ASOS RESEARCH BRIEF

Research Request:

Braking action restrictions - how it's determined and how to use it for the movement at hand. (ex. nil - no taxi, takeoff, landing) should we only be referencing MU numbers and not Good, Fair, Poor, Nil ??

Research Response:

Braking Action Reports

Braking action reports are issued whenever the weather and runway conditions warrant their reporting. The determination of the quality of the runway conditions are based on the runway surface condition and/or a pilot report. According to the Air Traffic Control Manual (Order 7110.65R), the quality of braking action is referred to as good, fair, poor, nil, or a combination of these terms. Upon receipt of a pilot report, ATC will state the current braking action along with the type aircraft reporting the braking action. For example: “Braking action poor, reported by a Boeing 747.” ATC may also specify which section of the runway has poor braking action using intersections for reference or by specifying the first or second half of the runway. These braking action advisories are issued when the following condition(s) are met:

- No MU (coefficient of friction) measurement is available
- Braking action reports are received from pilots
- Airport management uses the terms poor or nil
- Weather conditions are conducive to deteriorating or rapidly changing runway conditions

Braking Action Reports Defined

Normal: Maximum energy stops possible with little deterioration in certified stopping distance.
Good: More braking available than will be used in average deceleration. If it is a maximum energy stop, some excess distance from certified stopping distances is expected.
Fair: There is sufficient braking and cornering available for a well flown approach using light braking. Excess speed and/or long touchdown may result in narrowed safety margins.
Poor: Crosswind is the biggest concern and the room for error is minute.
Nil: There is no braking friction, even at low taxi speeds. It is recommended if the reported braking action is nil, no landing attempt should be made unless no other safe course of action is possible.

ATC

When conditions are met for reporting braking action advisories the ATIS will state, "Braking action advisories are in effect." ATC will issue reports to every arrival and departure, and attempt to correlate reports of similar type aircraft (i.e. aircraft classified as 'heavy' will receive reports from other 'heavy' aircraft.) If there is no report available, ATC will make a statement such as, "No braking action reports received for runway three-four."

Pilots

Pilots will typically report the braking action as either fair or poor, but are not limited to those terms. The determination a pilot makes is purely subjective. There is no real accurate method of braking action determination other than the extent to which the pilot feels there is adequate braking to maintain control of the aircraft. This will vary with each type aircraft, where they actually touchdown on the runway and the current conditions. Water may pool at certain spot on the runway depending on the runway slope, and uneven surface heating may cause patches of ice. Threshold areas may provide an additional hazard due to the slippery painted surface, and touchdown zone areas are typically smoother due to rubber from repeated landings in the same area.

MU (coefficient of friction or μ)

ATC may report braking action in terms of MU on the ATIS if measuring equipment is available. The MU measurements are usually gathered from three different sections of the runway. If all three MU values are greater than 40, no report will be made. The ATIS will state the:

- Runway
- MU number for the three runway segments
- Time of report
- Description of the friction problem

An example of an ATIS reporting MU is; “Runway seven-left, MU forty-two, forty-one, twenty-eight at one zero one eight Zulu, ice.” ATC will also state the current MU number if requested by the pilot.

In order to measure MU, airport management will use friction measurement devices such as a:

- MU-Meter
- Saab Friction Tester (SFT)
- Skiddometer

These are simply vehicles with devices attached to them that measure MU at various runway locations. The average of these results is taken due to the varying conditions on a runway.

MU-Meter

Sample Charts

The chart below is an example of the correlation between the pilot terminology for braking action with the ATC phraseology, and the MU numbers for a Part 121 air carrier.

Pilot terminology	Fair		Poor	
Braking Action Report	Good/medium (Fair)	Medium (Fair)	Medium (Fair)/ poor	Poor
Mu-Meter	0.39 to 0.35	0.34-0.30	0.29-0.25	0.24-0.20

Source: Part 121 Airline

This chart is another example of the correlation between the MU numbers and the braking action terms. It also highlights the importance of crosswind consideration when landing on a runway.

