# Aircraft Certification Considerations

Federal Aviation Administration

Presented to: FAA/EASA Composite Transport Working Group

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# Existing Crashworthiness Regulatory Requirements

- **Requirements focus primarily on occupant protection**
  - 25.561 Emergency Landing Conditions General
  - 25.562 Emergency Landing Dynamic Conditions
  - 25.785 Seats, Berths, Safety Belts and Harnesses
  - 25.787 Stowage Compartments
  - 25.789 Retention of items of Mass
  - 25.801 Ditching
- **Requirements at the airplane level are limited to ‘large’ items of mass**

# Existing Crashworthiness Regulatory Requirements cont'd

- **Existing requirements fall into two categories**
  - Static Strength
  - Dynamic Response
- **No requirements address the airframe response, per se**
- **The requirements are based on extensive research using traditional airframe design as a baseline**
- **Nonmetallic airframe construction has necessitated special conditions and other alternative methods of certification**

# Special Condition Requirements

- **Special conditions have addressed crashworthiness at the airframe level**
- **Requirements have been, up to now, comparative in nature**
- **The requirements are built on four primary objectives:**
  - Maintain livable space
  - Keep occupant loads survivable
  - Retain of items of mass
  - Permit egress

# Potential Future Requirements

- **As noted, prior special conditions are comparative**
  - Comparison based on traditional construction of the same geometry
  - Comparison only requires comparable performance over a range of impact conditions
- **Future requirements would likely tend toward specific performance**
- **Wouldn't be limited to a particular material type**

# Potential Future Requirements

- **Special condition objectives would be starting point**
- **Existing criteria, such as 25.562, would not change (but might have provision to accommodate the airframe response.)**
  - Existing 2X.562 criteria are different
  - SC accounts for this possibility
- **R&D may be needed to further establish response characteristics sufficiently to define objective criteria**

# Summary of Crashworthiness Certification Issues

- **Past and current**
  - No specific dynamic regulatory requirement for airplane level crashworthiness.
  - Existing requirements are based on extensive research using traditional airframe design as a baseline
  - Special conditions are issued for composite structures used to ensure a comparable level of safety to existing metallic structures
- **Future**
  - Need to define crashworthiness requirements
  - Need to understand composite response characteristics sufficiently to define objective criteria

# Define Crashworthiness Requirements

- **Acquire**
  - Impact requirements/ data (make assumption that some existing impact data is generic)
    - Flight regime
    - Pitch, roll, yaw angle
    - Velocity
  - Aircraft performance/ impact response
    - Metallic
    - Composite

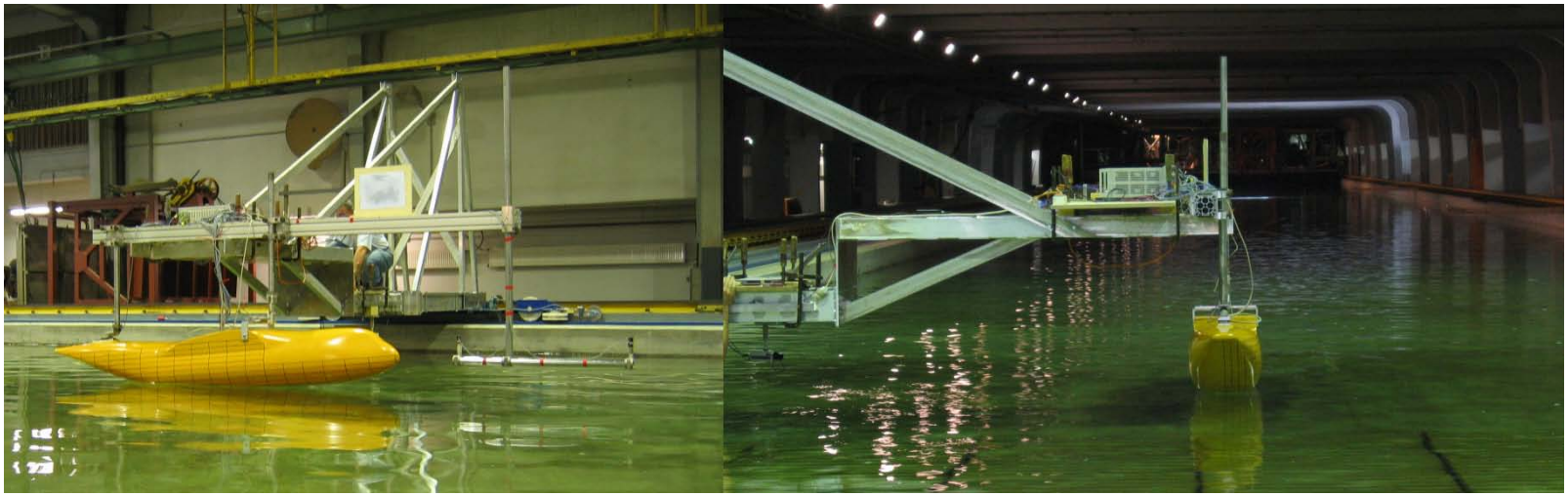
# Identify and Resolve High Level Issues

