Transport Canada Transports Canada

Advisory Circular

Subject: **Braking Action Reports**

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1.0 Introduction

(1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

1.1 Purpose

(1) The purpose of this AC is to provide information and guidance to pilots and operators regarding the observation, reporting, and operational use of braking action reports; including:

- (a) pilot braking action reports (PBAR); and
- (b) aircraft braking action reports (ABARs).

(2) The information and guidance in this AC is intended to:

- (a) enable flight crews to accurately and consistently report the level of wheel braking performance experienced during landing, thus providing a key safety assurance check to the predictive levels of braking outlined in the Runway Condition Assessment Matrix (RCAM);
- (b) establish suitable phraseology for reporting braking action reports to air traffic services (ATS); and
- (c) provide an explanation of the engineering principals used to define braking action as detailed by the industry standards in Appendix A.

(3) This AC is intended for pilots and operators of aircraft equipped with fully modulating anti-skid systems who utilize landing performance calculation methods as documented in ICAO Doc 10064 and FAA AC 25-32.

Note: A braking action report, whether taken from pilot observations (PBAR) or aircraft data (ABAR), is intended to convey specific engineering principles that are common to all aircraft meeting the above criteria. While this is most commonly applicable to Transport category turbojet aircraft, it can also apply to other aircraft meeting the above criteria.

(4) It is recommended that operators use the guidance in this AC to develop policies and procedures that will:

- (a) enable flight crews to provide accurate and consistent braking action reports; and
- (b) facilitate time-of-arrival (TOA) landing performance assessments.

(5) This AC helps to facilitate the introduction and effective use of newly emerging safety enhancement technologies that are currently being developed.

(6) This AC also serves the additional purpose of providing supplemental information regarding performance engineering, safety considerations and acceptable standards, which are contained in Appendix D.

(7) **Caution**: **The guidance in AC 700-060 in no way changes the established regulatory requirements and guidance for runway surface condition reporting by airport and aerodrome operators.** These regulatory requirements and guidance include, but are not necessarily limited to, the responsibilities for airport and aerodrome operators to:

- (a) inspect and report runway surface conditions in accordance with the regulatory requirements specified in Subparagraph 302.07 (1)(e)(iii) of the *Canadian Aviation Regulations* (CARs) and associated guidance material;

(b) measure and report Canadian Runway Friction Index (CRFI) as per the regulatory requirements in Section 302.416 of the CARs and associated guidance material; and

(c) consider and take any appropriate action deemed necessary in response to braking action reports from all aircraft (not just those that have incorporated the guidance in this AC).

1.2 Applicability

(1) This AC is applicable to:

(a) Pilots, flight dispatchers and other flight operations personnel involved with the operation of Transport category aircraft including:

(i) Canadian air operators holding an Air Operator Certificate (AOC) issued under subparts 705 and 704 of the *Canadian Aviation Regulations* (CARs);

(ii) Canadian private operators holding a Private Operator Registration Document issued under subpart 604 of the CARs; and

(iii) Foreign air operators holding a Foreign Air Operator Certificated (FAOC) issued under subpart 701 of the CARs.

(b) Transport Canada Civil Aviation TCCA inspectors with certification and safety oversight responsibilities; and

(c) This document is also available to the aviation industry at large for information purposes. Its contents may be of particular interest to:

(i) Private pilots, other flight dispatchers and air operators, as well as foreign air operators,

(ii) Aerodrome and airport operators; and

(iii) Individuals and organizations that exercise privileges granted to them under an External Ministerial Delegation of Authority.

1.3 Description of changes

(1) Not applicable.

2.0 References and requirements

2.1 Reference documents

(1) It is intended that the following reference materials be used in conjunction with this document:

(a) *Aeronautics Act* (R.S.C., 1985, c. A-2)

(b) Chapter 525 of the AWM - Transport Category Aeroplanes

(c) AC 300-019, Global Reporting Format (GRF) for Runway Surface Conditions

(d) Title 14, *Code of Federal Regulations* (CFR), Part 25, Transport Category Aeroplanes

(e) FAA AC 25-32, Landing Performance Data for Time of Arrival Landing Performance Assessments

(f) ICAO Doc 10064, Aeroplane Performance Manual

(g) ASTM E3188, Standard Terminology for Aircraft Braking Performance; and

(h) ASTM E3266 – Standard Guide for Friction Limited Aircraft Braking and Reporting.

Note: The information and guidance in this AC makes reference to ASTM E3188 and E3266, which were developed by the Society of Aircraft Performance and Operations Engineers (SAPOE).

2.2 Cancelled documents

(1) Not applicable.

(2) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

2.3 Definitions and abbreviations

(1) The following **definitions** are used in this document:

(a) **Aircraft Braking Action Report** (**ABAR**): means, a report describing the level of braking action using data from an aircraft.

(b) **Autobrakes:** means, an automated aircraft control system that normally allows a flight crew to select a targeted deceleration rate to be achieved for the landing rollout.

(c) **Braking Action:** means, the method for describing the maximum capability of a vehicle's braking system on a wet or contaminated surface that references a standardized scale.

(d) **Friction Limited Braking:** means, a condition of aircraft ground deceleration performance where the amount of deceleration force that can be applied by the aircraft brakes is limited by the friction level of the runway surface. Any increase in command to the brake system will be limited by the anti-skid system.

