AC 20-107A "Composite Aircraft Structure" Updates

Federal Aviation Administration

- *Overview of FAA initiatives*
- *Background for AC 20-107A updates*
  - *3/03 CAA Gatwick Meeting*
  - *FAA perspectives*
  - *2007 FAA/EASA/TCCA Meetings*
- *Draft outline for updates*
- *Industry interface*
  - *CACRC Safety Management TG (and CMH-17 WG)*

Larry Ilcewicz

CS&TA

Federal Aviation Administration

Nov. 14, 2007

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Ongoing Composite Safety & Certification Initiatives*

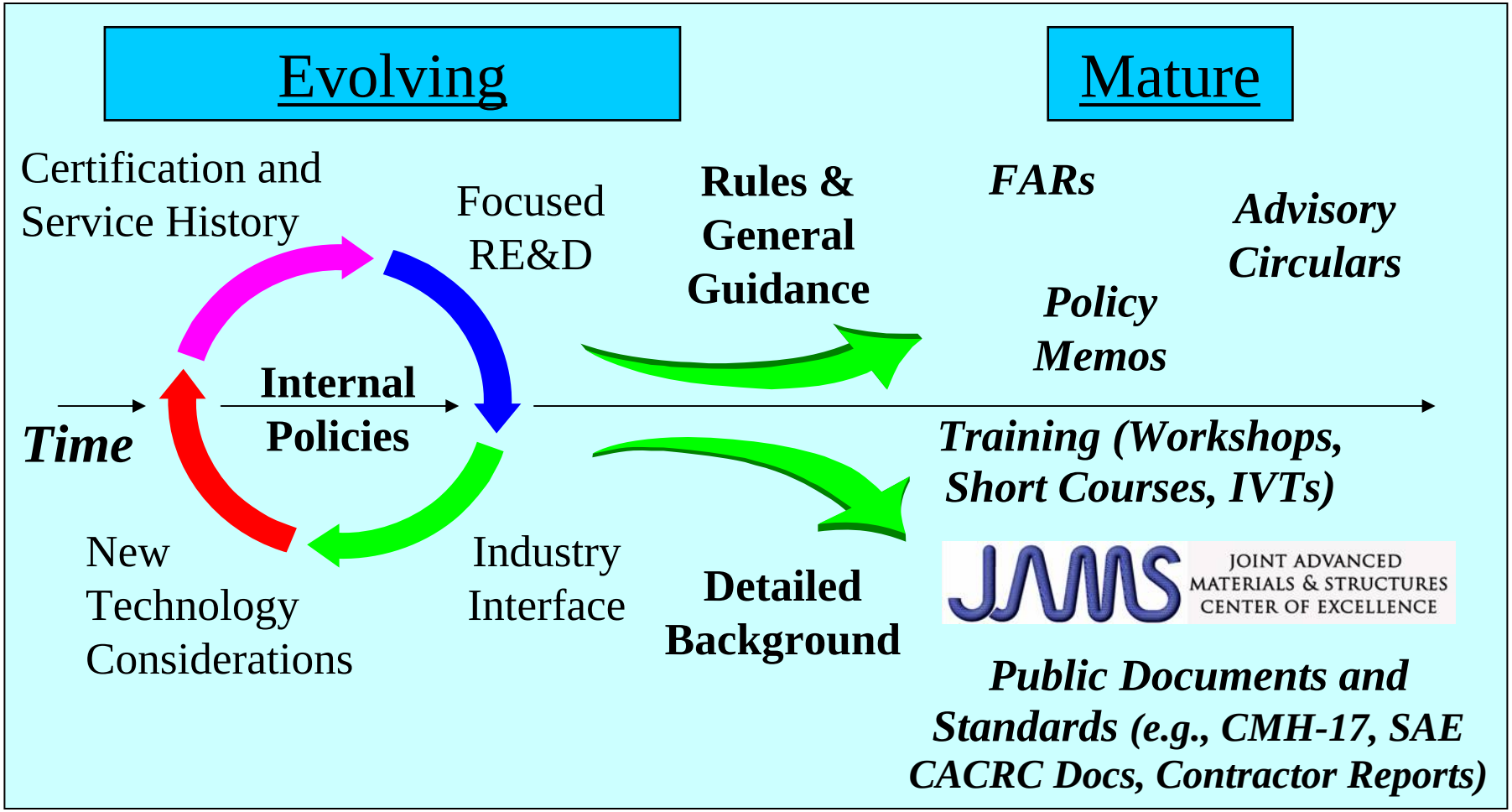
Objectives

1) Work with industry, other government agencies, and academia to ensure safe and efficient deployment of composite technologies used in existing and future aircraft

2) Update policies, advisory circulars, training, and detailed background used to support standardized composite practices

