

LRM Material and Process Spec Review

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General

- We don't perform LRM at Lancair, but we have investigated it. We do perform structural wet layup.
- Most comments are picky details
- Some are based on our ACO's requirements for material database reports

Terminology

- I was very confused on the term 'batch acceptance.'
Spec must differentiate:
 - Supplier Quality Assurance performed by the fiber manufacturer
 - Receiving tests performed by fabric manufacturer
 - Quality assurance tests performed by the material manufacturer (on mixed resin batches and fabrics)
 - Receiving tests performed by the end-user (aka part producer) on resin and fabric
 - Tests performed by the end-user as in-process verification

Terminology

- To me 'acceptance' should indicate 'when it comes in the door.' I believe the term 'quality assurance' should be used in place of 'acceptance' testing by the base material manufacturers after they have made their product.
- The term "Equivalence" is used for different things. Section 4.3 of Material Spec is "Equivalency Baseline Enhancement." This should be retitled "Database Enhancement" or something similar to distinguish it from equivalence testing performed by an end-user to show they can use properties developed by the material supplier.
- The Glossary should include terms like Batch, Batch Acceptance, Equivalence, etc., that may be defined in the text of the document, but should be defined in the glossary as well.

Material Specification, LRM Processes and Materials

- Figure 2.1 (1.1 in the process specification) flow chart should not have a line between the Fiber Reception/Storage and Resin Mixing, nor between the Resin Reception/Storage and Preform Assembly (unless you consider Tackifiers to be Resin).

Material Specification, LRM Processes and Materials

- Section 2.2 lists materials that are typically not controlled by their own material specification, but rather by a qualified products list. We have had to put mold release agents into a material specification which include receiving inspection testing. Not sure what is meant by 'adhesives' in this section.
- Figure 3 shows tackified fabric as part of the material procurement spec. I would have expected this to be part of the material acceptance spec. Materials aren't purchased in preforms, are they?

Material Specification, Development of Material Controls

- Section 3.3, titled Part Producer Responsibilities for Material use in Structural Design, should include more information on other tests for qualification of a material (lightning protection, compatibility with secondary adhesives, etc.)
- Our ACO has requested that the material database reports have specific wording regarding the limitations of the data. If we want to work that into the specification, this may be the place to do it.
 - This report provides material data that may be used in Part 23 aircraft design, including B-Basis values that meet the requirements of 23.613 taking into account environmental factors per 23.603.

Material Specification, Development of Material Controls

- Section 3.3 recommends “that the end-user perform the purchaser batch acceptance tests on panels cured using the material supplier’s baseline cure process.” I disagree. Receiving Inspection should be performed using the same cure cycle that the parts will be made with. In practice it won’t work at our facility to have a separate cure cycle just for receiving inspection.

Material Specification, Qualification Requirements

- Section 4.2 recommends a check for maximum T_g . Is this really something to check?
- Section 4.3 Item 1 says the material equivalency and batch acceptance requirements should be recalculated and the specification updated. I think it should specifically say in this step that the B-Basis design values are NOT changed.

Material Specification, Qualification Requirements

- Section 4.6.3 says Level 2 changes can be approved with less than the full equivalency test plan required for a Level 3 change. So what is required?
- Section 4.6.4 says that a full equivalency test program is required per AR-03/19 for a Level 3 change. I haven't seen this document, but if it is the same as AR-00/47, it requires one batch with 8 replicates for strength and 4 for modulus. Section 4.6.4 further states that "Testing to validate Level 3 changes should involve a minimum of three batches..." Appears to be in conflict.

Material Specification, Resin Procurement

- Section 6.3.2 says “None of the tests in Table 1 are recommended for batch acceptance testing” yet the footnote on Table 1 identifies some tasks as ‘acceptance tests.’
- Table 2 recommends cured resin tension test. Wouldn't compression be more relevant?
- Section 6.3.5 is the PCD for resins, yet it includes references to fabric.

Material Specification, Resin Procurement

- Section 6.4.2.4 (typo, listed as 6.4.3.4) says that replacement data is only allowed if (1) test abnormality, (2) statistical outlier, *and* (3) bad specimen prep or conditioning. I believe that should be *or*.
- Retest section should be specifically identified as pertaining to both supplier and part producer testing.
- Paragraph three references prepreg

Material Specification, Resin Procurement

- Section 6.4.3 requires two copies of certs. Why?
- Section 6.4.5 says the specification should define the requirements for certifying a test lab. I don't think that should go in each material specification. Belongs in a separate guidance document, or nowhere. Test lab certification is left to the Quality Department at Lancair, just like any other vendor approval (no type design requirements).

Material Specification, Resin Procurement

- Section 6.7 says that batches rejected by a purchaser should not be rerouted to other purchasers. We should allow a way for the material supplier to sell to a different customer with different requirements (e.g. sports industry). Can this be reworded?

Material Specification, Fabric Procurement

- Section 7.1 discusses 'cure conditions.' Is this applicable to fabrics?
- Section 7.3.3 is the PCD for fabric, but discusses resin.
- Section 7.4.2.2 references cured and uncured materials

Material Specification, Cured Material Acceptance

- Table 6 may be easier to understand if it were broken into three tables that corresponded to text descriptions of (1) IMQ testing (2) Receiving Inspection testing and (3) Database Enhancement testing, with frequencies given for each.
- Section 8.3.4.4 should perhaps reference foam instead of honeycomb core. Mentions prepreg. (recommend search and replace)

Material Specification, Cured Material Acceptance

- Should the laminate tests include planned variations in cure cycle, resin content, and hardener content?
- As shown in Figure 4, was it considered to forego performing the Batch Acceptance (receiving) tests and instead perform only the Batch Release Tests?
 - Goal should be for it to be the responsibility of the supplier to provide a good product and prove it. (i.e. not the responsibility of the end-user to ensure they received good material) Responsibility of the end-user to provide a good part and prove it.

Material Specification, Cured Material Acceptance

- Section 8.4.2.2, Constituent Receiving Inspection Tests, copies the material procurement spec. Does it belong here?
- Section 8.4.2.4, Part Acceptance Tests, recommends only performing a test on excess resin to validate proper cure, when the materials have batch release testing prior to use. What kind of test should that be?
- 8.4.2.5, Retest, says to inform end-users of a material batch for which retests were performed. Is this applicable to the material acceptance spec?

Process Specification

- Should Section 2.3 on Materials be included, or just reference the material specification?
- Bagging materials should be controlled in some manner, perhaps in Section 2.4
- Section 2.7.1 says that at least two thermocouples should be used for each panel. Perhaps more useful to define a ratio for number of thermocouples to panel area.

Process Specification

- I recommend Section 2.8.2, Inspection and Process Monitoring, references the material specification or the material specification references this one rather than put in both places.
- Section 2.8.3, Panel Inspection, includes a check on panel thickness. Is this unique to LRM or also in prepreg? If values are normalized by ply thickness, is this necessary?

Recommendations

- Table of standard tolerances
- Flammability Testing
- Effects of lightning mesh (included in the samples or not)
- For us, Environmental/Variability Factors are a big part of what we get out of laminate tests. Can that be discussed in this document?

$$\text{E/V Factor} = \frac{\text{Mean Strength at Test Environment}}{\text{B-Basis Strength at HW}}$$