Takeoff and Landing Performance Assessment Aviation Rulemaking Advisory Committee (TALPA ARC) Recommendations

Federal Aviation Administration

Presented to: Society of Aircraft Performance and Operations Engineers

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Topics

- TALPA ARC Background
- Runway Surface Condition Reporting
- Runway Surface Condition Matrix
- Airports Recommendations
- Airplane Operations Recommendations
- Airplane Certification Recommendations
- Next Steps

TALPA ARC Background

Initiating event: **December 8, 2005 landing overrun of a Southwest Airlines Boeing 737-700 at Chicago's Midway Airport**

TALPA ARC Background

- FAA established an internal team to review FAA regulations/policies and industry practices
- Team found deficiencies in landing performance assessment at the time of arrival, particularly when conditions have changed en route
- To address these deficiencies, the FAA published a notice on June 7, 2006, announcing OpSpec/MSpec requirements for assessing landing performance at the time of arrival

TALPA ARC Background (cont.)

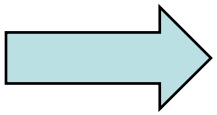
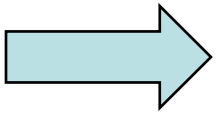
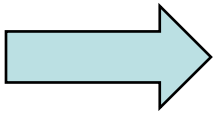
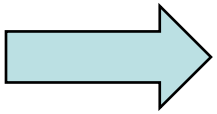
- Many comments received
- Strong suggestions to use public rulemaking process
- On August 31, 2006, the FAA published Safety Alert for Operators (SAFO) 06012, “Landing Assessments at Time of Arrival (Turbojets)” containing voluntary guidance and recommendations
- The FAA chartered the Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) to provide recommendations for rulemaking

TALPA ARC Charter

Provide advice and recommendations to:

- **Establish airplane certification and operational requirements (including training) for takeoff and landing operations on contaminated runways.**
- **Establish landing distance assessment requirements to be performed at the time of arrival, including minimum landing distance safety margins.**
- **Establish standards for runway surface condition reporting and minimum surface conditions for continued operations**

Many Links in the Safety Chain

Determine and report runway surface condition		**Airport Operators**
Transmit runway surface condition/braking action reports		**Air Traffic Services, NOTAMs**
Provide airplane performance data for various runway surface conditions/braking action		**Airplane Manufacturers**
Perform takeoff/landing performance assessments		**Airplane Operators/Pilots**

Many Inter-Related Changes Needed

Airport Standards

- Part 139

Airplane Operating/Training Requirements

- Parts 91-K/121/125/135

Airplane Type Certification Standards

- Parts 23 and 25

NOTAMS/Air Traffic Services Directives

- Internal Orders/Directives

TALPA ARC Participants

Regulatory authorities

- FAA (Airports, Flight Standards, Certification, NOTAMS, Rulemaking, Legal)
- Transport Canada
- Brazilian Certification Authority
- EASA (Limited Participation)

Airplane manufacturers

- Airbus
- Boeing
- Bombardier
- Cessna
- Eclipse
- Embraer
- Gulfstream
- Hawker

Airplane Operators

Part 91-K/125/135

- Alpha Flying, Inc
- Bombardier Flexjet
- Chantilly Air
- Conoco Phillips Alaska
- Flight Works
- Jet Solutions
- Net Jets
- Pogo Jet, Inc

Part 121

- ABX Air
- Alaska
- American Eagle
- American
- Continental
- Delta
- Express Jet
- Federal Express
- Northwest
- Pinnacle
- Southwest
- United
- UPS
- US Airways

TALPA ARC Participants
(continued)

Airports

- Cherry Capital
- Chicago Airport System
- Chicago O'Hare
- Grand Rapids Regional
- Minneapolis/St. Paul Airport System

Other Organizations

- Air Transport Association
- Airline Pilots Association
- Airports Council International
- Allied Pilots Association
- National Air Carrier Association

Other Organizations (cont.)

