

FAA Composite Plan

Composite Safety Meeting & Workshop New Zealand

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Federal Aviation
Administration



Outline

- **Background (CS&CI) (1999-2014)**
- **AVS Composite Plan (2014-)**
- **Summary and Closure**

Composite Safety and Certification Initiatives (CS&CI)

Before the Composite Plan, there was CS&CI

Objectives

- 1) Work with industry & other government agencies to ensure safe and efficient deployment of advanced composite technologies in aircraft products
- 2) Update policies, advisory circulars, training, and detailed background used to support standardized composite engineering practices

Background - Part 23 TC Projects with Extensive Use of Composites in Airframe Structure



Raytheon Premier I

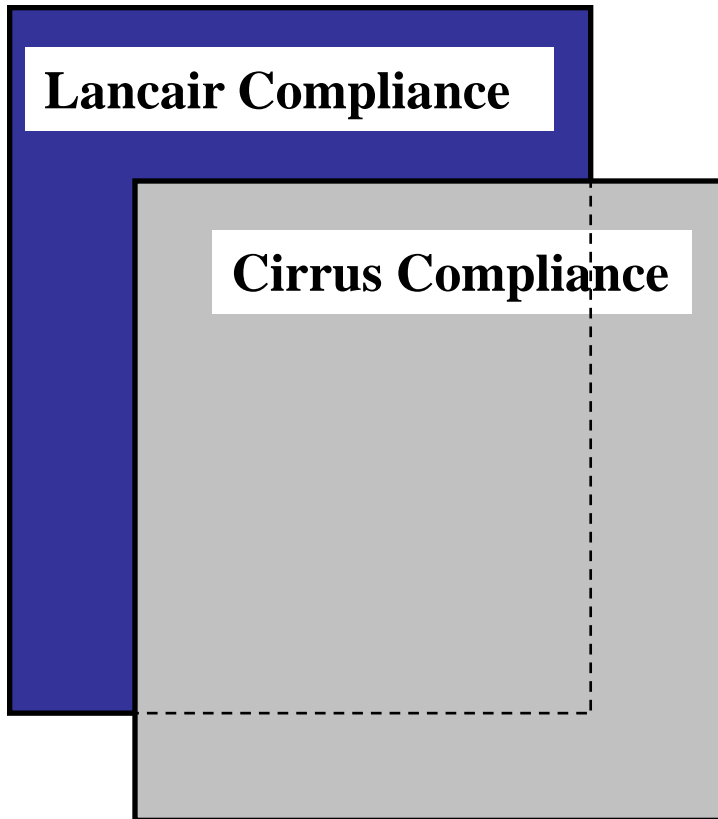


Cirrus Design Corp. SR20



PAC USA Lancair LC40-550FG

PACUSA Lancair LC40-550FG & Cirrus Design Corp. SR20 Composite Structure Certification Experiences



- **Both challenged composite paradigms**
- **Some overlaps, but also distinct differences (based on individual approach)**
- **Consistent engineering rationale can be used to account for most differences**
- **Discussions with the FAA following certification led to a list of composite initiatives**

List of Composite Certification Initiatives from GA Experience

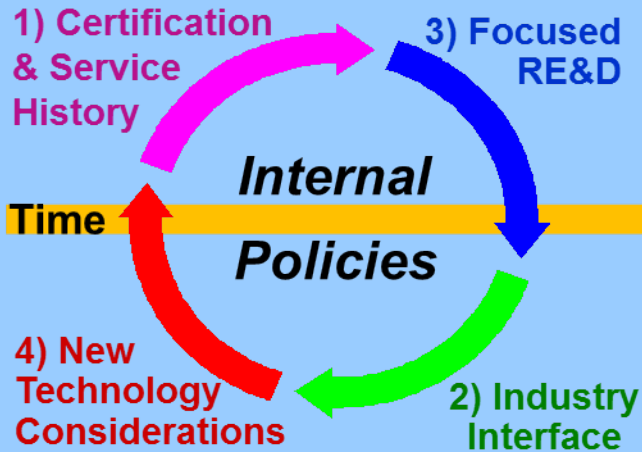
- **Base material qualification and equivalency**
- **Material & process specifications for composites and adhesives**
- **Critical environment for application of load requirements**
- **Environmental resistance guidelines: update to “ ΔT rule”**
- **Static strength substantiation approach**
(analysis & building block tests versus load enhancement for environment & material variability in large scale tests)
- **Common design databases** (cooperative work with RITA)
- **Bonded joint processing issues**
(e.g., surface preparation, layer thickness)
- **Structural integrity & damage tolerance of bonded joints**

List of Composite Certification Initiatives from GA Experience (cont.)

