



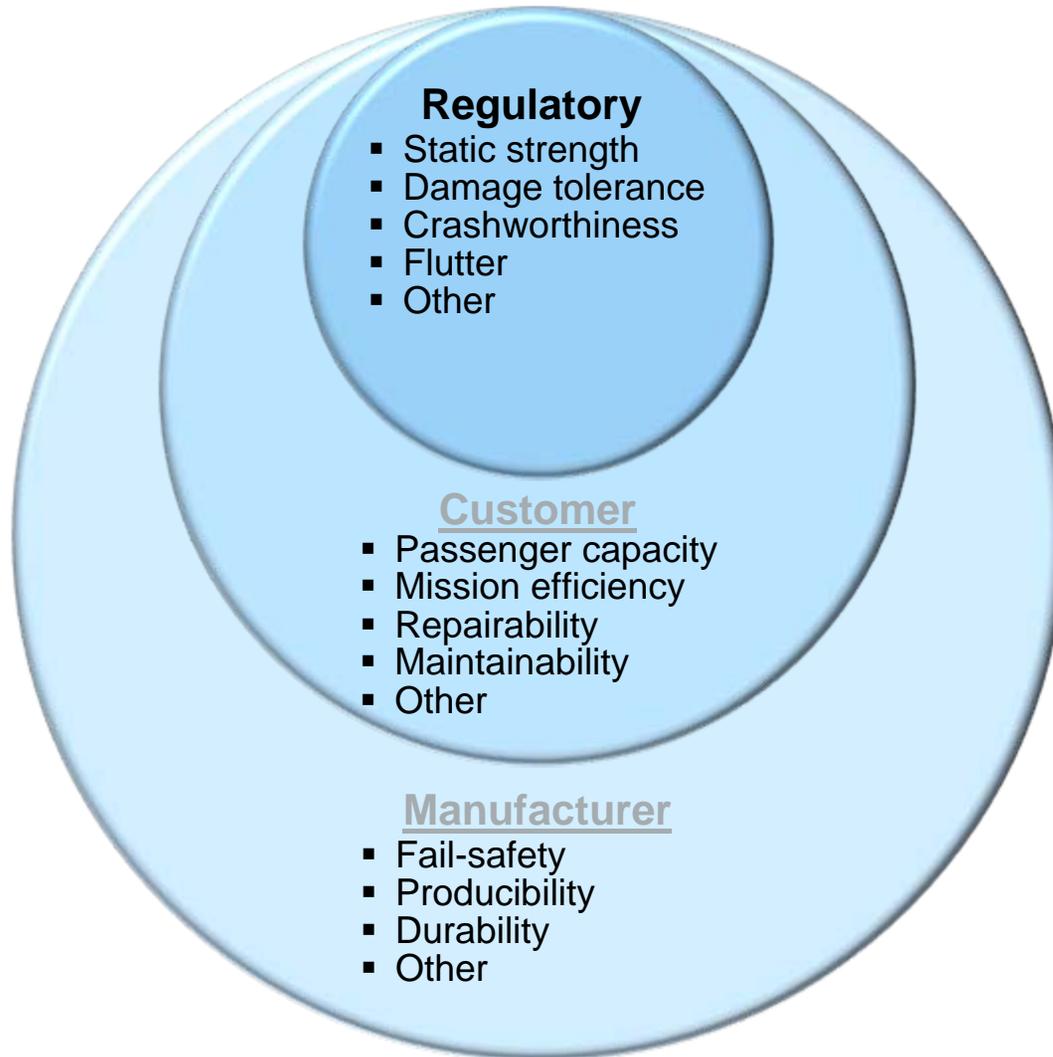
Airplane Fuselage Structural Integrity Forum