** Efforts started in 1999 to address issues associated with increasing composite applications*

FAA Approach to Composite Safety and Certification Initiatives



FAA Composite Team Members

Represented Group	Team Member Name	FAA Organization Number & Routing
FAA Tech. Center	*Curtis Davies*	*AAR-450 (FAA Technical Center)*
	TBD	AAR-450 (FAA Technical Center)
International	John Masters	AEU-100 (Brussels Aircraft Certification Staff)
Directorates	*Lester Cheng*	*ACE-111 (Small Airplane Directorate)*
	Bob Stegeman	ACE-111 (Small Airplane Directorate)
	Sharon Miles	ASW-110 (Rotorcraft Directorate)
	Ian Won	ANM-115 (Transport Airplane Directorate)
	Mark Freisthler	ANM-115 (Transport Airplane Directorate)
	Jay Turnberg	ANE-110 (Engine & Propeller Directorate)
DC Certification	James Kabbara	AIR-120 (Aircraft Standards Division)
Flight Standards	*Rusty Jones*	*AFS-309 (Aircraft Maintenance Division)*
	Gary Goodwin	*ANM-200 (Seattle AEG)*
ACOs, MIDOs, & CMOs	Roger Caldwell	ANM-100D (Denver ACO)
	Ed Garino	*ACE-117A (Atlanta ACO)*
	Fred Guerin	ANM-120L (Los Angeles ACO)
	Angie Kostopoulos	ACE-116C (Chicago ACO)
	David Ostrodka	*ACE-118W (Wichita ACO)*
	Richard Noll	ANE-150 (Boston ACO)
	John Harding	ANM-108B (Seattle CMO)
	David Swartz	ACE-115N (Anchorage ACO)
CS&TA	*Larry Ilcewicz*	*ANM-115N (CS&TA, Composites)*

Those attending the CACRC Meetings this week are highlighted in blue italics.

CSTA Advisors:
Al Broz, Robert Eastin, Terry Khaled, Steve Soltis, Dave Walen, Chip Queitzsch

Important Teammates

- **NASA has been a leader for composite applications**
  - Significant research support since 1970/1980s
  - AA587, A300-600 accident investigation
  - NCAMP support to material standardization
- **Partnerships with industry have been essential,** e.g., CMH-17, SAE P-17, CACRC, ASTM, SAMPE, AGATE, SATS, RITA, SAS/IAB/AACE

Training
Databases
Standardization
Engineering guidelines

- **DOD and DARPA research**
- **EASA and other foreign research/standardization**

Composite Technical Thrust Areas

Advancements depend on close integration between areas

Material Control, Standardization and Shared Databases

Progress to Date

- 2 Advisory Circulars
- 6 Policy Memos
- 9 Workshops
- 3 Training Initiatives
- 2 Technical Reports
- CMH-17 Updates
- SAE CACRC Standard
- ~50 FAA R&D Reports

