U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: AIRWORTHINESS APPROVAL AND OPERATIONAL ALLOWANCE OF RFID SYSTEMS

Date: 09/22/08 **AC No:** 20-162
Initiated By: AIR-100

1. Purpose of this AC.

a. This advisory circular (AC) offers guidance on installing and using radio frequency identification (RFID) systems on aviation products and equipment. Specifically, we provide an acceptable way to use RFID readers or interrogators installed on aircraft, and advice on allowing use of RFID devices on baggage, mail containers, cargo devices and galley/service carts. We cover using portable RFID readers or interrogators carried onboard aircraft. Finally, we incorporate and supersede jointly-issued AIR-100, AFS-200, and AFS-300 RFID policy.

b. This AC is not mandatory and does not constitute a regulation. It describes an acceptable means, though it's not the only means, to show compliance with applicable installation and operational requirements. However, if you use the means described in this AC, you must follow it in all important aspects.

2. Whom this AC Applies to. We've written this AC for—

a. Manufacturers and modifiers of aviation products and equipment, who want to install RFID devices on aircraft, aircraft engines, propellers, and equipment. "Equipment" includes components, component parts thereof, and cabin furnishings including galley/service carts. (See paragraphs 7 and 8).

b. Aircraft operators, who want to use RFID devices on galley carts and baggage, passenger-convenience items (pillows, headsets, blankets and other items), and service provisions (towels, coffee service and other disposables) carried on-board an aircraft. (See paragraph 9.)

3. Cancellation. AIR-100/AFS-200/AFS-300 joint memorandum, *Policy for Passive-Only Radio Frequency IDentification (RFID) Devices*, dated May 13, 2005, is cancelled.

4. Scope. In this AC, we cover only *passive or low-power active* RFID devices, not RFID devices that communicate using cellular or satellite telephone technology, wireless wide area networks, high power radio transmitters, or other types of tracking devices.

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5. RFID Systems Covered by this AC.

a. General characteristics. An RFID system includes the RFID device, a reader or interrogator, and in some cases, an information management system. The data from an RFID device may identify or give specific information about the product or equipment onto which it's installed. RFID interrogation typically does not require line-of-sight or contact between RFID devices and respective readers. RFID devices have varying data storage capacity and field programmable utility. Many RFID devices may also incorporate means to monitor and transmit time-in-service, temperature, humidity or other conditions.

b. Passive RFID devices. A passive RFID device has no integral power source. The device provides information during interrogation using "backscatter" energy. Passive RFID devices are usually made up of an integrated circuit (containing information) and integral antenna. The size of the RFID device is determined by many factors, which may include desirable energy-to-distance range. The backscatter energy reflected by the passive RFID antenna is directly proportional to the incident power from the reader or interrogator, which can influence the operating range.

c. Low-power active RFID devices. An active RFID device relies on a self-contained power source. Active RFID devices have greater operating range and often provide more information than passive RFID devices. Active RFID devices consist of a low-power radio frequency (RF) transmitter, an integrated circuit controller, memory, antenna, and power source. Active RFID devices operate in one or more modes to discriminate the time and period of replying to an interrogation. These are typical modes in which RFID devices transmit:

(1) Interrogated. Only when interrogated by a reader.

(2) Beacon. At a predetermined time.

(3) Random transmit. When triggered by external conditions, like motion or temperature, and

(4) Multiple. In multiple modes, like beacon and random, or beacon and interrogated.

d. Battery assisted passive (BAP) RFID devices. BAP RFID or semi-passive devices are similar to active devices. They have their own power source, but the battery powers only the microchip. The device transmits only when interrogated. We consider BAP RFID devices as low-power active RFID devices.

e. RFID reader. An RFID reader or interrogator obtains information from an active or passive RFID device, either transmitted from or backscattered by the device. Some RFID readers are called interrogators, because the reader has to transmit to the RFID device first, modulating an RF signal, before the device responds. An RFID reader may be portable or permanently installed in an aircraft.

