FAA Composite Safety Awareness Courses

Emphasis on Composite Structural Engineering Technology (CSET) & Manufacturing Technology (CMfgT)

Level II Course Development

Session Objectives

1. Review FAA composite initiatives, incl. educational strategies
2. Review CSET & CMfgT status
3. Discuss Convergent Manufacturing Technologies (CMT) plans for CMfgT development

Background

- Composites aircraft structures are non-standard technology
- Composite Safety and Certification Initiatives (CS&CI) proactively pursue composite needs based on field support to certification and safety-related issues
  - Structured to meet FAA Flight Plan & AVS "Processes"
  - Utilizes the "FAA Composite Team" (field offices & each directorate)
  - CS&CI approach expands the safety/regulatory workforce through the use of industry and other country regulatory technical experts

    Important to the most challenging safety-related issues (i.e., limited FAA resources with required composite experience)
- CS&CI have a successful track record since 1999
  - Industry acceptance has been inherent through this approach
  - Inter-directorate/field office integration through the composite team
  - Global harmonization with participation of EASA/TCCA
  - Training has become a current priority with expanding applications

Composite Technical Thrust Areas

Advancements depend on close integration between areas

Material Control, Standardization and Shared Databases

Damage Tolerance and Maintenance Practices

- Critical defects (impact & mfg.)
- Bonded structure & repair issues
- Fatigue & damage considerations
- Life assessment (tests & analyses)
- Accelerated testing
- Structural tear-down aging studies
- NDI damage metrics
- Equivalent levels of safety
- Training standards

Structural Substantiation

- Advances in analysis & test building blocks
- Statistical significance
- Environmental effects
- Manufacturing integration

Progress to Date

- AC 20-107B (9/09)
- 2 other Advisory Circulars
- 6 Policy Memos
- 11 Workshops
- 3 Training Initiatives
- 2 Technical Documents
- CMH-17 Updates
- SAE CACRC Standard
- ~60 FAA R&D Reports

Crashworthiness & Flammability

Support to cabin safety research groups

Bonded Joint Processing Issues

Advanced Material Forms and Processes

Significant progress, which has relevance to all aircraft products, has been gained to date

Progress in Composite Safety and Certification Initiatives

Milestones achieved to date

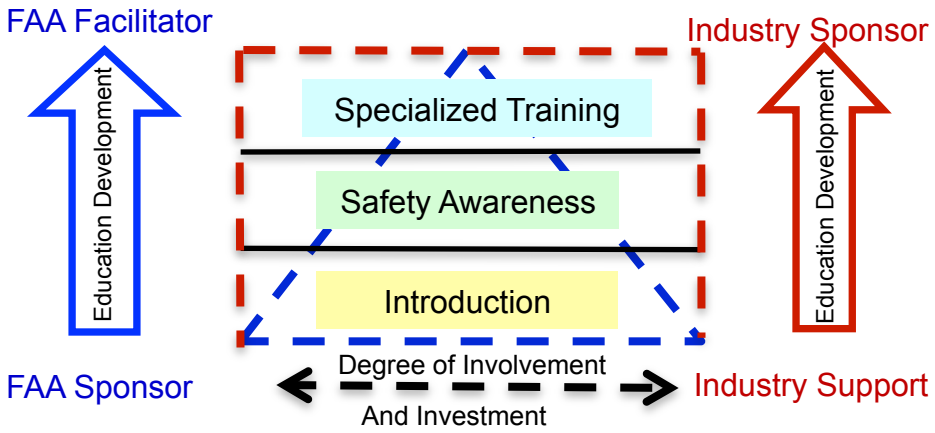
- FAA policy/training for base material qualification & equivalency testing for shared databases (update 2003)*
- Policy/training for static strength substantiation (2001)
- New rule & AC for damage tolerance & fatigue evaluation of composite rotorcraft structure (2002, 2005 & 2009 releases)
- AC for material procurement & process specs (2003)*
- Tech. document on composite certification roadmap (2003)
- Policy on substantiation of secondary structures (2005)
- Policy for bonded joints & structures (2005)*
- Tech. document on composite maintenance & repair (2006)
- Composite maintenance & repair awareness training (2008)*
- AC 20-107B (Composite Aircraft Structure) (2009)*
- National Center for Advanced Material Performance Policy (2010)
- Revision G to CMH-17 in work (2011)

* FAA Technical Center reports exist for detailed background on engineering practices

Composite Educational Initiatives

FAA AVS Composite Training

- FAA composite training strategy using existing courses, FAA COE & industry support [Sept., 2009]
  - Courses to support airframe engineering, manufacturing and maintenance functional disciplines
- Incl. three levels of competency:

