International Efforts on COS Risk Mitigation, Certification Efficiency & Benchmarking Best Practices

Objectives, Technical Drivers, and Discussions for Participant Commenting

+ a Few Cartoons/Jokes

Presented at: 2015 FAA/Bombardier/TCCA/EASA/Industry Composite Transport Damage Tolerance and Maintenance Workshop (Montreal, Quebec)

By: Larry Ilcewicz

Date: September 15 to 17, 2015

Federal Aviation Administration

Workshop Objectives

- **Review progress in addressing technical issues of bonded repair, sandwich disbond growth, and severe damage impact threats, which are critical for continued operational safety**
  - Understand participant perspectives on related safety risk mitigation strategies and educational needs for the expanding composite workforce
- **Provide a forum to share perspectives on damage tolerance & maintenance subjects deemed important to certification efficiency**
  - Support the identification, definition and prioritization of international initiatives (e.g., ongoing Transport Airplane §25.571 ARAC) to develop composite regulatory guidance, training, industry guidelines & standards and other forms of safety risk mitigation

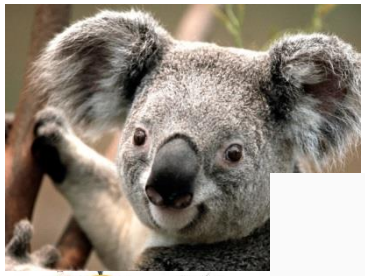
Importance of Linking Damage Tolerance and Maintenance

From FAA Chicago Workshop 2006

- **One of the main purposes for damage tolerance is to facilitate safe & practical maintenance procedures**
- **Findings from the field help improve damage tolerance and maintenance practices in time**
  - *Structural safety, damage threat assessments, design criteria, inspection protocol, documented repairs and approved data all benefit from good communications between OEM, operations and maintenance personnel*
- **Structural substantiation of damage tolerance, inspection and repair should be integrated**

International Composite Team Approach

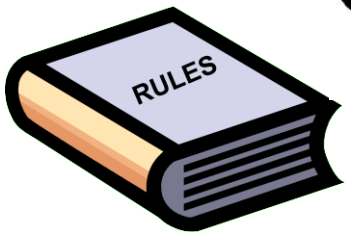
Assemble individuals known to have common interests and wear similar outfits to see if you can gain some agreement



IDENTIFY A FEW SUBJECT MATTER EXPERTS (SME) WILLING TO CONTRIBUTE

INVITE MORE EXPERTS TO THROW IN THEIR TWO CENTS

Charter a Few Pioneers to Create Standards and Educate the Masses



Publish Some Regulations and *Cheat Sheets* to Figure Them Out

Key Factors for Composite Fatigue, Damage Tolerance, Inspection, and Repair

- *Categories of Damage* have a strong relationship with accepted composite PSE design & inspection practices
- Difficult to standardize the full range of accidental damage scenarios that represent possible damage threats
  1) visual detection and instrumented inspection for damage disposition
  2) large damage capability to bound the “rare events”
- Some of the most serious damage threats to composite PSE certification and safety must be dealt with outside scheduled maintenance through “other procedures”
- Understrength or weak bond defects (manufacturing or repair)
  1) Must first be dealt with through avoidance using stringent QC
  2) Large damage capability for “rare/local” disbonding (fail-safe design features)
- Potential aging and widespread damage phenomena for composites will likely differ from metal fatigue

Composite Supporting Technologies

- **Methods are needed for damage stress concentration, load redistribution and potential interlaminar growth**
- **Probabilities can serve essential support in safety analyses (inspection to control rare events)**
- **“Smarter testing” needs proper focus on suitable design criteria to address the safety aspects of various damage threats (e.g., what impact threats yield the least detectable but most critical damage)**
- **Inspection methods need focus on the extent of damage and damage metrics suitable for structural analyses, including methods to detect early stages of weak bonds**
- **Partnerships are a practical solution to major composite airframe modification, alterations and repair**

September 15, 2015 Agenda

- **Regulatory Perspectives (FAA, EASA, TCCA)**

9:00-9:30	"FAA Composite Plan" - Cindy Ashforth (FAA)
9:30-10:00	"EASA Composite Safety Issues" - Simon Waite (EASA)
10:00-10:30	"2015 Industry/Authorities FAA Composite Transport DT and Maintenance Workshop – TCCA Perspectives" - Maurizio Molinari (TCCA)