6. Airworthiness Concerns about RFID Systems. At the FAA, our airworthiness concerns about RFID systems installed on aircraft include—

a. Integrity, accuracy, and authenticity of both safety-related and identification data from RFID devices.

b. Fire and electrical safety, crashworthiness, and environmental effects.

c. RFID device-generated RF intended transmissions or spurious emissions, both of which can interfere with aircraft electrical and electronic systems and components, and

d. Maintenance required for RFID devices and readers.

7. Airworthiness Considerations with Installed RFID Devices and Readers. Manufacturers and modifiers of aviation products and equipment, intending to install RFID devices and readers or interrogators, gain approval under Title 14 of the Code of Federal Regulations (14 CFR) parts 21, 23, 25, 27, 29, 33, and 35. This paragraph applies to RFID devices and systems permanently installed on:

- Products (aircraft, aircraft engines, propellers), aircraft equipment, and
- Cabin furnishings (including galley/service carts).

a. Intended function of installed RFID devices. If you're applying for system approval or certification, define the intended function of the installed RFID devices. The standard intended functions for installed RFID devices covered in this AC are:

(1) Ancillary part marking. RFID part marking is not an alternative to meeting the part marking requirements implemented by airworthiness regulations. We consider installed RFID devices, used as ancillary means for aircraft part marking, to be performing a non-required, non-essential function. When a part with "human-readable" part markings also has specific information transmitted by an RFID device, we consider the RFID marking as ancillary. But when the aircraft, engine, or propeller components or parts are identified as critical or life-limited, we don't consider RFID device part marking as ancillary.

(2) RFID part marking of critical component or life-limited parts. When using RFID devices for part marking of aircraft, engine, or propeller critical or life-limited components, those devices must comply with the requirements of 14 CFR 45.14, "Identification of critical components", or 14 CFR 45.16, "Marking of life-limited parts."

(3) Other functions. Other RFID device functions include temperature logging, vibration monitoring, weight records, or time-in-service computation done by the RFID device itself. State in the instructions for continued airworthiness (ICA) that the RFID devices are an ancillary means for providing these functions.

b. Evaluate RFID devices that perform "other" functions to determine any adverse effects from the device installation and function, including loss of device data integrity. Address those considerations in your system safety assessment. RFID device functions with adverse effects

that could cause *catastrophic*, *hazardous/severe-major*, or *major* failure conditions are outside the scope of this AC. Address them in a specific certification plan.

c. Passive RFID devices should meet the most current revision of SAE International's Aerospace Standard (AS)5678, *Passive RFID Tags Intended for Aircraft Use*.

d. Installed RFID readers. RFID readers installed on an aircraft should meet the applicable regulations based on their intended function, and the use of the information that the RFID device transmits. For RFID readers installed in transport category airplanes performing non-required, non-essential function, if FAA AC 25-10, *Guidance for Installation of Miscellaneous, Nonrequired Electrical Equipment* is used, supplement it with airplane electromagnetic compatibility (EMC) certification requirements in paragraphs 8.d(2) - 8.d(4) of this AC.

8. Specific Requirements Table. Table 1 below lists the requirements to consider when installing RFID. The table lists the type of installation across the top, and the requirements along the side. The table then points to the paragraph providing detail on the specific requirement.

Table 1. Installed RFID Device Requirements

Requirement	Ancillary part marking		Critical component/life-limited part marking Other functions
	Passive RFID		Passive and active RFID
Safety assessment	Paragraph 8.a	Paragraph 8.a	Paragraph 8.a
Major alterations	Paragraph 8.b	Paragraph 8.b	Paragraph 8.b
Configuration control	Paragraph 8.c	Paragraph 8.c	Paragraph 8.c
EMC demonstration	Not required	Paragraph 8.d	Paragraph 8.d
Software and complex hardware	Not required	Not required	Paragraph 8.e
Environmental qualification	Paragraph 8.f	Paragraph 8.f	Paragraph 8.f
Battery safety	Not required	Paragraph 8.g	Paragraph 8.g
Flammability and fire safety	Paragraph 8.h	Paragraph 8.h	Paragraph 8.h
Mounting and attachment integrity	Paragraph 8.i	Paragraph 8.i	Paragraph 8.i
ICA	Paragraph 8.j	Paragraph 8.j	Paragraph 8.j

a. Safety assessment.