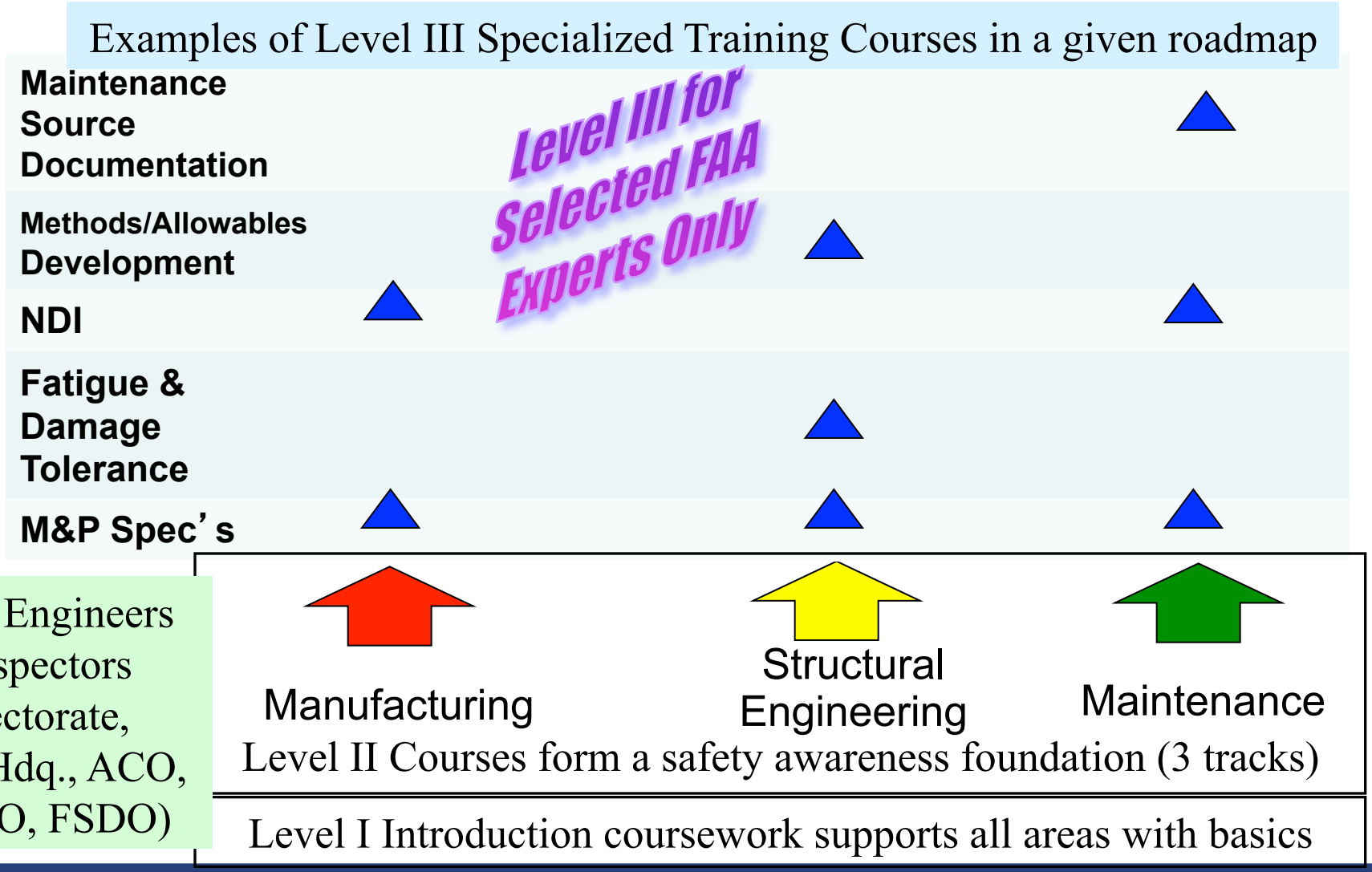


I) Introduction (common to all functional disciplines)
- Self-study intro content for composite basics/terminology
- CMH-17 Tutorial for composite certification & compliance [Aug, 2008]

II) Safety Awareness (courses for each functional discipline)
- Skills needed for FAA workforce supporting composite applications
- FAA development status summarized on the next chart

III) Specific Skills Building (most courses developed by the industry)
- Specialized skills needed in the industry & some FAA experts

Overview of FAA Composite Education Plan
Education roadmap illustration



Composite Educational Initiatives

Composite Level II Course Development Status

- Composite Safety Awareness for Maintenance/Repair [CACRC AIR5719]
  - FAA-led course development completed [Sept., 2008]
  - AFS-500 class-room version available to FAA [since 2009]
    - *~ 400 AFS ASI trained to date through FAA contract with ABARIS*
  - On-line version is also available to the industry thru WSU NIAR
- Composite Safety Awareness for Structural Engineering – *In work*
  - Development sponsored by FAA R&D COE & AIR-520
  - Detailed outline and Material & Process Control module [Sept., 2010]
  - Course content 75% completed [Sept., 2011] and available in 2012
- Composite Safety Awareness for Manufacturing – *In work*
  - Development sponsored by FAA R&D COE & AIR-520
  - Detailed outline and key contractors [Sept., 2011]
  - Course content 75% completed [Sept., 2012] and available in 2013
- Industry experts support course development and delivery

~$1.7M to Develop

Composite Structural Engineering Technology Level II Safety Awareness Course Development