Panel 3: Design Requirements and Validation

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Boeing Commercial Airplanes

September 21, 2011

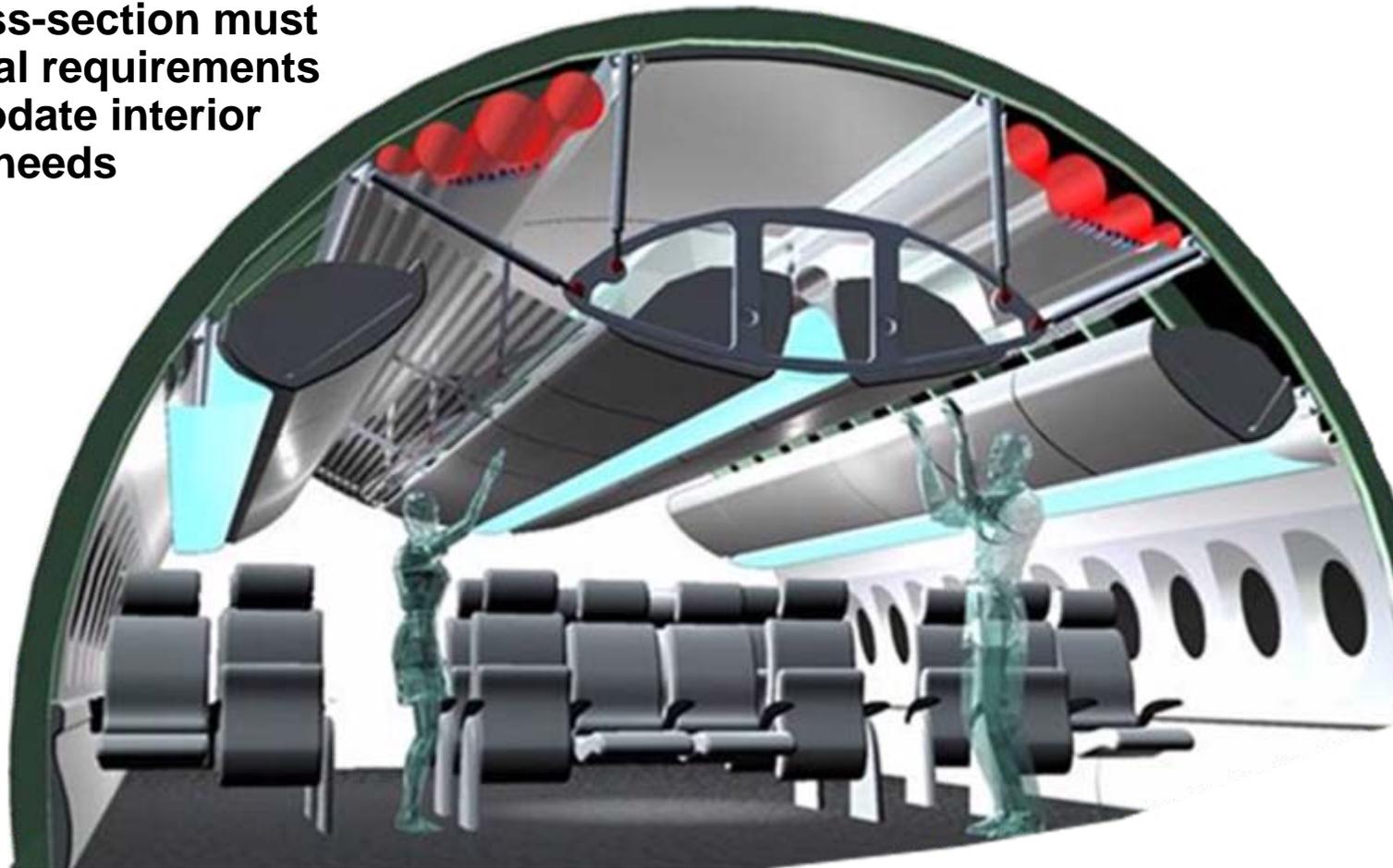
Design Drivers



Customer Requirement

Passenger Capacity

Fuselage cross-section must meet structural requirements and accommodate interior arrangement needs

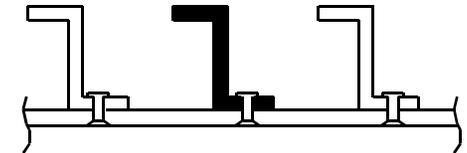


Boeing Requirement

Fail-Safe Structure

- Fail-safety is a fundamental Boeing design requirement
- “All primary flight-loaded structure, including trailing edge flaps and control surfaces, must be designed to be fail safe”
 - Alternate/intermediate/adjacent members that pick up load from failed members
 - Fastener capability matched to load redistribution requirements
 - Damage containment features (e.g., tear straps)
 - Boundaries of components and subcomponents (e.g., major joints or heavy frames)
 - Appropriate operating stress levels
 - Material toughness and elongation characteristics
 - Special attention for integral structure