- National Business Aviation Association
- National Transportation Safety Board
- Neubert Aero Corporation
- Regional Airline Association
- Southwest Airlines Pilot Association
- Allied Pilots Association

TALPA ARC Overview

- **First Meeting – March 2008**
- **Separate workgroups established to address:**
  - Part 139 Airports
  - Part 121 Airplane Operations
  - Part 91-K/125/135 Airplane Operations
  - Part 23/25 Airplane Type Certification
- **Final Meeting – May 2009**
- **Landing recommendations provided to FAA on April 15, 2009**
- **Takeoff recommendations provided to FAA on July 7, 2009**
- **ARC Charter expired October 12, 2009**

Starts With a Common Language

- **It quickly became apparent that a common runway surface condition description was needed between:**
  - Those who report the conditions (Airports)
  - Those who transmit the information (NOTAMS, Air Traffic)
  - Those who provide airplane performance data (Manufacturers)
  - Those who use the runway surface condition and airplane performance data to assess landing performance capability (Pilots, Operators)
- **Reviewed existing ICAO, EASA, FAA terms/methods**

Current Runway Surface Condition Information

- Runway Friction Measuring Devices, μ (or Mu) Reports
- Pilot Braking Action Reports
- Runway Surface Contamination Description (Type and Depth of Contamination)

Problems With Using Reported μ

- **Limited runway surface conditions for which they are applicable**
  - Conditions rarely exist during winter storm events for use of the devices
  - Often used and reported outside of device manufacturers' limitations for their use
- **Timeliness in changing conditions**
- **Need for runway closure to obtain μ measurements**
- **Lack of repeatable results with same type of measuring device, or same device with consecutive measuring runs**
- **Device calibration concerns and procedures**
- **No operationally usable correlation between the different devices**
- **Many examples where reported μ over-estimated the available airplane braking friction**

Problems With Using Pilot Braking Action Reports

- **Subjective**
  - No standard definition of the pilot braking action reporting terms
  - No training or guidance given to pilots on how or when to report braking action
- **Unknown correlation of reports between different airplane types**
- **Most airplane manufacturers do not provide performance data in terms of pilot braking action**
- **Nevertheless, in many cases overrun accident analysis has shown pilot reports to often be more accurate than other forms of runway surface condition information**

Problems With Using Runway Surface Contamination Descriptions (Type and Depth of Contamination)

- **Typically only available through NOTAM information**
- **Not updated in a timely manner**
- **Varying terms and definitions**
  - Patchy
  - Thin
  - Sanded
  - Dry snow vs. Wet snow
  - Wet snow vs. Slush
- **How to accurately measure depth?**
  - Significant airplane performance differences between ¼" (6 mm) and ½" (13 mm) of slush

Runway Surface Condition Reporting

Conclusion:

No Silver Bullet!

Runway Surface Condition Reporting

TALPA ARC Recommendation:

- Use a combination of the best attributes of each method
- Address known deficiencies
- Beta test proposed method
- Continue researching improved methods

Runway Surface Condition Matrix

- Aligns runway surface conditions reported by airport operators with contaminated landing performance data supplied by the airplane manufacturer
- Runway condition codes provide a short, simple descriptor of runway surface conditions in place of μ readings
- Provides for a standardized method of reporting runway surface conditions for all airports
- Provides more detailed information for the flightcrew to make operational decisions
- Standardizes pilot braking action report terminology
- Is not perfect, based on the best information available today and a significant improvement over current practices

Runway Surface Condition Matrix

- **Appearance of the Matrix may have different formats for the different user groups to aid in its usability**
  - Airport Operators
  - Flight Operations Personnel
  - Airplane Manufacturers
- **The information, terms, and relationships portrayed are the same**

Braking Action Report PIREPs		Associated Runway Surface Condition	Runway Condition Code
Term	**Definition**		
Dry	-	**Any temperature:** ▪Dry	**6**
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	**Any temperature of:** ▪Wet surface (Smooth, Grooved, or PFC runway) ▪Frost **Any temperature of: 1/8" or less of:** ▪Water ▪Slush ▪Dry Snow ▪Wet Snow	**5**
Good to Medium	Brake deceleration and controllability is between Good and Medium.	**At or below -13ºC:** • Compacted Snow	**4**
Medium	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	**Any temperature when:** ▪Wet (When runway is reported as "slippery when wet") **At or below -3°C, and Greater than 1/8" of :** ▪Dry or Wet Snow **Above -13°C and at or below -3°C:** ▪Compacted Snow (Any depth, depth not reported)	**3**
Medium to Poor	Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	**Any Temperature, and Greater than 1/8" of:** ▪Water ▪Slush **Temperature Above -3°C and:** ▪1/8" and Greater of Dry or Wet Snow ▪Compacted Snow (Any depth, depth not reported)	**2**
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	**At or below -3°C:** • Ice	**1**
Nil	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	**Any temperature of:** ▪Wet Ice ▪Water on top of Compacted Snow ▪Dry or Wet Snow over Ice **Temperature Above -3°C:** Ice	**0**

