•Federal Aviation
•Administration

FAA / CAAs “Composite Meeting”

- Development of AC 20-107B -

Larry Ilcewicz
Lester Cheng
FAA Composite Team

Singapore, Singapore
September 01-04, 2015

Composite Safety & Certification Meeting
- Development of AC 20-107B -

- **Background – Products & Certification**
- **Update Justification & Knowledge Basis**
  - **Gatwick Meeting (Understanding)**
  - **CS&CI Achievements**
  - **Industry Participation**
- **AC Content Development**
- **Review Processes & Issuance**
- **Post AC 20-107B Activities**

Background - Composite Aircraft Structures

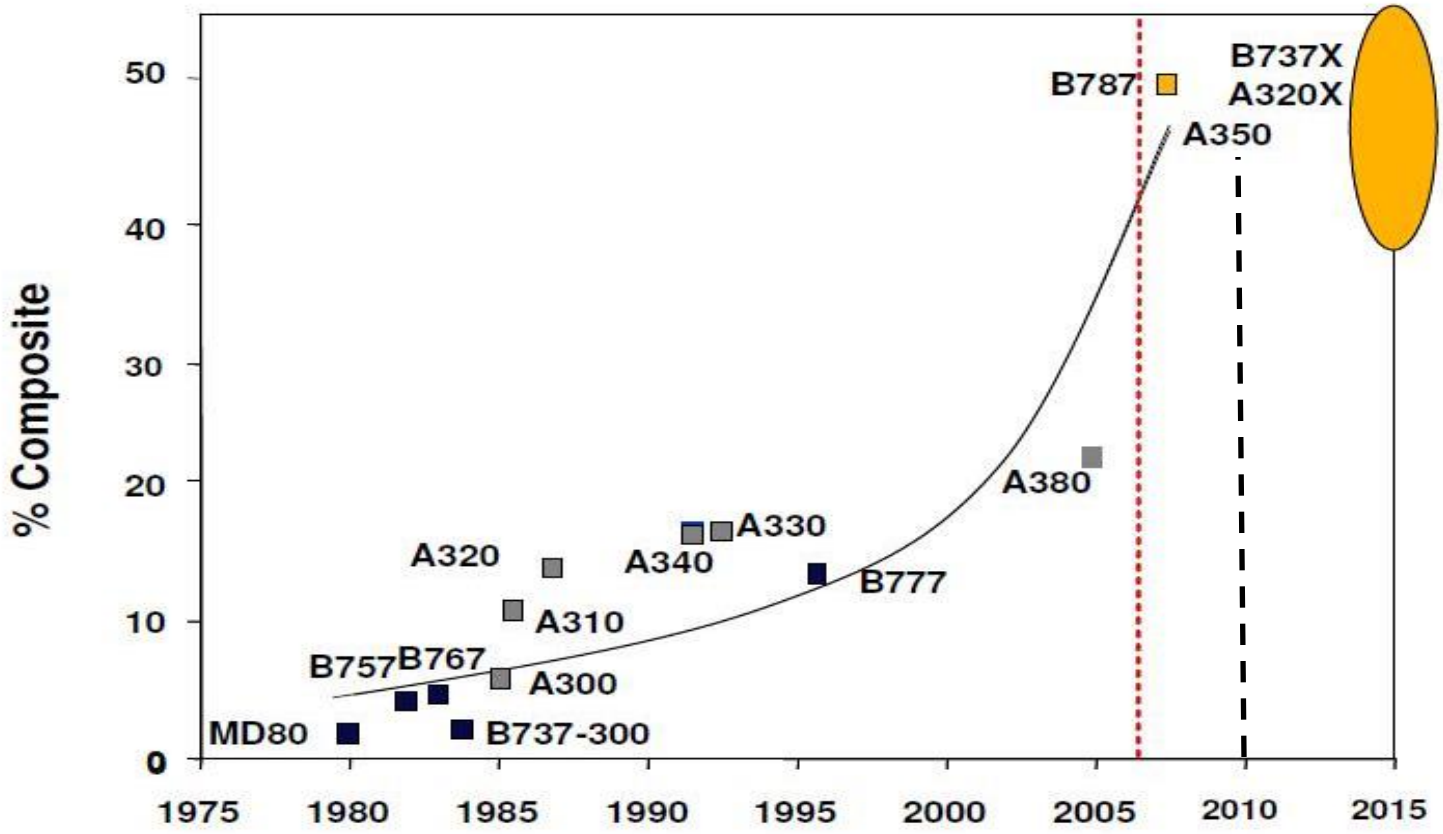
Transport Aircraft

- Secondary structure
- Control Surfaces
- Empennage
- Wing & fuselage applications for new aircraft
- Some engine (e.g., fan blades)

