Research Considerations in Design For Security Requirements

Jeff Gardlin

October 31, 2007

5th Triennial International Fire & Cabin Safety Research Conference

Background

- **Considerations of Security In Aircraft Design Date back to Lockerbie Bombing**
- **ICAO Amendment 97 to Annex 8 Requires Consideration of Eight Issues**
- **Subsequent ARAC Activity to Adopt ICAO Requirements as Harmonized Requirements**
- **Aviation and Transportation Security Act**

What are The Eight Issues?

- Systems survivability for significant damage events.
- Cargo compartment fire suppression to address sudden and extensive fires.
- Cabin smoke extraction for large quantities of smoke and fumes that could result from explosions.
- Protection of the flight crew compartment from smoke and fumes.
- Identification of a least risk location to place a suspect device.
- Design of a least risk location to place a suspect device.
- Design of flight crew compartment door and bulkhead to resist penetration by small arms fire and shrapnel.
- Interior design to facilitate searches and inhibit the hiding of dangerous objects.

Current Regulatory Situation

- **All Passenger-Carrying part 121 Transport Category Airplanes were modified with reinforced flightdeck doors as of April 9, 2003**
- **All Foreign airlines operating into the US must also have a reinforce flightdeck door**

Rulemaking Underway

- **Proposed Changes to 14CFR25 (NPRM 06-19)**
  - Amend existing flightdeck door rule
  - Add new requirements to address remainder of ICAO recommendations
- **Proposed Applicability**
  - Commercial Operation
  - 60 or More Passengers
  - 100,000lbs or More MTGW

Challenge to Implementation

- **ICAO Standards are necessarily general**
  - "maximize"
  - "consider"
  - "take into account"
- **Regulatory language must state a requirement that:**
  - Is clear in its intent
  - Is achievable
  - Is enforceable

Existing Relevant Regulations

- **Section 25.831**
- **Section 25.841**
- **Section 25.851**
- **Section 25.853**
- **Section 25.855**
- **Section 25.857**
- **Section 25.858**

-That is, quite a few

Need to maintain compatibility and avoid redundancy

Fire Safety Related ICAO Requirements

- **Flightdeck smoke protection**
- **Passenger cabin smoke protection**
- **Cargo fire protection systems**
- **System survivability**

Different Issues for each of the areas

- **Occupant safety**
- **Airplane survivability**
- **Airplane controllability**

Flight Deck Smoke Penetration

- **Rule would require Flight Deck to prevent smoke penetration from "anywhere"**
- **Current rules address:**
  - Smoke from a cargo fire
  - Smoke *evacuation* from the flightdeck

Research Needed

- **Effects of Geometry and air conditioning system variations**
- **Effect of positive pressure differential**
- **Is there a simple but effective compliance method?**

Research Conducted

- **Ground Tests with different airflow configurations**
- **Different airplanes**
- **Pressure measurements**

Findings

- **Pressure differential is sufficient to prevent smoke penetration**
- **Differential is too small to measure effectively**
- **Visual assessment using a membrane between areas is possible***

***DOT/FAA/AR-TN03/36**

Empirical Method

Cabin Smoke Evacuation

- **No Current Rules address cabin smoke evacuation**
- **Proposed approach would permit compliance using a rate of air change, w/no further demonstration**
- **Approach based on:**
  - Smoke quantity from cargo fire
  - Hazard based on Fractional Effective Dose (FED)
  - Air change rate needed to keep FED below 1

