NTSB National Transportation Safety Board

Office of Aviation Safety

FAA Great Lakes Region
Airports Division

23rd Annual Airport Conference

November 29 – 30, 2007

NTSB National Transportation Safety Board

Office of Aviation Safety

Survival Factors/Airport Accident Investigation

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National Transportation Safety Board

- Five-member Board – Presidential appointees
- Charged by US Congress to investigate transportation accidents
- Independent agency
- ~400 employees in 10 regional and field offices and Washington headquarters
- Modes: surface, railroad, pipeline, marine, *aviation*

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Safety Board Responsibilities

- Conduct investigations
- Determine “probable” cause
- Publish accident/incident reports
- Conduct special studies
- Issue recommendations

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Aviation Accident Investigation: Groups

- Operations
- Air traffic control
- Weather
- Vehicle performance
- Aircraft Structures
- Aircraft Systems
- Maintenance records
- Human performance
- Flight data recorders
- Cockpit voice recorders
- *Survival factors (including airports and emergency response)*

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Aviation Accident Investigation: Party System

- FAA (always)
- Operator (airline)
- Airplane manufacturer
- Engine manufacturer
- Pilot's union
- Flight attendant union
- ATC union
- Airport or municipality

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Who makes up the Survival Factors Group?

- NTSB group chairman
  - Others as needed
- Airline
  - flight attendant training
  - Interiors engineers
- Flight attendant union
- FAA
  - Cabin Safety Inspector
  - Biodynamics engineer (CAMI)
  - Fire engineer (Tech Center)
  - Airports
- Airplane Manufacturer
  - Interiors engineer
- Emergency Equipment Manufacturer
  - Seats/Restraints
  - Escape slides
  - Flotation equipment
- Airport Representative
- ARFF Representative
- Others as needed

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Why Look at Survival Factors?

(Nobody survives, anyway... Right?)

- A review of recent US accidents (1983-2000) indicate that most occupants survive
- Many improvements in occupant protection are a result of Survival Factors Investigations

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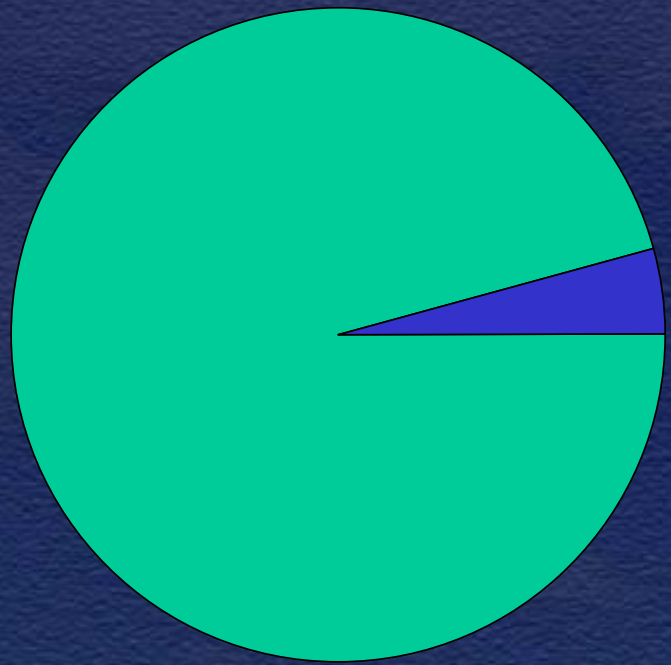
Occupant Survival for All U.S. Part 121 Accidents