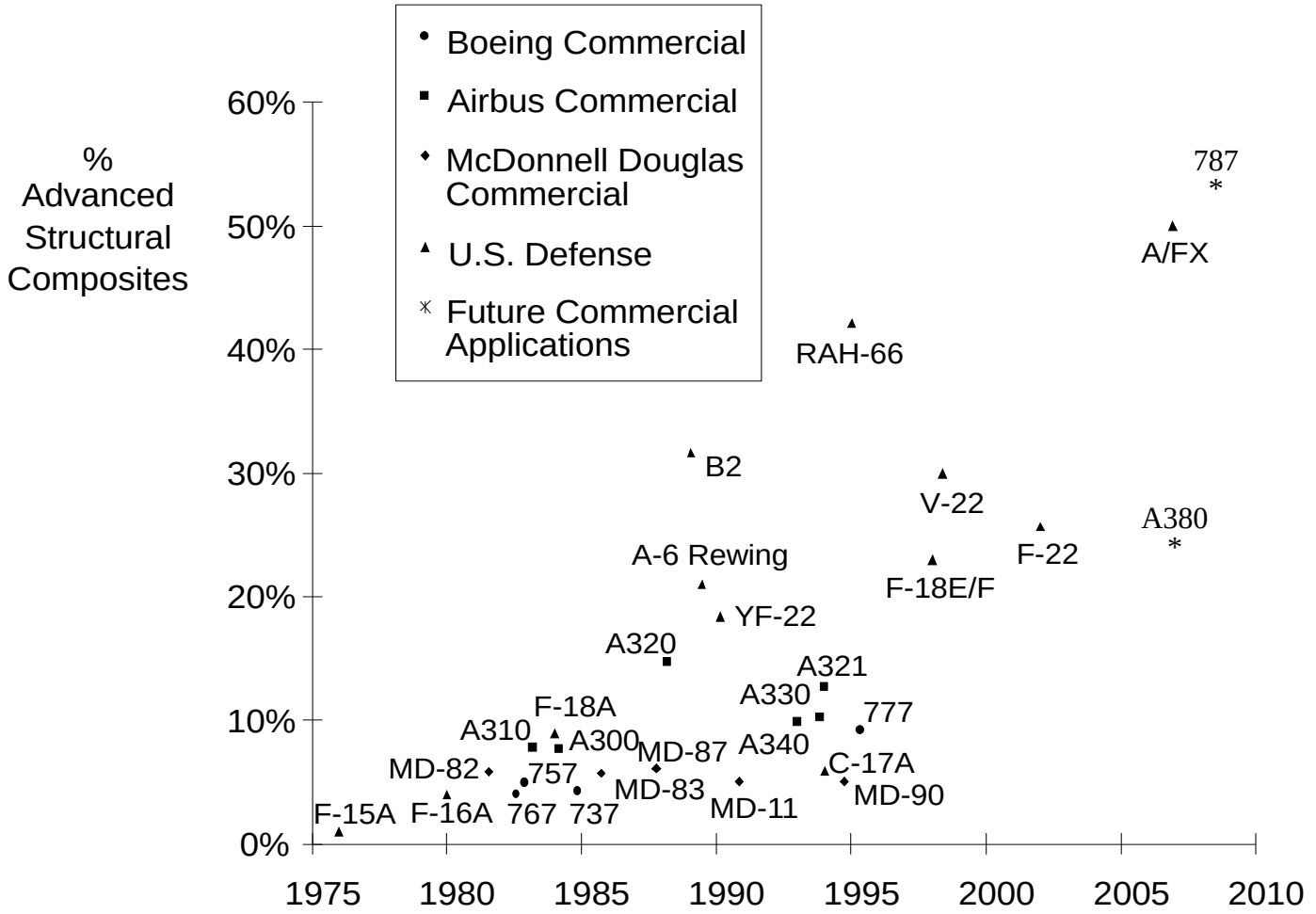
Small Airplanes and Rotorcraft

- Most structures
  - Pressurized fuselage
  - Wing
- Dynamic components
  - Propellers & rotor blades
- Extensive bonding

Development of Composite Usage:



Composite Structural Weight in Commercial Transport and Military Applications

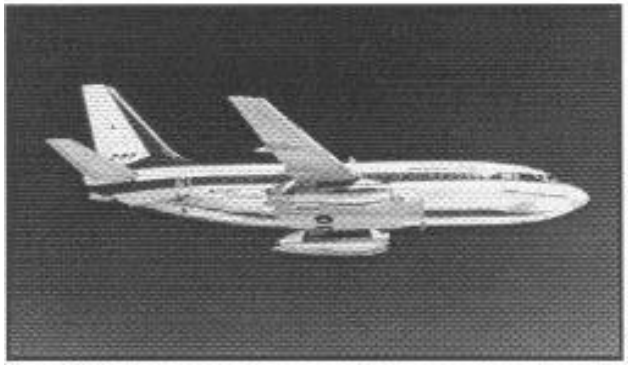


U.S. Development & Certification Basis

FAA

Advanced composite transport airframe structures were derived from NASA Prototype & military applications from the 1970/1980s