(e) **Operator:** means, for the purpose of this AC, any air operator, foreign air operator or private operator.

(f) **Pilot Braking Action Report** (**PBAR**): means the pilots' assessment of the aircraft's maximum wheel braking capability on a wet or contaminated runway, which references the terminology and criteria in the Runway Condition Assessment Matrix (RCAM).

Notes:

1. Additional details appear in Section 4.5 – Recommended method for quantifying braking action reports based solely on pilot observations.
2. In some countries and in some other Canadian guidance documents, pilot braking action reports may be referred to as a PIREP or AIREP.

(g) **Reliable Pilot Braking Action Report**: Items to be considered to determine if the braking action report is reliable:

(i) Similar types of aircraft (e.g. Transport category jet aircraft with fully modulating anti-skid systems), and

(ii) Time since braking action report was given. For example, stable conditions with cold temperature and no active precipitation will likely be reliable for a longer time than reports provided during an active precipitation event with temperatures near 0°C.

Notes:

1. Pilot education and training may be required to demonstrate a minimum level precision and accuracy in reporting. (The contents of this AC are intended to serve this purpose.)

2. Stopping results do not necessarily correlate to braking action. For propeller driven aeroplanes, the effects of reverse pitch and/or discing – while certainly beneficial to stopping performance – should not be part of a braking action report (which should only describe the effectiveness of the wheel brakes).

(h) **Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC)**: means, an FAA body that developed the procedures and methods that formed the basis of the ICAO GRF.

(i) **Torque Limited Braking:** means, a condition of aircraft ground deceleration performance where the amount of deceleration force that can be generated by the aircraft brakes is limited by the maximum torque capability of the wheel brakes.

(j) **Wheel Braking Coefficient:** means, the ratio of the deceleration force from the braked wheels/tires relative to the sum of the vertical (normal) forces acting on the braked wheels/tires. The wheel braking coefficient is the result of the combination of all functioning braked wheels.

(2) The following **abbreviations** are used in this document:

(a) **ABAR:** Aircraft Braking Action Report

(b) **AC**: Advisory Circular

(c) **AIREP**: Air Report (See ICAO Annex 3, Chapter 5, Aircraft Observations and Reports)

(d) **ASTM**: American Society of Testing and Materials

(e) **ATS:** Air Traffic Services

(f) **AWM**: Airworthiness Manual

(g) **CARs:** *Canadian Aviation Regulations*

(h) **CFR:** *Code of Federal Regulations* (United States)

(i) **FAA:** Federal Aviation Administration

(j) **GRF:** Global Reporting Format

(k) **ICAO:** International Civil Aviation Organization

(l) **PBAR**: Pilot Braking Action Report

(m) **PFC**: Porous Friction Course

(n) **PIREP**: Pilot Report

(o) **RCAM:** Runway Condition Assessment Matrix

(p) **RWYCC:** Runway Condition Code

(q) **SAPOE:** Society of Aircraft Performance and Operations Engineers

(r) **TALPA ARC:** Takeoff and Landing Performance Assessment Aviation Rulemaking Committee

(s) **TCCA:** Transport Canada Civil Aviation

(t) **TOA:** Time-of-Arrival

3.0 Background

3.1 ICAO Global Reporting Format (GRF) / Runway Condition Assessment Matrix (RCAM)

(1) The ICAO Global Reporting Format (GRF) provides consistent terminology and runway assessment criteria, presented in a standardized format which is used by:

(a) airport operators for the reporting of runway surface conditions;

(b) aircraft manufacturers for the development of performance information that is based on improved methods (i.e. TALPA-based performance information); and

(c) flight crews who utilize the reported runway surface conditions and TALPA-based performance information when determining takeoff and landing performance assessments.

(2) The core principle of GRF is a matrix which maps an equivalency between standard runway conditions, airport reporting codes, braking action reports, and aircraft performance engineering guidance. Known as the Runway Condition Assessment Matrix (RCAM,) this guide is used to harmonize airport observations with the time-of-arrival (TOA) landing performance assessments made by the flight crew, providing a significant advancement over the previous performance methods and practices. An example of the RCAM appears in Appendix C.

(3) The RCAM features Runway Condition Codes (RWYCCs), which are assigned by the airport or aerodrome operator. The RWYCC is a number from 0 to 6, which represents the slipperiness of a specific third of a runway and provides a standardized “shorthand” for reporting this information to pilots.

(4) The RCAM also includes Pilot Braking Action Reports. These levels of braking, as observed by the pilot of an aircraft, are expressed using standardized terms, including: GOOD, GOOD TO MEDIUM, MEDIUM, MEDIUM TO POOR; POOR and NIL.

Note: This standardized terminology differentiates reports based on aircraft observations (i.e. PBAR or ABAR) from those based on runway observations made by the airport or aerodrome operator.

(5) In general, the RCAM provides a useful and effective tool to predict the slipperiness of the runway, based on the observed runway surface description (i.e. type and depth of contamination). However, there are circumstances where the runway may be more slippery than indicated by a reported runway surface description and the corresponding RWYCC; these circumstances include, but are not necessarily limited to:

(a) active precipitation and/or rapidly changing conditions;

(b) any process that transfers heat to the surface which may make the runway more slippery. Heat sources can include the aircraft tires, engine exhaust/thrust reverse, atmospheric conditions and precipitation;

(c) a runway surface treatment including de-icing or anti-icing chemicals making the runway temporarily more slippery; and

(d) an aircraft’s anti-skid system reacting differently than expected.

