Safety in the Air

3rd NSF Large Facilities Workshop

2010 Operations

James R. Huning

NSF Senior Aviation Management Official (SAMO)

Aviation Safety Officer

National Science Foundation

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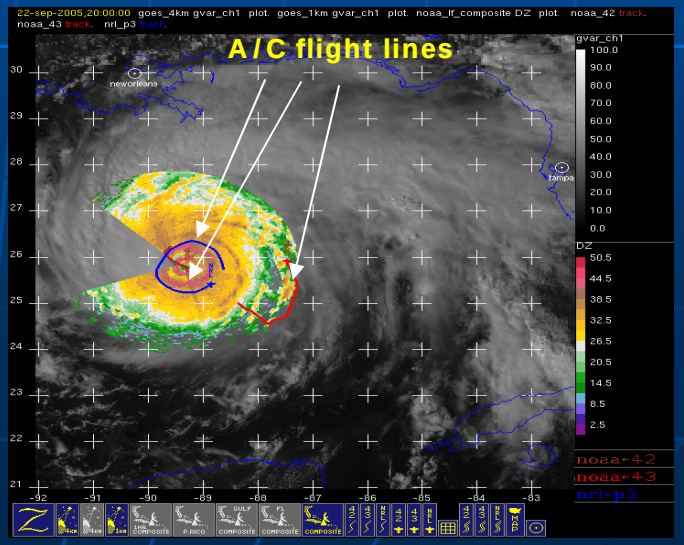


Safety: A critical element during the life-cycle of any facility

- Design: anticipate safety issues and plan for mitigation
- Construction: environmental, facility safety issues
- Operations: covers a suite of issues often specific to the facility type and for air safety the most important element
- Decommissioning: time limited parts, aircraft disposal

Design

Construction

Operations

Decommissioning

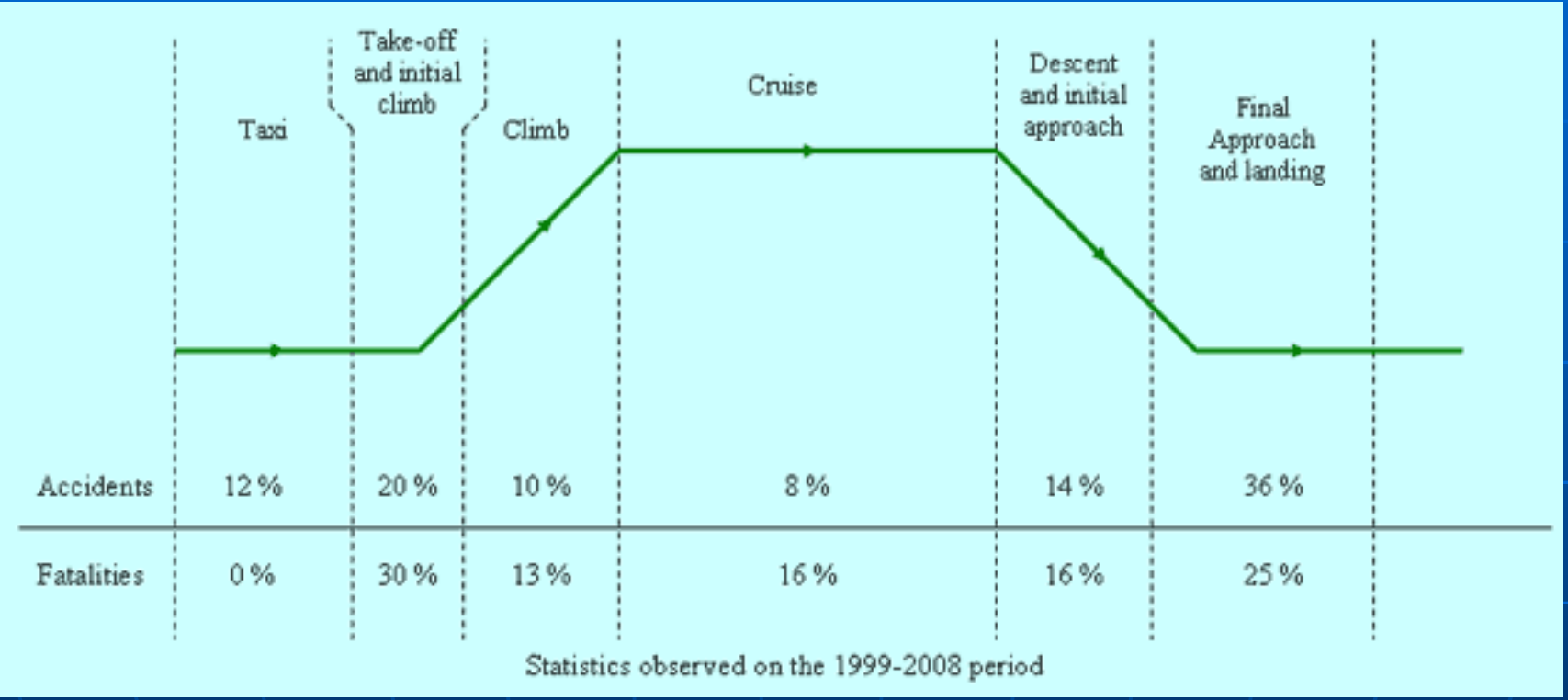
Variety of Factors Affect Air Safety
The “al” List

