TALPA ARC
Airport/Part 139 Working Group Recommendation
April 9, 2009

Background: Following the overrun of a Boeing 737 at Midway in December of 2005 the FAA found that the current state of the industry practices did not have adequate guidance and regulation addressing the operation on non-dry, non-wet runways, i.e., contaminated runways. As such they chartered an Aviation Rulemaking Committee (ARC) to address Takeoff and Landing Performance Assessment (TALPA) requirements for the appropriate part 23, 25, 91K, 121, 125, 135, and 139 Parts of 14 CFR. In formulating their recommendations it became clear to the ARC that the ability to communicate actual runway conditions to the pilots in real time and in terms that directly relate to expected aircraft performance was critical to the success of the project. While researching current NOTAM processes numerous significant short comings were discovered that hampered this communication effort. This document provides NOTAM formatting recommendations and reporting procedures intended for a digital communication process that would support this major safety initiative and resolve the identified short comings. Without accurate real time information pilots cannot safely assess takeoff or landing performance.

At the core of this recommendation is the concept of using the included **Paved Runway Condition Assessment Table** (the matrix) as the basis for performing runway condition assessments by airport operators and for interpreting the reported runway conditions by pilots in a standardized format based on airplane performance data supplied by airplane manufacturers for each of the stated contaminant types and depths. The concept attempts, to the maximum extent feasible, to replace subjective judgments of runway conditions with objective assessments which are tied directly to contaminant type and depth categories, which have been determined by airplane manufacturers to cause specific changes in the airplane braking performance. However, since the concept is radically different from the traditional practices in this area, several caveats are integral to this recommendation:

In order to succeed, this concept will require extensive retraining of airport operations personnel, dispatchers and pilots to assure that the application of the matrix is consistent across airports and that interpretation of the results and reporting of braking performance via PIREPs is consistent with the terms of the matrix. Specific training issues requiring attention are identified in Appendix A.

Since the matrix has only been tested at two airports for a portion of the winter of 2008/2009, and some potential discrepancies between the matrix and both airport personnel assessments and PIREPs have been identified under certain conditions, a much more extensive pilot program should be conducted during the winter of 2009/2010. This pilot program should involve 10 – 20 airports and require standardized documentation that can be analyzed in support of refinements to the matrix or the accompanying instructions, if warranted. This pilot program might be conducted under the auspices of the Commercial Aviation Safety Team, using the ASIAS program with its capability of employing FOQUA data to correlate individual airplane stopping performance with runway condition assessment codes in effect at the time. It would also be highly desirable to have airline participation in the pilot program.

During the course of this ARC work effort, numerous cases were identified by the airport/Part 139 working group where various FAA guidance documents use inconsistent terms or definitions. A thorough harmonization of other guidance documents with this recommendation should be undertaken. The documents identified by the working group are listed in Appendix B.

Advisory Circular 150/ 5200-30 was amended last winter to address the immediate needs of closing a runway upon receipt of a "nil" braking action report and taking specific actions upon receipt of two successive "poor" braking action reports. There is a pressing need to further revise that AC before next winter to clarify the appropriate method of returning a runway to service after a closing due to "nil" braking reports and to address other inconsistencies the working group has identified.

Because of the close interrelationship between performing runway condition assessments and the reporting of those assessments, these recommendations are presented in two sections: each section must be considered as integral to the overall recommendation. The first section addresses runway condition assessment using the matrix and the second section addresses changes to the reporting system that should be incorporated into the revisions to the NOTAM system, currently being designed. While the use of the matrix as the basis for ultimate implementation of runway condition assessment and reporting is the core recommendation of the working group, it must be treated as a "living document" and any changes that result from additional experience gained during the pilot program, or otherwise, must be fully coordinated with all stakeholders and incorporated into both sections of this recommendation.

Section 1 - RUNWAY CONDITION REPORTING

This document is intended to capture necessary runway condition reporting logic to support the Takeoff and Landing Performance Assessment ARC recommendations. This is not a standalone document. These procedures must be incorporated into existing AC and other guidance materials. While there are numerous acceptable methods to accomplish the communication of this information, the specific terms, depths, percentages, thresholds and definitions must not be altered unless such changes are reviewed and approved by the airplane manufacturers' aviation performance engineers and the changes are coordinated with each stakeholder.

Instructions to Airport Operators:

Whenever a runway is not dry the airport operator is responsible for providing current runway surface condition reports. Report runway surface conditions using the runway condition and contamination terms, percentage of runway coverage, contaminant depth, and procedures provided in this document.

