

DOT/FAA/AR- 02/110

**Guidelines for the Development of
Process Specifications, Instructions, and
Controls for the Fabrication of Fiber-
Reinforced Polymer Composites**

**Overview Presented by
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Material Control
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Topics to be Covered

- Document Development
- Document Outline
- Background
- Objective
- Process Instruction Guidelines
- Producibility Validation Guidelines

Document Development

- **Team**

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- **Time Line**

- First Draft: April - July 2002
- FAA Workshop: August 2002
- Final Draft: October 2002
- Release by FAA: April 2003

Document Outline

EXECUTIVE SUMMARY

1. INTRODUCTION

- 1.1 Objective
- 1.2 Background
- 1.3 Certification Process

2. PROCESS SPECIFICATION GUIDELINES

- 2.1 Work Instructions
- 2.2 Personnel
- 2.3 Materials
- 2.4 Equipment Description
- 2.5 Facility Description
- 2.6 Tooling
- 2.7 Panel Lamination
- 2.8 Inspection and Process Monitoring

3. PRODUCIBILITY VALIDATION GUIDELINES

- 3.1 Producibility Qualification Tests
- 3.2 Fabricator Qualification

4. REFERENCES

5. GLOSSARY

APPENDICES

- A—Example Process Specification
- B—Typical Processing Parameter Tolerances

Background

- Material and Process Specifications are inter-woven through out the certification validation process.
- Process instructions are used to define and control the processes used for the conversion of materials into structural components.
- Composite laminate properties are directly determined by the specific processes used for their fabrication.
- It is critical that the test specimens fabricated through the various levels of the Building Block Approach utilize the same process instructions, and that this process is representative of the process that will be used in the fabrication of production articles.

Objective

- Provide a set of guidelines for the development of process instructions for the fabrication of composite laminate test panels.
 - Process Specifications
 - Work Instructions
 - Material Specifications
 - Certification and Qualification Test Plans
- Provide an approach for the validation of composite composite fabrication processes.

Process Instruction Guidelines for the Fabrication of Test Panels

Guidelines Address The Following Areas

- Work Instructions
- Personnel
- Materials
- Equipment Description
- Facility Description
- Tooling
- Panel Lamination
- Panel Acceptance
- Process Monitoring

Process Instruction Guidelines for the Fabrication of Test Panels

- Work Instructions
 - Detailed step-by-step work instructions have been found to be a successful approach for the fabrication of repeatable quality laminates.
- Personnel
 - Highly skilled technicians are necessary for the fabrication of quality laminates
 - Fabricators are encouraged to establish a comprehensive training program for technicians directly involved with the fabrication of composite test panels

Process Instruction Guidelines for the Fabrication of Test Panels

- Materials
 - All materials required for the fabrication procedures and requirements relevant to the use of the materials should be listed within the work instructions
 - Materials which can come in contact with the composite prepreg should be evaluated to verify they do not contaminate the prepreg material.
 - Prepreg materials should be inspected upon receipt by the purchaser per the applicable material specification.
 - Prepreg material freezer storage conditions (temperature) and shelf life limits should be defined.
 - Ambient working life limits should be defined

Process Instruction Guidelines for the Fabrication of Test Panels

- Equipment Description
 - All equipment necessary to perform the fabrication process with necessary requirements should be listed in the process instructions.
 - Calibration and certification requirements should be defined.
- Facility Description
 - Collation (lay-up) of plies should be performed in a cleanroom.

Process Instruction Guidelines for the Fabrication of Test Panels

- Tooling
 - Tools should be designed for the defined process conditions
 - A heat survey should be performed on all tools.
 - A method for accurately positioning the plies is required
 - Detailed tool preparation procedures are necessary.
- Panel Lamination
 - Detail instructions for the collation of plies is required (debulking, ply tolerances, bagging procedures)
 - Cure Cycle must be clearly defined
 - Each panel must be identified

Process Instruction Guidelines for the Fabrication of Test Panels

- Panel Acceptance
 - Each inspection or examination required should be tied directly to a requirement specified by the Process Instructions
 - After cure it is strongly recommended that the panel is inspected to ensure all engineering requirements have been met prior to machining of test specimens.
- Process Monitoring

Producibility Validation Guidelines

Producibility Qualification Tests

- Verification of material attributes that affect producibility
- Test panels do not discern material attributes that can impact ability to fabricate large scale laminates.
- Scale up effects must be addressed to fully evaluate a composite prepreg material.
- The need exists for a panel design that will "discriminate" these material changes.
- The objective of the "Discriminator Panel" is to distinguish one material from another similar (or like) material by exposing the differences related to fabrication processes.

Fabricator Qualification

Qualify Fabricator as part of Certification Process

- Verify Coupon Property Equivalence
 - AGATE Process for Property Equivalency
- Verify Component Structural Equivalency
 - Destructive Testing of Full-Scale Part
 - Dimensional inspection, NDT, Photomicrographs, Physical Properties, Element Tests
- Verify Engineering Compliance
 - First Article Inspection