Airplane Performance on Runways Contaminated by Standing Water, Slush, Snow, or Ice

FAA In-Flight Icing/Ground De-icing International Conference

Don Stimson, Federal Aviation Administration

June 19, 2003

Topics

- Definitions
- Safety Record
- Performance effects
- Economics
- Current regulations/guidance
- Future regulations/guidance

What is a Contaminated Runway?

A Runway Is Considered Contaminated When:

More than 25% of the surface area within the length and width being used is covered by:

- **Standing water or slush more than 1/8-inch deep**
- **Loose (dry) snow more than ¾-inch (20 mm) deep**
- **Compacted snow or ice, including wet ice**

Types of Runway Contaminant

- **Standing Water – Flooded runway**
- **Slush – Partially melted snow or ice with high water content**
- **Wet Snow – Can form a snowball**
- **Dry Snow – Will not stick together**
- **Compacted or Compressed Snow – Resists rutting**
- **Ice – Frozen water or snow**

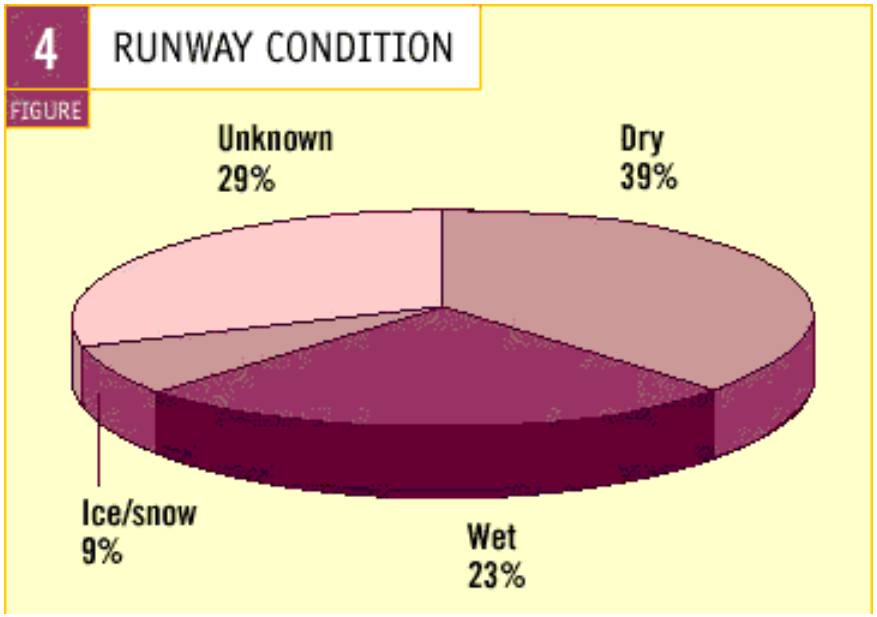
Other Types of Runway Contamination

- **Treated Surfaces – Chemical treatments, sand, etc.**
- **Mixed Conditions – e.g., patches of ice and snow**
- **Airplane Deicing/Anti-icing fluids**

