OAK RIDGE National Laboratory

Overview of Potential Improvements to DOE-STD-3014

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Overview

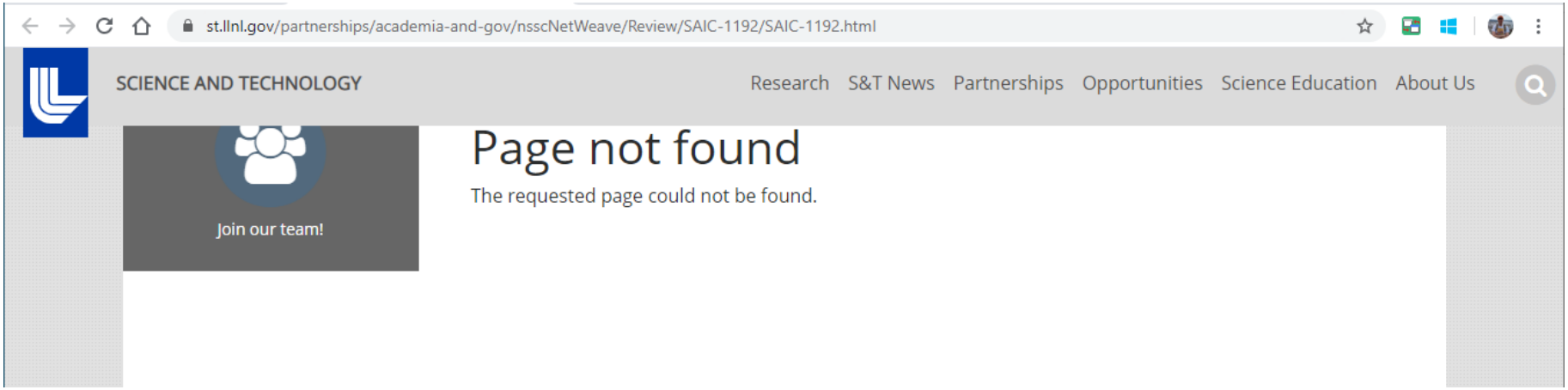
- Structure of DOE-STD-3014
- Consequence Screening
- Frequency Screening
- Structural Screening
- Summary and Conclusions

Consequence Screening

- Methodology is provided in Section 7 (10 pages)
- Provides highly simplified approach
  - ARF*RF values
  - Atmospheric dispersion
- Section 1.3 identifies applicability as HC-1 or HC-2
  - What would motivate these facilities use this highly simplified approach?
- What purpose is this section serving for users of the Standard?
- Should the section be removed or updated?
  - If updated, how will it be maintained consistent with other documents (STD-3009, HDBK-3010, STD-5506, etc.)

Consequence Screening

- Key references of this section are not readily available
  - Two SAIC publications (95-1192 and 96-1193)
    - Screening nomographs for radiological and chemical hazards
    - Background information for development of source terms and atmospheric dispersion model for reference above.
  - Hyperlinks provided in reference section of standard are broken, leading to defunct page.



Frequency Screening

- Anecdotally, the most often used portion of the Standard.
- Based on a large volume of statistical information
  - Availability
  - Time sensitivity
  - Developments in analytical approach

The Four-Factor Formula

$$F = \sum N \cdot P \cdot f(x,y) \cdot A$$

- Where;
  - F = Est. annual aircraft impact frequency; [Crashes/Yr]
  - N = Est. annual no. of aircraft operation; [Ops/Yr]
  - P = Aircraft Crash Rate; [Crashes/Ops]
  - f(x,y) = Aircraft crash location conditional probability; [1/mi^2]
  - A = Facility specific Effective Impact Area; [mi^2]

Which of these are affected by updated statistics?

All of them.

Frequency – N (operations/yr)

- ORNL efforts have focused on General Aviation
  - Nationwide – number of landings **decreased by ~32%** referenced against the Standard
    - Standard Ref. 5.2 Table 3.20 (1986-1993) – 35,335,209 landings/yr
    - FAA Activity Summaries (2006-2014) – 24,034,910 landings/yr
- No investigation into Commercial or Military ops
- FAA ATC database could allow localized, high resolution assessment of **all categories**
  - May be able to provide type-specific operations data
  - FAA relationship allows more up-to-date data
    - Activity surveys typically ~1 CY behind (CY2018 pub. Jan 2020)

Frequency – P (crashes/operation)

- NTSB data indicates potentially significant change.
  - Statistics below are accidents/100,000 flight hours
  - **Need detailed analysis of data to establish actual effects on F**
- Reduced op. no. likely driven by amateurs.
  - Could be driving reduced crash rates
- Commercial number not clear since most accidents do not involve an aircraft crash.
  - Last non-airport (Not takeoff or landing) crash in US was in 2000.

Category	Standard	NTSB 2017	Change
General Aviation	8.21	5.67	-31%
Air Taxi (Part 135)	1.36	1.53	+12%
Commercial (Part 121)	0.303	0.172	-57%

Frequency – f(x,y)

- Localization factor accounts for site location
- Previously evaluated using crash data (NP)
- **Statistics expertise is needed to evaluate how this term should be handled.**
  - How does localization of N affect f(x,y)?
  - Is a localization factor for P needed/permissible?

