# Unveiling the Matrix

**A new tool for assessing and reporting runway condition.**

BY PATRICK CHILES

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Government and industry members of the Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC) provided some welcome insights into their findings and recommendations for improving the safety of operations on contaminated runways at an October 2010 presentation to Boeing's Performance and Flight Operations Engineering Conference. The presentation included a briefing on progress in developing a decision-making tool that is informally called the "Runway Condition Matrix." The matrix enables the correlation of various criteria to prepare a runway condition report for pilots in readily understood terminology.

The TALPA committee was formed by the U.S. Federal Aviation Administration (FAA) following the Boeing 737-700 overrun at Chicago Midway International Airport in 2005 — and a subsequent attempt to mandate before-landing performance assessments that was dropped in favor of a comprehensive review of the safety issues involved in operations on contaminated runways.

As is often the case with a tragic event, the Midway accident drove regulators to search for deficiencies within their own policies and guidance. While the landing field length margins for dispatch seem quite generous, the safety provisions of the "60 percent rule" diminish if the expected runway is changed or if conditions deteriorate.[1] Unless landing distances are recalculated before arrival based on existing conditions, operators sometimes are exposed to considerable risk.

## Back-Door Legislation

Within months of the Midway accident, an FAA internal review team proposed two requirements: that manufacturers provide landing data for contaminated runways; and that operators conduct landing performance assessments before arrival that include a 15 percent safety margin.[2]

The proposed requirements were issued as a "notice of policy statement," which was met with sizeable resistance. Many operators expressed concern at what they saw as subversion of the public rule-making process — requiring new OpSpecs (operations specifications) without a supporting regulatory framework. Charter and fractional ownership operators were alarmed that the practical effect of the requirements would be to shut them out of the smaller airports where their businesses thrive.

The FAA eventually replaced the notice of policy statement with a safety alert for operators (SAFO) that "urgently recommends" that operators develop procedures for flight crews to perform a before-landing assessment that incorporates the 15 percent safety margin.[3] At the same time, the TALPA committee was chartered to begin work on formal rule making. Its task was threefold: establish airplane certification and operating standards for contaminated runways; create distance assessment and safety margin requirements; and improve standards for runway surface condition reporting. The solution would not just be on the operator's shoulders; manufacturers, airport operators and air traffic service providers also would be affected.

It soon became clear that, in terms of runway contamination, there in fact were no common terms. Current surface reporting methods have suffered from nonstandard descriptions and different measurement techniques, and they are inherently subjective. Braking action reported as "good" by the crew of a Cessna Citation might be entirely different for the crew of a widebody Boeing following in trail. Further, runway friction reports — Mu reports — can be deceptively imprecise because they don't directly correlate with an airplane's braking friction tables; they are, in fact, measuring different values of friction.

The only commonality was that all these methods have shortcomings. This led the committee to devise a combination of the best attributes of each method while attempting to correct their known deficiencies.

## Enter, the Matrix

The Runway Condition Matrix is a result of the committee's efforts.[4] The matrix is an attempt to correlate the various types of surface condition reports with a given aircraft's contaminated-runway landing data in a standardized and easily understood reporting method (Table 1). This has been an elusive goal primarily due to different frames of reference: an airport's measurement — or, more often, *estimate* — of Mu is a wheel-to-pavement friction value, whereas an aircraft manufacturer's Mu represents internal friction between wheels and brakes.

The matrix is not yet a finished product; the FAA is still working to develop better characterizations of runway conditions. A limited round of beta testing was completed last winter; further testing will be performed this winter with two aircraft operators and 13 airports. The final results may be presented in different formats depending on the user, but the terminology and relationships between values will be the same for operators, airports and aircraft manufacturers. The matrix eventually will present reliable information to pilots and dispatchers in an unambiguous decision-making tool. It will also provide airport managers and aircraft manufacturers with common reference points for surface conditions and related braking effectiveness.

## Clearer Coding

Accurately reported runway conditions with common definitions will be the linchpin of this effort. The scheme will rely to a great extent on the airport operators who adopt the new reporting conventions.

Several changes are being proposed for notice to airmen (NOTAM) coding. Abandoning the use of terms such as "patchy," "thin" and "trace," airport operators would, instead, use terminology that is more in line with airplane flight manual (AFM) contaminated-runway terminology. They would report runway conditions in terms of contaminant type, depth and percentage of runway coverage in a manner more consistent with the International Civil Aviation Organization (ICAO) recommendation of a numbering system that varies from zero for wet ice to six for a dry runway. For example, Table 1 shows that a runway condition report of "4/4/3" would indicate that frost or compacted snow (Code 4) covers the first two-thirds of the runway, while the final third is covered with dry or wet snow deeper than 1/8 in (Code 3). This would also be equivalent to a pilot report of "good-to-medium" braking action.

Standardization also means that airports could continue using Mu measurements and pilot reports to support their assessments but would cease issuing these directly. The information will be part of the data set used to substantiate a condition report, not the report itself. In particular, Mu measurements and pilot reports can contribute to the *downgrading* — or modification — of a prior assessment (i.e., from bad to worse) based on contaminant type and depth, alone, but not to upgrading it. Direct observations of the runway and measurements of contaminant depth are required to upgrade an assessment.