During active snow events or rapidly changing conditions (e.g., increasing snowfall, rapidly rising or falling temperatures) airport operators are required to maintain a vigilant runway inspection process to ensure accurate reports.

Downgrade Assessment Adjustments

When data from the shaded area in the table (i.e., CFME/deceleration devices, pilot reports, or observations) suggest conditions are worse than indicated by the present contaminant, the airport operator should exercise prudent judgment and, if warranted, report a lower runway condition code than the contamination type and depth would indicate in the table below. While pilot reports (PIREPs) of braking action provide valuable information, these reports rarely apply to the full length of the runway as such evaluations are limited to the specific sections of the runway surface in which in which wheel braking was utilized. Downgrade assessment criteria may never be used to upgrade contaminant based assessments of condition codes (e.g., from 2 to 3).

> ***Example:*** *The full length of the runway is covered with ½" wet snow (-4°C) resulting in a 3/3/3 runway condition code. However, if the airport operator finds the last third of the runway is slicker than would be indicated by this runway condition code, the airport operator should consider reporting a runway condition code of 3/3/2.*

PAVED RUNWAY CONDITION ASSESSMENT TABLE

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	• Dry	-	-	Dry
5	• Wet (Smooth, Grooved or PFC) • Frost ***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	• Wet (Slippery) ***At or below -3°C:*** • Dry or Wet Snow greater than 1/8" ***Above -13°C and at or below -3°C:*** • Compacted Snow	35-30μ	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	Medium
2	***Greater than 1/8" of:*** • Water • Slush ***Above -3°C:*** • Dry or Wet Snow greater than 1/8" • Compacted Snow	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	• Wet Ice • Water on top of Compacted Snow • Dry or Wet Snow over Ice ***Above -3°C:*** • Ice	20μ or lower	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain.	Nil

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 0.125 inches (3 mm), or any 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.*

Section 2 - CONCEPT FOR RUNWAY CONDITION NOTAMs

1. The system must allow for all season real time NOTAM dissemination in a manner accessible via typical requests for NOTAMs by any customer. The output should be retrievable in several formats to include clear text, contractions, and machine readable. The system should allow for easy import of NOTAM data into information systems used by air carrier dispatch centers.
2. The input side of the system should:
    a. Allow for secure password protected web access for easy input by airport personnel.
    b. Incorporate simplified drop down input menus and logic to only allow use of the following standardized runway condition and contamination terms, percentage of runway coverage and contamination depths:
        i. Runway Condition and Contamination terms:
            1. Dry
            2. Wet (Smooth)
            3. Wet (Grooved)
            4. Wet (PFC)
            5. Wet (Slippery)
            6. Water
            7. Slush
            8. Wet Snow
            9. Dry Snow
            10. Compacted Snow
            11. Frost
            12. Ice
            13. Wet Ice
        ii. Percentage of runway coverage:
            1. Whenever a runway is not bare and dry, runway condition NOTAMs are to be issued. The menu system should provide options for input of the specific runway condition and contamination terms above, and the depth and percentage of runway coverage per the specifications in this document.
            2. Reported Runway Width: Include a menu option to designate the reported runway width (e.g., cleared, treated, usable) when less than full.
            3. Simple drop down menus should provide the following percentage of runway coverage as it pertains to the full width of the runway, or if the cleared width is reported in the NOTAM, the percentage of coverage of that cleared width:
                - 10% (Label the drop down tab "10% or less")
                - 25% (Label the drop down tab "11% thru 25%")
                - 50% (Label the drop down tab "26% thru 50%")
                - 75% (Label the drop down tab "51% thru 75%")
                - 100% (Label the drop down tab "76% thru 100%")
            4. Runway condition codes (see the Paved Runway Condition Assessment Table) are only reported when contaminant coverage exceeds 25 percent of the runway length and width (or cleared width if cleared width is reported in the NOTAM). When contaminant coverage exceeds 25 percent of the runway length and width (or cleared width as noted above), the system should automatically provide an additional menu to capture the data necessary to automatically determine and issue runway condition codes for each third of the runway per the Paved Runway

Condition Assessment Table (e.g., 3/3/2). The data to be captured includes the contamination type and depth present on the full width or cleared width (if so reported) for each third of the runway, and surface or OAT temperature values (see Paved Runway Condition Assessment Table). (Automated capture of temperatures is preferred.) If a cleared width is reported, the runway condition codes pertain to that limited width, not the full width. The contaminants (type and depth) on the uncleared runway edges must also be reported, but without a corresponding runway condition code.