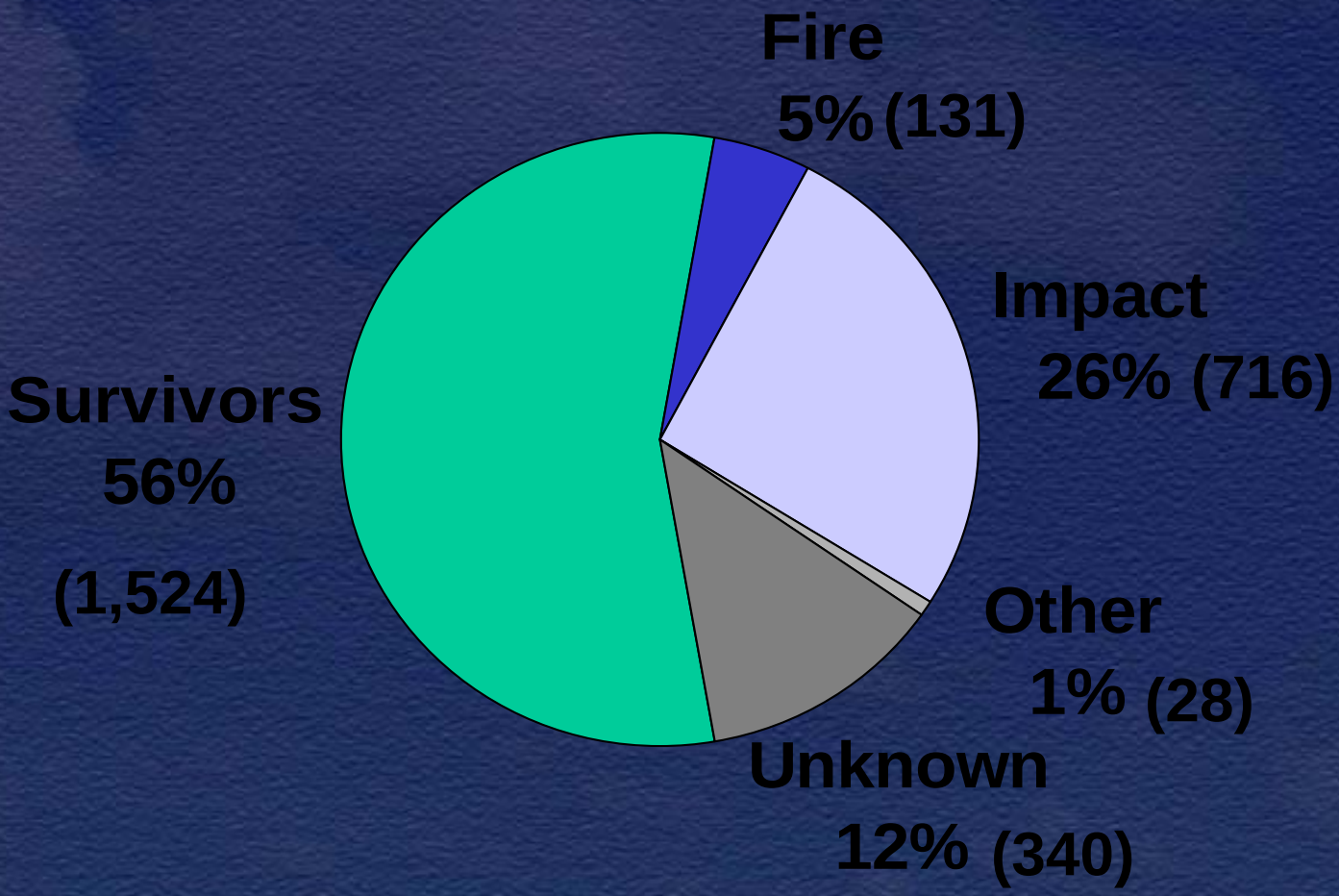
Fatalities
4%

(2,280)

Survivors
96%

(51,207)

Occupant Survival for Serious Part 121 Accidents



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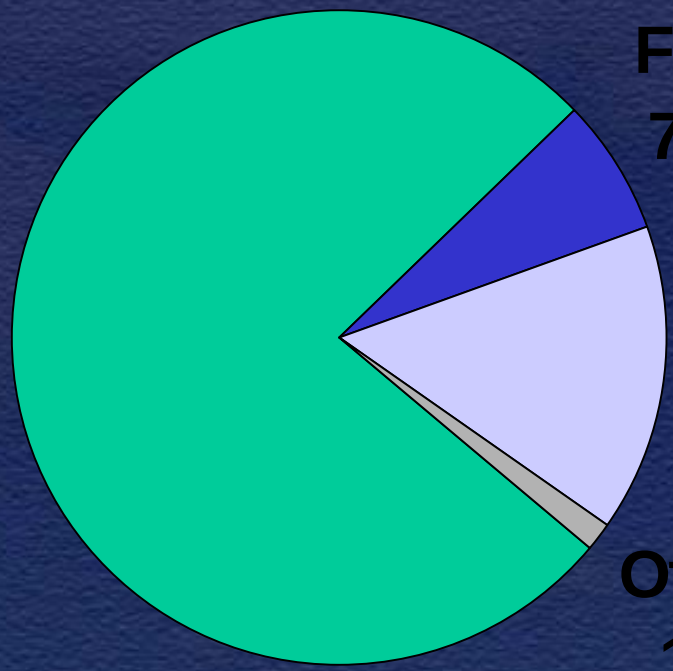
Occupant Survival for *Survivable* Serious Part 121 Accidents



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Survival Factors Group: Responsibilities

