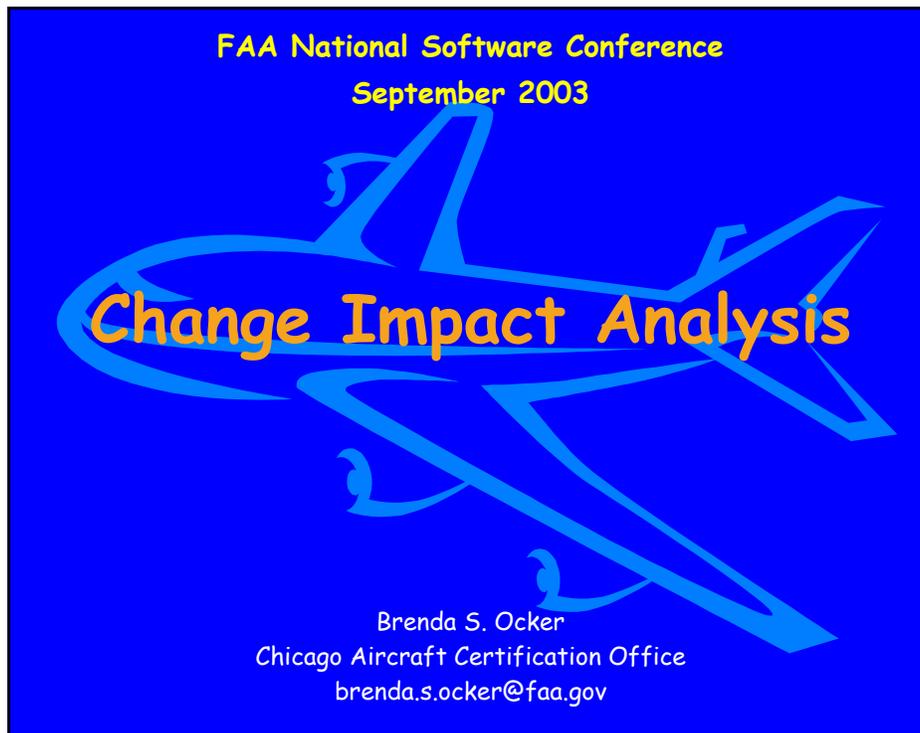


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Change Impact Analysis



Presentation Overview

- Background
- Purpose
- Definition of Major and Minor
- Components of CIA
- Process
- Example
- Summary

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Change Impact Analysis

History

- Notice 8110.85, "Guidelines for the Oversight of Software Change Impact Analyses used to Classify Software Changes as Major or Minor"
- Order 8110.49, Chapter 11

Purpose of CIA

- Determine the impact of the change on the system
- Assure that safety is not adversely affected
- Determine the rework and reverification required

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Definition of Major and Minor Change

- 21.93(a)
 - Type Certificate
 - Supplemental Type Certificate
 - Parts Manufacturer Approval
- 21.611(b)
 - Technical Standard Order (TSO)

Definition of Major and Minor Change

- Per 14 CFR 21.93(a):
 - A minor change has "no appreciable effect on the weight, balance, structural strength, **reliability**, **operational characteristics**, or **other characteristics affecting the airworthiness of the product**"
 - All other changes are considered major

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Definition of Major and Minor Change

- Per 14 CFR 21.611(b):
 - A major change is a design change that is "extensive enough to require a substantially complete investigation to determine compliance with a TSO"
 - All other changes are considered minor
- A minor change to the TSOA could have a major affect on the aircraft

Types of Software Changes

- Pre-Certification
 - During software development/before software approval
 - Change control in place
 - Problem reporting & correction in place
 - Re-verification in place
 - Addressed in DO-178B, Sections 7 & 8

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Types of Software Changes

- Post-Certification
 - After software approval and product certification
 - Addressed in DO-178B, Section 12.1
 - Order 8110.49 Chapter 11 focuses on the post-certification change

Components of a CIA

- Identify software change
- Perform analyses to assess the effect of the change
- Identify life cycle data to be updated
- Identify verification activities to be performed

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Components of a CIA

- Traceability Analysis
- Memory Margin Analysis
- Timing Margin Analysis
- Data Flow Analysis
- Control Flow Analysis
- Input/Output Analysis
- Development Environment & Process Analyses
- Operational Characteristics Analysis
- Certification Maintenance Requirements (CMR) Analysis
- Partitioning Analysis

Components of a CIA

- Traceability Analysis
 - Identify areas affected by the software change:
 - Requirements & Design Analysis
 - Code Analysis
 - Test Procedures and Cases Analysis
 - VERY IMPORTANT!