(6) Braking action reports that are accurate and precise can be an effective means of mitigating the potential hazards created by the circumstances described above. In this regard, braking action reports play a number of very important roles, and are used:

(a) by pilots to make the TOA landing performance assessment

(b) by airport and aerodrome operators to validate preliminary runway condition code (RWYCC) in a Runway Surface Condition (RSC) NOTAM; and

(c) by airport or aerodrome operators to take specific actions when reports of POOR or LESS THAN POOR / NIL braking are received.

(7) To effectively accomplish the important functions listed above, it is important for flight crews as well as airport and aerodrome operators to have reliable braking action reports.

(8) Although pilot braking action reports are very important, there is considerable evidence that these reports have not always been consistent:

(a) The National Transportation Safety Board (NTSB) report on the Chicago Midway accident, which occurred on December 8, 2005, stated:

> …pilot braking action reports are subjective and can vary significantly depending on the reporting pilot's experience level and the type of airplane in use…
>
> …pilot braking action reports are subjective and reflect individual pilot expectations, perceptions, and experiences…
>
> …braking action reports are sensitive to airplane type and the actual deceleration methods used to slow or stop the airplane….

(b) TCCA also received important feedback from airport operators during the implementation of GRF in Canada, which indicted that pilot braking action reports have been inconsistent.

(9) The importance of braking action reports – and their well-known shortcomings – compelled TCCA to search for a solution.

(10) This AC, which benefits from the significant efforts made by the Society of Aircraft Performance and Operations Engineers (SAPOE), is intended to help pilots to provide braking action reports with increased accuracy and precision (i.e. reliable braking action reports).

4.0 Braking action

4.1 Understanding aircraft deceleration

(1) The term "braking action," when used in the context of the GRF, describes the maximum capability of a vehicle's braking system on a wet or contaminated surface that references a standardized scale.

(2) The deceleration performance of a landing aircraft is a combination of:

(a) aerodynamic forces; and

(b) mechanical wheel braking forces.

(3) The relative impact of these forces changes during the landing rollout with aerodynamic forces being dominant at higher speeds and mechanical forces playing an increasing role as the aircraft decelerates:

(4) The levels of landing performance provided in the RCAM are differentiated exclusively by the maximum levels of wheel braking that can be applied.

4.2 Quantifying wheel braking action

(1) The scale of wheel braking is characterized by the degree to which the weight on the braked wheels can be transferred into decelerating force by the wheel braking system. This system is comprised of the tire, wheel brakes, and anti-skid system.

(2) The relationship between the decelerating force from the braked wheels and the vertical force acting on them is known as the wheel braking coefficient. As the runway condition becomes more slippery, the wheel braking coefficient decreases. The standardized scale used in the RCAM is based on an engineering definition of wheel braking performance and has three distinct characteristics:

(a) the scale only represents values where the aircraft's braking system is performing at its maximum capability. i.e. the deceleration produced is limited by the anti-skid system in response to the slipperiness of the runway;

(b) each division of the scale represents a range of values with the defining value for that division being the lowest inclusive wheel braking coefficient value for that range; and

(c) the scale assumes this anti-skid induced limit and coefficient value for the entire length of the landing roll.

4.3 Braking action reports: overview and purpose

(1) A braking action report communicates the maximum capability of wheel brakes as observed during landing. As such, it has the capability to provide time critical and operationally relevant information to flight crews as well as airport and aerodrome operators when a runway may be more slippery than previously reported.

(2) Wheel braking information can come from either a system utilizing aircraft data or the observations of the flight crew.

(3) The following terms are based on ASTM E3188 and are considered an industry standard for appropriate terminology.

(a) **Braking Action**. refers to a means of describing the maximum capability of a vehicle's braking system (i.e. when it is friction limited) on a wet or contaminated surface that references the standardized scale as outlined in the RCAM, under "Control, Braking Assessment Criteria."

(b) Braking action is classified according to the primary source of information used to generate the report:

(i) **Pilot Braking Action Report (PBAR)**. This term describes a braking action report resulting from the observations of a pilot.

(ii) **Aircraft Braking Action Report (ABAR)**. This term describes a report of braking action using data from the aircraft.

(4) A braking action report is intended to convey information relevant to all aircraft that utilize similar performance engineering methods as outlined in 1.1(3) of this document.

(5) Braking action reports can be used by:

(a) flight crews when making a TOA landing performance assessments to affirm or counter RCAM's predicted level of performance; and/or

(b) airport operators and aerodrome operators to confirm or downgrade a RWYCC.

4.4 Criteria for making observations

(1) The observations used for a braking action report need to be based solely on the wheel braking component of the aircraft's deceleration.

(2) Pilots need to understand that stopping results do not necessarily correlate to braking action. Therefore, the effects of aerodynamic forces – while certainly beneficial to stopping performance – should not be considered when making a braking action report:

(a) For jet aeroplanes, the effects of reverse thrust should not be considered; and

(b) For propeller driven aeroplanes, the effects of reverse pitch and/or discing should not be considered.

(3) To make an accurate assessment of the aeroplane's braking performance – whether the braking action report is based on the pilot's observations (PBAR) or aircraft data (ABAR) – the following questions need to be considered:

(a) Was it possible to detect wheel braking during aircraft's deceleration on the runway?