Boeing 777 Empennage
Certified in 1995



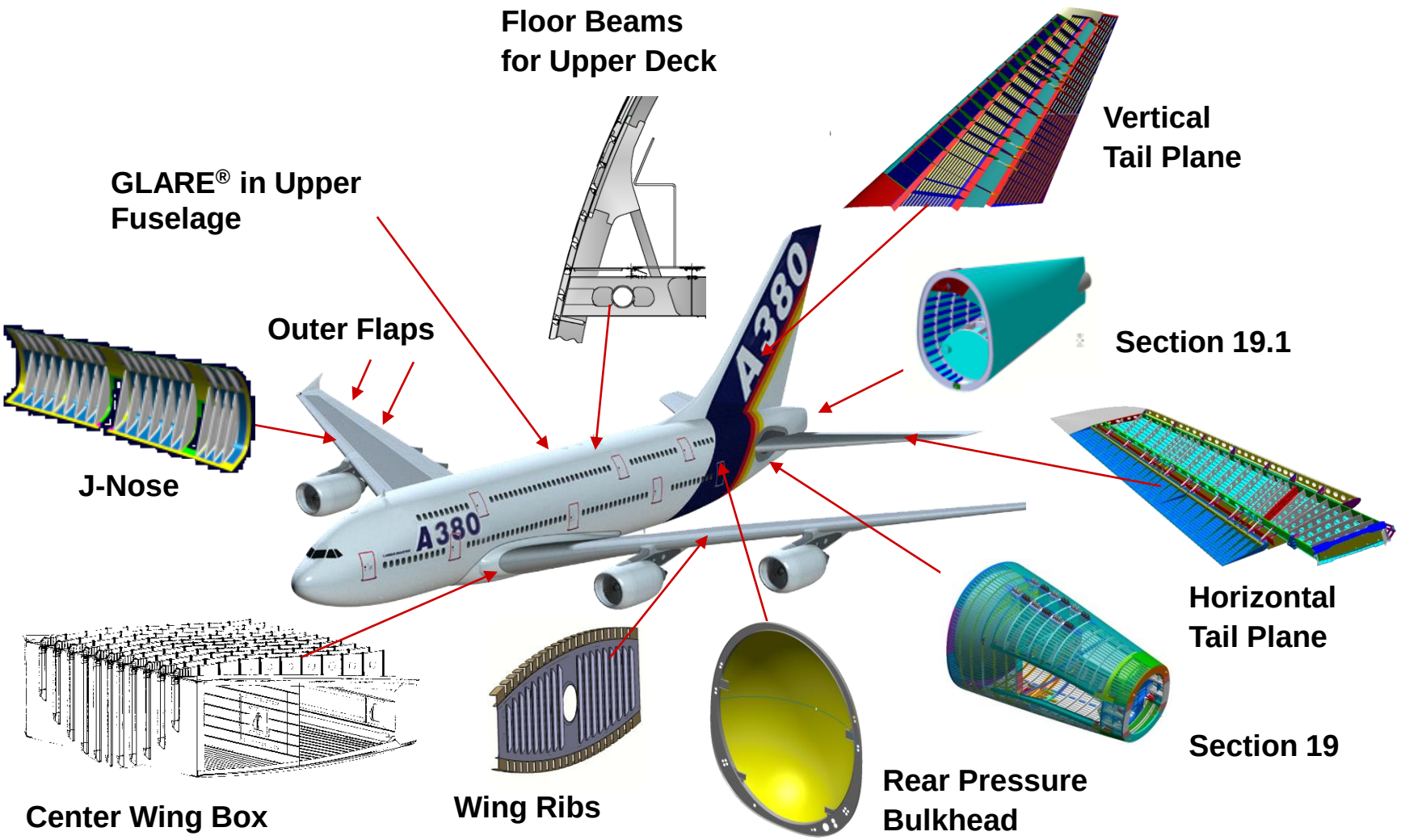
NASA—ACEE/Boeing
737 Horizontal Stabilizer
Certified in 1982 *

* Prototype aircraft application
(5 shipsets)