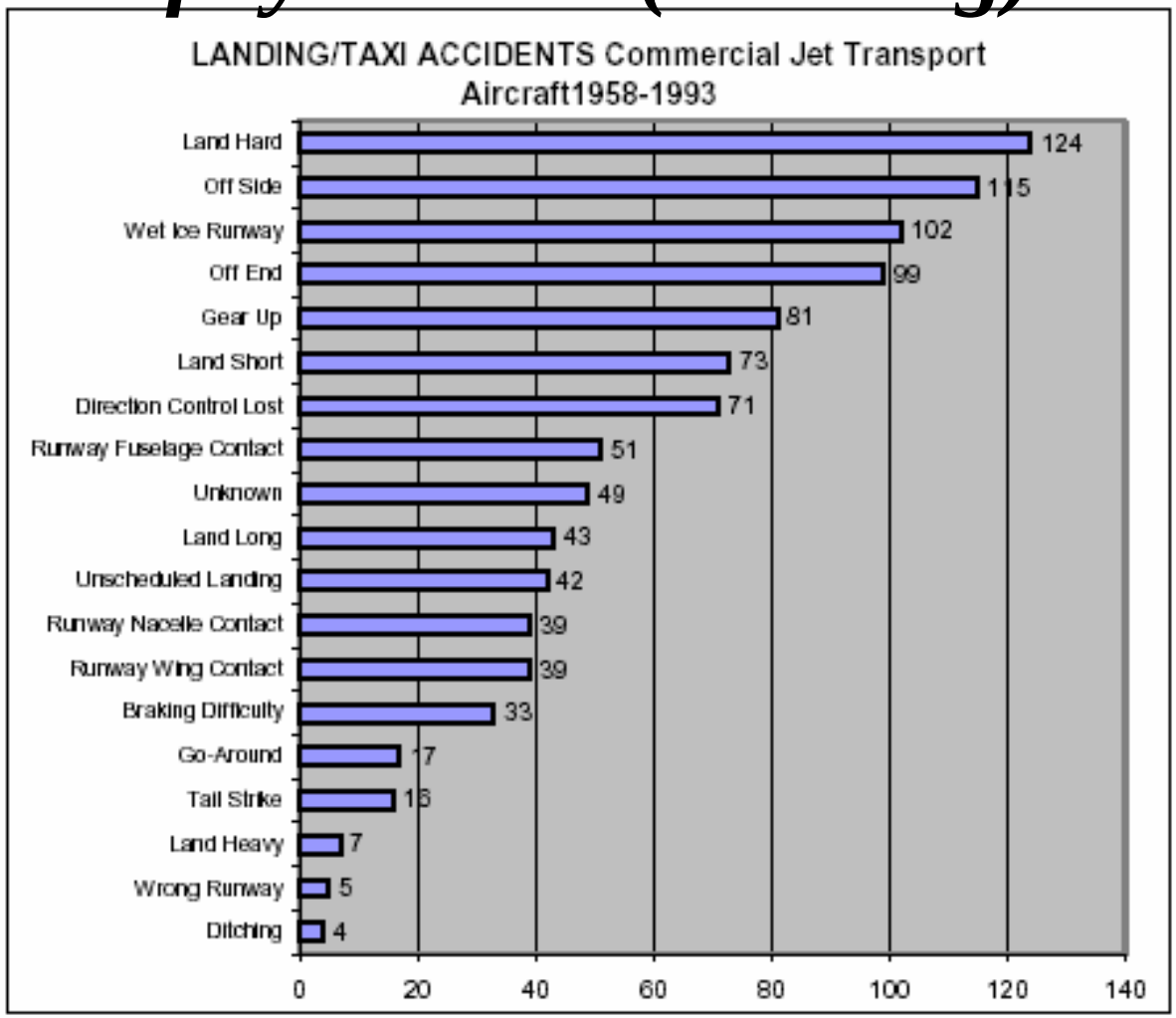
The Safety Record on Contaminated Runways

Safety Record (Rejected Takeoffs)
(1961 to 1999)

- **94 Rejected Takeoff Overruns**
- **9% Were On Contaminated Runways**



Safety Record (Landing)



Landing accidents by event descriptor 1958 through 1993 - NTSB

Performance Effects

Performance Effects

- Airplane acceleration may be affected
  - Airplane wheels moving through and displacing the contaminant
  - Spray impinging on the airplane
- Reduced airplane stopping capability

Performance Effects

Comparison of Braking Coefficients:

Runway Condition	Braking μ
Dry	0.4
Wet	~0.2
Compacted Snow	0.2
Dry or Wet Snow	0.17
Slush, Standing Water	~0.15
Ice	0.05