(b) Did the aircraft's braking system reach the point where it was friction limited?

(c) What was the level of braking performance in relation to the scale in the RCAM?

(d) Was the runway condition such that the observed braking action could reasonably be expected throughout the landing rollout?

(4) The following techniques can be used to answer the above questions.

(a) Confirm that wheel braking can be readily distinguished. This is usually done by initiating braking demand to the point where a change in deceleration can be identified. This change in deceleration is:

(i) readily discernable during manual braking by noting the effect of increasing brake application on deceleration, and

(ii) may also be discernable while using autobrakes (if the aircraft manufacturer or operator has developed appropriate procedures for this purpose).

(b) Identify when friction limited braking occurs by observing the point where an increase in brake activation yields no increase in deceleration.

(c) Determine the level of braking with reference to the level of "Pilot Braking Action" as listed in RCAM:

(i) for flight crews with little or no direct instrumentation on wheel braking forces, a recommended method is provided in Section 4.5 – Recommended method for pilot braking action reports based on pilot observations, and

(ii) for flight crews with access to an ABAR system, the information from this system can be used to help calibrate pilot observations.

(d) Assess whether the observed level of braking could reasonably be expected throughout the landing rollout; this assessment is made by observing the runway surface conditions and/or weather phenomenon.

(5) For observations based on aircraft data (ABAR):

(a) the ABAR system will automatically:

(i) detect wheel braking,

(ii) identify if braking is friction limited, and

(iii) determine the level of braking referencing the RCAM scale;

Note: Pilots will still need to assess whether the observed level of braking could reasonably be expected throughout the landing rollout. (i.e. need to perform a gross error check to confirm that the information generated by ABAR appears to be a reasonable indication of runway conditions.)

(b) flight crews need to be aware of minimum system requirements for runway length and/or time for data collection.

4.5 Recommended method for quantifying braking action reports based solely on pilot observations

(1) The guidance in this section is applicable to pilot braking actions reports solely based on the observations made by a pilot without any reference to aircraft data. This guidance utilizes industry best practices and engineering standards to provide observational references for the braking levels listed.

(2) In order to maximize the accuracy and precision of these reports, it is recommended that the terms GOOD, MEDIUM, POOR and NIL be used for pilot braking action reports. These terms allow an observer with little or no flight deck instrumentation on braking to reasonably infer operationally significant ranges of braking performance.

(3) The criteria for these reporting terms are described below:

(a) **GOOD** - This level of braking capability is typically seen on a wet runway where aggressive braking can still be achieved, and directional control is not significantly compromised. For this level of performance, the initiating of friction limited braking may not be required as aggressive braking can be reasonably inferred.

(b) **MEDIUM** - This level of braking capability is typically seen on snow covered runways. Wheel braking forces can still be discriminated, and their effectiveness modulated but at a noticeably reduced level. Friction limited braking is readily identified as the point where brake pedal commands cease to increase deceleration and/or when anti-skid braking becomes active. Directional control will be noticeably reduced.

(c) **POOR** - This level of braking capability is typically seen on ice-covered runways and can also be indicative of hydroplaning during heavy rain. Friction limited braking is readily identified soon after initial braking initiation. Braking and directional control are minimal, and an increase in brake application fails to produce any increase in deceleration (i.e. no matter how much additional braking is applied, there is no increase in deceleration). POOR braking is considered a hazardous condition as small errors in aircraft configuration and technique can result in excessive deviations in landing performance.

(d) **NIL** - Braking deceleration is minimal to non-existent or directional control is uncertain.

Note: The criteria listed above can be readily observed by pilots and are easily taught. For additional background information, to help understand the physics involved during aircraft braking, we can consider an airplane that weighs 120,000 lbs, where 100,000 lbs of that weight is supported by the main landing gear (which is equipped with wheel brakes) and the remaining 20,000 lbs is supported by the nose landing gear (which does not have wheel brakes):

- **GOOD** - A 120,000 lbs airplane could experience a wheel braking force on the order of 30,000 lbs. or approximately 0.3 G's.
- **MEDIUM** - A 120,000 lbs airplane would only experience a wheel braking force on the order of 16,000 lbs, approximately a 47% decrease from GOOD braking.
- **POOR** - A 120,000 lbs airplane would experience a wheel braking force on the order of 7,000 lbs; this is approximately a 57% decrease from MEDIUM and approximately 77% from GOOD.

(4) An illustration of the GOOD, MEDIUM and POOR braking is provided in Figure 1, below.