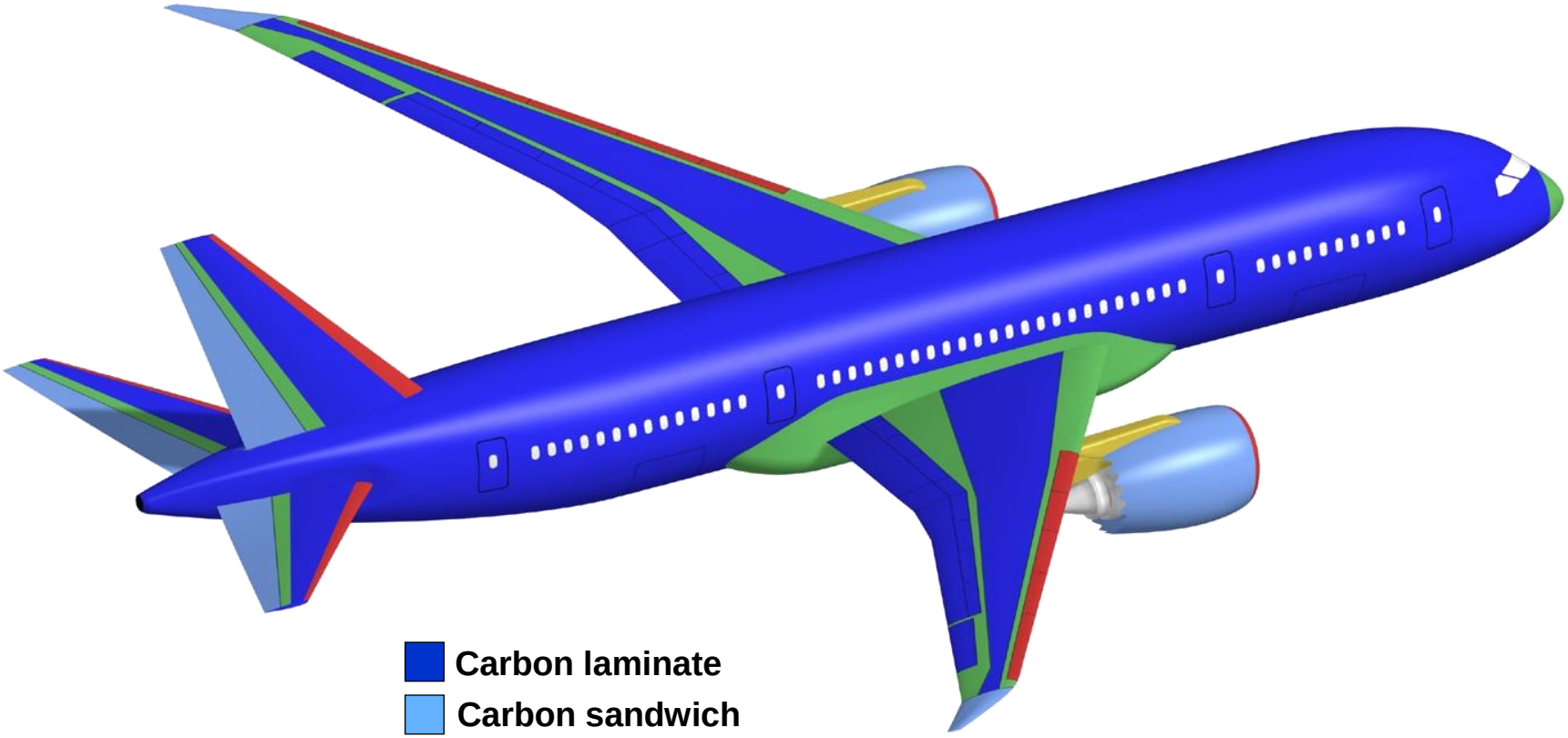
B-2 Bomber
60 foot wing box

V-22 Osprey
Wing & fuselage development

Composite Structures on Airbus 380 Aircraft:

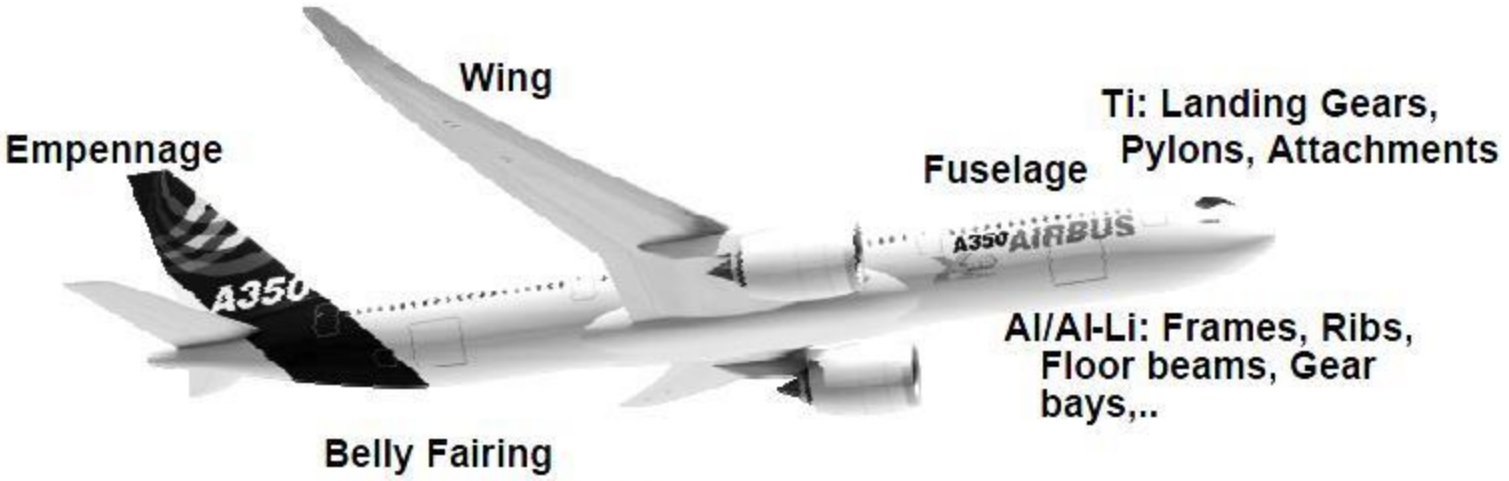


Composite Structures on Boeing 787 Aircraft:



- Carbon laminate
- Carbon sandwich
- Fiberglass
- Aluminum
- Aluminum/steel/titanium pylons

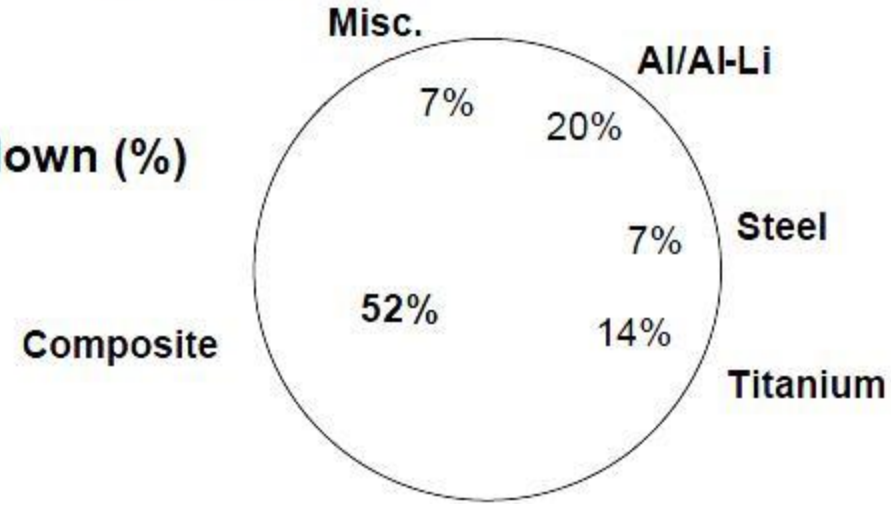
Composite Structures on Airbus A350 Aircraft:



A350-900 XWB

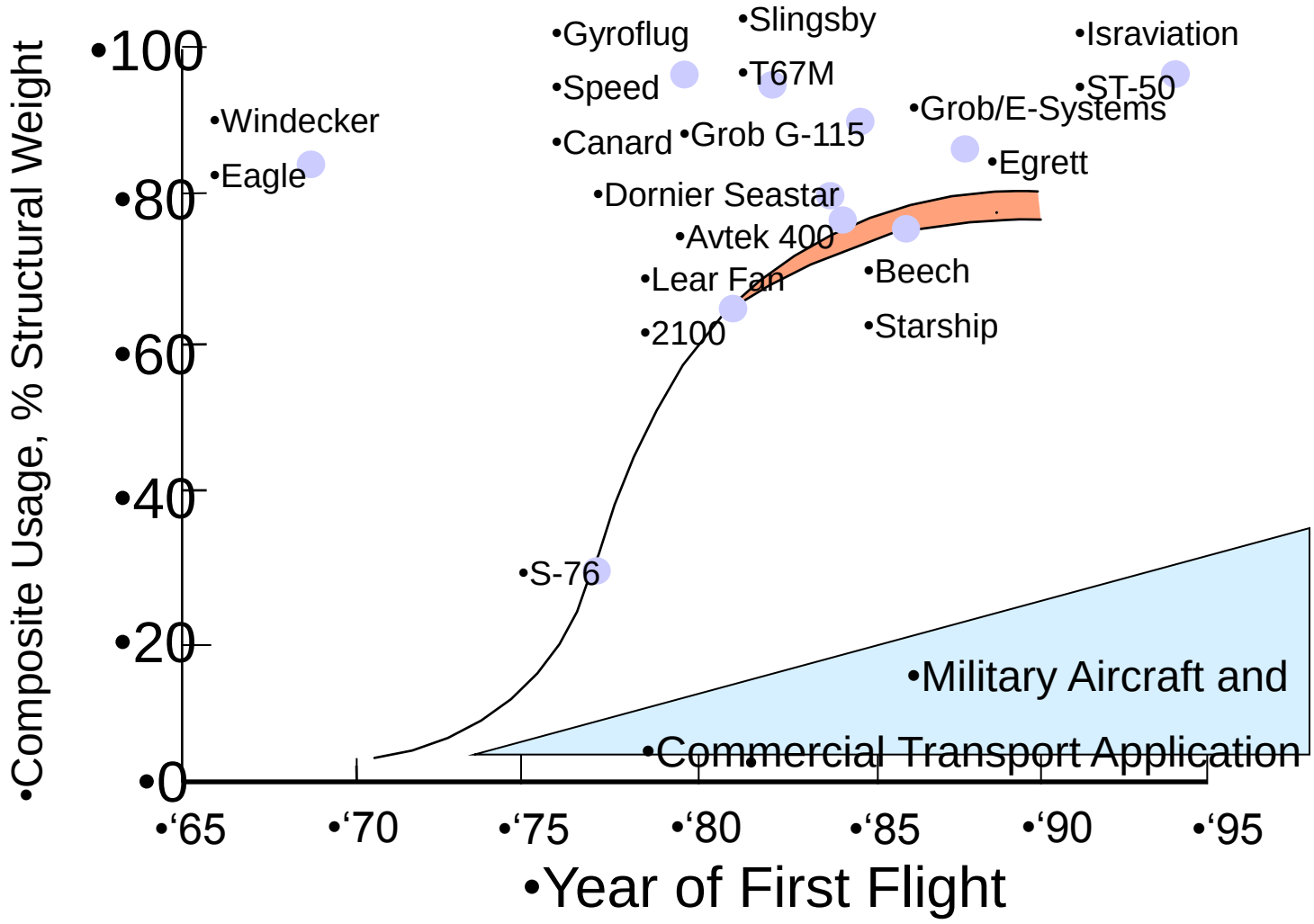
Material Breakdown (%)