- Medic*al*
  - Class 1,2 or 3 physical
- Technic*al*
  - Introduction of new technologies (GPS, Wx Radar, NextGen)
  - Failures (electrical, mechanical, structural)
- Meteorologic*al*
  - Weather Conditions
    - CAT
    - Lightning
    - Microbursts
    - Up and downdrafts
    - Space weather
    - Icing
- Physiologic*al*
  - Alcohol
  - Hypoxia – Payne Stewart
    - 25K – 20 minutes
    - 39K – 6-12 seconds
    - Condensation - vision
- Geologic*al*
  - Volcanic eruptions
  - BA, KLM, NASA
  - “Ladies and gentlemen this is your captain speaking. We have a small problem. All four engines have stopped. We are doing our damnedest to get them under control. I trust you are not in too much distress?"
- Leg*al*
  - FAA Part 121, 135 or 91
  - Environmental impacts/issues
    - Noise
    - Fuel dumping
    - Construction
  - Instrument operations: lasers (eye safety)
    - Zenith
    - Nadir
  - Public vs Civil
    - Government function
    - State aircraft
- Psychologic*al*
  - Stress
- Operation*al*
  - Flight Readiness Reviews
    - Maintenance
    - Long duration/night
  - National Air Space
  - International Air Space Access
    - Safety Management System (SMS)
    - State Aircraft Designation
      - Chicago Convention 1944
      - ICAO 1947

Non-Flight Safety Issues

- Security of the physical facility
  - Perimeter fencing (mandated after 9/11)
  - Secure access to facility (hangar, instrument room, aircraft)
- Personnel
  - PIs and technical support team
  - Foreign nationals
  - Media
- Equipment (Air Worthiness Flight Safety Review)
  - Active vs. passive sensors
    - Radars
    - Lasers: since 19 November 2004 more than 2,800 incidents of lasers directed at aircraft in the US
    - "eye safe" (1500nm – 1800nm) means less susceptible to eye damage
      - distraction, glare. temporary flash blindness
    - LIDARS are commonly used in atmospheric and other environmental studies
    - FAA established laser free zones
    - NOTAMS published listing laser and bright light uses
    - *In situ* sensors
  - PI Instruments
    - Safe operation (cryogens, electrical)
      - Certified
      - Safety review if not certified

Accidents by Phase of Flight



Taxi: to runway or to gate
TO/IC: acceleration, lift, initial climb
Climb: retract slats/flaps, to cruise altitude
Cruise: ATC controlled altitude; longest portion of flight
D/IA: descend toward a/p; ATC may require loitering and other changes
FA/L: a/c put in landing configuration; alignment to runway , approaches threshold, land and slows

Some Statistics

“Pilot error (weather related)" represents accidents in which pilot error was the cause but brought about by weather related phenomena. "Pilot error (mechanical related)" represents accidents in which pilot error was the cause but brought about by some type of mechanical failure. "Other human error" includes air traffic controller errors, improper loading of aircraft, fuel contamination and improper maintenance procedures. Sabotage includes explosive devices, shoot downs and hijackings. "Total pilot error" is the total of all three types of pilot error (in yellow). Where there were multiple causes, the most prominent cause was used.

