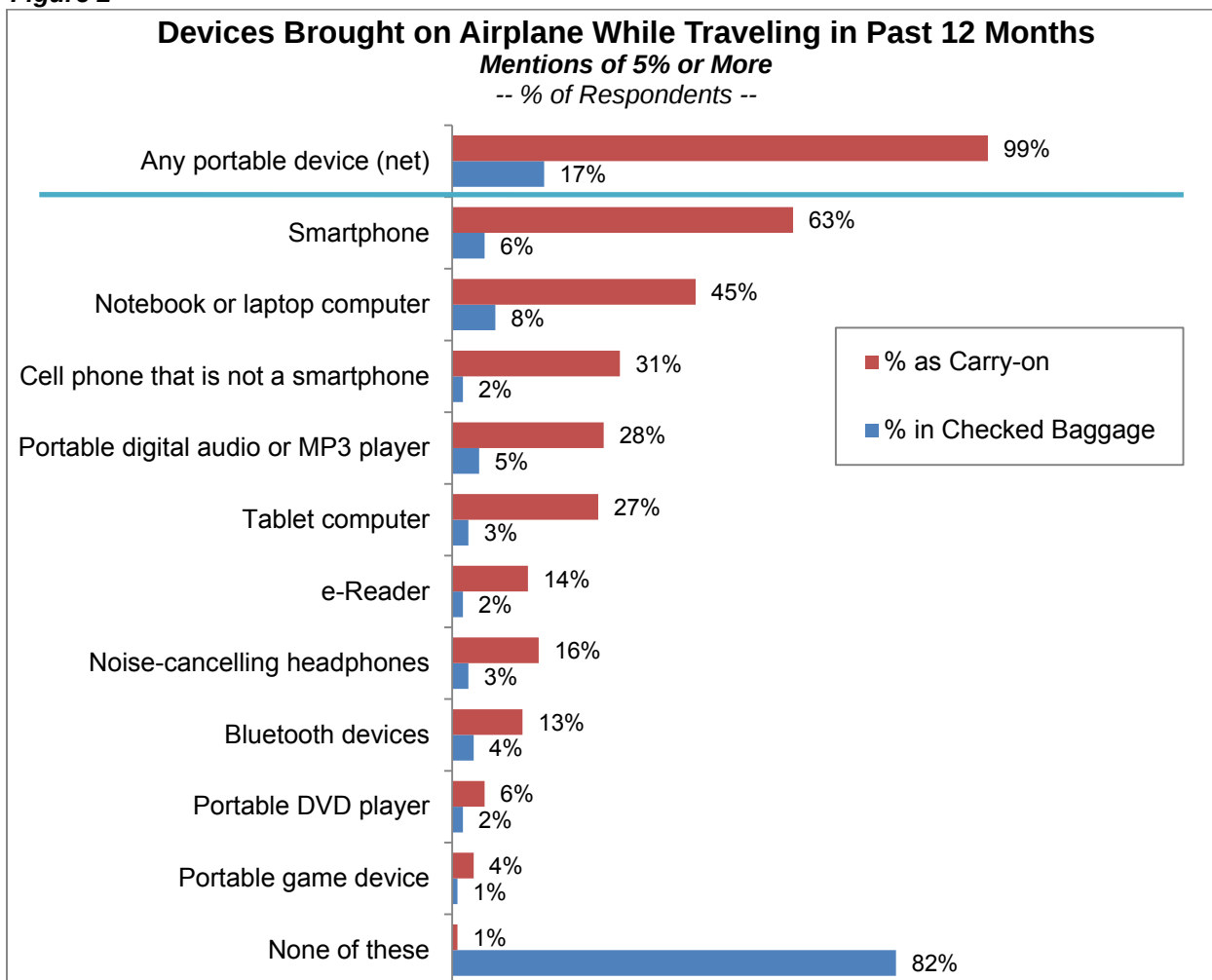


Base=U.S. adults (n=1,629)

Q. In the PAST 12 MONTHS, how many airline FLIGHTS have you, personally, taken where the purpose of travel was for each of the following. Please count each individual flight, including direct and connecting flights.

Nearly all (94%) passengers have brought at least one PED with them onto an aircraft while traveling in the past 12 months, either in a checked baggage or as a carry-on item. The majority of PEDs brought on aircraft are carried-on. Among those who have flown in the past 12 months and who have brought PEDs with them while flying, 99% carried-on at least one device and 17% checked at least one device in their baggage. The most common PEDs carried-on include smartphones (63%), notebook or laptop computers (45%) and basic cellphones (31%), while the most frequently checked PEDs include notebook or laptop computers (8%), smartphones (6%) and portable digital audio or MP3 players (5%).

Figure 2



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. Which, if any, of the following portable electronic devices have you brought with you when traveling by airplane in the PAST 12 MONTHS?

Base=U.S. adults who have taken any flights in the past 12 months and who have brought portable electronic devices with them while flying (n=353)

Q. Of those portable electronic devices you have brought with you while traveling by airplane in the past 12 months, which ones did you... A.) take on the plane with you? B.) put in your checked baggage?

While on the airplane, seven in ten (69%) PED carrying passengers report they used their device(s) during the flight, with 85% using their PED(s) prior to take-off or after landing. While in-flight, roughly one quarter of these passengers used their smartphone (28%), notebook or laptop computer (25%), tablet computer (23%) or their digital audio or MP3 player (23%). While on the ground, communication appears to be key; the most commonly used PEDs prior to take-off or after landing are smartphones (55%) and basic cell phones (23%).

Figure 3

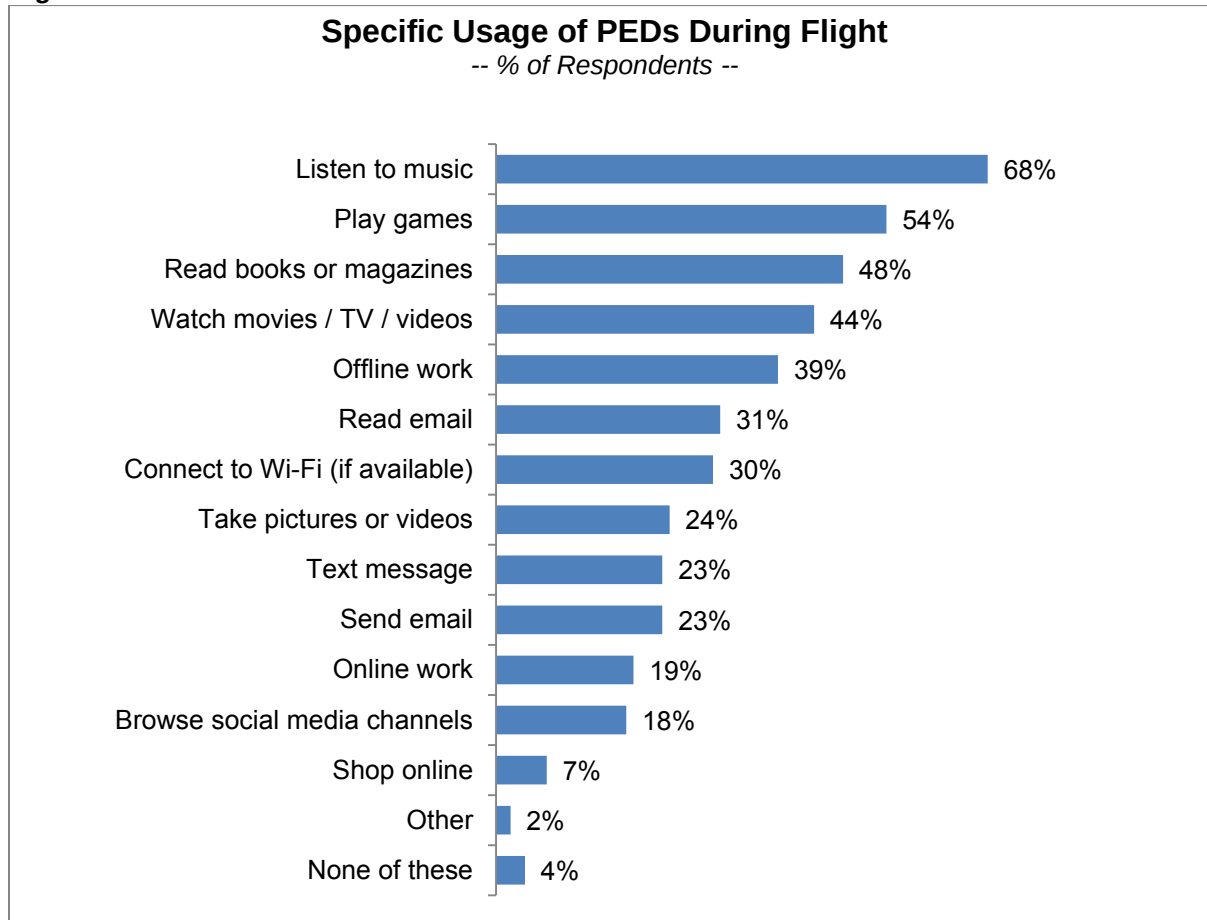
Devices Personally Used on Airplane While Traveling in Past 12 Months <i>Mentions of 5% or More</i> -- % of Respondents --		
	<i>During the Flight</i>	<i>Prior to Take-Off or After Landing</i>
<i>Any portable electronic device (net)</i>	69%	85%
Smartphone	28%	55%
Notebook or laptop computer	25%	19%
Tablet computer	23%	16%
Portable digital audio or MP3 player	23%	15%
e-Reader	13%	7%
Noise-cancelling headphones	12%	5%
Cell phone (non-smartphone)	5%	23%
Portable DVD player	5%	3%
Bluetooth devices	3%	5%
None of these	31%	15%

Base=U.S. adults who have taken any flights in the past 12 months and who have brought any listed portable electronic devices with them on the plane while flying (n=348)

Q. And which of those portable electronic devices have you personally USED while on the airplane... A.) during the flight B.) prior to take off or after landing

What do airline passengers use their PEDs for while flying? During flight, passengers are most often entertaining themselves by listening to music (68%), playing games (54%), reading books or magazines (48%) and watching movies, TV or videos (44%). There are also a number of passengers who tend to work in-flight, with 39% working offline, 31% reading email, 23% sending email and 19% working online.

Figure 4

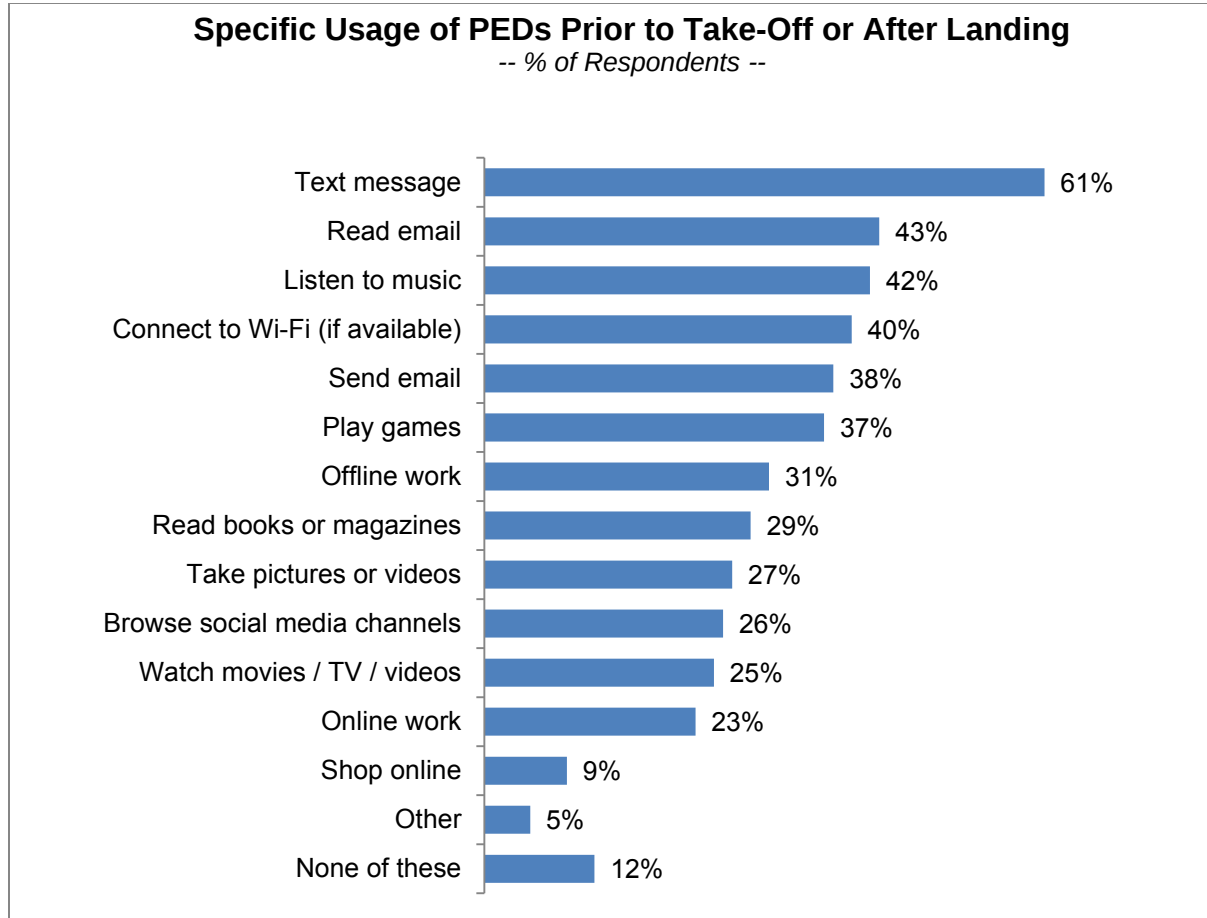


Base=U.S. adults who have taken any flights in the past 12 months and who have used any listed portable electronic devices brought on the plane with them during the flight (n=239)

Q. What functions do you personally use your portable electronic devices for while on the airplane during the flight?

While on the ground, either before taking off or after landing, work and entertainment co-mingle at the top of the list of activities reported by PED users. Sending text messages (61%) is the No. 1 activity, followed by reading email (43%), listening to music (42%), connecting to Wi-Fi (if available) (40%), sending email (38%) and playing games (37%).

