AIRLINES' BUSINESS REQUIREMENTS

for Original Equipment Manufacturers
on Radio Frequency Identification (RFID)
and 2D Barcode Tagging
for Aircraft Cabin Equipment

International Air Transport Association

Safety and Operations

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Contents

1. INTRODUCTION

Over the years, a number of airlines have implemented RFID Technology in their Technical Operations. The RFID implementation is one of the critical technology pillars that will enable the industry to improve compliance, transfer the data electronically, and provide ability to track and trace aircraft parts quickly and accurately. Using RFID and 2D Barcode technology ensures that parts will be accurately identified if Spec 2000 industry standards are followed. This document provides guidance for RFID implementation to original airframe manufacturers (OAM), MROs and original equipment manufacturers (OEM), and any repair facility. It is weighted toward the airline needs since they are the end user of this technology and are reading the tags repeatedly in an operational environment. In addition, airlines have the final responsibility to follow the airworthiness regulations and are accountable for the use of this technology.

This requirement is the start of a broader guidance for industry on other Auto-ID technologies, that have use cases for aircraft maintenance and parts tracking (IoT, sensors, Bluetooth, active RFID, etc.).

1.1 PURPOSE

This paper outlines airlines' business specification for entities (e.g. OAM, OEM, and Repair Facility) that provide RFID tagged parts for use on the aircraft.

1.2 SCOPE

This requirement focuses on passive UHF RFID tags as specified in industry standards for aviation, including but not limited to the tag, data and performance requirements and are utilized on aircraft equipment. It will not cover battery-assisted passive (BAP) tags, active tags.

2. REQUIREMENTS

RFID and 2D Barcode discussed in this document shall follow ATA SPEC2000 Chapter 9-4 and 9-5. Whenever possible, both technologies should be used to benefit the airline usage. 2D barcode ISO/IEC15434 syntax is used for Military industry only and is not accepted in civil aviation.

2.1 TAG REQUIREMENTS
The RFID tag shall:
- Satisfy read distance performance defined in section 4 and 7
- Be ISO 18000-6C and GS1/EPC Gen 2 UHF compliant
- Ensure Construct 1 schemas is used with UID

- Have 2D barcode and Human Readable Information (HRI) printed on the RFID tag when tag dimensions allow. (i.e. 0.75"(H) x 0.75"(W) minimum for 2D barcode only, 0.75" (H) x 1.25" (W) for HRI and 2D barcode)
- Have structured data and associated barcode that comply with ATA SPEC2000 Chapter 9 (latest revision) data formatting standard
- Be designed to remain attached to the part for its serviceable life unless specific instructions for removal and replacement are provided in the CMM during overhaul or maintenance tasks that would degrade/destroy the tag
- Only one RFID tag should be applied to each component if installed by OAM/OEM
- Employ a cycle redundancy check (CRC) for Data Verification and therefore have the CRC indicator set to 1 (True)

The RFID tag shall NOT:
- Change form, fit, function or impede operation of the equipment
- Use Construct 2 schemas with UID
- Have 2D barcode on the RFID tag encoded in the ISO/IEC15434 syntax.
- Have a Permalock block size larger than 2 words (=32bits) for a tag that will use 16-bit addressing, or larger than 1 word (=16bits) for a tag that will use 32-bit addressing, that or leaves no extraneous null characters embedded within the record descriptor data area of the tag (Applicable to Multi-Record RFID tag only)
- Roll the part number due to presence of an RFID tag or 2D barcode (airline requirement)

2D Barcode Tag shall:
- Satisfy requirements as per ATA SPEC2000 Chapter 9-4
- Be printed with high contrast (e.g. Silver or White label with black ink, laser etch not preferred)
- Have only one 2D barcode

2D Barcode Tag shall NOT:
- Follow ISO/IEC15434 syntax
- Be covered with any other labels, clamps, or brackets after installed
- Have the data specified in this requirement encoded over multiple 2D barcodes on the component

2.2 FEDERAL AVIATION ADMINISTRATION GUIDANCE
- The part number should not roll due to presence of an RFID tag [reference AC 20-162A]
- The part number should not roll by adding 2D barcode on the TSO label [per FAA]

- Adding an RFID tag to an existing certified component is considered a minor modification [AC 20-162A]
- Tags added to parts can be considered ancillary part marking if the TSO data plate is present [AC 20-162A]
- Passive RFID tags used for ancillary part marking should meet the flammability requirements of RTCA/DO-160, Section 26, which includes small parts exemption.
- If integrated data plates applied to parts, the human readable is considered the primary part mark and the RFID piece is considered ancillary [reference AC 20-162A]

2.3 OTHER GUIDANCE

- If integrated data plates applied to parts, the human readable is considered the primary part mark and the RFID piece is considered ancillary [reference SAE AS5678A]

3. RFID TAG TYPES

The ATA SPEC2000 Chapter 9-5 covers 4 different RFID tag types; the Single-Record Utility Tag (often referenced as "Legacy Tag" because of its use by operators to tag their equipment), Single-Record Birth Tag, the Dual-Record Tag, and Multi-Record Tag.