(1) Assess the installed RFID system safety according to14 CFR §§ 23, 25, 27, or 29.1309. Identify the hazard levels associated with installing and using the RFID system. Determine the maximum acceptable levels of "probability of failure" for the system as installed on the aircraft. Show that the system complies with safety objectives. Your safety analysis of the design and installation of RFID systems/devices should demonstrate that normal operation, failures, or malfunctions will not have greater adverse impact than "minor effect" according to

AC 23.1309-1, *Equipment, Systems, and Installations in Part 23 Airplanes,* AC 25.1309-1, *System Design and Analysis,* AC 27-1, *Certification of Normal Category Rotorcraft* or AC 29.2, *Certification of Transport Category Rotorcraft.*

(2) The safety assessment for using passive RFID devices for ancillary part marking was accomplished during the development of the FAA's policy for use of those devices. We've determined that normal operation, failure, or malfunction of passive RFID devices defined in this AC will not have greater than "minor effect" according to AC 23.1309-1.

b. Major alterations.

(1) The installation of RFID devices is considered a major alteration if it might appreciably affect the aircraft's weight, balance, structural strength, performance, flight characteristics, or other qualities affecting airworthiness.

(2) Installing passive RFID devices on approved articles and appliances, including equipment, components and component parts thereof, cabin furnishings including galley/service carts and cargo devices like ULDs is a minor alteration.

> **Note:** Performing a minor alteration does not invalidate the existing approval of the articles and appliances. We don't require a part number "roll."

c. Configuration control. To ensure RFID device and system interoperability or compatibility between those components, it may be necessary to enter the RFID device(s) make, model, part number, and perhaps serial number into the product or equipment ICA or FAA accepted documentation. In addition, if there are particular details and requirements about how the device is mounted, located, oriented and used where configuration control is significant, ensure that you enter those details in the ICA or FAA-accepted documentation.

d. EMC requirements for RFID devices.

(1) Passive RFID devices incorporate electronic circuits that operate only when interrogated by the RFID device reader. Therefore, no laboratory RF emissions tests, like those in RTCA, Inc. document RTCA/DO-160, *Environmental Conditions and Test Procedures for Airborne Equipment,* are required for them. No aircraft EMC tests are required for passive RFID devices installed on aircraft, aircraft engines, or propellers and the equipment, components, or parts of these aircraft, engines and propellers, or for passive RFID devices permanently installed on galley carts.

(2) Active RFID devices incorporate battery-powered electronic circuits that may operate continuously, even when the devices are not transmitting. Therefore, use laboratory RF emissions tests and aircraft EMC tests to demonstrate that operation of the active RFID devices does not adversely affect other aircraft electrical, electronic and radio systems.

(3) Perform laboratory RF emission tests using procedures in RTCA/DO-160, Section 21. Use Section 21, Categories M, H, or P to test and establish the RF emission limits. Measure the RF emissions both when the RFID device transmits, and when not transmitting. With active RFID devices that transmit in response to an interrogation, take great care to ensure that the RF interrogation signal does not interfere with the RF emission measurements. To prevent measurement errors, you may need an RF notch filter tuned to the RF interrogation signal at the input to the RF emission measurement instrument.