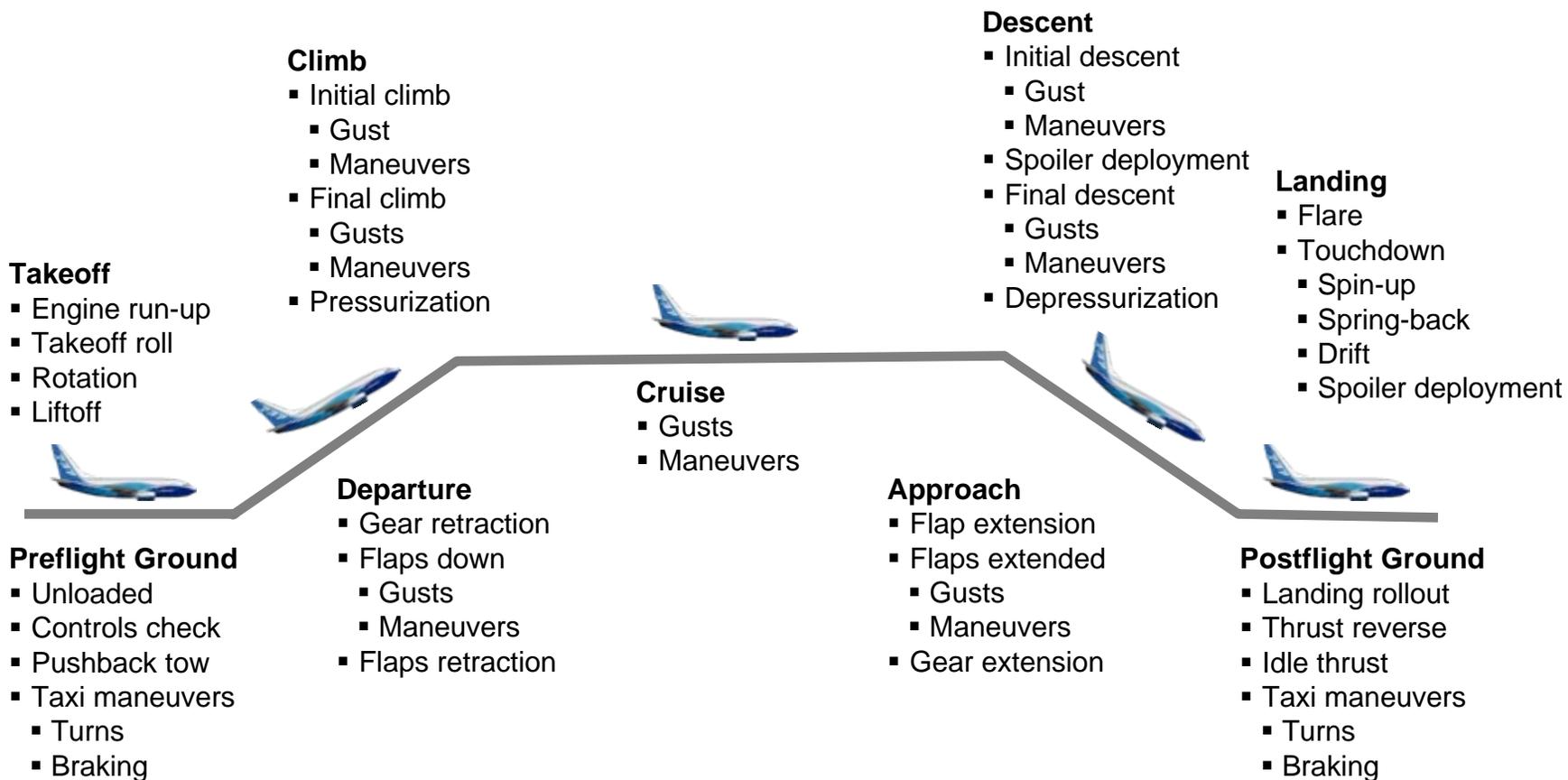
Fail Safe



- Redundant load path
- Capable of withstanding regulatory loads with a single element failed