Figure 5

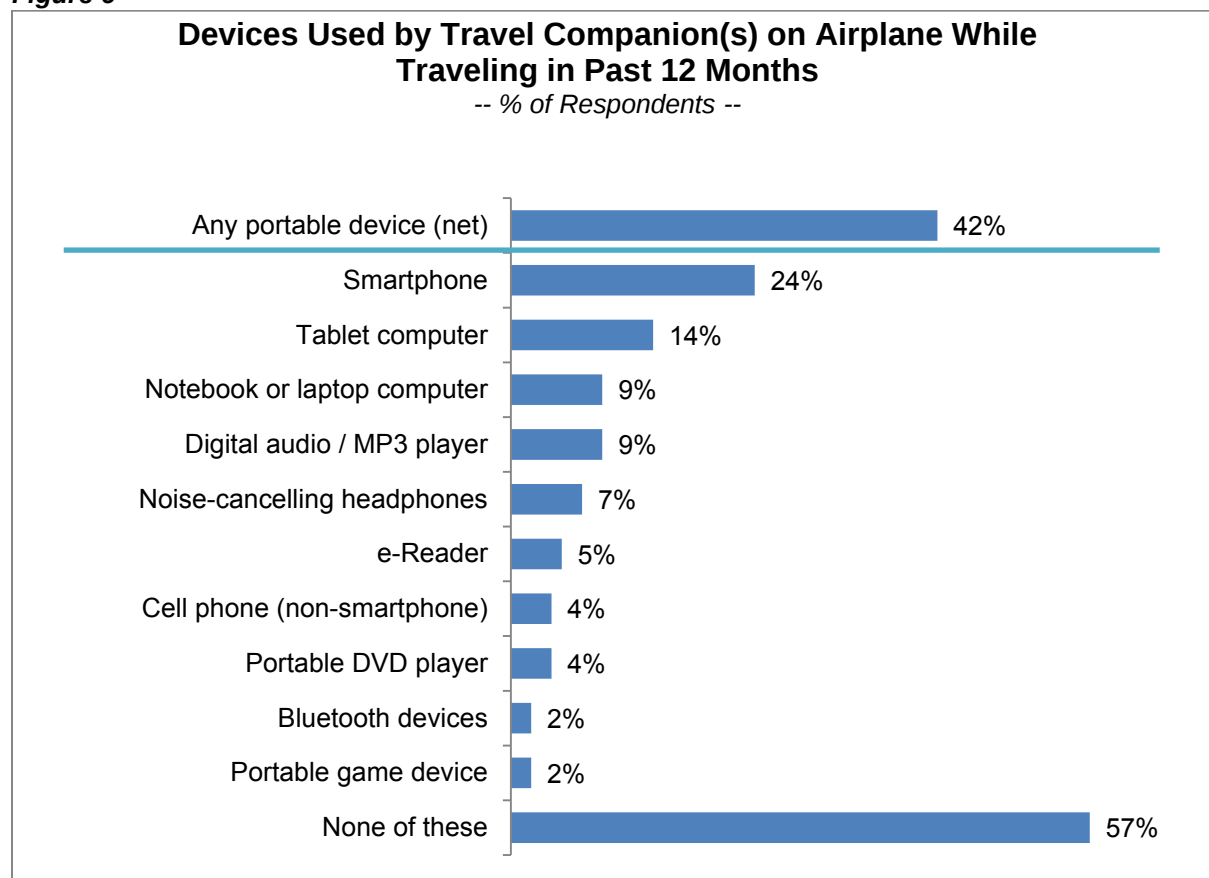


Base=U.S. adults who have taken any flights in the past 12 months and who have used any listed portable electronic devices brought with them prior to take off or after landing (n=296)

Q. What functions do you personally use your portable electronic devices for while on the airplane prior to take off or after landing?

In addition to their own PED usage on airplanes, four in ten (42%) passengers report travel companions, such as family members, also using PED(s) during flight(s) in the past 12 months. Travel companions most commonly use smartphones (24%) and tablet computers (14%), devices likely used for entertainment purposes such as playing games, listening to music, reading books or magazines or watching movies, TV or videos.

Figure 6



Base=U.S. adults who have taken any flights in the past 12 months and who have brought any listed portable electronic devices with them while flying (n=348)

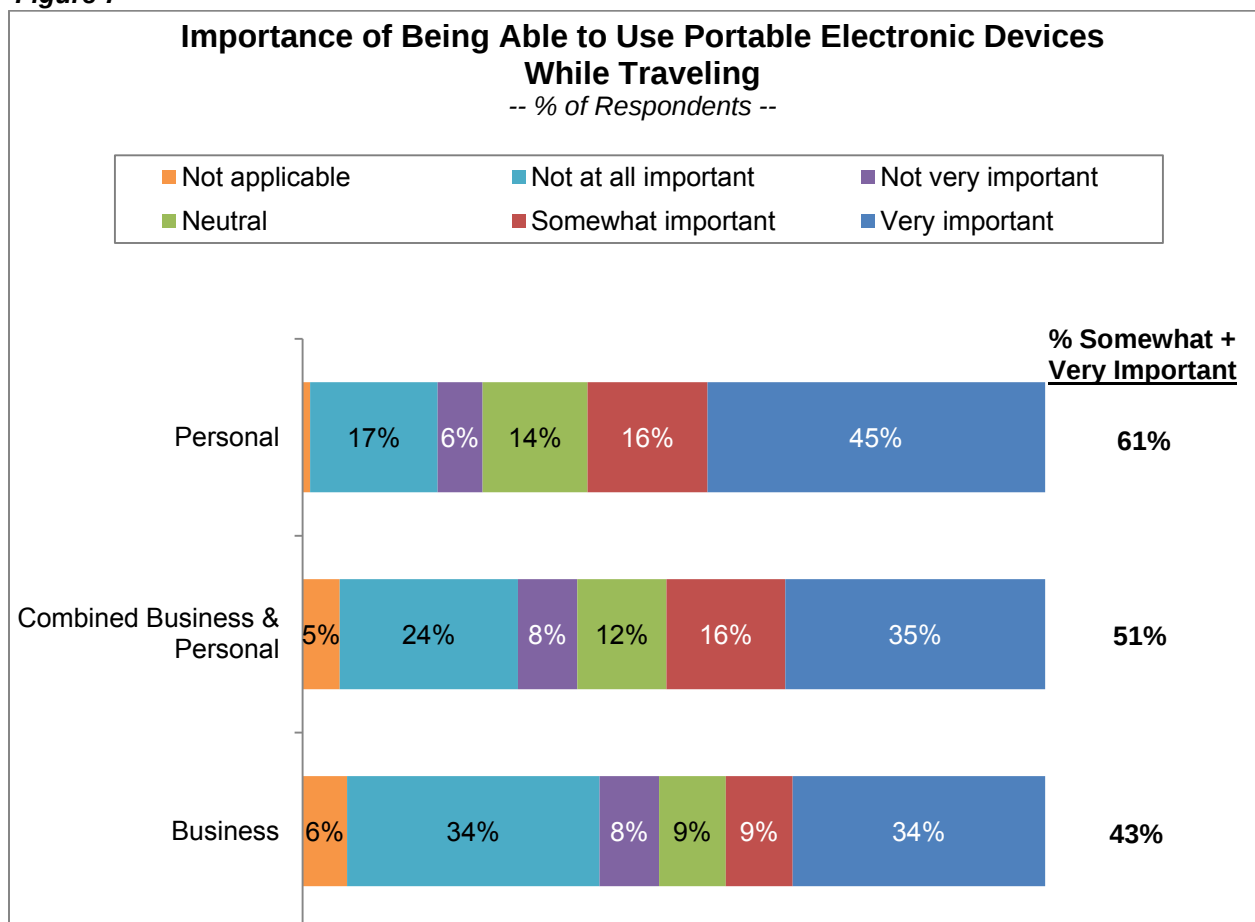
Q. Which were used by others, such as family members, traveling with you while on the airplane?

Importance of Staying Connected While Traveling

Six in ten (61%) passengers feel it is important to be able to use their PEDs when flying for personal reasons. Interestingly, a considerably lower 43% feel the same is true for business travel, while about half (51%) feel it is important to be able to use PEDs when flying for business and personal purposes combined. This discrepancy in importance may be due to personal travelers wanting PEDs available for entertainment purposes, while business travelers may not want their PEDs with them so they don't feel obligated to work while on the plane.

Notably, passengers ages 35-54 are more likely to consider the use of PEDs while on flights for business or for personal purposes to be important than are passengers ages 55+. Additionally, those ages 25-54 are more likely to consider the use of PEDs while on flights for combined business and personal reasons to be important when compared to those 55+.

Figure 7



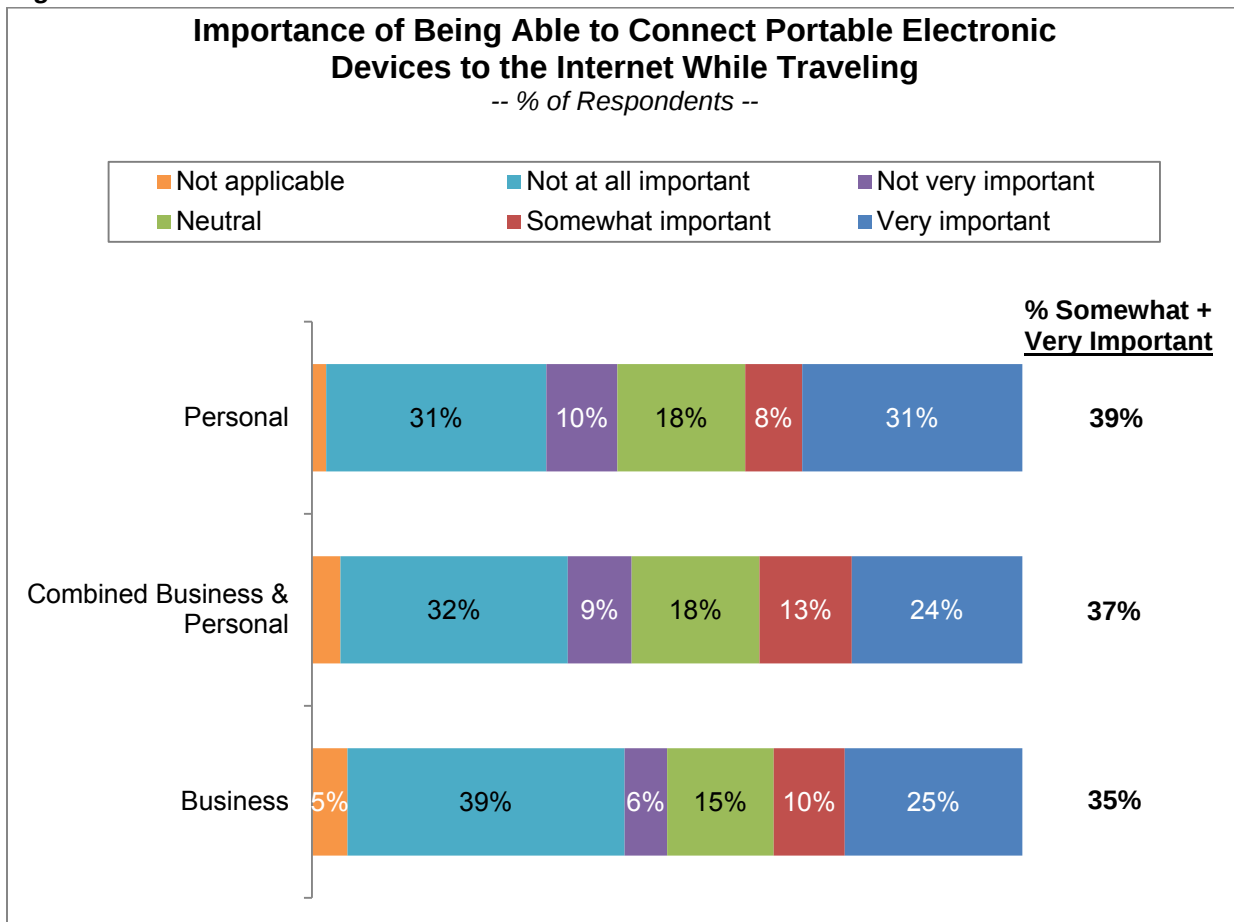
Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. How important is it to you to be able to use portable electronic devices while traveling for each of the following purposes?

Importance of actually being able to connect PEDs to the Internet is considerably lower than the importance of having the devices while traveling, suggesting that PED usage for entertainment purposes is more important than usage for work-related purposes. Approximately four in ten agree it is important to be able to connect PEDs to the Internet while traveling for personal (39%), combined business and personal (37%) and business purposes (35%) alike.

