Memorandum

U.S. Department
of Transportation
Federal Aviation Administration

Subject: INFORMATION: Policy Statement on Certification of Power Supply Systems for Portable Electronic Devices on Part 25 Airplanes

Date: March 18, 2005

From: Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100

Reply to: ANM-01-111-165
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To: See Distribution

Regulatory Reference: *§§ 25.601, 25.869, 25.981, 25.1301, 25.1309, 25.1333, 25.1351, 25.1353, 25.1357, 25.1431, and 25.1529*

Summary

This policy memorandum provides guidelines for the certification of power supply systems (PSS) installed in part 25 airplanes that are intended to be used with a portable electronic device (PED). PED devices include but are not limited to portable computers, hand-held computing devices, and hand-held gaming devices. This policy does not cover the approval of the use of these devices or any interconnecting means (adapters, cords, etc.) used to power such equipment onboard an airplane. This guidance covers low voltage (e.g., nominal 15V DC) and high voltage (e.g., 110V AC, 60 Hz, 220 V AC, 50 Hz) systems.

These guidelines are applicable to PSS intended for use with PED and are independent of the PSS outlet location (e.g., seat, wall, or cabinet mounted) and apply only to the electrical aspects of PSS for PED. It should be noted that although previous policies discussed only seat mounted power supply outlets, the safety concerns and certification requirements should be considered independent of outlet location. This policy clarifies the applicability of previous guidance.

Although PED are not specifically referred to by regulation, the regulations or requirements that apply are identified below and *italicized*. It is our intent that each method of compliance tie back clearly to the requirement. At this time no novel or unusual design features associated with these devices have been identified that indicate the current regulations or standards cannot provide an adequate level of safety when the means of compliance discussed herein are applied. In addition to means of compliance, the FAA has included recommendations which may be considered when designing these systems and used as an acceptable means of compliance where applicable.

Current Regulatory And Advisory Material

The applicable regulations relative to the electrical aspects of these systems are: *§§ 25.601, 25.869, 25.1301, 25.1309, 25.1333, 25.1351, 25.1353, 25.1357, 25.1431, and 25.1529*. These lay out the regulatory basis for the approval and installation of PSS for PED. The standards clearly establish that operation of any one unit or system of units (i.e., the PSS for PED) must not adversely affect the operation of other electrical units or systems essential to safe airplane operation, nor create a hazard that would endanger the occupants.

Policy memorandum 97-111-34, "Revised Guidance Regarding the Installation of In-Seat Power Supply Systems (ISPSS) for Portable Electronic Devices (PED)," dated June 24, 1997, previously provided guidance for in-seat power supply systems which connect airplane electrical power to passenger-provided carry-on devices. That guidance is superseded by this policy.

Similar regulatory guidance is provided in policy memorandum PS-ANM-100-2000-00105 for "Certification of In-flight Entertainment Systems" (issued as policy number ANM-01-111-160, dated September 18, 2000). The principles and guidance contained in that memorandum address the installation of wire bundles and components in the passenger cabin and the need to ensure that cabin systems do not adversely interfere with critical system functionality. It also addressed the necessity of being able to remove power from such systems when deemed necessary by the flightcrew or cabin crew without affecting critical or essential systems. These same principles should be applied to the installation of power systems for use with PED.

Policy memorandum PS-ANM111-2002-01-04, "System Wiring Policy for Certification of Part 25 Airplanes" (issued as policy number ANM-01-04, dated January 28, 2003), was issued to provide guidance regarding the kinds of system wiring type design data and instructions for continued airworthiness that are necessary to support type design, amended type design, and supplemental type design changes. This policy should be applied for the installation of PSS for PED installations.

Relevant Past Practice

As noted above, three policy memoranda exist which provide means to meet the regulatory standards for PSS for PED and IFE systems. Copies of these policies are available from the FAA Regulatory and Guidance Library. The regulations that apply to such systems are also applicable to electrical systems in general and the methods of compliance presented are applicable to similar systems within the cabin interior.

Policy

This guidance is for the approval of the electrical installation aspects of a PSS for PED. Operational (operating procedures, crew training, etc.) and ICA approval aspects of these systems should be coordinated with Flight Standards and Aircraft Evaluation Groups (AEG) in accordance with FAA Order 8110.4B, Type Certification.