- **What is a large scale test**
  - Entire aircraft
  - Section test
    - Complete structure
    - Half barrel
  - Scaling  (size)
    - Full-scale test article
    - Half-scale
    - etc

# Identify and Resolve High Level Issues cont'd

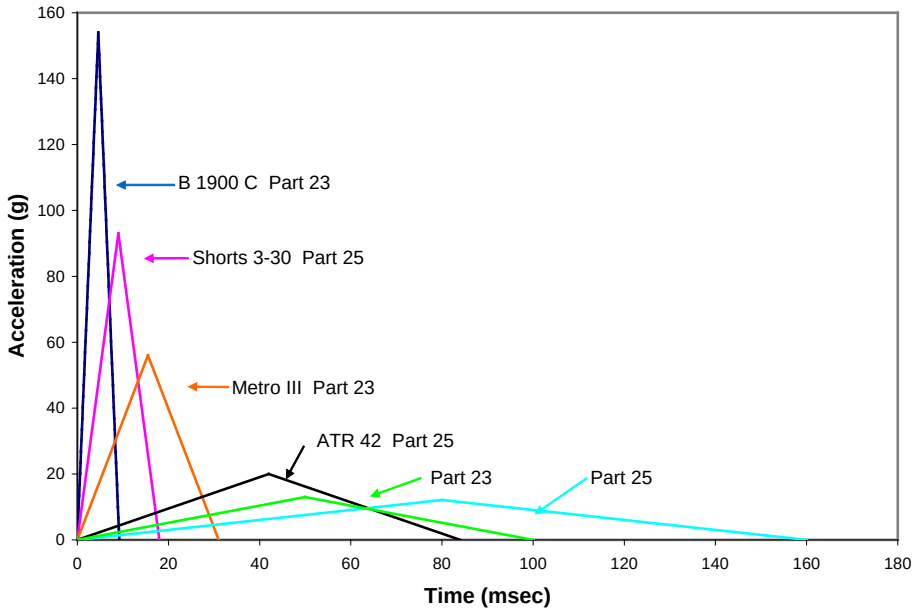
- **FAR 25.801 (b)**

  "The probable behavior of the airplane in a water landing must be investigated by model tests or by comparisons with airplanes of similar configuration for the ditching characteristics are known."



# Identify and Resolve High Level Issues cont'd

- Airplane classification
  - Currently by weight
  - Weight
  - Size
  - Under floor crush depth
  - Under floor crush volume




Impact response and

Parts 23/25 cabin seat requirements

# Basis for Certification

- **Certification by Analysis (CBA)**
  - Special cases (derivatives)
- **Certification by Test**
- **Certification by Analysis and Test (CBAAT)**
  - a.k.a.