*No Longer Required by FAA
A Boeing Requirement to Provide an Additional Level of Safety*

Loading Spectrum



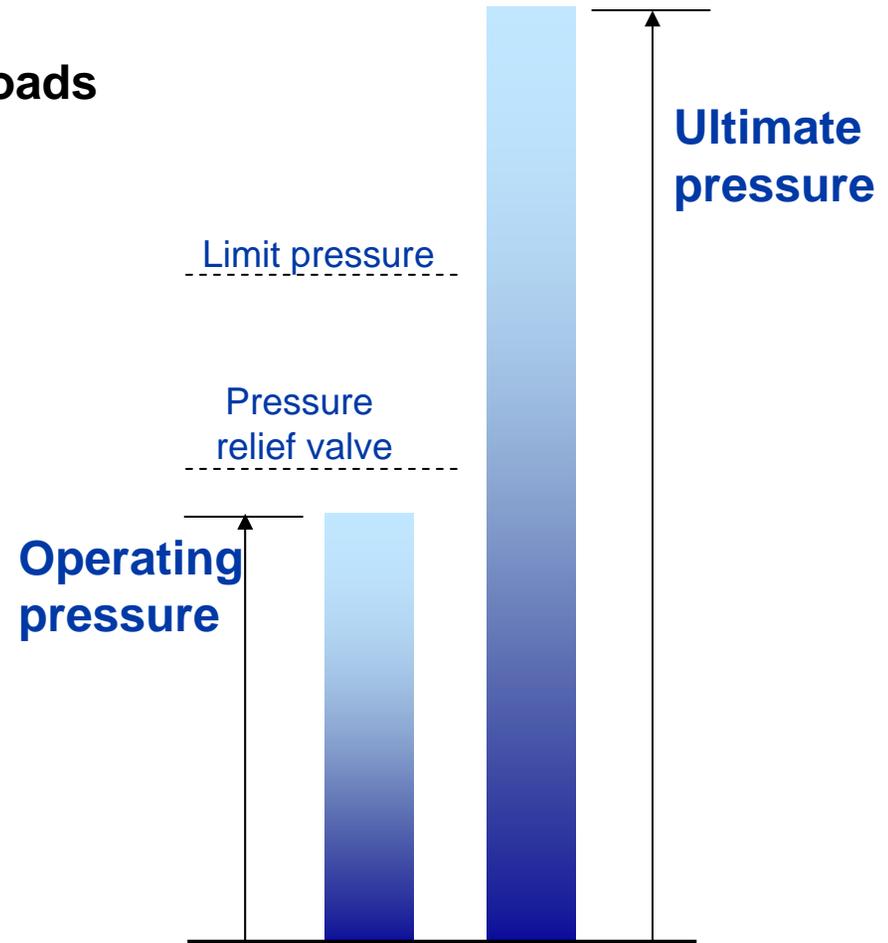
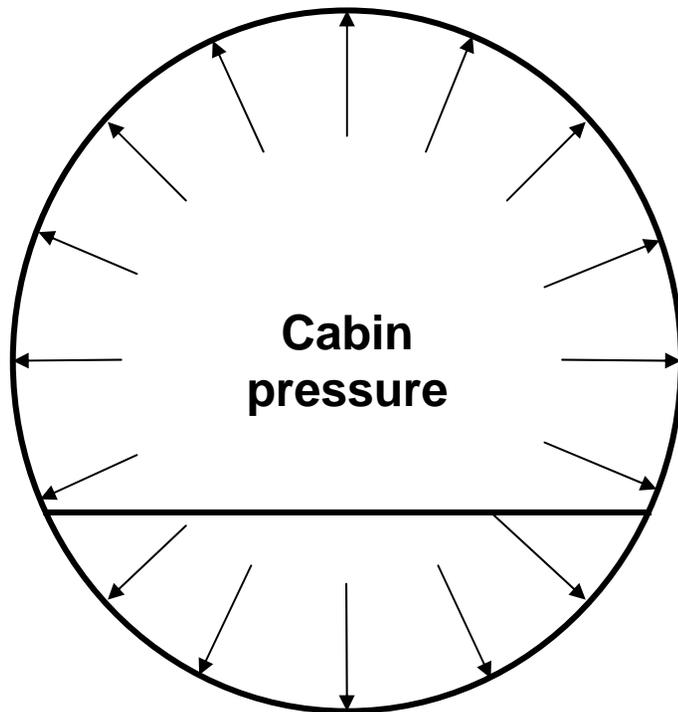
- A detailed “flight profile” is developed for each airplane model based on projected flight operations