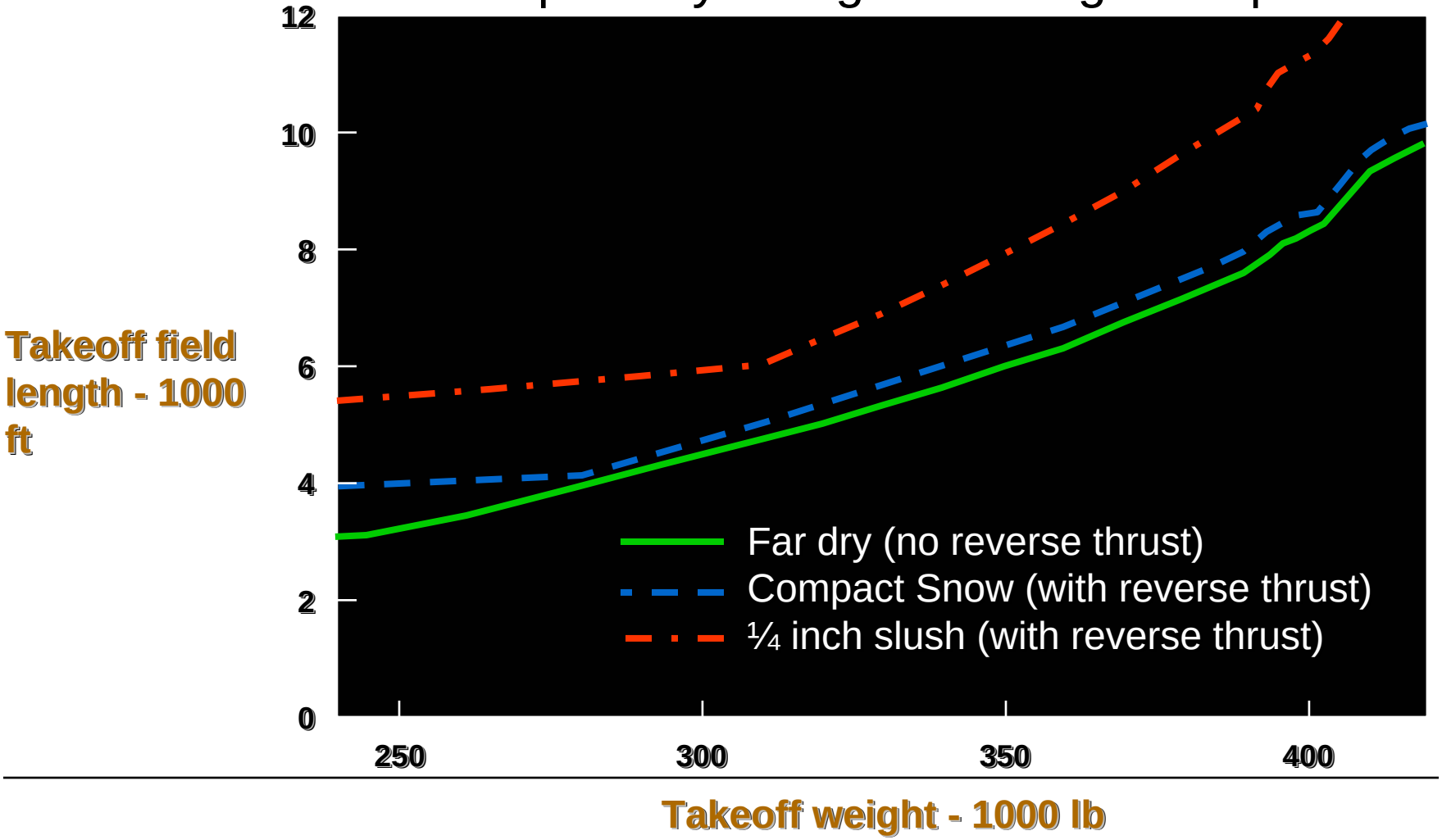
Performance Effects

<u>Performance Basis for Determining Rejected Takeoff Performance</u>

- **Consider engine failure?**
- **Credit for use of reverse thrust**
- **15 foot takeoff screen height**

Performance Effects

Example only – large twin-engine airplane



Performance Effects

(Example only – mid-size twin engine airplane)

Weight Reduction (lbs)	¼-Inch Slush	½-Inch Slush	Ice
All Engines Operating	7,900	18,600	0
One Engine Inoperative	34,200	48,200	22,600