FAA **AVS**	**FAA Research**
Rusty Jones	Curt Davies
Lester Cheng	
Allen Rauschendorfer	
Walt Sippel	

- **Session 1: Sandwich Disbond Assessments**

10:45-11:30	"CMH-17 Honeycomb Sandwich Disbond Growth Team Status - Mid 2015" - Ralf Hilgers (Airbus) and Ronald Krueger (NIA)
11:30-11:45	"Sandwich Disbond Recap" - Led by Larry Ilcewicz and Ralf Hilgers (Airbus)

Airbus Experience & CMH-17 Task Group for Sandwich Disbond*

CMH-17
COMPOSITE MATERIALS HANDBOOK

Honeycomb Sandwich Disbond Growth Team

* Initiated by Larry Ilcewicz in 2011

Sandwich Disbond Recap

- **Summary (comments please)**
  - Progress of an international team effort that started with a particular OEM safety challenge (design details and processing defects)
  - Generalized to cover additional design/process space in the development of supporting technologies needed to evaluate the potential for disbonding with other sandwich constructions
- **What significant technical issues for sandwich disbonding that are not covered by the current effort**
- **Is your organization willing/able to contribute (support development, review progress, provide data)**
- **Questions for Ralf Hilgers** (as Sandwich Disbond TG Leader)

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- **Session 2A: Bonded Repair 2A (Part 1)**

11:45-12:00	"Sessions 2A and 2B - Introduction and Objectives" - Michael Borgman (Spirit AeroSystems, Inc.)
12:00-12:30	"Operator Field Experiences and Future Perspectives" - Eric Chesmar (UAL)

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- **Session 2A: Bonded Repair 2A (Part 2)**

1:15-1:45	"Airbus Bonded Repair Applications to Pressurized Fuselage" - J. Charles and C. Fualdes (Airbus)
1:45-2:15	"Substantiation Approaches for Bonded Repairs" - Allen Fawcett (Boeing)

- **Session 2B: Bonded Repair 2B (Part 1)**

2:15-2:45	"Lessons Learned from CACRC Depot Bonded Repair Round Robin Exercise" - Dr. John Tomblin & Lamia Salah (WSU)
2:45-3:15	"Effect of Processing Parameters on Bonded Repair Quality and Strength" Dr. Pascal Hubert (McGill Univ.); Dr.Rushabh Kothari, David Wilson, Geoff Walsh (Bombardier)

