

Review of Liquid Resin Molding Specifications

FAA Workshop
September 2003

Scott Reeve
National Composite Center





Areas of Comment

- Use of Guidelines
- Format
- General Comments
- Resin
- Fiber
- Material/Part Acceptance
- Process



Use of Guidelines

- Applaud drive towards industry standards
- Guidelines will help set the standards
- Make sure UNIQUE features of LRM are addressed
 - Guidelines start to become de facto spec, policy
 - Deviations will face uphill battle
 - Want to minimize deviations so that near-term producer specs can eventually be superceded by industry specs



Format

- Educational information followed by examples and details is fine
- Make the two documents consistent
 - Prefer the Material Spec format
- Guidelines and example don't always match
 - Material spec Section 3.1
 - Process spec Section 2



General Comments

- Provides good guidelines for specification structure, but does not go beyond autoclave prepreg enough
- Needs to address more of the unique features of LRM
 - Preform and binder, not fabric
 - Resin formulations
 - Processing
 - Part variations



Material Spec Guidelines

- Good basic info on LRM (sections 1, 2)
- Need more details on where the variabilities come from during LRM especially Vacuum Infusion
 - Will put reviewers, producers and customers on a similar information plane
- Less focus on Receiving Inspection, more on Process Control



Qualification

- Assumes too much will be done by the resin supplier (Section 3.4)
 - Relies too heavily on what prepreggers did
- More variables in LRM
- Part producer is now controlling more of those variables
 - This is what gives him the design and manufacturing flexibility
- Not all resin suppliers have the resources of traditional prepreg suppliers



Resin Specification

- Resin and mixing process must account / allow for variabilities needed to successfully fabricate parts
 - Viscosity, temperature, part size interactions
- Bias towards one-part epoxies makes it difficult for less traditional resins to be used
- Reaction driven cures must have mix varied for part size and desired properties
 - Reviewers, customers must be aware of this
 - Producers need to address this



Fabric, Then Preform, Specification

- Fabric spec is straightforward
- Need to have a PREFORM spec
- Preform spec can be for purchasing or accepting internally fabricated preforms
- Recognize other preform constructions
 - Braid, 3D, Z-reinforced, discontinuous fibers
- Have to address binder issues
 - Quantity, compatibility, tack, out time



Cured Material Acceptance Spec

- Need to address unique LRM issues
- Resin-binder compatibility, binder movement
- More complex shapes may not mirror physical or mechanical properties of flat panels
- Cannot run full test matrices on all combinations
- Use correlation factors, acceptable ranges and equivalency testing



Vacuum Infusion / VARTM

- There is interaction between fiber volume, thickness, loft, binder, shape that affect final part characteristics
- Reviewers and customers must understand and accept
- Producer must control parameters for parts
 - Identify key process parameters
 - Allowables
 - Translate from flat panels or else test elements
 - Affects downstream operations (NDI, assembly)



Mechanical Properties & Testing

- Section 3.4 (page 60)
- Represents high end (prepreg for wings)
- Add guidance reflecting part criticality
- LRM will have to work its way up the structural hierarchy
 - Set some reasonable requirements for less demanding parts
 - Give LRM a chance to grow



Process Spec

- Good, basic tutorial with some LRM details
 - Degassing, non-supplier resin formulation
- Need to include more on
 - The key attributes in Section 1.3 (discuss details in the later sections)
 - Tooling for RTM, VARTM, VI
 - Equipment
 - Facility (Section 2.5) may be more restrictive than necessary



Summary

- Guidelines and industry standards are a necessity
 - Coming at right time
 - Encouraging to see key guidelines
 - We will use it
- Must include **UNIQUE** aspects of preforms and LRM
 - Technical and business sides
 - Don't box new technology into the prepreg world
 - Need to allow for benefits and growth of new technology
 - Shared database will be have new set of issues