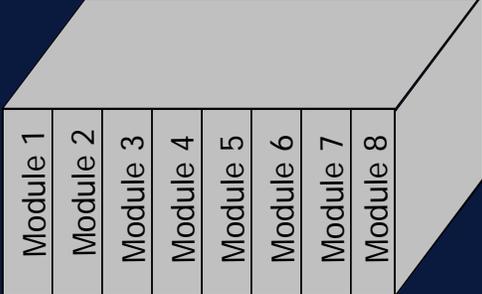


# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status



### Integrated Modular Avionics (IMA)



**Leanna Rierson**

September, 2003

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### Acronyms



☞ AC = Advisory Circular	☞ MA = Modular Avionics
☞ ARP = Aerospace Recommended Practice	☞ MPS = Minimum Performance Specification
☞ ATC = Amended Type Certificate	☞ P/N = Part Number
☞ ASTC = Amended Supplemental Type Certificate	☞ PSSA = Preliminary System Safety Assessment
☞ CAST = Certification Authorities Software Team	☞ SC = Special Committee
☞ CCA = Common Cause Analysis	☞ SSA = System Safety Assessment
☞ CM = Configuration Management	☞ STC = Supplemental Type Certificate
☞ FAA = Fun & Adventuresome Authorities	☞ TC = Type Certificate
☞ FHA = Functional Hazard Assessment	☞ TSO = Technical Standard Order
☞ IMA = Integrated Modular Avionics	☞ WG = Working Group

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## IMA Guidance Overview and SC-200 Status



### Presentation Overview

- ☞ What is IMA?
- ☞ Overview of TSO-C153
- ☞ TSO-C153 Keys
- ☞ Overview of AC 20-145
- ☞ AC 20-145 Keys
- ☞ Hottest Topics in TSO-C153 & AC 20-145 Usage
- ☞ Overview of SC-200/WG-60 IMA activities
- ☞ Summary

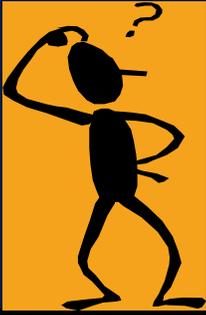


More details on IMA may be found at:  
<http://av-info.faa.gov/software>

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# What is IMA?



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# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status



### What is IMA?

- ☞ Defining “IMA” is difficult
- ☞ The RTCA modular avionics team created the following definition:
  - Modular avionics is defined as a shared set of flexible, reusable, and interoperable hardware and software resources that create a platform that provides services, designed and verified to a defined set of safety and performance requirements, to host applications performing aircraft-related functions.



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# TSO-C153 Overview

- ☞ Title: “TSO-C153, INTEGRATED MODULAR AVIONICS HARDWARE ELEMENTS”
- ☞ Completion Date: May 6, 2002
- ☞ Location: <http://av-info.faa.gov/software>

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## IMA Guidance Overview and SC-200 Status



### Some Unique Things About TSO-C153

- ✎ TSO is for “Brain Dead Hardware”
- ✎ Manufacturer Develops and Submits MPS to FAA
- ✎ TSO Provides Criteria to Be Addressed in the MPS
- ✎ Software Functionality is Limited
- ✎ TSO'd Hardware Elements May Support Functional TSOs
- ✎ Manufacturer Creates a Data Sheet to Aid Users



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### Why Do Applicants Want TSO-C153 Authorization?

- ✎ Allows manufacturers to ship and stock generic components and add functional software later
- ✎ Enables use of environmental qualification data for multiple projects
- ✎ Gives assurance that the hardware element performs as intended
- ✎ Allows the workload to be broken into smaller pieces
- ✎ Supports electronic part marking and configuration management (reduces human error)



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## IMA Guidance Overview and SC-200 Status



### TSO Overview

- ☞ Section 1 – Purpose
- ☞ Section 2 – Applicability
- ☞ Section 3 – Requirements
- ☞ Section 4 – Marking
- ☞ Section 5 – Application data requirements
- ☞ Section 6 – Manufacturer data requirements
- ☞ Section 7 – Furnished data
- ☞ Section 8 – Manufacturer data sheet
- ☞ Section 9 – Availability of references
- ☞ Appendix 1 – MPS criteria
- ☞ Appendix 2 – Example format for data sheet
- ☞ Appendix 3 - Definitions