- **Fatigue & damage test parameters**
(for damage tolerance test substantiation)
- **Severe accidental and large debond damage considerations**
- **Substantiation of secondary structures**
- **Stiffness variation and flutter assessment**
- **Analysis and tests for un-pressurized fuselage structure**
- **Updates for advanced material forms & manufacturing processes**
- **Flammability considerations**
- **Crashworthiness considerations**

FAA Approach to CS&C

Evolving



#) Order of Influence for Unwritten Internal Policies

Rules & General Guidance

Detailed Background
(Various forms of technology transfer)

Mature

Policy Statements

Advisory Circulars

FARs

Training (Workshops, Courses, and Videos)

JAMS JOINT ADVANCED MATERIALS & STRUCTURES CENTER OF EXCELLENCE

Public Documents and Standards (e.g., CMH-17, SAE AMS, Contractor Reports)

Milestones Achieved via CS&CI

- 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** was released (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** (2012)

AVS Composite Plan

- **The FAA created an AVS Strategic Composite Plan (August 2013) that identifies three focus areas**
 - Continued Operational Safety (**COS**)
 - Certification Efficiency (**CE**)
 - Workforce Education (**WE**)
- **Updated Annually**
- **Priority is assigned to tasks based on issues that pose the greatest safety threats**

AVS Composite Plan

The FAA will work with industry to ensure safe and efficient use of composites in aircraft products. This will include:

- the continuous improvement of regulatory standards to address the needs of composite technologies developed for aircraft applications and
- related support for the training and global standardization of evolving industry practices used for certified composite aircraft structure.

AVS Composite Plan

- AVS Composite Plan Consists of a **Strategic Management Plan** and a **Working Plan**
- Based on **safety management** approach
- The Plans are linked to:
 - Best Industry Practices
 - Certification and Field Experiences
 - Focused Research
 - **Technological Advances** in Aircraft Structures
- Priority is given to **structural engineering** issues, related **manufacturing procedures & maintenance practices** resulting from service experience and industry input.

Overview FY2016

Continuous Operational Safety (COS)	Certification Efficiency (CE)	Workforce Education (WE)
COS A: Bonded Structure	CE A: Hybrid F&DT Substantiation	WE A: Composite Manufacturing Technology
COS B: HEWABI (High-Energy, Wide-Area Blunt Impact)	CE B: Advanced Composite Maintenance	WE B: Composite Structures Technology
COS C: Failure Analysis of Composites Subjected to Fire	CE C: Composite Structural Modifications	WE C: Composite Maintenance Technology
	CE D: Composite Quality Assurance	
	CE E: Bonded Structure Guidance	
	CE F: General Composite Structure Guidance	

New FY16 initiative in Green

COS Initiatives

- **Continued Operational Safety is always the FAA's highest priority**
 - Continued operational safety depends upon the use of approved designs, materials, and methods. Alternatives require additional qualification data and further proof of structural substantiation.
- **Three COS items in the Composite Plan:**
 - A. Bonded Structure
 - Bonded repairs
 - Bond quality control
 - Sandwich disbond growth
 - B. HEWABI (high-energy, wide-area, blunt impacts)
 - C. Failure analysis of composites subject to fire

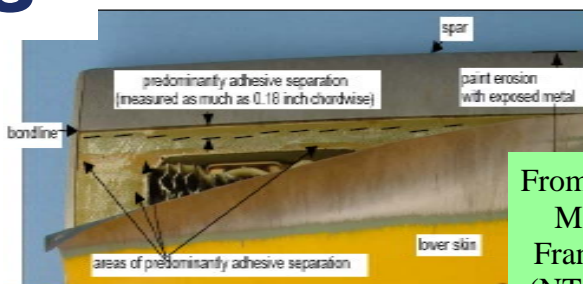
COS A, Bonding

- **Background**

- The bonded repair process is operator and process dependent, cannot be fully inspected after the fact, and is highly individualized due to lack of standard materials, processes and structural details.
- The bonding processes, environmental durability and weak bonds have been identified as contributing factors in multiple incidents and accidents
- Sandwich structure is a type of bonded structure that has its own service and certification challenges. Developing standards and guidelines to control disbond growth for sandwich structures.