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Components of a CIA

- Memory Margin Analysis
 - Assure memory allocation requirements and margins are maintained
 - Examples of tasks:
 - Estimate change to flash memory
 - Estimate change to RAM
 - Evaluate memory margins

Components of a CIA

- Timing Margin Analysis
 - Assure timing margin issues are not introduced due to the change
 - Examples of tasks:
 - Review timing requirements
 - Review CPU task scheduling requirements
 - Review interface timing requirements
 - Review changes to the timing margins (usually want at least 10% margin)
 - Review throughput change for each task

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Components of a CIA

- Data & Control Flow Analysis
 - Assess changes in data & control flow and coupling between software components
 - Evaluate any adverse affects due to the change
 - Required for Levels A, B, and C software

Components of a CIA

- Input/Output Analysis I/O
 - Evaluate impact of the change on the interface with the external world
 - Examples of tasks:
 - Bus loading
 - External databus I/O
 - External hardwire I/O
 - Access to memory
 - Communication with hardware

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Components of a CIA

- Development Environment & Process Analysis
 - Identify changes in the environment or process that might have adverse affects on the system
 - Examples include changes to:
 - Compilers
 - Linkers
 - Loaders
 - Tools

Components of a CIA

- Operational Characteristics Analysis
 - Identify adverse effects in the operational environment due to software changes.
 - Examples of changes that could affect the operation of the product:
 - Gain changes
 - Limit changes
 - Filter changes
 - Interrupt changes
 - Exception handling changes
 - Fault mitigation changes

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Components of a CIA

- Certification Maintenance Requirements (CMR) Analysis
 - Determine if the software change requires new or modified CMR
 - Example:
 - Assume the software change to the anti-skid systems increases the time that the brakes are applied during landing. This could result in more frequent maintenance of the brakes and tires.

Components of a CIA

- Partitioning Analysis
 - Determine the affect of the software change on the protective mechanisms

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Components of a CIA

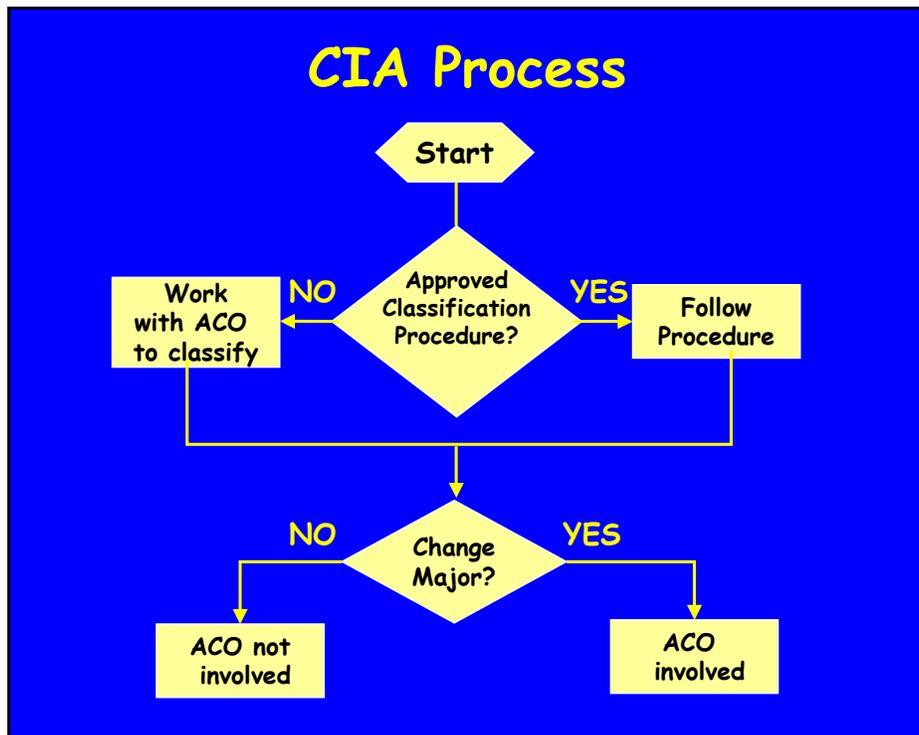
- Focus on the potential adverse affects
 - Change in safety-related information
 - Change in operational or procedural characteristics of the aircraft
 - New functions
 - Different interfaces
 - Significant change to life cycle data