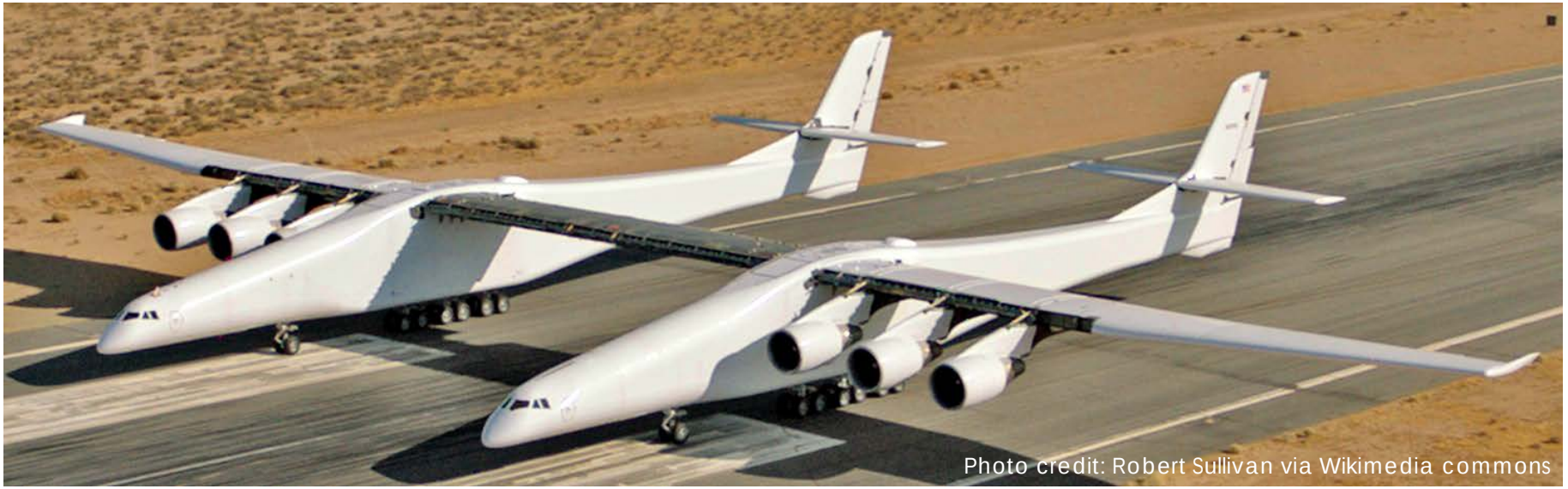
Frequency – Effective Area

- Combination of facility (building) and aircraft
- Aircraft terms based on statistics
  - Wingspan
    - Bill has done a lot with the FAA registry
  - Impact angle
    - Ostensibly based on NTSB accident reports (**GA data**)
    - Major contributor to effective area for all categories
  - Skid distance
    - Derived from impact angle and velocity and aircraft weight
    - Primarily of concern for commercial and military, small GA

Structural Screening

- If total impact frequency is >10^{-6}/yr
  - Evaluate categories or subcategories of aircraft
  - If no potential affect on MAR, remove from frequency est.
- Select missiles and targets
  - Identify what type of aircraft at what speed and angle
  - Identify structure faces, material of construction, SSCs that could be impacted
- Two structural response evaluations
  - Local response – can the aircraft penetrate or seriously damage the structure
  - Global response – could the aircraft impact cause excessive deformation or collapse of the structure

Critical Missiles – Subcategorization



Dual fuselage, 385 foot wingspan, 6 turbofan engines, MTOW = 650 tons

- **Discussion of methodology and results to subcategorize would add significant value to the STD**

Critical Missiles – Selection Options

- Critical Missile selection uses kinetic energy to grade missiles – higher kinetic energy = higher hazard
- The STD offers two ways to select critical missiles
  - Both require OUO reference document (UCRL-ID-123577)
- Bounding Missile – Identify a worst case missile
  - Highest kinetic energy ($1/2\ m*v^2$)
- Site-wide basis aircraft hazard analysis
  - Need aircraft activity distribution by type (make and model)
  - Approachable for airport operations, daunting for overflight
- **A methodology that provides a moderate effort option could add value to the STD.**

Critical Missiles – Aircraft Characteristics

- Sparse data in Data Development Document
- No guidance on selecting an aircraft weight
- No data provided on engine weights or dimensions
  - Data tables list type of powerplant and nominal horsepower
  - Harder to obtain than aircraft dimensions
- Data provided lends minimal aid
- **Improved data tables or summary values could make the *screening* process more useful, save the detail for evaluation**

Structural Screening & Evaluation

- Little difference between the activities of each
- Analysis is from first principles and fairly detailed
  - Evaluates specific impact locations
  - Considers MAR and safety SSCs in each area
- Gives no option to **account for existing analyses (NPH)**
  - Missiles due to high wind (similar to local response)
  - Structural collapse during seismic event (similar to global response)
- Local impact methodology only looks at reinforced concrete and steel.
  - **Discussion of other materials of construction**
- **A true screening process would improve the STD**

Summary

- Consequence – Revisit the intended goals and uses of this section and integrate with established processes
- Frequency – Update data and update techniques
  - Significant changes in aviation activity in last 20 years
  - Drastic improvement in the availability of data
  - Aircraft data lacks depth considering its importance
- Structural – Grading in methodology, build database
  - Provide options between high conservatism and high detail
    - Integrate structural analysis from other events
  - Use modern data sources to simplify critical missile selection

Conclusions

- Significant opportunities for improvement exist in every major section of DOE-STD-3014
- Acting on these opportunities effectively requires a cross-functional team, likely from several labs
- ORNL has been investing in a few of these efforts, but the task is too large to tackle alone.
- An effective revision of DOE-STD-3014 should involve a team similar to the authorship team
  - ~30 members from 8 organizations