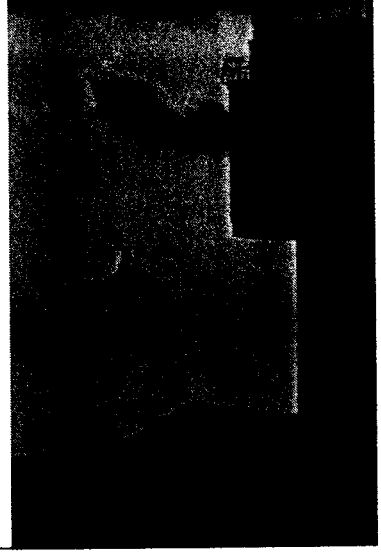
Design Values Testing

Federal Aviation Administration



Presented to: Cabin Safety Break-out Session

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Date: November 17, 2005

Summary

- FAA Policy
- A&B Basis Definitions
- Test Plan/Report Review and Data Reduction

FAA Policy

- **Only FAA approved design values may be used**
- **Not Acceptable**
  - Foreign approved but not FAA approved – FAA validity finding is required
  - Samples tested and you use lowest value without further data reduction
  - "Found this old sheet of values that looks good to me"

FAA Policy

- **Acceptable**
  - MIL-HDBK-5 test and data reduction methods (any revision)
  - MMPDS-01 (Metallic Material Properties Development and Standardization) design values (MIL-HDBK-5 replacement)
  - MIL-HDBK-17 test and data reduction methods (any revision) for composites

A & B Basis Design Values

- **14 CFR 25.613 Material Strength Properties & Design Values – Requires Statistical Basis**
- **A Basis – At least 99% of the population meets or exceeds the A basis mechanical property design value with a confidence of 95%**
  - Used for single load path structure
- **B Basis – At least 90% of the population meets or exceeds the B basis mechanical property design value with a confidence of 95%**
  - Used for redundant load path structure – most interior structures

Test Plan Review

- **DERs are not typically delegated to approve, talk to your project specialist**
- **Make sure there are three (or more) batches of material**
  - Must have multiple material lots defined in the plan for the mechanical property design value to be generated. Examples:
    - Insert pull-out values in composite panels: multiple batches of potting
    - Insert shear values in composite panels: multiple batches of potting and face sheet material
    - Composite panel beam shear and bending: multiple batches of face sheet and core
    - Metals properties: multiple batches of material

Test Plan Review

- **Make sure manufacturing process batch variation is included. Example:**
  - Don't cut all specimens out of one composite sandwich panel
  - Use multiple panels built during different days by different personnel on different equipment to capture manufacturing variation
- **Important idea to remember is that the final A & B design values must reflect the variability inherent in the materials and processes used to produce them**

Test Plan Review

- **Make sure there are enough specimens to produce a statistically based design value**
  - For a B basis design value only for interior structures use: A **minimum** of 15 test specimens (5 specimens x 3 material batches or 3 specimens x 5 material batches ok also – usually harder to get multiple batches)
  - 15 specimens is not enough to produce a statistically based A basis design value

  For comparison, assuming data fits a distribution:
  - For composites MIL-HDBK-17 requires at least 30 test specimens (6 specimens x 5 material batches) for a B basis allowable
  - For metals MIL-HDBK-5 requires at least 100 test specimens (10 specimens x 10 material batches) for an A basis allowable

Data Reduction Methods

- **Follow the MIL-HDBK procedures for each design value to be determined (Example: insert pull-out)**
  - Examine test specimen failure modes and attempt to group specimen raw test data
  - Run statistical tests on data to determine if all specimens are part of the same population, if so group them - no arbitrary data censoring is allowed!
  - Run statistical tests on group data to determine if population distribution is Normal, Lognormal, Weibull or fits no distribution
  - If data fits a distribution (say Normal) calculate B basis design value using appropriate (Normal) table calculation
  - If data doesn't fit a distribution you must use a non-parametric method to calculate the design value – can't assume it's Normal!

Test Report Review

- **Typical cert. test requirements apply**
  - Approved test plan followed
  - Specimens and set-ups conformed
  - At least critical tests witnessed
  - Lab approved and equipment calibrated
  - Photos pre and post test, load/stroke plots included
  - Specimens retained

Test Report Review

- **Report must include:**
  - All raw data
  - Data reduction assumptions (data censoring must be explained and tied to a valid cause – "Test rig broke", "Specimen came loose from fixture" etc; Not "This data point is too low and will kill my final design value")
  - Calculations, load plots, and failure mode photos or figures
- **Each design value must be clearly traceable to the raw data, data reduction assumptions, and calculations that produced it**

Conclusion

- **Bottom line is design values must reflect the actual variability of materials and processes that produced them to be statistically based as required per 14 CFR 25.613**
- **If good methodology is not followed in the test plan, test report and data reduction, the design value calculated will be unconservative and not statistically based**