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### Section 1 – Purpose of TSO-C153

#### Two-Fold Purpose

(1) Requirements For TSO-C153 Authorization	(2) Criteria for Hardware Element MPS
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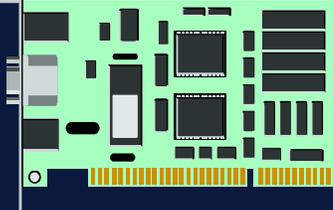
# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status

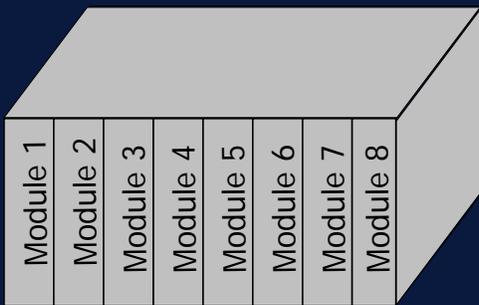


### Section 2 – Applicability of TSO-C153

**Hardware modules**



**Rack/cabinet to host hardware modules**

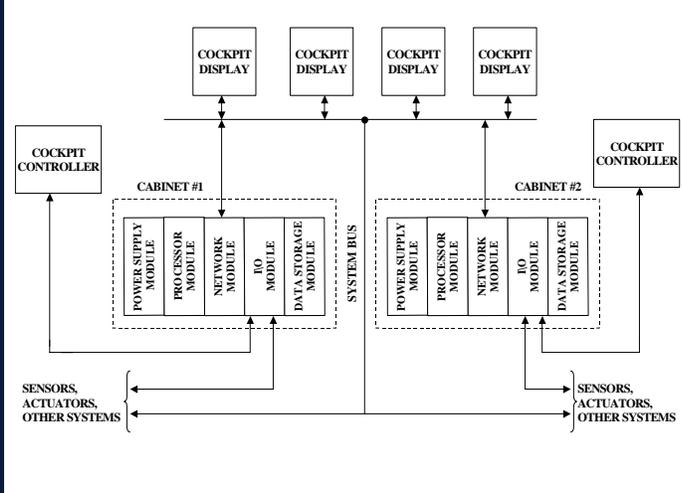


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### Section 2 – Applicability of TSO-C153 (cont)

Table 1 in Appendix 1 gives examples of hardware elements.



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## IMA Guidance Overview and SC-200 Status



### Section 3 – Requirements of TSO-C153



- a. Functionality
- b. Functional Limitations
- c. Failure Condition Classification
- d. Functional Qualification
- e. Environmental Qualification
- f. Software Design Assurance
- g. Hardware Design Assurance
- h. Configuration Management
- i. Quality Control
- j. Deviations

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### Section 4 - Marking

 **Must comply with § 21.607(d)**

**§ 21.607 General rules governing holders of TSO authorizations.**

Each manufacturer of an article for which a TSO authorization has been issued under this part shall—

(d) Permanently and legibly mark each article to which this section applies with the following information:

- (1) The name and address of the manufacturer.
- (2) The name, type, part number, or model designation of the article.
- (3) The serial number or the date of manufacture of the article or both.
- (4) The applicable TSO number.

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## IMA Guidance Overview and SC-200 Status

