U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Integrated Modular Avionics Development, Verification, Integration, and Approval Using RTCA/DO-297 and Technical Standard Order-C153

Date: 11/21/2013 **AC No:** 20-170
Initiated by: AIR-120 **Change:** 1

Purpose. This advisory circular (AC) sets forth an acceptable means of compliance for aircraft and engines that utilize Integrated Modular Avionics (IMA) systems. This AC calls out and supplements the guidance material of RTCA/DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*, dated November 8, 2005. This AC incorporates pertinent guidance material and information from AC 20-145, *Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements.* AC 20-145 is now cancelled.

Principal Changes. This change incorporates minor changes and updates, and a new appendix to AC 20-170. These changes are necessary in order to address incorrect references in RTCA/DO-297 when using SAE ARP 4754, Rev. A, which is recognized by AC 20-174. Information regarding whom you may contact with questions regarding the information in this AC, and where you may obtain a copy, are also included.

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Susan M Cabler

FOR David W. Hempe
Manager, Aircraft Engineering Division
Aircraft Certification Division

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Susan J. M. Cabler

FOR David W. Hempe
Manager, Aircraft Engineering Division
Aircraft Certification Division

Table of Contents

Chapter 1 RTCA-DO-297 as an Acceptable Means of Compliance.

1-1. Purpose of this AC.

a. This advisory circular (AC) shows you how to obtain Federal Aviation Administration (FAA) airworthiness approval for the development, verification, and integration of an integrated modular avionics (IMA) system for installation into an aircraft or engine. We cite RTCA, Inc. document RTCA/DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*, dated November 8, 2005 and supplement it with this text. This AC also provides guidance on how to show compliance with Technical Standard Order (TSO)-C153, *Integrated Modular Avionics Hardware Elements.*

b. This AC is not mandatory and does not constitute a regulation. In it, we describe an acceptable means, though it is not the only means, to obtain FAA approval of IMA systems.

c. This AC uses the terminology "should" when discussing compliance to the AC itself, as the AC represents one, but not the only, method of complying with the regulations. This AC uses the term "must" when discussing compliance to the regulations, as compliance to a regulation is not optional. In these cases, the AC text supplies a reference to the specific rule(s) being discussed.

1-2. Whom this AC Affects.

a. We wrote this AC for:

(1) Applicants for type certificates (TC), amended TC (ATC), supplemental TC (STC), or amended STC (ASTC) of aircraft and aircraft engines implementing IMA systems and equipment,

(2) Developers of IMA systems, applications, and components,

(3) Applicants for TSO-C153, *Integrated Modular Avionics Hardware Elements,* and for functional TSOs as they apply to IMA systems,

(4) Integrators of IMA systems,

(5) Installers of the IMA system into the aircraft, and

(6) Those involved in the approval and continued airworthiness of IMA systems.

b. When the term "applicant" is used in this AC, we are referring to the applicant for an aircraft or engine TC, STC, ATC, or ASTC. When this AC is referring to an applicant for a TSO authorization (TSOA), the phrase "applicant for TSO authorization" or other similar phrase is

used. When this AC is referring to an applicant for an IMA Component Acceptance Letter, the phrase "applicant for IMA Component Acceptance Letter" or other similar phrase is used.

1-3. Cancellation. This AC cancels AC 20-145, *Guidance for Integrated Modular Avionics (IMA) that Implement TSO-C153 Authorized Hardware Elements*, and incorporates all pertinent information from it that is not covered by RTCA/DO-297.

1-4. Using this AC and RTCA/DO-297.

a. The means in this AC are a complete method to show compliance and obtain approval of IMA components and systems for installation into an aircraft or engine. We intend that this AC be applied at the aircraft or engine level by the applicant for a TC, STC, ATC, or ASTC. That is, this AC is not intended as guidance solely for an IMA developer, IMA system integrator, or IMA application/component supplier.

b. If you are an applicant for an authorization for TSO-C153, *Integrated Modular Avionics Hardware Elements,* you may use the guidance in this AC as one acceptable means of compliance to requirements defined in TSO-C153. See paragraph 8-7 and appendix A of this AC for more information.

c. We find that the objectives, processes, and activities in RTCA/DO-297, plus the additional guidance material contained in this AC, constitute an acceptable means of compliance for the development, integration, verification, and installation approval of IMA systems. If the applicant wants to propose an alternative means, including those from other industry documents referenced by RTCA/DO-297, document those alternative means and secure FAA approval during your project's planning stage. Prepare to use Issue Papers to document agreements reached.

d. According to the definition of an IMA in Appendix E, Glossary, an IMA is a "shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a platform that provides services." You should keep in mind that an IMA system is defined by the system architecture, not by the functionality the system provides. IMA systems may not always implement functions historically regarded as "avionics", such as flight deck displays, navigation, communication, etc. IMA systems may also be used to implement other aircraft functionality, such as fly-by-wire flight controls, inertial reference/air data systems, or electrical power control systems. There may be more than one IMA system on an aircraft. An IMA system could feasibly be mounted within an engine assembly.

1-5. Applying RTCA/DO-297 as an Acceptable Means of Compliance.

a. RTCA/DO-297 describes objectives, processes, and activities to incrementally accumulate design assurance and acceptance of IMA systems and components. RTCA/DO-297 refers to industry standards such as SAE International's Aerospace Recommended Practice (ARP) 4754, *Certification Considerations for Highly Integrated or Complex Aircraft Systems*, and SAE ARP 4761, *Guidelines and Methods of Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*. When RTCA/DO-297 invokes the processes and methods in specific

sections of those industry standards as part of the IMA development, integration, verification, or approval process, you should consider those sections of the referenced industry standard (or other acceptable alternative means) to be part of the overall acceptable means of compliance as outlined in RTCA/DO-297.

> **Note:** SAE International updated their ARP 4754 to ARP 4754A, "*Guidelines for Development of Civil Aircraft and Systems*" in December 2010. AC 20-174, *Development of Civil Aircraft and Systems*, dated September 30, 2011, recognizes ARP 4754A as an acceptable means of compliance for development of aircraft systems. This revision A reflects a significant change to that document, including section and paragraph numbering from that used in the original release. As a result, several references to ARP 4754 by RTCA/DO-297 are incorrect when using SAE ARP 4754A. Please see appendix H of this AC in order to cross reference ARP 4754 with ARP 4754A sections and paragraphs referenced by the original release of RTCA/DO-297.

b. You may use this AC as an acceptable means of compliance for a IMA systems that include TSO authorized articles. Although RTCA/DO-297 does not address TSOs, you should apply the intent of its objectives in Annex A to IMA systems that include TSO authorization(s) in order to obtain IMA system approval. See chapter 8 of this AC for more information.

c. If you choose to follow this AC to show compliance, apply the AC to your IMA development and approval process regardless of the complexity of the IMA system or business model under which it is developed and approved. RTCA/DO-297 is written primarily from the perspective of a complex IMA system developed and integrated by multiple organizations and companies (see RTCA/DO-297, subsection 2.4). Although the development, integration, verification, and approval of an IMA system developed by a single company are likely to be less complex than for multiple companies, RTCA/DO-297 applies equally. This AC should be used as an acceptable means of compliance for IMA systems that:

(1) Are developed by a single company as well as those developed by multiple companies. If a single company develops a complete IMA system, many of the separate roles defined in RTCA/DO-297 – such as IMA developer, application developer, and IMA integrator -- will be taken by this single company.

(2) Are *simple* IMA systems as well as *complex* IMA systems. These terms are purposely left undefined, because it is difficult to make a clear distinction between them. The purpose of this item is to illustrate that this AC should be applied to IMA systems of all levels of complexity.

(3) Are closed architecture as well as open architecture. (See Appendix E, Glossary.)

(4) Use TSO authorized components (that is, TSO-C153) and functional TSOs (such as TSO-C113, *Electronic Flight Displays* and TSO-C9, *Automatic Pilots*) as well as IMA systems that do not use TSO authorized components.

Note: Because of the variations described in c. above, not all aspects of RTCA/DO-297 or the additional guidance contained in this AC may apply to every IMA development program. We strongly recommend that any question regarding the application of this AC be discussed with us at the beginning of the certification program and the agreements reached during those discussions be documented. The FAA may require an Issue Paper on these questions.

d. Appendix A of this AC, Environmental Qualification Guidance for TSO-C153, *Integrated Modular Avionics Hardware Elements*, shows applicants for TSO-C153 authorization how to conduct environmental qualification testing (EQT) that ensures compliance to the minimum performance standard (MPS) of TSO-C153. We do not require compliance to appendix A if you are not using TSO-C153 authorized hardware components.

1-6. What This AC Covers. This AC describes an acceptable means by which to apply RTCA/DO-297, along with the additional guidance material included in this AC, to an aircraft or engine certification program which uses an IMA system. We cover the following subjects in detail:

- Acceptance and Incremental Acceptance (in chapter 2).
- Getting An IMA Component Acceptance Letter (in chapter 3).
- Reuse Of IMA Components (in chapter 4).
- Configuration Management of an IMA System (in chapter 5).
- IMA Recovery Features (in chapter 6).
- Additional Topics Not Covered by RTCA/DO-297 (in chapter 7).
- Use of TSO Authorized Components in IMA Systems (in chapter 8).

Chapter 2 Acceptance And Incremental Acceptance.

2-1. Comparison of RTCA/DO 297 Acceptance and FAA Approval.

a. RTCA/DO-297, paragraph 2.1.2, gives the following definitions:

(1) *Acceptance* - Acknowledgement by the FAA that the module, application, or system complies with its defined requirements. Acceptance is recognition by the FAA (typically in the form of a letter or stamped data sheet) signifying that the submission of data, justification, or claim of equivalence satisfies applicable guidance or requirements. The goal of acceptance is to achieve credit for future use in a certification project.

(2) *Incremental Acceptance* - A process for obtaining credit toward approval and certification by accepting or finding that an IMA module, application, and/or off-aircraft IMA system complies with specific requirements. This incremental acceptance is divided into tasks. Credit granted for individual tasks contributes to the overall certification goal. Incremental acceptance provides the ability to integrate and accept new applications and/or modules, in an IMA system, and maintain existing applications and/or modules, without the need for re-acceptance.

b. We view acceptance, as defined above, as part of the processes documented by Title 14 of the Code of Federal Regulations (14 CFR) and published FAA policy used to approve airborne systems during an aircraft or engine certification program. To obtain approval for installation on a certified aircraft or engine, applicants must show that the aircraft or engine system/function meets with the applicable regulatory requirements. See §§ 21.17, 21.20, and 21.115. Some of the regulatory requirements are accompanied by an AC (such as this one) that describes one, but not the only, possible means of complying with those regulations.

c. The main differences between RTCA/DO-297 "acceptance" and our current formal process of showing compliance in an aircraft certification program are 1) each stage of RTCA/DO-297 acceptance is accompanied by some form of recognition, such as a "signed letter or stamped data sheet" or "accepted or approved compliance data package," and 2) a goal of acceptance, as defined by RTCA/DO-297, is to "achieve credit for future use in a certification process." Otherwise, the two concepts are very similar: data submissions and statements of compliance are used to show that an airborne system or component complies with all applicable requirements and therefore can be approved for installation onto an aircraft or engine.

d. "Acceptance" is a term often used during the approval of aircraft or engine systems, but its meaning may not be consistent throughout the certification process. The meaning of this word can depend on the context. For example, the RTCA/DO-297's "acceptance" is very similar, but not identical, to AC 20-148, *Reusable Software Components*. That AC states: "Acceptance is credit the FAA grants for fully or partially meeting RTCA/DO-178B objectives for an (Reusable Software Component) RSC. The FAA shows acceptance by issuing a RSC acceptance letter." Although the concept is similar between RTCA/DO-297 and AC 20-148, the specific definitions of "acceptance" are not identical. This example illustrates that the meaning

of "acceptance" may vary, given its context. Make sure you understand the context and meaning of this term when you encounter it.

e. "Incremental acceptance", as defined in RTCA/DO-297, takes the concept of acceptance further. It divides acceptance into "certification tasks" accomplished during different points, or increments, in the certification program. Each task builds upon previous tasks. Incremental acceptance of IMA components is normally associated with the IMA Component Acceptance Letter process described by RTCA/DO-297. See RTCA/DO-297, Section 4 for more information.

f. An applicant may use acceptance of components within the IMA to accumulate certification credit toward installation approval of an IMA system on an aircraft or engine. The concept of acceptance does not alter or replace FAA certification processes. Instead, acceptance is a means to recognize that a specific IMA component complies with all documented requirements and objectives, and that an accepted component can be used without detailed examination of the compliance data for that component – that is, is the component acceptable for use in an approved airborne system? IMA Component Acceptance Letters described in Chapter 3 of this AC are not required to accumulate certification credit toward installation approval.

2-2. Major Benefits of Incremental Acceptance.

a. The major benefit of using the incremental acceptance process, as defined in RTCA/DO-297, is that incremental acceptance provides the ability to integrate and accept new components in an IMA system and maintain existing components without the need for re-acceptance. This allows you to:

(1) Reuse accepted IMA components in multiple applications in the same certification program by submitting certification data packages that have an established pedigree. This reduces certification effort of the current aircraft or engine program without compromising system safety.

(2) Reuse accepted IMA components in future certification programs by submitting certification data packages that have an established pedigree. This reduces follow-on certification effort without compromising system safety.

b. The incremental acceptance process defined in RTCA/DO-297 shows how to package and document the data and artifacts of a specific IMA component, so the previously accepted data and artifacts may easily be used in multiple concurrent or future programs.