Causes of Fatal Accidents by Decade (percentage)

Cause	1950s	1960s	1970s	1980s	1990s	2000s	All
Pilot Error	40	32	24	25	27	26	29
Pilot Error (weather related)	11	18	14	17	21	17	16
Pilot Error (mechanical related)	7	5	4	2	4	3	5
Total Pilot Error	58	57	42	44	53	46	50
Other Human Error	0	8	9	6	8	8	6
Weather	16	10	13	15	9	9	12
Mechanical Failure	21	20	23	21	21	28	22
Sabotage	5	5	11	13	10	9	9
Other Cause	0	2	2	1	0	1	1

Notable Accidents

- Bird Strikes – 7 (Cactus 1549, 1/15/09)
- ATC Error – 13
- Cargo Hold/Cabin Fire – 19
- Design Flaw – 17 (uncommanded deflection of rudder)
- Sabotage/Explosive Device - 48 (UAL in 1933, almost all outside USA, only 5 since 1989 (Panama, Brazil, China and 2 in Russia)
- Fuel starvation – 43
- Hijacking (with fatalities) – 30
- Lightning – 17
- Pilot incapacitation – 12
- Sabotage, design flaws, are not unique to airborne safety
- Tu-154 10 April 2010
  - Pilot error; 97 fatalities
  - 1 attempt only; advised not to land in heavy fog; pressure??
- *The majority of airlines have never had a fatal accident (e.g, Easy Jet, Air Namibia, SW (an accident did result in a fatality on the ground))*