1. <u>Power Supply Systems For Portable Electronic Devices Certification Guidelines</u>

a. <u>Affect on Critical Systems</u>: The requirements of sections *25.1333, 25.1353 and 25.1431 state that the operation of any one unit or system of units will not adversely affect the operation of a system essential to safe operation of the airplane.* As previously noted, certain IFE systems were identified as having design features that could adversely affect systems necessary for the safe operation of the airplane. Should it be determined that PSS for PED have the same design features, additional mandatory airworthiness action may be warranted.

(1) <u>Power Control</u>: To ensure that these systems *will not adversely affect the operation of a system essential to the safe operation of the airplane* the means of compliance with the noted regulations is for the PSS to be designed such that it can be de-powered at any time by a crewmember.

(a) The installation of a clearly labeled on/off switch for de-powering the PSS by the cabin or flightcrew would allow the system to be appropriately de-powered. Although multiple power control switches may be used (e.g., zonal control of system power), there should be a single master switch that allows for the immediate removal of power to the entire PSS for PED. If multiple switches are used, the design should prevent crew confusion and they should be in a serial configuration with the master power switch to prevent reactivation of the system by crewmembers unaware of a hazardous or potentially hazardous condition of the system. Procedures for the use of such switches should be documented in the appropriate crew operating/training manuals.

(b) The removal of power should occur as close to the source of power as practical.

(c) The use of a circuit breaker as a means of de-powering a function is not acceptable since the repeated use of circuit breakers as switches can degrade their performance and prevent them from actuating at the rated current trip point.

(d) In addition, a separate switch is not the only means of achieving power removal for PSS for PED. For example, some airplanes have a switch in the flight deck that removes all power from non-essential cabin systems. On other airplanes the PSS for PED may be powered from an airplane's utility bus, and the flightcrew can disconnect the utility bus when they deem it necessary. These methods still address the issue of *not adversely effecting systems essential to safe operation*, by de-powering the non-essential systems by a crewmember.

(2) <u>Electrical Power Source.</u> As noted in the current policy for IFE systems, these systems should also be connected to an electrical bus that <u>does not</u> supply power to airplane systems necessary for continued safe flight and landing. The utility, galley, and ground service busses are examples of the types of electrical busses that should be utilized to provide power to the PSS for PED. This would ensure the level of safety intended by the noted regulations is provided and that failure or malfunction of the PSS *will not affect safe operation of critical or essential systems.*
<u>NOTE</u>: Although the regulations noted above do not specifically prohibit the powering of miscellaneous, non-required systems (e.g., PSS for PED or IFE systems) from busses that also power essential or critical level systems, the unsafe conditions identified and corrected by the subsequent issuance of *airworthiness directives for IFE systems* warrants such segregation in

order to achieve the level of safety intended by the rules. As an example, the most reliable busses supply power to the most critical systems, whereas those busses that are the first to be shed (either manually or automatically) supply power to systems such as galleys, telephones, IFE systems, and PSS for PED. The higher-level busses are the last to be shed, if at all. Therefore, connecting a PSS for PED to an essential or critical level bus without a dedicated means to remove power inhibits the ability of the crew to remove power from the system when deemed necessary (e.g., in a smoke/fumes emergency). Connecting PSS for PED and other non-essential passenger convenience systems to non-essential busses helps ensure that these systems will not adversely affect other systems necessary for the safe operation of the airplane.

(3) **Wire and Component Vulnerability.** Power supply systems for PED or similar system wire bundles and components (exposed in some cases) are present throughout the passenger cabin. Thus the potential for system faults is increased by the wide exposure to varying hazards (e.g., pinched wires in the seat track, passengers stepping on or kicking the seat electronic box, spilled liquid, etc.). Since these systems are exposed to hazards, *the potential to adversely affect other systems necessary for safe operation* significantly increases, as well as the possibility of shock hazards to people. To guard against damage to PSS for PED cable assemblies installed in the seat itself, seat mounted wiring should have appropriate protection means. One example of a method for providing such protection is the use of conduits. Engineering data that control the installation of PSS wiring and equipment should contain specific, unambiguous requirements for the routing, supporting, and protection of all PSS wiring and equipment, and should identify all parts necessary to accomplish those installations.

b. System Status Indication:

(1) It is recommended that a means of indication be provided to enable the cabin crew to determine which outlets are in use or which outlets are available for use. If multiple de-powering switches are used in the design, consideration should be given to including a system status indicator at each switch location. This desirable, but not required feature would allow cabin crewmembers to determine if problems associated with an individual passenger outlet are related to the localized components (e.g., seat mounted components) or the system as a whole and provide the ability to address any potential safety issues quickly.