- Document damage and safety equipment:
  - cabin, floor, seats and restraints, exits, escape slides, flotation equipment
- Interview: passengers, flight attendants, firefighters, airport ops, witnesses
- Obtain medical records and autopsy reports to document injuries and fatalities
- Review flight attendant training and procedures
- *Document Airport and Emergency Response*

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Recent Accident with Survival Factors Issues

- August 2, 2007
- Okinawa, Japan
- China Air B-737
- Fuel leak at the gate

- Issues:
  - Evacuation procedures
  - Evacuation slides
  - Fire/smoke
  - ARFF response

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Airport and Emergency Response Documentation: Initial items obtained from the Airport

- Airport Layout Plan (ALP)
- Contour map of the airport
- Airport Certification Manual
- All airport logs (e.g., ops, snow, self-inspection, emergency response)
- Previous Part 139 certification inspection reports (and disposition)
- FAA Runway Safety Area Determinations and status of improvements
- Security camera videos
- Photos, videos, etc.
- Statements from ops, ARFF, other responders
- Maintenance history for affected area (rubber removal, construction, paint, signs, lights
- NOTAM procedures (including NOTAMS at the time of the accident)

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Selected Accidents and Resultant Safety Recommendations

- Southwest Airlines 1455
- American Airlines 1420
- Comair 5191
- Southwest Airlines 1248

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Southwest Airlines 1455

- March 5, 2000, Burbank, CA
- 1811 PST, Boeing 737-300,
- Over ran runway 08, and collided with an airport blast fence and airport perimeter wall. The airplane left the airport property, and came to rest on Hollywood Way Boulevard.
- 137 passengers, three flight attendants, and two flight crew
- 94 passengers and four crewmembers - no injuries
- 41 passengers and one flight crewmember - minor injuries.
- 2 passengers - serious injuries.
- Non-standard lateral and longitudinal runway safety areas

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Southwest Airlines 1455

NTSB Recommendations to the FAA:

- Require all Part 139 airports to meet RSA dimensional standards
- Require all Part 139 airports that cannot meet RSA dimensional standards to install EMAS

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American Airlines 1420

- June 1, 1999, Little Rock, AR
- 2351 Central Daylight Time (CDT),
- McDonnell Douglas MD-82,
- Overran the end of runway 4R and collided with the approach lighting structure
- The captain and 10 passengers - fatal injuries
- 110 passengers and crew - various injuries
- 24 passengers – no injuries.

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American Airlines 1420

NTSB Recommendations to the FAA:

- Evaluate crash detection and location equipment and require implementation (beyond DEVS)

- Require a minimum ARFF staffing level to allow exterior firefighting and and rapid entry into an airplane to perform interior firefighting and rescue activities

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Comair 5191

- August 27, 2006
- Bombardier CL-600
- Blue Grass Airport, Lexington, Kentucky.
- 47 passengers, 2 crew - fatal
- 1 crew – serious

Comair 5191

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Comair 5191

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Comair 5191

Conclusions

- Adequate cues existed on the airport surface…to allow the flight crew to successfully navigate from the air carrier ramp to the Runway 22 threshold.

- The emergency response for this accident was timely and well coordinated.

- The first officer's survival was directly attributable to the prompt arrival of the first responders.

- Enhanced taxiway centerline markings and surface painted holding position signs provide pilots with additional awareness about the runway and taxiway environment.

Comair 5191

Probable Cause:

…the flight crewmembers' failure to use available cues and aids to identify the airplane's location on the airport surface during taxi and their failure to cross-check and verify that the airplane was on the correct runway before takeoff.

Recommendation:

Require that all airports certificated under 14 *Code of Federal Regulations* Part 139 implement enhanced taxiway centerline markings and surface painted holding position signs at all runway entrances.

Southwest Airlines 1248

- December 8, 2005
- Overran Runway 31C at Midway Airport, Chicago, IL
- Departed the end of the runway, exited the airport, and struck an automobile
- Several minor injuries among the 98 passengers and 5 crewmembers on board
- One ground fatality and several other ground injuries
- Moderate snowfall

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Southwest Airlines 1248

Issue areas:

- Winter operations
- Runway friction measurement
- Pilot braking action reports
- Runway safety areas
- EMAS
- Autobrake usage
- OPC limitations
- Arrival calculations

Southwest Airlines 1248

Two points:

Dispatch v. Arrival Assessments

-Not required by FAA
-Assessment uses braking action reports and field condition reports

Braking action reports

- Mixed reports
- Brake/reverser schedule

Southwest Airlines 1248

What happened:

- Crew did an arrival landing calculation using OPC (not required)
- Crew was getting “fair/poor” (one “good/poor”) braking action reports
- Used “fair” for calculations, got positive stopping margin
- Plugged in “poor” and got an uncomfortably small positive number
- Decided to use autobrakes for the first time ever
- Did not realize that autobrakes were not authorized at that time
- Did not realize that thrust reverser use was included in their numbers
- Did not realize that SWA policy required them to use the most restrictive BA report (“fair/poor” = “poor”)
- Knew that landing with “poor” BA and a tailwind > 5 knots was prohibited
- After landing, did not immediately deploy thrust reversers
- Probably distracted by autobrakes
- FO deployed reversers ~ 18 seconds after landing

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SOUTHWEST

SWA 1248 Animation

Roll ‘em

Southwest Airlines 1248

Conclusions:

- Chicago Midway International Airport personnel monitored runway conditions and provided appropriate snow removal service on the night of the accident.

- Because the pilots did not use the more critical braking action term (poor) during their arrival landing distance assessment (which, combined with the associated tailwind limitation, would have required them to divert), they were not in compliance with Southwest Airlines' policies.

- Southwest Airlines did not provide its pilots with clear and consistent guidance and training regarding company policies and procedures in several areas, including interpretation of braking action reports and the assumptions affecting landing distance assessments.

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Southwest Airlines 1248

Conclusions:

- The pilots would have been able to stop the airplane on the runway if they had commanded maximum reverse thrust promptly after touchdown and maintained maximum reverse thrust to a full stop.

- Although landing distance assessments incorporating a landing distance safety margin are not required by regulation, they are critical to safe operation of transport-category airplanes on contaminated runways.

- The absence of an engineering materials arresting system (EMAS) installation in the limited overrun area for runway 31C contributed to the severity of the accident; even a nonstandard EMAS installation would have safely stopped the airplane before it left airport property.

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Southwest Airlines 1248

Probable Cause:

The pilots' failure to use available reverse thrust in a timely manner to safely slow or stop the airplane after landing, which resulted in a runway overrun. This failure occurred because the pilots' first experience and lack of familiarity with the airplane's autobrake system distracted them from thrust reverser usage during the challenging landing.

Contributing to the accident were:

1) Southwest Airlines guidance and training regarding company policies.

2) Programming of its on board performance computer

3) Implementing autobrake procedures without a familiarization period

4) Failure to include a margin of safety in the arrival assessment to account for operational uncertainties.

5) The pilots' failure to divert to another airport given reports that included poor braking action and a tailwind component greater than 5 knots.

6) Contributing to the severity of the accident was the absence of an engineering materials arresting system, which was needed because of the limited runway safety area beyond the departure end of runway 31C.

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Southwest Airlines 1248

Recommendations:

- Immediately require all 14 *Code of Federal Regulations* Part 121, 135, and 91 subpart K operators to conduct arrival landing distance assessments before every landing based on existing performance data, actual conditions, and incorporating a minimum safety margin of 15 percent.

- Establish a minimum standard for 14 *Code of Federal Regulations* Part 121 and 135 operators to use in correlating an airplane's braking ability to braking action reports and runway contaminant type and depth reports for runway surface conditions worse than bare and dry.

- Demonstrate the technical and operational feasibility of outfitting transport-category airplanes with equipment and procedures required to routinely calculate, record, and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll. If feasible, require operators of transport-category airplanes to incorporate use of such equipment and related procedures into their operations.