**Proposed Runway Condition Matrix, October 2010**

| Assessment Criteria | | Downgrade Assessment Criteria | | Pilot Reports Provided to ATC and Flight Dispatch |
|---|---|---|---|---|
| **ICAO Code** | **Runway Condition Description** | **Mu (µ)** | **Deceleration and Directional Control Observation** | |
| 6 | Dry | | — | Dry |
| 5 | Wet (smooth, grooved or PFC runway)<br>1/8 in or less depth of:<br>Water<br>Slush<br>Dry snow<br>Wet snow | 40 or higher | Braking deceleration is normal for the wheel braking effort applied. Directional control is normal. | Good |
| 4 | Frost<br>At or below –15°C outside air temperature:<br>Compacted snow | 30–39 | Braking deceleration and controllability are between good and medium. | Good to medium |
| 3 | Wet ("slippery when wet" runway)<br>Dry snow or wet snow (any depth) over compacted snow<br>Greater than 1/8 in depth of:<br>Dry snow<br>Wet snow<br>Warmer than –15°C outside air temperature:<br>Compacted snow | | Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced. | Medium |
| 2 | Greater than 1/8 in depth of:<br>Water<br>Slush | 21–29 | Braking deceleration and controllability are between medium and poor. Potential for hydroplaning exists. | Medium to poor |
| 1 | Ice | | Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced. | Poor |
| 0 | Wet ice<br>Water on top of compacted snow<br>Dry snow or wet snow over ice | 20 or lower | Braking deceleration is minimal to nonexistent for the wheel braking effort applied. Directional control may be uncertain. | Nil |

ICAO = International Civil Aviation Organization; Mu = runway friction measurement; ATC = air traffic control; PFC = porous friction coating

Source: U.S. Federal Aviation Administration

**Table 1**

## Safety Margin

As expected when the SAFO was published in 2006, airline operators will be required to conduct before-landing performance assessments that incorporate the 15 percent safety margin. The safety margin largely is considered necessary because it will be applied to *operational* distances that contain no other adjustment factors and typically include credit for the use of thrust reversers. The AFM numbers used for *dispatch*, on the other hand, are based on an entirely different set of assumptions, which already confirm that the airplane can stop within 60 percent of the available runway without reversers. *ASW* readers might recall that misunderstanding the differences in operational and dispatch landing performance contributed to the Midway accident (*ASW*, 2/08, p. 28).

Before-landing assessments will not be required if the condition of the intended runway has not changed or deteriorated while en route, but takeoff performance assessments will have to consider contaminant reports.

After some initial objections, TALPA ARC members representing the airlines eventually concluded that the proposed 15 percent safety margin is "arbitrary but reasonable." However, due to different operating environments and philosophy, agreement was not reached between air carrier and business jet operators. For this reason, the 15 percent margin will be proposed only for U.S. Federal Aviation Regulations (FARs) Part 121 air carrier operators; it will not affect Part 135 air taxi/commuter operators, Part 91K fractional ownership operators or Part 125 operators, which operate airplanes with 20 or more passenger seats or with a maximum payload capacity of 6,000 lb (2,722 kg) or more.

Airline participants on the committee have pointed out that better guidance and training, and changes to fundamental thought processes will be needed to make this effort successful. In particular, differences among manufacturers in air-distance assumptions — basically, the assumed length from the approach threshold to the touchdown point on the runway — can have a significant effect on actual landing lengths. Pilots should be encouraged to treat contaminated runways as if they were "short fields" — not allowing their airplanes to "float" for a softer touchdown and being ready and willing to go around if they are unable to touch down as planned.

## More Data Needed

Operators, of course, won't be able to do any of this without new data from the manufacturers, which will face significant changes in airplane certification standards and requirements for the related FAA-approved AFMs. In the United States, performance data for contaminated runways are not required and are typically not included in the AFM, although such data may be provided in unapproved operating manuals or performance software.

Other than evolving from advisory to approved status, this is not an entirely new concept. European authorities already insist that contaminants be compared against approved dry or wet numbers for landing and takeoff. New flight testing is not expected; manufacturers will be able to develop the data from calculations based on adapting the current European Aviation Safety Agency (EASA) CS-25 transport category airplane certification standards. The data will assume uniform coverage of contaminants on the runway and include specific braking coefficients for each coded surface condition. Effects of contaminant-displacement and -impingement drag, and hydroplaning also must be considered for each contaminant type and depth, across the spectrum of braking actions from "poor" to "good."

All new and existing airplanes certificated under FARs Part 25 would be affected, as well as new Part 23 commuter and multiengine turbojets, and some existing Part 23 models. After the final rule goes into effect, manufacturers will have two years to bring in-production aircraft into compliance. Four years will be allowed for out-of-production models.

## Rule-Making Logjam

The TALPA ARC charter expired after the committee presented its final recommendations in October 2009. The FAA has begun the rule-making process but has yet to reach some decisions on content, scope or timing. The committee's total-system approach, although admirable, unfortunately has made new performance rule making enormously complex, intertwining multiple lines of authority across the FAA, which recently has been burdened further by congressional mandates for new crew rest and scheduling rules. Resolution has become limited by available resources.

Readers should bear in mind that no formal action has been taken on the recommendations of the TALPA committee; the final results may appear different. The FAA expects to move on the committee's recommendations in 2011, barring any further congressional intervention.

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### Notes

1. The "60 percent rule" refers to FARs Part 121.195, Part 135.385 and Part 91.1037, which basically prohibit a large turbine airplane operated by an air carrier, a commuter or on-demand operator, or a fractional ownership operator, respectively, from departing unless its weight at the expected time of arrival at the destination airport allows a full-stop landing within 60 percent of the effective length of the intended runway.
2. A "15 percent safety margin" means, for example, if a flight crew calculated an actual landing distance of 5,000 ft based on the conditions existing upon arrival, they would have to ensure that the available landing distance on the intended runway is at least 5,000 times 1.15, or 5,750 ft.
3. SAFO 06012. "Landing Performance Assessment at Time of Arrival (Turbojets)." Aug. 31, 2006.
4. The official title of the matrix has undergone several changes and currently is the "Paved Runway Condition Assessment" table.