(2) If a flight deck indication of PSS for PED status (e.g., system “on” or “off”) is installed, then it should be consistent with the airplane manufacturer’s design philosophy with regard to system status indication.

c. Radiated and Conducted Emissions. When considering the effect of PSS for PED on critical systems, *§§ 25.1353 and 25.1431, radiated or conducted emissions from the PSS for PED must also be considered*. The levels of conducted and radiated interference generated by the PSS for PED equipment via power supply feeders or other system components should not cause an unacceptable degradation of performance of other aircraft systems. If filters are used to accomplish this, then the effect of human-generated electrostatic discharge damage to the filters should also be addressed. These potential emissions should not be worse than those set by Federal Communication Commission regulations controlling conducted emission from such equipment.

Performing tests per Radio Technical Commission for Aeronautics (RTCA) DO-160D/EUROCAE ED-14D/ISO7137 (see Sections 4 through 9, 11, and 15 through 22, as applicable to a particular design) is an acceptable means of demonstrating compliance. Such testing should include 150 kHz to at least 30 MHz as depicted in Section 21 of document DO-160D. In addition, an evaluation of electromagnetic compatibility for the PSS for PED should be accomplished for all foreseeable operating and standby conditions.

Simulated PED loads may be used to check the conducted and radiated EMI from the PSS for PED. When using simulated loads the following minimum load conditions, should be evaluated:

- No load;
- One load: minimum, maximum power delivered by the PSS for PED;
- Several loads connected;
- All loads connected: minimum, maximum power delivered by the PSS for PED.

Further tests with the intended PED connected to the PSS for PED system to check the conducted interference from the PED in the range of 30-100 MHz are recommended, but not required for certification. To check for conducted interference known worst case loads at worst case locations should be tested. Applicants should consider conducting the tests with wireless devices, such as Bluetooth enabled PEDs, since the use of such devices is increasing. Additional testing using computer modeling techniques can also be used.

Note: It is not expected that the PED perform to the category 'H' level of radiated emissions (reference DO-160D Section 21). However, the power supply system should filter undesirable conducted emissions generated by the PED or by the PSS for PED itself and prevent the propagation of any unwanted RF into other airplane systems.

d. Circuit Protection is required for compliance with *§ 25.1357*. This is normally accomplished by the use of appropriately rated thermal circuit breakers. However, it is recommended that arc fault circuit breakers be used as they become more readily available.

h. Overheat Protection. It is recommended that the system components include overheat protection. Such a feature provides automatic shutdown of the system if an overheat situation is detected and lowers the possibility that it will be the source of smoke or fire. However, if this feature is included, it should not be automatically resettable. Resetting of the system after an automatic shutdown because of an overheat situation should be accomplished manually by the cabin crew or flightcrew.

e. Hazards to Occupants. Experience has shown that electrical shock, smoke, and fire can be hazardous to occupants. Therefore, *§ 25.601 requires that an applicant substantiate the design does not introduce a source of injury due to electrical shock, smoke, and fire***.** A fault of the circuit associated with the PSS in the cabin interior or system short circuits could lead to system overloads or fire/smoke hazards. These types of faults may be caused by spilled liquids or insertion of conductive objects into the outlets. The design of the PSS socket installation

should prevent fluid from reaching the electrical circuitry of the PSS electrical components or the power sockets. The design should also minimize the possibility that conductive objects could be inserted into the power sockets. Otherwise an applicant should show that a design means is in place to mitigate the hazard of these situations. An example of such mitigation would be a design where output power is present at the PSS socket only when the PED connector is correctly mated with the socket.

f. <u>Flammability Requirements.</u> *Section 25.869 requires that wire insulation used with the PSS for PED must be shown to be self-extinguishing when tested in accordance with the applicable portions of part I, appendix F of part 25. Even though PSS for PED systems may utilize wiring that is produced for the consumer market the wiring must meet the flammability requirements of § 25.869. In addition, the applicant is required to show that all components associated with the PSS for PED meet the applicable flammability requirements of § 25.853***.**

g. <u>Intended Function.</u> The *intended function* (*§ 25.1301*) of the PSS for PED is to supply the power needed to enable the PED to operate while connected to the power supply outlet. As such, the PSS for PED should not supply more power than the normally expected uses would demand. Limiting the power available at the outlets prevents the use of these outlets for purposes outside of the intended function.