Safety in the Air: Examples of Research Aircraft

NSF

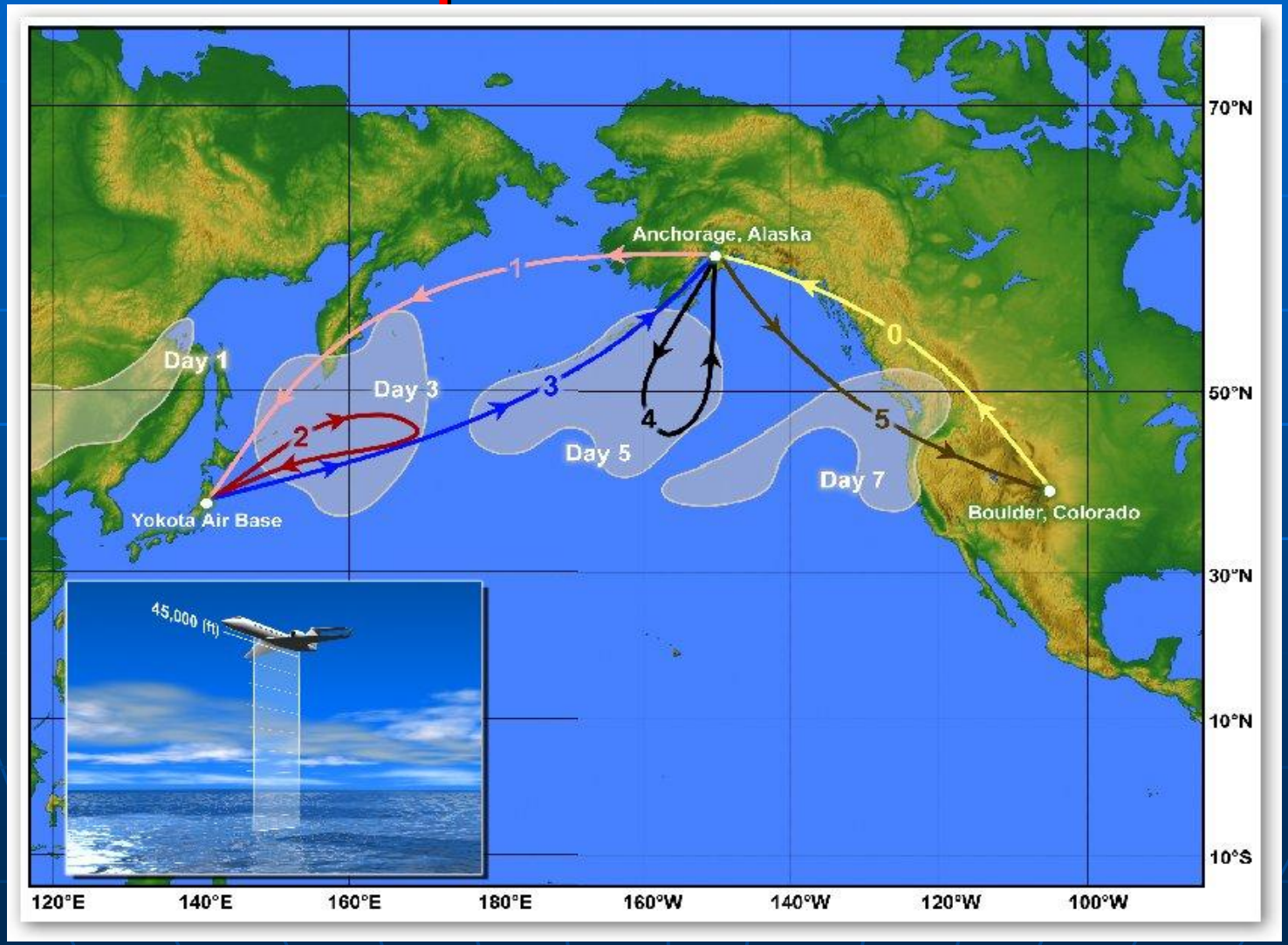
Federal Aircraft Accidents

- Federal aviation is safe and getting safer
- FMR 102-33 requires agencies to report accidents and incidents to NTSB and to GSA (headquarters for the Interagency Committee on Aviation Policy, ICAP)
- In 2009 there were 13 accidents and 0 incidents reported
- A total of 9 injuries and 6 fatalities
  - 5 fatalities USFS (3 Lockheed P2V-7 (non dropping)); 1 Bell 212 helitack firefighter
  - 1 fatality BLM/DOI Air Tractor AT-802A during fire retardant drop
  - 1 fatality FAA Robinson R-44 Helo during hover maneuver
- Total flight hours were 303,982
- 2009 Accident Rates per 100,000 hours: Agency owned/Agency operated: 3.75; Contractor Owner/Agency Operated 5.44; Airline rate in 2008 1.52
  - Atypical flight patterns

Atypical Flight Patterns Adds to Risk

- Racetracks – circular or oval patterns
- Spirals/Corkscrews: require major altitude changes (ATC issues)
- “Lawn mowing” – precision repeats (GPS)
- Point to point with altitude changes (porpoising)
- Multiple aircraft (some campaigns have 6 a/c operating in same general location) in zero or near zero visibility – communications and weather radars required

Flight Patterns - Pacific Dust Experiment 2007



NSF G-V: Instrument Integration and Departure
NOAA P-3B Hurricane Aircraft

Hurricane Dennis (7/05)

Low Altitude Flying (Air New Zealand Flight 901 28 Nov 79); Aftermath of a Bird Strike

NASA DC-8 flying over Pine Island Glacier, Antarctica, October 2009 in Project Ice Bridge. Glacier is fastest moving one in the world at 1 ft/hour.