Bonding Field Difficulties

- Helicopter main rotor blade metal bonding problems
 - 2008 NTSB Safety Recommendations
 - Possible metal bond processing problems
- Rudder debonding
 - NDI to control current field problems
 - OEM shared technical solutions & design concerns with industry in FAA 2009 Tokyo Workshop
- Extensive repair deficiencies
 - DER-approved *repair design and processes* without supporting data
 - Inappropriate material substitutions, poor workmanship & inadequate tooling
 - Discovered when rigging on aircraft



From Air Force MP3 Mtg. Frank Zankar (NTSB, 2008)

In-flight Rudder Failure
(Large damage causing flutter)
Air Transat Flight 961 [3/6/05]



COS A, Bonding

- **FAA Deliverables**

- Published Policy Statement PS-AIR-20-130-01 “Bonded Repair Size Limits” November, 2014
- Chapter in Order 8900.1 “Flight Standards Information Management System” outlining Bonded Repair Size Limits FY2016
- Revise Advisory Circular (AC) 65-33, “Development of Training/Qualification Programs for Composite Maintenance Technicians” to include specific guidance on bonded structure FY2017
- Short Course for Bonded Repair Design, Substantiation, and Approval FY2018
- Part 21 AC for Bonded Structure that includes Bonded Repair Best Practices FY2020
- Part 21 AC for Sandwich Structure FY2020



COS A, Bonding

- **Prerequisite Industry Deliverables and Research**
 - Publication of the AC is dependent on successful completion of the following documents by industry groups: Best Practices in Bonded Repair (SAE), CMH-17 Repair Substantiation (CMH-17 Rev H), Standards for Metal Bond Process QC (ASTM D3762), Test Standards for Disbond Growth (ASTM) and CMH-17 Risk Mitigation Guidelines (CMH-17 Rev H)
 - *One example:* Vol 3, Chapter 14 Substantiation of Bonded Repair
 - Numerous FAA research projects on bonded structure are underway and planned for the next few years
 - FAA also researching current maintenance instruction practices

2014 Policy Content:

Bonded Repair Size Limits

- *The size and extent of a bonded repair is first constrained by the limits of substantiating data* used to meet appropriate rules
 - Repair processes must produce consistently sound structure (performed using approved/qualified materials and processes)
 - Repair design must have structural substantiation needed for the structure (tests or analyses supported by tests)
 - Service inspections of bonded repair should be capable of finding complete or partial failure of the bondline. Inspection intervals must consider criticality of the structure and residual strength with the repair failed.
- *Critical structure will have an additional repair size limit to be no larger than able to yield Limit Load residual strength capability with the repair failed* within arresting design features
 - Note that this requirement may not control depending on the repair size limit coming from the first constraint
 - Residual strength with the repair failed should be shown by tests or analysis supported by tests

