

DOT/FAA/AR- 02/109

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Guidelines and Recommended Criteria for the  
Development of a Material Specification For  
Carbon Fiber/Epoxy Unidirectional Prepregs

Overview Presented by  
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# Document Development

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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

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- 1.0 Introduction
- 2.0 Development of Material Controls
- 3.0 Scope
- 4.0 Applicable Documents
- 5.0 Technical Requirements
  - 5.1 Definitions
  - 5.2 Material Requirements
  - 5.3 Prepreg Ingredient and Process Requirements
  - 5.4 Uncured Prepreg Requirements
  - 5.5 Cured Prepreg Property Requirements
  - 5.6 Material Characterization
- 6.0 Quality Assurance
  - 6.1 Changes to Qualified Materials
  - 6.2 Supplier Site Qualification
  - 6.3 Statistical Process Control
  - 6.4 Reduced Testing
  - 6.5 Product Certification
  - 6.6 Material Test Methods
  - 6.7 Test Panel Fabrication
- 7.0 Packaging and Shipping
- 8.0 Acknowledgement
- 9.0 Rejection
- 10.0 Notes

## Guidelines Limited to Hot Melt Uni-tape

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- Easiest product form to tackle first.
- Familiar industry standard for manufacture, design, and use.
- Addresses common themes such as resin mixing, combining resin with fiber, and testing.

## Shared Databases

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- Document promotes approach for shared material property databases
- The material supplier will benefit by:
  - Not conducting multiple qualifications of the same material to various user specifications.
  - Manufacturing fewer materials, gaining better efficiency.
- The user will benefit by:
  - Simpler, easier, cheaper qualifications and certifications.
  - Better understood, more consistent materials.

## Technical Requirements - Highlights

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- Detailed definitions for “material batch”
- Strongly recommends establishment of PCD for prepreg
  - Determine process parameter targets and ranges by engineering trials
- Each specification designation to include:
  - Single resin formulation, single specific fiber
  - Unique “slash sheet” for industry specification
- Recommends characterization of resin cure kinetics
- Recommends demonstration that properties are valid over entire prepreg process window (time/temp extremes)
- Recommends tracking storage/out-life from date of manufacture

## Technical Requirements - Highlights

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- Recommends prepreg manufacturer establish baseline cure cycle for initial database
- Recommends minimum set of uncured and cured laminate properties
  - Initial characterization (qualification)
  - Establish specification
  - Material allowables
  - Database for batch acceptance and equivalency evaluations
- Recommends additional tests for expanded database
  - Extent to depend on end-user requirements

## **Technical Requirements – Recommended Characterization Test Matrices**

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- Neat resin properties
- Carbon fiber properties
- Uncured prepreg properties
- Cured laminate physical properties
- Cured laminate mechanical properties
  - Minimum set
    - Unidirectional and cross-ply strength and modulus
  - Additional for general applications
    - Open hole tension, compression strength



## Technical Requirements – Recommended Expanded Database Tests

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- Quasi, hard, soft layups:
  - Unnotched tension and compression
  - Open hole tension and compression
  - Filled hole tension and compression
  - Bearing
- Interlaminar shear
- Sandwich flexure (unnotched, open hole, impacted)
- In-plane shear (solvent sensitivities)
- Fracture toughness
- Laminate compression after impact
- Open hole fatigue

## Technical Requirements - Qualification

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- Initial material characterization
  - Minimum of 3 prepreg batches (3 resin, 2 fiber batches)
  - Use AGATE developed procedures for establishing acceptance limits and equivalency requirements
  - Batch acceptance tests:
    - Fiber, resin, volatile contents
    - Flow, HPLC
    - Cured thickness
    - RT [0/90] tension
    - Hot [90/0] compression
    - RT SB shear

## Technical Requirements – Expanded Batch Testing

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- Recommends expanded batch testing:
  - Provide robust equivalency database
  - Ongoing validation of structural properties
  - Reduce chances for “surprises” for re-qualifications, equivalency demonstrations
  - Potential for higher allowables
  - Reduced levels of testing once material is demonstrated to be in control

## Quality Assurance Requirements - Highlights

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- Recommends SPC for key characteristics and key process parameters
  - KCs: batch acceptance tests
  - KPPs: resin mixing and prepreg processing parameters that have a significant influence on the KCs
    - Determine prior to qualification
    - Document in PCD
  - Data should be collected, plotted, analyzed and acted upon

## Quality Assurance Requirements - Highlights

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- Changes to qualified materials
  - Expansion of AGATE equivalency procedures
  - Defines 5 levels of change
    - Based on FAA draft composite material TSO
    - Recommends types of changes that apply to each level

## Changes in Final Version

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- Major changes based on FAA workshop input:
  - Aligned document to SAE specification format
  - Revised batch definitions
  - Simplified and removed FAA policy wording from material qualification process sections (2.4, 2.5)
  - Clarified recommendations on demonstrating capability of prepreg for cure process extremes
  - Separated test conditions and methods in tables
  - Added test method recommendations
  - Clarified expanded batch testing recommendations
  - Added Glossary