Airlines require OEM to utilize high-performance (low memory solution) using the Single-Record Birth Tag (~ 512 bit) format contains a non-rewritable part identification record, e.g. birth record, if data size permit. The Single Record Utility Tag (~512 bit) contains the ATA EPC along with a user memory area where birth record can be stored for components airlines already own or installed on the aircraft. When minimum required birth record cannot be fit into 512 bit, Airlines authorize OEM to use 1k ~ 2k memory size in Single or Dual-record format Tag.

3.1 HIGH PERFOMANCE SOLUTION

Whether the archiving of historical records is necessary or not, high-performance/low memory solutions can be used on most aircraft parts. Low memory tags are the preferred and most commonly used by the operators to identify and track aircraft equipment (expendable, repairable, and/or rotable) due to read distance and speed performance. The Single-Record Tag is a low memory solution designed to provide static part identification (birth record). The Dual-Record tag is another low memory solution designed to provide static part identification (birth record) and life cycle information. However, the Dual-Record tag can be applied to specific items that require an updated Lifecycle record. Updating data on tags is expensive and error-prone for operators and avoided when possible.

3.2 LOW PEFORMANCE SOLUTION

The low-performance/High Memory solution is not currently supported by airlines communities and it is

NOT the preferred RFID tag type to be installed by OEM regardless of component value, type or life expectancy. High memory solutions could be beneficial when:

- All parties who touch the part in aviation industry successfully obtained ability to read, write, and maintain the maintenance history on the tag
- Every regulatory agencies approve and recognize the maintenance history stored in the RFID tag can be used as a primary record
- Capability of data synchronization between system of record and the tag has been established
- The tag read/write interoperability standards issues have been resolved

4. TAG PERFORMANCE REQUIREMENTS

The most important RFID tag performance factor for Airlines is Read Distance. This leverages one of the most important aspects of RFID technology – the ability to read hundreds of tags per second in the tag-rich environments without the time-consuming need to gain access or provide direct line-of-sight to the part. Desired minimum read distance of 4.5m/15ft for parts which have frequent inspections for presence, expiration date, and/or inventory adjustment etc. (e.g. Slides, Rafts, Life Vests, O2 Generators, Seat Assemblies, Oven, IFE). Desired minimum read distance of 1.5m/5ft is for parts with low removal rates (e.g. Flight Instruments, Components installed in Engine cowl)

4.1 TAG READ RANGE

- Minimum read range: 4.5m/15ft on metallic (metal-mount tags) or non-metallic surfaces (non-metal mount tags) for full EPC memory bank read
- Minimum read/write ranges shall be attained with the RFID tag attached to the installed component on an aircraft in the final configuration or a representative mock-up of the final aircraft configuration
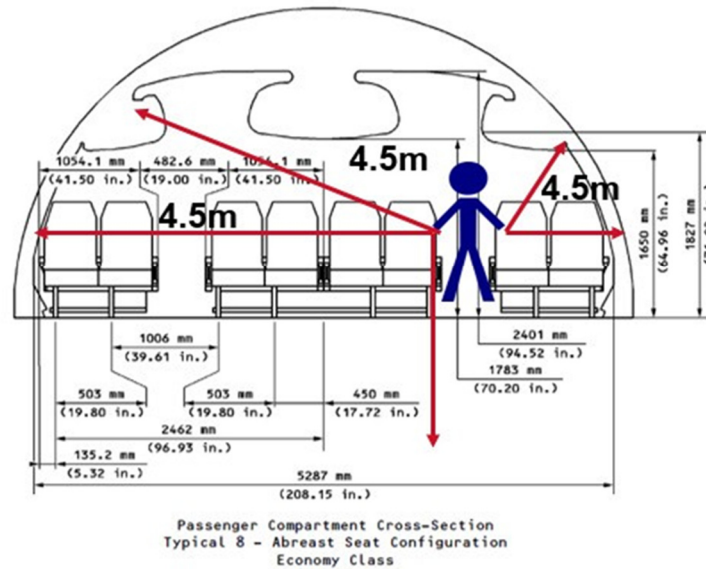
Figure 1: Minimum required read range of the Emergency Equipment RFID tags inside of a Boeing – 777

4.2 TAG WRITE RATE

Minimum write range: 0.5m/1.5ft on metallic (metal-mount tags) or non-metallic surfaces (non-metal mount tags) for full EPC number write.

4.3 READ/WRITE DATA RATE

Minimum rate shall be 40 to 640 Kbits/second, per EPC global standard.

4.4 TAG QUALITY

It is critical to make sure that the performance is not just demonstrated on small quantities of tags at one instance. It should be consistent over time and larger volume. The RFID tag and chip supplier should have strong and comprehensive Quality Management System (QMS) that covers all the critical aspects of the design, manufacturing, and distribution of RFID tags to deliver consistency and reliability over time. The variation of sensitivity should be within 4 dB (+-2 dB) for any tag model (see figure 2).