- The output NOTAM should not include contaminant type and depth for each third of the runway as this would cause excessive NOTAM lengths. The by thirds input is solely a means to determine and provide runway surface condition codes for each third of the runway (e.g., 3/3/2).
- Issuing runway conditions codes (e.g., 3/3/2) is the pilots' cue to start using non-dry stopping performance values.
- When multiple contaminants are present assign the runway condition code based on the slickest contaminant condition (type, depth and temperature based on the definitions in the Paved Runway Condition Assessment Table above) that exceeds 10% of the runway third. Runway condition codes should not be based on contaminants with 10% or less of coverage in a given runway third.
- To support data tracking and quality control there should be an input field to capture and track the Mu reading (if obtained) for each third of the runway. This Mu value would not be output in the NOTAM but would help with future reviews of the data and possible improvements in the Matrix logic. Additionally, if the Mu value is worse than defined in the table above, its input could be used to cause the system to automatically downgrade the runway surface condition code.

iii. Contamination depths. When reporting contamination depths, do not report depths for ice, frost, or compacted snow. Report all other levels of contamination depths as follows:

1. 1/8" (Label the drop down tab: "1/8" or less")
2. ¼" (Label the drop down tab: "Greater than 1/8" thru 1/4")
3. ½" (Label the drop down tab: "Greater than 1/4" thru 1/2")
4. ¾" (Label the drop down tab: "Greater than 1/2" thru 3/4")
5. 1" (Label the drop down tab: "Greater than 3/4" thru 1")
6. 2" (Label the drop down tab: "Greater than 1" thru 2")
7. 3" (Label the drop down tab: "Greater than 2" thru 3")
8. 4" (Label the drop down tab: "Greater than 3" thru 4")
9. Note: After 1 inch of accumulation report additional accumulation in whole inches and discontinue the use of fractions. After a depth of 35 inches report the additional amounts in whole feet only. (AC 150/5200-28D)

c. The menu must have an override feature to allow manual (or automatic??) downgrade of assigned runway condition codes (i.e., to assign a lower number) when desired.

i. Logic should not allow upgrading of the runway condition code (i.e., assigning a higher number).

ii. From a quality control standpoint, there should be an input field to capture the reason for the downgrade (e.g., click one of the following options: Mu, Pilot or Operations vehicle Braking Action Report and capture the data). This information would help with future improvements in the Matrix logic.

d. The menus should have provisions for entering optional data in a standardized format, such as:
    i. CENTER XXX FEET CLEARED, EDGES (contamination description), or
    ii. FIRST, CENTER or LAST XXXX FEET (contamination description), or
    iii. Use of the "OVER" description (e.g., WET SNOW OVER COMPACTED SNOW, DRY SNOW OVER ICE etc.). When the "OVER" descriptor is used assign the runway condition code based on the slickest contaminant condition (type, depth and temperature based on the definitions in the Paved Runway Condition Assessment Table above) that exceeds 10% of the runway third. Runway condition codes should not be based on contaminants with 10% or less of coverage in a given runway third.

e. The menu needs to include a "Runway Properties" tab where established properties such as the runway number, surface type (i.e., smooth, grooved, PFC or slippery) are pre-designated. These properties should be referenced to auto generate numeric runway options available on the runway condition input menu (e.g., RWY 17, RWY 35 etc.). Incorporate programming logic so that if "wet" is selected as the runway condition, the output NOTAM would automatically include the designated surface type as follows:
    i. WET (SMOOTH), WET (GROOVED), WET (PFC) or WET (SLIPPERY).
    ii. If friction evaluations conducted in accordance with AC 150-5320-12C reveals the average friction level is less than required, downgrade the runway property as appropriate (e.g., SMOOTH or SLIPPERY). Following this downgrade, if "wet" is the reported condition, the system would automatically generate the corrected output NOTAM (e.g., WET (SMOOTH) or WET (SLIPPERY)).
    iii. WET (SMOOTH, GROOVED or PFC) must automatically generate a runway condition code of 5.
    iv. WET (SLIPPERY) must automatically generate a runway condition code of 3.
    v. When a friction failed runway is brought back into proper specifications the airport operator would change the runway property back to its design specification (e.g., GROOVED).
    vi. The SLIPPERY modifier in the properties tab needs to include a location selection breakout such as: FIRST XXXX', LAST XXXX' or ENTIRE, where XXXX' is the designated slippery zone. For example, if the first 3000' of RWY 35 failed a preventive maintenance friction survey and the runway is wet, the output would read "RWY 35 3/5/5 WET (GROOVED), FIRST 3000' WET (SLIPPERY)". (Conversely, if runway 17 is the active runway the output NOTAM would automatically read "RWY 17 5/5/3 WET (GROOVED), LAST 3000' WET (SLIPPERY)".) If the entire runway is slippery, the NOTAM would read "RWY 35 3/3/3 WET (SLIPPERY)".

