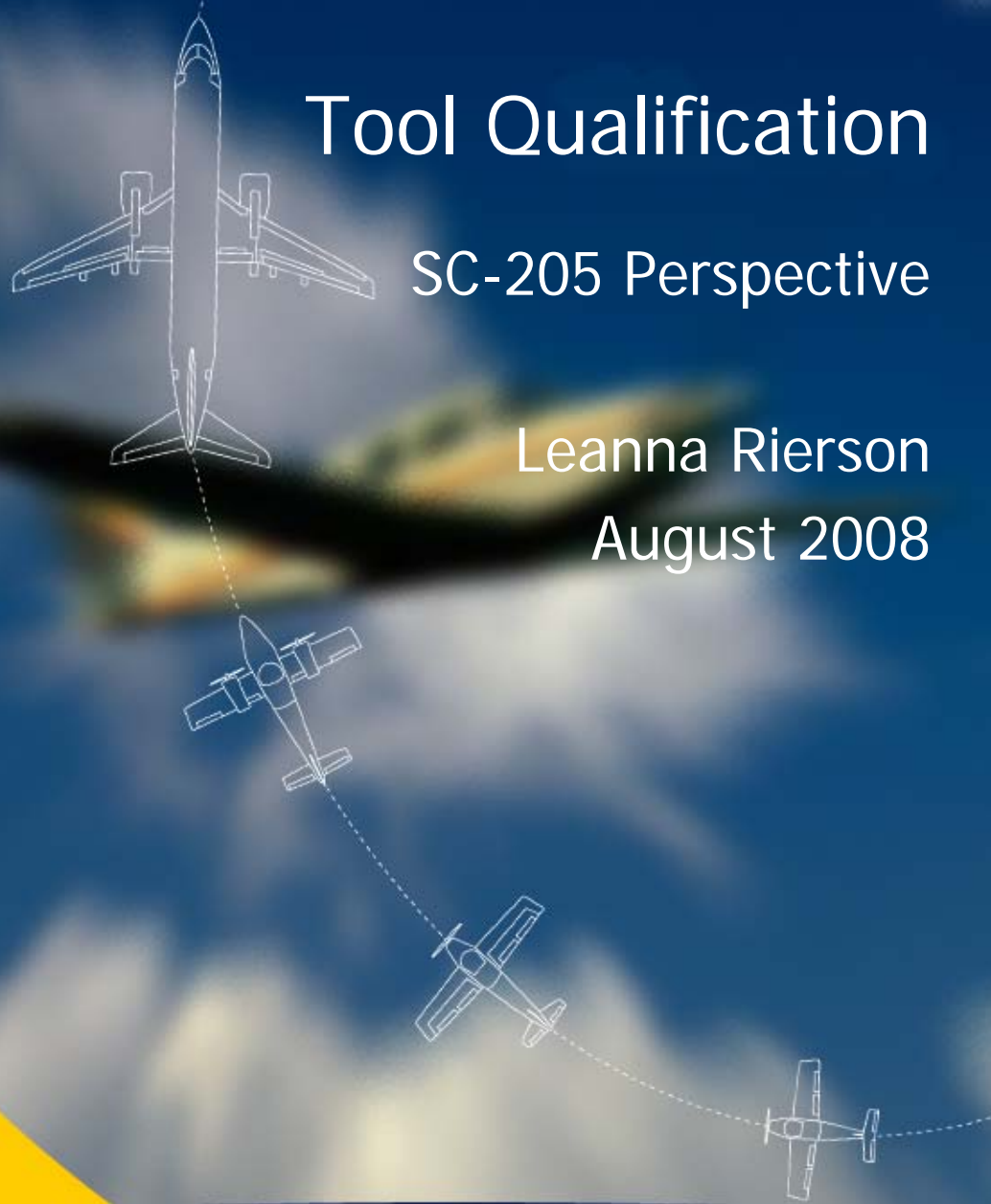


Tool Qualification

SC-205 Perspective

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August 2008



Presentation Overview

Home

Previous

Next

Help

- Issues with the current tool qualification approach
- Objectives of SG3 (tool qualification team)
- Overview of SC-205/WG-71 tool qualification approach
- Overview of proposed DO-178C/ED-12C section 12.2
- Overview of tool qualification document
- Summary