Including Landing Gear



Implementation of Composites in Small Airplane and Rotorcraft Applications

FAA



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

Composites in Advanced Rotorcraft, Including Dynamic Components of Rotor Structure

Background - State of the Industry

- **Situation**
  - Composites have traditionally offered advantages due to fatigue & corrosion resistance, weight savings and other aircraft performance advantages (aero shape, larger cutouts)
  - More recently, the additional advantages from manufacturing cost savings, customer comfort interests & damage tolerance are driving more applications
- **Composite applications are expanding faster than the qualified workforce involved in structural engineering, manufacturing and maintenance functions.**
- **Technical concerns driving Safety Management:**
  - Composites are a non-standard technology
  - Limited shared databases, methods, guidance
  - Small companies have limited resources and certification experience
  - "Big-brother" expectations by industry

Background - AC 20-107A vs. 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

Background - AC 20-107A vs. 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: Ilcewocz retained Joe Soderquist's "Library"
(thorough, step by step records of developing AC 20-107A)

Justification of Updating AC 20-107A

- **AC 20-107A issued on 4/25/1984**
- **Inputs collected from certification projects (20+ years) (Noted by FAA Directorates)**
- **Continued evolvement of composite technology**
- **Gatwick Meeting (March 2003) - Understanding**
- **FAA Composite Safety & Certification Initiatives (CS&CI) developed more definitive guidance**

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.X. Cames
Lockheed-California Company

J.W. Bristow
Civil Aviation Authority

L. Barenes
Service Technique des
Programmes Aéronautiques

D. Chaumette
Aviona Marcel Daasault-
Breguet Aviation

T.W. Coombe
British Aeroapace Aircraft Group

J.F. van der Spek
Rijksluchtvaartdienst

Review of "Composite Aircraft Structure" AC
Participants: Gatwick (UK) Meeting (March/2003)

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

Review of "Composite Aircraft Structure" AC

Goals: Gatwick (UK) Meeting (March/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**

Summary from Review of "Composite Aircraft Structure" AC

Gatwick (UK) Meeting (March/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 as a "general composite guidance"
  - Agree that other more definitive guidance is also needed as industry standards evolve

Summary from Review of "Composite Aircraft Structure" AC

Gatwick (UK) Meeting (March/2003) (Cont.)

- 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 formed initial basis for FAA plan.*

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

Summary - Reasons to Update/Change AC 20-107A & Associated ACJ 25.603

- **To remove obsolete guidance**
- **To change for harmonization**
- **To update based on service and/or certification experiences**
- **To add or change for new technology** (materials, processes, engineering methods, maintenance procedures, etc.)