f. The system logic must only allow a runway third to be reported as "DRY" (code 6) when other sections are wet or contaminated (codes 0 through 5).
    i. The code of 6 should only be used if the runway's cleared width is more than 25% wet or contaminated and at least one third of the runway is reportable as DRY (e.g., 6/6/5).
    ii. A runway with a cleared width of at least 76% dry would not have any codes assigned; the dry sections would be reported as DRY and the contaminated sections and edges would be reported appropriately.
    iii. A runway 100% bare and dry would be reported as DRY (if a runway condition report is issued) and would have no codes assigned. (A code report of 6/6/6 should be inhibited.)

g. The menu should allow for reporting conditions for each specific runway (by number).Report the runway numbers directionally according to the direction of takeoff and landing (e.g., RWY 35).

3. The output NOTAMs should include the option for retrieval in multiple formats to include clear text, contractions and machine readable. To help clarify the logic and guidance provided in this document, the following examples provide an airport observation and the resulting (clear text) NOTAM:

Scenario 1:

Grand Rapids Airport observed the following conditions for runway 17:

- Average surface temperature -7C
- Mu 32/32/32
- The entire runway was covered with ½" dry snow
- Operations vehicle experienced reduced directional control slightly reduced braking action and no downgrade in condition was recommended.

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

Scenario 2:

Cherry Capital Airport observed the following conditions for runway 28:

- Average surface temperature -4C
- Mu 42/44/46
- The runway had 75% coverage of 1 inch dry snow over 50% coverage of compacted snow
- Operations vehicle experienced significantly reduced braking action and directional control
- The runway condition codes were downgraded from 3/3/3 to 1/1/1 based on the observers judgment given the poor operations vehicle braking action and control.

TVC RWY 28 1/1/1 75% 1 INCH DRY SNOW OVER 50% COMPACTED SNOW 2115Z 20 JAN 2009

Scenario 3:

Denver International Airport observed the following conditions for runway 07:

- Average surface temperature -1C
- Mu 24/31/27
- The runway had 75% coverage of 1/4 inch slush 130 feet wide with compacted snow on the remaining edges. The compacted snow on the remaining edges was not used to determine runway condition codes.
- The operations vehicle experienced noticeably reduced braking action and directional control and no downgrade in condition was recommended.

RWY 07 2/2/2 75% 1/4 INCH SLUSH 130 FEET WIDE REMAINING EDGES COMPACTED SNOW 1420Z 20 JAN 2009

Scenario 4:

Denver International Airport observed the following conditions for runway 35L:

- Average surface temperature -4C
- Mu 32/24/21(the last 2 numbers were outside approved measuring parameters)
- The first 7000'of the runway was plowed to 60' wide with 50% compacted snow remaining
- The remaining edges of the first 7000' averaged 2 inches of dry snow over compacted snow
- The last 5000' was 75% covered with 4 inches of dry snow over compacted snow and 10% covered with 6 inch dry snow drifts over compacted snow
- The snow banks just off the runway edges was averaging 24 inches high
- Operations vehicle experienced noticeably reduced braking action and directional control and no downgrade in condition was recommended.

DEN RWY 35L 3/3/3 FIRST 7000 FEET 50% COMPACTED SNOW 60 FEET WIDE REMAINDER 100% 2 INCH DRY SNOW OVER COMPACTED SNOW LAST 5000 FEET 75% 4 INCH DRY SNOW 10% 6 INCH DRY SNOW 24 IN SNOWBANKS 1200Z 20 JAN 2009

RATIONALE

- Contaminant terms were harmonized to the maximum extent possible with ICAO. The few differences are due to the ARC's desire to limit terms to those for which manufactures can provide performance data. Runway surface descriptions such as

SMOOTH, GROOVED and PFC were added to WET conditions to allow manufactures to gain improved performance capability when providing such data (as a few currently provide). This descriptor technique made also made it easier to deal with and report when the SLIPPERY condition exists.