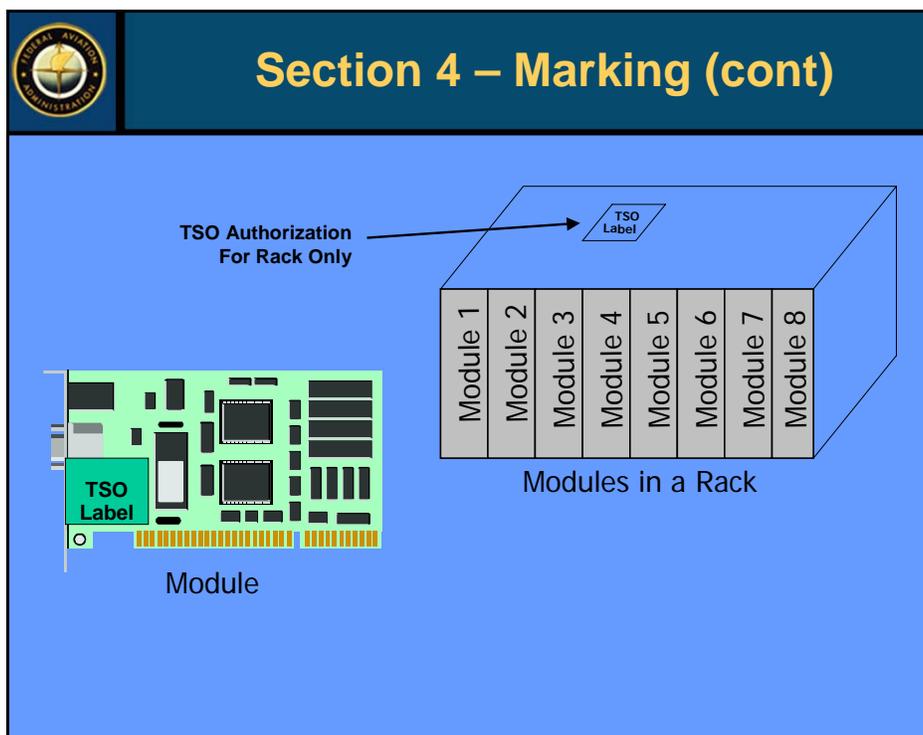


### Section 4 - Marking

- a) May mark hardware element with P/N in multiple places
- b) May support electronic part marking
- c) Hardware element may have software to enable field loading of software and/or electronic part marking
- d) If (c) is true, may have separate hardware and software P/N
- e) Must have unique part identification
- f) Mark cabinet/rack with "TSO authorization for cabinet/rack only"



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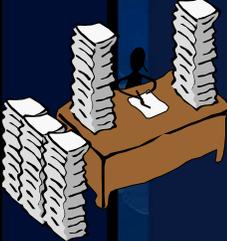
## IMA Guidance Overview and SC-200 Status



### Section 5-7 – Data

Similar to other TSOs, except the following:

- *DO-254 data*
- *Data sheet (Appendix 2)*
- *MPS for each hardware element (Appendix 1)*
- *Instructions for viewing TSO-related electronic part identification*



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### Section 8 – Manufacturer's Data Sheet

- ☞ Each hardware element must have a data sheet to summarize its characteristics
- ☞ Example format shown in Appendix 2
- ☞ Data sheet will become part of TSO authorization letter
- ☞ Data sheet will be supplied to all purchasers of the hardware element



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## IMA Guidance Overview and SC-200 Status



### Section 9 – Availability of Reference Documents

- ☞ Provides information for manufacturers to obtain:
  - DO-160D
  - DO-178B
  - DO-254
  - Part 21
  - Advisory Circulars
  - SAE document – ARP 4754

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### Appendix 1

- ☞ Appendix 1 is entitled:
  - “Development Criteria For Integrated Modular Avionics Hardware Element Minimum Performance Standards”
- ☞ It is the meat of the TSO
- ☞ It represents a “non-traditional” approach to TSO – the manufacturers develop their own MPS
- ☞ It documents detailed criteria of what manufacturers should include in their MPS

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## IMA Guidance Overview and SC-200 Status



### Appendix 1 Contents

Intro	{	1. Appendix Layout
		2. Introduction
		3. MPS Overview
MPS Guidance	{	4. General MPS Requirements
		5. Equipment Performance – Standard Conditions
		6. Equipment Performance – Environmental Conditions
		7. Equipment Test Procedures

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### Appendix 1 Contents (cont)

Installation & Operational	{	8. Installed Equipment Performance
		9. Equipment Operational Performance Characteristics

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# 2003 FAA National Software Conference IMA Guidance Overview and SC-200 Status



## Two Types of Data

<p><b><u>MPS:</u></b></p> <ul style="list-style-type: none"><li>• Section 4 info</li><li>• Section 5 – Table 1 characteristics</li><li>• Section 6 – Env Qual categories</li></ul>	<p><b><u>MPS Compliance Data (perf &amp; env qual tests):</u></b></p> <ul style="list-style-type: none"><li>• Sections 5, 6, &amp; 7<ul style="list-style-type: none"><li>• <i>Test configuration</i></li><li>• <i>Test planning</i></li><li>• <i>Test procedures</i></li><li>• <i>Test results</i></li></ul></li></ul>
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# TSO-C153 Keys