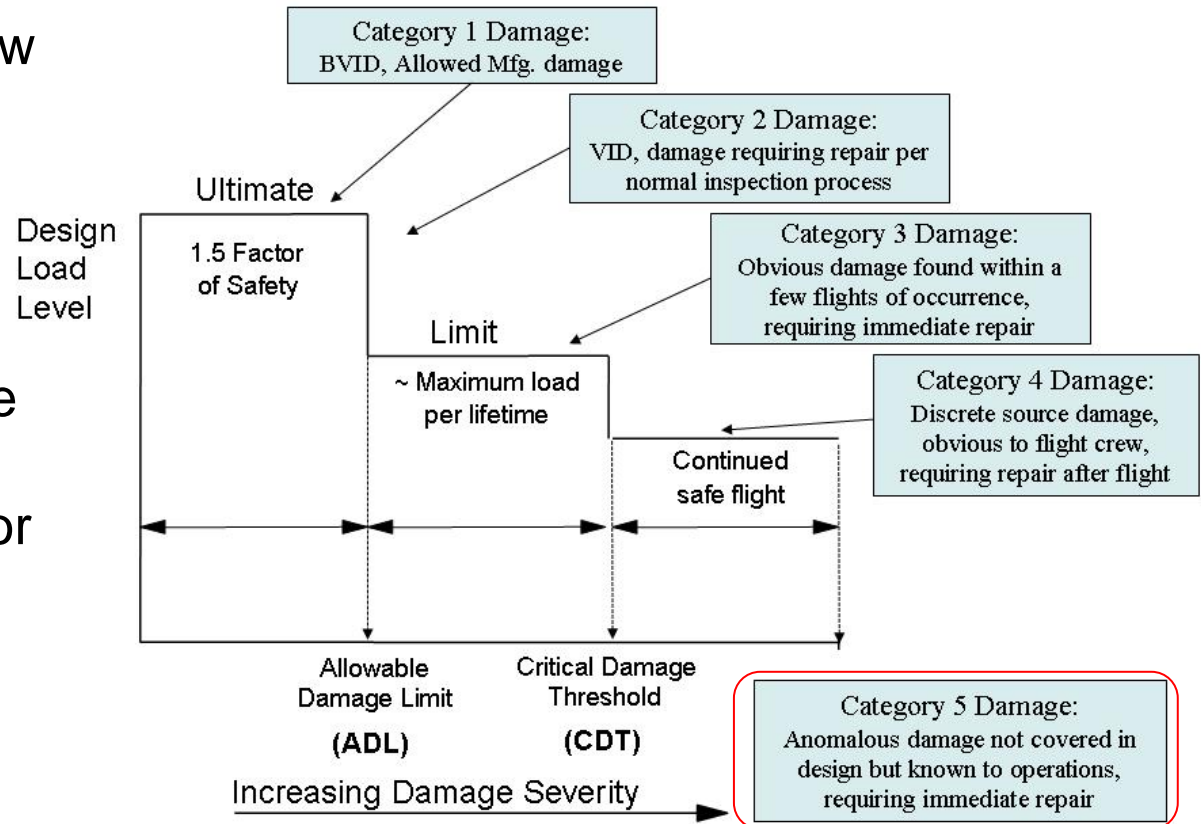
COS B, HEWABI

- **Background**

- The FAA is concerned with damage that occurs after part inspection when it is not visible to the naked eye. High-energy wide-area blunt impacts (HEWABI) are a type of this damage.
 - Composite airframe structures may not show damage as readily as traditional metallic structures (less prone to plastic deformation / dents)
 - In-service characteristic of transport airplanes where they are impacted by baggage carts and other service vehicles
 - *Also possible from damage in the factory or in production flight line*
 - In either case, reporting is essential for safety

COS B: HEWABI

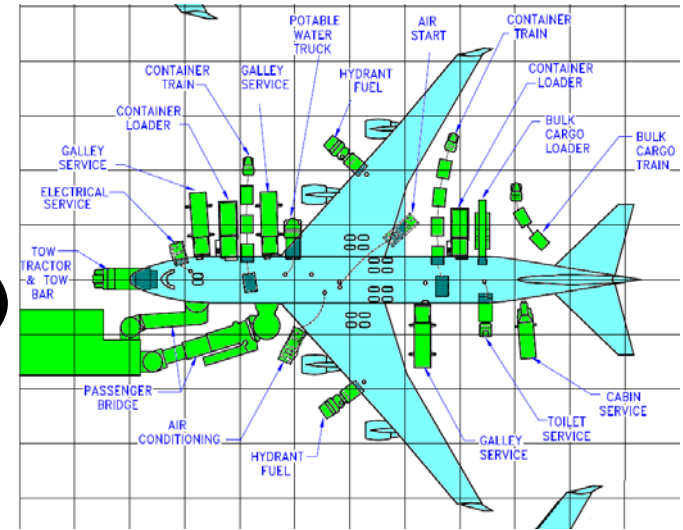
- **Category 5 Damage**
 - Severe damage
 - Rare event
 - Capability is below limit load
 - Beyond design considerations
 - Unbounded
 - Examples: severe collisions with service vehicles or other aircraft, flight overload conditions, very large bird strike



COS B: HEWABI

Not all damaging events (e.g., severe vehicle collisions) can be covered in design & scheduled maintenance

- Safety must be protected for severe accidental damage outside the scope of design (defined as Category 5 damage) by operations reporting
- Awareness and a “No-Blame” reporting mentality is needed
- Category 5 damage requirements:
 - a) damage is **obvious** (e.g., clearly visual) and **reported** &/or
 - b) damage is **readily detectable** by required pre-flight checks &/or
 - c) the **event** causing the damage is otherwise **self-evident** and **reported**
e.g., obvious, severe impact force felt in a vehicle collision



COS B, HEWABI

- **FAA Deliverables**

- Policy requiring HEWABI evaluation during the certification of aircraft structures FY2016

- Draft Policy on FAA website

- http://www.faa.gov/aircraft/draft_docs/policy/ comment period closed 11/13/15

- **Prerequisite Industry Deliverables and Research**

- FAA has funded research in this area

- Develop a chapter in CMH-17 specific to HEWABI

- The FAA is researching what additional risk mitigation activities can be taken

COS C, Failure Analysis of Surfaces Subjected to Fire after Part Failure

- **Background**

- Composite structure that failed in an accident may be subjected to fire, changing failure surfaces and potentially masking clues that could identify the root cause for part failure or the extent of damage

- **FAA Deliverables**

- Failure Analysis Handbook FY2022

- **FAA Research Planned**

Certification Efficiency (CE) Initiatives

- Certification Efficiency initiatives **capture best industry practices** via regulatory guidance and industry standards documents.
- Goal is to **standardize methods** to certify composite structures and repairs.