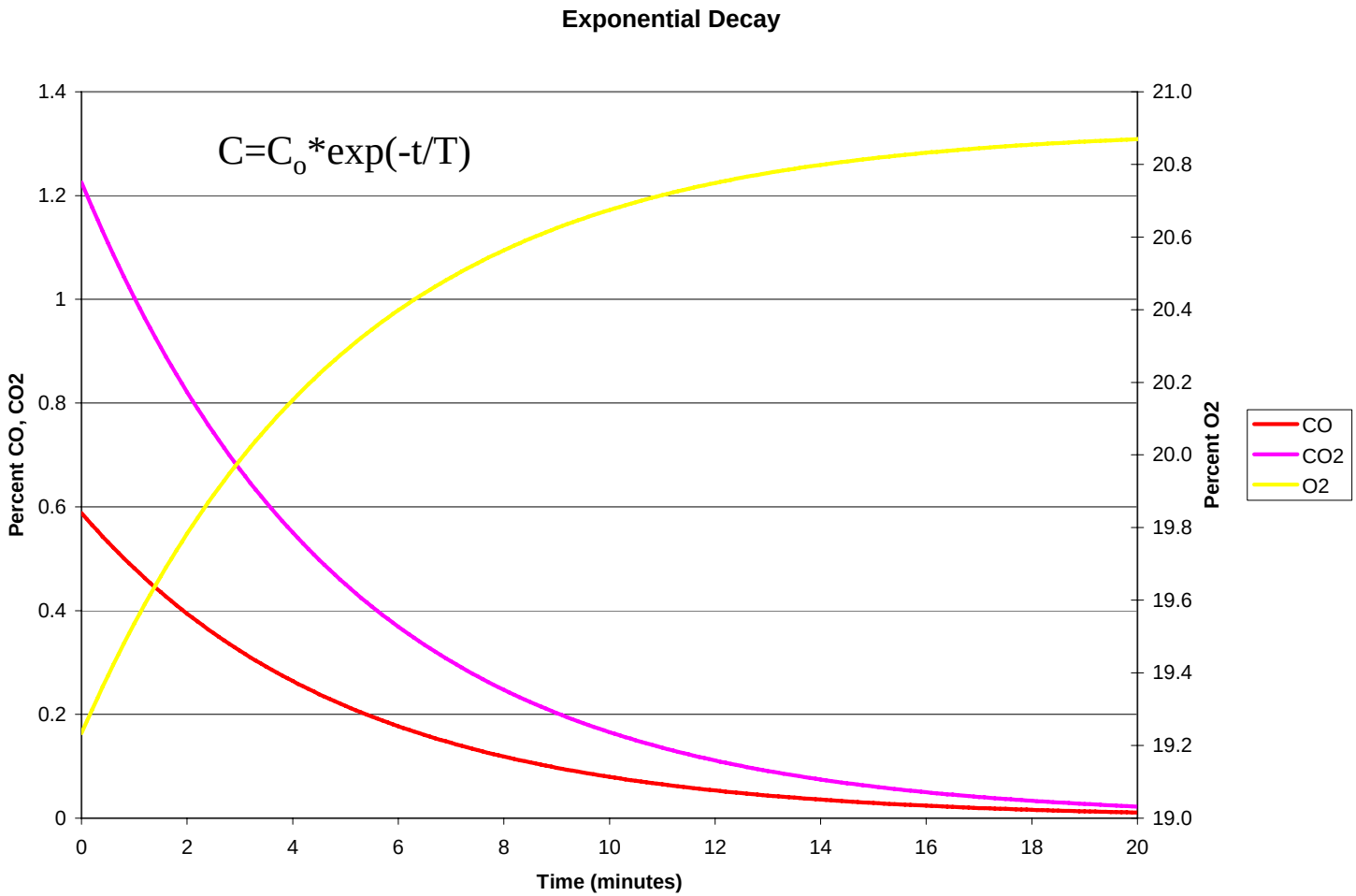
Research

- **Literature on:**
  - type of fire
  - hazards from the fire
  - means to mitigate hazards
- **No new experiments needed**