Economics

Economics

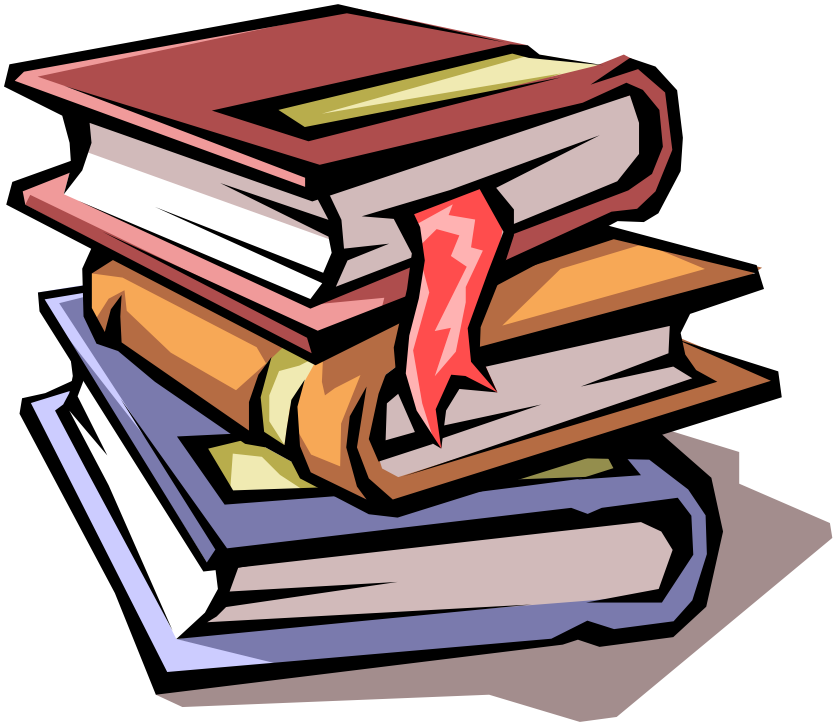
- **Cost is a major issue in implementing contaminated runway requirements**
- **Significant performance effects lead to significant economic penalties**
- **3 major U.S. operators estimated annual revenue losses of $10 Million if engine failure accountability is included**

Economics

Revenue analysis conducted by one major U.S. operator:

- **446,015 departures**
  - **0.1% from runways with 1/4-inch of contaminant**
  - **0.02% from runways with 1/2-inch of contaminant**
- **Total operating revenue $4,735,587,000**
- **$190,739 (0.004%) lost due to accounting for contaminated runways**

Current Regulations/Guidance



Current Regulations/Guidance

United States

- **Airplane certification and operating rules do not address contaminated runways**
- **Advisory Circular (AC) 91-6A, “Water, Slush, and Snow on the Runway,” dated May 24, 1978, provides guidance for contaminated runway operations**
- **FAA Order 8400.10, “Air Transportation Inspector’s Handbook, provides guidance to FAA Inspectors**

Current Regulations/Guidance

AC 91-6A

- **Takeoffs should not be attempted in slush, standing water, and wet snow depths greater than ½-inch**
- **Adjustments should be applied to takeoff data for lesser depths**
- **Operators' manuals should contain specific instructions for determining runway conditions and applying adjustments**