- The contaminant coverage threshold of 25% for the total runway (or less with a reported width) for when runway condition codes are to be reported mirrors guidance in existing AC 91-6A (and draft B) for when takeoff performance penalties apply. The issuance of runway condition codes is the signal for pilots to use appropriate non dry landing data. Additionally this threshold was reviewed and recommended by the manufacture performance engineering team represented in the ARC. To prevent a small ice puddle or other minor situation from causing a runway third to be coded slicker than reasonable, the minimum threshold of 10% was established and each runway third should be coded with the slickest condition exceeding this 10% threshold.
- The recommended percent coverage thresholds (e.g., 10%, 25% etc) were designed to provide a reasonable idea of what a pilot can expect without causing unnecessary complication. The smaller 10% threshold provides a means for airports to convey a minor contaminant issue (e.g., a few low spots trapped water and froze) without giving the impression the runway is worse than it is. The 25% or less option conveniently hits just shy of the threshold requiring the reporting of runway condition codes. Vague terms such as PATCHY were eliminated.
- The measurement increments recommended for depth reporting (e.g., 1/8", 1/4" etc) are aligned to correlate with changes in both takeoff and landing performance issues. Vague adjectives such as THIN or TRACE were eliminated.
- Runway condition codes are to be issued per the definitions provided in the Paved Runway Condition Assessment Table. However, because it is occasionally possible for metrological conditions to cause the correlated stopping performance to be less than expected the ability to allow for intervention and a downgraded code must be possible. Code downgrades may be accomplished manually or automatically if reasonable logic constraints are designed and incorporated in the data capture process. Downgraded runway condition codes assessments should be based on all available observations to include Mu, PRIRPs, operations vehicle controllability issues or simply the judgment of the observer. Conversely, for safety reasons it is not desired to allow airport personnel to upgrade a runway condition report from what is defined in the table.
- To prevent confusion and provide ease of understanding runway condition NOTAMs should only report the runway numbers directionally according to the direction of takeoff and landing (e.g., RWY 35). There is no desire to include the word OPEN in the NOTAM. The act of providing a runway condition NOTAM means the runway is open. Closed runways are to be NOTAMed as CLOSED with no condition provided. The runway condition codes were placed in the leading part of the NOTAM to make it easy to scan the list of runways and locate an acceptable runway option.
- It is highly desirable to organize all runway, taxiway and ramp condition NOTAMs by type, together in a single section of the airports NOTAM report (e.g., an airfield condition section).

APPENDIX A – TRAINING ISSUES

Specific needs for Airport Operators' Guidance Identified by the W.G.:

Clear guidance is needed on the process of when and by how much to downgrade a runway condition code.

Guidance is needed on the frequency with which NOTAMs must be reissued during changing conditions.

Guidance is needed on developing codes for the reported center section vs the edges or the "remainder" of runways.

Guidance is needed on reporting the surface temperatures, differentiating between the use of the average of multiple imbedded runway surface temperature reporting devices ("pucks") and infrared temperature measurements of the surface of any contaminants that may be present.

Specific Needs for Pilots' Guidance Identified by the W.G.:

General guidance must be developed for pilot training in the use of the matrix – both how to interpret it via their airplane performance data and how to report braking action PIREPs which are consistent with the airplane handling characteristics described in the matrix. Particular emphasis should be placed on the difficulty of interpreting the intermediate braking action categories of "good to medium" and "medium to poor".

APPENDIX B – GUIDANCE DOCUMENTS REQUIRING HARMONIZATION

Amend 150-5200-30, "Winter Safety and Operations" to include contaminant description and braking action portions of the runway safety matrix and to eventually include the entire matrix and associated methodology, to clarify the appropriate method of returning a runway to service after a closing due to "nil" braking reports, to define runway condition assessments, to establish a frequency for conducting runway condition assessments, to place proper emphasis on the use of friction measurement equipment (Mu) to assess runway conditions and to address other inconsistencies the working group has identified.

Amend NOTAM AC 150/5200-28 and Order 7930.2 to reflect changes in matrix (patchy, thin, trace vs. contaminant % coverage, depth, etc).

Amend AC 150/5320-12, "Measurement, Construction, And Maintenance of Skid Resistant Airport Pavement Surfaces", for consistency with matrix (establish threshold minimum friction value for matrix entry).

Amend AC 150/5200-18 "Airport Safety Self Inspection" to correlate snow and ice section with winter operations AC.

Amend training programs for airport operators, airplane operators, FAA personnel (Order 7110.65, 7110.10, etc.). Harmonize ATC and Airports procedures.

Amend AC 150/5235-4, "Runway Length Requirements for Airport Design" to include 15% safety margin for Snow Belt airports.

Amend the AIP handbook to establish eligibility for runway extensions needed to meet the 15% safety margin.

Amend AC 91-6A, "Water, Slush and Snow on Runway" to be consistent with Winter Operations AC and TALPA recommendations.