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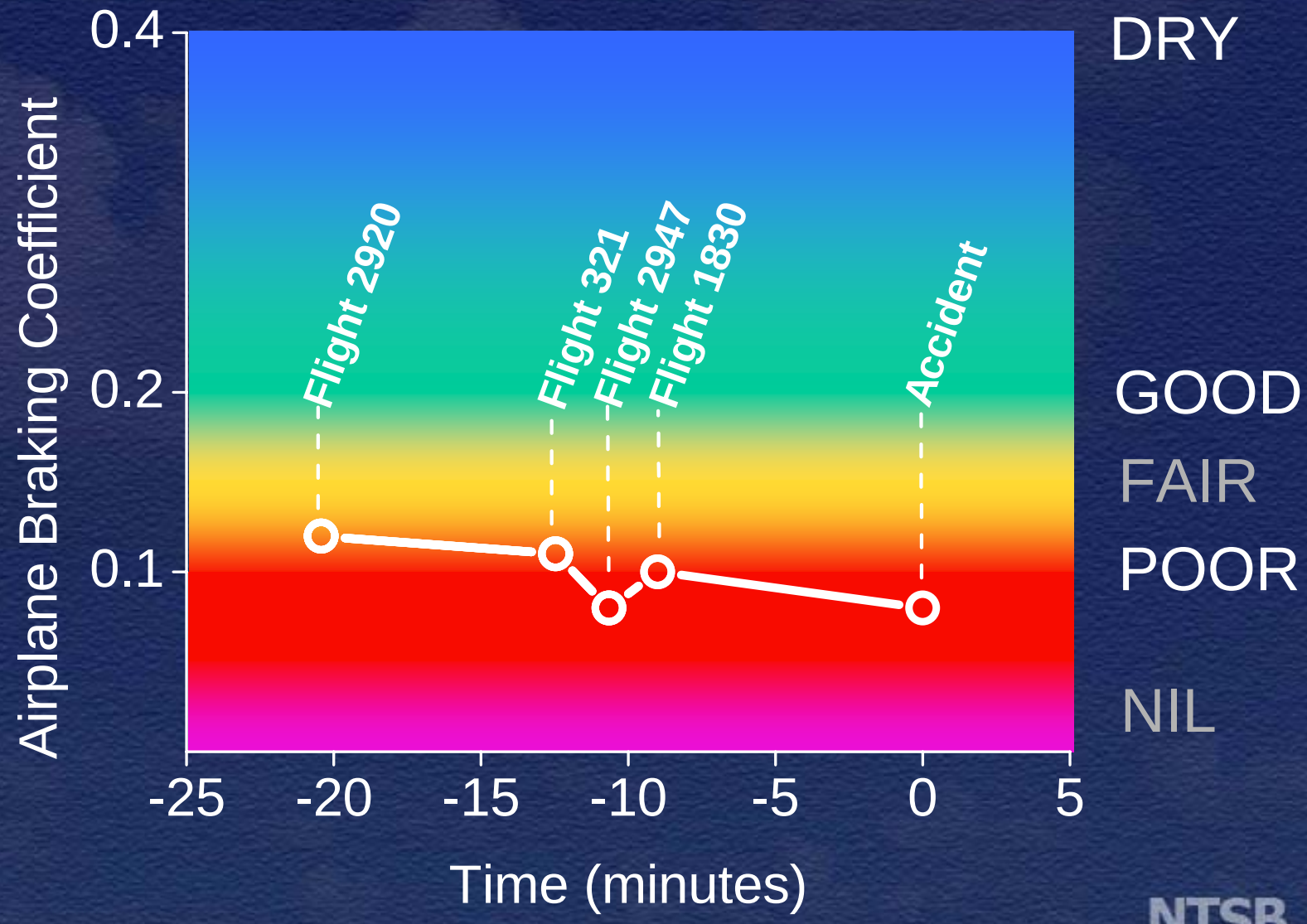
Runway Surface Conditions



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Airplane Stopping Capability

Reverse Thrust Configuration	Stopping Margin (feet)	Conclusion/ Runway Exit Speed (knots)
SWA practice [target 80/60 stow]	-1310	**Overrun (44)**
Flight 1248 [accident conditions]	-790	**Overrun (50)**
OPC/Boeing [target 60/30 stow]	-410	**Overrun (25)**
Maximum reverse thrust [maintained to a complete stop]	230	**Stop**
Flight 1248 [accident conditions, except with a headwind]	550	**Stop**

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Southwest Airlines 1248

Lessons Learned:

- Comprehensive operations and snow logs
- Ops personnel located in the tower during winter ops
- Knowledge and experience about friction assessments
  - Equipment
  - Procedures (Mu meter or vehicle)
- Frequent friction measurements
- Detailed field condition reports
  - Type and depth, wet or dry
- Ops when the tower is closed
  - Strict radio etiquette
  - Definitive field condition reports
- Consider “triggers” for closure due to contamination
  - Mu value or BA report
  - Type and depth of contaminant

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Image NASA
© 2007 Europa Technologies
Google
Pointer 41°47'32.85" N 87°45'45.11" W elev 605 ft
Streaming 100%
Eye alt 2129 ft

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Runway Safety Areas

- Options for improving RSAs:
  - Acquisition of land (to standards)
  - Relocate or shift runway
  - Reduction in runway length
  - Declared distances
  - Engineered Materials Arresting System (EMAS)

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Runway Safety Areas - EMAS

- Engineered Materials Arresting System
  - Crushable concrete blocks
  - Attenuates energy as the airplane crushes the blocks
  - Tunable for “design” airplane and available space
  - Standard EMAS – 70 knot exit speed
  - Non-standard EMAS – 40 knot exit speed

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Runway Safety Areas - EMAS

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