Notably, passengers ages 35-44 are more likely to feel it is important to be able to connect their PEDs to the Internet while flying for business purposes or for business and personal purposes combined, more so than their counterparts ages 25-34 or 55+. In addition, male passengers are more likely than female passengers to assign higher importance to being able to connect their PEDs to the Internet while flying for business purposes.

Figure 8



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

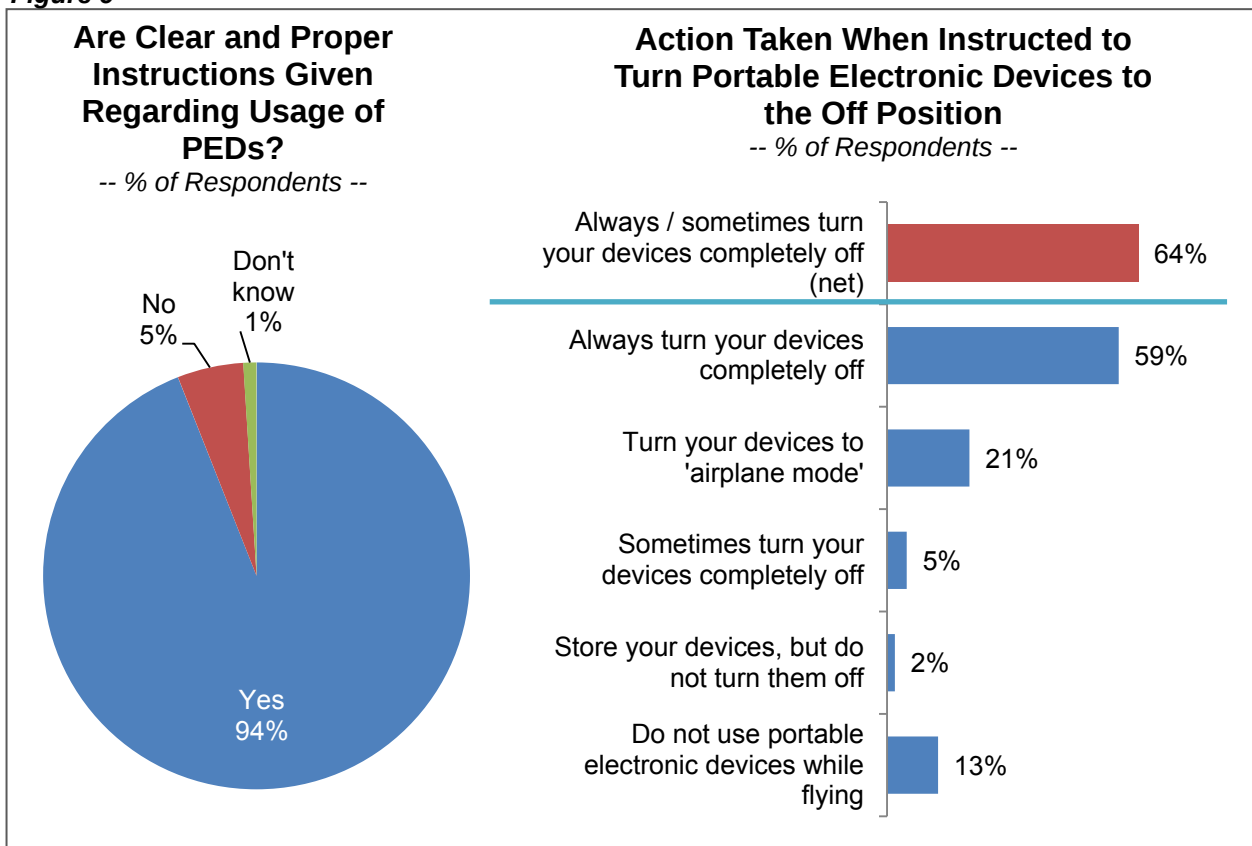
Q. How important is it to you that your portable electronic devices be connected to the internet while traveling for each of the following purposes?

Understanding of Allowed PED Usage While on Aircraft

While the majority of passengers feel they receive clear and proper instructions on the allowed usage of PEDs prior to take-off, the data show this is not always the case. More than nine in ten (94%) passengers agree the instructions are clear, yet only six in ten (59%) say they ***always*** turn their devices completely off when asked to do so, with an additional 5% who say they ***sometimes*** turn their devices completely off. If so many passengers understand the instructions given to them, why don't they turn their devices off when instructed to do so? Some may honestly forget – perhaps they have a device in their carry-on bag that they overlooked. Others simply choose not to, evidenced by the 21% of passengers who say they turn their devices to airplane mode and the 2% who store their devices, but do not turn them off.

Of particular interest, more passengers ages 25-34 are defiant and turn their devices to airplane mode than are the more rule-abiding passengers ages 55+, who are also more likely to not use PEDs while traveling than are their counterparts ages 25-54.

Figure 9



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

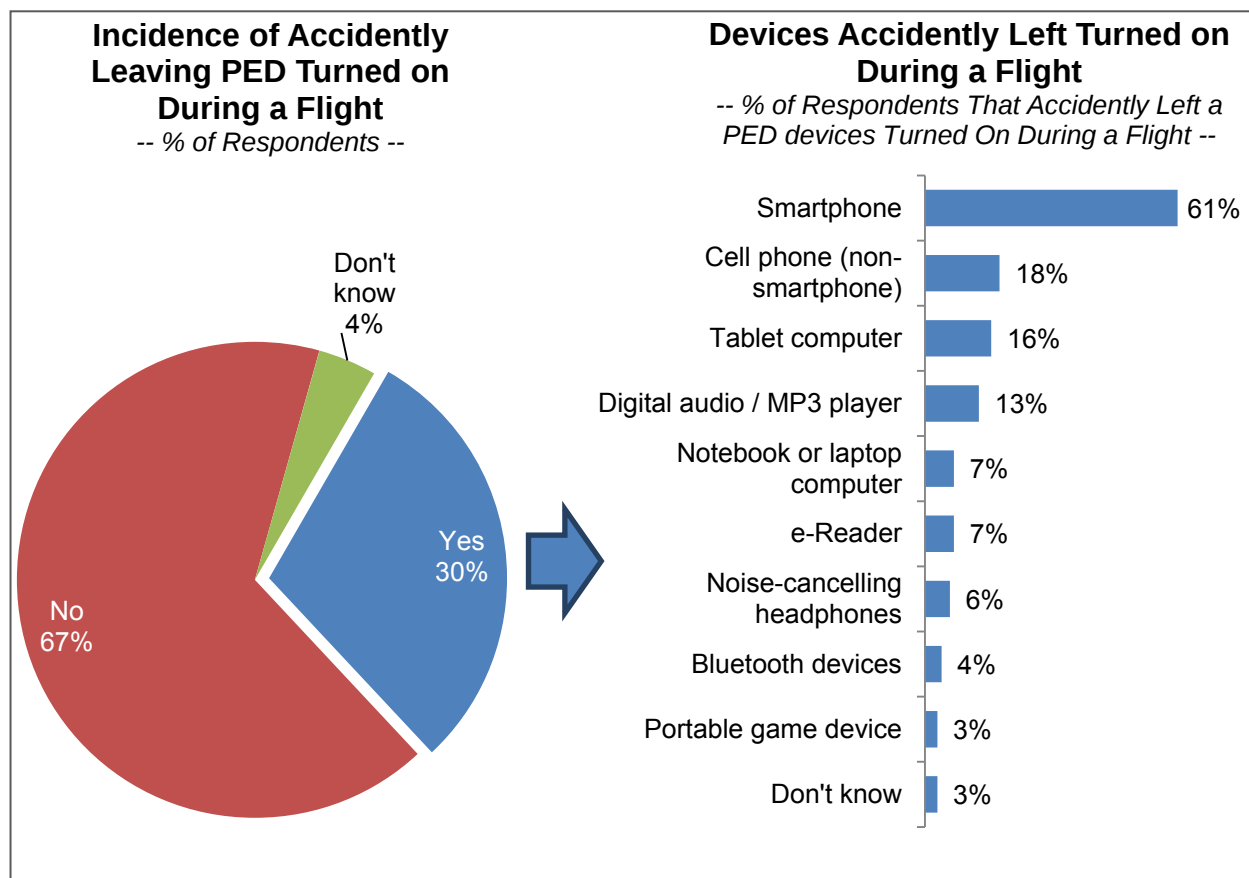
Q. Do you think clear and proper instructions are given by the flight attendants prior to take-off about the usage of portable electronic devices while on the airplane?

Q. When instructed to turn your portable electronic devices 'to the off position' before take-off or landing, which of the following best describes how you respond to these instructions? Would you say...

Almost one third (30%) of passengers report they have accidentally left a PED turned on during a flight. Smartphones, which are the most common PEDs carried onto planes with passengers, are also the most common PED accidentally left turned on. Basic cellphones (18%), tablet computers (16%) and digital audio/MP3 players (13%) are also left on occasionally, though not nearly as often as smartphones.

Passengers ages 35-54 are more likely to have accidentally left a PED turned on during a flight when compared to those 55+, which aligns nicely with the fact that passengers 55+ are less likely to be using PEDs while flying, making them less likely to leave one turned on.

Figure 10



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. Have you ever accidentally left any of your portable electronic devices **TURNED ON** during a flight?

Base=U.S. adults who have taken any flights in the past 12 months and who have accidentally left any listed portable electronic devices turned on during a flight (n=110)

Q. Which of the following devices have you accidentally left **TURNED ON** during a flight?

Additionally, many passengers do not have a clear understanding of when their PEDs can be used while on an aircraft. Current rules and regulations require PEDs to be stored and completely powered off during the following times: while on the ground taxiing to the runway, in the air before reaching cruising altitude (10,000 feet) and during the final descent. However, four in ten (43%) passengers incorrectly believe it is okay to use their PEDs while taxiing to the runway, 32% while in the air before reaching 10,000 feet and 26% while the plane is in its final descent, indicating that some passengers are likely using their devices during these PED-restricted times.

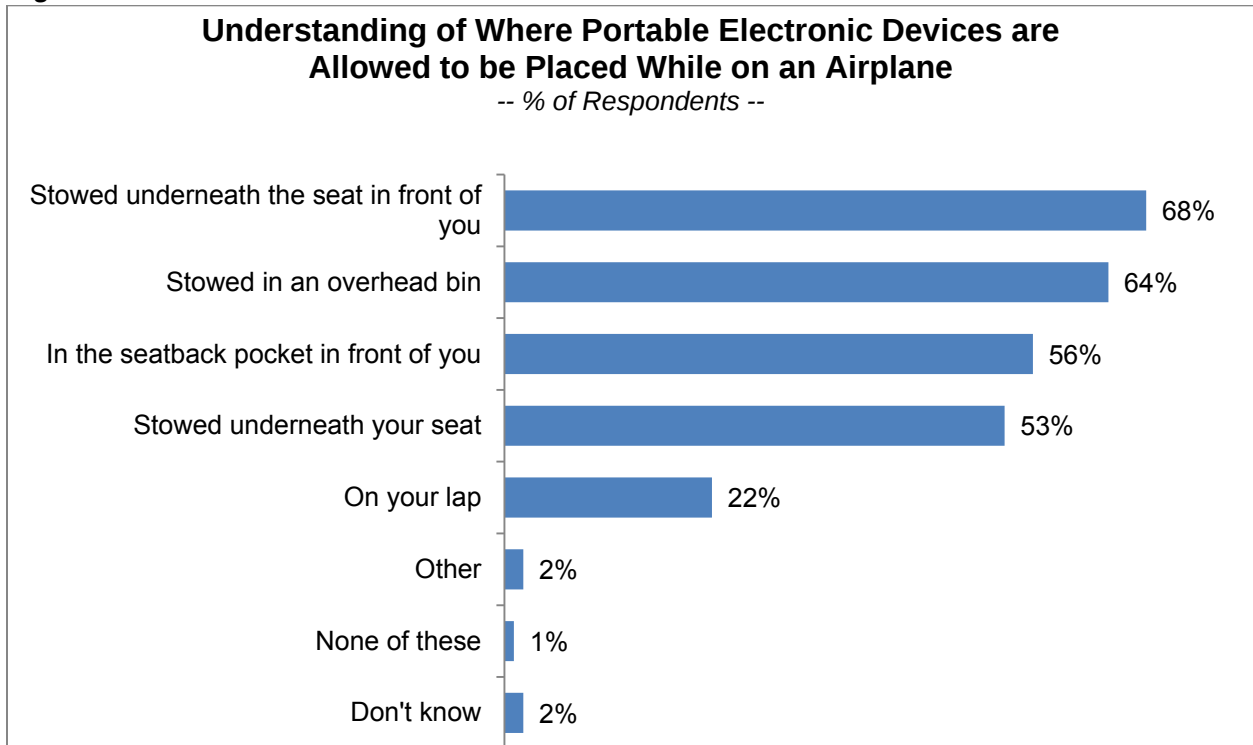
Figure 11

Understanding of When Portable Electronic Devices Can be Used While on an Airplane							
	On the ground, before the doors close	On the ground, while taxiing to the runway	In the air, before reaching 10,000 feet	In the air, after reaching 10,000 feet	During the initial descent	During the final descent	After landing, while taxiing to the gate
Any PEDs are allowed (net)	89%	43%	32%	73%	33%	26%	73%
Cell phone (non-smartphone)	73%	21%	6%	36%	8%	6%	54%
Smartphone	72%	21%	9%	45%	9%	7%	58%
Portable digital audio / MP3 player	71%	29%	16%	61%	18%	10%	52%
e-Reader	70%	25%	15%	61%	15%	9%	50%
Tablet computer	70%	21%	11%	59%	13%	7%	48%
Portable DVD player	68%	23%	14%	59%	16%	7%	47%
Notebook or laptop computer	68%	22%	12%	63%	11%	6%	47%
Portable game device	67%	24%	13%	58%	15%	9%	47%
Noise-cancelling headphones	66%	31%	23%	57%	23%	18%	50%
Portable Blu-ray Disc player	64%	23%	12%	58%	14%	8%	47%
Bluetooth devices	62%	20%	8%	41%	9%	7%	45%
No PEDs are allowed	5%	48%	57%	18%	59%	67%	20%
Don't know	5%	8%	11%	9%	9%	7%	7%

Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. To the best of your knowledge, which of the following portable electronic devices can be used while on an airplane during the following times?

