Suppliers Guide for Aviation RFID and Barcode Part Marking

An Easy Guide to the Industry Standards

Abstract

The aviation industry has had ATA part marking standards for 30+ years. This document provides a quick overview of the key part marking requirements

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Overview:

- **Purpose** – The purpose of this document is to provide suppliers an overview of aviation part marking using barcodes and RFID and how to implement it correctly to meet their own needs and customer's needs. These are the summary and views of what is important to know but is not exhaustive – reading the referenced material would be necessary for a full understanding.
- **Barcode Birth Record** data on parts/labels/data plates is a minimum requirement for the airlines. If your part is the type that airlines want to read quickly from a distance (e.g., most emergency equipment) they also want it to have an RFID tag. The RFID tag typically carries the 2D barcode and the human readable data, if space is available on the face of the tag.
- **Key requirements discussed:**
    - Spec2000 has defined data structure – follow it exactly!
    - Serialized parts – there are two ways to serialize your parts:
        - Unique serial number within your CAGE Code (Construct 1), and
        - Unique sequence number within part number within your CAGE Code (Construct 2).
        - These are different and needed for cradle-to-grave traceabililty of the part. Spec2000 data requires that you specify which one you are using – understand how you uniquely ID your parts via Construct 1 or 2!
- **Brief History** – the aviation industry has had a part marking specification since 1990. Usage of RFID part marking began in 2002 when Boeing had their first meeting with the FAA to discuss how they could go forward with using this technology safely and effectively. Within the ATA organization the standard started being developed in the 2003-2005 time frame with the first publication of ATA Spec2000 Chapter 9-5 RFID in 2006. In 2004, the ATA applied to the EPC Global organization to be assigned our own identifier number on RFID tags which would separate our needs, our data structure, and our process from other industries like retail, medical, logistics and agriculture. Because of the radical new approach we were taking with this standard UHF RFID technology it took 5 years to be approved by the international GS1 organization and it was approved in 2009 as the Aviation & Defense Indicator (ADI) data structure format.

In the beginning the industry was enamored with the 64KB high memory tag where lots of data could be stored, with the ultimate goal being to store the entire maintenance history of the aircraft part on the tag. It took a decade and some real world experience to realize the high memory tag, though possible and available, was not realistic in our business environments. This idea was not realistic because:

- tags are too expensive
- it takes a longer time to read/write to them (compared to small memory tags)
- high memory tags can only be read from a very close distance, losing a significant advantage of RFID
- the data would have come from mechanics typing data into a small keyboard on a handheld computer - a recipe for a lot of data mistakes to occur plus airlines do not want their mechanics spending their valuable time in that way
- data on the tag does not constitute a System of Record for that part as there is no way to know if a repair agency around the world overhauled the part but did not have RFID technology available to write that to the tag – data is incomplete and cannot be traced to find what repair is missing

In 2019 the ATA Spec2000 RFID Ch 9-5 has been re-structured (not changed significantly) to reflect the industries priorities today. Each company's System of Record for that part is still maintained on servers and the RFID tag is officially ancillary data (and not the System of Record). The industry focus is now on Single and Dual Record tags that meet the customer's needs for high reads rates at long distances and a simpler business process to implement and maintain. Airline operators will need to use these tags for the next couple decades so their RFID requirements are paramount.

- **Airline Customer RFID Preferences** – from an IATA RFID document (https://www.iata.org/whatwedo/ops-infra/Documents/RFID%20OEM%20Requirements_%20FINAL.pdf) the airlines have clearly stated their goals and preferences for how they are using RFID tags applied by suppliers (as well as themselves):
  - **High read rates** – the most frequent use of RFID on aircraft is to check that all emergency equipment is both present and not expired. These are safety and compliance issues that are top priorities among airlines. Currently we are aware of over 60 emergency equipment items in the aircraft cabin that have been RFID-tagged and they can be checked in less than a minute by walking down one aisle of a twin aisle aircraft with all the data being recorded and saved.
  - **Long read distances** – to increase the speed of reading airlines want the tags to read from 4.5m away as they walk through the aircraft. If they have to get very close to the tag to read it, they might as well read the barcoded data on the tag.
  - **Frequent check, high item count** – items that need to be RFID-tagged first are those that need to be read relatively frequently and that have a high item count on the aircraft – life vests, O2 generators, portable oxygen bottles,

medical kits, other emergency equipment, seats covers, seat belts are such examples. Other items that have a high turn rate like galley carts and security seals are also candidates for tagging. Some companies are even tagging new carpet pieces.

- **Minimal data entry, use 2D barcodes** – maintenance technicians have a job to accomplish and the airlines do not want them spending (much) time entering data into computers. The use of Spec2000 intelligent barcodes and RFID tags allows accurate data entry very quickly so the airlines want to use both those technologies to the fullest extent.

