



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Landing Performance Data for
Time-of-Arrival Landing Performance
Assessments

Date: 12/22/15

AC No: 25-32

Initiated By: ANM-111

This advisory circular (AC) provides guidance and standardized methods that data providers, such as type certificate (TC) holders, supplemental type certificate (STC) holders, applicants, and airplane operators, can use when developing landing performance data for time-of-arrival landing performance assessments for transport category airplanes. This AC also promotes the use of consistent terminology for runway surface conditions used among data providers and FAA personnel.

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback form attached at the end of this AC.



Jeffrey E. Duven
Manager, Transport Airplane Directorate
Aircraft Certification Service

Contents

Paragraph	Page
1 Purpose.....	1
2 Applicability.	1
3 Related Documents.	1
3.1 Regulations.	1
3.2 Advisory Circulars.	2
3.3 Other Documents.	2
4 Background.	2
5 Time-of-Arrival Landing Performance Assessments.	3
6 Definitions.....	4
6.1 Dry Runway.	4
6.2 Wet Runway.....	5
6.3 Contaminated Runway.....	5
6.4 Loose Contaminants.....	6
6.5 Pilot-Reported Braking Action.	6
6.6 Runway Condition Code.....	7
6.7 Runway Surface Condition.	7
6.8 Solid Contaminants.....	7
6.9 Slippery When Wet.....	7
6.10 Specific Gravity.	7
6.11 Wheel Braking Coefficient.	7
7 Time-of-Arrival Performance Data.....	8
8 Determination of Landing Distance for Time-of-Arrival Landing Performance Assessments.....	10
8.1 Landing Distance.	10
8.2 Air Distance.	11
8.3 Transition Distance.	12
8.4 Final Stopping Configuration Distance (Full Braking Distance).	15
9 Accounting for Drag of Loose Contaminants.	15
10 Credit for Reverse Thrust.....	16
11 Guidance for Existing Type Designs.	18
12 Documentation.	19

Contents (continued)

Paragraph	Page
12.1 Data Location.....	19
12.2 Data Label.....	19
12.3 Other Information.	19

Figures

Figure 1. Landing Distance Segments	10
---	----

Tables

Table 1. Runway Surface Condition—Descriptions and Contaminant Category.....	8
Table 2. Runway Surface Condition—Pilot-Reported Braking Action— Wheel Braking Coefficient Correlation Matrix	14
Table 3. Loose Contaminant Specific Gravity.....	16

1 **PURPOSE.**

This AC provides guidance and standardized methods that data providers, such as TC holders, STC holders, applicants, and airplane operators, can use when developing landing performance data for time-of-arrival landing performance assessments for transport category airplanes. This AC also promotes the use of consistent terminology for runway surface conditions used among data providers and FAA personnel.

2 **APPLICABILITY.**

- 2.1 The guidance provided in this document is directed towards airplane manufacturers, modifiers, foreign regulatory authorities, FAA transport airplane type certification engineers, flight test pilots, flight test engineers, and their FAA designees.
- 2.2 The guidance in this AC is neither mandatory nor regulatory in nature and does not constitute a requirement. This AC is written in response to an Aviation Rulemaking Committee (ARC) recommendation to provide guidance to manufacturers for a standardized approach for computing time-of-arrival landing performance data.
- 2.3 This material does not change or create any additional regulatory requirements, nor does it authorize changes in, or permit deviations from, regulatory requirements.
- 2.4 The guidance provided in this AC can be used both for new airplane designs and for previously certificated airplane designs. See section 11 of this AC for additional information on applying the guidance in this AC to previously certificated airplane designs.

3 **RELATED DOCUMENTS.**

3.1 **Regulations.**

The following Title 14, Code of Federal Regulations are referenced in this AC. These regulations are available at the [U.S. Government Printing Office website](http://www.gpo.gov).

- Section 25.101, *General (Performance)*.
- Section 25.125, *Landing*.
- Section 25.1587, *Performance information*.
- Section 91.1037, *Large transport category airplanes: Turbine engine powered; Limitations; Destination and alternate airports*.
- Section 121.195, *Airplanes: Turbine engine powered: Landing limitations: Destination airports*.
- Section 135.385, *Large transport category airplanes: Turbine engine powered: Landing limitations: Destination airports*.

3.2 **Advisory Circulars.**

The following ACs are referenced in this AC. These ACs are available at the [FAA website](#). If any AC is revised after publication of this AC, you should refer to the latest revision.

- AC 25-7C, *Flight Test Guide for Certification of Transport Category Airplanes*, dated October 16, 2012.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.
- AC 150/5200-28E, *Notices to Airmen (NOTAMs) for Airport Operators*, dated October 8, 2015.

3.3 **Other Documents.**

- FAA Order JO 7930.2Q (or later revision), *Notice to Airmen (NOTAM)*, dated December 18, 2015.
- European Aviation Safety Agency (EASA) Acceptable Means of Compliance (AMC) 25.1591, *The Derivation and Methodology of Performance Information for use when Taking-off and Landing with Contaminated Runway Surface Conditions*.
- Safety Alert for Operators (SAFO) 06012, *Landing Performance Assessments at Time of Arrival (Turbojets)*, dated August 31, 2006.