- RFID tags shall be submitted to Auburn University for testing (See Appendix A)
- Tags that meet Quality/Performance requirement are added to approved tag list
- Suppliers shall use RFID tags that are constructed with inlays from the approved tag list. (See Appendix A)

If the RFID tag currently used is not constructed with inlays from the approved tag list, OEM shall require its tag suppliers to get their tag tested at Auburn University Lab.

If the tag does not meet the performance and quality requirement, OEM shall require RFID tag supplier to find an alternate RFID tag from the approved list.

If an approved RFID tag is not offered by an OAM-approved RFID tag suppliers, the OAM shall allow OEM to use an RFID tag selected from the approved RFID tag list (Which may be a non-OAM approved RFID tag supplier).

Figure 2: Illustration of RFID tag Quality

5. TAG DATA REQUIREMENTS

For companies who serialize uniquely within their CAGE code (commercial aviation preferred, also called UID Construct 1), a zero-length string shall be used to delimit the beginning of the serial number, meaning the part number is not part of the unique identity and is not present in the EPC header.

- Tag data shall follow ATA SPEC2000 Chapter 9-5 unless defined in section 6
- Tag EPC Header shall follow ATA SPEC2000 Chapter 9-5 using SER (Construct 1 – serial number unique within Manager Number/CAGE code) for serialized parts unless supplier/operational restriction
- OAM shall perform QA audit on both RFID and 2D barcode data accuracy through FAI process on SFE parts
- Employ a cycle redundancy check (CRC) for Data Verification and therefore have the CRC indicator set to 1 (True)

EPC Header (req'd)	Filter Value (req'd)	Manager number: CAGE Code (req'd)	Original Part Number (PNO) (conditional)	Terminator (req'd)	Serial number (SER, SEQ, UCN) (req'd)	Terminator (req'd)
Fixed 8-bit value is assigned by GS1, specifically: 0011 1011	See Filter Value section below	A Space and 5-character CAGE Code, or 6 character DODAAC (military)	Up to 32 alphanumeric characters, but excluded for Construct 1 serializations	00 0000	Up to 30 alphanumeric characters	00 0000

Figure 3: EPC Header graphic – ATA SPEC2000 Chapter 9

6. TEXT ELEMENT IDENTIFIERS (TEIs)

For all RFID tagged aircraft components except items listed in 7.1 - 7.7, RFID /2D barcode tag must contain the following minimum data using the ATA SPEC2000 text element identifiers (TEIs);

- Cage Code (MFR or SPL)
- Serial Number (SER, SEQ, UCN), SEQ can be used by Non-OEM only
- Original Manufacturer Part Number (PNO)
- Date of Manufacture (DMF)
- Service Life Expiration Date (EXP) – Conditional
- Date of Last Hydrostatic Test Date (DOH) – Conditional
- Date of Next Hydrostatic Test Date (DNH) – Conditional (Approval Pending)
- Lot Number (LOT, LTN) – If applicable
- Part Modification Level (PML) – Conditional
- Customer PO# (CPO) - Conditional

   NOTE 1: All dates must be written in YYYYMMDD format, defaulted to the last DAY of the month if the item does not EXP on a specific calendar day.

   NOTE 2: 2D Barcode encoding data example:
   MFR xxxxx*PNO 123456789*SER yyyyyyyy*DMF YYYYMMDD*EXP YYYYMMDD*LOT zzzzzzzz

7. TAG POSITIONING

- The RFID tag should generally not be visible to passengers, but still easily read by maintenance personnel
- The RFID tag associated to the tracked assembly shall be installed on the structure of the core component and not on removable/replaceable parts
- The RFID tag shall not impede emergency equipment function(s)

7.1 OXYGEN GENERATORS

Due to numerous installation variations (e.g. heat shield, clamps, positioning), and to maximize read distance, If shipped at component level, RFID tag shall not be permanently affixed on to O2 generator prior to final installation in PSU/ASU/Lavatory Assembly by OEM. It should be attached only after the generator is in its final positon and with consideration for any RFID-challenging assembly designs.

NOTE: OEM should design PSU assembly with RFID friendly material in the future if not currently doing so. It is strongly encouraged to avoid design with the complete metal PSU enclosure. Avoid RFID-unfriendly enclosure material PSU/ASU/Lavatory Assembly box design.