- **ATA Spec2000 Chapter 9-4 and 9-5** (http://www.ataebiz.org) – this is the specification that must be followed in aviation and is referenced by the FAA in several documents, discussed below. Chapter 9-4 defines the 2D barcode requirements (Unique ID and the Birth Record data) when applied to part marking (as well as other things like shipping labels). Chapter 9-5 is the specification for RFID part marking. The goal of this standard is to give each part a unique 'social security number' and provide part data interoperability between suppliers, airframers, airlines and MROs so that basic identity of the part is consistent and recordable including the CAGE Code of the company who made it, Part Number, Serial Number, and the Date of Manufacturer. With the application of this technology the whole supply chain can be better, faster, and cheaper in how we conduct our business without making the simple mistakes that take so much time to correct.

- **Aviation RFID Tags** – the Spec2000 defines three tag types – Single, Dual and Multi-Record tags. All aviation tags have four memory banks – Reserved, EPC, TID and User Memory banks. We use the EPC and User Memory banks only. The EPC bank holds the unique identity data and offers a very fast read rate. The User Memory holds, at a minimum, the Birth Record data of the part it is attached to but it requires a separate read command and is much slower to read. Single record tags are typically 512 -1000 bits of User Memory and read the longest distance – something the end customer airline wants very much. Dual record tags are typically 2 – 4 kilobits of User Memory and also read a long distance. Dual record tags have a locked User Memory section for the Birth Record data and also an open (writeable) Traceability section that more, and current, data can be written and re-written over time, like during future overhauls. Multi record tags have a lot of User Memory (typically 8 kilobytes to 64 kilobytes). These tags need a lot of energy to power up, have very short read ranges and are therefore not preferred.

    - Aviation tags have to meet the SAE AS 5678B requirements for data integrity and flammability standards. Known tag providers that can meet these standards are:

        - William Frick & Company (www.fricknet.com)
        - Fujitsu (http://www.fujitsu.com/global/solutions/business-technology/intelligent-society/ait/)

        - Brady Corp. (http://www.bradysmartid.com/aerospace)
        - Tego Inc. (www.tegoinc.com)

    - Aviation tags vary greatly in the size, shape and memory of the tag. Many are gummed label type that can go through desktop printers but others are the size of a domino and can only be encoded with a handheld reader. Some tags are designed to work on metal parts while others absolutely will not work at all on metal. For many emergency equipment parts in the cabin, airlines will zip-tie the RFID tag to, say, a metal fire extinguisher. Many/most life vests come with tags already applied. Oxygen Generators may come with the tag temporarily banded to the O2 Gen because applying it ahead of time may interfere with the hold down clamps on the fleet the airline is tagging. Ask your airline customers before you commit to a solution.

- **RFID Readers** – aviation has insisted on using standard, commercial (non-proprietary) handheld readers as we do not want to get locked into an expensive, proprietary hardware solution. Any commercial UHF RFID reader should be able to read an aviation RFID tag; not all readers can perform the Block Permalock functionality needed to lock the tags when writing them. Please ask if you have any questions. Some readers are all-in-one (reader, computer, communications); some are ruggedized against dropping; others are less expensive Bluetooth-connected RFID/barcode readers that use the computer/communications of smartphones and tablets to read tags on aircraft.

- **FAA guidance** (i.e., not regulation). The FAA has been very supportive and offered guidance for the use of RFID in our business processes. It is important to note that these are just guidance and not a regulation that must be followed. Beside ATA Spec2000 Ch 9-5 noted above, the FAA references other document to help the industry move forward with this technology implementation:
    - **SAE AS 5678B** – defines the requirements for RFID tags, currently in revision to become more practical for all to use
    - **AC 20-162B** – Airworthiness Approval of Installed Radio Frequency Identification (RFID) Tags and Sensors; key excerpts shown below
    - **AC 119-2** – Operational Use of Radio Frequency Identification Systems Onboard Aircraft; key excerpts shown below
    - **DO 160G** – the basic ‘shake’n’bake and flammability testing for all components
    - 14 CFR Parts 1, 21, 43, et al.
    - Production and Airworthiness Approvals, Part Marking, and Miscellaneous, Amendments; Final Rule, Oct 16, 2009

Referenced material – key points.

Shown below are key points copied from the documents that you should be aware of. Please reference the full document for a complete understanding.

Main take-always from above references:

1) RFID tags on aircraft emergency equipment are approved by the FAA/EASA and there are an estimated 2+ million tags currently installed and flying on aircraft around the world. Tags have been flying since at least 2009.
2) RFID tags may be installed by the OEM on new equipment or may be installed by operators on their existing installed equipment (called legacy tagging).
3) Tags are considered ancillary part marking (I.e., not the primary part mark) providing secondary - even if identical - information as the TSO data plate.
4) Adding an RFID or barcode tag to an item does not require a 'part number roll' or cause the part to be re-certified. If an RFID or barcode tag is to be added to an engineering drawing it is considered a 'less than minor' change and does not need FAA/EASA approval. A simple note on the drawing maybe all that is required.
5) Failure of the RFID or barcode tag on an item does not cause the item to become unserviceable.
6) FAA reference to ATA Spec2000 standard are in several of their Aircraft Circulars. See references at the end of this document.