Flight Profile Events Simulate a Complete Flight Cycle

Pressure Loading

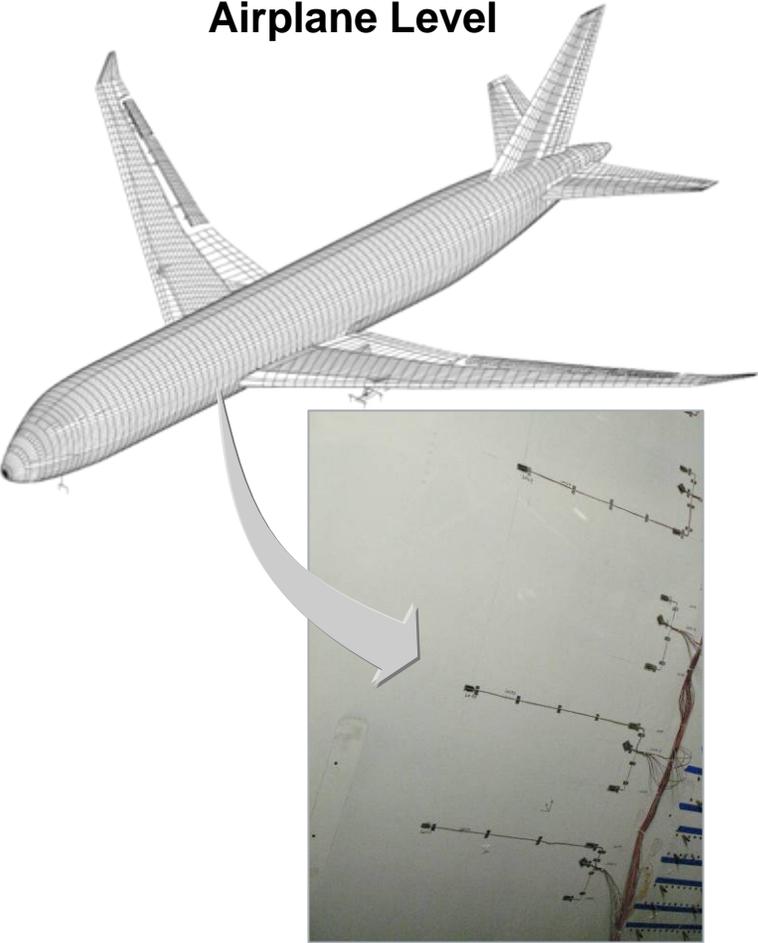
Cabin pressure

- 1.5 x maximum relief valve + flight loads
- 2.0 x maximum relief valve only

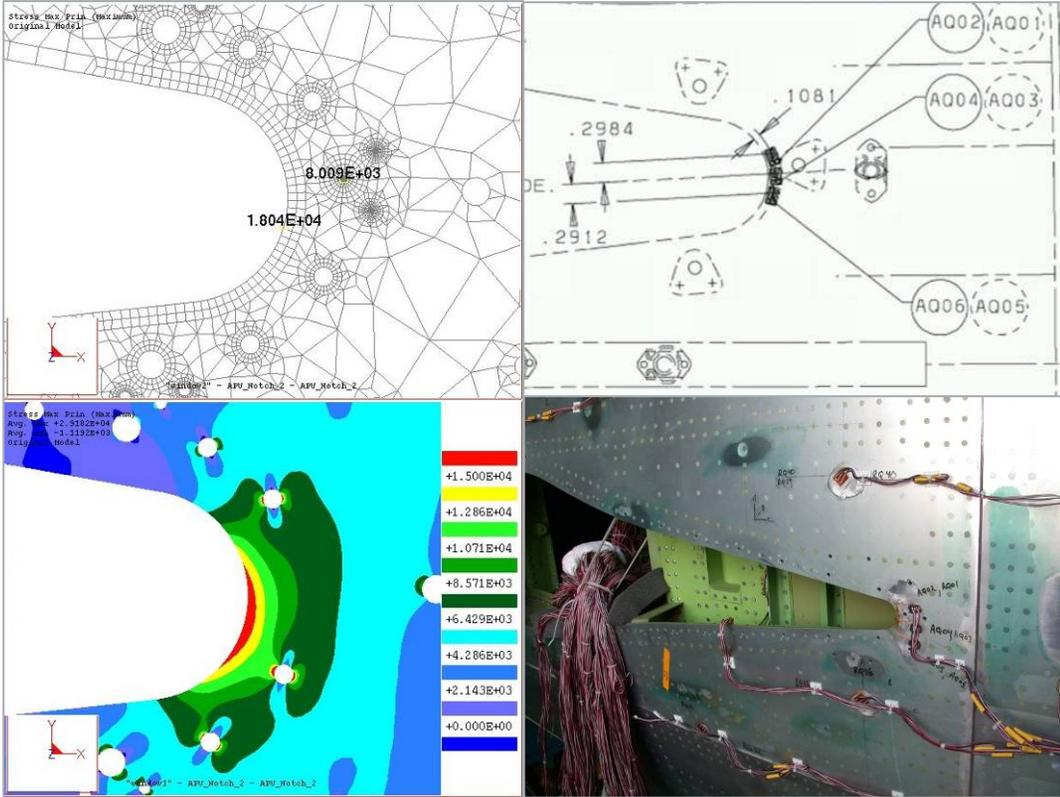


Analysis and Validation

Airplane Level