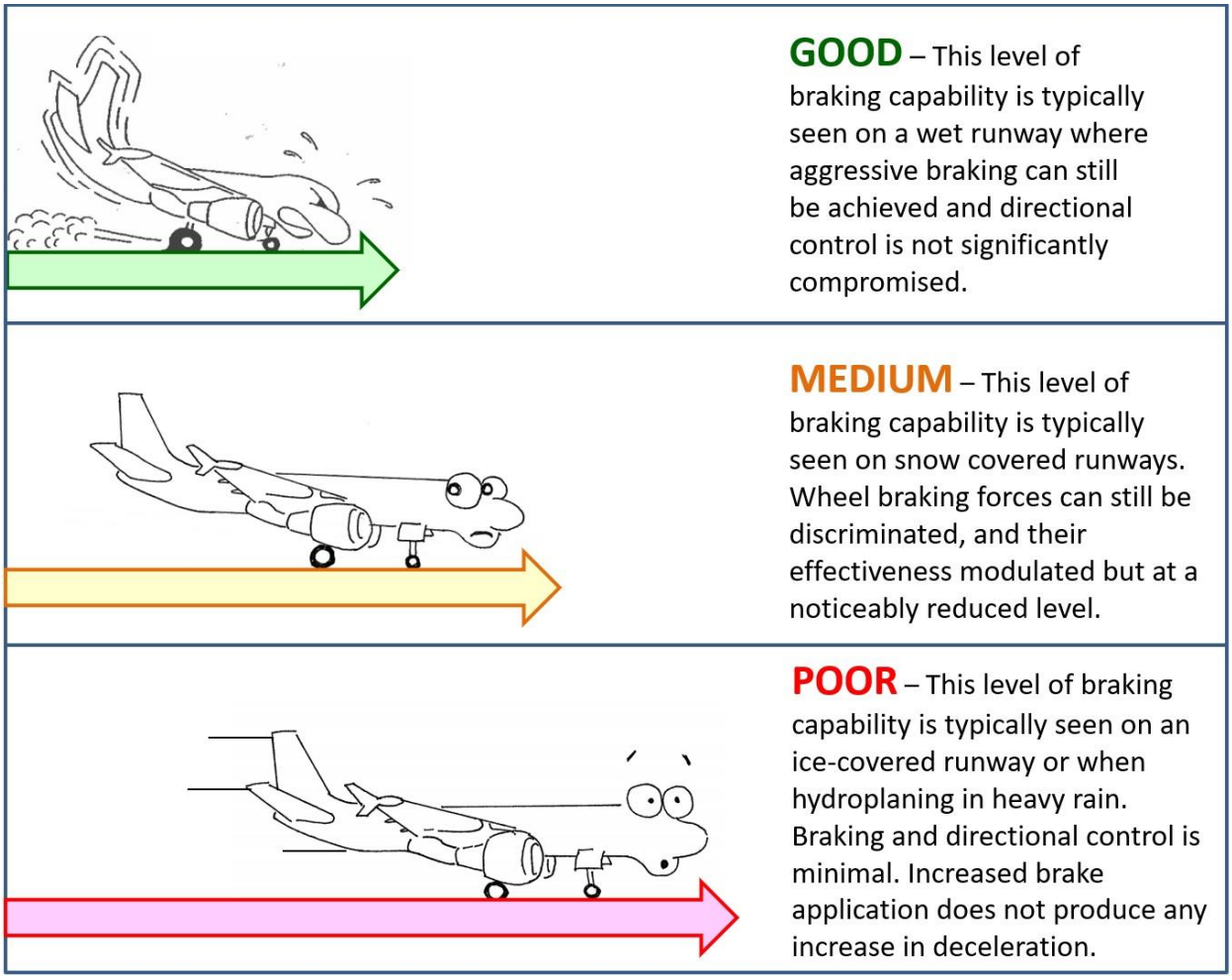

Figure 1. Illustration of GOOD, MEDIUM and POOR braking

(5) It is recommended that an operator should only use GOOD TO MEDIUM and MEDIUM TO POOR if the techniques and criteria for reporting these observations – with precision and accuracy – can be appropriately documented.

(6) An important distinction needs to be made between the terms used when providing a pilot braking action reports and the terms associated with TOA landing performance assessments:

(a) as explained above, to maximize accuracy and precision, it is recommended that the levels of braking specified in 4.5(3), above, be used for reports based solely on pilot observations; and

(b) in contrast, TOA landing performance assessments based on runway conditions can use the finer scales listed in the RCAM. These represent predictive assessments based on approved guidance material.

(7) It is the operator's responsibility to create policies, procedures, and/or checklists that represent appropriate risk management practices.

4.6 Reporting conventions

(1) Both PBAR and ABAR reports are normally considered to be valid for the entire landing area unless a qualification is made by the flight crew.

(2) Braking action reports may be qualified using location descriptors at the flight crew's discretion.

Note: Braking action reports may be reported with reference to the applicable third; however, this is not a requirement. (Airport or aerodrome operators may report runway surface conditions and CRFI by runway thirds.)

(3) The following examples illustrate:

(a) Braking action reports applicable to full runway length

(i) PBAR - "Tower, (airline name and flight number/callsign) reporting pilot braking action POOR."

(ii) ABAR - "Ground, (airline name and flight number/callsign) reporting aircraft braking action MEDIUM."

(b) Braking action reports applicable to specific portion of the runway:

(i) PBAR - "Tower, (airline name and flight number/callsign) reporting pilot braking action POOR due to standing water at the intersection of runways 33 and 10."

(ii) ABAR - "Ground, (airline name and flight number/callsign) reporting aircraft braking action MEDIUM on the last third of the runway just before the turnoff at Juliet."

(4) If an observation is made that does not include an affirmative indication of friction limited wheel braking, the appropriate response to a braking action query is "**Braking Action Not Observed**."

Note: Stopping action does not necessarily equate to braking action, as explained in 2.3(1)(g) and 4.4(2), above.