Damage Tolerance and Maintenance Practices

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

Structural Substantiation

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

Bonded Joint Processing Issues

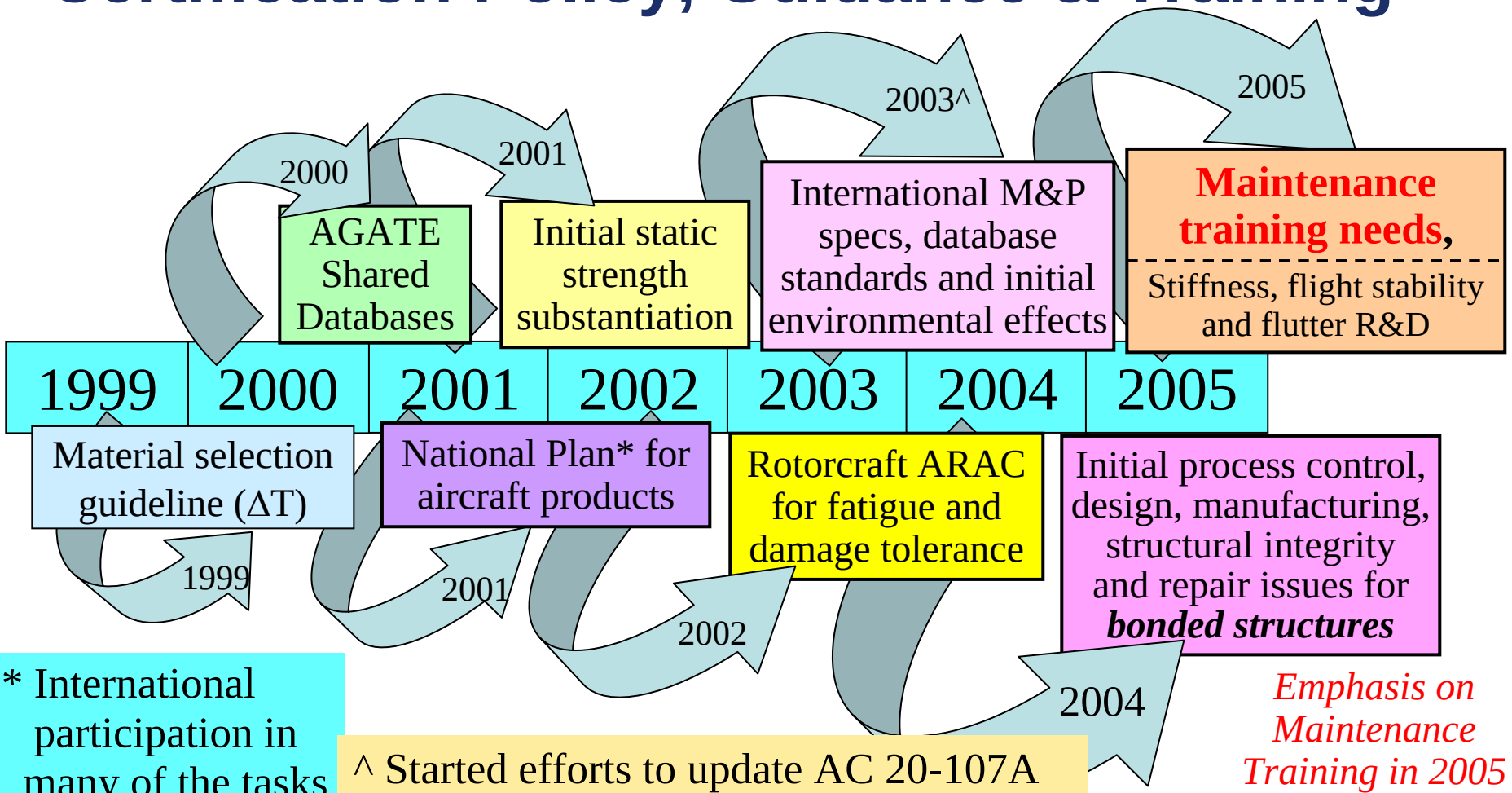
Advanced Material Forms and Processes

Flammability & Crashworthiness

Support to cabin safety research groups

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

Past Milestones for Composite Safety & Certification Policy, Guidance & Training

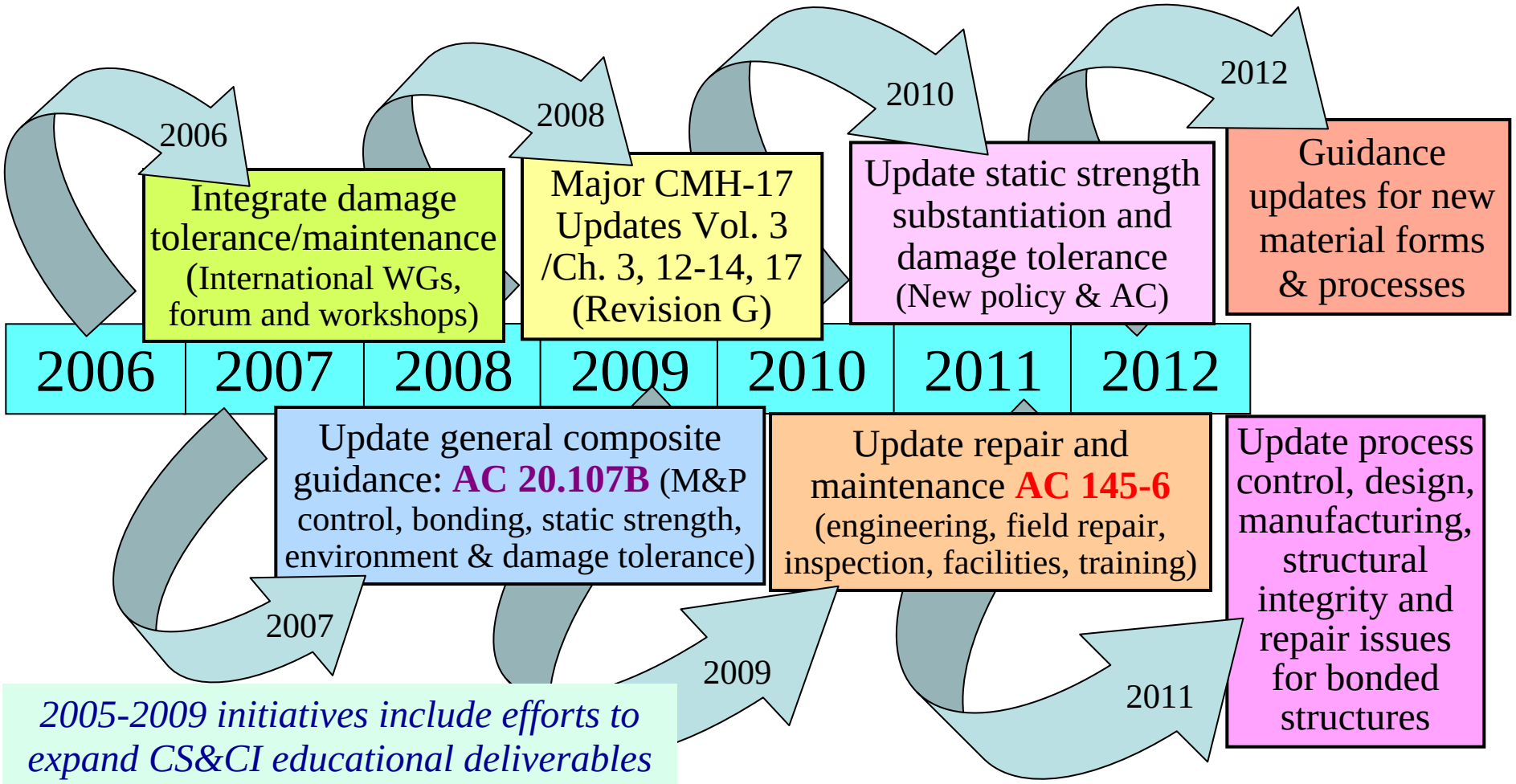


* International participation in many of the tasks since 2001

^ Started efforts to update AC 20-107A with 3/03 Gatwick Meeting and plans to add detailed background in CMH-17

Emphasis on Maintenance Training in 2005

Future milestones for Composite Safety & Certification Policy, Guidance & Training



2005-2009 initiatives include efforts to expand CS&CI educational deliverables to meet needs of an expanding workforce

2006 & 2007 WG, Forum & Workshops on Aviation Damage Tolerance and Maintenance Practices

- Critical safety data shared in unique forum of practitioners
- Five *categories of damage* were proposed for damage tolerance and maintenance consideration
  - Integrated efforts in structural substantiation, maintenance and operations interface help ensure complete coverage for safety
- Coordinated inspection, engineering disposition and repair is needed for safe maintenance
  - Actions by operations is essential for detection of critical damage from anomalous events
- FAA is committed to CS&CI with industry, academia and government groups (~250 participants in two workshops)
  - Damage tolerance and maintenance initiatives are active
  - Principles of safety management will be used in future developments (policy, guidance and training)

11/14/07 CACRC Meeting Objectives

- **To review background on collecting data for AC 20-107A with the industry represented at the CACRC**