Passengers also show confusion over approved locations for PEDs during take-off and landing. During taxiing, take-off and landing, the times when PED usage is not allowed on aircraft, passengers are instructed to safely stow their PEDs underneath the seat in front of them or in the overhead bin. However, only 68% and 64% of passengers identified underneath the seat in front of them or in an overhead bin, respectively, as approved locations.

Figure 12

Base=U.S. adults who have taken any flights in the past 12 months (n=375)

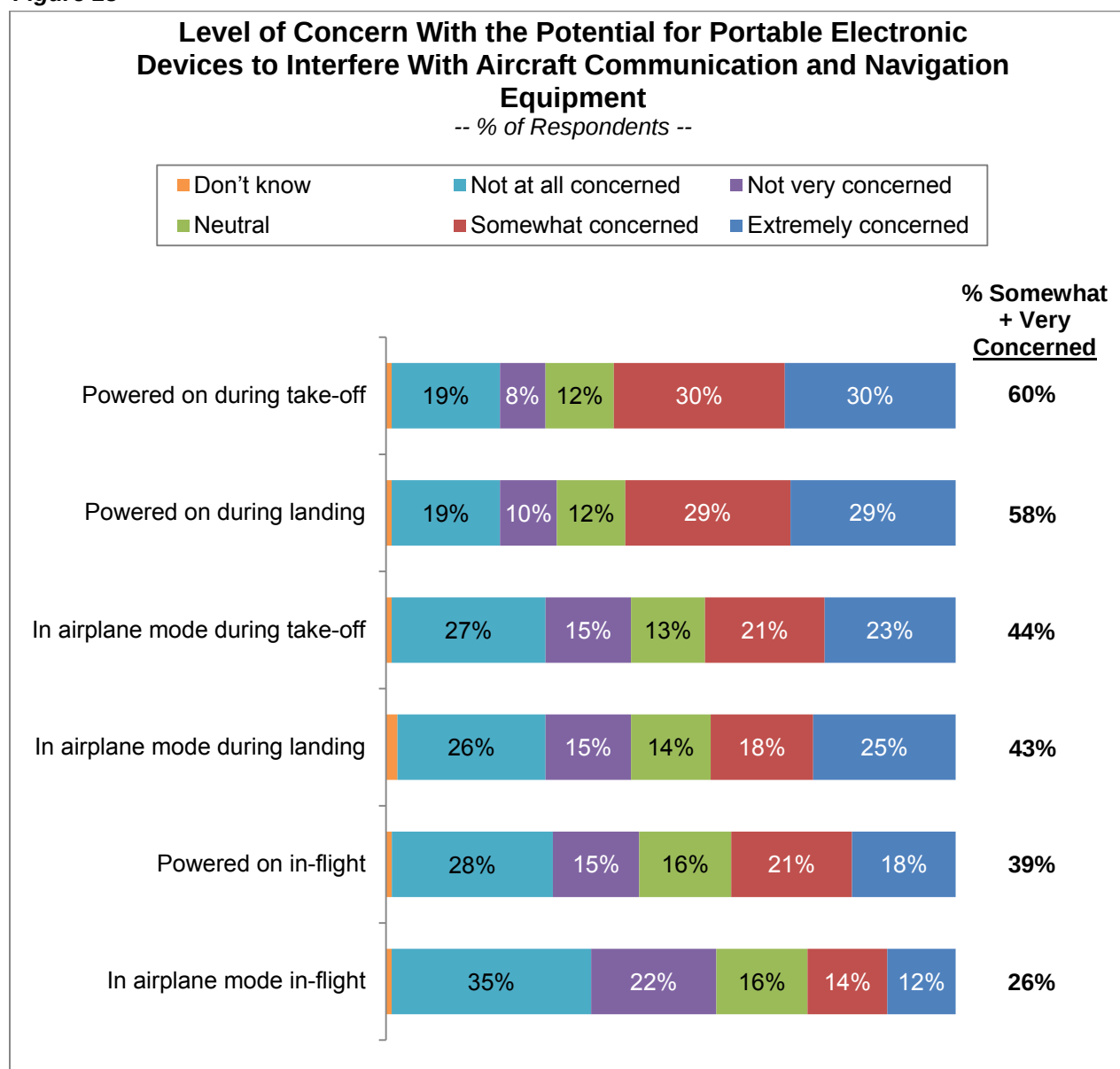
Q. As you currently understand it, where are portable electronic devices allowed to be placed during take-off, approximately the first 30 minutes of a flight, and landing, the last several minutes of a flight?

Concern About the Safety of PED Usage on Aircraft

Six in ten passengers are concerned about potential interference from PEDs powered on during both take-off (60%) and landing (58%). Passenger concern is not nearly as high for devices powered on while in-flight or for devices left in airplane mode. The level of concern is lowest for devices in airplane mode while in-flight with only one quarter (26%) either somewhat or very concerned.

Notably, those over age 55 are more likely to be concerned with the likelihood of interference from PEDs left in airplane mode during take-off, landing and while in the air than are some of their younger counterparts. Additionally, female passengers are more concerned with PED left in airplane mode while in-flight than are male passengers.

Figure 13



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. How concerned are you about the potential for portable electronics devices to interfere with aircraft communication and navigation equipment if they are each of the following? Would you say extremely concerned, somewhat concerned, neutral, not very concerned or not at all concerned?

Reasons for this concern vary, but mainly center around interference and safety in general, which go hand-in-hand on aircraft. Interference with the pilot's communication (17%) is the top reason for concern over PEDs on aircraft, followed by other safety concerns.

Figure 14

Reasons for Concern About Potential Interference Caused by PEDs on Aircraft <i>Mentions of 5% or More</i>	
	% of Respondents
<i>Interference (net)</i>	48%
Could interfere with pilot's communication	17%
Could interfere with navigation equipment	8%
Could interfere with take-off or landing	6%
Could interfere with communication (unspecified)	5%
Possibility of interference (unspecified)	5%
<i>Safety/Accident concerns (net)</i>	24%
Could cause plane crash / accident/injuries	13%
Safety concerns / Want a safe flight	11%
That's what you are instructed to do on a plane	8%
Concerned because not knowledgeable about what causes the problem	6%
There must be a reason why you are told to turn them off	6%
That's what I've heard / been told	6%

Base=U.S. adults who have taken any flights in the past 12 months and who are concerned about the potential for PEDs to interfere with aircraft communication and navigation equipment (n=261)

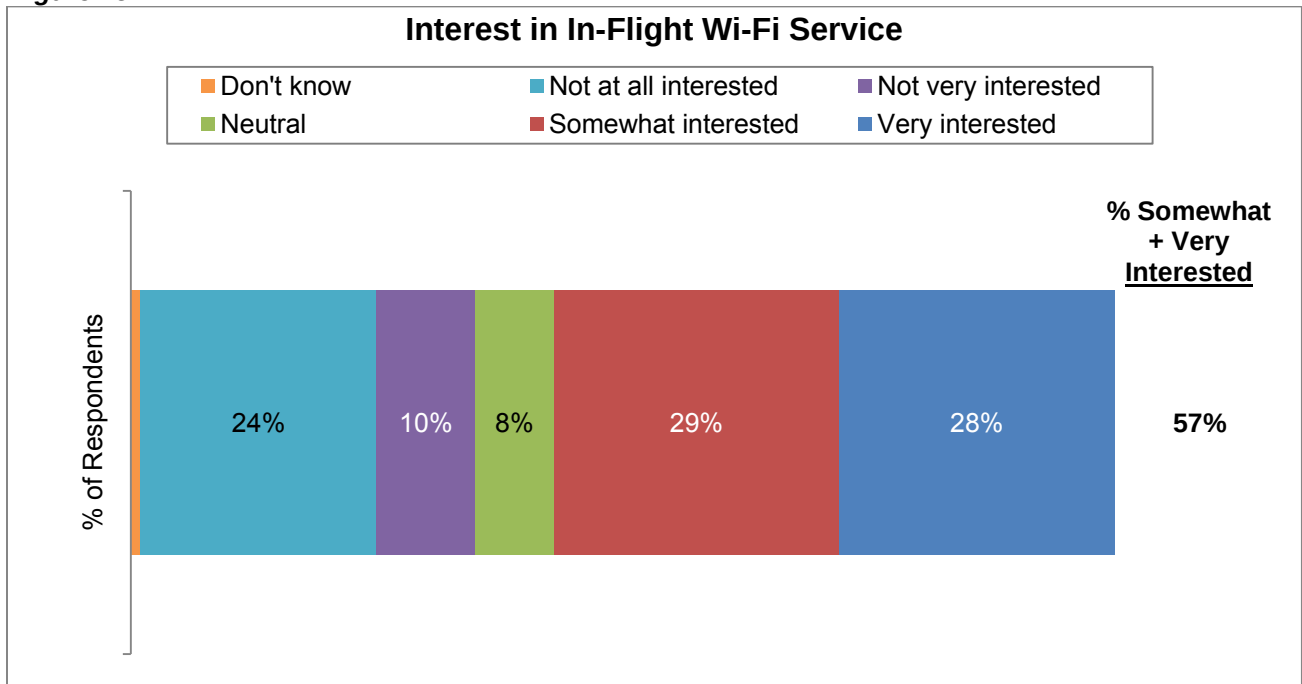
Q. Why are you CONCERNED about the potential for portable electronic devices to interfere with aircraft communication and navigation equipment?

Interest in and Likelihood to Purchase In-Flight Wi-Fi Service

More than half (57%) of passengers express interest in in-flight Wi-Fi services, while one third (34%) say they are not interested.

Passengers ages 25-54 express higher interest in the availability of in-flight Wi-Fi services than do passengers ages 55+, who logically would be less interested, again due to the lower incidence of this age group using PEDs while in-flight. Additionally, males are more likely to be 'very interested' than are female passengers.

Figure 15



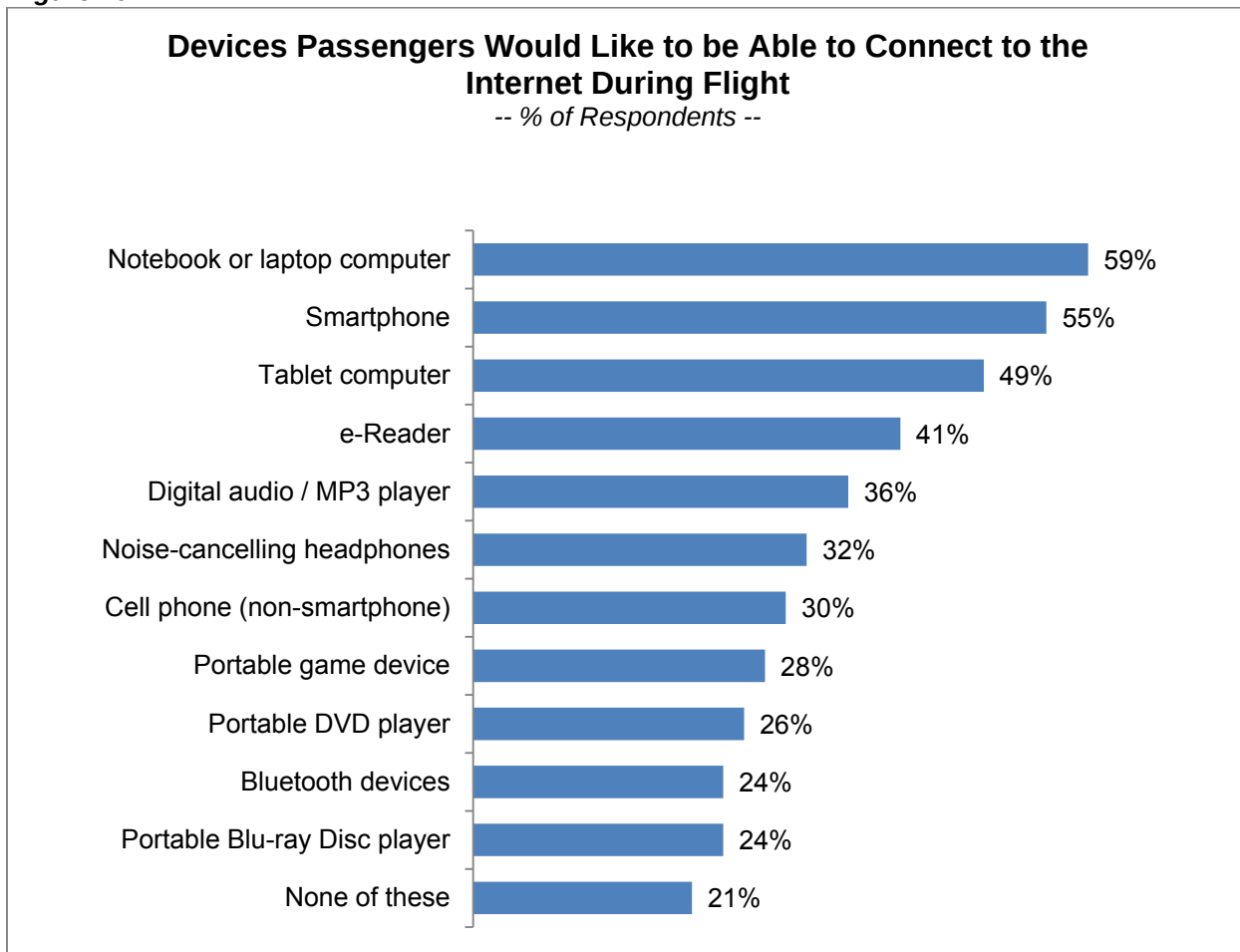
Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. As you may or may not know, some airlines are beginning to offer in-flight Wi-Fi service. How interested are you in in-flight Wi-Fi services offered by a commercial airline, such as American, Delta or United? Would you say...