<u>Note</u>: A 100-watt limit was recommended in the proposed 1997 policy memorandum because at that time this was more than sufficient power necessary to run that generation of laptop computers. This power limit was established to control the types of devices that could be powered using the PSS for PED. The intent of the PSS for PED is to provide power for personal electronic devices such as laptop computers, personal DVD players, and handheld gaming devices. The PSS for PED is not meant to provide power to devices like curling irons, light bulbs, or hair dryers. The use of such equipment by passengers could pose a safety threat to the passengers themselves, due to shock, and such high power consuming devices may increase the risk of fire. Therefore, by limiting the power output of the PSS for PED outlets, the types of devices that could be used is controlled. Considering the power demand of current PEDs, the FAA considers 200 watts of power to be a reasonable limit to the power provided by the PSS for PED at a given power outlet.

In specific cases where higher power levels are necessary, such as those for medical or other special use equipment or special use airplanes (e.g., military transports), the applicant should submit a proposal to the cognizant FAA office for the increased power capability of the PSS. The proposal should include rationale as to the need for the increased power requirements and the additional design features that will minimize the possibility of adverse effects on essential or critical airplane systems and the shock hazards to persons.

h. <u>Electrical Load Analysis.</u> *An airplane's electrical load analysis (ELA) is required by § 25.1351(a) to substantiate that the airplane's electrical power generating system has sufficient capacity to safely provide the maximum amount of power required by the PSS for PED to operate properly.*

The applicant should base the PSS for PED ELA on an ELA that accurately reflects the airplane's current pre-modified electrical loads. If this is not available the applicant should make measurements of the airplane's pre-modified condition and use these measurement for the PSS for PED *ELA that is required by § 25.1351(a).* The ELA should establish that the PSS for PED does not cause the total load on the electrical generating system to exceed 80 percent of the system's capacity as recommended by AC 43-13 1b.

i. <u>Safety Assessment.</u> *Compliance with § 25.1309 requires that appropriate quantitative and/or qualitative failure analyses of the PSS for PED be conducted such that any failure condition would not prevent the continued safe flight and landing of the airplane or that any other failure conditions would not reduce the capability of the airplane or the ability of the crew to cope with adverse operation conditions.* The analysis should consider the effects of the environment in which the PSS for PED equipment is installed, wiring installation and separation, cooling arrangements, and the safety features employed to prevent a fire, overheat, or shock hazard from being inadvertently created within, or by, the PSS for PED.

j. <u>Instructions for Continued Airworthiness (ICA).</u> Although these PSS for PED are non-essential electrical systems, *this does not preclude them from the requirement to prepare and submit ICA in accordance with § 25.1529.* The ICA should include all necessary maintenance actions required to maintain the PSS for PED so that the continued airworthiness of the airplane is maintained.

k. <u>Compliance with § 25.981, Amendment 102, Fuel Tank Ignition Prevention.</u> The application of Amendment 102 addresses an unsafe condition established under § 21.21(b)(2) by previously issued Airworthiness Directives. Therefore, *all wiring and equipment, including that associated with PSS for PED, must be designed to ensure compliance of the installation with the requirements of § 25.981, amendment 102 or later*. In order to meet these requirements, all PSS for PED wiring must be separated from the wiring listed below if the fuel tank system wiring is not protected by transient suppression devices or other means of preventing the development of hazardous energy levels in the fuel tanks:

(1) Wiring of circuits associated with in-tank components such as fuel quantity probes, refueling valves and float switches, and

(2) Wiring of circuits associated with equipment that interfaces directly with in-tank components, and that have not been found to possess adequate electrical isolation between fuel tank and non-fuel tank circuits. The concern is that a short between an electrical power wire and a wire associated with non-fuel tank wire connected to an LRU associated with the fuel tank system (such as a fuel quantity processor unit) could short to a printed circuit board trace within the LRU and introduce hazardous energy levels in the fuel tanks.

l. <u>Seat Mounted PSS for PED Equipment</u>. If the PSS for PED system includes seat-mounted equipment, the applicant is accountable for the certification of the entire PSS for PED system, including the seat-mounted equipment. In general, the seat Technical Standard Orders (TSO's) do not contain electrical requirements. Therefore, most electrical aspects of the PSS for PED components are not addressed under the TSO approval. Further information regarding seat

mounted PSS for PED equipment can be found in the AIR-100 policy memorandum, Policy and Guidance on the Approval of Electrical Components on Aircraft Seating Systems, dated October 27, 1998, or later revisions.