Detail Level



Analysis Supported by Test

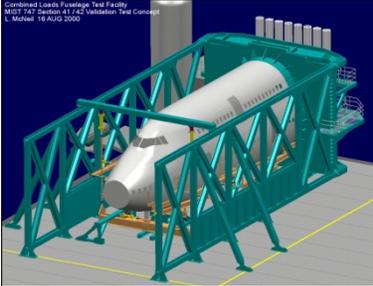
Validation



- Fleet experience

- Full-scale airplane test

- Partial airplane test



- Component test



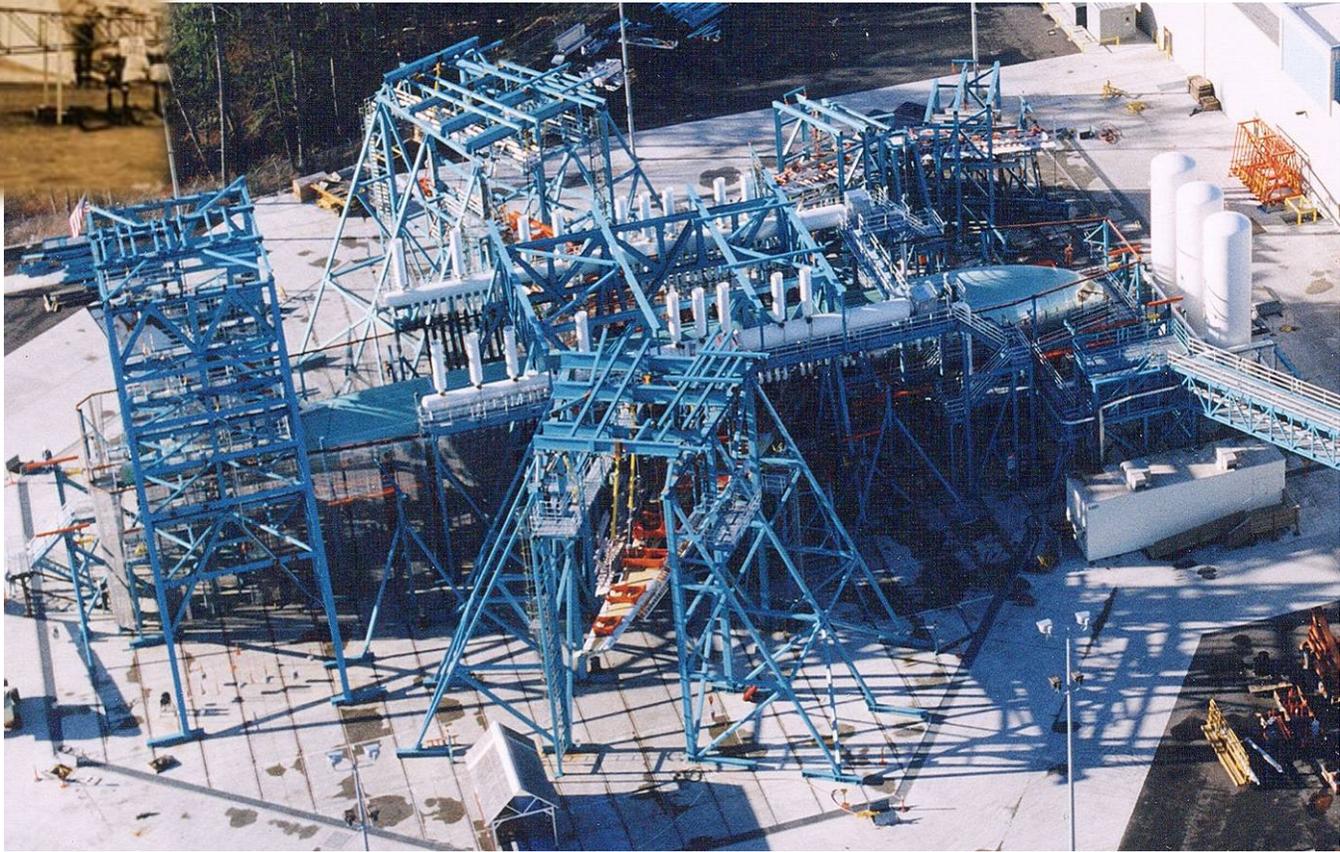
- Fleet full-scale part airplane or component test