Notes

- ***Contaminated runway.*** *A runway is contaminated when more than 25 percent of the runway surface area (whether in isolated areas or not) within the reported length and the width being used is covered by water, slush, frost or snow greater than 1/8 inch (3 mm), or any depth of compacted snow or ice.*
- ***Dry runway.*** *A runway is dry when it is not contaminated and at least 75% is clear of visible moisture within the reported length and width being used.*
- ***Wet runway.*** *A runway is wet when it is neither dry nor contaminated.*
- *Temperatures referenced are average runway surface temperatures when available, OAT when not.*
- *While applying sand or liquid anti-ice to a surface may improve its friction capability, no credit is taken until pilot braking action reports improve or the contaminant type changes (e.g., ice to water).*
- *Compacted Snow may include a mixture of snow and imbedded ice.*
- *Compacted Snow over Ice is reported as Compacted Snow.*
- *Taxi, takeoff, and landing operations in "Nil" conditions are prohibited.*

Use of Runway Friction Measuring Device Readings, μ

- Not to be reported to flightcrews
- Only to be used by airport operator to further assess if the runway condition code should be downgraded from that associated with the contamination type, depth, and temperature.
- Cannot be used to upgrade runway condition code

Airport Estimated Runway Condition Assessment

Pilot Reports (PIREPs) Provided To ATC And Flight Dispatch

Runway Condition Assessment – Reported		Downgrade Assessment Criteria		
Code	**Runway Description**	**Mu (μ)**	**Deceleration And Directional Control Observation**	**PIREP**
6	**Any temperature:** ▪Dry	-	-	Dry
5	**Any temperature of:** ▪Wet surface (Smooth, Grooved, or PFC runway) ▪Frost **Any temperature of: 1/8" or less of:** ▪Water ▪Slush ▪Dry Snow ▪Wet Snow	40μ or higher	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	Good
4	**At or below -13°C:** • Compacted Snow	39-36μ	Brake deceleration and controllability is between Good and Medium.	Good to Medium
3	**Any temperature when:** ▪Wet (When runway is reported as "slippery when wet") **At or below -3°C, and Greater than 1/8" of :** ▪Dry or Wet Snow **Above -13°C and at or below -3°C:** ▪Compacted Snow (Any depth, depth not reported)	35-30μ	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	Medium
2	**Any Temperature, and Greater than 1/8" of:** ▪Water ▪Slush **Temperature Above -3°C and:** ▪1/8" and Greater of Dry or Wet Snow ▪Compacted Snow (Any depth, depth not reported)	29-26μ	Brake deceleration and controllability is between Medium and Poor. Potential for hydroplaning exists.	Medium to Poor
1	**At or below -3°C:** • Ice	25-21μ	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	Poor
0	**Any temperature of:** ▪Wet Ice ▪Water on top of Compacted Snow ▪Dry or Wet Snow over Ice	20μ or lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may	Nil

Many Changes Proposed For Runway Surface Conditions Reports (NOTAMs)

- **Changes in reporting terminology**
  - Discontinue use of “patchy,” “trace,” and “thin” terms
  - Use contamination terminology consistent with AFM landing performance data
- **Provide runway surface conditions in terms of:**
  - Contaminant type
  - Contaminant depth
  - Percentage of runway coverage
- **Clearly identify runway and direction for which the report is applicable**
- **Runway condition codes provided in terms of thirds of runway length when greater than 25% runway coverage (example, 4/3/3)**

Proposed NOTAM Changes (cont.)