5.0 Comparison of braking action reports: PBAR vs ABAR

5.1 Accuracy and precision

(1) Braking action reports are of the greatest value when accuracy and precision are maximized.

(2) A clear understanding of accuracy and precision is important when considering the relative advantages and limitations of braking action reports which are based on:

(a) pilot observations (PBAR); and

(b) systems using aircraft data, i.e. aircraft braking action reports (ABAR).

(3) For the purpose of this AC, these terms are defined as follows:

(a) **Accuracy** refers to the degree to which the braking action report correctly correlates to the braking levels in the RCAM).

(b) **Precision** refers to the ability of a braking action report to consistently represent a given value for a given observation.

(4) The concepts of precision and accuracy are illustrated in Figure 2 where:

(a) **Accuracy** is represented by how close we are to the bullseye; and

(b) **Precision** is represented by the closeness of the grouping.

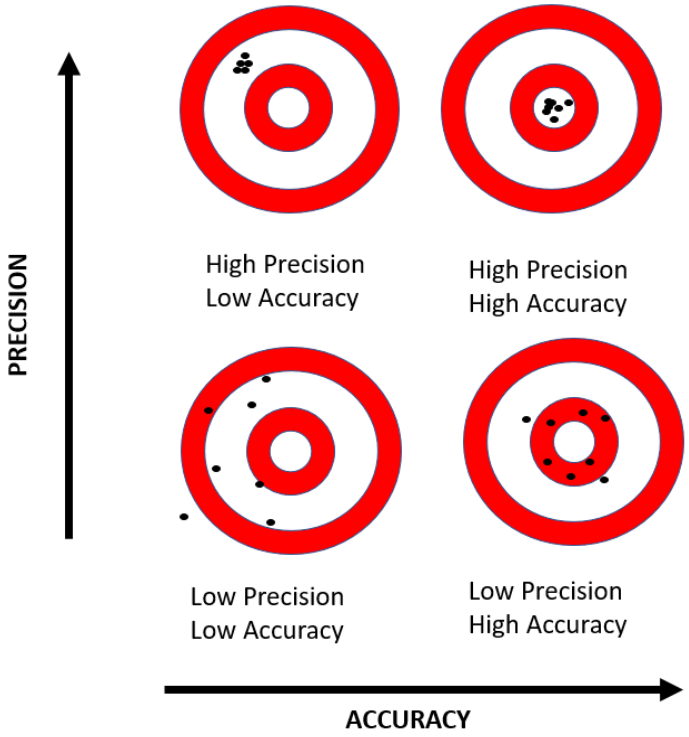

Figure 2. Accuracy and Precision

5.2 Limitations and advantages of various braking action reporting methods

(1) The concepts of accuracy and precision described above, determine the relative limitations and advantages of the of the following braking action reporting methods:

(a) pilot braking action reports based solely on pilot observations (PBAR) – made without any established guidance and training;

(b) the recommended method for pilot braking action reports based on pilot observations detailed in Section 4.5, above; and

(c) aircraft breaking action reports (ABAR)

(2) Pilot braking action reports based solely on pilot observations – without guidance and training – can be subject to large variations in accuracy and precision.

(3) With the recommended procedure specified in Section 4.5 – which provides engineering-based narrations for observing and analyzing braking characteristics – accuracy and precision are refined. With written guidance and training, reasonably accurate and consistent reporting can be expected from flight crews.

(4) ABAR systems provide the highest level of accuracy and precision. ABAR systems most effectively serve as the basis for continuous improvement in the safety assurance process.

(5) The relative limitations and advantages of the braking report categories (methods) described in paragraphs (2) through (4) are illustrated in Figure 3, below.

 Five Braking Categories Minimum Training	**Pilot Braking Action Report (PBAR)** **<u>Made without the enhanced guidance in Section 4</u>** • With little or no guidance and training, pilot braking action reports can be subject to large variations in accuracy and precision.
 Three Braking Categories Expanded Training	**Pilot Braking Action Report (PBAR)** **<u>Made with the enhanced guidance in Section 4</u>** • By explicitly refining the levels of braking for pilot observations and reporting, accuracy and precision are improved. • Harmonizes engineering analysis methods with the braking levels that can be discerned by the pilot.
 ABAR System	**Aircraft Braking Action Report (ABAR)** • ABAR systems provide the highest level of accuracy and precision • ABAR systems most effectively serve as the basis for continuous improvement in the safety assurance process.

Figure 3. Comparison (limitations and advantages) of various braking action reporting methods

6.0 Safety management systems

(1) Safety management systems (SMS) require that organizations establish and maintain safety assurance processes to identify and mitigate safety risks.

(2) By providing timely information relevant to all aircraft with similar braking systems, braking action reports serve as a vital safety assurance process to the RCAM methodology.

(3) Specifically, the important information in braking action reports can be used for this purpose by:

(a) flight crews to make TOA landing performance assessments to affirm or counter the RCAM's predicted level of performance; and

(b) airport operators and aerodrome operators to confirm, or downgrade a RWYCC; and

(c) airport and aerodrome operators to take specific actions deemed necessary in response to reports of POOR or NIL braking.

(4) Operators should review the information and guidance provided in this AC, including the appendices, using the principles of SMS, as applicable, to

(a) collect data, monitor trends, and identify hazardous conditions

(b) review and assess the risks associated with operations on wet and contaminated runways; and

(c) review their procedures and modify as appropriate to mitigate these risks.