- **To review key facets of a detailed outline for AC 20-107A updates, with some emphasis in added thoughts on maintenance**
- **To discuss the approach/timeline anticipated for FAA development & approval of AC 20-107B**

Background on AC 20-107A

- **Some inputs to update AC 20-107A collected in 20+ years of composite experience**
  - Noted by FAA Directorates (changes not pursued to date)
  - FAA Composite Safety & Certification Initiatives developed more definitive guidance (building supporting basis since 1999)
  - March 2003 CAA Meeting (see related charts 3-18)
- ***2007-2008 FAA Business Plan Items* to Update AC 20-107A (released April 25, 1984)**
  - *CMH-17 Vol. 3/Ch. 3,12-14 provide detailed background*
  - Coordinate for aircraft product types 23, 25, 27 & 29
  - Development process must also include industry
- **Principles of safety management should be added as appropriate**

Review of "Composite Aircraft Structure" AC

Goals for CAA (Gatwick, UK) Meeting (March 20 & 21, 2003)

- **To review individual perspectives and experiences on guidance in AC 20-107A and the associated ACJ 25.603**
- **To discuss strategies for future change and updates to AC 20-107A and the associated ACJ 25.603**
- **To discuss other composite guidance needs and joint efforts for development, including collaborative research efforts**

Review of "Composite Aircraft Structure" AC

Participants at CAA (Gatwick, UK) Meeting (March 20 & 21, 2003)

- **CAA (UK)**
  - John Bristow
  - Simon Waite
  - Richard Minter
- **CEAT (French, JAA Composite Specialist)**
  - Jean Rouchon
- **ENAC (Italian)**
  - Bruno Moitre
- **FAA (US)**
  - Larry Ilcewicz

Agreement from AASC/AECMA Specialists Group on Draft AC 20-107A “Composite Aircraft Structure”

5. It is agreed by all that this joint effort has been mutually beneficial, that this level of cooperation should be considered in other technical areas, and that this group should be reconstituted in no more than five years to update the guidance material to reflect technology developments.