2-3. IMA Module, Application, System, and Installation Acceptance.

a. Acceptance at each stage of IMA development and verification, as described RTCA/DO-297, subsection 4.2 (Task 1 – Module Acceptance), subsection 4.3 (Task 2 – Application Acceptance), subsection 4.4 (Task 3 – IMA System Acceptance), and subsection 4.5 (Task 4 – Aircraft Integration of IMA System), is required for IMA system installation approval. We intend that all important aspects in RTCA/DO-297 regarding IMA development, integration,

verification, and approval (Tasks 1 through 4) be followed and you show that the IMA system complies with all objectives of RTCA/DO-297, Annex A, regardless of whether you request IMA Component Acceptance Letters. The IMA Component Acceptance Letter process covered in RTCA/DO-297, Section 4, and chapter 3 of this AC is optional. As an applicant, IMA developer/system integrator, or IMA component supplier, you may decide whether or not to request an IMA Component Acceptance Letter.

Note: RTCA/DO-297, subsection 4.6 (Task 5) deals with changes to accepted modules and subsection 4.7 (Task 6) deals with reuse of modules or applications. These subsections are important and should be followed. However, for the purposes of the initial acceptance of the IMA system and approval for installation on an aircraft or engine, only subsections 4.2 through 4.5 (Tasks 1 though 4) are relevant. If previously accepted components are being reused, subsection 4.7 (Task 6) should also be considered.

b. The documentation required to obtain acceptance when you are planning to reuse IMA components may be more than that required if you seeking approval for a component to be only used on a single TC/STC/ATC/ASTC program. Although it is not mandatory, we strongly suggest that in your initial certification plans for the IMA system and/or components, you state which components for which you desire IMA Component Acceptance Letters at the end of the certification program, along with the name of the company or companies that will be asking for those letters.

c. The FAA will not grant acceptance at the higher task levels – that is, Tasks 2, 3, and 4 – until all acceptances at the subordinate levels on which those higher tasks depend have been completed. For example, to obtain acceptance for an IMA application, you should first obtain acceptance of all modules which comprise that application. Likewise, all applications that make up an IMA system should be accepted before we accept the system.

d. If you are going to deviate from certification planning documents already accepted by the FAA, you should request a deviation to those plans. The request should include a justification for the deviation and the mitigating actions (if any) that you plan to take.

2-4. Documentation And Data Packaging. RTCA/DO-297, Section 4 addresses the artifacts required for acceptance at the various task levels. Examples include the module acceptance plan, the module requirements specification, the module configuration index, the IMA system certification plan, and the IMA system validation and verification plan. This AC does not require that you use those specific document titles or methods of data packaging. They represent one particular acceptable means to comply with RTCA/DO-297. We accept alternative document titles and data packaging. However, if you use alternative documentation naming convention and data packaging, you should address all significant aspects in RTCA/DO-297, Section 4 and Annex A to claim compliance to this AC. See RTCA/DO-297, subsection 4.1 for more information.

Chapter 3 Obtaining an IMA Component Acceptance Letter.

3-1. General Guidance Regarding IMA Component Acceptance Letters.

a. Obtaining an IMA Component Acceptance Letter is optional for applicants, IMA developers/system integrators, and IMA component developers. The decision to apply or not apply for an IMA Component Acceptance Letter has no bearing on the final approval of the IMA system and its installation onto an aircraft or engine. The main reason to obtain an IMA Component Acceptance Letter is to formally document acceptance of the compliance data for future or concurrent reuse of that accepted IMA component. If you do not request an IMA Component Acceptance Letter, we will not issue one.

b. We typically issue the IMA Component Acceptance Letter after:

(1) The applicant has completed and submitted all applicable documentation and shown that the objectives of RTCA/DO-297, Annex A, Table A-1 and/or A-2 (depending on if the IMA component is a module or an application), Table A-3, and Table A-4 have been achieved, and

(2) We find no installation, safety, operational, functional, or performance concerns.

c. If there are software operating systems, generic hardware computing/power supply modules, or other IMA components not dependent on IMA system integration or aircraft installation, we may issue an IMA Component Acceptance Letter before completion of those later stages of IMA development and integration. However, you should work with the FAA during the planning process if you desire an IMA Component Acceptance Letter prior to the certification of the aircraft or engine. Otherwise, this request for an IMA Component Acceptance Letter may not be prioritized according to your needs, as the FAA will normally issue IMA Component Acceptance Letters after the completion of the certification program.

d. According to RTCA/DO-297, subsection 4.7, future reuse of compliance data for a previously accepted IMA component is limited to IMA modules and applications. Therefore, we will only issue IMA Component Acceptance Letters for IMA modules and applications. We will not issue IMA Component Acceptance Letters for an IMA system or its installation onto an aircraft or engine.

e. RTCA/DO-297, subsection 4.1, states: "IMA acceptance can only be proposed in the context of an actual certification project." That means we issue IMA Component Acceptance Letters only for IMA components being developed and approved for a specific aircraft/engine certification program. We do not issue IMA Component Acceptance Letters for TSO authorized articles that are not for an identified aircraft/engine certification program.

f. A request for an IMA Component Acceptance Letter is not limited to the developer of an IMA component. The applicant, IMA developer/system integrator, or IMA component developer may apply for an IMA Component Acceptance Letter. The intent to request an IMA

Component Acceptance Letter should be included in the appropriate certification planning documentation.

g. Because IMA component acceptance is relevant only within the context of an aircraft/engine certification program, you may ask if a specific compliance data package belongs to the applicant, or to the company supplying the IMA component or system. The answer depends upon the agreements reached between the various companies. Consequently, we strongly suggest that all parties document their plan for IMA Component Acceptance Letters, including the intent for concurrent or future reuse, at the start of the aircraft or engine certification program. This way, all parties will understand and agree on how data for the current program may be used in the future – possibly for a different applicant than the current aircraft/engine program.

h. Use the following guidance to determine which FAA office you should apply to for an IMA Component Acceptance Letter:

(1) If there is a valid IMA Component Acceptance Letter for an IMA component and that component is being updated, then you should apply for a new IMA Component Acceptance Letter to the Aircraft Certification Office (ACO) that issued the existing IMA Component Acceptance Letter. Otherwise, use the guidance in items (2) through (5).

(2) If the IMA component in question will not also be getting a TSO authorization (either TSO-C153 or functional TSO), you should apply for an IMA Component Acceptance Letter to the ACO that is responsible for the certification of the aircraft or engine that will be using that IMA component.

(3) If the IMA component is question will also be getting a TSO authorization (either TSO-C153 or functional TSO), you should apply for a new IMA Component Acceptance Letter to the ACO that is responsible for issuing the TSO authorization for that IMA component.

(4) If the aircraft or engine in which the IMA component is to be installed is of non-U.S. design and manufacture, you should apply for an IMA Component Acceptance Letter to the ACO that you would normally apply to for a TSO authorization. The manufacturer of that aircraft or engine should be in the process of obtaining, or has already obtained, an FAA certification. We will not issue an IMA Component Acceptance Letter for an IMA component that is used on an aircraft or engine that is not seeking an FAA certification. In this case, the ACO to which the application for an IMA Component Acceptance Letter is made will coordinate with the FAA office that is acting as the Validating Authority for that aircraft or engine program.

(5) We will not issue an IMA Component Acceptance Letter to a company that is not based within the United States. There is not an ACO that has geographic responsibility and oversight of that company.

3-2. Parts of the IMA Component Acceptance Letter.

a. An IMA Component Acceptance Letter is composed of three parts:

(1) The IMA Component Acceptance Cover Letter, prepared and signed by the applicant for the IMA Component Acceptance Letter. See paragraph 3-3.

(2) The IMA Component Acceptance Letter data sheet, prepared by the applicant for the IMA Component Acceptance Letter. See paragraph 3-4.

(3) The Acceptance Letter, prepared and signed by the FAA. See paragraph 3-5.

b. If you are an applicant for an IMA Component Acceptance Letter, assemble your request package (both the completed IMA Component Acceptance Cover Letter and the IMA Component Acceptance Letter data sheet) and submit it to the appropriate FAA office. If we approve your request, we will prepare and sign a Acceptance Letter for that IMA component. We will send the applicant for the IMA Component Acceptance Letter a copy of the IMA Component Acceptance Cover Letter and the signed Acceptance Letter. We will retain and archive the original of all three parts of the IMA Component Acceptance Letter.

c. At your request, we will provide extra copies of the signed Acceptance Letter and IMA Component Acceptance Cover Letter to you or to another company.

d. You should maintain your own files of the IMA Component Acceptance Cover Letter and IMA Component Acceptance Letter data sheet. We will not provide copies of the IMA Component Acceptance Letter data sheet.

e. We do not allow modifications to previously accepted IMA components under an existing IMA Component Acceptance Letter. If you change a previously accepted IMA component and still want an IMA Component Acceptance Letter, you will have to apply for another one. See paragraph 4-9 of this AC for more information on changes to an accepted IMA component.

3-3. Essential Elements of the IMA Component Acceptance Cover Letter.

a. The IMA Component Acceptance Cover Letter specifies what compliance data is being accepted by the FAA. The applicant for an IMA Component Acceptance Letter should include the following information in the IMA Component Acceptance Cover Letter:

(1) Date of application for the IMA Component Acceptance Letter.

(2) The FAA office to which the request for an IMA Component Acceptance Letter is being made.

(3) Unique identifier for the IMA Component Acceptance Cover Letter. The specific format of this identifier is left to the discretion of the applicant for the IMA Component Acceptance Letter. It could be a company correspondence number or a unique identifier used solely for the purpose of application for IMA Component Acceptance Letters. However, once a particular identification is used, it should not be re-used.

(4) Name and contact information for the company requesting the IMA Component Acceptance Letter.

(5) Name and contact information of the original IMA developer/system integrator, the airborne system and aircraft/engine in which the component will be installed, the target environment, such as the microprocessor, memory management unit, data busses, input/output devices, etc., and other information about the initial acceptance of the IMA component. Include name and contact information of the IMA component developer, if different than the applicant for the IMA Component Acceptance Letter.

(6) Contact information for persons or organizations who will answer questions about component acceptance and concurrent/future reuse.

(7) IMA component name, unique component identifier, and all associated document numbers, titles, and revision levels. Examples are the system, software or hardware (as appropriate) configuration index number and revision, a component's acceptance accomplishment summary number and revision, and any configuration information not included in the module configuration index.

(8) All configuration information (use references to other documents as necessary) to fully define the component and its development environment.

(9) High level description of the component purpose and usage domain. See RTCA/DO-297, paragraphs 4.2.10 and 4.3.2, and the Glossary of this AC for the discussion of and definition of usage domain.

(10) Short description of the software partitions, software levels, and hardware design assurance levels within the component.

(11) Definition of the compliance data type(s) being accepted and documented by this IMA component acceptance letter – that is, airborne software, complex electronic hardware (CEH), comprehensive testing for simple electronic hardware (SEH) components, EQT, and any other data type that has been mutually agreed on.

(12) State whether each compliance data type shows full or partial compliance to their respective standards – for example, RTCA/DO-178B for airborne software. A full description of any partial compliance is not necessary, as we expect you to include that information in the IMA Component Acceptance Letter data sheet described in paragraph 3-4.

(13) Statement of compliance that the signatories attest that the IMA component meets all the applicable requirements defined in the IMA Component Acceptance Letter.

(14) Signatures and dates. At least one managerial signature representing each of the technical disciplines covered by the IMA Component Acceptance Letter: RTCA/DO-178B compliance for airborne software, RTCA/DO-254 compliance for CEH, comprehensive testing

and analysis of SEH, and RTCA/DO-160F compliance for EQT. One signature may cover more than one technical disciplines. Other signatures, such as engineering personnel, may be included if the applicant for the IMA Component Acceptance Letter desires. Each signature should include the date of the signature and the typed or printed name, as well as an identification of which technical discipline that signature covers.

b. See appendix B for a sample IMA Component Acceptance Cover Letter.

3-4. Essential Elements of the IMA Component Acceptance Letter Data Sheet.

a. The IMA Component Acceptance Cover Letter or the accompanying IMA Component Acceptance Letter data sheet should fully define the usage domain of the IMA component, or else it should reference a document where the usage domain of the IMA component is fully defined. If that information is not in the IMA Component Acceptance Cover Letter, then you should include it as part of the accompanying IMA Component Acceptance Letter data sheet.

b. Each IMA Component Acceptance Letter data sheet should contain, at a minimum:

(1) Assumptions the IMA component developer made during the acceptance. These assumptions may be documented by referencing the component developer's accomplishment summary or other appropriate certification document. Include assumptions for each applicable RTCA/DO-297 objective in the appropriate accomplishment summary. The assumptions should be detailed enough that the FAA, the IMA developer/systems integrator, and applicant can apply this information to any future or concurrent IMA programs that will reuse this component.

(2) Summary of technical or policy issues that arose during the initial acceptance and how the applicant and FAA resolved them.

(3) Summary of additional activities that the IMA developer/system integrator and/or applicant need to perform to ensure that all objectives of RTCA-DO-297 Tasks 3 and 4 can be met when using the accepted IMA component. Describe any remaining compliance activity required to show full compliance to the appropriate standard – for example, RTCA/DO-178B for airborne software, any remaining EQT required by RTCA/DO-160F, *Environmental Conditions and Test Procedures for Airborne Equipment,* not covered by the IMA Component Acceptance Letter.

(4) The software level(s) and/or hardware design assurance level(s) of all software partitions and/or CEH/SEH devices.

(5) A description of the target computer, including the applicable hardware, operating system, board support package, drivers, etc., that will host software to perform aircraft-level functions.