Some Helpful Hints  
For ACO Engineers  
And DERs



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# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status



### TSO-C153 Keys

1. Remember the Uniqueness of TSO-C153
2. Coordinate With the ACOs that Will be Granting TC/STC/ATC/ASTC
3. Ensure that Data Package Meets TSO-C153 Requirements
4. When Satisfied With The Data Package, Write TSO Authorization Letter (ACO) or Recommend Approval (DER)

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# IMA AC Overview

📄 **Title:** “GUIDANCE FOR INTEGRATED MODULAR AVIONICS (IMA) THAT IMPLEMENT TSO-C153 AUTHORIZED HARDWARE ELEMENTS”

📅 **Date:** February 25, 2003

📍 **Location:** <http://av-info.faa.gov/software>

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## IMA Guidance Overview and SC-200 Status



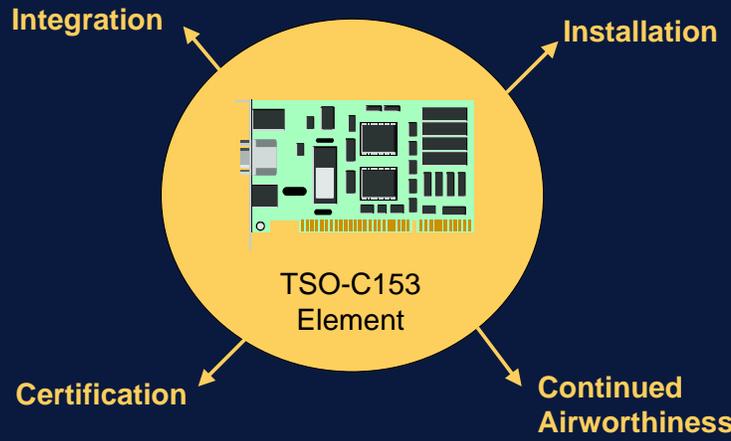
### AC Overview

- 1 – Purpose
- 2 – Related Docs
- 3 – Definitions
- 4 – Acronyms
- 5 – Scope
- 6 – Background
- 7 – Document Overview
- 8 – IMA System Cert Overview
- 9 – Safety Assessment
- 10 – Configuration Mgt
- 11 – Electronic ID
- 12 – Software
- 13 – Complex Hardware
- 14 – Design Guidance
- 15 – Environmental Qual
- 16 – Human Factors
- 17 – Testing (multiple levels)
- 18 – Roles & Responsibilities
- 19 – Third Party Guidance
- 20 – Airworthiness
- 21 – Maintenance & Continued Airworthiness

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### Section 1 - Purpose



Integration

Installation

TSO-C153 Element

Certification

Continued Airworthiness

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## IMA Guidance Overview and SC-200 Status

 **Section 3 - Definitions**

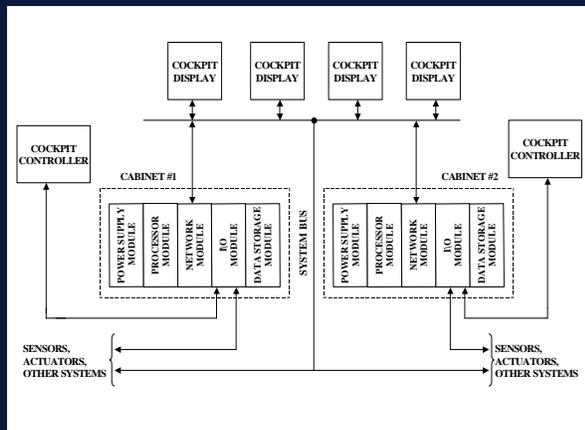
- ☞ **Functional TSOs** – A TSO with functionality
- ☞ **Functional Software** – Software that's approved as part a functional TSO or type certificate effort
- ☞ **Hardware Element** – hardware module, cabinet, or rack that may have TSO-C153 authorization
- ☞ **Stakeholders** – all entities involved in development, integration, and certification of an IMA system



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 **Section 3 – Definitions (cont)**

- ☞ **IMA System** – all components that interface with hardware elements to make the system functional



The diagram illustrates the architecture of an IMA system. It features two cabinets, labeled 'CABINET #1' and 'CABINET #2', connected to a central 'SYSTEM BUS'. Each cabinet contains four modules: 'POWERSUPPLY MODULE', 'PROCESSOR MODULE', 'NETWORK MODULE', and 'IO MODULE'. Additionally, each cabinet has a 'DATA STORAGE MODULE'. The system bus connects these cabinets to four 'COCKPIT DISPLAY' units and two 'COCKPIT CONTROLLER' units. The controllers are also connected to 'SENSORS, ACTUATORS, OTHER SYSTEMS'.