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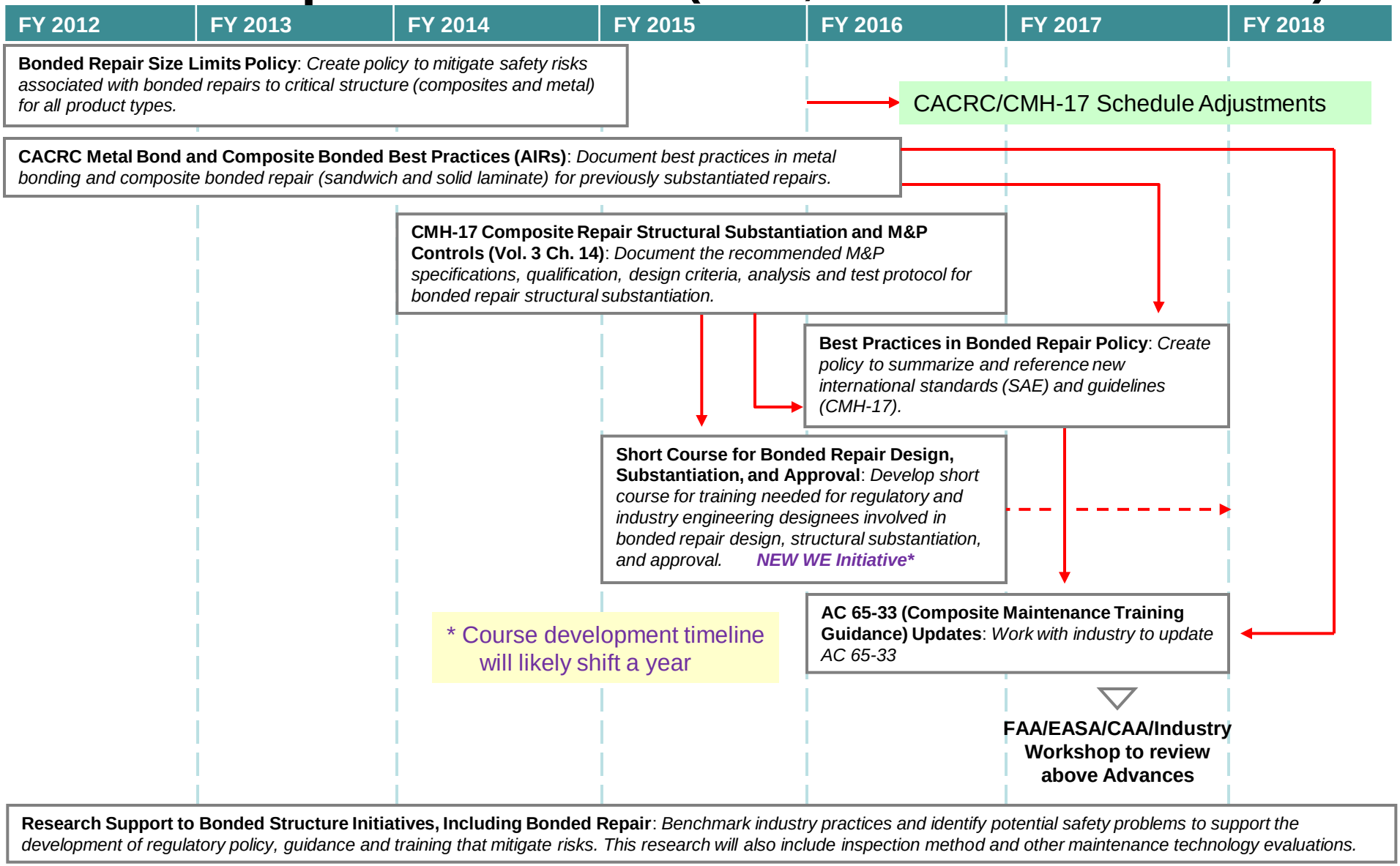
- **Session 2B: Bonded Repair 2B (Part 2)**

3:30-4:00	"Bonded Repair Service Provider - Service History and Substantiation" - John Welch (Spirit Aero Systems)
4:00-4:30	"Composite Operational Issues" - Rusty Jones (FAA) and Simon Waite (EASA)
4:30-4:45	"Standards for Substantiation of Bonded Repairs" -Michael Borgman (Spirit Aero Systems)

- **"Sandwich Disbond and Bonded Repair Recap"**

4:45-5:45	"Bonded Repair Recap" - Led by Larry Ilcewicz & Rusty Jones (FAA) and Mike Borgman (Spirit)

Bonded Repair Initiatives (COS, CE & WE deliverables)



Bonded Repair Initiatives Link with needs Identified by BRSL Public Commenting

- **Public Commenting for BRSL suggests the policy is not addressing some critical safety concerns**
  - Bond in-process and post-process controls are key (not in BRSL)
  - Structural substantiation guidelines are needed for level playing field
  - Some organizations don't understand what is design substantiation
  - Guidance for industry best practices is addressing the related issues, suggesting re-manufacturing (e.g., sandwich panel re-skinning) may be a better solution than multiple repairs
- **Bonded Repair Initiatives, which only start with BRSL, have components to address the above comments**
  - Work with industry on best practice guidelines
  - Updated WE content based on research findings and field interface
  - More research is needed, including tear-down and destructive testing of parts having aged field repairs

Bonded Repair Recap

- **Technology Transfer from OEM?**
  - Efficient and without fault
  - Lacking in detail and awareness of field issues
  - As good as exists for “partners” in part manufacturing
  - Constrained by proprietary limits and an overall lack of industry standardization
- **Do you agree that either more regulation or industry standardization are needed?**
  - What do you recommend?
  - Where should regulatory agencies seek such expertise?
  - Who should lead standardization?
- **Bonded repair constraints are currently needed for safety (agree or disagree)**

Bonded Repair Recap, *continued*

- **Comment on the need for repair structural substantiation guidelines**
  - Material & process qualification/control
  - Constraints against material or process substitutions
  - Design guidelines and process best practices
  - Proof of structure/building block recommendations
  - Part-specific examples and case studies
- **Repair competency**
  - Training (formal skill building and OJT)
  - Evaluation in the hands of industry or regulatory bodies
  - Benefits from industry standardization?
  - Support from advanced technologies (expert remote oversight, inspection, or other quality controls)