Issues With Current Tool Qualification

Home

Previous

Next

Help

- DO-178B approach only addresses “development” and “verification” tools.
- DO-178B criteria is difficult to apply for development tools. Each qualification effort makes its own assumptions.
- Some DO-178B objectives don’t make sense for tools (e.g., target computer items).
- Tool reuse is difficult, since qualification is performed on a project-by-project basis.
- It is difficult to qualify COTS tools – especially development tools.
- Current criteria is very oriented to airborne software tools (challenging to apply to other domains such as systems, databases, etc.)

Tool Qualification Team's Objectives

Home

Previous

Next

Help

- Develop a qualification approach that addresses the development tool qualification issues
- Maintain DO-178B approach for traditional verification tools (as much as possible)
- Develop an approach that will support emerging tool technologies
- Provide an approach that enables reuse of tool qual credit on multiple projects
- Identify general tool user and tool developer roles (in order to address integration of the tool into the development environment, support reuse, and help with COTS tools)
- Develop an approach which is clear but flexible for users
- Develop an objective-based approach (helps with reuse & flexibility)
- Provide an approach that may be adopted by multiple domains (if they desire to use it)

Note: These objectives are based on the SC-205 issues list.

SC-205 Approach for Tool Qual

Home

Previous

Next

Help

DO-178C/ED-12C Section 12.2:

- Identifies the need to qualify
- Explains how to determine the required "level" of qualification

(2-3 pages)

Other Domain or Supplements, e.g.:

- Formal Methods
- Model Based
- Object-Oriented
- Hardware
- Systems
- Database
- IMA
- Etc.

Supplement

- Title "Tool Qualification Guidance"
- Address "how" to qualify tools
- Objective-based
- Objectives applicable to each level
- Domain independent (secondary)
- Glossary of terms in addition to DO-178C/ED-12C

(50-70 pages)

SC-205 Approach for Tool Qualification (cont)

Home

Previous

Next

Help

- Section 12.2 and Tool Qual document have been developed and major portions have been approved by plenary
- The Tool Qual document is objective-based
- Like DO-178B, the tool qual approach is built upon five tool qualification levels
 - Four levels parallel the current development tools
 - The fifth level is equivalent to the current verification tool criteria
- The Tool Qual document implements tool guidance from DO-178B, DO-248B, and Order 8110.49

Overview of Proposed Section 12.2

Home

Previous

Next

Help

- 12.2.1 Determine need for tool qual
 - when processes (objectives) of this document are eliminated, reduced or automated by the use of a software tool without its output being verified as specified in section 6
- 12.2.2 Determine tool qual level
 - assess the impact of the tool in the software life cycle

Overview of Proposed Section 12.2 (cont)

Home

Previous

Next

Help

- Three criteria to assess tool impact:
 1. A tool whose output is part of the resulting software and thus could insert an error.
 2. *A tool that automates a verification process(es) and whose output is used to justify the elimination or reduction of:*
 - *verification process(es) other than that automated by the tool, or*
 - *development process(es) (which could have an impact on the resulting software).*
 3. A tool that, within the scope of its intended use, could fail to detect an error.

Overview of Proposed Section 12.2 (cont)

- Level Assignment:

| Software Level | Criteria | | |
|----------------|----------|--------------|-------|
| | 1 | 2 | 3 |
| A | TQL-1 | <i>TQL-4</i> | TQL-5 |
| B | TQL-2 | <i>TQL-4</i> | TQL-5 |
| C | TQL-3 | <i>TQL-5</i> | TQL-5 |
| D | TQL-4 | TQL-5 | TQL-5 |