(6) High-level description of the function and/or purpose of the component and target environment. If the component contains multiple software partitions and/or multiple CEH/SEH devices, include a high level description of each. This allows us and the IMA component

integrator to clearly understand the relationship of each partition and/or hardware device and their associated software levels and/or hardware design assurance levels.

(7) Testing levels achieved for all EQTs performed.

(8) Limitations, plus any installation, safety, operational, functional, or performance issues.

(9) Module or application acceptance data, including interface specifications, user's guide, and usage domain described in RTCA/DO-297, paragraphs 4.2.4e, 4.2.10, 4.2.12e, 4.3.2, and 4.4.2.

(10) Full explanation of kinds of technical data other than those specific technical disciplines addressed in paragraph 4-2.b of this AC included in the IMA Component Acceptance Letter. The applicant for the IMA Component Acceptance Letter should also include a detailed explanation of what remains to be done by the IMA developer/system integrator and/or aircraft or engine manufacturer, to obtain full compliance for the compliance data associated with this technical discipline.

(11) A copy of any pertinent document that demonstrates the compliance data contained in the IMA Component Acceptance Letter data sheet has been evaluated and found acceptable by the FAA or by an authorized representative of the FAA. Examples include signed 8110-3 forms and TSOA letters. By including evidence that data within the IMA Component Acceptance Letter data sheet has found to be acceptable, you will significantly speed the process of evaluating the application for an IMA Component Acceptance Letter.

3-5. Acceptance Letter.

a. The FAA will prepare and sign an Acceptance Letter for the IMA component to signify that the IMA component has been accepted. The Acceptance Letter will reference the IMA Component Acceptance Cover Letter unique identifier, so that the Acceptance Letter will be associated with that specific IMA Component Acceptance Cover Letter.

b. See Appendix C for a sample Acceptance Letter.

3-6. IMA Component Acceptance Letters For Revised IMA Components.

a. If a previously accepted IMA component has been changed or revised in any manner, the original IMA Component Acceptance Letter is no longer valid. As stated in paragraph 3-5 above, an IMA Component Acceptance Letter is associated with a specific configuration of that component, defined by its accompanying documentation. Any change to a previously accepted IMA component requires at least some of the accompanying documentation – such as the component configuration index – to be updated. This requires a new IMA Component Acceptance Letter.

b. If there's a change to a previously accepted IMA component and you want a new IMA Component Acceptance Letter for it, you should show that the component meets the guidance of RTCA/DO-297, subsection 4.6 for the updated IMA component. Paragraph 4.6.5 of RTCA/DO-297 discusses the change data that should be submitted when requesting a new IMA Component Acceptance Letter for a change to a previously accepted IMA component.

3-7. Cancelling an IMA Component Acceptance Letter.

a. The FAA may cancel a previously issued IMA Component Acceptance Letter. Reasons that we may cancel an IMA Component Acceptance Letter include, but are not limited to, the following:

(1) The accepted IMA component is determined to be the cause of or contributed to an in-service accident or safety related incident.

(2) The accepted IMA component is the subject of a § 21.3 report.

(3) The IMA component developer, IMA developer/system integrator, or applicant determines that the IMA component does not meet the acceptance criteria defined in the original IMA Component Acceptance Letter.

(4) It is discovered that the accepted component was developed from erroneous or incomplete requirements, and those erroneous or incomplete requirements could, given the correct circumstances, lead to a reduction in safety in any aircraft or engine in which the component is installed.

b. We will notify the holder of an IMA Component Acceptance Letter when it is cancelled. This action has the effect of not allowing that version of the IMA component to be reused on a future or concurrent certification program until the reason for the cancellation has been addressed. A new IMA Component Acceptance Letter for the updated IMA component may be requested per paragraph 3-6.

Note: Cancelling an IMA Component Acceptance Letter has no bearing on the continued safe operation of an aircraft or engine that uses that IMA component. If action is required, the FAA will issue an Airworthiness Directive that will require operators to update the component or aircraft function in question.

c. We expect the holder of an IMA Component Acceptance Letter to contact the ACO that issued the IMA Component Acceptance Letter in a timely manner if any issues such as those listed in a. are discovered.

Chapter 4 Reuse Of IMA Components.

4-1. Reuse of an Accepted IMA Component.

a. If a previously accepted IMA component is unchanged, its intended reuse meets the limitations in the IMA Component Acceptance Letter, and the FAA engineer for the certification program in which the IMA component is being reused does not have any concerns, you may reuse that component without need for additional FAA review of the originally accepted IMA component compliance data.

b. If you are an IMA developer/system integrator or applicant proposing to reuse a previously accepted IMA component, you should ensure and document that you identified no safety, installation, operational, functional, or performance concerns with the subsequent use of that component.

c. Although the intent of IMA Component Acceptance Letters is to document our acceptance of the compliance data for an IMA component, the existence of such a letter does not prevent us, on a new or concurrent TC/STC/ATC/ASTC program, from requesting to examine the compliance data associated with the accepted IMA component if we have questions or concerns. We will first try to address any open questions without resorting to re-examination of the previously accepted compliance data. However, if we have specific concerns that cannot be answered by any other means, we may ask you to provide some of the previously accepted data. Only compliance data specific to the identified issue or concern should need to be re-examined. If the initial IMA Component Acceptance Letter was done correctly and all necessary compliance data was included in the IMA Component Acceptance Letter, we should not need to resort to re-examination of previously accepted compliance data.

d. RTCA/DO-297, paragraph 4.7.1, states that future reuse of any component should be planned during the initial development of that component and documented in the appropriate certification planning document. An IMA component not initially developed for future reuse and lacking a signed Acceptance Letter should be treated as a newly developed component.

4-2. What Can Be Reused.

a. RTCA/DO-297, subsection 4.7 states that reuse of a previously accepted component should be limited to modules (see Task 1 in RTCA/DO-297, subsection 4.2) and applications (Task 2, subsection 4.3). We do not allow reuse of previously accepted data at the IMA system level (Task 3, subsection 4.4) or IMA installation level (Task 4, subsection 4.5).

b. RTCA/DO-297, subsection 4.7 limits reuse of the types of data for Tasks 1 and 2 to the following technical subjects:

(1) Airborne software compliance to RTCA/DO-178B. See RTCA/DO-297, paragraph 4.7.2 and paragraph 4-4 below.

(2) CEH component compliance to RTCA/DO-254. See RTCA/DO-297, paragraph 4.7.3 and paragraph 4-5 below.

(3) EQT compliance to RTCA/DO-160F. See RTCA/DO-297, paragraph 4.7.4 and to paragraph 4-7 below.

c. In addition to those three technical data types, this AC identifies comprehensive testing of SEH as another data type for which acceptance data can readily be developed, packaged, and accepted for future reuse. Reuse of compliance data for SEH is not covered in RTCA/DO-297.

(1) RTCA/DO-254, subsection 1.6, provides the following definition:

Simple Hardware Item – Item with a comprehensive combination of deterministic tests and analyses appropriate to the design assurance level that ensures correct functional performance under all foreseeable operating conditions, with no anomalous behavior.

(2) AC 20-152, *RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware*, says that applicants should apply RTCA/DO-254 to custom micro-coded components, which are a subset of "hardware items." This is AC 20-152's definition:

Custom micro-coded component – A component that includes application specific integrated circuits (ASIC), programmable logic devices (PLD), field programmable gate arrays (FPGA) and other similar electronic components used in the design of aircraft systems and equipment.

(3) FAA Order 8110.105, paragraph 5-1, explains that SEH is a custom micro-coded component that satisfies the definition a simple hardware item of RTCA/DO-254. The design of an SEH device can be shown to be correct and complete by comprehensive testing and analysis without a detailed development assurance process. Ask your FAA ACO for more information regarding definitions and explanations of CEH, SEH, hardware items, and custom micro-coded devices. See RTCA/DO-254, subsection 1.6 for more information on simple hardware items.

4-3. Reuse of Other Types of Compliance Data.

a. If you are an IMA component developer intending to develop any data for future reuse beyond those listed in 4-2.b and 4-2.c, you should include this intent in the appropriate certification planning document. Work closely with us, the IMA developer/system integrator, and applicant at the beginning of the component development program to ensure that future reuse of this data is feasible, and all parties agree on what is required to ensure the success of any future reuse. We are not required to accept a proposal for future reuse of data beyond those listed in 4-2.b and 4-2.c, but we will consider your proposal.

b. Any compliance data beyond those data types listed in paragraphs 4-2.b and 4-2.c. that you propose for inclusion in an IMA Component Acceptance Letter should fall within Tasks 1 and 2, per paragraph 4-2 above.

c. The IMA component requirements for the additional compliance data types should be documented in an appropriate certification document and referenced in either the IMA Component Acceptance Cover Letter or the IMA Component Acceptance Letter data sheet.

4-4. Reuse of Previously Accepted Software-Only or Hardware Component Containing Airborne Software.

a. RTCA/DO-297, paragraph 4.7.2, addresses reuse of a software module or application. However, as stated in RTCA/DO-297, paragraph 4.7.5, this guidance should also be followed for IMA hardware components that contain airborne software.

b. In addition to the guidance for reuse of a previously accepted component containing airborne software provided by RTCA/DO-297, the guidance for the reuse of airborne software contained in AC 20-148, *Reusable Software Components*, should also be used in its entirety, with the exception of Chapter 9 which addresses the Reusable Software Component (RSC) Acceptance Letter. AC 20-148 contains more detail than RTCA/DO-297 about developing airborne software for reuse, and reusing that software in another project. AC 20-148 specifies the roles and responsibilities of all parties, the processes to be used, how the data should be developed when future reuse is intended, and what data should be supplied by the software developer to the integrator of the software or to the applicant.

c. RTCA/DO-297, paragraph 4.7.2 states that the prerequisites for reusing previously accepted software is that the software should be hosted on the "same target hardware" and is "used in the same way operationally" for the earlier accepted application and the intended reuse application. Given the rapid change in technology employed in today's IMA systems as well as the rapid rate of hardware parts obsolescence, it's likely that the intended platform that is to host the reused software component will not include the same target hardware that initially hosted the accepted software. The target hardware may include a microprocessor from the same family as that of the previous target hardware. However, coming from the same family of microprocessors does not automatically qualify as "the same target hardware." If an IMA developer/system integrator or applicant wants to reuse a previously accepted IMA component that contains software, but that software will be hosted on non-identical target hardware, the applicant should ensure compliance with all RTCA/DO-178B and RTCA/DO-297 objectives and document how they intend on showing that compliance.

4-5. Reuse of CEH or Hardware Component Containing CEH.

a. AC 20-152, paragraph 2.c states that RTCA/DO-254 applies to complex custom micro-coded components with hardware design assurance levels A, B, and C. See paragraph 4-2.c (2) for definition of custom micro-coded components. Accordingly, we restrict granting IMA Component Acceptance Letters (per RTCA/DO-297, paragraph 4.7.3) to RTCA/DO-254

complex custom micro-coded components – that is, to CEH and not commercial-off-the-shelf (COTS) hardware devices.

b. Your ACO will use FAA Order 8110.105 for definitions and additional information on using RTCA/DO-254 as an acceptable means of compliance.

c. Currently, there is no guidance for CEH that defines a detailed acceptable means of compliance similar to that provided by AC 20-148 for an RSC. However, because of the many similarities between the processes in RTCA/DO-178B for airborne software and those in RTCA/DO-254 for airborne electronic hardware, adapt the paragraphs of AC 20-148 listed below to CEH. Use these paragraphs of AC 20-148 when negotiating an agreement between yourself and us on reusing CEH components:

(1) Paragraph 4 – General Guidelines for Getting the FAA to Accept an RSC.

(2) Paragraph 5 – Guidelines for the RSC Developer.

(3) Paragraph 6 – Data the RSC Developer Must Supply to the RSC Integrator or Applicant.

(4) Paragraph 7 – Guidelines for the Integrator and Applicant Using the RSC.

(5) Paragraph 8 – Expectations from FAA on First Use of an RSC.

(6) Paragraph 10 – Expectations from FAA on the Subsequent Use of an Accepted RSC.

4-6. Reuse Of SEH or Hardware Component Containing SEH. As with CEH, there's no current guidance on reusing SEH compliance data. Consult the same paragraphs listed in paragraph 4-5 above when negotiating with us on adapting and using these paragraphs for SEH components. Your ACO will use FAA Order 8110.105 for information on SEH and our expectations regarding comprehensive testing of SEH components.

4-7. Reuse of EQT Data.

a. RTCA/DO-160F, Section 1, stresses the importance of selecting the right environmental conditions and test procedures for equipment under test. A phrase used throughout RTCA/DO-160F is, "determine compliance with applicable equipment performance standards." If you are the tester responsible for EQT, it is up to you to determine the specific test configuration and requirements appropriate for the equipment under test. There are many aspects of environmental testing – vibration levels, temperature, altitude, orientation of equipment, electrical connectors, electrical grounding schemes, and electrical wire lengths – specific to the aircraft in which the equipment will be installed. The qualification test plan for the equipment under test should properly define all variable test parameters.

b. RTCA/DO-297, paragraph 5.2.6 stresses the flexibility and reconfigurable nature of modern IMA systems. That is, although the basic architecture of an IMA system is set and will

not change, each IMA system can be tailored specifically for the aircraft or engine in which it is installed. This is true for the functionality provided by the IMA system as well as for the environmental conditions to which it is subjected – for example, vibration levels for installation in a rotorcraft versus a fixed wing aircraft. This flexibility, while beneficial in many respects, introduces complications when you attempt to develop reusable EQT data per RTCA/DO-297, paragraph 4.7.4.

c. A company asking us for an IMA Component Acceptance Letter for an IMA component being developed for future reuse should ensure that the data package of this component clearly identifies all variables and parameters used during EQT. The IMA developer/system integrator intent on reusing a previously accepted component which includes EQT data should ensure that all aspects of that testing are appropriate for the aircraft or engine in which it will be installed. If any testing variable or parameter used during the component's initial acceptance is not identical to what is required for the intended reuse, then the integrator of that previously accepted component should document those differences and justify why they are acceptable for the new intended installation. If there is not adequate justification for any difference between the original acceptance and the intended reuse, then the IMA developer/system integrator or applicant should re-test that aspect of the EQT, using the appropriate values and test configurations.