J. Soderquist
Federal Aviation Administration

D.S. Warren
Mc Donnell Douglas Aircraft Company

J. McCarthy
Boeing Commercial Airplane Company

A.Y. Cames
Lockheed-California Company

J.W. Bristow
Civil Aviation Authority

L. Baranes
Service Technique des
Programmes Aéronautiques

D. Chaumette
Aviona Marcel Daasault-
Breguet Aviation

T.W. Coombe
British Aerospace Aircraft Group

J.F. van der Spek
Rijksluchtvaartdienst

Current Status of AC 20-107A vs. Existing Certification Practices

- **Much of AC 20-107A is still valid**
  - Benchmark for general composite guidance
  - More definitive guidance has been developed to fill needs (for aircraft types and specific technical issues)
  - It contains some complex/difficult wording for new users
- **Service safety problems and/or certification experiences have not forced a need for change**
  - No accidents or industry groups have suggested a need for change or update
  - General nature of the document has not constrained the industry in pursuit of new technology

Current Status of AC 20-107A vs. Existing Certification Practices (cont.)

- **Relevance to transport aircraft** (Part 25) **versus other aircraft types** (Parts 23, 27, 29)
  - AC 20-107A is intended to be valid for all aircraft
  - ACJ 25.603 implies transport aircraft
- **1998 report by White House Commission on Aviation Safety & Security** (Gore Commission)
  - Regulatory & guidance material should be performance based
  - Implies different safety levels will be needed for different categories of aircraft

Note that I retained Joe Soderquist's "Library"
(thorough, step by step records of developing AC 20-107A)

Reasons for updates/changes to AC 20-107A & associated ACJ 25.603

- **Remove obsolete guidance**
- **Change for harmonization**
- **Update based on service and/or certification experiences**
- **Additions or changes for new technology** (materials, processes, engineering methods, maintenance procedures)

Example of *Need to Remove Obsolete Guidance*

9. <u>ADDITIONAL CONSIDERATIONS</u>

b. Flammability

(2) Certain aircraft structure is required to be fire resistant. The following test is considered acceptable for demonstrating compliance for aircraft exterior and engine component materials that are to be fire resistant. … The specimen will be considered satisfactory if it resists flame penetration for a time period equal
to or greater than the aluminum sheet.

- **Incorrect statements** (superseded by AC 20-135).
- **Recommend removing it and adding a reference to AC 20-135**

Example of *Need for Harmonization*

- **New paragraph and a large appendix for "Change of Composite Material" was added to ACJ 25.603 but not AC 20-107A**
- **Past Part 25 structures working group looked into an update to AC 20-107B to include this new paragraph and appendix** (but not pursued)
  - Simple change did not address other paragraphs for purposes of harmonization (e.g., 9.b.(2) flammability example from previous page)
  - ACJ 25.603 distinguishes new paragraph 10 for Part 25
  - AC 20-107B was not a responsibility of Part 25 WG

Example of *Update for Service and/or Certification Experiences*

7. <u>PROOF OF STRUCTURE - FATIGUE/DAMAGE TOLERANCE</u>

b. <u>Fatigue (Safe-Life) Evaluation</u>

Sub-paragraph that describes an approach similar to the flaw tolerance/safe-life approach defined by Rotorcraft ARAC (2000 - 2002)

- **Recommend some rewording for consistency with the new rule and AC for rotorcraft fatigue and damage tolerance**

Example of *Additions or Changes for New Technology*

5. MATERIAL AND FABRICATION DEVELOPMENT

b. The material system design values or allowables should be established on the laminate level by either test of the laminate or by test of the lamina in conjunction with a test validated analytical method.

- **Some new composite material forms & manufacturing processes are not based in lamination** (e.g., braided/resin transfer molded parts, chopped fiber, injection molding)
- **Recommend a more general wording update**

Implications of New Composite Technologies & Expanding Applications

Industry push to more efficient certification

- **How should we deal with more sophisticated analysis methods?**
- **What is the influence of less structural testing?**
  - What constitutes analytical validation?
  - How do we ensure sufficient design/manufacturing integration with less tests at larger scales?
- **What additional regulatory oversight is needed for shared databases?**
  - e.g., new user equivalency testing

Implications of New Composite Technologies & Expanding Applications

Metal and Composite in the Same Structure

- **New wing and fuselage structure are combining metal and composite parts**
  - Factors of safety for environmental loads (internal residual stress?)
- **How do we accommodate the different approaches to large scale test substantiation?**
  - Static overload for environment
  - Accounting for scatter in fatigue and damage tolerance

Implications of New Composite Technologies & Expanding Applications

New Materials and Processes that Don't Lend Themselves to the Traditional Building Block Approach

- **What can be done to validate sufficient material & manufacturing process controls for structure that consolidates at a large scale?**
  - Does a "fragment approach" (i.e., cutting coupons & elements from as-manufactured, large scale structure) provide the necessary confidence?
- **Statistical significance in structural substantiation?**