What do you need to do as a supplier to the industry?

I cannot legally give you the ATA Spec2000 document but if your company is an ATA member you can easily download it for free from www.ataebiz.org. You can also check there to see if your company is an ATA member. What the airlines want from RFID and barcode data on the parts is explained in a published, free IATA document (https://www.iata.org/whatwedo/ops-infra/Documents/RFID%20OEM%20Requirements_%20FINAL.pdf) as well as Spec2000 Chapter 9-5.

The ATA Spec2000 standard wants, at a minimum, what we call the "birth record" data, consisting of:

- MFR XXXXX – XXXXX is the 5 character CAGE Code of the manufacturer
- SER YYYYYYYYY… – the unique serial # of this particular part
- PNO ZZZZZZZZZZ… - the part number of the new part
- DMF YYYYMMDD – the 8 numbers of the Year, Month, Day

Other data may be added as well if it makes sense for a particular part. e.g., if the part has an expiration date your airline customer will find that useful and/or they may specify that data be included. This data has the format of: EXP YYYYMMDD . Any additional data must be added after the Birth Record data.

All that data goes into a properly formatted Spec2000 2D barcode. There is a fair amount of technical detail implied behind these comments so that the data structure is exactly right. In the past, a text label with human readable data in any kind of format could be put on the part and humans could usually figure out which was the part number, the serial number and the date even if that data came in a variety of formats. Now there are industry data standards and the structure and format of the data has to be exactly right so machines (barcode/RFID readers) can read all the data in one beep and make sense of the data.

If you have not done RFID or barcode Spec2000 labels before, I will be glad to provide one hour of free phone consulting to help you get this right – contact email at bottom of page to arrange a call.

A few key points in this part marking effort are:

- ATA Spec2000 has a defined structure and must be followed exactly
  - The TEIs (Text Element Identifiers like MFR, SER, PNO, etc.) are 4 characters – 3 alpha characters and a single space
  - The data follows immediately after the space
- In the string of data that makes up how the barcode is printed, each piece of data is followed by a data delimiter separating one piece of data from the next - the character is an asterisks character, i.e. (*). The final piece of data should also have an asterisks character at the end.
- The 2D barcode symbology used is a Data Matrix ECC200. Any program that can create that 2D Data Matrix barcode will take the string of data fed to it and correctly create the 2D code.
  - The string of data would look like this:
    - MFR 12345*SER 98765-123*PNO ABC123-3*DMF 20190325*
    - You would substitute in your CAGE Code, Serial and Part Numbers
  - The data string is identical for both barcode data and the RFID data
- You can use your normal label design with your own data, logos, etc., and the addition of barcoded and/or RFID data the FAA approves as ‘ancillary part marking’ data that does not change the form, fit or function of the part and is considered a “less than minor” modification so the part does not need to be re-certified.
  - Here is a sample of what the airlines would like to see on the data plate:

MFR 12345
SER ABC123
PNO HN8345-234
DMF 20190325

- Additional data you and/or the customer want can be added in the same format after the four Birth Record data elements
- The ATA Spec2000 Common Source Data Dictionary (CSDD) defines all the approved data elements that might be used and includes the definition of the data as

well as the approved format. You must use one of the data elements defined in the CSDD – you cannot make up your own, they are part of the industry standard.
- If you do not have access to the CSDD please email/call me with what you want to do and I will help you accomplish it. (and yes, it is free for the first hour of my effort)

Links to 2D Data Matrix barcode printing solutions:

- Barcodes.com - https://barcode.com/bar-code-generator.html
- Bartender - https://www.bartendersoftware.com/software/features/barcode-software/
- Barcode-tec.it - https://barcode.tec-it.com/en/DataMatrix
- Barcode-soft - https://www.barcode-soft.com/datamatrix_font.aspx
- Zebra - https://www.zebra.com/content/dam/zebra_new_ia/en-us/solutions-verticals/product/Software/Printer%20Software/Link-OS/zebradesigner-software/zebradesigner-pro/spec-sheets/zebradesigner-pro-v2-fact-sheet-en-us.pdf

Spec2000 RFID encoding and barcode printing software:

There are only a few companies in the world who even offer aviation RFID solutions and some provide the complete interoperability the industry is looking for while others are more limited dealing only with their own tags or their own products. Because we are in a global industry where parts are manufactured in one country, assembled into aircraft in another country, flown by airlines all over the world and then repaired in other countries, the need for RFID software that works with all possible aviation tags is necessary.