O2 generator shall be delivered as follows:

1. For new aircraft at delivery:

- OAM to submit CR to OEM if RFID tag installation requirement is not yet implemented at the O2 generator level
- Single Memory Birth Record RFID tag shall be installed/attached on the O2 generator itself by OEM prior to delivery to OAM
- If O2 generator is shipped as part of PSU/ASU/Lavatory Assembly, an appropriately-designed RFID tag that allows for maximum read distance must be installed on O2 generator.
- Multi-Record RFID tag shall not be used
- RFID tag for PSU/ASU assembly is optional, however, Spec2000 ch9-4 properly encoded 2D barcode is required
- OAM shall perform QA audit on both RFID and 2D barcode data accuracy through FAI process on SFE parts

2. For aftermarket RFID tagging:

- Single Memory Birth Record RFID tag shall be provided by OEM if birth record data size allows
- RFID tag shall be temporarily attached to O2 generator (e.g. rubber band, taped) during shipping so that the tag will not be easily separated from the component
- Multi-Record RFID tag shall not be used
- Installer will permanently attach the RFID tag when O2 generator is installed
- Installer is responsible to ensure the tag will not impede functionality of the component such as prevent masks from dropping
- RFID Tag should be encoded with following TEIs:
  a.   Cage Code (MFR or SPL)

b.   Original Manufacturer Part Number (PNO)

c.   Serial Number (SER)

d.   Date of Manufacture (DMF)

▪ 2D Barcode on the Part label should be encoded with following TEIs:

a.   Cage Code (MFR or SPL)

e.   Original Manufacturer Part Number (PNO)

f.   Serial Number (SER)

g.   Date of Manufacture (DMF)

b.   Hazardous Code (HAZ) - Optional

c.   Lot Number (LOT) - Optional

7.2 LIFE VESTS

Life vest reading on aircraft is somewhat dependent of seat structure and placement of vest relative to metal parts, so in-situ testing (trial-and-error) may be required for consistent reads.

▪ OEM permanently attaches RFID tag to life vest in position capable of being read when installed (RFID tag installed within sealed packaging is considered permanently installed)

▪ Highly recommend that RFID tag be installed inside of closed life vest pouch if clear plastic pouch used

▪ Highly recommended that the RFID tag is installed within the sealed packaging of the life vest with special consideration to not damage the tag during packing or sealing.

▪ For RFID tags that are clearly visible when sealed, the HRI and 2D barcode must also be visible/readable through the packaging

▪ For RFID tags that are not clearly visible when sealed, the HRI and 2D barcode must be placed in a readable location on the sealing packaging.

▪ Ensure whole RFID tag with HRI and 2D barcode is visible/readable from one angle/side

▪ For life vests that are vacuum sealed, testing for 4.5m read range is advised after sealed

▪ RFID Tag should be encoded with following TEIs:

a.   Cage Code (MFR or SPL)

b.   Original Manufacturer Part Number (PNO)

c.   Serial Number (SER)

d.   Date of Manufacture (DMF)

▪ 2D Barcode on the Part label should be encoded with following TEIs:

a.   Cage Code (MFR or SPL)

b.   Original Manufacturer Part Number (PNO)

    c.   Serial Number (SER)

    d.   Date of Manufacture (DMF)

    e.   Service Life (Overhaul Due) Expiration Date (EXP) – Conditional

    f.   Lot Number (LOT) - Conditional

7.3 Crew and Portable Oxygen Bottles

Often OEM performs hydrostatic test before they assemble the unit with pressure gauge etc. Therefore, last hydro tested date on new bottle may be older than DMF printed by OEM. Errors may occur when components are supplied with multiple part markings without clear description of what the marking is for or if labels are not installed side by side. Most bottles are life-limited and require hydrostatic testing to be performed per OEM recommended cycle.

Also, make sure OEM installed placard will always face forward once pressure gauge is assembled and installed on the AC If possible, placards should be oriented in an accessible manner.

- RFID Tag should be encoded with following TEIs:
    - a.   Cage Code (MFR or SPL)
    - b.   Original Manufacturer Part Number (Final Assembled) (PNO)
    - c.   Serial Number (Final Assembled) (SER)
    - d.   Date of Manufacture (DMF)
    - e.   Last Hydro Test Date (DOH)
    - f.   Next Hydro Test Date (DNH) – TEI Approval Pending
- 2D Barcode on the Part label should be encoded with following TEIs:
    - a.   Cage Code (MFR or SPL)
    - b.   Original Manufacturer Part Number (Final Assembled) (PNO)
    - c.   Serial Number (Final Assembled) (SER)
    - d.   Date of Manufacture (DMF)
    - e.   Last Hydro Test Date (DOH)
    - g.   Next Hydro Test Date (DNH) – TEI Approval Pending
    - h.   Lot Number (LOT) if applicable

Figure 4   Figure 5

Figure 4 Good example vs. Figure 5 Not recommended part marking

NOTE: Figure 5 image viewed through inspection mirror)

7.4 Seat Belt Inflator bottle and Electronic Module Assembly (EMA)

RFID tag read performance of inflator and EMA on aircraft will depend on seat structure and installation method of the parts. Therefore, reaching acceptable read distance may be challenging.

For Inflator bottle, due to multiple install orientation method, multiple part markings with 2D Barcode are necessary are necessary. RFID tag and/or 2D Barcode label shall be replaced with new tag/label when components are overhauled.