Summary from Review of "Composite Aircraft Structure" AC

CAA (Gatwick, UK) Meeting (March 20 & 21, 2003)

- All participants agreed on a need for revision
  - Harmonization with ACJ 25.603 (AMC No. 1 to CS 25.603)
  - Remove obsolete guidance
  - Working group should include industry and regulatory composite experts
- Strategy to retain this AC material (and associated updates) as "general composite guidance"
  - Agree that other more definitive guidance is also needed as industry standards evolve

Summary from Review of "Composite Aircraft Structure" AC

CAA (Gatwick, UK) Meeting (March 20 & 21, 2003)

- Technical areas that need update or change
  - Damage tolerance (impact scenarios, composite/metal interface, scatter factors, fatigue spectra, test substantiation, product types)
  - Environmental conditioning & test substantiation
  - Structural bonding (weak bond issues)
  - Maintenance, inspection and repair
  - Flammability & crashworthiness
  - Recognize new materials and manufacturing processes
  - Composite specialist training needs
  - *More definitive guidance is also needed in above areas*
- *Gatwick inputs are initial basis for FAA current plans*

Copy of March 2003 Meeting Minutes are available from L. Ilcewicz upon request

2006-2007 CS&CI Building a Further Basis for AC 20-107A Updates

- **New CMH-17 Volume 3, Chapter 3 on "Aircraft Structure Certification and Compliance"**
  - Harmonized by FAA/EASA/TCCA
  - Type, Production & Airworthiness Certification relevance
  - Updates to table with Part 23, 25, 27, and 29 rules
  - Seeking industry acceptance via CMH-17 approval process
  - Links with FAA Technical Documents entitled "Composite Certification Roadmap"
  - Links with FAA Technical Documents entitled "Critical Technical Issues for Composite Maintenance & Repair"
- **Plans for an associated CMH-17 distance learning tutorial initiated in 2007**

2006-2007 CS&CI Building a Further Basis for AC 20-107A Updates, cont.

- **Updates to CMH-17 Volume 3, Chapter 12-14 on "Damage Resistance, Durability & Damage Tolerance", "Damage Types & Inspection Technology", and "Maintenance & Support"**
  - Initiated by Airbus/Boeing/EASA/FAA WG Industry Workshops on Composite Damage Tolerance & Maintenance (2005-2007)
  - To be harmonized by FAA/EASA/TCCA
  - Seeking industry acceptance via CMH-17 approval process
  - Links with FAA Technical Documents entitled "Critical Technical Issues for Composite Maintenance & Repair"
  - Links with composite maintenance training initiative
- **Future plans for more distance learning tutorials**

2006-2007 CS&CI Building a Further Basis for AC 20-107A Updates, cont.

- **June 2007 Ottawa Meeting**
  - FAA, TCCA and EASA presentations
  - Canadian industry review and recommendations
- **August 2007 Chicago Meeting**
  - FAA draft outline updates (to be presented in this meeting)
- **Internal FAA Team Development**
  - Associated FAA Clearance Record Process
  - International harmonization
- **Inputs from an Industry Advisory Team**
  - John Halpin
  - Bjorn Backman
  - Mike Borgman
  - More (TBD)

11/9/07 FAA Telecom Discussion

- **Should we try to keep AC 20-107B general?**
  - Yes, with some possible way of highlighting differences between different parts
- **Should it remain valid for Parts 23, 25, 27 & 29?**
  - Yes, because there isn't other guidance
  - What about Parts 33 and 35? (to some level of rules or TSO part or material control/specs)
- **Progress to date? Other comments?**
  - How to deal with true "point design" certification activities
- **Changes for approach to engage the industry?**
  - Need to engage GA (SAMA, GAMA) and RC (AHS)

4. General

- Update 4a.
  - Continued evolution of composite technology and expanding applications will require periodic updates
  - Add thoughts on the importance of inter-relationships between functional disciplines for composites (design, analysis, testing, M&P, manufacturing, maintenance and operations)
- Rewording of 4b.
  - Primary and secondary structure that can affect safety
- Additions and updates to definitions in Appendix 2
  - Seek consistency with CMH-17 and ASTM as appropriate

Note: Current AC 20-107A wording is awkward and difficult to follow (need to use "Industry-Recognized Language")

5. Material & Fabrication Development

- New information on material qualification & equivalency (material control, shared databases)
- Additional paragraphs on manufacturing implementation to include thoughts on quality control (9e) and production specifications (9f), incl. links with M&P qualification
- Additional paragraph on structural bonding (secondary)
- Update discussion on environmental effects (5a.) and add aviation fluid resistance (from 9d.)
- Update discussion of allowables and design values (5b.) to include non-laminated material forms
- Merge last two subsections (5c. & 5d.) and expand thoughts for impact damage
- Alternate materials & processes (CS 25.603) -> Appendix 3