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?**

CS&CI Knowledge Base
- Milestone Achieved -

- **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)***
- **Technical document on composite certification roadmap (2003)**

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

CS&CI Knowledge Base
- Milestone Achieved -

- **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)***
- **Support of CMH-17 (since 1999)**
  - **New CMH-17 V3/C3: Aircraft Structure Certification and Compliance**
  - **Updates to CMH-17 V3, C 12-14 in areas of DT & Maintenance**
  - **CMH-17 tutorials initiated in 2007**

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

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**

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

Safety Management Strategies Supporting AC 20-107A Updates

- **Safety Management WG addressed links between composite certification, operation and 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 & the interface between functional disciplines

Links with CMH-17, SAE CACRC and Safety Management

- **Composite Materials Handbook (CMH-17)**
  - ~ 100 industry engineers meet every 8-9 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 Safety Management TG is under consideration
  - *FAA strategy: use CACRC as a forum to develop guidance and support industry composite maintenance standards & training efforts*

2006 FAA Composite Damage Tolerance & Maintenance Workshop (Chicago, IL)

	Wednesday, July 19	Thursday, July 20	Friday, July 21
1st Hour		Session 2* **Substantiation of Structural Damage Tolerance**	Session 6 **Technical Breakout Sessions** (*Separate *working meetings covering technical subjects from Sessions 2 - 5)*
2nd Hour			
Break (15 min.)			
3rd Hour		Session 3* **Structural Test Protocol**	Session 7 **Breakout Team Summary** Recap/Actions/Closure/Adjourn
4th Hour			
Lunch (1 Hour)			
5th Hour	**FAA Initiatives Safety Management** Airbus/Boeing/EASA/FAA WG Maintenance Training Update	Session 4* **Substantiation of Maintenance Inspection & Repair Methods**	
6th Hour			
Break (15 min.)			
7th Hour	Session 1 **Applications & Service Experiences**	Session 5* **Damage/Defect Types and Inspection Technology**	
8th Hour			

Chicago, IL, USA
July 19-21, 2006

2007 FAA/EASA/Industry Composite Damage Tolerance and Maintenance Workshop

Amsterdam, Netherlands May 9-11, 2007

	Wednesday, May 9	Thursday, May 10	Friday, May 11
1st Hour	**SAE Commercial Aircraft Composite Repair Committee** Overview of Progess & Plans	**Session 1** **Applications & Field Experiences** *(continued)* Service History of Composite Structure Service Damage & Reliability of Repairs	**Session 5*** **Field Inspection and Repair QC** Test Standards & Inspector Qualifications Reliable NDI Technology Advances Material & Process Controls
2nd Hour			
Break (15 min.)			
3rd Hour	**Airbus and Boeing** Perspectives on Safe Industry Practices	**Session 2*** **Damage Tolerance** Design Criteria & Objectives Structural Test Protocol	**Session 6** **Technical Breakout Sessions** (*Separate *working meetings covering technical subjects from Sessions 2 - 5)*
4th Hour	**Airbus & Boeing (continued)** **SAE CACRC** Active Task Group Reports		
Lunch (1 Hour)			
5th Hour	**SAE CACRC** Active Task Group Reports	**Session 3*** **Damage in Sandwich Construction** Fluid Ingression Growth Mechanisms Analysis & Accelerated Tests	**Session 7** **Breakout Team Summary** **Recap/Actions/Closure/Adjourn**
6th Hour	**FAA & EASA Initiatives**		
Break (15 min.)			
7th Hour	**FAA & EASA Initiatives** *(cont.)* Recent Progress/Safety Management	**Session 4*** **Repair Design and Processes** Repair Limits Design Criteria & Process Guidelines Structural Substantiation	
8th Hour	**Session 1** **Applications & Field Experiences**		

~110 Participants

2009 FAA/EASA/Industry Composite Damage Tolerance and Maintenance Workshop

Tokyo, Japan June 4 & 5, 2009

	Thursday, June 4	Friday, June 5
1st Hour	**FAA Initiatives** Recent Progress/Safety Management	**Session 4*** **Damage Tolerance & Maintenance Guidance** Near- and Long-term Needs Design and Process Guidance Structural Substantiation = f(application criticality)
2nd Hour	**EASA Initiatives** **Session 1: Applications & Field Experiences**	
Break (15 min.)		
3rd Hour	**Session 1: Applications & Field Experiences** *(continued)* Service History of Critical Composite Structure Service Damage & Reliability of Repairs (all applications) Anticipated issues for expanding applications	**Session 5*** **CACRC Advances for the Future** Near and Long-term Initiatives Shared Databases and Methods Design & Process Guidelines = f(application criticality)
4th Hour		
Lunch (1 Hour)		
5th Hour	**Session 2*** **Damage Threats & Inspection Strategies** Data for Damage Threat Assessments Test Standards & Inspector Qualifications Reliable Technology Advances for Inspection	**Session 6** **Technical Breakout Sessions** (*Separate *working meetings covering technical subjects from Sessions 2 - 5)*
6th Hour		
Break (15 min.)		
7th Hour	**Session 3*** **Damage Tolerance & Repair Substantiation** Design Criteria & Objectives Building Block Approaches (benefits & est. costs) Structural Test & Analysis Protocol	**Session 7** **Breakout Team Summary** **Recap/Actions/Closure/Adjourn**
8th Hour		