Even though the airlines do not want the high memory tags (though there may be some niche, closed loop application where they are useful), some companies are still trying to sell them to suppliers but this is dying off until the read distance improves greatly.

Ensure that any solution that you select can create the kind of RFID tag you want to use on your part. Not all may be able to print a gummed label RFID tag or encode a high memory tag that is the size of a domino. You are encouraged to select a solution that can be integrated with your back office systems and/or minimize the typing involved as that is where most mistakes are made.

If you have questions about a tag or software vendor there is an independent 3rd party organization called Auburn University RFID Lab (https://rfid.auburn.edu/) who is supporting aviation's RFID efforts.

FAA references to ATA Spec2000 RFID standard:

From **AC 20-162B** (10/11/2018) : 6.2.4 RFID Data Format.

> **6.2.4 RFID Data Format**
> Using the automated identification and data capture standards identified in Airlines for America ATA Spec 2000 is one means to ensure data standardization and traceability supports the intended functions defined in this AC and AC 119-2. Applicants are not required to use ATA Spec 2000.
>
> **6.2.5** Unchanged Identification Record.
> Once the RFID tag is installed, there should be no means for the user to change the identification data contained on the RFID tag.
>
> **6.2.6** Part Number Revision for RFID Tag Addition.
> A part number "roll" or change is not required on parts, components and/or appliances for the installation of RFID tags or sensors used as alternative part marking means to meet the requirement of 14 CFR Part 45, Subpart B.

From **AC 119-2** (10/17/17):

> **2.** The Data Content and Format Standard. Airlines for America (A4A), formerly Air Transport Association of America (**ATA), Spec 2000**, E-Business Specification for Materiels Management, defines the requirements for data standardization for all RFID tag configurations. Because RFID-tagged components may be exchanged between operators through inventory pools or original equipment manufacturer (OEM) overhaul processes, no proprietary or otherwise sensitive data should be written to an RFID tag with the exception of the birth record of the part or component that must conform to the original, as delivered, data contained in the original park marking. Otherwise, the operator has sole discretion to write any additional data or information, as desired, for its particular maintenance or inspection program.
>
> **5.** Applications (descriptions abbreviated here):
> - Life Preserver Inspections
> - Life Preserver Containers
> - Oxygen Generators
> - Miscellaneous Cabin Safety Equipment
> - Aircraft Cabin Interiors and Furnishings
> - Aircraft Cabin Security
> - Repairable Exchange Components

[Ed. footnote: some airlines have tagged more than 60 different cabin components]

> **7.2 RFID-Enabled Aircraft Parts.** A part number "roll" or change is not required on parts, components, or appliances for RFID tag or sensor installation. Operators should consider developing a procedure to track RFID marked parts or components.

7.3 Changing Birth Record Data. Once installed, operators should not be able to change birth record data on the RFID tag. However, an operator may need to write additional part or component birth record data to the RFID tag in the event of a required maintenance activity that changes the part number. Refer to **ATA Spec 2000, chapter 9, section 9-5**.

8.8.4 Retention. Operators should note that data written to an RFID tag may stay with that tag for a part's life cycle, which may exceed 30 years. Data written to an RFID tag should be consistent with the format of, and limited in content to, **ATA Spec 2000, chapter 9**.

I hope this was helpful. Any questions can be answered by emailing me. Jon@TechSoln.com

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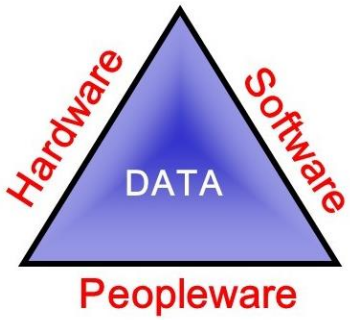

Technology Solutions was established in 1986 and been profitable every year since. We provide consulting to integrate business and technology into aviation, manufacturing, warehouse and hospital organizations through ourselves and selected partners. We can provide the complete Hardware – Software – Peopleware solution, or any individual piece.

The Principal, Jon Andresen, has a Master Degree in Mechanical Engineering from MIT, spent 17 years at United Airline Maintenance and consulted with major organizations like the DoD, Boeing, Honeywell, Logistics Management Institute, United Airlines, Delta Airlines and many others. Andresen was the primary architect and author of the ATA Spec2000 Barcode, RFID, and Traceability sections and has recently re-written the Barcode and RFID sections to make them more useful and readable. He has also participated in the creation of the IATA documents, the SAE and the FAA documents referenced. Having been at this for 30+ years, he is anxious for the industry to move toward more digitization (and less typing mistakes!) so that we can be working with clean business data. If interested, he can be available for onsite educational seminars or phone consultations.