

# **“The Future of Air Transportation – A Progressive Look Towards the Next 25 Years” ISABE 2015**

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# Introduction

- **Even with a bridge across the Pacific and Atlantic oceans in the next 25-years, Air Transportation will be primary method of travel.**
- **Earlier panel members have described advances in technology that must be made to make these aircraft superior, safe, affordable, reliable, etc.**



# Outline

- **What does the future bring?**
- **Manage the air traffic for the future**
  - Nextgen modernization of U.S. air traffic system
  - More efficient use of fuel, air space, and airport capacity resources
    - Financial stability is important as is reduction of pollution
- **New airplane configurations**
- **Couple of our current concerns will still be with us for years to come**
  - Volcanic eruptions impacting flight operations
  - UAV's in proximity of airports

Take remainder of time to briefly discuss these areas



# What Does the Future Bring?

- **Global traffic predicted to double by 2050**
  - From 1970 to 2015: 300M to 2500M
- **But can the airlines remain profitable?**
  - Many consolidations of airlines in last few years – can it continue?
    - Or, will another kind of airline model emerge?
- **How is the energy demand met and the environment compatibility answered?**



# FAA Sponsored Nextgen

- **Nextgen modernization of U.S. air traffic system**
  - Much of infrastructure will be completed in 2015, but work on plan will continue well into the future
  - Improve safety and accessibility to airports
  - Will deal with congested air space & weather
  - Attempt to deal with increased traffic growth in an environmentally responsible manner
  - Improve parallel runway operations , minimize spacing (needed new technologies) while maintaining safe operation from wake vortices
  - Go to <http://www.faa.gov/nextgen/update/>



# New Airplane Configurations

- **Many of you have flown on a DC-3 and on a B-777; The difference in the future could be even more**
- **A couple of the future possibilities include:**
  - High speed civil transport: LA to Tokyo in 4 hours with 300 passengers & tickets less expensive than today
  - Subsonic double-deck flying blended wing body with 800 passengers, e.g. N3-X, & again tickets less expensive
- **Worth looking @ the European Commission “Out of The Box” 2<sup>nd</sup> Workshop Report – it is not only configurations that are going to change**
  - New concepts and technologies for future aircraft
  - Radical changes rather than incremental steps
    - Drivers: demands of the market, new technology, & changes in the aviation system; unfortunately, airport sector not represented



# Current Concerns

- **At least two of our current concerns will still be with us for near future**
  - Volcanic eruptions impacting flight operations
  - UAV's in proximity of airports, landing & takeoff both are potential problem