~120 Participants

Summary of 2006, 2007 & 2009 Workshops

- 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 (~370 participants in three workshops)
  - Damage tolerance and maintenance initiatives are active
  - Principles of safety management will be used in future developments (policy, guidance and training)

Presentations, recaps and breakout session summaries at:
http://www.niar.wichita.edu/niarworkshops/

AC 20-107B Development Biz Plan

- **FAA Established a Business Plan to Update AC 20-107A (FY 2008 & 2009)**
- **Key Milestones**
  - **^ Document Development – (2007 – 2009)**
  - **^ FAA Internal Review – Fall 2008**
  - **^ Public Commenting – Spring 2009**
  - **^ Final Issuance – September 2009**

AC 20-107B Development Effort

- **A Joint Effort of Global Community**

  ^ FAA Development Team Meeting (Seattle, Dec/07)

  ^ FAA/EASA/TCCA/LBA Meeting (Cologne, Apr/08)

  ^ FAA/EASA/TCCA/LBA Meeting (Seattle, Jun/08)

  ^ Interactions with Industry

  (CMH-17 Mtgs – Cocoa Beach, Ottawa & Salt Lake City)

  (CACRC Meetings – Wichita, Athens & Minneapolis)

  (EASA-Industry Meeting – Cologne)

AC 20-107B Review Processes

- **Clearance Record Process (CRP)**

  - Initiated in Oct/2008

  - Comments Received from AFS & AIR (250+)

  - Additional (Informal) Comments

  ^ CACRC Meeting

  ^ CMH-17 Meeting

  ^ Europe Industry

  - Development Team Conducted Review/Disposition

  - AC Updated per Disposition in Apr/2009

AC 20-107B Review Processes

- **Public Commenting Process (PCP)**

  - Initiated in May/2009

  - Comments Received from Global Communities (165+)

  - Development Team Conducted Review/Disposition

  - AC Updated per Disposition in Aug/2009

AC 20-107B Final Issuance

- **AC 20-107B Final Issuance**
  - **- AIR-100 Fine-Tuned AC Format**
  - **- AIR-100 Manager Approved AC**
  - **- FAA Issued AC 20-107B (9/8/09)**
  - **- “Change 1” (minor items) (Aug/10)**
    - **^ wordings**
    - **^ format**
    - **^ page-number**

AC 20-107B Outline

AC 20-107A 11 pages
AC 20-107B 37 pages
(new sections highlighted by blue)

1. Purpose
2. To Whom This AC Applies
3. Cancellation
4. Related Regulations & Guidance
5. General
6. Material and Fabrication Development
7. Proof of Structure – Static
8. Proof of Structure – Fatigue & Damage Tolerance
9. Proof of Structure – Flutter & Other Aeroelastic Instabilities
10. Continued Airworthiness
11. Additional Considerations

Appendix 1. Applicable Regulations & Relevant Guidance
Appendix 2. Definitions
Appendix 3. Change of Composite Material and/or Process

Post AC 20-107B Activities

- **Harmonization Efforts**

  - AC 20-107B & AMC 20-29

  ^ FAA/EASA Meeting (Cologne, Dec/09)

  ^ FAA Participation on EASA CRD

  ^ EASA Issued AMC 20-29 (7/26/10)

  - AC 20-107B & TCCA Guidance

  ^ FAA/TCCA Meeting (Ottawa, Aug/10)

Post AC 20-107B Activities (Cont.)

- **AC Interaction Meetings**
  - ^ Atlanta ACO Meeting (Nov/09)
  - ^ Rotorcraft Directorate Meeting (Mar/10)
  - ^ EU Industry Meeting (Hamburg, Apr/10)
  - ^ Los Angeles ACO Meeting (Jul/10)
  - ^ LA Area Industry Meeting (Jul/10)
  - ^ Denver ACO Meeting (Aug/10)
  - ^ Canada Industry Meeting (Montreal, Nov/10)
  - ^ SAD Dir. (Wichita ACO) Meeting (Mar/11)
  - ^ Chicago ACO Meeting (Aug/11)
  - ^ TAD Dir. (Seattle ACO) Meeting (Aug/11)
  - ^ Anchorage ACO Meeting (Jul/12)
  - ^ E&P Dir. (Boston & NY ACOs) Meeting (Aug/12)
  - ^ CAAs Meeting (Singapore, Sep/15)

Composite Safety & Certification Meeting
- Development of AC 20-107B -

- **Thanks for Opportunity.**
- **Questions and/or Thoughts?**
- **Further Discussion.**

"AC 20-107B Content Review"

[To Be Followed After Break]