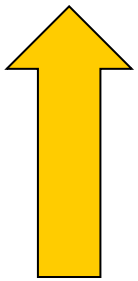
    Certification by analysis supported by test

    Certification by analysis supported by test evidence

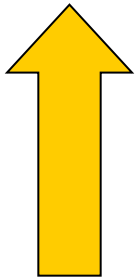
# Basis for Certification - Roll Change

- **Certification has and continues to transition from**
  - Certification by test to CBAAT

**AS** **Analytical Modeling Capability Increases**



**The** **Role of Large Scale Testing Changes**

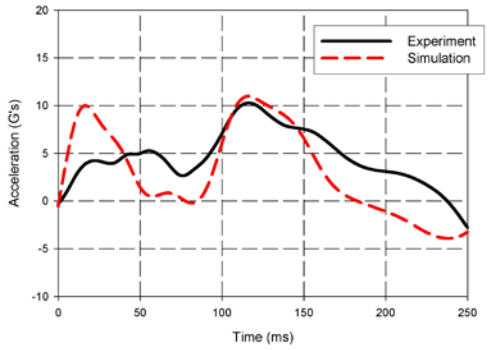


**Certification Model Verification**

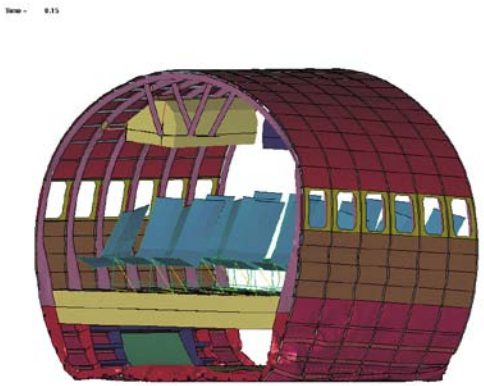
**Certification Design/Development Experimental Data**

# CBAAT

- **Analysis substantiated by test**
  - Comparable kinematics (response)
  - Comparable data (e.g., loads, failure modes)







# Technical Considerations

- **How do we perform analytical verification and validation**
  - Compare analytical and test results
    - Load stress/strain distribution and inertial loads
    - Static and dynamic deformation
    - Kinematics
    - Damage
      - % of all significant occurrences
      - % of those deemed critical
  - Establish metrics (i.e, pulse duration and magnitude)

# Technical Considerations cont'd

- **What damage should analysis predict?**
  - Floor and floor tracks
  - Exits/doors
  - Overhead stowage bins
  - Fuselage
    - Frame sections
    - Stringers
    - Longerons
    - Skin (water impact)
    - Bulkhead (water impact)