250kts at 1500 feet AGL

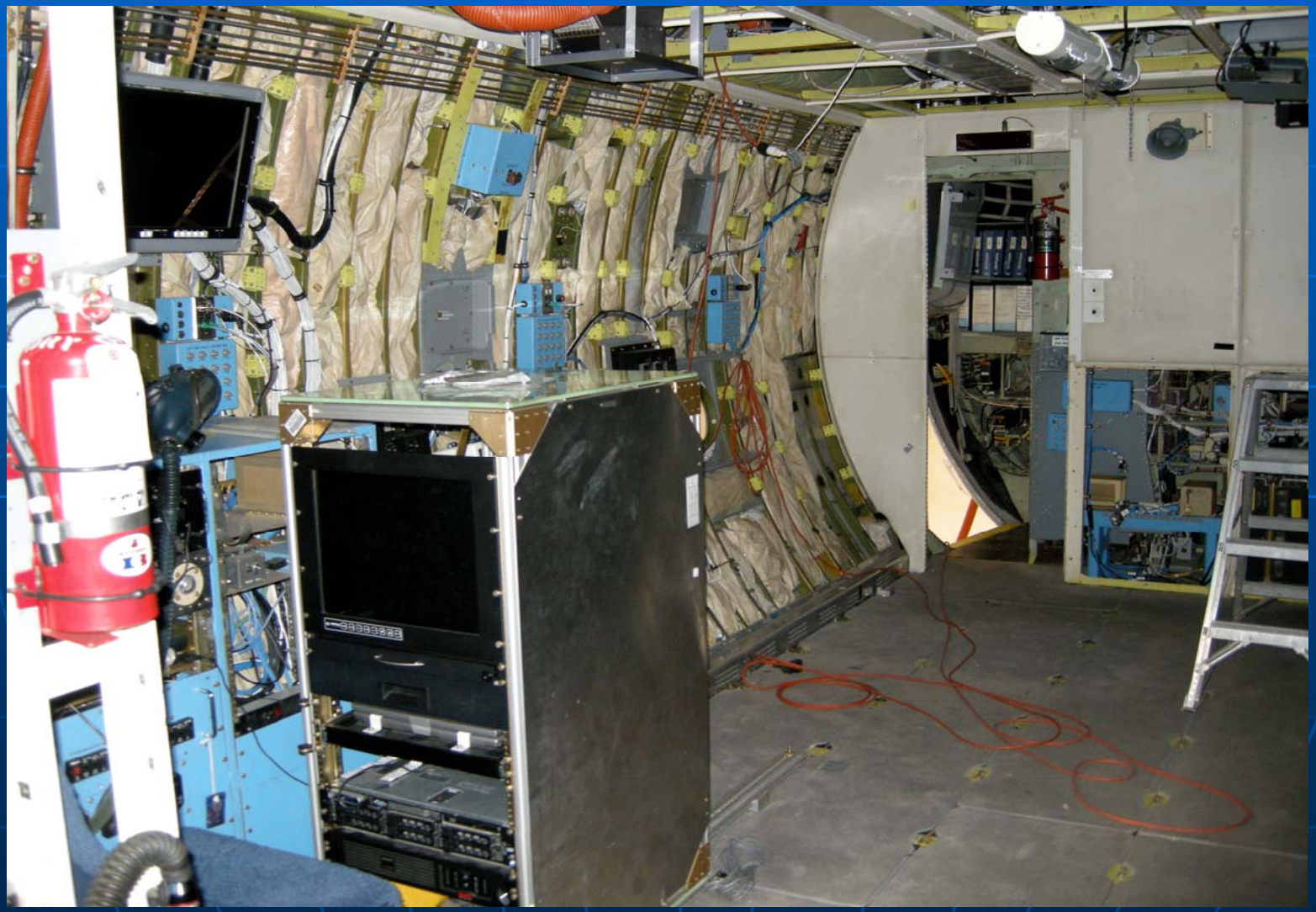
Bird Strike

PASE Campaign, Christmas Island

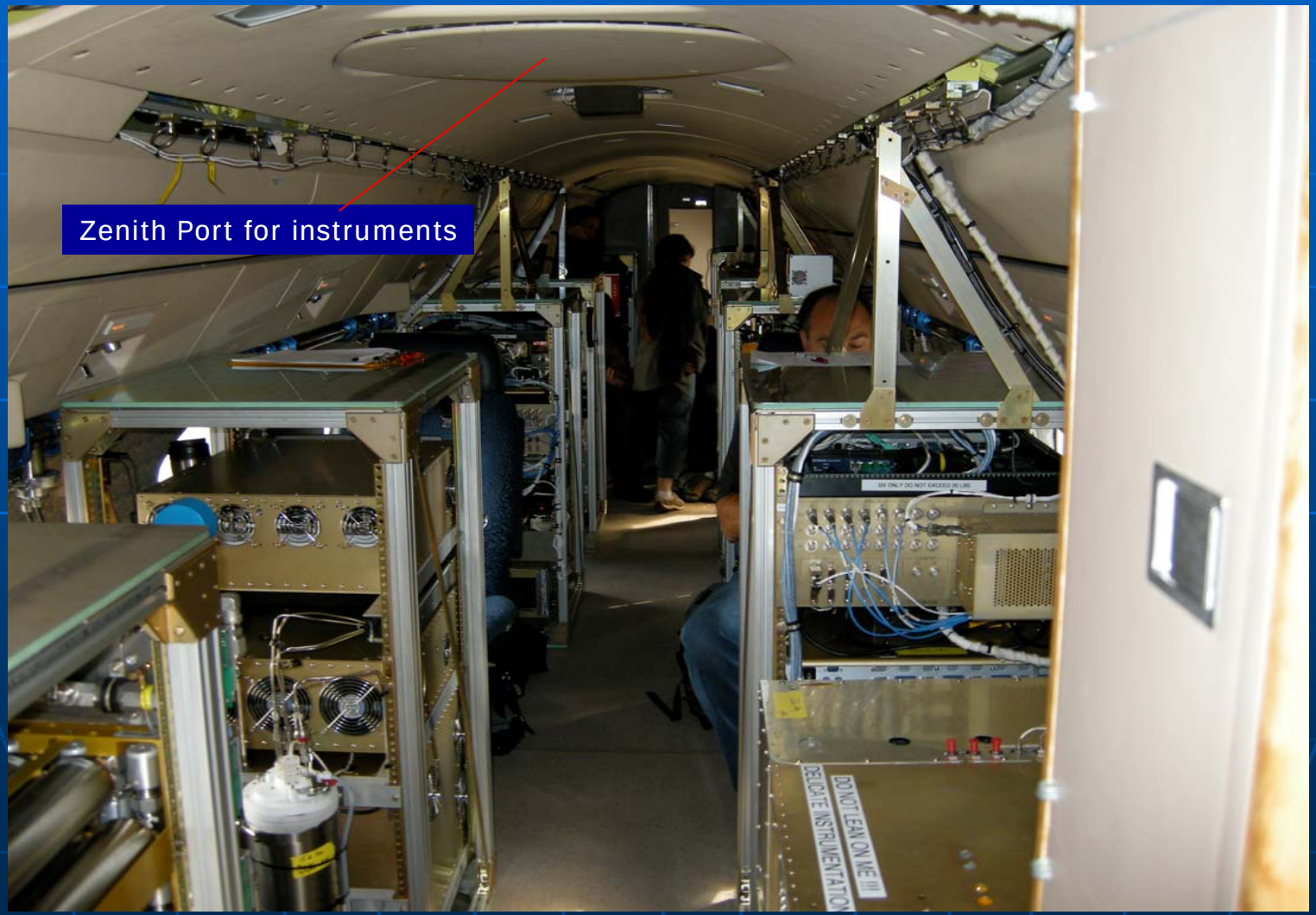
(Pacific Atmospheric Sulfur Experiment)