4-8. Data the Component Developer Owes to the IMA Developer/System Integrator or Applicant.

a. The developer of a previously accepted IMA component should supply the IMA developer/system integrator and/or applicant who is reusing the component with many different types of data. This ensures that the IMA developer/system integrator and applicant can fully satisfy the objectives of RTCA/DO-297, subsection 4.7 and Annex A. The data required by the IMA developer/system integrator and applicant are likely to exceed that included in the IMA Component Acceptance Letter.

b. Instead of providing data directly to another company, the developer of a previously accepted IMA component may choose to use a data/software escrow approach. See AC 20-148, paragraph 6.j(2) for guidance regarding data/software escrow.

c. AC 20-148, paragraph 6 details the data for airborne software that a developer of a previously accepted software component should make available to the IMA developer/system integrator, the applicant, and to us, if we ask. As noted previously, there is no similar guidance for accepted reuse of either RTCA/DO-254 or RTCA/DO-160F compliance data. However, RTCA/DO-297, paragraphs 4.2.3, 4.2.12, 4.3.1, and 4.3.2 document many of the elements required. A developer of a previously accepted IMA component should provide the data required to ensure compliance with RTCA/DO-297, subsection 4.7 and with the objectives of Annex A, either directly or by data escrow, to the IMA developer/system integrator and/or applicant.

4-9. Reuse of a Previously Accepted IMA Component That Was Revised. A previously accepted IMA component that has been revised since its last acceptance should meet the

guidance in RTCA/DO-297, subsection 4-5 to be reused in a new or concurrent application. If you want a new IMA Component Acceptance Letter, see paragraph 3-6.

4-10. Reuse of an IMA Component with a Previous TSO Authorization.

a. If the IMA component that has a previous TSO authorization also has been previously issued an IMA Component Acceptance Letter, then the process for reuse of a previously accepted IMA component takes precedence. The applicant and IMA developer/system integrator should use the guidance in section 4 without regard to remainder of this paragraph.

b. If the IMA component that has a previous TSO authorization has not been issued an IMA Component Acceptance Letter, then the following applies:

(1) You should follow all limitations described in the TSO authorization when integrating the component into the IMA system. These limitations should be documented in the appropriate certification planning document(s).

(2) The intended usage domain of the TSO authorized IMA component should be identical to the usage domain identified in the TSO authorization. If the intended usage domain is not the same as identified in the TSO authorization, then you should do analysis and/or testing to demonstrate those differences do not affect the use of the IMA component within the intended usage domain.

(3) You should identify all RTCA/DO-178B and RTCA/DO-254 objectives that have only been partially met under the TSO authorization and describe in the appropriate certification planning document(s) how full compliance to these objectives will be shown for the integrated IMA system. See AC 20-148, paragraph 5.d(1) for more information.

(4) You should identify all remaining EQT that are required for the aircraft or engine installation that is not covered by the TSO authorization. These remaining EQT should be described in the appropriate certification planning document(s). Any EQT results from the TSO authorization that you desire to take credit for at the aircraft or engine installation level should be described in the appropriate certification planning document(s). See paragraph 4-7 for more information regarding reuse of EQT data.

(5) Any SEH devices that are within the TSO authorized IMA component should be identified in the appropriate certification planning document(s). Compliance to RTCA/DO-254 for SEH devices are not covered by TSO authorizations, unless specifically stated in the TSO. The guidance of paragraph 4-6 should be used.

Chapter 5 Configuration Management of an IMA System.

5-1. IMA Configuration Management.

a. The applicant is responsible for overall IMA system configuration management.

b. Configuration management of an IMA system installed in an aircraft is critical because the system may contain many hardware components and functional software components, with each component having multiple approved versions or on-aircraft option selections. Some possible combinations of hardware and software versions will not be approved for flight.

c. Configuration management techniques to manage the IMA architecture are necessary to safely accommodate system attributes, such as (but not limited to) the following:

(1) Hosting multiple software applications on a single processor or on multiple, non-dedicated processors.

(2) Producing and distributing hardware components without loading specific functional software.

(3) Allowing electronic part numbering for software components, without the need to physically mark hardware elements with the software part number(s).

(4) Allowing the electronic display of TSO identification.

(5) Allowing the field-loading of hardware components with functional software components for efficient maintenance and incorporation of approved design changes.

(6) Allowing the stocking of generic, non-configured hardware components for maintenance purposes. A non-configured hardware component is one that does not already contain the functional software components needed for satisfying an aircraft, engine or system function. These hardware components will be loaded later with field-loadable software. Each generic hardware component may have multiple versions, as components normally undergo updates during their lifecycle. Unless a specific effort is made to purge operator spares of earlier versions of a hardware component, you should assume that every version of a hardware component will exist in service and could be used on an aircraft or engine installation.

(7) Providing the ability to update and maintain IMA system configuration files without corruption.

5-2. Automated, Robust Configuration Management.

a. We strongly recommend a robust, *automated* configuration management scheme for an IMA system installed on an aircraft. A key feature of an automated configuration management scheme is that the IMA system itself monitors the configuration of either all or a subset of the

IMA hardware and software components. When an invalid configuration of the monitored components is detected, it should be annunciated in a way that will not allow the aircraft to be dispatched until the invalid configuration is corrected.

b. A robust, automated configuration management scheme should be able to detect, at a minimum:

(1) Incompatible versions of a software component hosted in a hardware component.

(2) Incompatible versions of multiple copies of a software component hosted in multiple hardware components.

(3) Incompatibilities or uncertified configurations between various systems that are closely coupled, such as autopilot and flight management systems.

(4) Incompatible system configurations with the aircraft model in which it is installed, and

(5) Incompatible option selections.

c. Any loss of function caused by configuration management system protections must be shown to be acceptable through the applicant's aircraft or engine level safety assessment. See § xx.1309, xx denoting parts 23, 25, 27, or 29 as applicable.

5-3. Non-Automated, Robust Configuration Management. If your configuration management scheme of the IMA system installed on the aircraft or engine is not automated or depends on maintenance personnel to configure the system, either fully or partially, and to determine if the system configuration correct for that specific aircraft or engine, you should explain, in the appropriate certification document, why your configuration management scheme is robust. You should address possible issues with your proposed approach, such as likely maintenance errors that could result in a non-approved IMA configuration. You should explain the testing and analysis that you plan to do to ensure the process is indeed robust.

5-4. Software Loading Procedures. For IMA systems that allow on-aircraft loading of software, the applicant should provide field-loading procedures that ensure correct software loading, as well as a means to verify that the software load operation was completed successfully and that the correct version of software is now installed.

5-5. Assurance Level of IMA Components Used in Configuration Management. Any IMA system component used in determining the validity and/or safety of an IMA configuration, whether the configuration management system is fully automated or manual, should be developed to the assurance level commensurate with the hazard classification of allowing a non-approved configuration to be dispatched. This includes automatic configuration monitoring and displaying electronically stored part numbers and versions on a flight deck or maintenance display.

Chapter 6 IMA Recovery Features.

6-1. Restarting Safety Critical IMA Functions. Due to unforeseen circumstances, an IMA function, collection of IMA functions, or an entire IMA cabinet may unexpectedly shut down without the hosting IMA hardware components experiencing a permanent failure. IMA systems must include the ability to restart any hosted function or functions whose continued operation is required by the system or aircraft level safety assessment. See § xx.1309, xx denoting parts 23, 25, 27, or 29 as applicable.

6-2. Restart Mechanism Implementation.

a. An IMA function or system restart feature included in an IMA system, when feasible, should be initiated automatically when a safety critical loss of function is detected. The IMA design should avoid the need for crew-initiated recovery features.

b. If an automatic recovery feature is not feasible and a crew-initiated – that is, non-automated – recovery feature is implemented instead, you should put protection mechanisms and operations procedures in place to prevent accidental activation of the recovery feature by the flight crew.

c. The system design should carefully consider how many automatic attempts at restarting failed IMA functions or cabinets should be attempted. Attempting to restart indefinitely when the failed function or cabinet repeatedly shuts itself down may cause increased crew workload or distraction. Repeated failures after restart attempts may indicate that there is a failed IMA resource that should not be restarted. The system restart mechanism design should consider potential causes for restarts and determine the appropriate number of restarts to attempt before declaring the system failed. Factors that influence this architecture are the failure condition(s) associated with loss of IMA functionality, the impact of multiple restarts of a function or functions on interfacing systems, and the functionality remaining from non-IMA systems.

d. The IMA design should not rely on cycling aircraft circuit breakers to restart any IMA system or function. If crew-initiated manual recovery features are used, design a means other than cycling circuit breakers.

e. The applicant should evaluate the effects of automatically and/or manually activating recovery features in both normal and failed conditions for all phases of flight. The applicant should evaluate the effects of loss of functions during manual or automatic restart for all phases of flight.

Chapter 7 Topics Not Covered by RTCA/DO-297.

7-1. Electrical Power For IMA Systems.

a. The applicant and IMA developer/system integrator should design the physical and electrical power architecture of the IMA to support the flight crew's ability to manage smoke or fire events without losing functions whose loss are catastrophic.

b. If arc fault circuit breakers (AFCB) are utilized for IMA cabinet or rack circuit protection, they should be specifically qualified for use on aircraft. At the issue date of this AC, the use of AFCB technology in airborne systems is in its infancy. Therefore, until more experience is gained and updated regulatory and/or guidance material is issued for the certification of AFCBs, the FAA may develop a method of compliance Issue Paper for certification programs that use AFCB technology.

c. The IMA cabinet or rack should not be powered with circuit protection features such as software controlled circuit breakers that are controlled by microprocessors hosted in that IMA cabinet or rack. The intent of this guidance is to prevent the complete loss of control of the circuit protection feature(s) of any specific IMA cabinet or rack, or IMA components installed within that cabinet or rack, such that the electrical power input cannot be removed to that cabinet or rack if it fails.

d. The following applies to part 25 transport airplanes only.

(1) Electrical wiring interconnection system (EWIS) components, as defined by § 25.1701, associated with IMA systems must comply with the applicable EWIS requirements of Part 25. See § 25.1701. Refer to Advisory Circular 25.1701-1, *Certification of Electrical Wiring Interconnection Systems on Transport Category Airplanes*, for specific compliance guidance.

(2) We consider EWIS to be an airplane system. Therefore, EWIS associated with IMA systems required for type certification or by operating rules, including those specifically listed in § 25.1705(b) must be considered as an integral part of that IMA system and must be considered in showing compliance with the applicable requirements for that IMA system. See § 25.1705(b).

(3) Circuit protective devices for the IMA cabinet or rack must comply with the requirements of § 25.1357. See § 25.1357. This includes § 25.1357(f) which requires IMA systems for which the ability to remove or reset power during normal operations is necessary be designed so that circuit breakers are not the primary means to remove or reset system power unless specifically designed for use as a switch.

7-2. Field Loadable Software.

a. Many IMA systems use field loadable software (FLS) as part of the TC/STC/ATC/ASTC installation. FLS is software that can be loaded into the host hardware without removing the equipment from the aircraft installation. FLS might also include software

loaded into a line replaceable unit (LRU) or hardware component at a repair station or shop. FLS can refer to either executable code or data, such as a database. When seeking approval to use FLS, you should consider the following:

(1) FLS should meet the objectives and guidance of RTCA/DO-178B or other acceptable means of compliance, as agreed to between the applicant and your responsible ACO.

(2) The FLS should be loaded on the target computer and hardware configuration that the software was verified on during DO-178B on-target verification testing.

(3) A means must exist to ensure that the FLS is loaded into the proper IMA configuration approved for that aircraft. See § 21.31. See Chapter 5 for more information on configuration management.

(4) If redundant functions of the IMA system are field loadable, the applicant should ensure that they have the same software configuration, unless intermixing of different software configurations is supported by the safety assessment and approved for the aircraft configuration and type design.

(5) The applicant should have a process to assure that the software loaded is the software approved and that it hasn't been corrupted – for example, verification with a cyclic redundancy or other data transfer integrity check. Different data integrity algorithms give different assurances that the data transfer is correct. Ensure that the algorithm used is commensurate with the integrity required for the software level of the data being loaded.

(6) If the applicant proposes more than one medium for loading the FLS, such as a diskette, mass storage device or compact disc, loading from each medium should comply with the guidance in this section.

(7) The applicant should demonstrate that the airborne equipment software part numbers can be verified with onboard equipment, carry-on equipment, an automated configuration management scheme, or other appropriate means.

(8) Loading protection mechanisms should be implemented to inhibit loading FLS during flight. The reliability of these mechanisms should be commensurate with the failure condition associated with the inadvertent loading of software during flight.

Note: Please refer to AC 120-76A, *Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices,* for guidance that pertains to loadable IMA software components that implement an Electronic Flight Bag function.

b. FLS installation documents should specify the following elements:

(1) Aircraft and hardware applicability and intermixability allowances for redundant systems that load software.

(2) Verification procedures to ensure that the software was correctly loaded into an approved, compatible target computer and memory device(s).