The top devices passengers would like to connect to the Internet while traveling on aircraft are notebook or laptop computers (59%), followed by smartphones (55%), tablet computers (49%) and e-Readers (41%).

Passengers ages 35-54 are considerably more likely to want to connect any PED to the Internet while flying than are their age 55+ counterparts, again likely due to the fact that those 55+ are less likely to use PEDs while on aircraft.

Figure 16



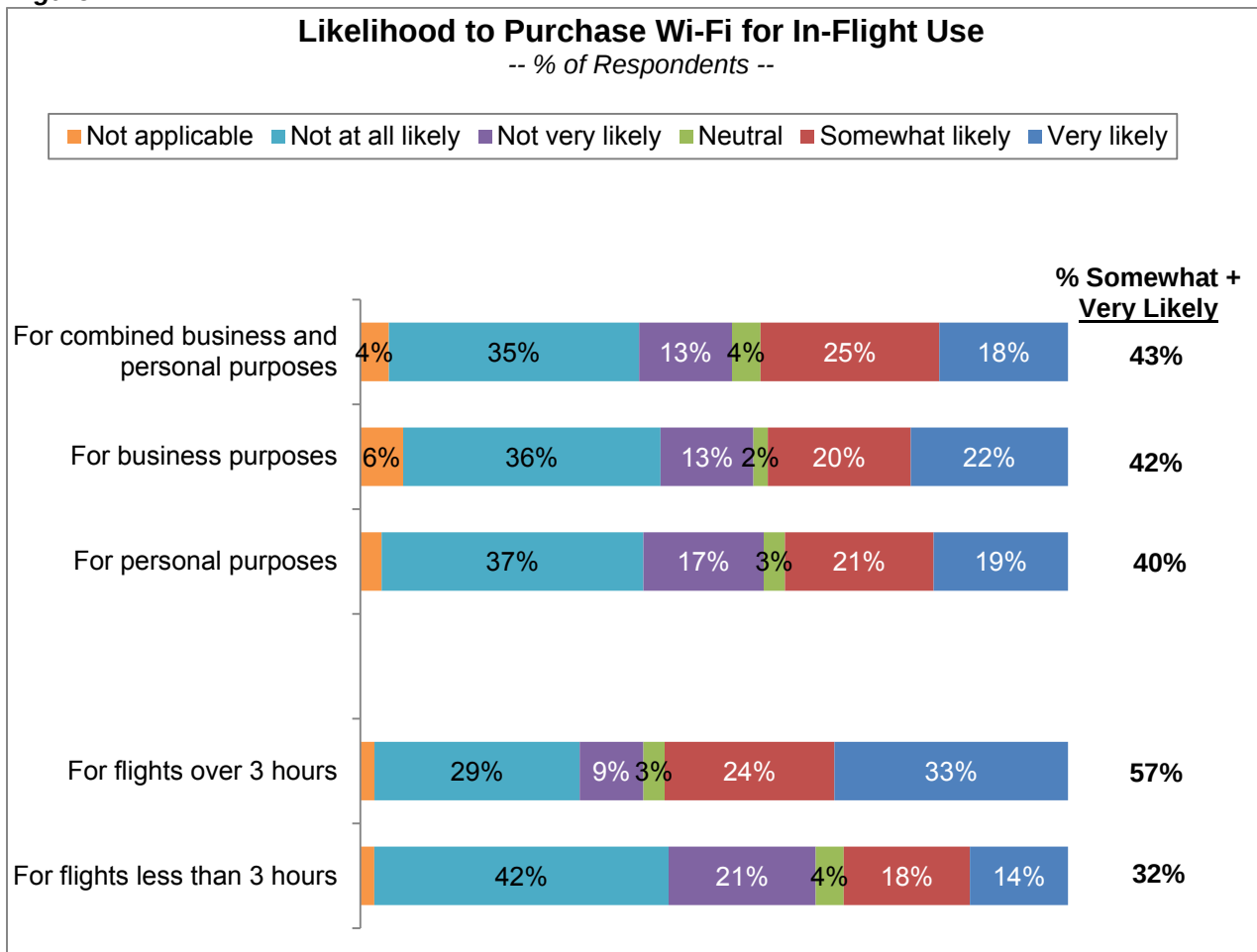
Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. Which of the following portable electronic devices would you like to be able to connect to the internet during flight?

Passengers are more likely to purchase Wi-Fi on longer flights. If available on a flight and reasonably priced, passengers are most likely to purchase Wi-Fi in-flight if the flight is over three hours (57% likely). Conversely, they are least likely to purchase if the flight is less than three hours long (32%). The purpose of the trip, business versus personal versus combined, does not make much of a difference in likelihood to purchase, as approximately four in ten would purchase for any of said travel purposes.

Regardless of length of flight or for what purpose, passengers ages 25-54 are more likely to purchase Wi-Fi in-flight than are those ages 55+, while males are more likely than females to be 'very likely' to purchase for business purposes and are more likely in total (somewhat + very likely) to purchase for combined business and personal flights.

Figure 17



Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. If Wi-Fi was available on a flight, and were available at a reasonable cost, how likely would you be to purchase access to it while traveling in each of the following ways? Would you say very likely, somewhat likely, neither likely nor unlikely, not very likely or not at all likely?

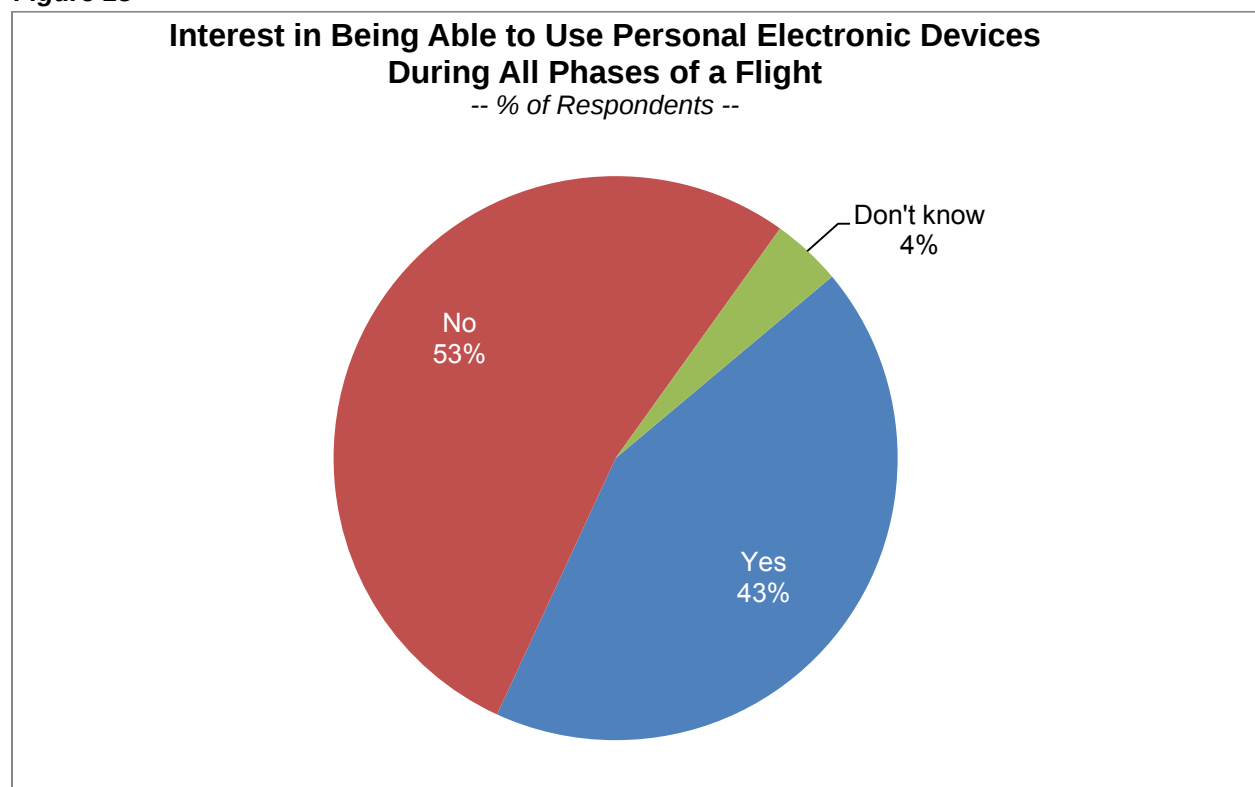
Length and purpose of flight aside, “reasonably priced” in-flight Wi-Fi generally means less than \$10.00 to a majority of passengers. For personal flights, 60% of passengers would be willing to pay up to \$9.99 for in-flight Wi-Fi, while 53% of passengers would be willing to pay the same for business flights. Notably, passengers seem to justify higher Wi-Fi prices for longer flights and for business purposes.

Again, passengers ages 25-54 are most willing to pay for in-flight Wi-Fi access no matter the length of flight or for what purpose it serves.

Interest in Expanded PED Usage and Ability to Make Cell Phone Calls on Aircraft

Four in ten (43%) passengers indicate they would like to be able to use PEDs during all phases of their flights, including during take-off and landing. Not surprisingly, passengers over the age of 55 are less likely to be interested than are those ages 25-44.

Figure 18



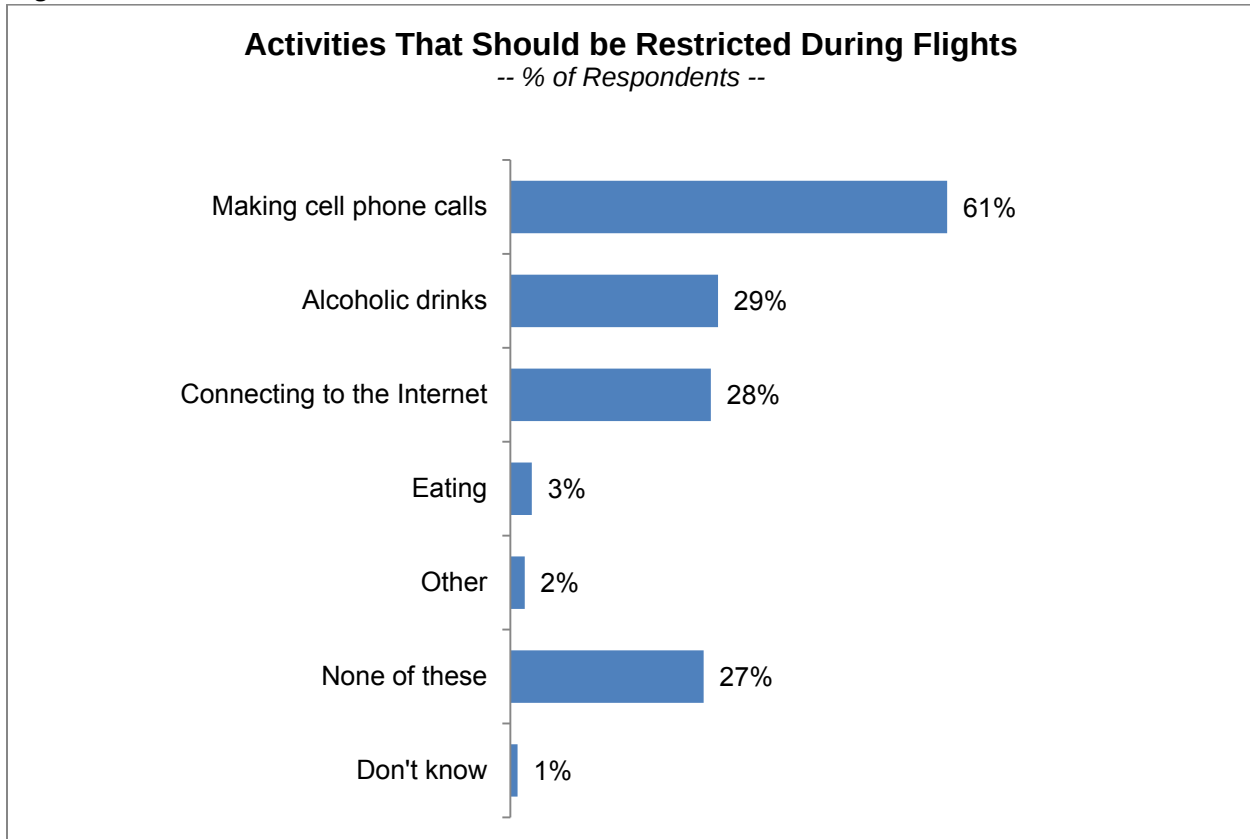
Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. Would you like to be able to use your personal electronic devices during all phases of a flight, including take-off and landing?