Low altitude, increased corrosion due to salt spray; issues with night time flying at low altitudes in unfamiliar territory; atypical flight patterns

NSF C-130Q Cabin During a Typical Upload
No Room for Error



Example of G-V Instrumentation and Certified Racks

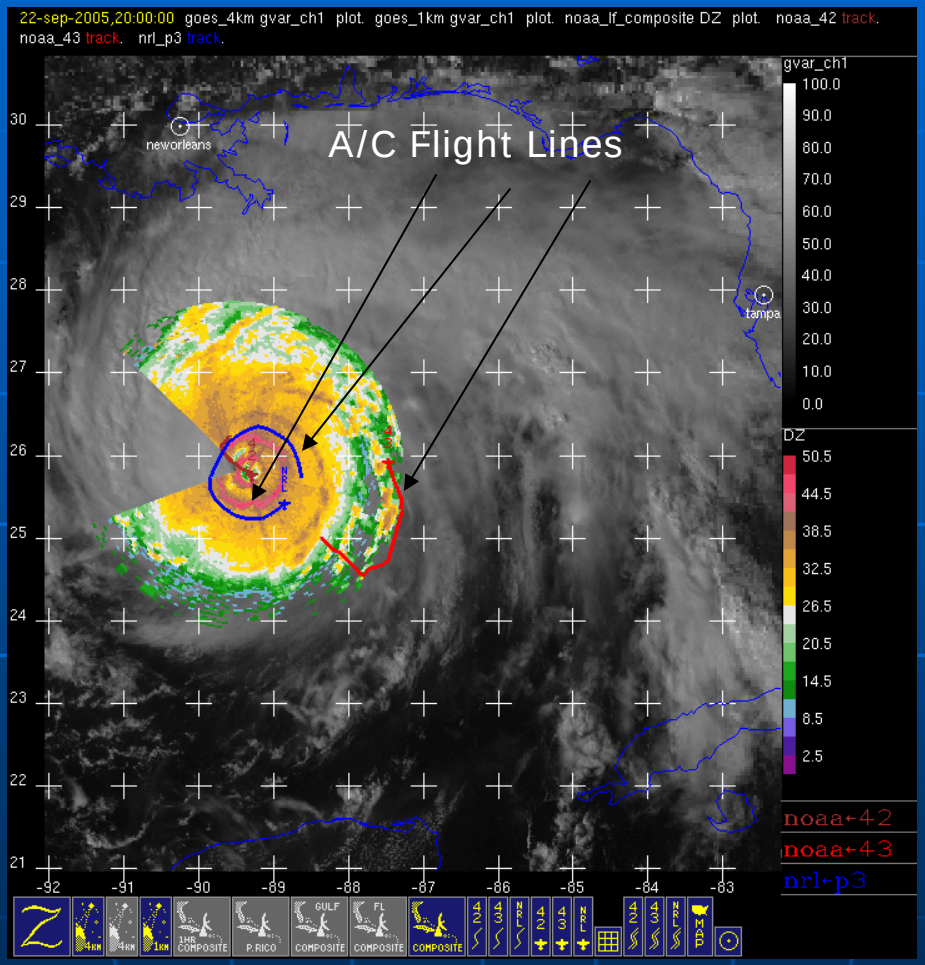


Weather and Terrain Require Crews Stay Alert

T-REX: Terrain-induced Rotor Experiment

Low, medium and high altitude a/c flying different patterns

RAINEX: Science Summary for Hurricane Rita
Day 4: 22 September 2005
Concentric Eyewalls



Flight tracks for NOAA 43 (red), NOAA 42 (brown), and NRL (blue) superimposed on lower-fuselage radar composite and visible satellite image for 2000 UTC 22 September 2005

Rita's Eyewall

Eyewall penetrated by research aircraft

Dropsonde Issue
Safety and Liability Questions

Ski Bird with JATO Assist (Adds Risk)

JATO assist used to insure takeoffs in Antarctica. If new props successful in providing additional thrust then savings amounts to approximately $7M per year.