(3) Any post-load verification and/or test procedures required to show compliance to the guidelines specified in this AC.

(4) Actions to take – for example, prohibiting dispatch of aircraft – if there's an unsuccessful load.

(5) Reference to an approved loading procedure.

(6) Maintenance record entry procedures required to document and maintain configuration control.

(7) Reference to the appropriate Aircraft Flight Manual (AFM), Aircraft Flight Manual Supplement (AFMS) or operator's manual, if necessary.

7-3. Electronic Identification Guidance.

a. Identification of software components field-loaded into hardware elements should be implemented by electronic means. Electronic identification markings consist of identifying software components by electronically embedding the identification within software contained in the hardware, rather than on the equipment nameplate.

b. Electronic software part numbers and versions should be verifiable through an electronic query, such as an electronic display. Software part number configuration errors detected by an automated robust IMA configuration management function should be annunciated to the flight crew until appropriate maintenance action is performed.

c. Equipment authorized by TSO must be permanently and legibly marked with specific information. See § 45.15(b). The applicant can demonstrate compliance to § 45.15(b) when you provide the information required by an electronic identification query system stored in non-volatile memory. This approach is commonly called an "electronic TSO nameplate." The electronic identification system should be verifiable onboard the aircraft when the aircraft is on the ground at any geographic location. It must provide the specific information for all applicable TSOs being marked is using the electronic TSO nameplate as the only means of labeling. See § 45.15(b).

d. Electronic identification may also provide software and hardware component revision or modification status information and RTCA/DO-178B software level. The applicant can use this to demonstrate conformity to type design configuration.

e. Include information identifying the location of each hardware component in the electronic identification. This is necessary because the configuration depends on the specific location of each hardware component within the cabinet or rack. You can satisfy this

requirement when an automated configuration management system scheme tracks and protects the IMA system configuration by ensuring hardware components are properly located.

f. All hardware components that support functions approved by a TSO should have a physical TSO nameplate. However, you may use electronic means instead of verifying nameplates on each hardware component, if all required information is available electronically. Electronic identification does not replace hardware and software conformity inspections that determine the components are produced in conformity to type design.

g. Order 8150.1 (see the most current version) provides additional information on TSO part marking.

7-4. Aircraft System Lightning and HIRF Protection.

a. When you are showing compliance with aircraft lightning and HIRF protection regulations, you must demonstrate that the functions performed by electrical and electronic systems, whose failure could prevent continued safe flight and landing, are not adversely affected when exposed to lightning and HIRF. See §§ 23.1308, 25.1316, 25.1317, 27.1317, and 29.1317. The compliance demonstration for these systems should consider the performance of the integrated system, not only the equipment or modules that make up the system. To comply with this requirement to demonstrate no adverse effects on the functions performed by the system, lightning, and HIRF tests should be performed with the IMA system in a test setup that represents the wiring, hardware, and software configuration that will be installed on the aircraft. These lightning and HIRF system test configurations are typically more complex than those used for TSO compliance or equipment qualification. Guidance for compliance is in AC 20-136A, *Protection of Aircraft Electrical/Electronic Systems Against the Indirect Effects of Lightning,* and AC 20-158, *The Certification of Aircraft Electrical and Electronic Systems for Operation in the High-Intensity Radiated Fields (HIRF) Environment.*

b. For systems that perform functions whose failure would significantly reduce the capability of the aircraft or the ability of the flight crew to respond to an adverse operating condition, the compliance demonstration may be based on lightning and HIRF tests performed on individual elements of equipment. RTCA/DO-160F tests satisfy these requirements.

c. Electromagnetic compatibility (EMC) between the IMA system and other aircraft systems should be demonstrated when the IMA system is installed in the aircraft. RF emission tests, such as those in RTCA/DO-160F, Section 21, should be performed on the IMA modules, equipment and systems to provide confidence that the IMA system does not produce unacceptable RF emissions. However, the EMC demonstration to comply with regulations such as §§ 23.1431, 25.1431, and 29.1431 should be performed with the IMA system and the other electrical and electronic systems installed on the aircraft.

7-5. IMA System Data Network. Many, if not all, IMA systems will include a dedicated data network, such that the elements within an IMA system may communicate with each other without using the main aircraft or engine data network. This data network may be purely internal to an IMA cabinet or, for distributed IMA components, the data network may be

required to span the length and breadth of the airframe in which the IMA is installed. For data networks that are dedicated to or primarily for IMA system data transmission and reception and are distributed in nature – that is, not purely internal to the IMA cabinets or modules – the applicant and IMA developer/system integrator should follow the guidance provided in AC 20-156, *Aviation Databus Assurance,* or use another acceptable means.

Chapter 8 Use Of TSO Authorized Components In IMA Systems.

8-1. IMA Systems and TSOs.

a. IMA systems, depending on the specific aircraft or engine application, may combine many functions that were historically in functionally and physically separated systems. These IMA functions are made up of hardware and software components, each of which may be authorized by TSO, either complete or incomplete. Additionally, hardware modules, cabinets, and racks that host the IMA hardware modules may also be authorized by TSO.

b. TSO authorizations are allowed under 14 CFR part 21, subpart O. Your responsible ACO can explain how we evaluate and issue TSOAs and letters of TSO design approval (LODA) for aviation-related articles.

c. TSOs associated with IMA systems are:

(1) TSO-C153, which covers two types of hardware used in IMA systems: generic hardware modules and cabinets/racks that host hardware modules.

(2) Functional TSOs. See paragraph 8-7 below and refer to Appendix G for examples of functional TSOs. You should keep in mind that this term is not normally used except in the context of IMA systems.

d. RTCA/DO-297 does not specifically address TSO authorized articles within an IMA system. This chapter offers you a way to obtain approval for IMA systems that contain hardware and/or software components authorized by TSO.

e. Due to the high integration, functional TSO data packages for IMA systems are typically developed in parallel with the TC/STC/ATC/ASTC effort. In these cases, you should not submit TSO data to the ACO for authorization until the TC/STC/ATC/ASTC testing for the IMA system is completed and the final IMA system configuration is established. This will ensure that the IMA system meets all required TSO MPS. Alternatively, compliance data for TSO authorization and compliance data for the TC/STC/ATC/ASTC maybe be submitted to the appropriate FAA offices concurrently, such that the TSO authorization may be issued concurrently with the aircraft/engine certificate. This alternative approach requires a high level of coordination between the responsible FAA offices to ensure that issues that arise in one area do not affect the other.

8-2. TSO-C153 Authorization for IMA Hardware Components.

a. To obtain TSO-C153 authorization, the applicant for TSO authorization must demonstrate that the individual hardware components meet the MPS and defined subset of RTCA/DO-160F environmental qualification requirements in TSO-C153, as described in Appendix A. See § 21.616(c). TSO-C153 does not provide either functional or installation approval.

b. The applicant for an IMA Component Acceptance Letter may use TSO-C153 authorization as compliance data to obtain IMA component acceptance for IMA hardware components. See RTCA/DO-297, Table 4.

8-3. Functional TSO Authorization.

a. A functional TSO is a TSO with a defined aircraft functionality. For example, TSO-C106 is for an air data computer. Other examples of functional TSOs are listed in Appendix G of this AC. TSO-C153 is not considered a functional TSO because the hardware element it addresses does not have system level functionality. A functional TSO authorization is issued for a specific IMA system configuration, including hardware and software components, that performs the function defined in the functional TSO MPS. It is not simply for the software component that is loaded into a TSO-C153 authorized hardware element.

b. If the IMA system provides all or part of the functionality required by the functional TSOs MPS and the company applying for functional TSO authorization also controls the design and quality of the complete IMA system, then that company may apply for functional TSO authorizations (either complete or incomplete) for each aircraft function for which there is an applicable functional TSO. As noted above in 8-3(a), the TSO authorization will apply to the IMA system and not a specific IMA component.

Note: Per § 21.601(b)(5), the manufacturer of an article is the "person who controls the design and quality of the article produced... including the parts of them and any processes or services related to them that are procured from an outside source." For paragraph 8-3(b) to be applicable, the applicant for a TSO authorization must control the design and quality of the parts, processes, and services that are provided by any supplier to that applicant for a TSO authorization. See § 21.601(b)(5).

c. If the company supplying functional software that will be installed in an IMA system does not control the entire design and quality, per 8-3(b) above, of the article that provides the functionality defined in the functional TSO MPS, then that company may not apply for functional TSO authorization.

d. It should be noted that there will typically be multiple functional TSO authorizations that comprise the IMA system, and the IMA system will likely contain functionality and features not addressed by any TSO. The overall functionality of the IMA system and the portions covered by TSOA versus TC, STC, ATC, or ASTC should be carefully documented and coordinated with the FAA.

8-4. EQT of IMA Components with TSO Authorization.

a. There will be three different stages at which TSO authorized IMA components and the IMA system in which these components are installed need to comply with EQT requirements:

(1) TSO-C153. This TSO contains EQT MPS for IMA hardware modules that qualify for TSO-C153 authorization. Comply with these requirements to obtain TSO-C153 authorization for the generic IMA hardware.

(2) Functional TSO MPS. Each individual functional TSO (see Appendix G for examples) MPS normally include EQT requirements. Comply with these requirements to obtain the individual functional TSO authorization(s).

(3) Aircraft or engine installation EQT requirements. EQT procedures and test configurations are based on the specific aircraft or engine installation of the complete IMA system. Compliance to the aircraft or engine level installation EQT requirements may be completed under the aircraft/engine certification program independent of the TSO authorizations. Alternatively, certification credit at the aircraft or engine installation level may be taken from the TSO authorizations, if applicable at the installation level.

b. TSO-C153 was written specifically to address how partial EQT compliance at the aircraft or engine installation level can take credit from the EQT compliance from TSO-C153 authorization. EQT procedures that require the test to be run on the specific IMA system configuration as it will be installed on the aircraft or engine should be accomplished during the aircraft or engine TC/ATC/STC/ASTC program. TSO-C153 and Appendix A of this AC address how this can be done.

c. Compliance to the EQT MPS for the individual functional TSO MPS is still required, even with TSO-C153 authorization of the hardware components which host that function.

d. An applicant for an IMA Component Acceptance Letter may use the EQT compliance data from a TSO authorization to use as compliance data for the IMA Component Acceptance Letter process addressed in Chapter 3 of this AC. The IMA Component Acceptance Cover Letter and the accompanying IMA Component Acceptance Letter data sheet should include which EQT are being accepted, including a statement of full or partial compliance and a matrix or table of all EQT procedure testing levels accomplished.

8-5. IMA Component TSO Part Marking.

a. If loadable software components are used with generic hardware modules authorized under TSO-C153 to implement a functional TSO, an applicant for functional TSO authorization should identify the loadable software – both the electronic identification and the physical or electronic media containing the loadable functional software – with the functional TSO identification.

b. The generic hardware components authorized by TSO-C153 must be permanently marked as being authorized under that TSO, in addition to any electronic identification. See § 21.607(d).

c. See paragraph 7-3 for electronic identification guidance.

8-6. Integration of TSO Authorized Components in IMA Systems.

a. The applicant should demonstrate that all RTCA/DO-297 objectives required to obtain Acceptance of the IMA modules, applications, system, and installation into the aircraft or engine have been met. This is true regardless whether any of the modules or applications are also part of a TSO authorized article as described above in paragraph 8-3. The TSO authorization for the IMA function may be used, if relevant, in showing that you met RTCA/DO-297 objectives. The presence of a TSO authorization in no way removes or reduces your responsibilities as an applicant, which is to ensure that the installed IMA system – including any TSO authorized components – meets the appropriate aircraft and engine regulations and the guidance in this AC.

b. Functional TSOs, such as TSO-C113, *Airborne Multipurpose Electronic Displays*, do not normally cover integration with other aircraft functions or hardware/software components in the integrated IMA system. Each TSO MPS is normally written assuming that it is a stand-alone function and that no integration requirements exist beyond integration into the aircraft. For this reason, additional work is likely to be required beyond the TSO authorizations when showing compliance at the integrated IMA system level. Please refer to RTCA/DO-297, subsection 4.4.

c. The installation instructions for TSO authorized IMA components should include all information necessary for the applicant and/or the IMA developer/system integrator to fully integrated the TSO authorized IMA component into the IMA system.

8-7. Aircraft Installation Approval of IMA Systems Including TSO Authorized Components.

a. The applicant must demonstrate that the installed IMA system configuration – including both hardware and software components – and performance meets the appropriate aircraft and engine certification basis. See § 21.20. This demonstration should include functional performance, interoperability, aircraft-level and system-level safety assessments, environmental qualification, system integration test, flight-test, software and hardware assurance, etc., as required to show compliance to the regulations.

b. The applicant may use TSO authorizations to support airworthiness assessment if you show that the TSO requirements apply to the installation into the aircraft or engine. Any change to the hardware or software configuration of an IMA component must be controlled at both the TSO and the aircraft installation level. See §§ 21.31 and 21.611.

8-8. Roles and Responsibilities When TSO Authorized Components Are Used in IMA Systems.

This section identifies the major roles and responsibilities for the TSO-C153 applicant, the functional TSO applicant, and the aircraft/engine applicant when TSO authorized components are used. These lists are not all-inclusive. We encourage all affected parties to coordinate with us throughout the entire IMA system development. See Appendix A for more guidance applicable to TSO-C153 authorization.

a. TSO-C153 Applicant Roles and Responsibilities:

(1) Apply for TSO-C153. If you are a manufacturer of a TSO article, due to the complexity of IMA projects, we recommend that you coordinate with us early in the program.

(2) Build an MPS for the hardware element according to TSO-C153. Ensure that you document all the appropriate items in TSO-C153, Appendix 1 and that we approved them.