Findings

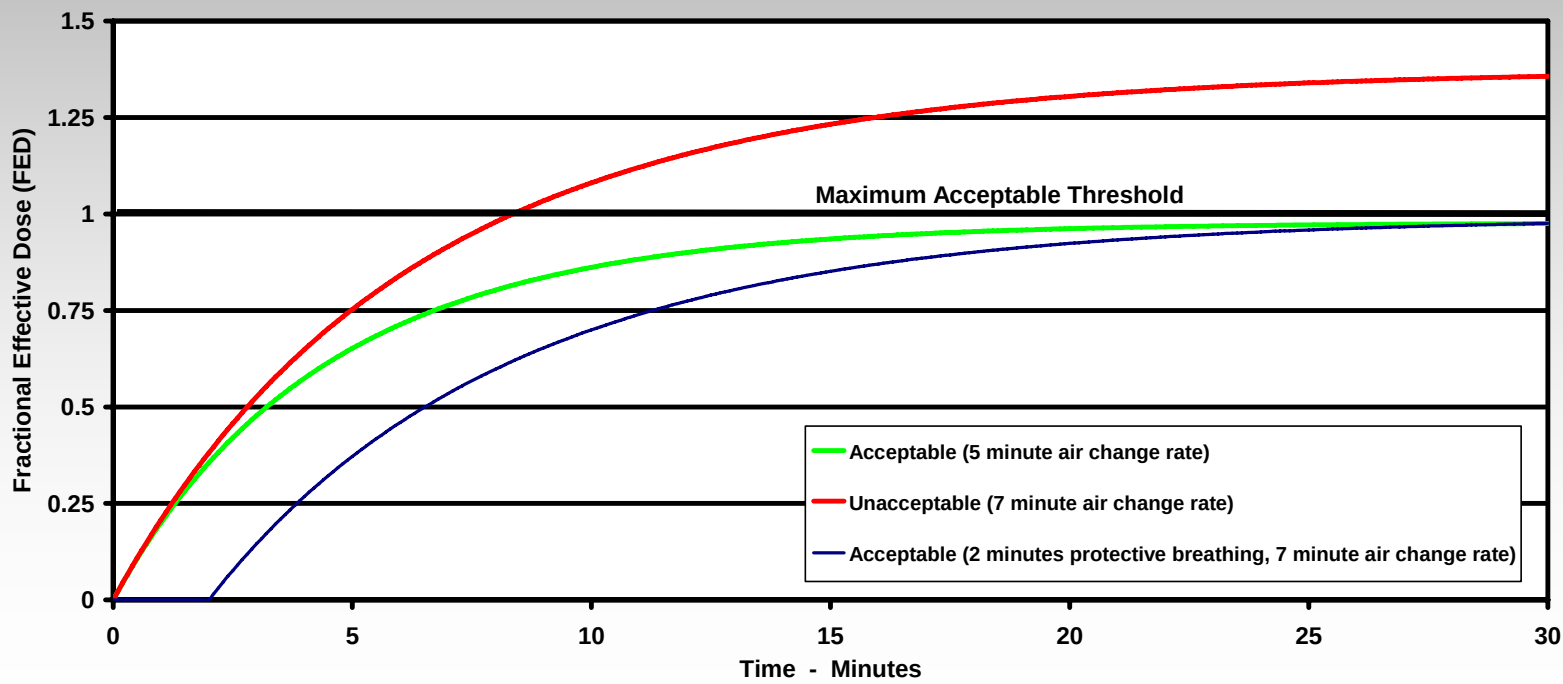
- **Type of fire is surface burning**
- **Hazards from fire are smoke/toxic gases**
- **Using a simplified Fractional Effective Dose Model, dilution of the toxic gases will maintain an acceptable environment**

Cabin Smoke Evacuation



Cabin Smoke Evacuation

$$FED = \Sigma_1^n FED_i$$



Conclusion

- **Adequate fresh (outside) air change rate would be a suitable method of compliance**

Cargo Fire Protection

- **Two Facets:**
  - Agent

    As good as Halon
  - System Survivability

    Either shock or fragment damage, or tolerance to large displacements
- **Tests or Analysis to Substantiate**

Cargo Fire Protection: Agent

- **Current Minimum Performance Standards Address Multiple Threats**
- **Fire from an incendiary is a surface fire (previous FAA research)**
- **Existing agents cope with this**
- **Minimum performance standards for Halon replacement agents address sufficient criteria**