Current Regulations/Guidance

<u>FAA Order 8400.10</u>

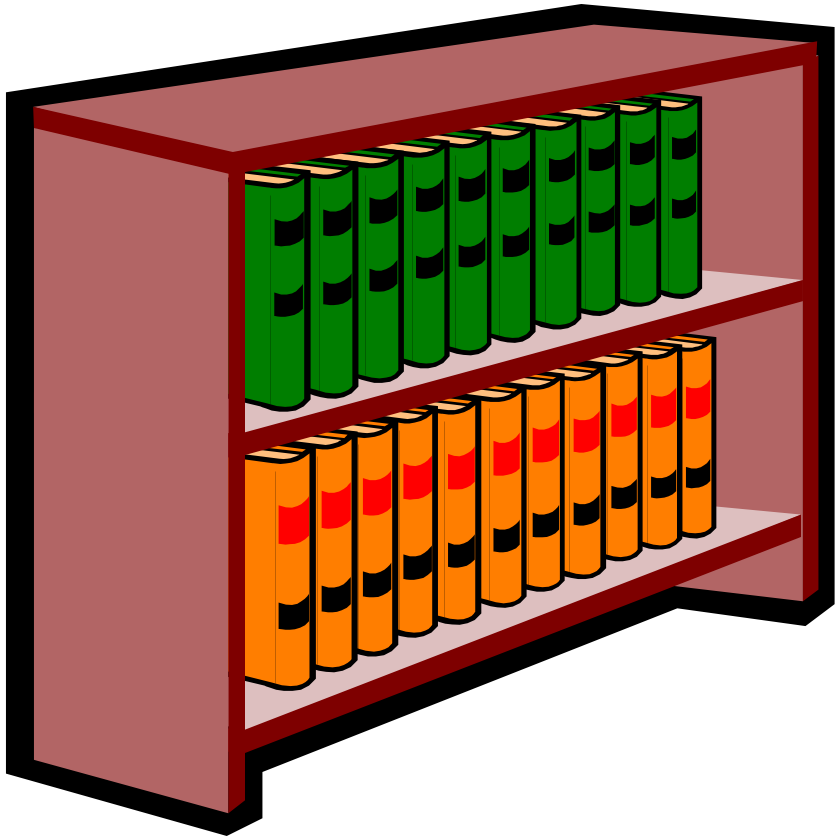
- **The FAR's do not require the effects of contaminated runways be published in the Airplane Flight Manual**
- **These affects must be accounted for during revenue operations**
- **Consult AC 91-6A for operations on contaminated runways**

Current Regulations/Guidance

Europe

- **JAR 25X1591 requires performance data for operations on contaminated runways to be published in an approved document**
- **AMJ 25X1591 provides guidance on developing the contaminated runway performance data**
- **JAR-OPS 1 requires operators to use these data for contaminated runway operations (takeoff and landing)**

Future Regulations/Guidance



Future Regulations/Guidance

- **In 1997, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC) to recommend harmonized operational performance requirements, including contaminated runway operations**
- **Tasking completed by the Airplane Performance Harmonization Working Group in March 2002**

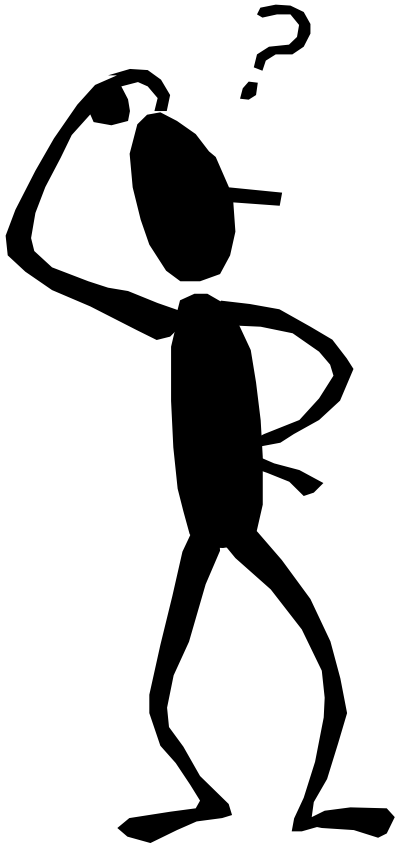
Future Regulations/Guidance

<u>ARAC Recommendation</u>:

- **Adopt requirements for takeoff operations on contaminated runways (consensus not achieved on issue of engine failure accountability)**
- **Do not require consideration of landing on a contaminated runway at dispatch**
- **Develop harmonized airplane certification requirements for contaminated runway performance**

Future Regulations/Guidance

Current Status:

- **FAA has not yet taken action on the ARAC recommendation**
- **Many U.S. Operators already account for contaminated runways**

Questions?