6. Proof of Structure - Static

- Reword and update 6a. through 6g.
  (see fifth area of AC 29-2C, MG8)
- Add additional thoughts on environmental design criteria
  (see ACE static strength substantiation policy)
- Add thoughts on building block approach
  (see ACE static strength substantiation policy)
- Add links with material and process control
  - Considerations of minor to major changes (ref. Appendix 3)
- Add thoughts on the threshold of detectability and allowed damages (see ACE static strength substantiation policy)
  - Introduce BVID acronym
  - Outline manufacturing defects and discrepancies

7. Proof of Structure – Fatigue/Damage Tolerance

- Update wording for opening paragraph (add FAR 23.573)
- Update wording and add thoughts to 7a.(1) to (6)
  - Categories of damage (e.g., small to large VID) as related to scheduled inspection methods
- Add words on damage threat assessment (AC 29-2C, MG8)
  - Types of damage, bond failures and structural impact surveys
  - Guidance on impact test simulation for quantifiable treats
- Add thoughts on large scale test protocol
  - Fatigue, damage tolerance and static
  - Substantiate LEF
  - Composite and metal hybrid structures

8. Proof of Structure - Flutter

- Title change to consider “other aero-elastic instabilities” (but still recognize the phenomena of flutter)
- Add words to consider the effects of damage

9. Continued Airworthiness

- Move existing “Inspection and Maintenance (9g.)” and “Substantiation of Repair (9h.)” to this new section
- Add words on service difficulty reporting for maintenance and design/manufacturing updates (safety management principles)
- Add words on “safety training standards” linked to SAE AIR 5719
- Design (incl. access for repair and inspectability)
- Operations awareness of critical damage not covered by design or scheduled maintenance

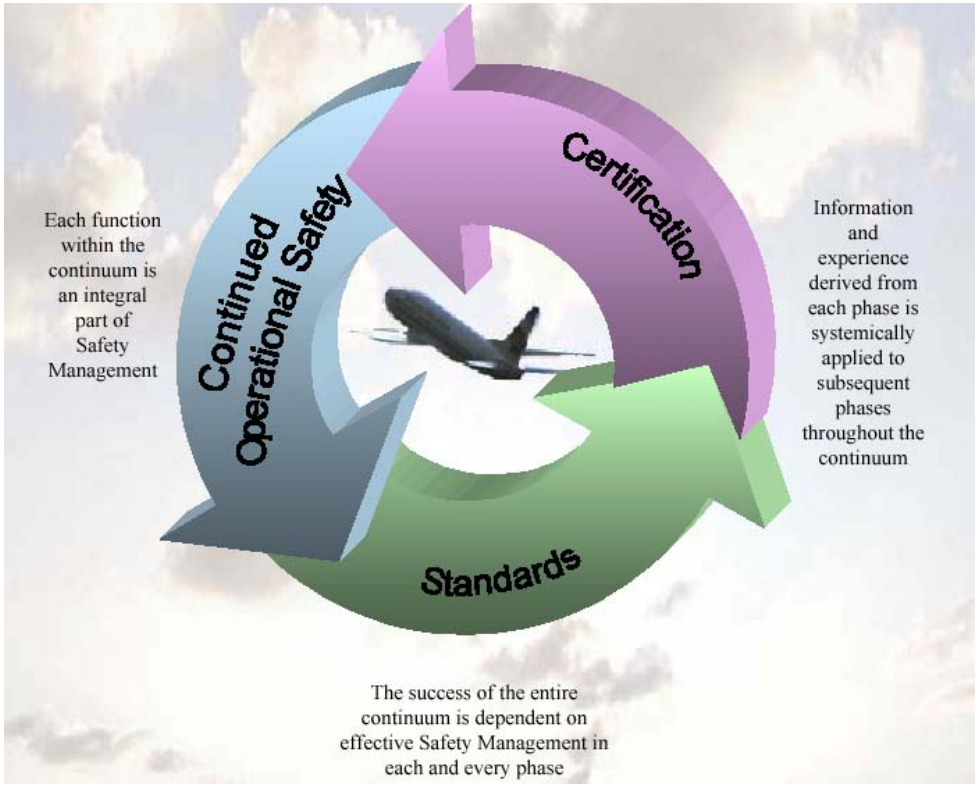
10. Additional Considerations

- Move inspection and maintenance (9g.) and substantiation of repair (9h.) to a new section entitled "Continued Airworthiness" that appears before "Additional Considerations"
  - Develop safety standards based on ACE Technical Report
  - Design for repair and inspectability
- Rename 9a. Crashworthiness: Update and expand
- Rename 9b. Fire Protection, Flammability and Thermal Issues: Update (removing incorrect info) and expand
- Update 9c. and 9d.(move aviation fluid resistance to 5.)