Home

Previous

Next

Help

Tool Qualification Document Outline

1. INTRODUCTION
 2. PURPOSE OF TOOL QUALIFICATION
 3. TOOL QUALIFICATION LEVELS
 4. TOOL QUALIFICATION PLANNING PROCESS
 5. TOOL DEVELOPMENT PROCESSES
 6. TOOL VERIFICATION PROCESS
 7. TOOL CONFIGURATION MANAGEMENT PROCESS
 8. TOOL QUALITY ASSURANCE PROCESS
 9. TOOL QUALIFICATION LIAISON PROCESS
 10. TOOL QUALIFICATION DATA
 11. ADDITIONAL CONSIDERATIONS FOR TOOL QUALIFICATION
- Annex A – TOOL QUALIFICATION OBJECTIVES
- Annex B – GLOSSARY
- Annex C – Frequently Asked Questions and Discussion Papers on Tool Qualification

Home

Previous

Next

Help

1. Introduction / 2. Purpose

Home

Previous

Next

Help

1. Introduction

- Explains purpose of the document
- Provides an overview of the document

2. Purpose of Tool Qual

- The purpose of the tool qualification process is to obtain confidence in the tool functionality.

3. Tool Qualification Levels

- The required qualification level of a tool is determined based on the tool use and its potential impact on the overall development process and system safety.
- Determined by section 12.2 criteria

Home

Previous

Next

Help

Sections 4 to 10: Tool Qualification Processes

Home

Previous

Next

Help

Processes are similar to the DO178B/ED12B processes

4. Tool Qualification Planning Process
5. Tool Development Processes
6. Tool Verification Process
7. Tool Configuration Management Process
8. Tool Quality Assurance Process
9. Tool Qualification Liaison Process
10. Tool Qualification Data

Sections 4 to 10: Tool Qualification Processes (cont)

- Variations from the DO-178B processes for the tool qualification process:
 - Data items are named to address tools rather than airborne software (e.g., Tool Qualification Plan instead of Plan for Software Aspects of Certification).
 - User needs (a.k.a. system requirements) are documented as Tool Operational Requirements.
 - Tool requirements trace to the tool operational requirements.
 - Low-level requirements are only required if needed.
 - Derived requirements are evaluated for impact on the user, rather than the safety assessment process.
 - “Tool operational environment” is used instead of “target computer”.
 - Structural coverage – gives more flexibility and focuses on unintended functionality
 - Attempts to be domain-independent (to be used by other domains)
 - Delineation of the tool usage and tool development (to support reusability)

Home

Previous

Next

Help

11. Additional Considerations

Home

Previous

Next

Help

- 11.1 Multi-function Tools
- 11.2 Previously Qualified Tools
 - 11.2.1 Changes to previously qualified tools
 - 11.2.2 Reuse of previously qualified tool data
- *11.3 Qualifying COTS Tools*
- 11.4 Service History
- 11.5 Alternative Methods

Annex A – Tool Qualification Objectives: Table T-0 (Tool Operational Process)

1. ***The tool qualification need is established. (Planning)**
2. ***Tool Operational Requirements are defined. (Requirements)**
3. ***Tool Executable Object Code is installed in the Tool Operational Environment. (Integration)**
4. ***Tool Operational Requirements are complete, accurate and consistent. (V&V)**
5. ***Tool operation complies with the Tool Operational Requirements. (V&V)**
6. ***Tool adequacy is ensured in the Tool Operational Requirements. (V&V)**
7. ***Ensure software life cycle process needs are met. (V&V)**

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-1 (Tool Qualification Planning)

1. Tool development and integral processes activities are defined.
2. Transition criteria, inter-relationships, and sequencing among processes of tool processes are defined.
3. Tool Development Environment is defined.
4. Additional considerations are addressed.
5. Tool development standards are defined.
6. Tool plans comply with this supplement.
7. Tool plans are coordinated.

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-2 (Tool Development)

1. Tool Requirements are developed.
2. Derived tool requirements are defined.
3. Tool architecture is developed.
4. Low-level Tool Requirements are developed.
5. Low-level derived tool requirements are defined.
6. Tool Source Code is developed.
7. Tool Executable Object Code is produced.
8. Tool is installed in the Tool Verification Environment.