(3) Develop and implement part identification and configuration management functionality into hardware elements. The configuration management and part identification approach should follow chapter 5 and paragraphs 7-3 and 8-5 of this AC.

(4) Coordinate with the applicant and/or IMA developer/system integrator who will be integrating and installing the hardware elements on the aircraft to ensure that the relevant issues are identified and addressed as early as possible.

(5) Design and build hardware elements per TSO-C153 and the MPS.

(6) Perform the tests necessary to demonstrate compliance with the TSO-C153 and the MPS. See paragraph 8-4 and appendix A of this AC. If special purpose test software is used for EQT, validate and control the configuration of the hardware elements and software components to ensure the validity of the testing.

(7) Submit the data package (the information in TSO-C153 paragraph 5, including the MPS) to your responsible ACO for review and issue of TSO authorization.

(8) Apply for changes to TSO-C153 elements as design changes occur. Notify TC, ATC, STC, and ASTC holders and functional TSO holders, if any, of the design change.

b. Functional TSO Applicant Roles and Responsibilities.

(1) Apply for functional TSO to your responsible ACO.

(2) Design the system according to the appropriate TSO MPS.

(3) Identify the usage domain in which the TSO authorized IMA component was shown to meet the TSO MPS. If the environment in which the component verification was conducted is not exactly the same as the usage domain of the completed IMA system, then you should perform analysis and/or testing to demonstrate those differences do not affect the use of the IMA component within the intended usage domain.

(4) Identify and address all integration and approval issues with the IMA hardware component that will host the functional TSO software. Coordinate these issues with the applicant and/or the IMA developer/system integrator (if different than the functional TSO applicant).

(5) Develop mapping between the TSO requirements and the IMA system implementation – for example, a mapping matrix. Mapping should identify TSO requirements that are fully met, partially met, or not met at all. This includes any partial compliance to RTCA/DO-178B for software, RTCA/DO-254 for CEH, and RTCA/DO-160F for EQT.

(6) Identify any limitations regarding the use of the IMA component in an IMA system.

(7) Refer to FAA Order 8150.1, *Technical Standard Order Program*, as needed to understand the FAA policy regarding TSO authorized articles. You should contact your responsible ACO if you have any questions you cannot answer.

(8) Identify functions in the IMA system not addressed by the TSO. Any functionality not specifically addressed by the functional TSO MPS may require deviations. This additional functionality may be classified as a "non-TSO function", or it may be small enough in nature or closely related to the functional TSO, such that the applicant for a functional TSO classifies it as a "feature." Both non-TSO functions and features should be documented and addressed.

(9) Perform tests to demonstrate compliance to the functional TSO or functional performance standards. Some required EQT may not have been accomplished during TSO-C153 authorization. You should demonstrate that all testing, including EQTs required for the functional TSO, has been accomplished. If special purpose test software is used for environmental qualification, you should verify and control the configuration of the software to ensure the validity of the testing. Credit may be applied for EQT conducted for the TSO-C153 authorization, if appropriate. See paragraph 8-4 for more information.

(10) Submit the data package required by the functional TSO to the responsible ACO for review and issuance of the TSO authorization. Include installation data and configuration of the functional TSO as part of the data package. See paragraph 8-3 for more information.

(11) Apply for changes to functional TSOs, as design changes occur. Notify TC, STC, ATC, and ASTC holders of the design change.

c. Applicant Roles and Responsibilities.

(1) Develop and submit a Project-Specific Certification Plan (PSCP) for the IMA system to the responsible ACO for approval.

(a) We recommend that you include a detailed conformity plan covering all hardware and software components' conformity and installation conformity inspections (including the plan for addressing any "red label" units).

(b) The PSCP should clearly identify what functions will and will not be approved through the TSOA process. This is necessary to identify what will be TSO authorized and what will be TC/STC/ATC/ASTC approved.

(c) The PSCP should address integration and approval of all components of the IMA system (including all hardware elements and software components).

(2) Define aircraft system and performance requirements.

(3) Perform aircraft-level safety assessment per RTCA/DO-297, subsection 5.1 and submit it to your ACO.

(4) Integrate all hardware elements and software components in the IMA system. This task may be accomplished by the IMA developer/system integrator.

(5) Integrate the IMA system into the aircraft or engine.

(6) Ensure that no TSO assumptions are violated in the installation. For example, ensure that relocating the GPS card does not invalidate the environmental qualification credit for the GPS TSO. (See chapter 8 of this AC.)

(7) Develop field-loading procedures to ensure that proper software is loaded on the aircraft. (See paragraphs 5-4 and 7-2 of this AC.)

(8) Verify software and complex electronic hardware issues were properly addressed for the installation. (See RTCA/DO-297, Sections 3, 4, and subsection 5.2.)

(9) Determine appropriate aircraft environmental conditions and ensure that EQTs were performed. (See RTCA/DO-297, subsection 5.2.6.)

(10) Develop all required test plans (see RTCA/DO-297, Section 4) and perform necessary tests.

(11) Develop a plan for addressing human factors issues (see RTCA/DO-297, subsection 3.10) and perform human factors and flight crew evaluations of the IMA system.

(12) Ensure that the IMA system meets all airworthiness requirements.

(13) Submit the functional hazard analyses, safety assessments, hardware design assurance data, software data, test plans, test results, compliance reports, and all other appropriate certification data to the FAA for approval. The preliminary functional hazard analysis and preliminary system safety analysis should be submitted before finalizing the software, CEH, and SEH levels and the IMA architecture.

(14) Maintain aircraft system configuration management. (See RTCA/DO-297, subsection 3.7 and paragraph 5-1 of this AC.)

(15) Evaluate and document changes to IMA system and elements per § 21.93. (See RTCA/DO-297, subsection 4.6.)

(16) Ensure that aircraft design features address safety. (See RTCA/DO-297, subsection 3.3.)

Appendix A Environmental Qualification Guidance for TSO-C153.

1. TSO-C153, Appendix 1 lists environmental qualification tests (EQT) to satisfy the TSO minimum performance standard. Perform these EQTs according to procedures and category levels in RTCA/DO-160F. Select the category levels tested as appropriate for the aircraft installation and environment. The EQTs should apply to functional TSO environmental qualification and may be applied to the aircraft TC, STC, ATC, or ASTC environment qualification.

2. Table 1-1 below lists the RTCA/DO-160F environmental tests that can be accomplished under TSO-C153 authorization, and how they may affect functional TSO authorization.

Table 1-1. RTCA/DO-160F Environmental Qualification Requirements.

RTCA/ DO-160F Section #	RTCA/DO-160F Section Title	Required for TSO-C153	Required for Functional TSO
4	Temperature and Altitude - Temperature	Not tested	Yes
4	Temperature and Altitude - Altitude	Yes	Yes, TSO-C153 qualification data may be used by similarity
5	Temperature Variation	Not tested	Yes
6	Humidity	Yes	Yes, TSO-C153 qualification data may be used by similarity
7	Operational Shock and Crash Safety - Operational Shock	Not tested	Yes
7	Operational Shock and Crash Safety - Crash Safety	Yes	Yes, TSO-C153 qualification data may be used by similarity
8	Vibration	Not tested	Yes
9	Explosion-proofness	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity
10	Waterproofness	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity
11	Fluid Susceptibility	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity
12	Sand and Dust	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity
13	Fungus Resistance	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity

RTCA/ DO-160F Section #	RTCA/DO-160F Section Title	Required for TSO-C153	Required for Functional TSO
14	Salt Spray	Yes, if appropriate	Yes, TSO-C153 qualification data may be used by similarity
15	Magnetic Effect	Yes	Yes, TSO-C153 qualification data may be used by similarity
16	Power Input	Not tested	Yes
17	Voltage Spike	Yes	Yes, TSO-C153 qualification data may be used by similarity
18	Audio Susceptibility – Power Inputs	Yes	Yes, TSO-C153 qualification data may be used by similarity
19	Induced Signal Susceptibility	Not tested	Yes
20	Radio Frequency Susceptibility	Not tested	Yes
21	Emissions of Radio Frequency Energy	Not tested	Yes
22	Lightning Induced Transient Susceptibility	Not tested	Yes
23	Lightning Direct Effects	Not tested	Yes
24	Icing	Yes	Yes, TSO-C153 qualification data may be used by similarity
25	Electrostatic Discharge	Yes	Yes, TSO-C153 qualification data may be used by similarity

Note: RTCA/DO-160F, Sections 20 and 22 may require additional testing at aircraft installation.

3. Certain EQTs cannot be appropriately performed on the hardware elements as part of TSO-C153. These EQTs can only be appropriately performed when the IMA system and hardware elements are arranged in the configuration specified for the applicable aircraft, as defined for the aircraft TC, STC, ATC, or ASTC. Also, these EQTs can only be appropriately performed with the functional software installed and operating. Therefore, certain RTCA/DO-160F EQTs are excluded from TSO-C153. You should address these EQTs as part of the functional TSO compliance, or as part of the TC/STC/ATC/ASTC environmental qualification. These tests are described below:

a. EQT for temperature (RTCA/DO-160F, Section 4) and temperature variation (RTCA/DO-160F, Section 5). Perform these with the cabinet or rack and modules in the hardware configuration intended for the functional TSO authorization or the TC/STC/ATC/ASTC approval. For temperature and temperature variation tests for the functional TSO or

TC/STC/ATC/ASTC, the hardware module arrangement should represent the expected worst-case temperature conditions. Alternately, applicants for the functional TSO or for aircraft/engine certification may perform engineering analysis, using validated models, of the thermal characteristics of the expected cabinet or rack and module configuration variations to determine temperature test parameters that exceed the worst-case expected temperature conditions. These temperature test parameters could be used instead of the standard RTCA/DO-160F, Sections 4 and 5, temperature conditions.

b. EQT for operational shock (RTCA/DO-160F, Section 7) and vibration (RTCA/DO-160F, Section 8). Perform these with all cabinet/rack module positions occupied in the hardware configuration specified for the functional TSO or TC/STC/ATC/ASTC installation. Alternately, you could perform an engineering analysis, using validated models, of the characteristics of the expected cabinet or rack and module configurations to determine vibration and operational shock test parameters that exceed the worst expected conditions. These test parameters could be used instead of the standard RTCA/DO-160F, Sections 7 and 8 conditions.

c. EQT for induced transients (RTCA/DO-160F, Section 19), radio frequency (RF) susceptibility (RTCA/DO-160F, Section 20), RF emissions (RTCA/DO-160F, Section 21), and lightning induced transients (RTCA/DO-160F, Section 22). These are most appropriately performed with the functional hardware and software in the IMA system. This is because the response of the system may be highly dependent on the functional software and hardware. Therefore, perform these EQTs as part of the functional TSO compliance or as part of the TC/STC/ATC/ASTC environmental qualification.

d. EQT for lightning and HIRF protection. Perform these with the hardware elements and software components loaded in the configuration specified for the applicable aircraft, per the lightning regulations, ACs, and the HIRF policy. The interface wiring and connected equipment should represent the wiring and connected equipment installed in the aircraft.

4. You may use EQT performed for a single functional TSO authorization or aircraft TC/STC/ATC/ASTC to support other applications for functional TSOs or aircraft TC/STC/ATC/ASTCs with similar configurations. A TSO applicant may use similarity assessment and worst-case test conditions to minimize the EQT required for subsequent functional TSO applications or aircraft TC/STC/ATC/ASTC. Your use of the environmental qualification data should be accompanied by a rational engineering analysis of the differences between hardware and software configuration used during the original environmental tests and the proposed new configuration. The engineering analysis may consider worst-case environmental limits developed above.

5. The functional TSO qualification data sheet should state explicitly the RTCA/DO-160F test categories and tests performed in the functional TSO configuration and the test categories and tests performed in the TSO-C153 configuration. Include this information in the installation instructions.

6. Hardware modules and software components providing a function that lacks an applicable functional TSO must meet the TC/STC/ATC/ASTC environmental requirements. See § 21.31.

7. You must evaluate all hardware elements before installation to ensure that the TC/STC/ATC/ASTC environmental requirements have been satisfied. See § 21.31.

Appendix B Sample IMA Component Acceptance Cover Letter.

Use the following as a guide for an IMA Component Acceptance Cover Letter. The format given here does not need to be followed precisely. It is important, however, that all the information be present, in some form, in the letter.

COMPANY NAME
COMPANY ADDRESS
COMPANY CONTACT INFORMATION

Date of application

Unique identifier

IMA Component Acceptance Cover Letter

General Information

IMA component name:

_____

IMA component top level identification: ___*(Must uniquely identify the component, including any revision or modification level.)*_____

Name and contact information of company that developed the IMA component (if different than the applicant for the IMA Component Acceptance Letter):

_____

Contact information: *(List the name(s) of engineering and/or managerial staff to which the FAA and other companies involved in the use and possible future reuse of this component may correspond. Include the person's position or title within the company, telephone number and, if possible, a stable e-mail address.)*

FAA office to which the application for IMA component acceptance is being made:

_____

Aircraft or engine certification program in which IMA component will be used for initial acceptance, including target certification date:

_____

Name and identification of IMA system in which the IMA component will be used for initial acceptance: _____

Name and address of IMA system developer/integrator (if different than the IMA component developer making this application):_____

Information Regarding Initial Use of IMA component

Describe the airborne system and environment in which the IMA component will be operating, also referred to as the "usage domain." This information may vary widely based on the type of component. Information about hardware components, such as their being installed in a rotorcraft or in an unpressurized location of the aircraft structure, will be different than if the component is a software operating system. For hardware components, this description should be adequate to estimate the environmental qualification testing levels for RTCA/DO-160F compliance for the initial installation.