RFID/2D Barcode tag on seat belt, EMA, and inflator should be encoded with following TEIs at the assembly level;

  a. Cage Code (MFR or SPL)
  b. Original Manufacturer Part Number (PNO)
  c. Serial Number (SER)
  d. Date of Manufacture (DMF)
  e. Service Life (Overhaul Due) Expiration Date (EXP)
  f. Lot Number (LOT, LTN) – Conditional

7.5 SEATBELTS

RFID tag read performance of seatbelt on aircraft will dependent of seat structure or the placement of the

parts. Therefore, reaching primal read distance may be challenging.

- RFID/2D Barcode tag on seat belt, EMA, and inflator should be encoded with following TEIs at the assembly level;
  a. Cage Code (MFR or SPL)
  b. Original Manufacturer Part Number (PNO)
  c. Serial Number (SER)
  d. Date of Manufacture (DMF)
  e. Service Life (Overhaul Due) Expiration Date (EXP)
  f. Lot Number (LOT, LTN) – Conditional

7.6 SLIDES & LIFE RAFTS

Slides and rafts often come with multiple time-controlled/life-limited subcomponents. Often, maintenance programs differ based on fleet type and/or operator. It is necessary to capture the component birth record of each time-controlled or life-limited subcomponent when slides and life rafts are installed on the aircraft. RFID tag and/or 2D Barcode label shall be replaced with new tag/label when components are overhauled.

- RFID/2D Barcode tag on Slides and Raft should be encoded with following TEIs at the assembly level:
  a. Cage Code (MFR or SPL)
  b. Original Manufacturer Part Number (PNO)
  c. Serial Number (SER)
  d. Date of Manufacture (DMF)
  e. Customer PO# (CPO) – Conditional
  f. Lot Number (LOT, LTN) – Conditional
  g. Part Modification Level (PML) – Conditional

- OEM to list subcomponents' birth records in both HRI and 2D data matrix format on 8130-3 in block 12 Remarks section (see example below)
- Installed using following TEIs;
  a. Cage Code (MFR or SPL)
  b. Original Manufacturer Part Number (PNO)
  c. Serial Number (SER)
  d. Date of Manufacture (DMF)
  e. Service Life Expiration Date (EXP)
  f. Date of Hydrostatic Test (DOH)
  g. Customer PO# (CPO) – Conditional

h.   Lot Number (LOT, LTN) – Conditional

i.   Part Modification Level (PML) – Conditional


1. Approving Civil Aviation Authority/Country: FAA/United States	2. **AUTHORIZED RELEASE CERTIFICATE** FAA Form 8130-3, AIRWORTHINESS APPROVAL TAG		3. Form Tracking Number: 0000497244
4. Organization Name and Address:			5. Work Order/Contract/Invoice No. 0000000001 / 123456789

6. Item:	7. Description:	8. Part Number:	9. Quantity:	10. Serial Number	11. Status/Work:
1	SLIDE/RAFT, 777-200LR DOOR2	65342-220	1	0001	Overhaule ▾

12. Remarks:

Inspected and overhauled in accordance with OEM CMM 25-61-41 Rev11 with applicable xxxxx Supplemental information Rev.14, PUB 37390

Slide PNO 65342-220 (should be same as cell#8) / SER 0001 (Same as cell#10) / EXP 20210224 (means 24 FEB 2021)

Cylinder: MFR xxxxx/PNO xxxxxxxxxx/SER 11111/ DMF 122008/ DOH 022018/ EXP122023

Battery: MFR xxxxx/PNO xxxxxxxxxx/ SER 22222/ Exp 082022

Inflatable: MFR xxxxx/PNO xxxxxxxxxx/SER 3333/ DMF 032009

13a. Certifies that the items identified above were manufactured in conformity to:	14a. [X] 14 CFR 43.9 Return to Service [X] Other regulation specified in Block 12
☐ Approved design data and are in a condition for safe operation. ☐ Non-approved design data specified in Block 12.	Certifies that unless otherwise specified in Block 12, the work identified in Block 11 and described in Block 12 was accomplished in accordance with Title 14, Code of Federal Regulations, part 43 and in respect to that work, the items are approved for return to service.

13b. Authorized Signature:	13c. Approval/Authorization No.:	14b. Authorized Signature:	14c. Approval/Certificate No.:
13d. Name (Typed or Printed):	13e. Date (dd/mmm/yyyy):	14d. Name (Typed or Printed):	14e. Date (dd/mmm/yyyy):

User/Installer Responsibilities

It is important to understand that the existence of this document alone does not automatically constitute authority to install the aircraft engine/propellor/article.

Where the user/installer performs work in accordance with the national regulations of an airworthiness authority different than the airworthiness authority of the country specified in Block 1, it is essential that the user/installer ensures that his/her airworthiness authority accepts aircraft engine/propellor/article from the airworthiness authority of the country specified in Block 1.