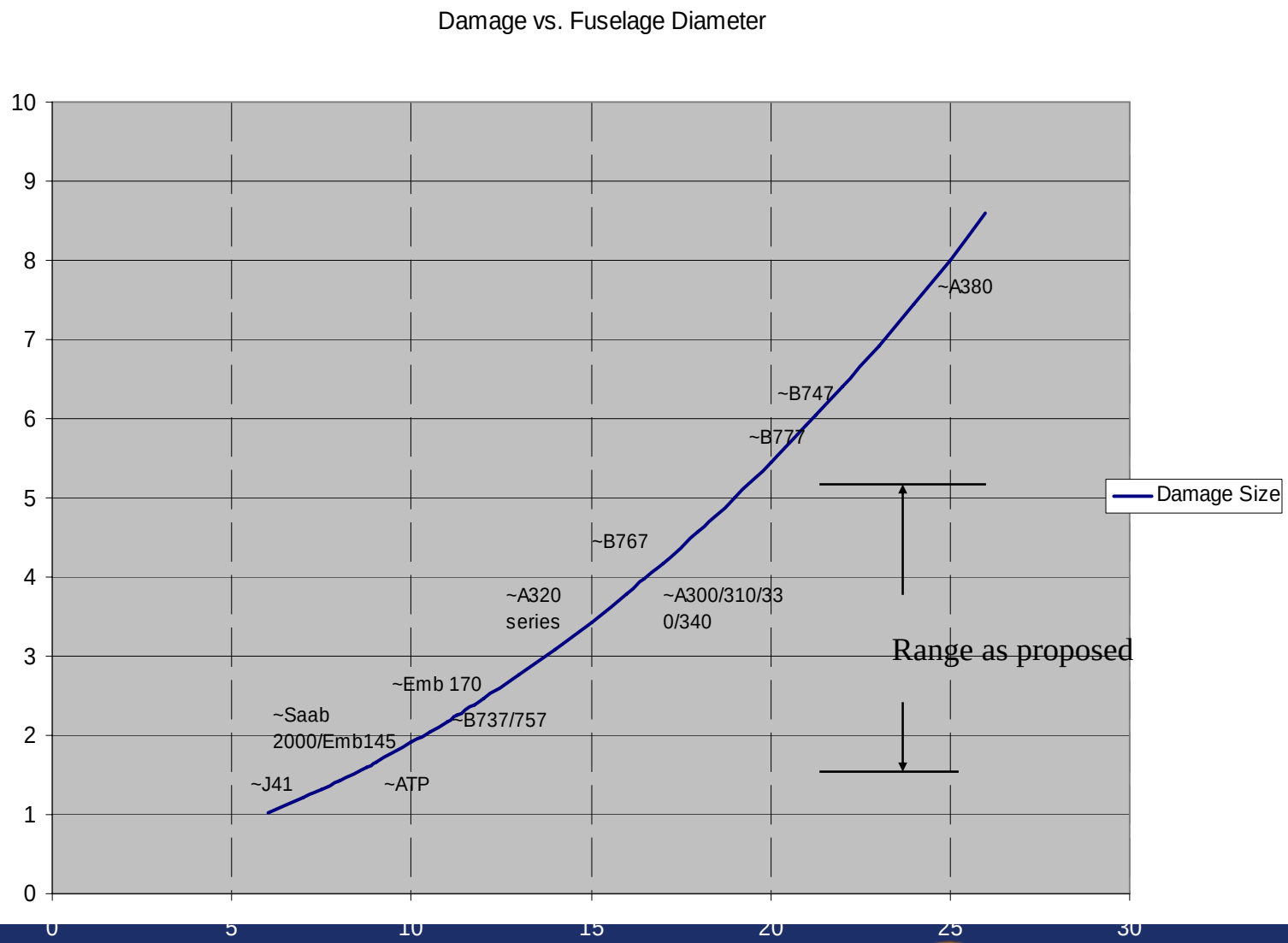
Cargo Fire Protection: System

- **Most relevant research is sensitive**
  - Specific threats
  - Specific vulnerabilities
  - Derivations of same
- **Generally:**
  - Shock Itself Does not Appear to be a Threat
  - Fragments (or other debris) could damage or disable system
  - Relative displacement of supporting structure a concern
- **Redundancy of vulnerable components may be acceptable to show compliance**
- **Shielding also option**