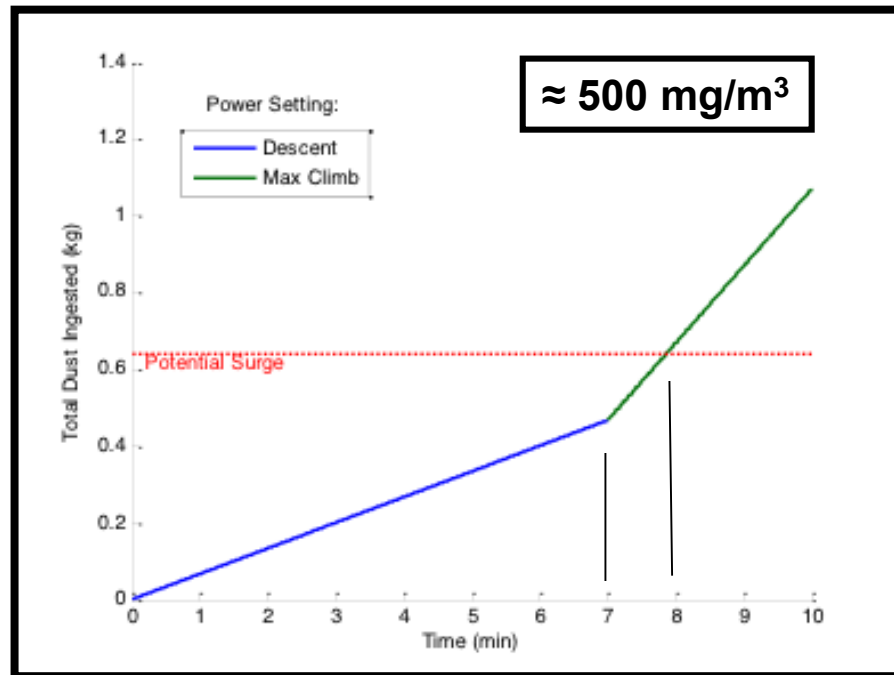
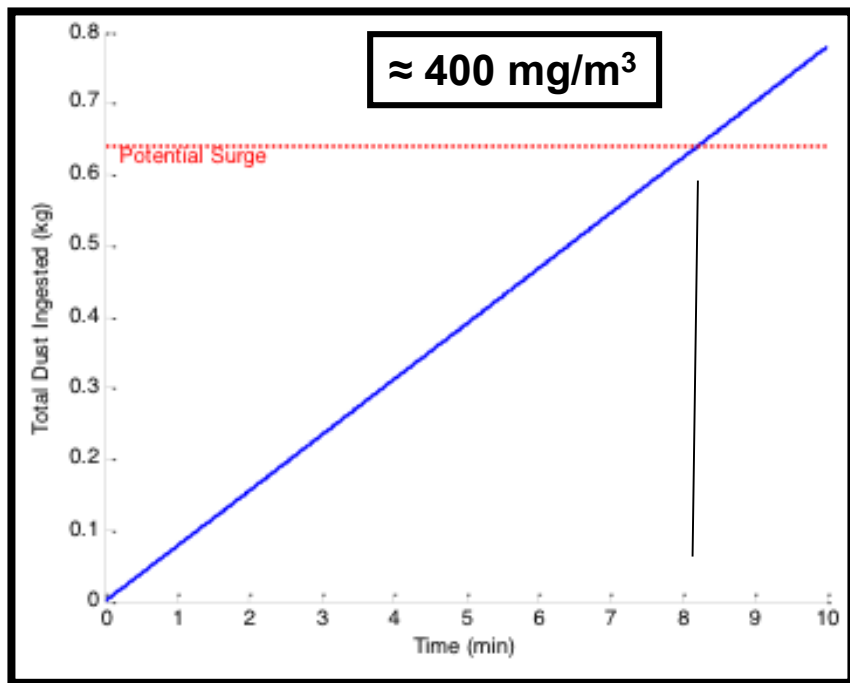
# Recent Volcanic Eruptions

Date	Country	Volcano	Plume Height, ft.
4/22/2015	Chile	Calbuco	50,000
5/10/2015	Costa Rica	Turrialba	12,000
7/23/2015	Indonesia	Sinabung	23,000
7/23/2015	Indonesia	Ruang	17,000
8/20/2015	Mexico	Colima	10,000
8/22/2015	Ecuador	Cotopaxi	12,000
9/10/2015	Buenos Aires	Ubinas	20,000





# Current Prediction Capability



RR RB-211 Indonesia, 1982 cruise  
4 engines lost, landed on 3

GE CF-6 Alaska, 1989 on approach  
4 engines lost, landed on 4

Past 2 years spent reviewing in detail Calspan data for  
P/W F-100 & GE F-101 engines (see ASME GT2016-56052)





# Future Plans for Flight

- **Difficult to predict dust cloud concentration, length, depth, width, and migration**
- **Problems that won't go away easily for dust concentration values greater than 0-mg/M<sup>3</sup>**
  - Particles in ECS  $\approx$  6 microns (have measured them)
    - Anything  $<10$  microns &  $> 1$  micron remains in the human lung
      - What are the long term impacts?? Sounds like lawyer heaven!
  - Influence of dust in cooling air on engine electronics
  - Influence on engine controller (see previous slide)
- **At a minimum, until these problems are resolved, difficult to say that it is “safe to fly”**