(4) Ground-test aircraft EMC with the active RFID devices installed on the aircraft, aircraft engines, propellers, and the equipment, components, or parts of these aircraft, engines and propellers, or permanently installed on galley carts. Ground-test the aircraft EMC with the active RFID devices, both when the RFID device transmits and when it's not transmitting. You may use the results of the laboratory RF emissions tests to select systems or frequencies to be monitored during the EMC ground test. Base the aircraft EMC ground tests on a source-victim analysis matrix and evaluate functional performance of the potential aircraft victim systems.

e. Software and complex hardware. Consider the appropriate software level, per RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, for RFID devices using software. If your application uses complex electronic hardware, consider the appropriate hardware level according to AC 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware*. RFID system software and hardware qualification requirements are determined by system failure condition level.

f. Environmental qualification (other than EMC). Follow SAE AS5678, Section 5.3.6, for other environmental qualifications of active RFID devices.

g. Battery safety. For batteries in active RFID devices, safety concerns include the possibility of explosion caused by failures of lithium ion or nickel metal hydride batteries. Batteries must prevent explosion if they fail, and meet the explosion proofness requirements of RTCA/DO-160, *Environmental Conditions and Test Procedures for Airborne Equipment,* Section 9. If you use lithium-ion (LI-ion) batteries, they may need to be approved under FAA technical standard orders (TSO)-C142a, *Non-Rechargeable Lithium Cells and Batteries*, and TSO-C179, *Rechargeable Lithium Cells and Lithium Batteries*. If using larger LI-ion batteries, develop them to meet the requirements of RTCA/DO-311, *Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems.*

h. Flammability and fire safety. Batteries in active RFID devices, with the RFID device itself, must meet the flammability requirements of 14 CFR 25.853(a) and appendix F, part I.

i. Mounting and attachment integrity. The RFID installation must be a permanent one. Installers of RFID devices should comply with 14 CFR §§ 23, 25, 27, or 29.301, .303, .305, .307, .471, .561, .601, and .609, and §§ 23 or 25.333 by design data review, analysis and/or test. Document the method you used, and that the FAA agreed on, before you submitted your request for finding compliance. See 14 CFR 25.789 and § 23, 25, 27, or 29.787. You can demonstrate compliance with these requirements by reviewing and analyzing the design data.

j. ICA. If the RFID device has a service life limit, state it in the ICA. State if and when the RFID device requires battery replacement, recharging, or other periodic maintenance. State whether the RFID device, if malfunctioning, must be removed from the aircraft and replaced with one of the same type and configuration. Your responsible aircraft certification office (ACO) will use FAA Order 8110.54, *Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents*, to give you further requirements or details for preparing ICA.

9. Operational Allowance for Portable RFID Devices and Readers on Aircraft. If you're an aircraft operator, this paragraph will help you comply with 14 CFR §§ 91.21, 121.306, 125.204, and 135.144 which require you to determine the extent you'll allow the use of portable RFID devices (sometimes called portable electronic devices, or PED). We cover only portable RFID devices and readers performing non-essential, non-required functions.

a. Portable RFID devices are not permanently attached to the aircraft, engine or propeller parts, equipment, line replaceable units (LRUs), or structure. Examples of their non-essential, non-required functions are:

- Ancillary means for cargo identification and positioning,
- Passenger baggage identification and counting, and
- Monitoring provisions carried on board aircraft.

b. Regulations cited in paragraph 9 above require that aircraft operators determine that the RFID device and reader will not cause interference with the navigation or communication system of the aircraft on which it is used. See AC 91.21-1, *Use of Portable Electronic Devices Aboard Aircraft.*

c. You should determine if the devices interfere with aircraft electrical/electronic systems with failure classifications that are *major*, *hazardous/severe-major*, or *catastrophic*, or with devices required by regulations, such as flight data/voice recorders. Make the assessment by using either the certification approach in paragraphs 7 and 8 (this AC) or by following RTCA/DO-294B, *Guidance on Allowing Transmitting Portable Electronic Devices.*

10. How To Get Referenced Documents.

a. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036. Telephone (202) 833-9339, fax (202) 833-9434. You also can order copies online at www.rtca.org.

b. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790. You can also order copies online at www.sae.org.

c. Order copies of 14 CFR parts from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2250. You also can order copies online at www.access.gpo.gov. Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

d. You can find a current list of advisory circulars on the FAA internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl.

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