This section informs the FAA, as well as any potential future re-users of the accepted component, how the IMA component is being used for its initial acceptance and what might need to be re-examined during any future reuse.

Information may be at a high level, with more detailed information contained in the IMA Component Acceptance Letter data sheet.

Information Regarding Partitions (if any) and Assurance Levels within the IMA Component

Describe all the various software partitions (if any) within the IMA component. Identify the software assurance level for each software partitions. Justify at a high level why that assurance level is appropriate. With hardware components for which you are seeking acceptance for compliance to RTCA/DO-254, identify and describe each component along with the design assurance level (DAL) of each component and a justification of why this DAL is appropriate. If there are multiple DALs on a single CEH/SEH device, then address each of those DALs. Include information regarding the separation of the multiple DALs on a single device.

This section informs the FAA, as well as any potential future re-users of the accepted component, of the various assurance levels (both hardware and software) within the IMA component and what might need to be re-examined during any future reuse.

Information may be at a high level, with more detailed information contained in the IMA Component Acceptance Letter data sheet.

Statement of Full or Partial Compliance to Industry Standards

State for which industry standards RTCA/DO-178B for airborne software, RTCA/DO-254 for CEH, RTCA/DO-160F for EQT) acceptance is being sought with this IMA component. State whether you seek full or partial compliance to these standards. Your IMA Component Acceptance Cover Letter does not need to explain, in detail, any partial compliance to these standards--include that detailed information in the IMA component acceptance data sheet. The statement of full or partial compliance in the IMA Component Acceptance Cover Letter is only

an indicator to the FAA and any future re-user of this component that additional activity is needed to show full compliance at the time of installation approval of the IMA system.

If you seek any compliance for SEH for the IMA component acceptance, this section should document that fact. Include the compliance data or references to where the compliance data may be found in the IMA component acceptance data sheet.

If you seek compliance to any other technical discipline, besides those listed above with this IMA component acceptance, document it here. Include a high-level discussion of the requirements for which you seek compliance, and where the detailed requirements are documented. Include more detailed information about the compliance data in the IMA Component Acceptance Letter data sheet.

Configuration Information of IMA component

Include enough information to specify exactly the baseline configuration of the IMA component being accepted, including the development and verification environment. Include only a list of the documents names, numbers and revision levels. All other information concerning the configuration identification may be included in the IMA Component Acceptance Letter data sheet.

This section makes clear the configuration of the IMA component being accepted. If any of the documents identified in this section are revised, then write a new IMA component acceptance letter.

Statement of compliance to the applicable requirements

State in the IMA Component Acceptance Letter that the signatories attest that the IMA component meets all the applicable requirements defined in the IMA Component Acceptance Letter. A sample statement is shown below:

> We, the undersigned, attest that we, to the best of our ability, have found this IMA component to be compliant with the applicable requirements as documented within this IMA Component Acceptance Letter.

Signatures – Applicant for the IMA Component Acceptance Letter

This section should show the signatures of specific company individuals, per paragraph 4-3 of this AC. There should also be a printed version of the signing individual's name and title. Each signature should include the date on which they signed the IMA Component Acceptance Cover Letter, as well as an indication of which technical discipline to which that signature applies. The IMA component acceptance letter should be signed by the appropriate persons before submitting the original, along with the IMA Component Acceptance Letter data sheet, to the FAA.

Appendix C Sample Acceptance Letter.

U.S. Department
of Transportation
Federal Aviation
Administration

Issuing FAA office

Issuing FAA office address

Issuing FAA office address

In Reply Refer To: (*FAA correspondence number*)

(*Date of Letter*)

(*Name and address of recipient*)

Subject: Integrated Modular Avionics (IMA) Component Acceptance Letter (*unique identifier from company's application for an IMA Component Acceptance Cover Letter*)

The FAA has determined that (*company name*) complies with AC 20-170 and RTCA/DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*, with regards to (*IMA component name*), (*IMA component top level identification, including revision level*), for the purposes of IMA component acceptance.

The following terms and conditions are applicable to this IMA Component Acceptance Letter:

1. This acceptance is based on the usage domain, restrictions, partial compliance, assurance levels and other such information as documented in the attached IMA Component Acceptance Cover Letter and its IMA Component Acceptance Letter data sheet.

2. This IMA Component Acceptance Letter is only applicable to (*IMA component name and top level identification, including revision level*). This Acceptance Letter is not transferable to an updated version of (*IMA component name*). A new FAA IMA Component Acceptance Letter should be requested for the updated component, if one is desired.

3. (*Company name*) should report to the (*FAA office issuing this IMA Component Acceptance Letter*) any failure, malfunction, defect of the component or finding of any non-compliance or deviation from the compliance statements made in the attached IMA component acceptance letter. The FAA may choose to cancel this IMA Component Acceptance Letter if warranted, which will have the effect of requiring (*company name*) to update (*IMA component name*) to address the shortcoming before a new IMA Component Acceptance Letter can be issued.

4. (*Company name*) should coordinate with and supply any required data to any future or concurrent user of the accepted IMA component, such that the user is able to show full compliance to AC 20-170 and RTCA/DO-297 for that future or concurrent use.

The holder of a valid FAA IMA Component Acceptance Letter may use it as proof of acceptance by the FAA, as defined in the IMA Component Acceptance Letter including the IMA component acceptance data sheet, for the purpose of future or concurrent use of the accepted IMA component. The actual compliance data used in obtaining the IMA Component Acceptance Letter does not need to be re-submitted to the FAA, unless the FAA has concerns that cannot be answered by any other means except by re-examining the original IMA component acceptance data.

(*signature*)

(*printed FAA signatory*)

cc: (*as appropriate*)

Attachment: (*Copy of the IMA Component Acceptance Cover Letter. Do not include the IMA Component Acceptance Letter data sheet.*)

Appendix D Related Documents And How To Get Them.

1. Copies of 14 CFR parts are available from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis MO 63197. Telephone (202) 512-1800, fax (202) 512-2250. You can also order copies online at www.access.gpo.gov. Select "Online Bookstore." Then select "Code of Federal Regulations."

2. The following ACs are available from the FAA website at http://www.faa.gov/regulations_policies/advisory_circulars/.

1) AC 20-88, *Guidelines on the Marking of Aircraft Powerplant Instruments (Displays).*

2) AC 20-115, *RTCA, Inc. Document RTCA/DO-178B.*

3) AC 20-136A, *Protection of Aircraft Electrical/Electronic Systems Against the Indirect Effects of Lightning.*

4) AC 20-148, *Reusable Software Components.*

5) AC 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware.*

6) AC 20-156, *Aviation Databus Assurance.*

7) AC 20-158, *The Certification of Aircraft Electrical and Electronic Systems for Operation in the High-Intensity Radiated Fields (HIRF) Environment.*

8) AC 20-174, *Development of Civil Aircraft and Systems.*

9) AC 21-16, *RTCA, Inc. Document RTCA/DO-160F.*

10) AC 23.1309-1, *System Safety Analysis and Assessment for Part 23 Airplanes.*

11) AC 23.1311-1B, *Installation of Electronic Displays in Part 23 Airplanes.*

12) AC 25-11A, *Electronic Flight Deck Displays.*

13) AC 25.1309-1, *System Design and Analysis.*

15) AC 25.1701-1, *Certification of Electrical Wiring Interconnection Systems on Transport Category Airplanes.*

15) AC 27-1, *Certification of Normal Category Rotorcraft.*

16) AC 29-2, *Certification of Transport Category Rotorcraft.*

17) AC 33.28-1, *Compliance Criteria For 14 CFR § 33.28, Aircraft Engines, Electrical And Electronic Engine Control Systems.*

18) AC 33.28-2, *Guidance Material For 14 CFR § 33.28, Reciprocating Engines, Electrical and Electronic Engine Control Systems.*

19) AC 33.75-1, *Guidance Material for 14 CFR 33.75, Safety Analysis.*

20) AC 120-64, *Operational Use and Modification of Electronic Checklists.*

21) AC 120-76A, *Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices.*

3. The following FAA policy statements are available from the FAA website at http://www.faa.gov/regulations_policies.

1) FAA Policy Memo ANM-01-03, *Factors to Consider When Reviewing an Applicant's Proposed Human Factors Methods of Compliance for Flight Deck Certification.*

2) FAA Policy Memo ANM-99-2, *Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks.*

3) FAA Policy Memo PS-ACE100-2001-004, *Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Part 23 Airplanes.*

4. Order RTCA documents from RTCA, Inc., 1150 18th Street NW, Suite 910, Washington, D.C. 20036. You can also order copies online at www.rtca.org. We referenced the following RTCA documents:

1) RTCA/DO-160F, *Environmental Conditions and Test Procedures for Airborne Equipment.*

2) RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification.*

3) RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware.*

4) RTCA/DO-257A, *Minimum Performance Standards for the Depiction of Navigational Information on Electronic Maps.*

5) RTCA/DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations.*

5. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. You can also order copies on-line at www.sae.org. We referenced the following SAE documents:

1) ARP4754 Rev A. *Guidelines for Development of Civil Aircraft and Systems.*

2) ARP4761, *Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.*

Appendix E Glossary

Acceptance	FAA acknowledgement that the module, application, or system meets defined requirements.
Aircraft function	Capability of the aircraft provided by the hardware and software of the systems on the aircraft.
Airworthiness	Condition of an item (aircraft, aircraft system, or part) in which that item operates in a safe manner to accomplish its intended function.
Applicant	Person or organization seeking approval from the FAA.
Application	Software and/or application-specific hardware with a defined set of interfaces that, when integrated with a platform(s), performs a function.
Application-specific hardware	Hardware dedicated to one application.
Approval	Act or instance of giving formal or official acknowledgement of compliance with regulations.
Assumptions	Statements, principles, and/or premises offered without proof.
Assurance	Planned and systematic actions necessary to provide adequate confidence and evidence that a product or process satisfies given requirements.
Authority	Organization or person responsible within the state (country) concerned with applicable requirements. Aircraft, engine, or propeller type certification or equipment approval is normally handled by the certification authority. Matters concerning continuing airworthiness might be handled by (what's referred to as) the airworthiness authority.
Baseline	Approved, recorded configuration of one or more configuration items, that serves as the basis for further development. Baseline is changed only through change control procedures.

Cabinet	Physical package containing one or more IMA components or modules. Provides partial protection from environmental effects (shielding). May enable installation and removal of those component(s) or module(s) from the aircraft without physically altering other aircraft systems or equipment.
Certification	Legal recognition by the FAA that a product, service, organization, or person complies with the requirements. Certification comprises the activity of technically checking the product, service, organization, or person and the formal recognition of compliance with the applicable requirements by issuing a certificate, license, approval, or other documents as required by national laws and procedures. In particular, product certification involves: (a) assessing the product design to ensure that it complies with standards applying to that type of product to demonstrate an acceptable level of safety, (b) assessing an individual product to ensure that it conforms with the certified type design, and (c) issuing a certificate required by national laws to declare that compliance or conformity was found with standards according to items (a) or (b) above.
Certification credit	Acceptance by the FAA that a process, product, or demonstration satisfies a certification requirement.
Closed architecture	System whose technical specifications are not made public. Such systems restrict third parties from building products that interface with or add enhancements to them.
Complexity	Attribute of systems or items that makes their design and/or operation difficult to comprehend.
Complex electronic hardware	A subset of a complex hardware item; a custom micro-coded component that is not considered to be simple. (See "simple electronic hardware.")
Complex hardware item	Any hardware item not considered to be simple. (See "simple hardware item.")
Compliance	Successful performance of all mandatory activities; agreement between the expected or specified result, and the actual result.
Component	Self-contained hardware or software part, database, or combination thereof that is configuration controlled.
Computer	Device or group of devices that performs a data processing function.
Configuration control	See "change control."
Configuration identification	Process of designating the configuration items in a system and recording their characteristics.

Configuration index	Approved documentation that defines a configuration item.
Configuration item	1) One or more hardware or software components treated as a unit for configuration management purposes. 2) Software life cycle data treated as a unit for configuration management purposes.
Configuration management	Discipline applying technical and administrative direction and surveillance to (a) identify and record the functional and physical characteristics of a configuration item, (b) control changes to those characteristics, and (c) record and report change control processing and implementation status.
Criticality	Indication of the hazard level of a function, hardware, software, (and so forth), addressing abnormal behavior of this item alone, or with external events.
Custom micro-coded component	Component that includes application specific integrated circuits (ASIC), programmable logic devices (PLD), field programmable gate arrays (FPGA) and other similar electronic components used in the design of aircraft systems and equipment.
Domain	Grouping items into areas that share a common interest or characteristics.
Feature (of an article authorized by TSO)	An aircraft or engine function that is not identified in a functional TSO minimum performance specification. However, that feature is related to the functionality provided by a function provided by an article authorized by a functional TSO. The feature is also smaller than a complete function (see "non-TSO function), such that the feature can be included in the article authorized by the functional TSO, even though the functional TSO MPS does not specifically mention that functionality. Features are not approved by the functional TSO authorization. They should be approved during the aircraft or engine certification program.
Federated system	Aircraft equipment architecture consisting of primarily line replaceable units that perform a specific function, connected by dedicated interfaces or aircraft system data buses.
Function	Named capability that performs a specific task.
Functional software	Software applications that will be approved as part of a functional TSO authorization or as part of a type certification effort. Sometimes called operational software, application software, or flight software.
Functional TSO	TSO with a defined function. Examples of functional TSOs are in appendix G of this AC. TSO-C153 is not a functional TSO, because hardware elements typically do not provide system-level functionality.