- Composite Structural Engineering Technology (CSET) course development started in 2010 for *"safety awareness"*
  - *80 Hour* classroom/lab equivalent (3 days of hands-on lab)
  - More hours in self-study when taught online
- Draft top-level outline following AC 20-107B
  - Challenges faced in composite applications (2 hours)
  - Design, material and fabrication development (~4 days)
  - Proof of structure – general, static and fatigue & damage tolerance (~4 days)
  - Manufacturing interface issues (3/4 day)
  - Maintenance interface issues (3/4 day)
  - Other: flutter, crashworthiness, fire safety & lightning strike protection (3/4 day)

Composite Structural Engineering Technology Selected Course Outline Details

1. Prerequisite self-study module to ensure common level of basic understanding and terminology
2. Practical appreciation for the challenges of composite applications (high non-recurring costs, limited advantages from shared data, industry trends to keep developing "advanced technology", while not striving for standardization)
3. Design, Material and Fabrication Development Module
   - 3.1 Integrated product team needs (emphasis on composite specialists)
   - 3.2 Material & Process Control Section (roughly 1/3 of this section)
   - 3.3 Composite Structural Design (roughly ½ of this section)
   - 3.4 Manufacturing Interface Section (as related to the integration of design and manufacturing)
   - 3.5 Maintenance Interface Section (as related to the integration of design and maintenance)
4. Proof of Structure Module [integrated for static strength, fatigue & damage tolerance]
   - 4.1 to 4.9 General (incl. rules/guidance, key concepts, compliance approaches, damage & defects and related design considerations)
   - 4.10 Damage Threat Assessment
   - 4.11 to 4.13 Structural substantiation (building block approach, reliability and full scale tests)
   - 4.14 Inspection Program Definition and Substantiation

Composite Structural Engineering Technology Selected Course Outline Details, *cont.*

5. Quality Control of Composite Manufacturing Processes
   - 5.1 Quality Control methods and Examples
   - 5.2 Critical Items to Consider
   - 5.3 Conformity Issues Unique to Composites
   - 5.4 Production Defect Disposition
   - 5.5 Approving Changes in Materials and Processes
6. Maintenance Interface issues
   - 6.1 Repair Design and Process Substantiation
   - 6.2 Need for Teamwork and Skilled Disposition
   - 6.3 Composite Damage Characterization (Detection, Inspection)
   - 6.4 Bonded and Bolted repair Methods
   - 6.5 Dependence on Source Documentation in Meeting Regulations
7. Additional Considerations
   - 7.1 Proof of Structure - Flutter
   - 7.2 Crashworthiness
   - 7.3 Fire Safety and Fuel tank Issues
   - 7.4 Lightning Protection
   - 7.5 Maintenance of Structural Coatings and Paint

Composite Structural Engineering Technology Level II Safety Awareness Course Development

- FAA Composite Team (led by L. Ilcewicz, C. Seaton & L. Cheng)
  - Structures Specialists, Dave Walen (Lightning Protection CSTA), Mark Freisthler (Transport Directorate Standards), Cindy Ashforth (Transport Directorate International Branch), Angie Kostopoulos (Chicago ACO), Allen Rauschendorfer & Melanie Violette (Seattle ACO)
  - Cabin Safety Experts (Joseph Pellettiere, Crash Dynamics CSTA, Dick Hill & Alan Abramowitz, FAA Technical Center, Jeff Gardlin, Transport Directorate Standards),
- Key subject matter experts (SME)
  - Peter Smith (retired Boeing)
  - Keith Kedward, UCSB (incl. composite design/analysis textbook)
  - Steve Ward (M&P control, design/analysis and proof of structure)
  - NSE Composites (Tom Walker and D.M. Hoyt, fatigue & damage tolerance)
  - Wichita State University (Ng, Senevertine, Clarkson, lab development)
  - Delft University (Christos Kassapoglou)
  - Other SME (contractors and volunteers)
    - Michael Niu (UCLA, composite design)
    - Max Davis (Adhesion Associstes, metal-bonding)
    - Michael Borgman (Spirit Aero, repair substantiation)
    - FAA JAMS (Paolo Feraboli, Hyonny Kim, Dan Adams)
    - John Halpin (retired Air Force)
    - Will McCarvill (retired Hexcel)
    - John Adelmann (retired Sikorsky)
    - Dan Ruffner (Boeing, Mesa)
    - Convergent Manufacturing Technologies (Univ. of British Columbia composite manufacturing experts)
    - Heatcon (Field and Production repairs, including those performed on-airplane)
    - Workshop participants: presentations, discussions, testimonials (M&P control, fatigue & damage tolerance, crashworthiness)

Composite Manufacturing Tech. (CMfgT) Course Development Plan: Strategies

- Work with a major contractor qualified to create most portions of the course not requiring FAA involvement
  - Involve FAA Manufacturing Inspection District Office (MIDO) focal from the start
  - Work with FAA composite experts to refine content as needed for MIDO Aviation Safety Inspectors (ASI)
- Follow "near-ideal" approach to course development

  Detailed outline → TCO/teaching points → Course content → Beta review with industry → Course implementation
- Industry experts involved in Beta course review
- Course ready for beta check by mid 2013