Runway Condition and Contamination Terms (for reporting)

- Dry
- Wet (also report runway type – smooth, grooved, PFC, or slippery when wet)
- Water
- Slush
- Wet Snow
- Dry Snow
- Compacted Snow
- Frost
- Ice
- Wet Ice

Example Report

Grand Rapids Airport observed the following conditions for runway 17:

- Average surface temperature -7C
- Mu 32/32/32
- Entire runway covered with ½" dry snow
- Operations vehicle experienced reduced directional control slightly reduced braking action – no downgrade in code needed.

GRR RWY 17 3/3/3 100% 1/2 INCH DRY SNOW 1512Z 20 JAN 2009

Airport Estimated Runway Condition Assessment

Pilot Reports (PIREPs) Provided To ATC And Flight Dispatch

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0	**Any temperature of:** ▪Wet Ice ▪Water on top of Compacted Snow ▪Dry or Wet Snow over Ice	20μ or lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may	Nil

Matrix Evaluation

- Beta test at two airports last winter
- Matrix slightly modified based on the results of evaluation
- Approximately six more validation sites and two air carriers to do additional beta testing this winter

Goals Of Continued Beta Testing of Matrix Determine:

- Is it usable for airport operators?
- Is it usable for flightcrews and flight operations personnel?
- Are the relationships between type, depth, and temperature of contaminants and pilot observed braking action confirmed?
- Will the methods for disseminating runway surface condition information accommodate it?

Airports Recommendations

Airports Recommendations

- **The runway condition matrix and training in its use**
- **Report runway surface conditions whenever not dry**
- **Whenever 25% or more of reported width and length is covered by contaminant, report conditions in terms of:**
  - Runway condition code (in thirds of runway length)
  - Contaminant type, depth, percentage coverage
- **Downgrade runway condition code as necessary due to friction readings, PIREPS, or other observation**
- **Immediately close any runway for which a NIL braking action report is received**
- **If not already in effect, initiate continuous monitoring procedures after two consecutive POOR braking action reports**
- **Continue and expand pilot program using the matrix and recommended runway surface condition reporting procedures**

Airplane Operations Recommendations

Airplane Operations Recommendations

- **Differing recommendations received from the two working groups – Part 121 and Part 91-K/125/135**
- **Part 121 recommendations shown in black. Part 91-K/125/135 differences shown in red.**
- **Part 91-K/125/135 applicability recommendations:**
  - Landing performance assessment requirements would not apply to operations under Parts 91, 91-K, and 125. Would only apply to Part 135 operations conducted with multi-engine turbojet and large turboprop aircraft.
  - Contaminated runway takeoff requirements would only apply to new airplane designs

Airplane Operations Recommendations

- **Retain current pre-flight (dispatch) landing requirements**
  - **Part 135 ARC Recommendation:** Delete current dispatch requirements and only have an assessment at time of arrival
- **Add requirement to assess landing performance before initiating an approach**
- **Require the landing performance assessment to be performed in accordance with criteria and procedures in an FAA-approved program via an OpSpec**
  - **Part 135 ARC Recommendation:** Spell out the requirements for the landing distance assessment in the regulations and not require an approved program and OpSpec approval.
- **Assessment must consider:**
  - Runway surface condition
    - Runway condition code
    - Pilot braking action reports
    - Contaminant type/depth
  - Runway slope
  - Airport elevation
  - Wind, temperature
  - Airplane weight and landing configuration
  - Approach speed
  - Autoland or other guidance systems
  - Planned use of airplane ground deceleration means (e.g., thrust reversers, autobrakes, etc.)

Airplane Operations Recommendations

- **The landing distance available must be at least 15% longer than the required landing distance**
  - **Part 135 ARC Recommendation:** The safety margin recommendation is 11% for eligible on demand operations and 18% for all others.
- **Exception: No further assessment needed if the destination runway is dry or wet and compliance with the respective pre-flight (dispatch) requirement (1.67 or 1.92 factor) is shown. (The wet runway exception can only be used if the runway is grooved or PFC.)**
  - **Part 135 ARC Recommendation:** This would not apply to Part 135 operations since they would have no dispatch landing performance requirements.