Friction Cf or Braking Action Report		Recommended Crosswind Limit
0.40 or above	GOOD	35 KNOTS
0.39-0.35	FAIR TO GOOD	25 KNOTS
0.34-0.30	FAIR	20 KNOTS
0.29-0.25	FAIR TO POOR	15 KNOTS
0.24-0.20	POOR	5 KNOTS
BELOW 0.15	EXTREMELY POOR (NIL)	0 KNOTS

Source: Part 121 Winter operations manual- Saab 340

These charts are just a guide, and provide a fair estimate of the correlation between the braking action terminology and the MU numbers. However, the AIM states, **"no correlation has been established between MU values and the descriptive terms good, fair and nil used in braking action reports."**

A few guidelines for operating during contaminated runway conditions:

Taxiing
- Avoid large steering inputs
- Use gradual brake inputs
- Apply differential power to assist
- Deploy thrust reversers to stop
- Single engine taxiing on contaminated surface is not recommended

Take-off
- Should an RTO occur, make full use of thrust reversers and brakes.
- If veering occurs, stow the thrust reversers
- If equipped with anti-skid, continue to apply braking pressure and do not pump the brakes

Landing
- The runway length is the most critical consideration
- Avoid tailwinds
- Adhere to the recommended crosswind limitations of the aircraft
- Lower the nose wheel as soon as possible
- If there is a risk for hydroplaning, use brakes below your hydroplane speed
- Maintain directional control

Sources: Part 121 airline operations manual, Part 121 airline winter operations manual ,Order 7110.65R Air Traffic Control Manual, FAA 8400.10

Approach to McMurdo Station, Antarctica. Braking Action: Nil

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BRAKING ACTION

PIREPS

When braking action conditions less than Good are encountered, pilots are expected to provide a PIREP based on the definitions provided in the table below. Until FAA guidance materials are revised to replace the term Fair with Medium, these two terms may be used interchangeably. The terms “Good to Medium” and “Medium to Poor” represent an intermediate level of braking action, not a braking action that varies along the runway length. If braking action varies along the runway length, such as the first half of the runway is Medium and the second half is Poor, clearly report that in the PIREP (e.g., “first half Medium, last half Poor”).

CORRELATING EXPECTED RUNWAY CONDITIONS

The correlation between different sources of runway conditions (e.g., PIREPs, runway surface conditions and Mu values) ***are estimates***. Under extremely cold temperatures or for runways that have been chemically treated, the braking capabilities may be better than the runway surface conditions estimated below. When multiple sources are provided (e.g., braking action medium, runway covered with ice and runway Mu is 27/30/28) conflicts are possible. If such conflicts occur, consider all factors including data currency and the type of airplane a PIREP was given from. A valid PIREP or runway surface condition report are more reliable indicators of what to expect than reported runway Mu values.

Runway Friction Mu Reports

Mu values in the U.S. are typically shown as whole numbers (40) and are equivalent to the ICAO standard decimal values (.40). Zero is the lowest friction and 100 is the highest Mu friction. When the Mu value for any one-third zone of an active runway is 40 or less, a report should be given to ATC by airport management for dissemination to pilots. The report will identify the runway, the time of measurement, the type of friction measuring device used, Mu values for each zone and the contaminant conditions (e.g., wet snow, dry snow, slush, deicing chemicals). While the table below includes information published by ICAO correlating runway friction measurements to estimated braking actions, the FAA cautions that ***no reliable correlation exists***. Runway Mu values ***can vary significantly*** for the same contaminant condition due to measuring techniques, equipment calibration, the effects of contamination on the friction measuring device and the time passage since the measurement. ***Do not*** base landing distance assessments solely on runway Mu friction reports. If Mu is the only information provided, attempt to ascertain the depth and type of runway contaminants to make a better assessment of actual conditions.

BRAKING ACTION

Braking Action		Estimated Correlations		
Term	**Definition**	**Runway Surface Condition**	**ICAO**	
			Code	**Mu**
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	• Water depth of 1/8” or less • Dry snow less than ¾” in depth • Compacted snow with OAT at or below -15ºC	5	40 & above
Good to Medium	-		4	39 - 36
Medium (Fair)	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	• Dry snow ¾” or greater in depth • Sanded snow • Sanded ice • Compacted snow with OAT above -15ºC	3	35 –30
Medium to Poor	-		2	29 - 26
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Potential for hydroplaning exists. Directional control may be significantly reduced.	• Wet snow • Slush • Water depth more than 1/8” • Ice (not melting)	1	25 - 21
Nil	Braking deceleration is minimal to non-existent for the wheel braking effort applied. Directional control may be uncertain. ***Note:*** *Taxi, takeoff, and landing operations in Nil conditions are prohibited.*	• Ice (melting) • Wet Ice	9	20 & below

Note: The ICAO term “Unreliable” approximates Nil.

Source: NBAA