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## IMA Guidance Overview and SC-200 Status



### Section 5 & 6 – Scope and Background

- ✎ AC focuses on IMA systems that use TSO-C153 hardware elements
- ✎ Guidance may also be useful for IMA systems that don't use TSO-C153 hardware elements
- ✎ Guidance addresses multiple stakeholders (i.e., C153 TSO applicants, Functional TSO applicants, TC/STC/ATC/ASTC applicants)
- ✎ Guidance needed for compliance to regs when using C153 TSO'd hardware elements
- ✎ Guidance addresses the IMA system

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### Section 8 – Approvals and Authorizations

#### Three Levels of Approval



Aircraft Installation Approval  
(TC/STC/ATC/ASTC)

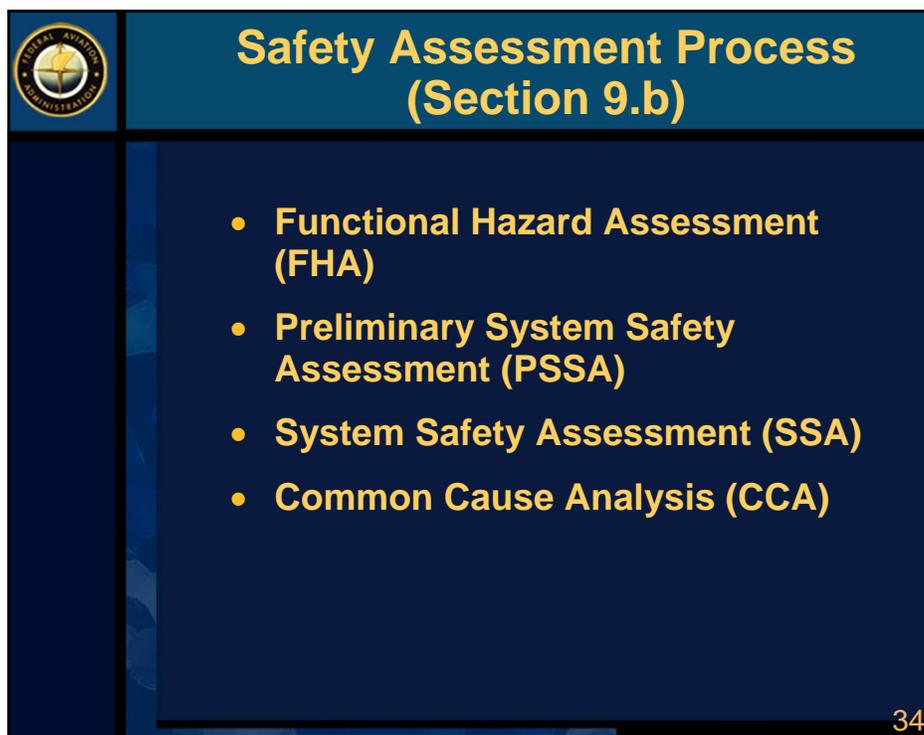
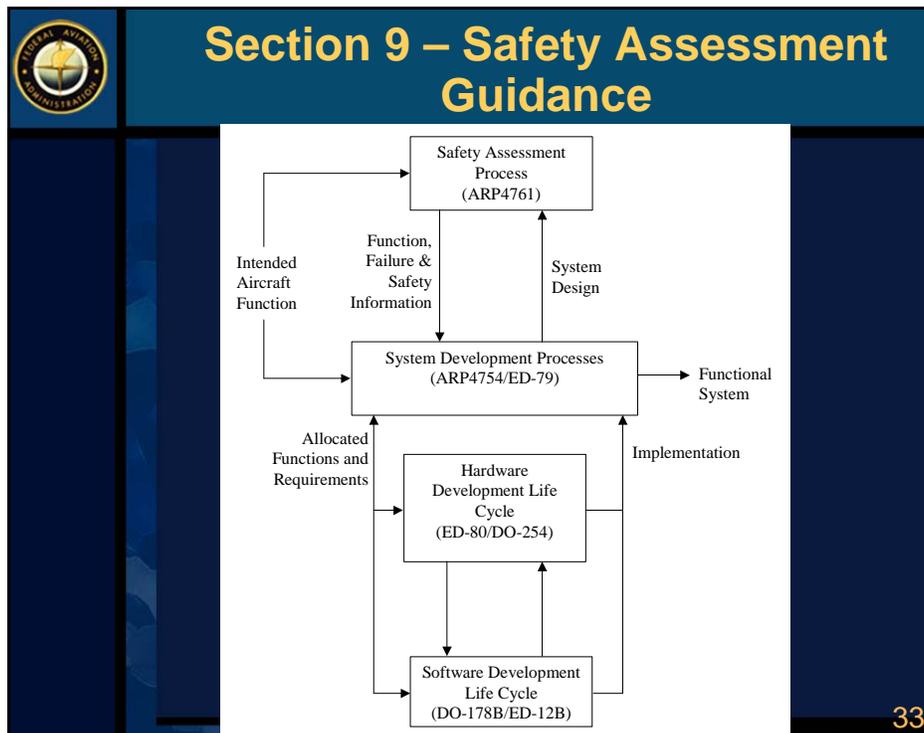
Functional TSO Authorization