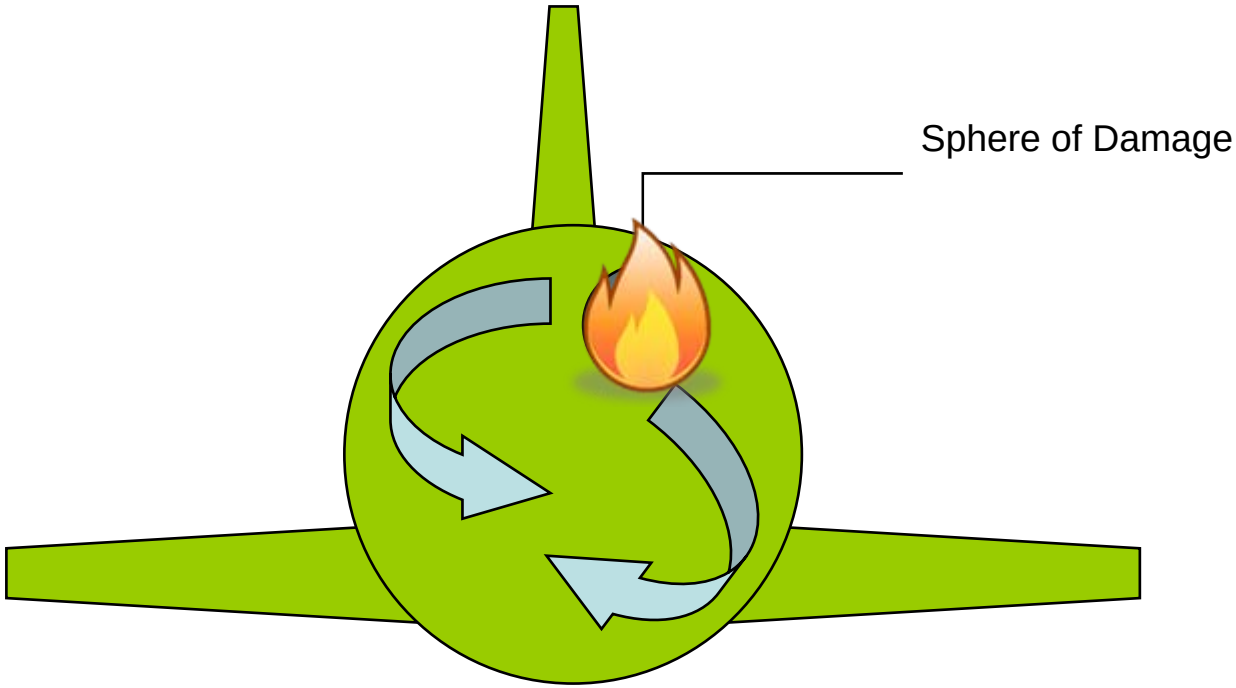
Separation of Flight Critical Systems and Controls

- **Driven by, but not limited to, Security Threat**
  - Fire is another potential threat
- **No current rule requires this in general**
  - §§25.729(f) and 25.903(d) address tire and rotor burst
- **Current Approach is “damage based” (Rather than “threat based”)**
- **Requirement would create a spherical volume, based on airplane diameter**
- **Similar to hole size in § 25.365**
- **Original proposals for §25.365 included consideration of explosive device**

Damage-Based Concept



Separation of vital Systems and Controls



Conclusion

- **Many of the proposed design for security requirements have implications, and benefits, for fire safety**
- **Compliance methods can be fairly straightforward with limited test and analysis required**

Questions?