Components of a CIA

- CIAs come in many forms
- Extent of analysis depends on the change size and affected items
- Enough detail to support the major or minor classification
- Should be revised if the scope of the software change changes

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Approved Classification Procedures

- Approved procedures in place to classify changes as major or minor
- Procedures should contain a process for:
 - Using CIA to classify change
 - Reviewing/approving the classification
 - Addressing minor changes
 - Addressing major changes
 - Informing FAA
 - Obtaining FAA concurrence on changes

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No Classification Procedures

- FAA more involved
- Applicant performs CIA
- Applicant proposes classification (major or minor) to FAA
- FAA reviews/accepts/modifies the classification
- Applicant & FAA follow procedures for major or minor changes, as applicable

Minor Changes

- Change performed without FAA involvement
- Data updated, as required
- Software Accomplishment Summary (SAS), Software Configuration Index (SCI), and/or other documents submitted to FAA on a periodic basis

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Major Changes

- FAA and/or DER involved
- PSAC and/or CIA submitted to FAA as agreed upon
- SAS, SCI, and/or other agreed upon data submitted to ACO
- ACO and/or DER reviews and approves data, as needed

Special Considerations for TSO Equipment

- A minor change to the TSOA could have a major affect on the aircraft
- TSOA Holder should consider the intended installation when performing the CIA
- Installer also needs to perform CIA to address the effect of the change on the specific aircraft installation

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Requirement Change Example

- Change Requirement
 - New
 - Modified
 - Deleted
- Most common type of change
- Applicant's and FAA's role in the CIA process

Requirement Change: Applicant's Responsibilities

- Perform CIA to assure that the new or changed requirement:
 - Does not conflict with other requirements
 - Is unambiguously stated and verifiable
 - Is verified to meet requirements of software level
 - Achieves desired functionality

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Requirement Change: Applicant's Responsibilities

- Assure that the following are completed, as needed:
 - Update the software architecture
 - Change prologue headers
 - Review changes against standards
 - Update traceability (both forward and backward)

Requirement Change: Applicant's Responsibilities

- Examine data elements to assure that new or changed code does not negatively impact existing functionality by:
 - Examining all areas of the code that use the same variables as those in the changed or new code
 - Re-examining variable declarations and interfaces
 - Examining control flow to assure that the change does not negatively impact execution sequence or timing

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Requirement Change: Applicant's Responsibilities

- Assure that:
 - Verification test cases for new and changed requirements exist
 - All requirements-based tests (normal and robust) that trace to new or changed requirements are run or re-run
 - Structural coverage is achieved for new or changed area, and still achieved for areas of code with dependencies
 - Verification record that documents the regression analysis exists

Requirement Change: FAA's Responsibilities

- Review CIA, as needed
 - Oversee the applicant's activities, when the change is major
 - Oversee designees
 - Perform on-site or desk-top reviews, as needed

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Additional Information

- View the "Software Change Impact Analysis" Video
- Self-Study Guide & Video Order Form available on FAA Software website:
<http://av-info.faa.gov/software/>

Summary

- Determine the impact of the change on the system
- Assure that safety is not adversely affected
- Determine the rework and reverification required
- Encourage applicant to get an approved CIA procedure