TSO-C153 Authorization

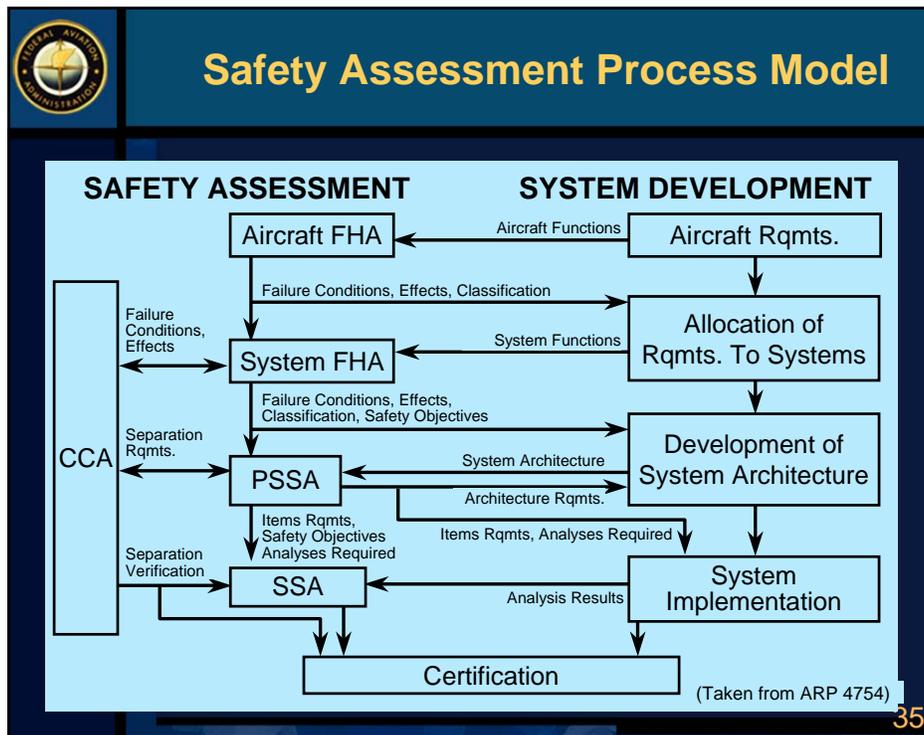
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## IMA Guidance Overview and SC-200 Status



# 2003 FAA National Software Conference IMA Guidance Overview and SC-200 Status



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## Section 10 - Configuration Management (CM) Highlights

- ☞ a) Many potential CM issues
- ☞ b) Robust automated CM system required:
  - Guarantee proper SW load
  - Identify improper system configuration
  - Annunciate “out of config” or “no dispatch” to crew
  - Means to verify proper SW & HW load
- ☞ e) Verification of correct SW load should not rely on a single action
- ☞ f) Changes to IMA SW or HW:
  - All SW changes to be tracked by automatic CM system
  - Major HW changes to be tracked by automatic CM system