When asked which activities, if any, should be restricted during flights, six in ten (61%) said making cell phone calls. Three in ten would like alcoholic drinks (29%) and connecting to the Internet (28%) to also be restricted. One quarter (27%) of passengers don't believe any of the listed activities should be restricted.

Of interest, passengers ages 25-34 are more likely than those 45-54 to think connecting to the Internet while in-flight should be restricted.

Figure 19



Base=U.S. adults who have taken any flights in the past 12 months (n=375)
Q. Which activities, if any, do you think should be restricted during flights?

When specifically asked how they feel about the possibility of passengers being able to make phone calls during flights, feelings were generally mixed. With 51% expressing negative feelings and 47% expressing positive feelings, there was no strong majority either way.

Notably, significantly more female passengers believe in-flight cell phone calls would be annoying or distracting when compared to male passengers.

Figure 20

Feelings About Passengers Being Allowed to Make Cell Phone Calls During Flights -- Mentions of 5% or More --	
	% of Respondents
Negative (net)	51%
Opposed / Don't want that / Not a good idea	16%
Too noisy / Too much talking	16%
Could be annoying / Distracting	13%
Positive (net)	47%
No problem / That's fine / Okay	18%
As long as it's safe / Doesn't interfere with plane operation or communication	7%
Neutral (net)	6%
Neutral / Don't care / Doesn't matter	5%

Base=U.S. adults who have taken any flights in the past 12 months (n=375)

Q. How would you feel about the possibility of passengers being able to make cell phone calls during flight?

Conclusions

- PEDs have become an integral part of our mobile society and the majority of U.S. adult airline passengers are bringing PEDs onto aircraft while traveling.
- Not only do they bring PEDs with them while traveling, airline passengers and their travel companions use them from the time they board until they de-plane, often for entertainment purposes, but also for work-related activities.
- Many passengers feel it is important to be able to use PEDs when flying for both business and personal reasons, although less so for business travelers, suggesting that PED usage for entertainment purposes is more important than usage for work-related purposes.
- Importance of actually being able to connect their PEDs to the Internet is considerably lower than the importance of having the devices with them while traveling, further supporting the notion that PED usage for entertainment purposes is more important than usage for work-related purposes.
- While the majority of passengers feel clear and proper instructions regarding the allowed usage of PEDs are given prior to take-off, the data show this is not always the case. Passengers are ***not*** always turning their devices completely off when instructed to do so – some are instead putting them in airplane mode, while others choose to do nothing.
- Almost one third of passengers report they have accidentally left a PED turned on during a flight. Smartphones, the most common PEDs carried onto planes with passengers, are also the most common PED accidentally left turned on.
- Concern over the potential for interference from PEDs powered on is highest during both take-off and landing. Passenger concern is not nearly as high for devices powered on while in-flight or for devices left in airplane mode.
- Passengers express interest in having in-flight Wi-Fi available to them and are more likely to purchase it on longer flights.
- Passengers also indicate they would like to be able to use PEDs during all phases of flight, including take-off and landing.
- While airline passengers express interest in expansion of PED use on aircraft, a majority believe that making cell phone calls should be restricted during flights, mainly due to the potential distraction it could create for other passengers.

Comparison Summary: Portable Electronic Devices on Aircraft 2003 vs 2013



CEA Market Research Report

April 2013



The Authoritative Source for Consumer Technologies Market Research

research@CEA.org | 703-907-7600

Comparison Summary: Portable Electronic Devices on Aircraft 2003 vs 2013

- **Over the past decade, more airline passengers report carrying at least one portable electronic device (PED) with them while traveling by plane.** In 2003, 76% of passengers said they brought at least one PED with them while traveling by plane. In 2013, that number rose by 18 percentage points to 94% of airline passengers.
- **Additionally, more passengers are carrying their PEDs with them onto the plane, as opposed to packing them in their checked luggage.** In 2003, 23% of passengers traveling with PEDs packed at least one device in their checked bag(s) and 70% carried at least one device onboard the plane. In 2013, the percent of PED-carrying passengers packing devices in their checked luggage decreased slightly to 17%, while the percent carrying devices with them onboard increased considerably to 99%.
- **As times have changed, so too have the devices passengers carry with them while traveling by air.** Cell phones (55%), calculators (22%), laptop computers (21%), CD/DVD players (20%) and camcorders (14%) were the top five PEDs brought with travelers as carry-on items in 2003. Ten years later, in a highly connected and mobile society, portable computing devices top the list with smartphones being the number one PED carry-on (63%), followed by notebook or laptop computers (45%), basic cell phones (non-smartphone) (31%), portable digital audio or MP3 players (28%) and tablet computers (27%).
- **With more passengers bringing PEDs with them onboard aircraft, usage of these devices while in-flight has increased as well.** In 2003, only four in ten (40%) passengers used PEDs while in-flight (specific flight phases not specified). By 2013, however, usage increased to 69% during the flight and 85% while on the ground, either prior to take-off or after landing¹.
 - Among those who carried PEDs onto the plane with them in 2003, the most commonly used device in-flight was the CD/DVD player (17%). This was followed by laptop computers (15%), calculators (13%), cell phones (8%) and PDAs or handheld computers (8%). In 2013, all-in-one mobile devices appear to have taken over with smartphones (28%) topping the list of PEDs used while in-flight. Notebook or laptop computers (25%) closely follow, along with tablet computers (23%), portable digital audio or MP3 players (23%) and e-Readers (13%) rounding out the top five.
- **Despite the fact that more passengers are bringing PEDs on board their flights, the incidence of devices accidentally being left on during the times they should be powered completely down has remained stable over the past decade.** In 2003, 29% of travelers who owned a cell phone or wireless pager reported they had accidentally left the device turned on during a flight. Comparatively, in 2013, 30% of passengers reported they had accidentally left a PED (not limited specifically to cell phones or wireless pagers) turned on while in-flight².
- **The percent of passengers who feel clear and proper instructions are given regarding the use of PEDs onboard an aircraft has increased slightly over the past 10 years.** In 2003, 90% of passengers felt instructions given by flight crews were clear and proper. By 2013 that percentage increased to 94%, suggesting airlines continue to do a good job both communicating



what is and what is not allowed during the various phases of a flight and in adapting to ever-changing mobile and wireless technologies.

- **Airline passengers are less concerned about the potential for interference with aircraft systems caused by PEDs than they were a decade ago.** In 2003, more than half (56%) of airline passengers were concerned about the potential for PEDs to interfere with aircraft systems (non-specific as to the phase of the flight). In 2013, with most devices equipped with an 'airplane mode' feature (a feature not always available on PEDs in the early 2000's) concern decreased to 45% on average across all phases of a flight. Concern is highest for devices powered on during take-off (60%) and lowest for devices in 'airplane mode' while in-flight (26%)³.
- **The perceived importance of being able to use PEDs on an aircraft has increased significantly over the past ten years, for both travel related to business and personal purposes.** In 2003, three in ten passengers felt it was important to be able to use PEDs on airplanes for business (31%) and for personal reasons (28%). By 2013, those percentages rose considerably to 43% for business travel and 61% for personal travel.
- **Interest in connecting to Wi-Fi in-flight has increased significantly over the past decade.** Only one-third (34%) of passengers expressed interest in in-flight Wi-Fi in 2003. As connectivity has gained in importance and the in-flight Wi-Fi market has become more competitive, interest has grown to 57% in 2013⁴.
- **Passengers are more likely to pay for in-flight Wi-Fi services in 2013 than they were in the past.** Nearly one quarter (23%) of passengers said they would be likely to pay for access to an in-flight wireless network in 2003. In 2013, regardless of purpose or length of flight, 43% of passengers (on average) say they are likely to purchase in-flight Wi-Fi. These passengers are most likely to pay for service on longer flights (over 3 hours) (57%) and least likely to purchase on flights less than three hours long (32%). The purpose of the trip (e.g. business, personal or both) does not make much of a difference in likelihood to purchase, as approximately four in ten would purchase for any of said travel purposes⁵.



Methodology

The Consumer Electronics Association is a member of the Marketing Research Association (MRA) and adheres to the MRA's Code of Marketing Research Standards.

CEA is responsible for all content contained in this briefing. Any questions regarding the study should be directed to CEA Market Research staff at info@CEA.org.

Portable Electronic Devices on Aircraft (2013)

The *Portable Electronic Devices on Aircraft* (2013) study was designed and formulated jointly by the Consumer Electronics Association (CEA) ® and the Airline Passenger Experience Association (APEX). This study presents the findings of a telephone survey conducted among two national probability samples, which, when combined, consist of 1,629 adults, 815 men and 814 women 18 years of age and older, living in the continental United States. Interviewing for this CARAVAN® Survey was completed on December 14-18, 2012. 1,093 interviews were from the landline sample and 536 interviews from the cell phone sample.

The margin of sampling error at 95% confidence for aggregate results is +/- 2.43%. Sampling error is larger for subgroups of the data. As with any survey, sampling error is only one source of possible error. While non-sampling error cannot be accurately calculated, precautionary steps were taken in all phases of the survey design, collection and processing of the data to minimize its influence.

During the fielding of this study, Consumer Electronics Association (CEA) ® and the Airline Passenger Experience Association (APEX) employed the services of Opinion Research Corporation (ORC) to conduct telephone interviewing. The telephone interviewing employed industry standard random-digit dialing and computer assisted telephone interviewing (CATI).

Sampling

ORC's CARAVAN® landline-cell combined sample is a dual frame sampling design. This means that the sample is drawn from two independent non-overlapping sample frames—one for landlines and one for cell phones.

Land Line Sample

ORC's Random Digit Dial (RDD) telephone sample is generated using a list-assisted methodology.

Cell Phone sample

The MSG Cellular RDD database is constructed quarterly utilizing Telecordia's LERG product.

As is common practice in survey research, the data was weighted to reflect the known demographics of the population under study. In this survey, weights were applied to cases based on gender, age, race and geographic region. As a result, this data can be generalized to the entire U.S. adult population.

The bases shown on all charts and tables are weighted bases. All percentages in the text, charts and tables included in this report are also based on weighted data.

Portable Electronic Devices on Aircraft (2003)

The *Portable Electronic Devices on Aircraft* (2003) study described herein was designed and formulated by eBrain Market Research (a division of CEA Market Research). The quantitative study was administered via telephone interview to a random national sample of 1,009 U.S. adults during September 2003. The telephone interviewing employed industry standard random-digit dialing (RDD) and computer assisted telephone interviewing (CATI). Raw data from the completed study was aggregated by eBrain Market Research (a division of CEA Market Research).



Appendix

Changes in the survey questions between 2003 and 2013

- 1 **2003:** Q. Which electronics product did you use DURING a flight?
2013: Q. And which of those portable electronic devices have you personally USED while on the airplane...A.) *during the flight* B.) *prior to take off or after landing*

- 2 **2003:** Q. Have you ever accidentally left your cell phone or wireless pager TURNED ON during a flight, perhaps by accident, either in your carry-on bag or pocket, or in your checked luggage?
2013: Q. Have you ever accidentally left any of your portable electronic devices TURNED ON during a flight?

- 3 **2003:** Q. How concerned are you about the potential for portable electronic devices to interfere with aircraft communication and navigation equipment?
2013: Q. How concerned are you about the potential for portable electronics devices to interfere with aircraft communication and navigation equipment if they are each of the following? Would you say extremely concerned, somewhat concerned, neutral, not very concerned or not at all concerned?

- 4 **2003:** Q. How interested or not interested are you in being able to do each of the following while traveling on an airplane? C.) *Connect to the Internet while in-flight using your own laptop computer through a wireless network on the airplane*
2013: Q. As you may or may not know, some airlines are beginning to offer in-flight Wi-Fi service. How interested are you in in-flight Wi-Fi services offered by a commercial airline, such as American, Delta or United? Would you say...