7.0 Conclusion

(1) Pilots need to understand how to provide accurate and consistent braking action reports.

(2) Operators should review the information in this AC, and consider its inclusion (as appropriate) in their:

(a) Company Operations Manual;

(b) Standard Operating Procedures;

(c) training programs for pilots and flight dispatchers; and/or

(d) any other established means of conveying safety and operational information within their organization (bulletins, notices, etc.).

(3) This AC provides information and guidance on methods for improving the accuracy and precision of braking action reports. These methods are intended to further mitigate the risks associated with operations on wet and contaminated runways.

(4) The original authors of TALPA intended for the RCAM to be improved upon as data and analysis methods improved. The methods described in this AC serve to accomplish that vital safety assurance function.

8.0 Information management

(1) Not applicable.

9.0 Document history

(1) Not applicable.

10.0 Contact us

For more information, please contact:

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E-mail: AARTFInfo-InfoAARTF@tc.gc.ca

We invite suggestions for amendment to this document. Submit your comments to:

Standards Branch Documentation Services
E-mail: AARTDocServices-ServicesdocAART@tc.gc.ca

Original signed by Andrew Larsen for

Félix Meunier
Director, Standards branch
Civil Aviation,
Transport Canada

Appendix A – Industry standards (non-regulatory)

(1) International standards associated with this guidance are the product of the ASTM Aircraft Friction Subcommittee (E17.26) of the Vehicle Pavement Systems Committee (E17.) Contact information is provided in Appendix B.

(2) ASTM Standard E3188 “Standard Terminology for Aircraft Braking Performance” is considered acceptable for all technical correspondence, training, and research involving aircraft braking performance.

(3) The ASTM E3266 “Standard Guide for Friction Limited Aircraft Braking Measurement and Reporting” is considered acceptable for the approval or acceptance of any system capable of providing an Aircraft Braking Action Report.

Appendix B – Industry references

B.1 Society of Aircraft Performance and Operations Engineers

(1) The Society of Performance and Operations Engineers (SAPOE) provides a worldwide network of expertise and experience. The engineers responsible for creating the ASTM guidance as well as original members of the TALPA ARC can be accessed and made available for assistance in all areas of aircraft performance engineering. They can be reached by visiting their website at www.sapoe.org.

B.2 American Society of Testing and Materials

(1) The American Society of Testing and Materials (ASTM) is responsible for the publication of the standards referenced in this document. Copies of these standards and contact information may be found at www.astm.org.

B.3 Industry sources

(1) The industry sources that assisted with the development of this AC may be reached by contacting Four Winds Aerospace Safety Inc. at www.FourWindsSafety.com .

Appendix C – Runway Condition Assessment Matrix

(1) The Runway Condition Assessment Matrix (RCAM), show in Table 1, is the core of the Global Reporting Format (GRF).

Table 1– Runway Condition Assessment Matrix (RCAM)

Assessment criteria		**Control/braking assessment criteria**	
Runway surface description	**RWYCC**	**Vehicle deceleration or directional control observation**	**Pilot braking action**
• DRY	**6**	**-**	**-**
• FROST • WET (The runway surface is covered by any visible dampness or water up to and including 1/8 **inch** (3 mm) depth) **Up to and including 1/8 inch (3 mm) depth:** • SLUSH • DRY SNOW • WET SNOW	**5**	Braking deceleration is normal for the wheel braking applied AND directional control is normal	GOOD
-15°C and Colder outside air temperature: • COMPACTED SNOW	**4**	Braking deceleration OR directional control is between GOOD and MEDIUM	GOOD TO MEDIUM
• SLIPPERY WHEN WET (wet runway) • DRY SNOW or WET SNOW (Any depth) ON TOP OF COMPACTED SNOW **Greater than 1/8 inch (3 mm) depth:** • DRY SNOW • WET SNOW **Warmer than -15°C outside air temperature:** • COMPACTED SNOW	**3**	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced	MEDIUM
Greater than 1/8 inch (3 mm) depth: • STANDING WATER • SLUSH	**2**	Braking deceleration OR directional control is between MEDIUM and POOR	MEDIUM TO POOR
• ICE	**1**	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced	POOR
• WET ICE • SLUSH ON TOP OF ICE • WATER ON TOP OF COMPACTED SNOW • DRY SNOW or WET SNOW ON TOP OF ICE	**0**	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain	LESS THAN POOR / NIL

Note: The version of the RCAM used by airport and aerodrome operators also includes additional information which is used to confirm, downgrade or upgrade the RWY issued in the RSC NOTAM.

Appendix D – Aircraft braking action report (ABAR) systems

D.1 Overview

(1) The information and guidance in this appendix is intended for consideration by flight operations management personnel responsible for creating policies and procedures regarding the use of automated systems used to generate an aircraft braking action report (ABAR). As such, it provides background information for management purposes and is not intended as an operational guide for pilots.

D.2 Design philosophy

(1) In general, an ABAR system will reflect to what degree the weight of an aircraft can be transferred to deceleration force via the wheel brakes when the anti-skid activates during a friction limited event. An ABAR system can be located either remotely or onboard an aircraft and uses the aircraft's data to produce a standardized level of wheel braking performance.