} Modified using small-scale laboratory specimen

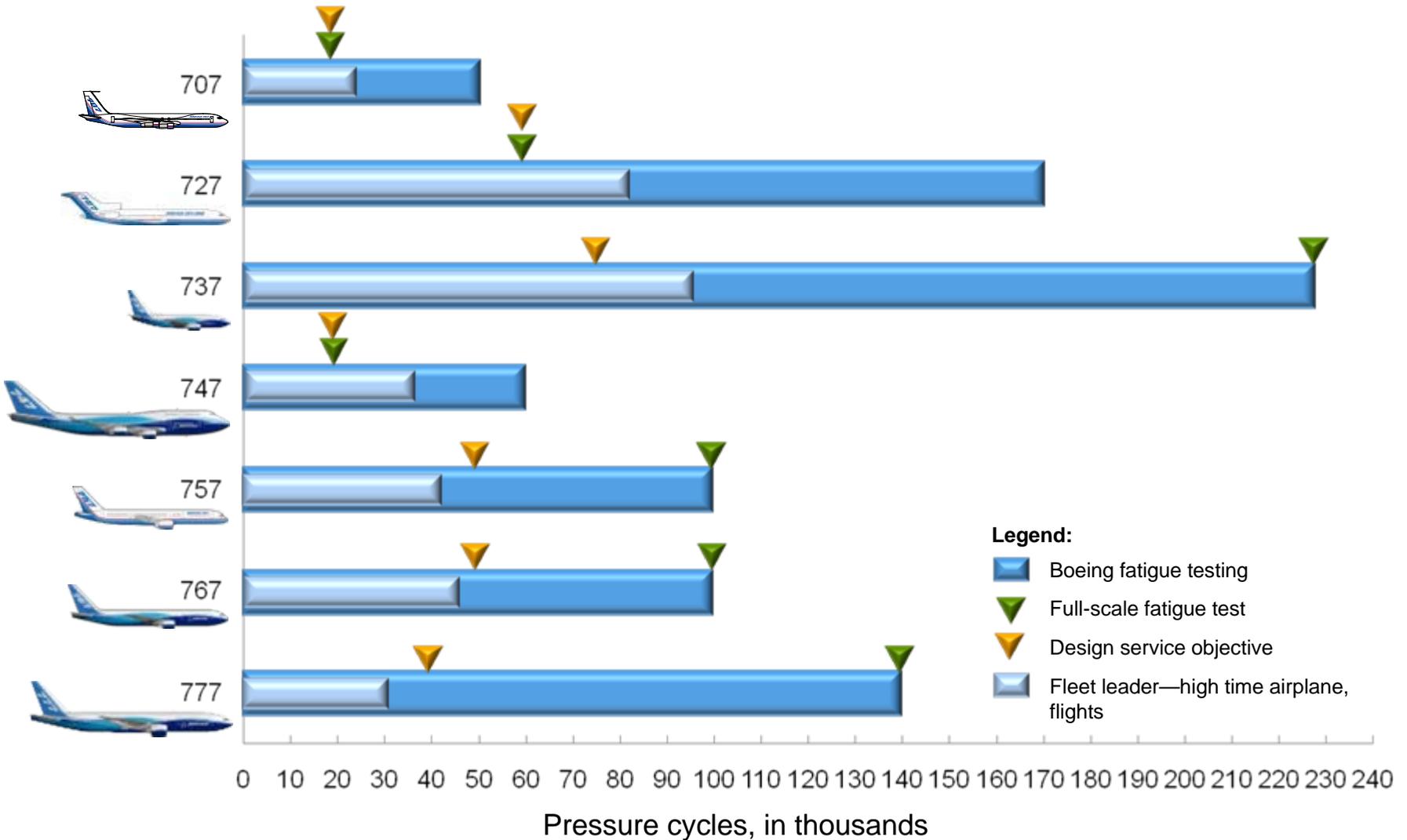
- Small-scale laboratory specimen



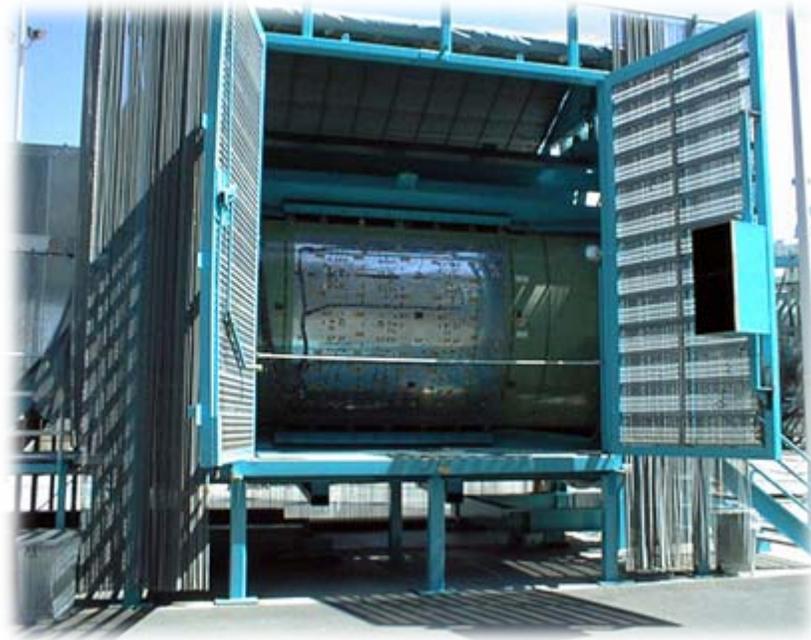
Understanding Fuselage Structure



Extensive Testing on All Boeing Models



Example: Major Section Tests



Fuselage Barrel Tests

Example: Next-Generation 737 Testing

- June 2000
- 737-800 Fuselage
- 225,000 simulated flights,
3 x 75,000 cycle DSO



Validated Next-Generation 737 Fuselage Design

Summary

- **Our designs meet regulatory requirements and Boeing's time-proven design standards, which can be even more stringent**
- **Analysis supported by test evidence**
- **Building-block approach to validation**

Coupon → Component → Full Scale → Fleet