- 5 **2003:** Q. If airplanes had wireless networks with Internet access, how likely would you be to buy the equipment you would need to use and connect to the wireless network?
2013: Q. If Wi-Fi was available on a flight, and were available at a reasonable cost, how likely would you be to purchase access to it while traveling in each of the following ways? Would you say very likely, somewhat likely, neither likely nor unlikely, not very likely or not at all likely?
 A.) *For business purposes*
 B.) *For personal purposes*
 C.) *For combined business and personal purposes*
 D.) *Flight less than 3 hours*
 E.) *Flight over 3 hours*





Delta Customer Survey Data

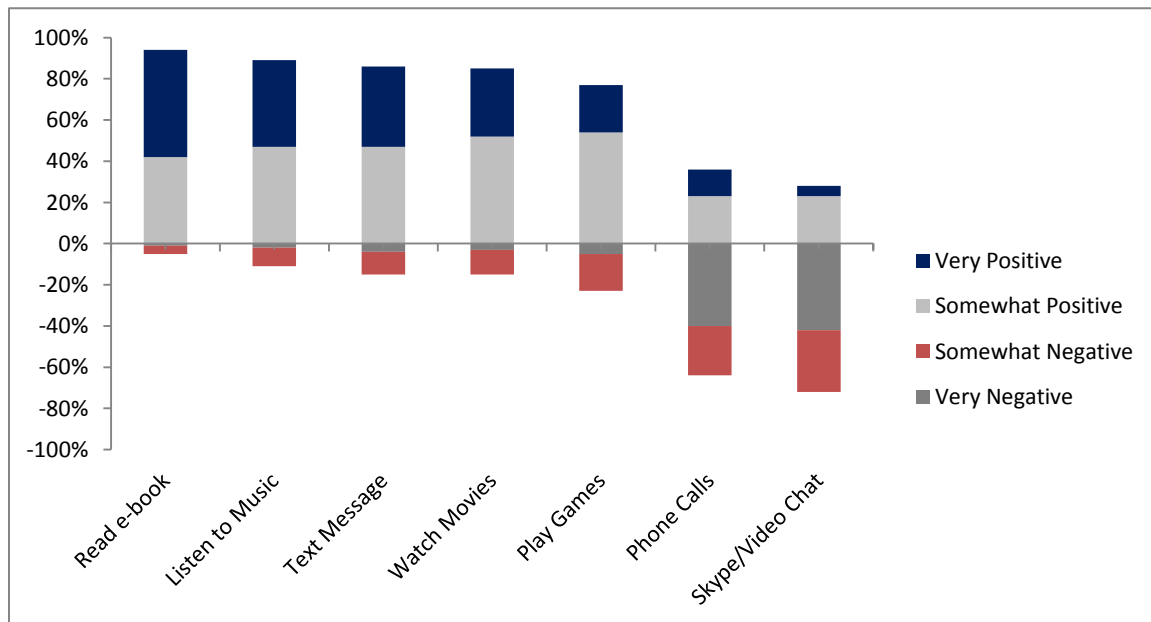
In support of the PED ARC efforts, Delta surveyed 1462 customers in October 2012 over the issue of expanded PED usage on flights. Our customers responded as follows:

- When asked to pick which device they would like to use the most below 10,000 feet, cell phone is the top choice followed closely by tablet computer.
- Reading e-books, text messaging, listening to music, watching movies and playing games are the top activities that customers would like to do below 10,000 feet

Note: Of the activities available on today's smart phones, making cellular calls is only the 6th priority

- Most customers feel that being able to use electronic devices below 10,000 feet would have a positive impact on the onboard experience
- The ability to make phone calls is seen to have a negative impact on the onboard experience for 64% of customers; however, 36% of customers believe it would be positive indicating that phone calls in flight can be polarizing.

**Impact on Onboard Experience if allowed to use PED's
Below 10,000 Feet**



APPENDIX I: PED INTERFERENCE DATA

Appendix I includes PED interference data reviewed by the PED ARC during its deliberations. The following information was compiled and prepared for publication by the member (organization) listed.

- Delta Air Lines, *Interference Event Data for PED ARC* (January 1, 2010 to August 31, 2012)
- National Aeronautics and Space Administration, *Passenger Electronic Device (PED) Related Incidents Special Request – Secondary Analysis*, Search Request No. 7115 (April 10, 2013) (presented to PED ARC by M. Schopp)

Note: The FAA presented Service Difficulty Report (SDR) data, which is summarized in the safety risk analysis included in Appendix F of this report.

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INTERFERENCE EVENT DATA FOR PED ARC (Jan 1, 2010 to Aug 31, 2012)

Delta Airlines provides a summary of all reported equipment interference events from January 1, 2010 to August 31, 2012. Any pilot or mechanic report that mentioned interference to the airline for any reason (mechanical, human factors or other cause) is included:

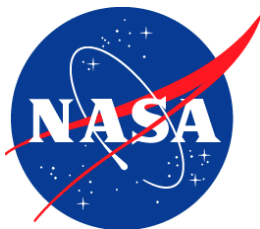
Summary:

- Delta flew 2.3 million flights during the period Jan 1, 2010 to Aug 31, 2012
- Data Collected via Pilot reports and Aircraft Maintenance Defect Logs
 - 3 Pilot Reports mentioned possibility of PED Interference, but none could be confirmed
 - 24 Maintenance Defect Logs mentioned possibility of Unknown Interference (Radar 1, ILS Locator 1, Radio/Comm/Intercom 2)
- Of the 27 events recorded:
 - 6 events were explained by a positive mechanical finding other than PED interference
 - 21 events remain
 - 2 events were associated with flying through weather/clouds
 - 1 event was reported to have been due to ACARS interference
 - 2 events were caused by a stuck open microphone
 - 16 remaining events were not confirmed, system worked fine on the ground

Search Request No. 7115

***Passenger Electronic Device
(PED) Related Incidents
Special Request – Secondary Analysis***

April 10, 2013



Aviation Safety Reporting System
P.O. Box 189 | Moffett Field, CA | 94035-0189



National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, CA 94035-1000



TH: 262-7

MEMORANDUM FOR: Recipients of Aviation Safety Reporting System Data

SUBJECT: Data Derived from ASRS Reports

The attached material is furnished pursuant to a request for data from the NASA Aviation Safety Reporting System (ASRS). Recipients of this material are reminded when evaluating these data of the following points.

ASRS reports are submitted voluntarily. The existence in the ASRS database of reports concerning a specific topic cannot, therefore, be used to infer the prevalence of that problem within the National Airspace System.

Information contained in reports submitted to ASRS may be amplified by further contact with the individual who submitted them, but the information provided by the reporter is not investigated further. Such information represents the perspective of the specific individual who is describing their experience and perception of a safety related event.

After preliminary processing, all ASRS reports are de-identified and the identity of the individual who submitted the report is permanently eliminated. All ASRS report processing systems are designed to protect identifying information submitted by reporters; including names, company affiliations, and specific times of incident occurrence. After a report has been de-identified, any verification of information submitted to ASRS would be limited.

The National Aeronautics and Space Administration and its ASRS current contractor, Booz Allen Hamilton, specifically disclaim any responsibility for any interpretation which may be made by others of any material or data furnished by NASA in response to queries of the ASRS database and related materials.

Linda J Connell

Linda J. Connell, Director
NASA Aviation Safety Reporting System

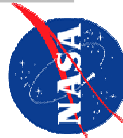
CAVEAT REGARDING USE OF ASRS DATA

Certain caveats apply to the use of ASRS data. All ASRS reports are voluntarily submitted, and thus cannot be considered a measured random sample of the full population of like events. For example, we receive several thousand altitude deviation reports each year. This number may comprise over half of all the altitude deviations that occur, or it may be just a small fraction of total occurrences.

Moreover, not all pilots, controllers, mechanics, flight attendants, dispatchers or other participants in the aviation system are equally aware of the ASRS or may be equally willing to report. Thus, the data can reflect **reporting biases**. These biases, which are not fully known or measurable, may influence ASRS information. A safety problem such as near midair collisions (NMACs) may appear to be more highly concentrated in area “A” than area “B” simply because the airmen who operate in area “A” are more aware of the ASRS program and more inclined to report should an NMAC occur. Any type of subjective, voluntary reporting will have these limitations related to quantitative statistical analysis.

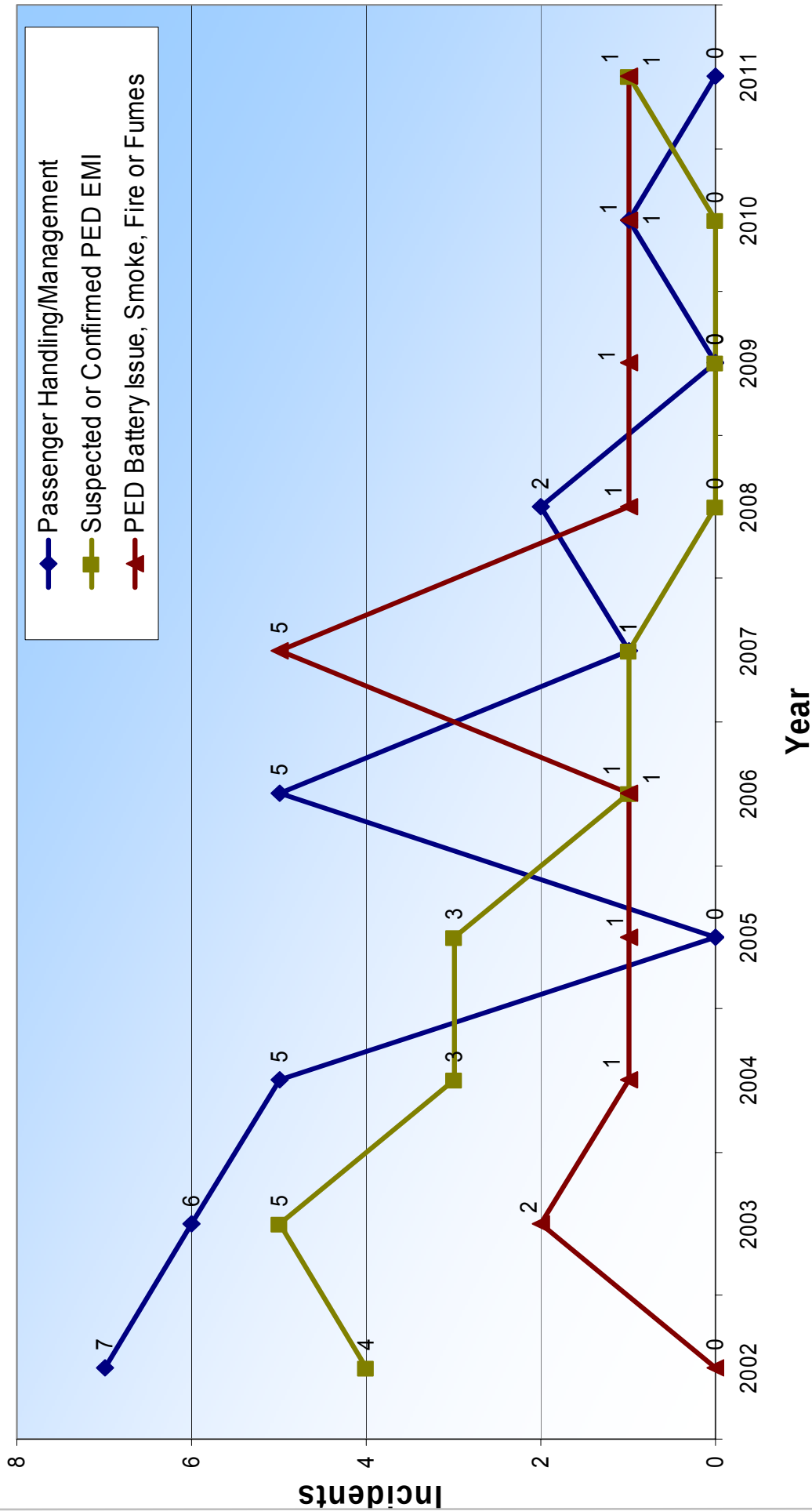
One thing that can be known from ASRS data is that the number of reports received concerning specific event types represents the **lower measure** of the true number of such events that are occurring. For example, if ASRS receives 881 reports of track deviations in 2010 (this number is purely hypothetical), then it can be known with some certainty that *at least* 881 such events have occurred in 2010. With these statistical limitations in mind, we believe that the **real power** of ASRS data is the **qualitative information** contained in **report narratives**. The pilots, controllers, and others who report tell us about aviation safety incidents and situations in detail – explaining what happened, and more importantly, **why** it happened. Using report narratives effectively requires an extra measure of study, but the knowledge derived is well worth the added effort.

Chart



Passenger Electronic Device (PED) Related Incidents

January 1, 2002 – Present (n = 56 from ASRS Database)
Special Request – Secondary Analysis*



*Secondary Analysis involves an ASRS Expert Analysts codifying each record into specific safety topic categories.