Airplane Operations Recommendations

- When variable runway surface conditions exist, or non-uniform runway condition codes are provided (e.g., 3/2/2), the takeoff or landing distance must be based on the worst condition or code for any part of the runway to be used
- Allow an alternate method of compliance for operators who can demonstrate capability and training to land in a shorter air distance than that provided in the manufacturer's operational landing distance data

Airplane Operations Recommendations

- **Operator/Pilot judgment must be used when comparing PIREPs, runway condition codes, and runway condition reports (i.e., contaminant type/depth)**
  - Currency
  - Forecast
  - Trend information
  - Airplane type/operator (for PIREPs)
    - **Part 135 ARC Recommendation:** Proposed a decision making tree for determining the reliability of the runway surface condition reports and recommended actions
- **Consideration must be given to anticipated runway surface conditions when computing fuel requirements → May affect selection of alternates**
  - **Part 135 ARC Recommendation:** No proposed consideration for fuel requirements

Airplane Operations Recommendations

- **Flightcrew and Dispatcher Training**
  - Stabilized approach concepts
  - Visual cues during transition from approach to landing
  - Knowledge in all aspects and assumptions used in landing performance determinations, including the runway condition matrix
  - How and when to report braking action
  - Effects of excess speed, touching down beyond the touchdown zone, delays in activating deceleration devices, etc.
  - Procedures for obtaining optimal landing performance on contaminated runways
    - **Part 135 ARC Recommendation:** No specific training elements recommended by Part 135 workgroup for landing.

Airplane Certification Recommendations

Airplane Certification Recommendations

- Retain current landing distance requirements
- Add new requirements pertaining to landing distances to be used for time of arrival landing distance assessments
- Add new requirements for contaminated runway takeoff data

Airplane Certification Recommendations

- Landing distances to be provided in terms of contaminant type/depth and braking action
- Takeoff distances to be provided in terms of contamination type/depth only
- Contamination type/depth and braking actions to be defined consistent with the runway surface condition matrix
- Braking coefficients to be used for distance calculations defined for each condition in the matrix

Airplane Certification Recommendations
(continued)

Runway Code	Runway Description	Braking Action	Wheel/airplane Braking Coefficient
6	Dry		90% of demonstrated dry capability
5	•Wet (smooth, grooved, or PFC) •Frost 1/8" or less of: •Water •Slush •Dry or wet snow	Good	Per method currently used for wet runway accelerate-stop distances
4	Compacted snow at or below -13ºC	Good to medium	0.20
3	•Wet (Runway NOTAM'd as slippery when wet) •Greater than 1/8" dry or wet snow at or below -3ºC •Compacted snow above -13ºC and at or below -3ºC	Medium	0.16
2	Compacted snow above -3ºC Greater than 1/8" of: •Water •Slush •Dry, or wet snow above -3ºC	Medium to poor	50% of wet smooth below 85% of the hydroplaning speed. 0.05 at speeds at and above 85% of the hydroplaning speed.
1	Ice at or below -3ºC	Poor	0.08
0	Wet ice or ice above -3ºC Water on top of compacted snow Dry or wet snow on top of ice	Nil	No data provided/operations prohibited

Summary of Recommendations

- Require manufacturers of large turbine powered airplanes and all turbojet airplanes to provide approved contaminated runway takeoff and landing performance data in the Airplane Flight Manual using a standardized method
- Require airplane operators to conduct an assessment of landing distance requirements at the time of arrival using manufacturers' approved contaminated runway performance data, taking into account:
  - Conditions at time of landing (wind, pressure altitude, temperature, runway slope, approach speed, airplane configuration, landing weight)
  - Reported runway surface conditions or braking action reports
  - A 15% safety margin
- Require airplane operators to use manufacturers' approved contaminated runway takeoff data for takeoffs from contaminated runways
- Provide the best available (considering accuracy, timeliness, and operational usability) runway surface condition information to flightcrews for them to make their takeoff and landing performance assessments

Next Steps

- **FAA team to review ARC recommendations, make recommendations, and provide options to FAA senior management for rulemaking. Rulemaking priority and timing affected by:**
  - Changes in FAA senior management personnel
  - Recent accidents
  - Congressional interest
  - Size of rulemaking “pipeline”
- **High priority items:**
  - Pilot training
  - Pilot fatigue
  - Icing

Next Steps (cont.)

- FAA is working with EASA and ICAO for international harmonization
- Both reacted favorably to the TALPA ARC recommendations
- Both are awaiting FAA response to the recommendations

Questions?

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