Statements in Blocks 13a and 14a do not constitute installation certification. In all cases, aircraft maintenance records must contain an installation certification issued in accordance with the national regulations by the user/installer before the aircraft may be flown.

FAA Form 8130-3 (2-14)   N SN: 0052-00-012-9005

Figure 6: 8130-3 Form sample

▪ OEM to list subcomponents' birth records in both HRI and 2D data matrix format on maintenance history card installed using following TEIs;

a.   Cage Code (MFR or SPL)

b.   Original Manufacturer Part Number (PNO)

c.   Serial Number (SER)

d.   Date of Manufacture (DMF)

e.   Service Life Expiration Date (EXP) – Conditional

f.   Date of Hydrostatic Test (DOH) – Conditional

Slide Assembly
(MFR 12345/PNO 62773-319/SER 0645/DMF 20000531)

Reservoir
(MFR 12345/PNO B66043-5/SER ALT941-174/DMF 20120731/DOH 20150731)

Battery (MFR 12345/PNO 64062-1/LOT 9692/SER 27914/EXP 20191031)

Figure 6: Mtc. History card sample

7.7 SEAT ASSEMBLY

- The "Seat Assembly" RFID tag shall be installed on the seat core structure (other subcomponents are removed/replaced which would remove the assembly tagging)
- The "Seat Assembly" RFID tag shall be installed on the same component as the TSO label(s) and Seat Assembly Data Plate
- All RFID tags and 2D barcodes (Seat Assembly tag, subcomponent tags, and TSO label) shall be encoded per Spec2000 and section 2 of this document
  a. P/N roll is not required when adding 2D Barcode to TSO label/Part Marking label per FAA
  b. Subcomponent part marking shall have 2D Barcode
- Seat design shall consider and incorporate RFID friendly materials, particularly for seat pan/diaphragm and live vest box/pouch
- RFID tag and/or 2D Barcode label shall be replaced with new tag/label when components are overhauled.

7.8 SERIALIZED COMPONENTS

- RFID tag shall be installed on non-removable location and not on doors, etc.

- RFID tag and/or 2D Barcode label shall be replaced with new tag/label when components are overhauled.
  a. If the Component is an assembly of sub-components the RFID Tag must be installed on the same component as the assembly data plate. If sub components have RFID tags or 2D barcodes they too shall be encoded per Spec2000 and section 2 of this document.
  b. TSO label/Part marking label to include 2D barcode. P/N roll is not required when adding 2D Barcode to TSO label/Part Marking label per FAA

7.9 OTHER FREQUENT VISUAL INSPECTION PARTS
- RFID tag shall be installed on non-removable location and not on doors, etc.
- RFID tag and/or 2D Barcode label shall be replaced with new tag/label when components are overhauled.
- All piece components must have RFID tag (e.g. seat harness, armrest, etc.) or 2D barcodes that are encoded per ATA SPEC2000 Chapter 9-4
  a. Cage Code (MFR or SPL)
  b. Original Manufacturer Part Number (PNO)
  c. Serial Number (SER)
  d. Date of Manufacture (DMF)
  e. Service Life Expiration Date (EXP)
  f. Date of Hydrostatic Test (DOH)
  g. Customer PO# (CPO) – If applicable
  h. Lot Number (LOT, LTN) – If applicable
  i. Part Modification Level (PML) – If applicable
- Examples of these parts would be: megaphone, flash light, halon, medical kits and etc.
- All relative part marking have to be combined or installed side by side that can be seen from same angle installed

Figure 7: Fixed ELT Part Making   Figure 8: Fixed ELT Battery Marking

NOTE: Figure 7 and 8 shows example of unacceptable part marking method. Battery expiration date (figure 8) should be part of the main part marking label shown in figure 7

8. TAMPER EVIDENT SECURITY SEALS

The RFID security seal program was designed to satisfy TSA-mandated cabin security search of locations on the aircraft that could house contraband. Common use of tamper evidence tag/seal is to affix them in such a manner as to electronically or visually indicate   tamper evidence. Depending on the software and seal design, an RFID security seal/padlock is installed properly and was damaged or broken due to tampering, the RF signal response from the seal will be either greatly reduced or will report a "tampered" status byte when interrogated   The scan result can be addressed per the operators' procedures and policies.

8.1 RFID SECURITY SEAL DESIGN

Security Seal Design should be defined by operator
- Physical tag dimensions
- The tag installation method
- The tag material (e.g. Color, Artwork)

8.3 RECOMMENDED TAG SECURITY FEATURES

- The RFID chip may be encoded with security features to indicate that a tag has been broken, damaged, or tampered using GS1 EPC Gen 2 UHF compliant software
- The tag must show visual signs (non-RFID) of tamper evidence and prevent the seal from being reattached and secured again.

More guidance from TSA on acceptable means of compliance is needed.