Certification Efficiency Initiatives

- **Six CE initiatives**
 - A. Hybrid Metallic/Composite Structure Fatigue and Damage Tolerance Substantiation
 - B. Advanced Composite Maintenance
 - C. Composite Structural Modification
 - D. Composite Quality Control
 - E. Bonded Structure Guidance
 - F. General Composite Structures Guidance
- **Additional standardization activities in the area of transport crashworthiness, fuel tank lightning protection, and composite flammability**
 - These FAA initiatives have some components specific to composites

CE A, Hybrid Structure

- **Background**

- Fatigue and damage tolerance (F&DT) engineering protocol for composite aircraft structures differ significantly from metal engineering practices. These issues must be considered for the substantiation of most modern structures that include a combination of composite and metallic parts and assemblies.



CE A, Hybrid Structure

- **Deliverables**

- Policy on interpretation of existing amendment 25.571 for composite structure (timing to be coordinated with ARAC)
 - FAA “White Paper” due 9/2016
- A new rule defining fatigue and damage tolerance requirements for the certification of composite transport aircraft FY2020
- Associated guidance for new part 25 rule FY2020

- **Prerequisite Industry Deliverables and Research**

- Publication of the policy is dependent on CMH-17 Rev H F&DT updates (Vol 3 Ch 12) and ASTM test standards for laminate damage propagation
- All deliverables linked to the two-year ARAC Tasking formed 1/26/2015 under the Transport Airplane Metallic and Composite Structures Working Group

CE B, Advanced Composite Maintenance

- **Background**

- Title 14 CFR part 147 appendix B requires that composite materials be included in the curriculum, however, no guidance exists to define the level of detail or application

- **Deliverables**

- Update maintenance technician training requirements FY2017
- Update chapter in Order 8900.1, “Flight Standards Information Management System” outlining minimum curriculum requirements FY2017

- **Prerequisite Industry Deliverables and Research**

- The FAA is researching current maintenance instruction practices

CE C, Composite Structural Modifications

- **Background**

- Non-OEM companies are applying to the FAA to modify critical composite structures, such as with installation of antennas on 787 or A350 aircraft.
- Many of these new applicants do not have experience in modifying critical composite structure, and assume their standard practices of reverse engineering can be applied.



CE C, Composite Structural Modifications

- **Deliverables**

- AC outlining **best practices approving modifications that involve composite materials** (either base structure and/or installed part) FY2018
- Will include information **relevant to repair and alteration**

- **Prerequisite Industry Deliverables and Research**

- To be determined
(team is being formed to write the guidance)
- FAA Workshop will be held July 2016

CE D, Quality Assurance Guidance



- **Background**

- Material and process control is essential to composite certification and continued airworthiness. The aviation industry continues to explore advanced design options that include: low-temperature cure materials; bonding; and co-cured assemblies. These advanced design options may not be able to utilize traditional quality controls, analyses, and accelerated test methods.

CE D, Quality Assurance Guidance

- **Deliverables**

- Revision to AC 21-26, “Quality System for the Manufacture of Composite Structures” FY2018
 - Will incorporate AC 21-31 “Quality Control for the Manufacture of Non-Metallic Compartment Interior Components” as well
- Revision to online job aid for audit and surveillance of composite repair facilities FY2018
 - Note this guidance for maintenance auditing will be revised to incorporate best practices from manufacturing facility auditing

- **Prerequisite Industry Deliverables and Research**

- None yet identified

CE E, Bonded Structure Guidance

- **Background**

- There is an existing part 23 policy memo covering bonded structure material and process, control, design, analysis, testing, manufacturing, and repair techniques. The policy will be expanded into a part 21 AC for all product types and will include sandwich construction guidance.