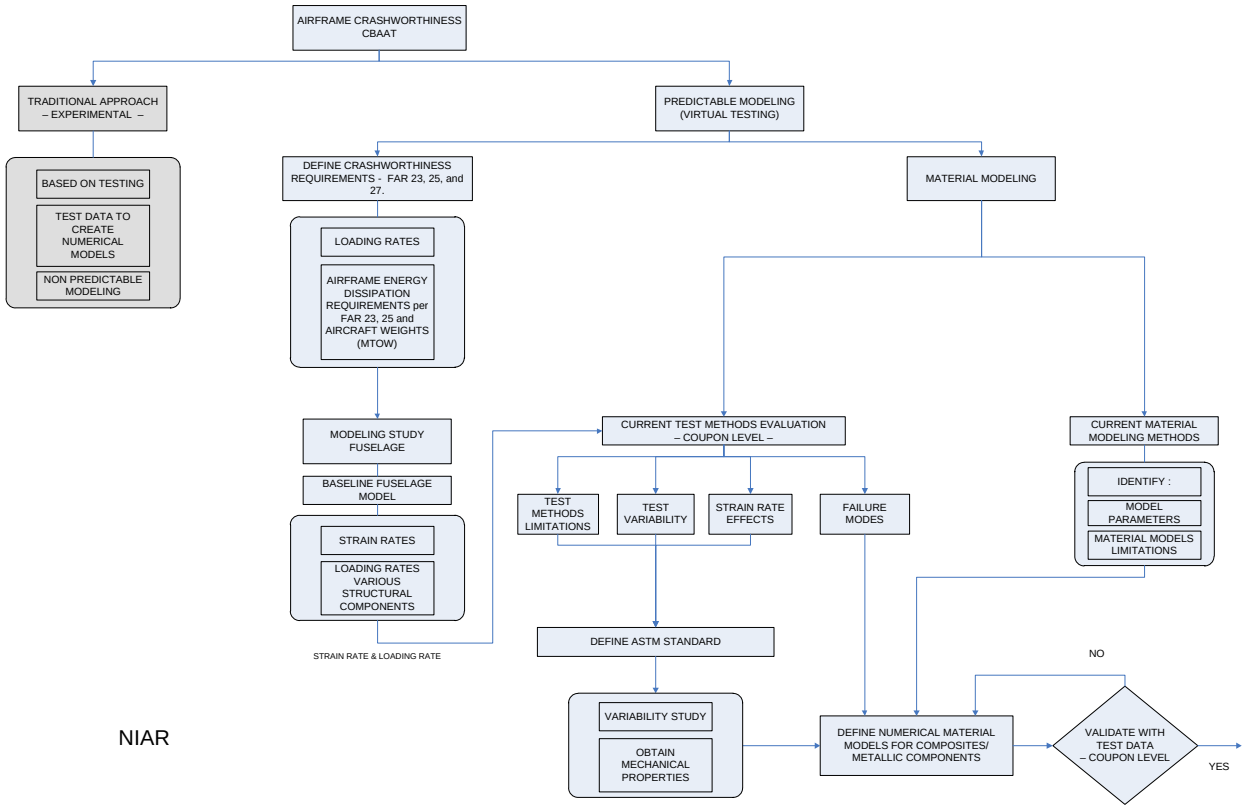
# Composite Structures Crashworthiness Methodology

**Need to develop standards**

- **Test methodology**
- **Reference data**

**Guidance**

- **Best practices**

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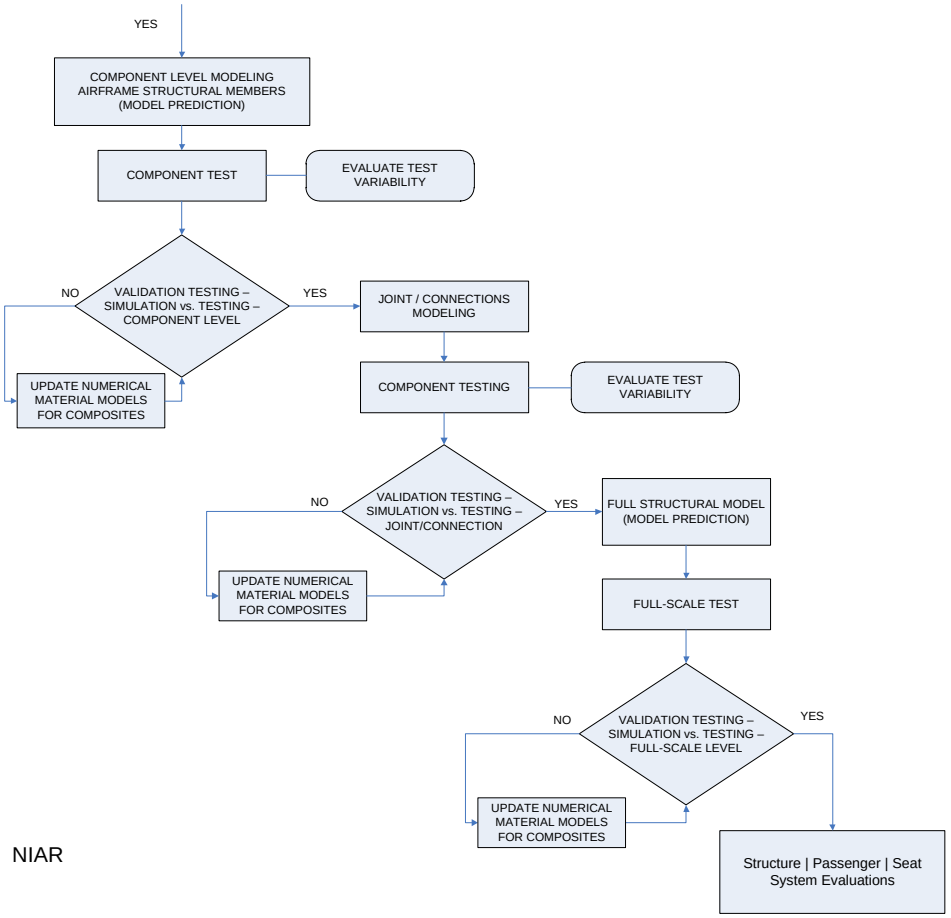
# Composite Structures Crashworthiness Methodology– cont.