9. ATA SPEC 2000 RFID CONFORMANCE PROGRAM

The RFID Lab at Auburn University is in the process of establishing an ATA Spec2000 conformance program to ensure both hardware and software used in aviation industry are interoperable. The use of passive Radio Frequency Identification (RFID) as a means for digital part identification has gained significant adoption in Aviation To ensure global interoperability, the ATA/IATA industry group has agreed that that the hardware and software should be compliant to the following two standards:

- GS1 EPC Class 1 Gen 2, ISO/IEC 18000-6C, standard for the air interface protocol between tags and readers

- ATA Spec 2000 Chapter 9-5 RFID on Parts standard for the readability of the data on the tags, and the required data content to carry out business operations

The conformance program will be deployed in three stages. Stage 1 will certify the RFID data encoding software as compliant to ATA Spec 2000 RFID Chapter 9-5 requirements. This will be done when there is a revised version of Spec2000 Ch. 9-5, new encoding software, or new RFID chip. Stage 2 will involve performing First article inspection on new suppliers and/or part. Stage 3 will involve performing Audits during various stages of deployment.

10. ACRONYMS

Acronym	Definition
1D	One Dimensional
2D	Two Dimensional
A/C	Aircraft
AIT	Automated Identification Technology (AIT)
ATA	Airline Transport Association (now referred to as A4A – Airlines for America)
CFR	Code of Federal Regulations
DMF	Date of Manufacture
DoD	Department of Defense
EMA	Electronic Module Assembly
EPC	Electronic Product Code
EXP	Expiration Date
FAA	Federal Aviation Administration
FAI	First Article Inspection
HRI	Human Readable Interface
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO/IEC15434	specification and syntax for automatic identification
LOPA	Layout of Passenger Accommodations
MFR	Manufacturer
MSN	Manufacturer Serial Number
NHA	Next Higher Assembly
O2	Oxygen Generator
OAM	Original Airframe Manufacturer
OEM	Original Equipment Manufacturer
P/N	Part Number
PNO	Original Part Number
PNR	Revised Part Number
QR	Quick Response Code
RF	Radio Frequency

RFID	Radio Frequency Identification
RTCA	Radio Technical Commission for Aeronautics
S2K	ATA Spec 2000
SAE	Society of Automotive Engineers (now referred to as SAE International)
TBD	To Be Determined
TEI	Text Element Identifiers
ToC	Table of Contents
TBD	Technical Operations Policy and Procedures
UHF	Ultra-High Frequency
UID	Unique Identification

11. DEFINITIONS

- **2D Barcode Data Matrix**: A two-dimensional barcode consisting of black and white "cells" or modules arranged in either a square or rectangular pattern. The information to be encoded can be text or numeric data, and the usual data size is from a few bytes up to 1556 bytes

- **Aircraft Part**: An article or component approved for installation on a Part 121 type certificated aircraft.

- **Barcode**: A form of automated identification technology (AIT) used to identify items based on lines of varying widths and spacing that are visually read by a scanner or reader.

- **Backscatter**: The reflected radio frequency (RF) energy that is modulated by an RFID chip and antenna. The RFID scanner then interprets the backscatter to read the RFID tag information. RF energy, which is not modulated, is considered reflected rather than backscatter.

- **Chip**: This refers to the integrated circuit of the RFID tag. The RFID chip is the "brain" that modulates reflected RF power to transmit data back to an RFID scanner or reader.

- **Conditional**: If information is available, and the data may impact the life cycle of the component

- **Emergency Equipment** (EE): Approved items installed on the aircraft to preserve the safety of passengers and crew. Emergency equipment items typically include passenger oxygen equipment, portable medical equipment, and portable fire extinguishers that are replaced after usage.

- **Expendables**: Non-repairable aircraft components. Nuts and bolts are excluded as expendables in this spec.

- **Human Readable** (HRI): Information printed in a manner which can be read and interpreted naturally by humans. Examples include the date of manufacture printed on an OEM part marking or a serial number printed below a 1D barcode.