2. Criteria For Installation Of High Voltage Alternating Current (AC) Systems.

The following criteria should be considered in addition to the material presented in the previous sections of this policy for approval of high voltage AC PSS for PED (e.g., 110 V 60 Hz AC, 220 V 50 Hz AC) due to the increased risk to the airplane and occupants.

a. Outlet Labeling. Due to the increased risk of personal injury from high power PSS for PED systems, it is recommended that output voltage and frequency be labeled on power outlets (e.g., 110V AC, 60 Hz). Such labeling would also reduce the likelihood of users connecting incompatible devices to the high voltage source. Given the variety of outlet and connector types used for various power sources and the variety of plug adapters that are available, outlet type alone is not considered to be sufficient.

b. Fault Protection. To prevent personnel injury it is recommended that differential protection and/or galvanic isolation (isolation transformer), be provided to guard against inadvertent contact with live parts of the system . If differential protection is utilized, it should have the following characteristics:

- Maximum fault current should be limited to 30 mA.
- Activation time in the event of a differential fault should be less than or equal to 30 mSec.
- In the event of differential protection circuit failure, output power to the outlet should be automatically removed.

Note: Fault current is defined as a current that flows from one conductor to ground or to another conductor owing to an abnormal connection (including an arc) between the two. Differential protection is a technique for protection from short circuits.

The fault protection system should include features for monitoring the health of the fault detection circuits. If a fault is detected, the power to the outlet should be automatically removed. Any automatic reset feature should not be permitted.

c. Cabin Decompression. Because of the possibility of cabin decompression and the resulting arcing that could occur it is recommended that a means be provided for the automatic removal of power from all components containing high voltage circuits unless they have been shown to be free of arcing during the environmental tests specified in RTCA DO-160, or equivalent tests. (refer to guidance contained in FAA AC 25-10).

3. Operational Considerations

When crew actions are needed to implement a chosen method of compliance, they should be included in the appropriate operations manual and coordinated with the aircraft evaluations

group as part of the certification process. Such information should include, but is not limited to, the following:

a. Description of the system including instructions for the activation/deactivation of the PSS, e.g., system switches and passenger controls;

b. Restrictions on use for each phase of flight (the PSS for PED should be deactivated during critical phases of flight such as takeoff and landing.);

c. Monitoring passenger use of system by cabin crew;

In addition, it is recommended that the following operation factors be considered and reviewed with the appropriate flight standards personnel. This list should include, but is not limited to, the following:

a. Flight deck and cabin crew communication;

b. Hazards, e.g., trip hazards, overheating of passenger devices because of being covered by pillows, blankets, etc.;

c. Information to passengers, such as, safety precautions and warning that power may be disconnected at any time if necessary without notice;

d. Malfunction of system and/or individual units and corrective action.

Note 1: Establishing the suitability of use of PED on a particular airplane model will remain with the airplane operator (e.g., 14 CFR Section 91.21)

Effect of Policy

The general policy stated in this document does not constitute a new regulation. The FAA individual that implements policy should follow this policy when applicable to the specific project. Whenever a proposed method of compliance is outside this established policy, it must be coordinated with the policy issuing office. To accomplish this coordination, the individual who is considering an alternate method should coordinate with the project officer and technical specialists to jointly determine if an issue paper is needed or if an item of record is more appropriate. Similarly, if the implementing office becomes aware of reasons that an applicant's proposal should not be approved, the office must coordinate its response with the policy issuing office.

Applicants should expect that the certificating officials will consider this information when making findings of compliance relevant to new certificate actions. Also, as with all advisory material, this statement of policy identifies one means, but not the only means, of compliance.

Implementation

The compliance methods discussed in this policy should be applied to type (TC), amended (ATC), supplemental (STC), and amended supplemental type certification programs whose application date is on or after the date the policy is finalized. For existing certification programs

whose application precedes the date this policy is effective and the methods of compliance have already been coordinated with and approved by the FAA or their designee, the applicant may continue to follow the previously acceptable methods of compliance or choose to follow the guidance contained in this policy.

/s/

Ali Bahrami

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