(2) ABAR systems are the most accurate and objective means of observing and reporting aircraft braking action. The use of aircraft data to generate an ABAR can mitigate the human errors resulting from inadequate training, inexperience, or cognitive bias that may occur with a PBAR.

(3) The data recorded by the ABAR system during the landing roll is used to:

- (a) isolate the mechanical wheel braking forces from all other forces contributing to deceleration, in order to identify when wheel braking is friction limited; and
- (b) map those forces to the scale used to make braking action reports.

(4) ABAR systems may come from different vendors and apply to different aircraft, however, all must comply with the minimum standards set out in the appropriate ASTM guidelines (Appendix A). Compliance with these standards ensures a minimum degree of confidence in all ABAR's and assures the information can be applied to all aircraft with fully modulating anti-skid systems that use standard guidance as referenced below.

(5) Aircraft systems may also transmit data that is not visible to the flight crew. Data not visible to the pilot is not considered an ABAR, and may be utilized for other data analysis purposes.

D.3 Aircraft considerations

(1) ABAR generating systems are considered applicable to a wide range of aircraft types and manufacturers whose design allows for such an analysis.

(2) ABAR systems installed on aircraft require appropriate supplemental type certification approval.

(3) ABAR generating systems are designed to be used on aircraft that utilize landing performance data derived in compliance with:

- (a) FAA AC 25-32 – Landing Performance Data for Time of Arrival Landing Performance Assessments; or
- (b) ICAO Doc 10064 – Airplane Performance Manual; or
- (c) other equivalent standards

D.4 Acceptance criteria for ABAR systems

(1) ABAR systems are not required for certification of Transport category aircraft and their intended function is not a regulatory requirement.

(2) The use of an ABAR by an operator is contingent on the **acceptance** of Transport Canada Civil Aviation. The word “acceptance” is specifically used in this case as it indicates a recognition that a non-mandatory system meets a minimum standard.

(3) ASTM E3266 – Standard Guide for Friction Limited Aircraft Braking Measurement and Reporting, provides suitable acceptance criteria for operators wishing to transmit information from an ABAR system.

D.5 Confidence of reports

(1) ABAR generating systems must inherently rely on data that is inferred from other sources to calculate the required values. Because these systems do not rely on sensors taking direct measurements of certain values, these systems cannot be calibrated in a manner similar to other cockpit indicators. Therefore, while the ASTM standard sets minimum levels of accuracy and precision for these systems, it must be recognized that there exists a statistical difference between what a system calculates and what a theoretical “real” value could be. For that reason, these systems are described as having “confidence factor.”

(2) ABAR generating systems standards require them to demonstrate a confidence factor on the order of 95% that their system will be within +/- one level of braking when using the GRF scale consisting of 5 levels of braking below dry (GOOD, GOOD TO MEDIUM, MEDIUM, MEDIUM TO POOR, POOR.)

Note: Additional information can be found in ASTM guidance listed in Appendix A

D.6 Development of operational guidelines

(1) Operators who utilize an ABAR will need to develop operational guidelines and training for flight crews regarding the use this system.

(2) ABAR systems whose intended function entails timely recognition from the flight crew need to comply with the appropriate certification standards for flight crew alerting (i.e. FAA AC 25.1322-1 – Flightcrew Alerting, or equivalent).

(3) **Caution**: Pilots and operators need to understand that an ABAR is a decision support tool rather than a decision-making tool. Pilots and operators should use an ABAR as one piece of information, along with the current weather (precipitation, winds, visibility, possibility of windshear, etc.), runway surface condition (RSC) NOTAMs, PBARs and other factors such as operational limitations, etc., to make the decision as to whether or not it is safe to conduct a landing.

(4) The following guidelines are considered acceptable for the operational use of information provided by ABAR systems:

(a) Where an ABAR provides in a braking action report that confirms the accuracy of the RWYCC (i.e. both values are the same), the TOA landing performance assessment should be based on this confirmed value;

(b) Where an ABAR provides a braking acting report that indicates that the runway is slipperier than the reported RWYCC, the TOA landing performance assessment should be based on the braking action report provided by ABAR; and

(c) Where an ABAR provides a braking action report that indicates that the braking action is superior to the reported RWYCC, the TOA landing performance assessment should be based on the RWYCC (which is more conservative).

Note: Canadian regulations require that airport and aerodrome operators provide reports of runway surface conditions; therefore, it is unlikely that an ABAR would be issued without other runway information. While unlikely, it is possible that an ABAR might be issued without other runway surface condition information when conditions are changing rapidly

(e.g. the onset of a heavy snow shower). In view of the confidence factor described in D.5, above, for the rare circumstances where an ABAR is the sole criteria for making a TOA landing assessment, operators should consider establishing procedures to ensure that an acceptable margin of safety exists for the runway being used (e.g. ensuring that landing performance data for MEDIUM TO POOR braking would not exceed acceptable safety margins if MEDIUM braking is reported).

(5) Guidance to flight crews should also emphasize that when conditions warrant, the TOA landing performance assessment can be based on a more conservative performance data (i.e. performance data associated with a lower RWYCC than that reported). In particular, prior to initiating an approach, pilots should verify, that the aircraft can stop within the Landing Distance Available using a RWYCC of "2" (corresponding to MEDIUM TO POOR braking), whenever there is the likelihood of:

(a) moderate or greater rainfall on a smooth runway; or

(b) heavy rain on a grooved/PFC runway.