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# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status



### Section 11 – Electronic ID

- ☞ b) SW P/N must be verifiable through electronic query
- ☞ b) Improper config of SW should annunciate “no dispatch” to crew
- ☞ c) Electronic TSO nameplate meets 21.607 when:
  - P/N is stored in non-volatile memory
  - P/N is verifiable on ground at any geographic location
- ☞ f) All HW elements that support a functional TSO must have a physical nameplate (either C153 or functional TSO)
- ☞ h) Separate process to record IMA configuration is required

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### Section 12 - Software

- ☞ a & b. Use DO-178B for software assurance (or an equivalent alternate)
- ☞ c. Field-Loadable Software (FLS)
  - Based on Notice 8110.77 & 8110.95
- ☞ d. Partitioning and Protection
  - Based on CAST paper and DO-248B discussion paper
- ☞ e. Software reuse
  - Based on Notice 8110.97

Note: Notices replaced by Order 8110.49



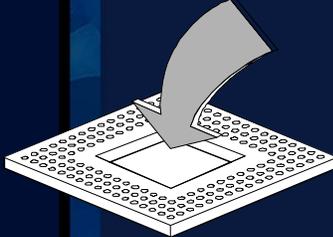
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## IMA Guidance Overview and SC-200 Status



### Section 13 – Electronic Hardware Guidance



- Invokes RTCA/DO-254 (or other acceptable means of compliance) for electronic devices whose functions cannot feasibly be evaluated by test and/or analysis.

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### Section 14 - IMA Design Guidance

- a. Electrical power
- b. Recovery features
- c. Built-in-test
- d. Maintenance diagnostics
- e. Failure detection and annunciation
- f. Functional partitioning
- g. Functional isolation
- h. Intentional transmitters
- i. Alerts and aural warnings

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## IMA Guidance Overview and SC-200 Status



### Section 15 – Environmental Qualification Guidance

- Some credit from TSO-C153 may be carried over to the installation approval
  - See Figure 15-1 in the AC
- Environmental qual tests excluded from TSO-C153 must be performed as part of functional TSO or installation certification.



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### Section 16 – Human Factors & Flight Crew Interface Guidance

#### Section 16.c – Numerous H.F. Issues in IMA Systems



Electronic Checklists

Cursor-Based Controls

Accessibility of Functions

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### Section 17 - Testing Practices

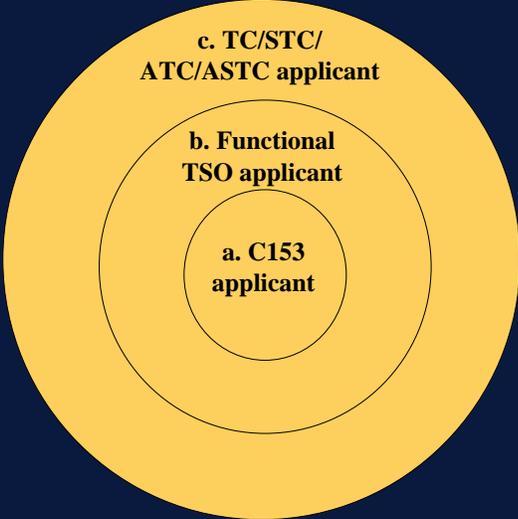
- Focuses on IMA-unique aspects of testing
- a. IMA Hardware Element Testing
- b. Individual System Testing
- c. IMA System Integration Testing
- d. Aircraft Ground Testing
- e. Aircraft Flight Testing
- f. Configuration Control During Flight Testing



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### Section 18 - Roles & Responsibilities



a. C153 applicant

b. Functional TSO applicant

c. TC/STC/ATC/ASTC applicant

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## IMA Guidance Overview and SC-200 Status



### Section 18 - Roles & Responsibilities (cont)

- ☞ **C153 Applicant**
  - Develop MPS (using Appendix 1 of TSO-C153)
  - Show compliance to MPS
- ☞ **Functional TSO Applicant**
  - Design system to comply with applicable TSOs
  - Address integration issues
  - Test to meet functional TSO(s)



### Section 18 - Roles & Responsibilities (cont)

- ☞ **TC/STC/ATC/ASTC applicant**
  - Bulk of AC is their responsibility
    - Sections 9-17 & 19-20
  - TC/STC/ATC/ASTC applicant is responsible for pulling it all together