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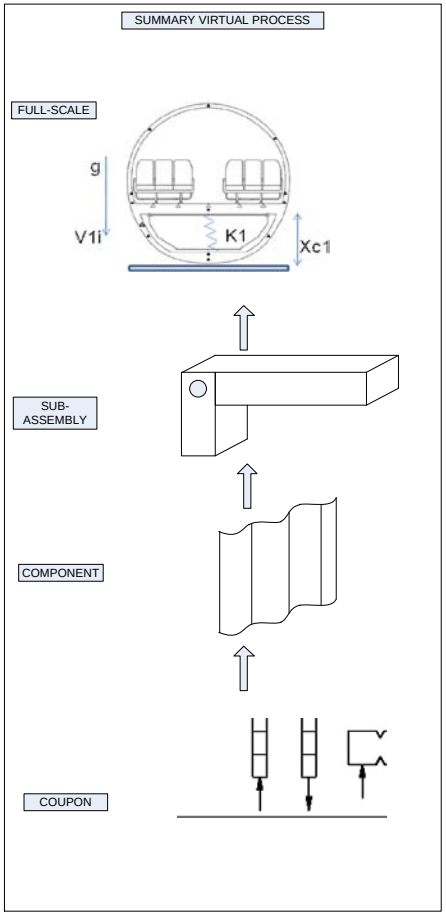
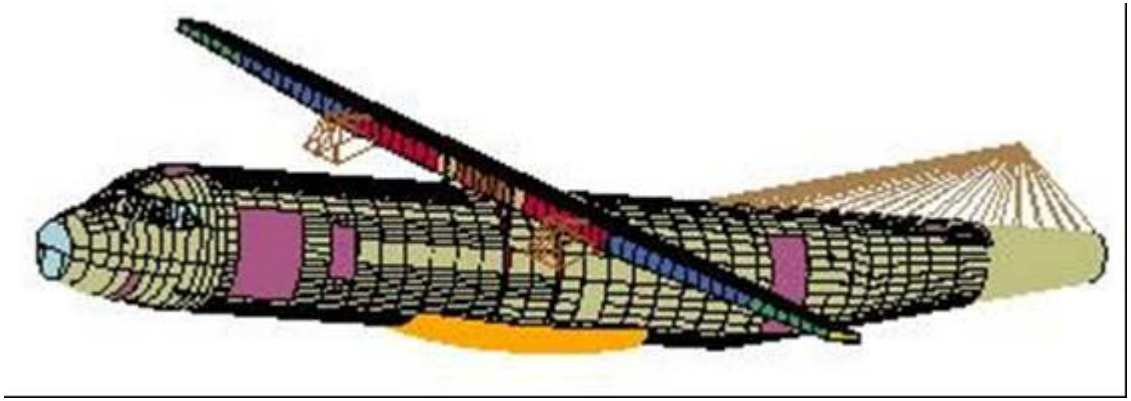


# Changes in Analytical Modeling Capability

## 63000 Elements 2003



## 2011

| | |
|---|---|
| No. of Elements | 6 million |
| Simulation Time | 150 ms |
| No. of CPU's | 16 |
| Total CPU Time | 70 hrs |

## 68000 Elements - 2000