Testing of 8-bladed props in Greenland

SOFIA – 747SP
Stratospheric Observatory for Infrared Astronomy
Major Engineering Effort

NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/Gallery/Photo/index.html
NASA Photo: ED08–0262–17 Date: October 8, 2008 Photo By: Carla Thomas

Engineers and technicians prepare SOFIA's German–built primary mirror assembly for reinstallation into NASA's 747SP airborne observatory.

NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/Gallery/Photo/index.html
NASA Photo: ED08–0296–40 Date: November 12, 2008 Photo By: Tom Tschida

Scientists carefully examine data being received during nighttime line operations testing of the SOFIA airborne observatory's 2.5–meter infrared telescope.

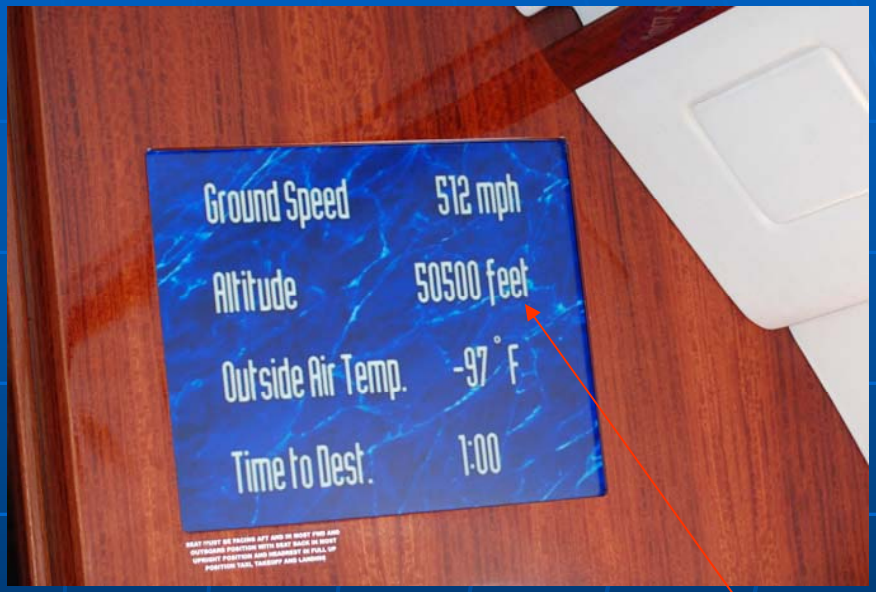
Pressure Testing after Modifications were made to G-V Cockpit Glass Protected

The HIAPER aircraft will be pressurized to 17.5 PSI according to guidelines set in FAA Advisory Circular 25-22, Section 25.843.

Tripler installed after ports cut into fuselage.
Use of strain gages for pressure testing.
Modifications required relocation of plumbing, electrical, and intercostals.

Instrument Pods: FAA certification Flight

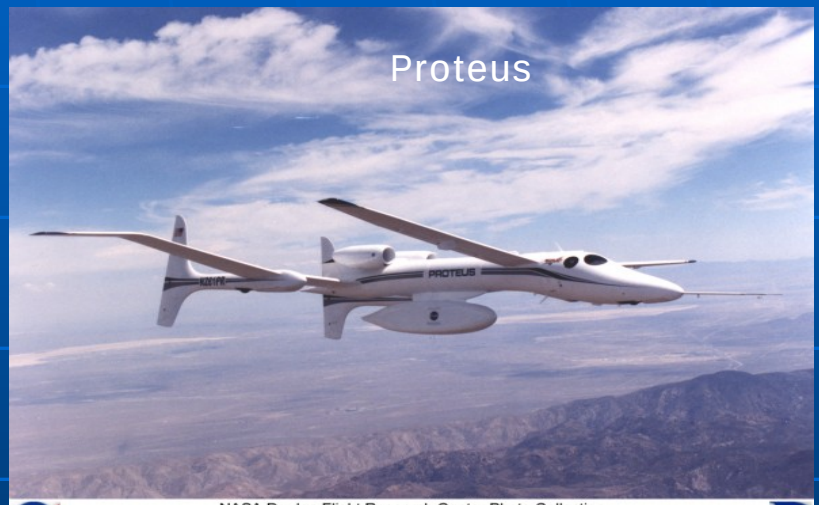
G-V certified to 51,000 ft
Highest altitude for a certified aircraft (above 45,000 ft do not follow ATC vectors)



Less Conventional Aircraft

Integration of UASs into the National Air Space is a major thrust of FAA and ICAO