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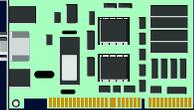
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## IMA Guidance Overview and SC-200 Status



### Section 19 – Guidance for Third Party Manufacturers

- ☞ Third party modules are those installed in C153 authorized rack/cabinet that are developed by a different manufacturer than the rack/cabinet
- ☞ Third party modules must meet environmental, interoperability, configuration management, & regulatory requirements
- ☞ Third party modules must participate in automatic configuration management system
- ☞ Data sheets should be provided for all third party modules

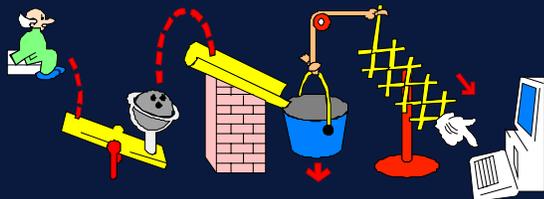


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### Section 20 – Airworthiness Considerations

- ☞ Addresses Change Impact Analysis
  - Based on Notice 8110.85 concept
- ☞ Limits Usage of FAA Form 337 for IMA systems



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# 2003 FAA National Software Conference IMA Guidance Overview and SC-200 Status



## Section 21 – Maintenance & Continued Airworthiness



- Maintenance instructions to addresses handling, storage, shipping, & installation of hardware elements.
- MMEL should be developed and justified by applicant.

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## Keys For IMA System Approval

Some Helpful Hints  
For ACO Engineers  
And DERs



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## IMA Guidance Overview and SC-200 Status



### Keys for IMA System Approval

1. Understand the “big picture”
2. Coordinate with appropriate certification authorities
3. Identify issues early
4. Ensure that the applicant(s) follows the IMA AC
5. Identify areas where additional guidance is needed
6. Consider all levels of certification
7. Involve specialists as needed



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### Hottest Topics



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# 2003 FAA National Software Conference IMA Guidance Overview and SC-200 Status



## Hottest Topics



- Functional TSOs
- Robust Automatic Configuration Management
- Who's Doing What
- Third Party Modules
- Partitioning/Protection
- Multiple Developers
- Multiple Certification Authorities
- Desire to use TSO-C153 for EVERYTHING under the sun

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## RTCA Special Committee #200 (SC-200)



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## IMA Guidance Overview and SC-200 Status



### SC-200 Schedule

- 3/02 - SC-200 Approved by RTCA
- 5/02 - First SC-200 Meeting
- 8/02 - Became joint with EUROCAE Working Group #60 (WG-60)
- 3/04 – Goal for Draft Guidance Document
- 10/04 – Goal for Final Guidance Document

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### SC-200 Highlights

- Builds on FAA's TSO and AC
- Builds on DO-255 (Avionics Computer Resource)
- Uses the "Module Qualification" concept

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## IMA Guidance Overview and SC-200 Status



### Document Overview

- ☞ **Section 1: INTRODUCTION**
  - Purpose
  - Scope
  - Background
  - Stakeholders
  - Relationship to other documents
  - References
  - How to use the document
- ☞ **Section 2: MODULAR AVIONICS**
  - System description & architecture
  - Key characteristics

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### Document Overview (cont)

- ☞ **Section 3: MA-Specific Design and Integration CONSIDERATIONS**
  - Design objectives
  - Partitioning & resource management
  - Health monitoring & fault management
  - Configuration
  - Integration
  - Shared databases for applications

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# 2003 FAA National Software Conference

## IMA Guidance Overview and SC-200 Status



### Document Overview (cont)

- ☞ **Section 5: SIGNIFICANT ISSUES**
  - Flight operations
  - Installation
  - Continued airworthiness
  - Human factors

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# Summary



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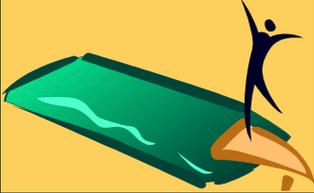
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## IMA Guidance Overview and SC-200 Status



### Summary

- There is a lot going on related to IMA
- The TSO-C153 and IMA AC are intended to address the hardware element approach to IMA
- SC-200/WG-60 is striving to address the “full-up” IMA approach



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