# UAV's in Proximity of Airports

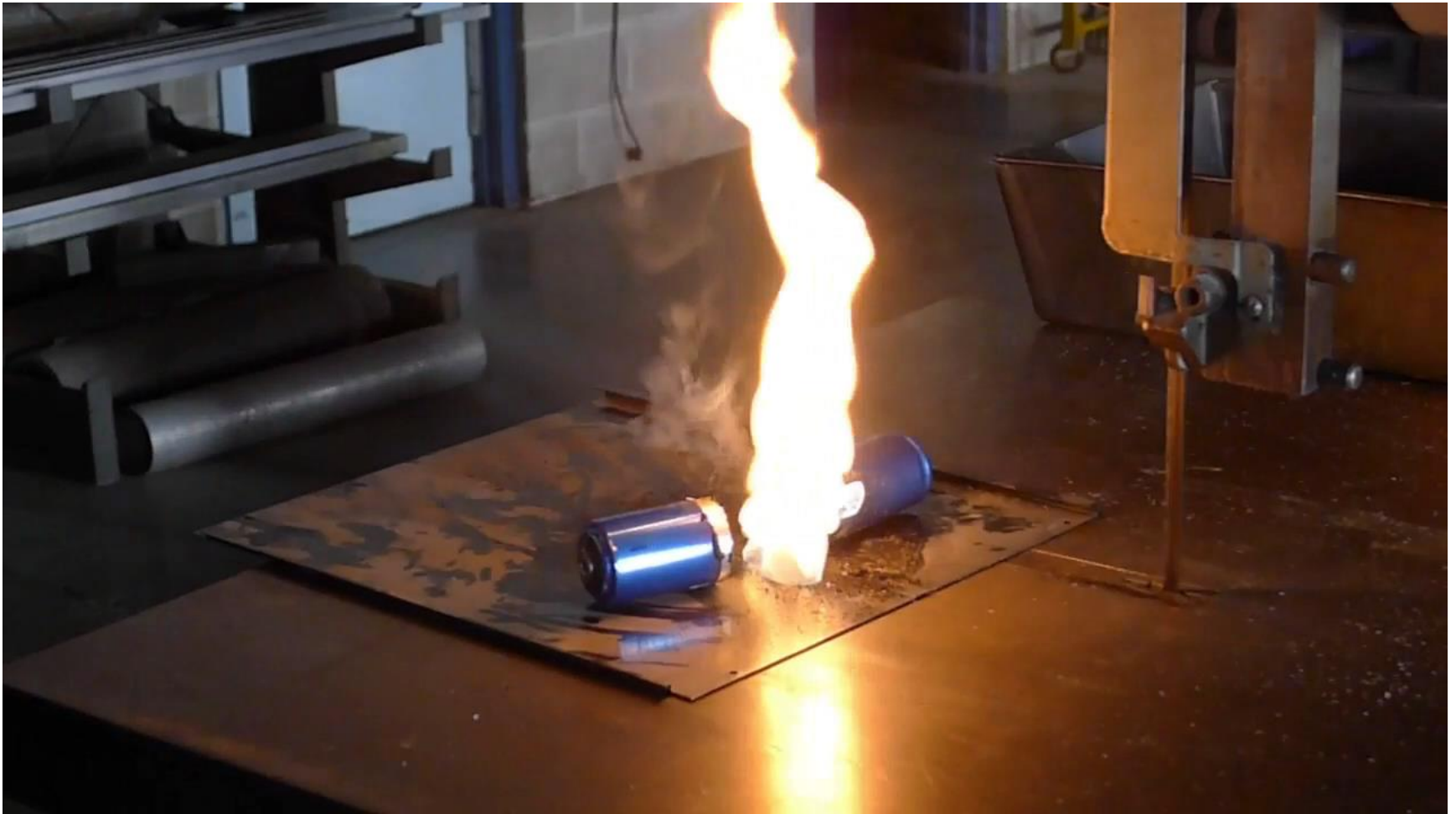
- **FAA requires engines to pass bird strike requirement, but there is presently no requirement for a UAV strike**
- **The frequency of “Rogue Drone” encounters is increasing rapidly (FAA reports  $\approx 25/$  month)**
  - On Sunday 8/16/2015; 12 encounters across U.S.
  - 9/15/2015; FAA “So far this year, there have been almost 700 incidents where pilots reported seeing drones near airports, almost triple the number in 2014”
  - Estimate is that  $\approx 1$ M drones will be purchased for Xmas 2015 – that is a lot of drones



# So What to Do?

- **Current interest is in constructing models of potential impact of small UAV's with aircraft**
- **To my knowledge, no one is currently interested in an experimental program**
  - Recall that many UAV are powered by lithium-ion batteries
  - When a lithium-ion battery ruptures, bad things may happen quickly (see next video)
  - This event would be difficult for analysis to predict, but also for crew to deal with during the landing or even more so during takeoff phase
    - Titanium airfoils in compressor early stages could be a potential problem – no one is happy with a Ti fire





# Summary Comments

- **Commercial and military aircraft will be with us as far into the future as I can envision and will be with you**
  - The next 25-years will be particularly exciting and see many changes for all of you
- **We still have many hurdles to get over, but all are possible to deal with if we face reality**