Future Plans and Process to Update AC 20-107A

- **Development and review process must include a strong interface with industry**
  - Part 23, 25, 27 and 29 aircraft structures (+ 33, 35)
  - Plans to use CMH-17 & CACRC industry forum
  - Will need to end with US NPRM Process
- **Proposed timeline (over the next year)**
  - Detailed industry review at CACRC and CMH-17 Meetings (Wichita, 11/07 and Cocoa Beach, 1/08)
  - First draft for Winter 2008 WG Meeting (EASA, Europe TBD)
  - FAA Development Team Meeting Early Summer 2008 (TBD)
  - Updated draft for Summer 2008 CMH-17 industry-review meeting (Canada TBD) prior to FAA Internal Review Process

FAA Strategic Plan: Safety Continuum



Safety management system to link certification standards, maintenance and operations

- **Studies indicate many factors combine to cause an accident**
  - Precursors are often evident but are usually not obvious
- ***Safety management*** **combines the awareness and skills of many disciplines**
  - Systems approach with airplane level awareness to mitigate risks
  - Critical relevant info must be disseminated *(i.e., service data, lessons learned)*
  - Industry standards groups can help promote safety management through consistent engineering practices and practical guidance

How Can Safety Management Strategies Support AC 20-107A Updates?

- **CMH-17 Safety Management WG and CACRC Airworthiness TG will address links between certification & continued operational safety**
  - Use “living” CMH-17 or CACRC documents to capture details and assumptions from composite certification rules, policy and guidance development
  - Similar to preamble material in rule-making
  - Essential starting point when updates are needed due to incidents, accidents or other service experience
- **Provide educational basis for safe applications**
  - Outline related aspects of training, teamwork and the interface between functional disciplines

Links with Mil-Handbook-17 (CMH-17), SAE CACRC and Safety Management

- **Mil-Handbook-17 (Composite Materials Handbooks, CMH-17)**
  - ~ 100 industry engineers meet every 8 months
  - Airbus/Boeing/EASA/FAA/TCCA WG deliverables to update CMH-17, Vol. 3 Chapters (3, 12-14, and 17) for Rev. G
  - CMH-17 Safety Management WG initiated in 2006
  - *FAA strategy: use CMH-17 as a forum to develop guidance and document items controlled by safety management*

- **SAE CACRC (Commercial Aircraft Composite Repair Committee)**
  - ~ 50 industry engineers meet every 6 months (~7 WG)
  - FAA industry initiatives on maintenance/repair training show good potential for collaboration
  - CACRC Airworthiness TG is under consideration
  - *FAA strategy: use CACRC as a forum to develop guidance and support industry composite maintenance standards & training efforts*

Discussion Points

- **Additions/edits to existing content for AC 20-107A**
  - Does it retain the intent of general guidance?
  - Does it apply to different aircraft product types?
- **New content for AC 20-107A**
  - Does it retain the intent of general guidance?
  - Does it apply to different aircraft product types?
- **Identify other composite guidance needs**
  - Does it retain the intent of specific regulatory guidance?
  - Does it apply to specific aircraft product types?
  - Is it more appropriate for initiatives driven by industry standards organizations (CACRC, CMH-17, SAE P-17, ASTM)?

Additions/edits to existing content for AC 20-107A

- **Analysis depth and validation**
- **Material and fabrication details (i.e. sandwich)**
- **Large-area repair substantiation**
- **Manufacturing defects**
- **Fleet data for damage threat assessment**
- **Engine component content/special considerations**
- **Failure criteria validation/limits of supporting data**

➢ Does it retain the intent of general guidance?
➢ Does it apply to different aircraft product types?

New content for AC 20-107A

- **Data to support safety management initiatives (mandatory reporting requirements)**
- **Galvanic corrosion for hybrid materials**
- **Composite propeller issues**
- **Repair records from the field**
- **Maintainability**
- **Lightning strike/HIRF/EME disposition**
- **Repair damage tolerance expectations**
- **New materials and processes (braids, thermoplastics)**

  - Does it retain the intent of general guidance?
  - Does it apply to different aircraft product types?

Identify Other Composite Guidance Needs

- **Additional details on fleet data for damage threat assessment**
- **Expectations for health-monitoring systems**
- **Large-scale repair: design criteria limitations**
- **Guidelines for allowable damage limits**
- **Limitations on temporary repairs**

  - Does it retain the intent of specific regulatory guidance?
  - Does it apply to specific aircraft product types?
  - Is it more appropriate for initiatives driven by industry standards organizations (CACRC, CMH-17, SAE P-17, ASTM)?