- **Deliverables**

- Part 21 AC for Bonded Structure that includes Bonded Repair Best Practices FY2020 (Note this is the same deliverable as COS Initiative A for Bonded Repair)

CE F, General Composite Structure Guidance

- **Background**
 - With the evolving/advancing composite technology and expanding composite applications, AC 20-107 “Composite Aircraft Structure” will require revision
- **Deliverables**
 - Revision to AC 20-107, “Composite Aircraft Structure,” to incorporate advanced composite technologies and lessons learned **FY2021**
- **Prerequisite Industry Deliverables and Research**
 - Will incorporate latest information from industry documentation and FAA research

Workforce Education Initiatives

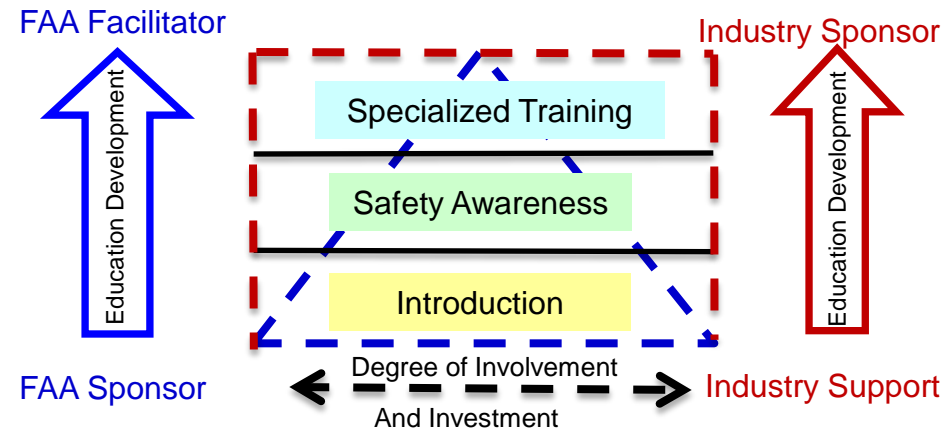
- **An essential component for COS and CE is a comprehensive educational development program**
- **Successful composite safety and certification oversight is dependent upon our workforce being knowledgeable of both basic and advanced composite technologies and terminologies**



Workforce Educational Initiatives

FAA composite training strategy using existing courses, FAA Centers of Excellence & industry support

Courses to support airframe engineering, manufacturing and maintenance functional disciplines



Incl. three levels of competency:

- **Introduction** (“Composites 101”)
- **Safety Awareness** (courses for each functional discipline)
 - Skills needed for FAA workforce supporting composite applications
- **Specific Skills Building** (most courses developed by the industry)
 - Specialized skills needed in the industry and some FAA experts

Workforce Education Initiatives

- **Three initiatives – developed by the FAA but available to industry as well**
 - A. Composite Manufacturing Technology
 - B. Composite Structures Technology
 - C. Composite Maintenance Technology
- **Additional activities supporting “composites 101” training and Composite DER designations**

WE A, Composite Manufacturing Technology

- **Background**

- Offered in an interactive online forum (approximately 40 hours of study over 8 weeks) plus a two-day laboratory session
- The Composite Manufacturing Technology (CMfgT) course was first offered in spring 2015
- It will be updated with the revision to AC21-26 (CE D) in 2018

- **Deliverables**

- Updated CMfgT course with revised content, lesson plans and a job aid FY2018

WE B, Composite Structures Technology

- **Background**

- The Composite Structural Engineering Technology (CSET) course will be updated every four years.
 - Offered in an interactive online forum (approximately 60 hours of study over 12 weeks) plus an optional two-day laboratory session
- Update the structural DER seminar content on a recurring basis

- **Deliverables**

- Updated CSET course with revised content, lesson plans and a job aid FY2017
- Update Structural DER seminar content FY2016

WE C, Composite Maintenance Technology

- **Background**

- Revise Flight Standards Service’s course #21900010, “Composite Awareness for the Aviation Safety Inspector,” on a five year basis (was just updated in 2015)
 - Follows industry standard (SAE AIR 5719) for maintenance training
 - Offered as a four-day in-person course to FAA inspectors
- Review options for industry training
- Develop a computer-based short course for Aviation Safety Inspectors that have oversight responsibilities for complex composite repair facilities FY16

Summary and Closure

- **AVS Composite Plan Established to Guide FAA Initiatives**
 - A living document updated annually
- **Continued involvement of industry, other agencies & institutions, and harmonization with foreign regulatory agencies**
- **Three main areas of Continued Operational Safety (COS), Certification Efficiency (CE) and Workforce Education (WE)**
 - Active initiatives for composite guidance/standards
 - Ongoing composite training initiatives