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-3 (Requirements Verification)

1. Tool Requirements comply with Tool Operational Requirements.
2. Tool Requirements are accurate and consistent.
3. *Requirements for compatibility with the tool operational environment are defined.
4. *Tool Requirements define the behavior of the tool in response to error conditions.
5. *Tool Requirements define user guidelines, instructions, and error messages.
6. Tool Requirements are verifiable.
7. Tool Requirements conform to Tool Requirements Standards.
8. Tool Requirements are traceable to Tool Operational Requirements

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-4 (Design Verification)

1. Low-level Tool requirements comply with Tool Requirements
2. Low-level Tool requirements are accurate and consistent.
3. Low-level Tool requirements are verifiable.
4. Low-level Tool requirements conform to Tool Design Standards.
5. Low-level Tool requirements are traceable to Tool Requirements.
6. Algorithms are accurate.
7. Tool architecture is compatible with Tool Requirements.
8. Tool architecture is consistent.
9. Tool architecture conforms to Tool Design Standards.
10. Protection mechanism, if used, is confirmed.
11. *External Component interface is correct.

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-5 (Code Verification)

1. Tool Source Code complies with low-level tool requirements.
2. Tool Source Code complies with tool architecture.
3. Tool Source Code is verifiable.
4. Tool Source Code conforms to Tool Code Standards.
5. Tool Source Code is traceable to low-level tool requirements.
6. Tool Source Code is accurate and consistent
7. Output of tool integration process is complete and correct.

Home

Previous

Next

Help

Annex A – Tool Qualification Objectives: Table T-6 (Testing of Tool Integration Outputs)

Home

Previous

Next

Help

1. Tool Executable Object Code complies with Tool Requirements
2. Tool Executable Object Code is robust with Tool Requirements
3. Tool Executable Object Code complies with Low-Level Tool Requirements.
4. Tool Executable Object Code is robust with Low-Level Tool Requirements.

Annex A – Tool Qualification Objectives: Table T-7 (Verification of Verification)

Home

Previous

Next

Help

1. Test procedures are correct.
2. Test results are correct and discrepancies explained.
3. Test coverage of Tool Requirements is achieved.
4. Test coverage of Low-Level Tool Requirements is achieved.
5. **Analysis of requirements-based testing of external software functions is achieved.*
6. **Analysis of requirements-based testing (structural coverage to the level of decision coverage) is achieved.*
7. **Analysis of requirements-based testing (structural coverage to the level of statement coverage) is achieved.*
8. *Analysis of requirements-based testing (data coupling and control coupling) is achieved.

Annex A – Tool Qualification Objectives: Table T-8 (Configuration Management)

Home

Previous

Next

Help

1. Configuration items are identified.
2. Baselines and traceability are established.
3. Problem reporting, change control, change review, and configuration status accounting are established.
4. Archive, retrieval, and release are established.
5. Tool Development Environment control is established.

Annex A – Tool Qualification Objectives: Table T-9 (Quality Assurance)

Home

Previous

Next

Help

1. Assurance is obtained that tool development and integral processes comply with approved tool plans and tool standards.
2. Assurance is obtained that transition criteria for the tool life cycle processes are satisfied.
3. Tool conformity review is conducted.

Annex A – Tool Qualification Objectives: Table T-10 (Tool Qualification Liaison)

Home

Previous

Next

Help

1. Communication and understanding between the applicant and the approval authority is established.
2. The means of compliance is proposed and agreement is obtained.
3. Compliance substantiation is provided.
4. *Impact of known problems on the Tool Operational Requirements is identified and analyzed.

Home

Previous

Next

Help

- Most of Tool Qual Supplement has been approved by plenary
- Areas still in work:
 - Criteria 2 rationale
 - Structural coverage approach
 - Leveling of objectives
 - COTS tool guidance
 - Frequently Asked Questions & Discussion Papers
- Could have some “ripples” as DO-178C/ED-12C changes
- Working toward completion in mid-2009