- **Inlay**: Referred to as the chip and antenna assembly on an RFID tag.
- **Legacy Tagging**: Installing ancillary RFID tag on the component other than original manufacturer
- **Machine Readable**: Information encoded in a form which can be read and interpreted by a computer or machine and its installed software. Examples of machine readable technology include 1D and 2D barcodes and RFID chips. Machine readable technology typically uses human readable print as a backup if the machine readable format cannot be read or interpreted.
- **Non-Repairable**: Non-repairable components are aircraft parts, which do not require restoring to serviceability by replacing or processing failed or damaged parts. Parts which are not normally repaired to fully serviceable condition. Non-repairables can include rotable parts, which are serialized or expendable parts. Typical items are: emergency equipment, life vests, squibs, oxygen masks, and oxygen generators.
- **Optional**: Data element that that added to the tag if memory size allow
- **Passive**: RFID tags that contain no internal power source (e.g. batteries). Passive RFID tags wait for an interrogating signal from an RFID reader. The tag draws enough energy from the interrogating signal to transmit a return signal back to the RFID reader.
- **Radio Frequency Identification**: A form of automated identification technology (AIT) used to identify and track tagged parts using non-line of sight transmission of radio frequency (RF) signals between a radio transmitter/receiver (scanner) and an ID chip.
- **Read Range**: Read range is defined as the distance at which the RFID tag can return correct information to the interrogator device, and can be influenced by many factors such as tag shape, antenna orientation, power of the interrogator, material to which it is installed, and the environment it is in
- **Repair/Repaired**: To restore an item serviceable by replacing or processing failed or damaged parts.
- **Repairable**: Part/Material with detail parts breakdown, applied to assemblies which are economically repairable and in the normal course of operations are periodically rehabilitated to fully serviceable condition over a period of less than the life of the flight equipment to which they are related. Repairable items are depreciated as a part of the flight equipment to which they are related. Typical items are: Valve assemblies, rod assemblies, bracket assemblies, pulley assemblies, and link assemblies, etc.
- **Rotable**: Parts/materials usually of a complex design and/or containing many integral parts/materials. These parts/materials have specific needs or requirements to track time and location at a serialized level. They are economically repairable and, in the normal course of operations, are periodically rehabilitated to a fully serviceable condition over a period approximating the life of the flight equipment to which they are related. They must be serialized or have the capability to become serialized. Typical items are: engines, APUs, landing gear assemblies, CSD computers, generators.
- **Scanner**: Any device which is capable of reading a combination of 1D barcodes, 2D barcodes, RFID, or a combination of the three. Scanners without imaging devices cannot read 2D barcodes. Scanners

without an RFID antenna cannot read or write to RFID tags. The terms "scanner," "reader," or "interrogator" may be used interchangeably in this document.

- **UHF**: Ultra-High Frequency RFID systems operate at multiple frequencies, including 868 MHz in Europe, 915 MHz in the U.S., and 953 MHz in Japan. UHF RFID systems typically utilize the 860 MHz to 960 MHz frequency band to take full advantage of worldwide operating frequencies.

12. REFERENCES

These are the references to various documents referred to in the paper. The first two references are free and available online. The Spec 2000 standard is available free of charge for ATA e-Business Program members online, and available for purchase by non-members. The AS5678A standard is available for purchase at the link below:

- FAA Advisory Circular 20-162A "Airworthiness Approval of Installed Passive Ultra High Frequency (UHF) Radio Frequency Identification (RFID) Tags"
- https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_20-162A.pdf
- FAA Advisory Circular 119-2 " Operational Use of Radio Frequency Identification Systems Onboard Aircraft"
- https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1031809
- SAE AS 5678A Specification http://standards.sae.org/as5678a/
- GS1/EPCglobal Tag Data Standard (TDS) http://www.gs1.org/gsmp/kc/epcglobal/tds/
- ATA e-Business Program "SPEC2000 Chapter 9-4 and 9-5" https://publications.airlines.org/CommerceProductDetail.aspx?Product=208
- Common Support Data Dictionary
- http://www.ahttps://publications.airlines.org/CommerceProductDetail.aspx?Product=243taebiz.org/specifications/

The information about IATA Airline RFID Interest Group (created in February 2012) and its members can be found by contacting IATA at psc@iata.org, or through the IATA Paperless Aircraft Operations web page at http://www.iata.org/pao.

13. APPENDIX A

RFID quality and performance testing is conducted at the inlay level. Inlay is defined as a combination of particular chip and antenna design. If either changes, the new combination needs to be re-certified.

Sensitivity is set at the 4 dB (+-2dB) for this testing. There is inherent variation present in the chip wafer, antenna, and the bonding process due to the fundamental technology limitations during the manufacturing of each of those components. It is difficult to produce a finished tag with less than the maximum tolerance of 4 dB without a significant increase in cost. A variation of more than 4 dB points could result in reliability issues.

- Process of RFID tag testing for quality and performance at Auburn University
  a. Submit a continuous roll of 2000 dry inlays and 2000 converted tags to the RFID Lab at Auburn University
     1. Shipping information and other submission information is available at
        https://rfid.auburn.edu/arc/AircraftCabin
  b. Upon submission of the tag, Auburn will add the tag to the testing queue. The testing will be performed in a reasonable amount of time based on the current testing queue. An estimate of time of testing completion will be sent to the manufacturer when the tag is submitted.
  c. If the tag meets the quality and performance requirements, the tag will be added to the appropriate approved tag list at https://rfid.auburn.edu/arc/AircraftCabin
  d. Inlays will be archived by Auburn after testing.
  e. A small fee to the inlay manufactures required for this testing. Contact RFIDlab@auburn.edu for cost
  f. AU will issue a certificate when inlays met the quality performance criteria. OEM should require RFID tag supplier to provide the certificate and it should be available for airlines or OAM per request