Max endurance 42 hours
Max altitude 65,000 ft



NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/gallery/photo/index.html
NASA Photo: EC99-45110-11 Date: July 26, 1999 Photo by: Patrick Wright

ERAST Program Proteus Aircraft in Flight over the Mojave Desert in California

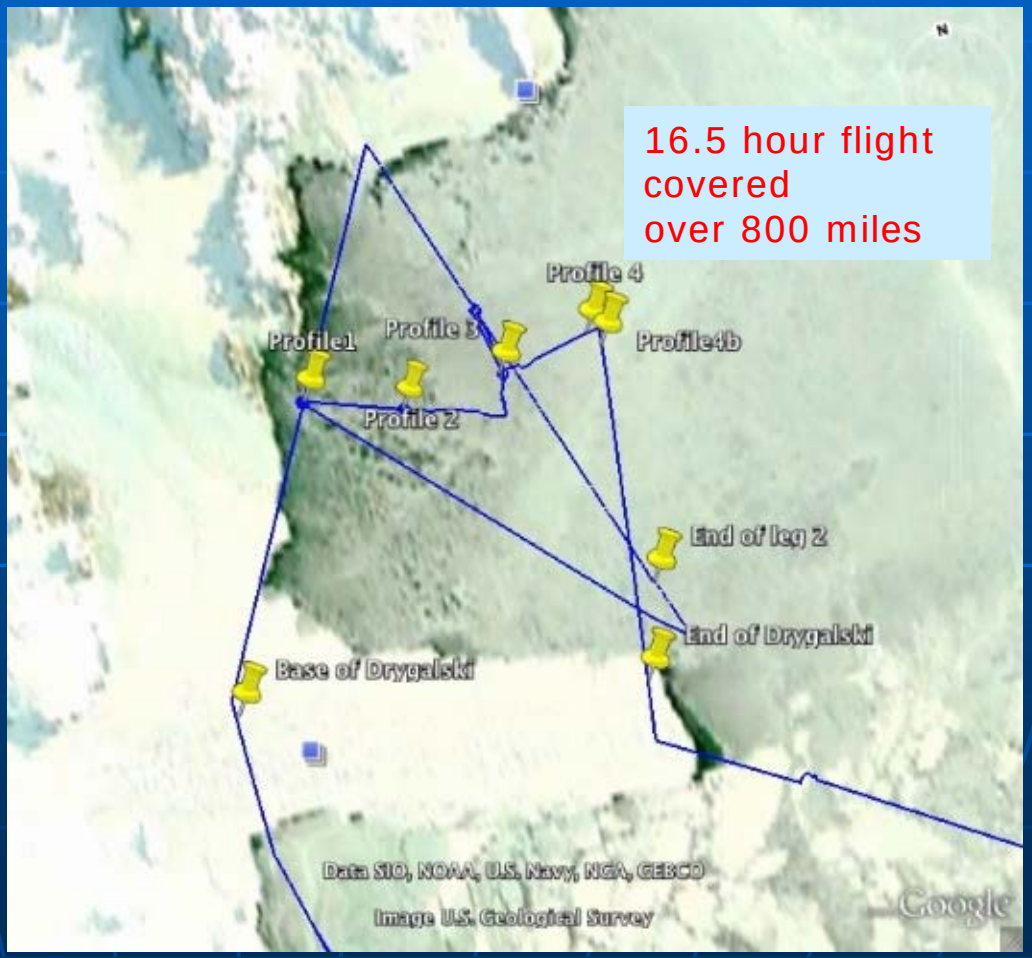
G-V continues to conduct science missions such as HIPPO (HIAPER Pole-to-Pole) and PREDICT which will be conducted out of St Croix this summer. Its objective is to better understand the process of tropical depression formation that results in tropical cyclones.

A-10: Replacement for T-28 Storm Penetration Aircraft
Mid-Size Infrastructure Facility
XFR from USAF to USN and Operated out of CIRPAS, Naval Postgraduate School

T-28 removed from service because performance too limited to meet science requirements

Aerosonde UAS in Antarctica

(Integration of UASs into National Airspace is currently high priority of the FAA - lots of issues)



Bottom Line

- Flying, especially commercial, is safe
- While research aircraft are highly modified and flying research profiles have more accidents and incidents than commercial flying, it remains safe because:
  - More rigorous pre-flight planning is conducted;
  - Flight readiness reviews are conducted for each phase of a mission;
  - Highly experienced flight crews and, by law, crew and qualified non-crew members can be on board federal aircraft all have specialized training.

Keep on Flying

Major inspection of C-130