Aviation Safety Reporting System

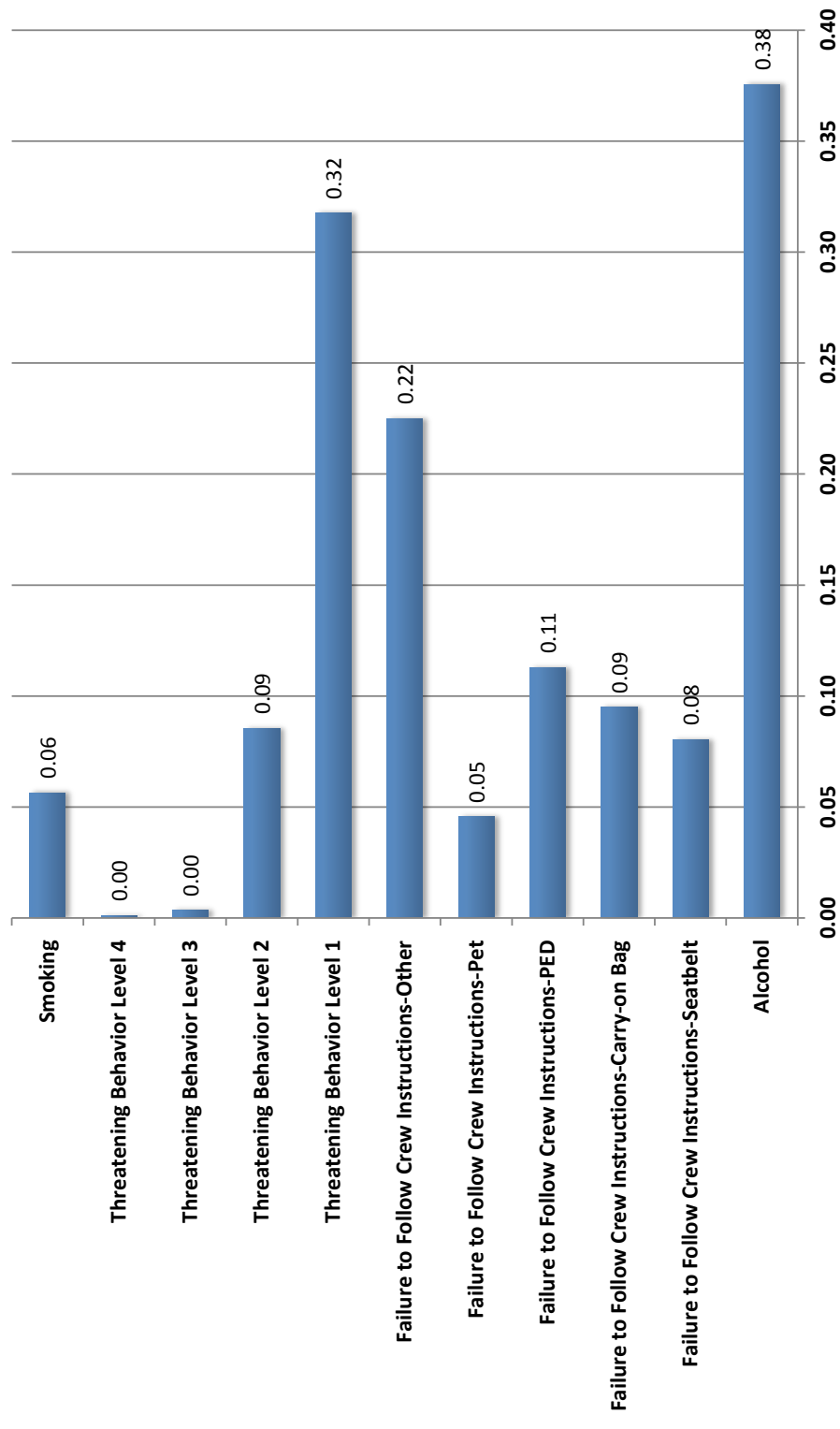


APPENDIX J: PASSENGER NON-COMPLIANCE DATA

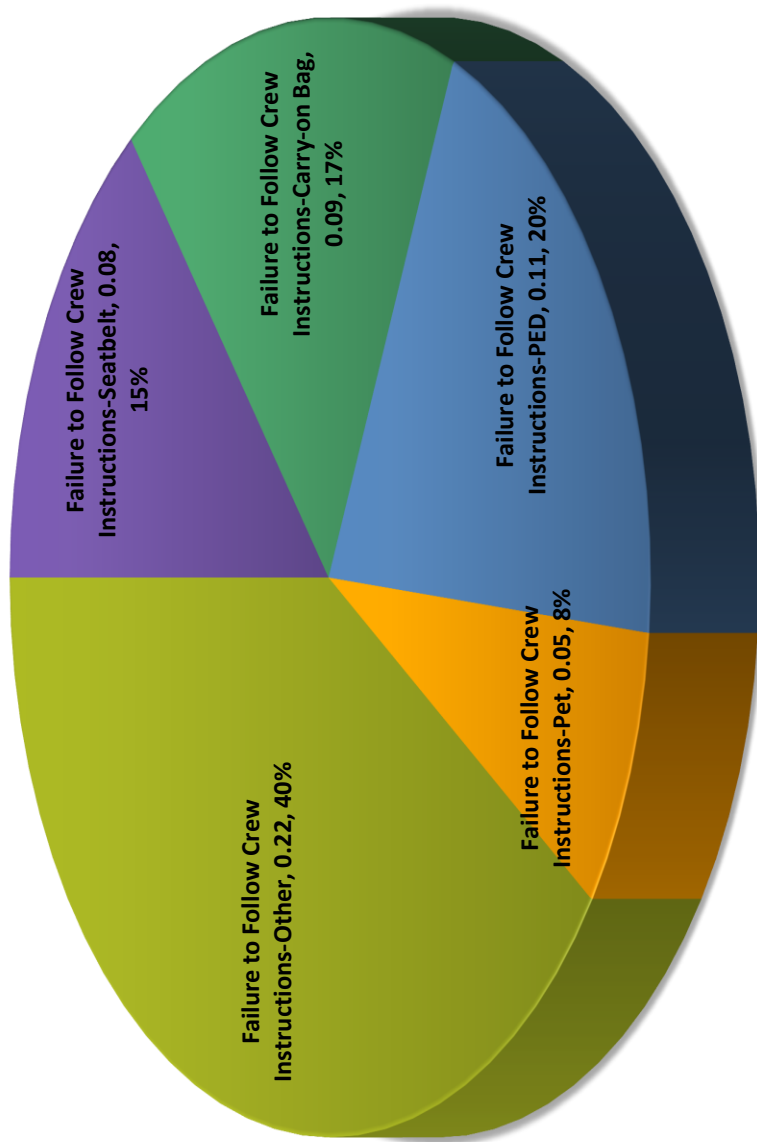
Appendix J includes passenger non-compliance data reviewed by the ARC during its deliberations. The information was compiled and prepared for publication by Airlines for America (A4A).

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Passenger Misconduct A4A Average 2011 - 2012 per 100M Revenue Passenger Miles



Passenger Misconduct - Failure to Follow Crewmember Instructions A4A Average 2011-2012 per 100M Revenue Passenger Miles



Airlines for America

COC Passenger Misconduct 2011-2012

Definitions:	
Alcohol:	Passenger appears intoxicated (boarding/during flight), drinking from own bottle not served by FA
Smoking:	Smoking on aircraft, tampering with smoke detector
Failure to follow Crew Instructions (Regulatory):	Failure to comply with crew instructions regarding carry-on baggage, portable electronic devices, seatbelt, pets , etc. (regulatory)
Threatening Behavior:	As defined by Levels of Threat: Level 1: Passenger Disruption (Suspicious/Threatening) - Includes verbal or written threats Level 2: Physical Contact (e.g., push, hit, slap, kick, grab) Level 3: Life Threatening (e.g., weapon displayed, credible terrorist or bomb threat, sabotage of systems, credible hijacking) Level 4: Breach of Flight Deck
<i>Data collected from A4A member carriers is a voluntary process and the volume of reports can vary based on individual carrier reporting policies and practices.</i>	



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APPENDIX K: INDEX OF REFERENCE DOCUMENTS

Appendix K includes an index of the guidance documents reviewed by the PED ARC and/or referenced in the PED ARC Final Report.

FAA Guidance Documents

AC 20-158, The Certification of aircraft Electrical and Electronic Systems for Operation in the High-Intensity Radiated Fields (HIRF) Environment (7/30/07)

AC 20-164, Designing and Demonstrating Aircraft Tolerance to Portable Electronic Devices (03/15/10)

AC 23.1309-1E, System Safety Analysis and Assessment for Part 23 Airplanes (11/17/11)

AC 25-17A, Transport Airplane Cabin Interiors Crashworthiness Handbook (05/18/09)

AC 25.562-1B, Dynamic Evaluation of Seat Restraint Systems and Occupant Protection on Transport Airplanes (01/10/06)

AC 91-21.1B, Use of Portable Electronic Devices Aboard Aircraft (8/25/06)

AC 120-76B, Guidelines for the Certification, Airworthiness, and Operational Use of Electronic Flight Bags (12/19/2011)

AC 121-24C, Passenger Safety Information Briefing and Briefing Cards (07/23/03)

AC 121-29B, Carry On Baggage (07/24/00)

ANM-02-115-20, Corded Electrical Devices (08/30/02)

FAA InFO 09018, Stowage of Items in Seat Pockets (11/12/09)

Order 8900.1, Flight Standards Information Management System

RTCA Guidance Documents

RTCA DO-160G, Environmental Conditions and Test Procedures for Airborne Equipment (12/8/2010)

RTCA DO-233, Portable Electronic Devices Carried Onboard Aircraft (8/20/1996)

RTCA DO-294C, Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDS) on Aircraft (12/16/2008)

RTCA DO-307 Change 1, Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance (12/16/2008)

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APPENDIX L: GLOSSARY

14 CFR Part 23: Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

14 CFR Part 25: Airworthiness Standards: Transport Category Airplanes

14 CFR Part 91: General Operating and Flight Rules

14 CFR Part 91K: Fractional Ownership Operations

14 CFR Part 121: Operating Requirements: Domestic, Flag, and Supplemental Operations

14 CFR Part 125: Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons on Board Such Aircraft

14 CFR Part 135: Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons on Board Such Aircraft

Adverse Effect: HIRF effect that results in system failure, malfunction, or misleading information to a degree that is unacceptable for the specific aircraft function or system addressed in the HIRF regulations. A determination of whether a system or function is adversely affected should consider the HIRF effect in relation to the overall aircraft and its operation. (AC 20-158)

Allowance Process: Process to allow the use of a PED on aircraft within an operator's fleet. (RTCA DO-294)

Altitude: Altitude represents the environmental pressure relative to sea level to which the equipment is exposed during the tests. (RTCA DO-160)

Approval: The act of formal sanction of an implementation by a certification authority (RTCA DO-294)

Assessment: An evaluation based upon engineering judgment (from SAE ARP4761) (RTCA DO-294)

Back Door Coupling: PED radio frequency transmissions that are radiated within the aircraft and received by aircraft electronic systems through their interconnecting wires or electronic equipment enclosures. (*See generally*, RTCA DO-294.)

Cabin Crew: Employees whose duties are performed primarily in the airplane passenger cabin. (RTCA DO-294)

Catastrophic: A failure condition preventing continued safe flight and landing. (Level A Systems) *Classification of Systems in Terms of Airplane Level Assessment (from SAE ARP5413)* (RTCA DO-294)

Certification: The legal recognition that a product complies with the applicable requirements. Such certification comprises the activity of technically checking the product and the formal recognition on compliance with the applicable requirements by issue of a certificate, license, approval, or other documents as required by national laws and procedures (from SAE ARP 4761) (RTCA DO-294)

Coupling: Process whereby electromagnetic energy is induced in a system by radiation produced by an RF source. (AC 20-158)

Critical Phases of Flight: All ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet except cruise flight. (121.542)

Electronic Flight Bag (EFB): An electronic display system intended primarily for flight deck use that includes the hardware and software necessary to support an intended function. EFB devices can display a variety of aviation data or perform basic calculations (e.g., performance data, fuel calculations, etc.). In the past, some of these functions were traditionally accomplished using paper references or were based on data provided to the flightcrew by an airline's flight dispatch function. The scope of the EFB functionality may include various other hosted databases and applications. Physical EFB displays may use various technologies, formats, and forms of communication. An EFB must be able to host Type A and/or Type B software applications. (AC 120-76B)

Fly-by-Wire Controls: The airplane control surfaces are actuated by electric motors, digital computers, or fiber optic cables. This flight control system replaces the physical connection between pilot controls and the flight control surfaces with an electrical interface. (*Airplane Flying Handbook*, FAA-H-8083-3A, Chapter 5)

Front Door Coupling: PED radio frequency emissions that are radiated within the aircraft, propagate through the aircraft windows and doors, and received by aircraft radio receivers through their antennas installed on the aircraft. (*See generally*, RTCA DO-294.)

Hazardous/Severe – Major: Failure conditions reducing the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be (Level B Systems) a large reduction in safety margins or functional capabilities, physical distress or higher workload such that the crew could not be relied on to perform their tasks accurately or completely, or serious injury to a relatively small number of the occupants. Classification of Systems in Terms of Airplane Level Assessment (from SAE ARP5413) (RTCA DO-294)

High-Intensity Radiated Fields (HIRF): Electromagnetic environment that exists from the transmission of high power RF energy into free space. (AC 20-158)

Major: Failure conditions that reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be, for example, a significant increase in crew work load or in conditions impairing crew efficiency, or discomfort to occupants, possible including injuries. (Level C Systems) Classification of Systems in Terms of Airplane Level Assessment (from SAE ARP5413) (RTCA DO-294)

Minor: Failure conditions not significantly reducing aircraft safety, and which involve crew actions that are well within their capabilities. Minor failure conditions may include, for example, a slight reduction in safety margins or functional capabilities, a slight increase in crew workload, such as routine flight plan changes, or some inconvenience to occupants. (Level D Systems) Classification of Systems in Terms of Airplane Level Assessment (from SAE ARP5413) (RTCA DO-294)

Phase of Flight – Arrival: Altitude within the sterile cockpit region and entering or crossing active runways. (RTCA DO-294, Table 2-1)

Phase of Flight – Cruise: Flight altitude above the sterile cockpit region. (RTCA DO-294, Table 2-1)

Phase of Flight – Departure: Entering active runway, take-off and climb out. Altitude within the sterile cockpit region. (RTCA DO-294, Table 2-1)

Phase of Flight – Park/Gate: On-ground, aircraft stationary/parked. (RTCA DO-294, Table 2-1)

Phase of Flight – Taxi-In: Taxiing between active runway and Park/Gate position. (RTCA DO-294, Table 2-1)

Phase of Flight – Taxi-Out: Taxiing between Park/Gate position and active runway. (RTCA DO-294, Table 2-1)

Spurious Emission: Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emission, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emission. (RTCA DO-294)

Sterile Cockpit: Rules in CFR 121.542 a, b, and c and CFR 135.100 a, b, and c discussion critical phases of flight operations are known as "Sterile Cockpit" rules. The rules list the altitude structure during departure and arrival where pilots must not be subject to undue distraction. The precise structure is determined by each operator and its oversight FAA office and generally includes operations below 10,000 feet except for cruise flight segments. (RTCA DO-294)

Title 14 of the Code of Federal Regulations (14 CFR): Aeronautics and Space

Title 47 of the Code of Federal Regulations (47 CFR): Telecommunications

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