Functional TSO applicant	Applicant seeking functional TSO authorization.
Guidelines	Recommended procedures for complying with regulations.
Hardware	Item with a physical being. Generally refers to line replaceable units or modules, circuit cards, power supplies and other line items.
Hardware element	Element authorized to TSO-C153. A hardware element (as defined in TSO-C153) is (1) a hardware module, or (2) cabinets or racks that host hardware modules. A hardware element with TSO-C153 authorization is *not* a functional TSO authorization. Note: This definition may differ from terms in RTCA/DO-254 and other documents.
Hardware/software integration	Embedding the software into the target computer.
Integrated modular avionics Component Acceptance Letter	A letter, signed by the FAA, which is composed of three parts; the IMA Component Acceptance Cover Letter, the IMA Component Acceptance Letter data sheet and the signed ACceptance Letter. The holder of a valid IMA Component Acceptance Letter may submit this letter as proof of compliance to the applicable requirements, as defined by the IMA Component Acceptance Cover Letter and IMA Component Acceptance Letter data sheet, to the FAA on a future or concurrent certification program for that IMA component.
Integrated modular avionics	Shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a platform that provides services. These services are designed and verified to a defined set of safety and performance requirements, to host applications performing aircraft functions.
IMA developer/system integrator	Company or organization responsible for IMA system integration. An IMA system integrator may or may not also develop most of the IMA hardware or software components.
Incremental acceptance	Process for obtaining credit toward approval and certification by accepting or finding that an IMA module, application, and/or off-aircraft IMA system complies with specific requirements. Credit granted for individual tasks contributes to the overall certification goal.

Integration	Gathering a number of separate components to form a single implementation.
Maintainability	Attribute of dependability in the ease of performing maintenance. In a quantified way, it is the measure of the interruption of service if a failure appears, the ease of identifying the failure, and performing the correct repair. A useful estimator associated with this measure is the MTTR, or mean time to repair.
Means of compliance	Method(s) used by the applicant to satisfy the requirements in the certification basis for an aircraft, engine or propeller.
Module	Component or collection of components that may be accepted by themselves or in the context of an IMA system. A module may also comprise other modules. A module may be software, hardware, or a combination of hardware and software, that provides resources to the IMA system's hosted applications.
Non-configured hardware component	A generic IMA hardware component that has not been configured (such as being loaded with operational software or enabling specific hardware pin programming) which is required before the component can perform an intended function or functions when installed on an aircraft or engine.
Non-TSO function	A non-TSO function: (a) Is anything that adds a performance capability to the article that is not covered or evaluated by any TSO MPS. (b) Does not support or must not affect the performance of the article addressed by the TSO MPS. Note: "Characteristics" or "features" added to enhance performance, usability or integrity of the TSO article, are inherent in the design of the TSO article, and have a direct bearing on the basic TSO operation are evaluated under the TSO approval and are not non-TSO function. Compliance with the software and hardware considerations in RTCA/DO-178 and RTCA/DO-254, when required by the TSO, provide the basis for approval of these characteristics or features of the article with respect to the RTCA/DO-178 and RTCA/DO-254 requirements. Examples might include: the capability to flip-flop the "active" and "standby" frequencies of a communication or navigation radio, facility information (such as, airport frequencies, runways, airport services available, etc.), built in test (BIT) capability on start-up, and health monitoring to name just a few. These examples are all associated with supporting the MPS of the TSO.
Open architecture	Type of computer or software architecture that allows adding, upgrading and swapping components with minimal effect on the remaining system.

Operating system	1) Same as executive software. 2) Software kernel that services only the underlying hardware platform. 3) Software that directs the operations of a computer, resource allocation and data management, controlling and scheduling the execution of computer hosted applications, and managing memory, storage, input/output, and communication resources.
Operational capability	Function or group of functions that provides an aircraft capability visible to the flight crew or other personnel.
Partition	Allocation of resources whose properties are guaranteed and protected by the platform from adverse interaction or influences from outside the partition.
Partitioning	Architectural technique to provide separation and independence of functions or applications. To ensure that only intended coupling occurs.
Robust configuration management	Capable of performing its intended function without failure under a wide range of conditions.
Platform	Module or group of modules, including core software, that manages resources support at least one application.
Resource	Any processor, memory, software, data, or object or component used by a processor, IMA platform, core software, or application. A resource may be shared by multiple applications or dedicated to a specific application. A resource may be physical (a hardware device) or logical (a piece of information).
Re-use	Subsequent use of unaffected, previously approved system hardware or software assurance data.
Robust Partitioning	Partitioning that provides demonstrable means of containment, protection and enforcement of the partition boundaries.
Safety	Attribute of dependability in non-occurrence of, or recovery from, failures and other conditions that could cause unacceptable, operational events of an aircraft, engine or component.

Simple electronic hardware	A subset of simple hardware item; a custom micro-coded component with a comprehensive combination of deterministic tests and analyses appropriate to the design assurance level. Ensures correct functional performance under all foreseeable operating conditions, with no anomalous behavior.
Simple Hardware Item	Item with a comprehensive combination of deterministic tests and analyses appropriate to the design assurance level. Ensures correct functional performance under all foreseeable operating conditions, with no anomalous behavior.
Software	Computer programs and, possibly, associated documentation and data of a computer system.
Software change	Modification in source code, object code, executable object code, or its related documentation from its previous baseline.
Software integration	Combining code components.
Software life cycle	1) An ordered collection of processes determined by an organization to produce a software product. 2) Period of time that begins with decision to produce or modify a software product and ends when product is retired from service.
Software product	Set of computer programs and associated documentation and data designated for delivery to a user. In this AC, it means software intended for use in an IMA system and its associated software life cycle data.
Specification	Collection of requirements which, when taken together, constitute the criteria that define the functions and attributes of a system, a component thereof, or an interface.
Standard	Rule or basis of comparison that provides both guidance in and assessment of the performance of a given activity or the content of a specified data item.
Structure	Specified arrangement or interrelation of parts to form a whole.
System	Collection of hardware and software components organized to accomplish a specific function or set of functions.

System architecture	Interfaces and structure of the hardware and software selected to implement the system requirements.
System safety assessment	1) Systematic, comprehensive evaluation of the proposed system to show that relevant safety-related requirements will be satisfied. 2) A systematic, comprehensive evaluation of the implemented system to show that the relevant safety-related requirements are satisfied.
Task 1	The activity associated with showing compliance to RTCA/DO-297, subsection 4.2, for IMA modules.
Task 2	The activity associated with showing compliance to RTCA/DO-297, subsection 4.3, for IMA applications.
Task 3	The activity associated with showing compliance to RTCA/DO-297, subsection 4.4, for an IMA system.
Task 4	The activity associated with showing compliance to RTCA/DO-297, subsection 4.5, for an IMA installation into an aircraft or engine.
Technical standard order authorization	Legal recognition by the FAA that a system, equipment, or part satisfies the TSO requirements and minimum performance specification, and FAA authorization to manufacture that item.
Unintended function	Function visible at the aircraft level and is neither intended nor a predicted (foreseeable) fault condition in the preliminary system safety assessment.
Usage domain	Declared set of characteristics for which it can be shown that: 1) Module complies with its functional, performance, and safety requirements as defined in the module requirements specification. 2) Module meets all the assertions and guarantees regarding its defined allocatable resources and capabilities. 3) Module performance is fully characterized, including fault and error handling, failure modes, and behavior during adverse environmental effects.
Validation	Determining that requirements are both correct and complete. System development may use requirements and derived requirements in system validation.
Verification	1) Evaluation of a requirements implementation to determine that they were met. 2) Evaluation of process results to ensure correctness and consistency of inputs and standards provided.

Appendix F Acronyms

AC	Advisory circular
ACO	Aircraft certification office
AFCB	Arc fault circuit breaker
AFM	Aircraft flight manual
AFMS	Aircraft flight manual supplement
ARP	Aerospace recommended practice
ASIC	Application specific integrated circuit
ASTC	Amended supplemental type certificate
ATC	Amended type certificate
CCD	Cursor control device
CEH	Complex electronic hardware
CFR	Code of Federal Regulations
CRM	Crew resource management
EQT	Environmental qualification test(s)
EMC	Electromagnetic Compatibility
EWIS	Electrical wiring interconnection system
FAA	Federal Aviation Administration
FLS	Field-loadable software
FMS	Flight management system
FPGA	Field programmable gate array
GPS	Global positioning system
HIRF	High intensity radiated field

IMA	Integrated modular avionics
LODA	Letter(s) of Technical Standard Order (TSO) Design Approval
LRU	Line replaceable unit
MCDU	Multi-function control and display unit
MMEL	Master minimum equipment list
MPS	Minimum performance standard
ODA	Organization Designation Authorization
PLD	Programmable logic device
PSCP	Project specific certification plan
RF	Radio Frequency
RSC	Reusable software component
RTCA	Formerly, the Radio Technical Commission for Aeronautics
SAE	SAE International. Formerly, The Society of Automotive Engineers
SEH	Simple electronic hardware
STC	Supplemental type certificate
TC	Type certificate
TCAS	Traffic alert and collision avoidance system
TSO	Technical standard order
TSOA	Technical standard order authorization

Appendix G Partial List of Functional TSOs

Below is a partial list of the FAA TSOs that might be considered functional TSOs in IMA systems. Applicants may apply for a TSO that does not adequately cover all the functionality in the system. Or, they may apply for multiple TSOs, since no single TSO covers all functions. If applicants apply for multiple TSOs for a single system, that combination of TSOs may result in the system being considered complex or integrated, even though the individual TSOs were not.

TSO NUMBER	DATE	TITLE
TSO-C2d	6/14/89	*Airspeed Instruments (Using Electronic Sensing)*
TSO-C4c	4/14/89	*Bank and Pitch Instruments*
TSO-C9c	9/15/60	*Automatic Pilots*
TSO-C10b	9/1/59	*Altimeter, Pressure Actuated, Sensitive Type*
TSO-C52b	5/30/95	*Flight Director Equipment*
TSO-C92c	3/19/96	*Airborne Ground Proximity Warning Equipment*
TSO-C93	11/26/76	*Airborne Interim Standard Microwave Landing System Converter Equipment*
TSO-C101	2/19/87	*Over Speed Warning Instruments*
TSO-C104	6/22/82	*Microwave Landing System (MLS) Airborne Receiving Equipment*
TSO-C105	6/13/84	*Optional Display Equipment for Weather and Ground Mapping Radar Indicators*
TSO-C106	1/15/88	*Air Data Computer*
TSO-C110a	10/26/88	*Airborne Passive Thunderstorm Detection Equipment*
TSO-C115b	9/30/94	*Airborne Area Navigation Equipment Using Multi-Sensor Inputs*
TSO-C117a	8/1/96	*Airborne Windshear Warning and Escape Guidance Systems for Transport Airplanes*
TSO-C118	8/5/88	*Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS I*
TSO-C119a	4/9/90	*Traffic Alert and Collision Avoidance System (TCAS) Airborne*

		Equipment, TCAS II
TSO-C123b	6/1/06	*Cockpit Voice Recorder Systems*
TSO-C129a	2/20/96	*Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)*
TSO-C146c	5/9/08	*Stand-Alone Airborne Navigation Equipment Using The Global Positioning System Augmented By The Satellite Based Augmentation System*
TSO-C147	4/6/98	*Traffic Advisory System (TAS) Airborne Equipment*
TSO-C151b	12/17/02	*Terrain Awareness and Warning System*

Note: TSO revisions may change. This list is for reference only. Ensure that you use the appropriate TSO.

Appendix H. SAE ARP 4754 to ARP 4754A Cross-Reference Matrix

Below is a cross-reference matrix between the sections and paragraphs of SAE ARP 4754 that are referenced by RTCA/DO-297 and the updated SAE ARP 4754A. Please refer to this matrix in order to determine the correct ARP 4754A paragraph.

RTCA/DO-297 Page # / Para. #	ARP 4754 Reference (Technical Subject of Discussion)	Corresponding ARP 4754A Reference / Para. # of Technical Subject of Discussion
3 / 1.5 [7]	ARP 4754	ARP 4754A
20 / 3.1	ARP 4754	ARP 4754A
56 / 4.5.7.d	ARP 4754	ARP 4754A
63 / 5.1	ARP 4754 (Safety Assessment)	ARP 4754A / 5.1
65 / 5.1.5.1	Section 6.1 (Functional Hazard Assessment)	ARP 4754A / 5.1.1
65 / 5.1.5.2.e	Section 6.2 (Preliminary System Safety Assessment)	ARP 4754A / 5.1.2
66 / 5.1.5.3.1	Section 6.3 (System Safety Assessment)	ARP 4754A / 5.1.3
66 / 5.1.5.4	ARP 4754 (Common Cause Analysis)	ARP 4754A / 5.1.4
72 / 5.3	ARP 4754 (Validation Process)	ARP 4754A / 5.4
73 / 5.4	ARP 4754 (Verification Process)	ARP 4754A / 5.5
75 / 5.5	ARP 4754 (Configuration Management Process)	ARP 4754A / 5.6
77 / 5.6	ARP 4754 (Quality Assurance Process)	ARP 4754A / 5.7
77 / 5.6 - Note	ARP 4754	ARP 4754A

Note: Some references within RTCA/DO-297 refer to the entire SAE ARP 4754 document, but the discussion in that RTCA/DO-297 paragraph is limited to a specific technical subject. This table provides information on the technical subject being discussed for that RTCA/DO-297 reference and provides the exact paragraph number of ARP 4754A. We believe that this information is of greater use to the reader than repeating the reference to the entire SAE ARP 4754A document. See rows 4, 8, 9, 10, 11, and 12.