4 **BACKGROUND.**

4.1 Following the overrun of a Southwest Airlines Boeing Model 737-700 series airplane at Chicago Midway International Airport on December 8, 2005, the FAA conducted an internal review to evaluate the adequacy of regulations and guidance in areas that came under scrutiny during the course of the accident investigation. Among other findings, the FAA identified areas to improve in the regulations, guidance, and industry practices for conducting landing performance assessments at the time of arrival, including concerns about the landing performance data provided by TC holders. These concerns include questions about whether these data are representative of in-service operational practices, whether these data are presented in a standardized format, how the landing distances are computed, and how the data are presented.

4.2 To address some of these concerns, the FAA issued SAFO 06012 on August 31, 2006. SAFO 06012 urgently recommended that operators of turbojet airplanes develop procedures for flightcrews to assess landing performance based on conditions existing at the time of arrival at the destination airport. On August 6, 2007, the FAA tasked the Takeoff and Landing Performance Assessment (TALPA) ARC to provide a forum for the U.S. aviation community to discuss incorporating the recommended actions identified in SAFO 06012 into regulatory requirements.

4.3 The TALPA ARC completed its actions and delivered its recommendations to the FAA on July 7, 2009. Although the Committee recommended adopting regulations requiring

TC holders to produce landing performance data for time-of-arrival landing performance assessments, the FAA does not currently plan to initiate rulemaking on this issue.

- 4.4 After the Committee delivered its recommendations to the FAA, the FAA worked with two airlines and 29 airports to validate the Runway Condition Codes of the contaminants on the Runway Condition Assessment Matrix (RCAM)¹ and the feasibility of obtaining an accurate rating of the runway surface condition from airport operations personnel using the TALPA ARC recommended methods. This validation testing lasted two winter seasons (2009-2010 and 2010-2011). After the first season of validation testing, the validation team made modifications to the original RCAM based on the data collected from the airports and correlated pilot braking action reports. These modifications were re-validated the second winter season. The Committee then used this data as the basis for its final recommended RCAM.
- 4.5 This AC provides guidance and standardized methods that data providers can use, at their option, to develop landing performance data for time-of-arrival (or en route) landing performance assessments. Data created following the recommendations of this AC would address the majority of the Committee recommendations for data providers. The created data would also be consistent with the terminology used for airport reporting of runway conditions.

5 **TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS.**

- 5.1 Sections 91.1037, 121.195, and 135.385 prescribe landing performance requirements that must be met at the time of takeoff. However, compliance with these requirements does not account for the time-of-arrival conditions of the runway that will be used for landing, when calculating whether the airplane can safely land within the distance available on that runway. The distance needed to safely complete the landing at the time of arrival may be different if the runway, runway surface condition, meteorological conditions, approach guidance, airplane configuration, airplane weight, approach speed, or use of airplane ground deceleration devices differs from that used to show compliance with § 91.1037, § 121.195, or § 135.385.
- 5.2 To enhance safety, procedures developed by airplane operators to assess landing performance at the time of arrival should include an adequate safety margin and should consider runway surface conditions/braking action, winds, temperatures, slope, pressure altitude, icing condition, final approach speed, airplane weight and configuration, and deceleration devices used.
- 5.3 Appropriate landing performance data would assist operators in performing these time-of-arrival landing performance assessments. Because of differences in the

¹ The RCAM is a matrix relating runway condition codes and runway surface conditions.

variables to be taken into account and how the data are to be used, the landing performance data for time-of-arrival landing performance assessments may be different than the landing performance data developed in accordance with § 25.125 and provided in the airplane flight manual in accordance with § 25.1587(b).

- 5.4 Part 25 landing distances are determined in a way that represents the maximum performance capability of the airplane, which may not be representative of normal operations. For use in time-of-arrival landing performance assessments, where the conditions at the time of arrival are known and taken into account, it would be beneficial if the landing performance data were representative of actual operations. The data for time-of-arrival landing performance assessments should represent expected landing performance by a trained flightcrew of average skill following normal flight procedures and training.
- 5.5 Like the landing distances defined in § 25.125, the landing distances for use with time-of-arrival landing performance assessments, if developed, should consist of the horizontal distance from the point at which the main gear of the airplane is 50 feet above the landing surface to the position of the nose gear when the airplane is brought to a stop. See figure 1 on page 10.
- 5.6 An important portion of the TALPA ARC's recommendations concerns the use of a common set of terms for describing runway surface conditions. The FAA agrees with the ARC that it would be beneficial for all parties involved in determining, transmitting, and using runway surface condition information to use the same terms and the same definitions for those terms. The FAA is issuing guidance information, including this AC, promoting use of common runway surface condition nomenclature for—
- Runway surface condition descriptions used in field condition reports originated by airports,
 - Runway surface condition reports relayed by air traffic controllers,
 - Development of airplane performance data for different runway surface conditions by data providers, and
 - Use of field condition reports and airplane performance data by pilots and airplane operators to make their time-of-arrival landing performance assessments.

6 **DEFINITIONS.**

6.1 **Dry Runway.**

A runway is dry when it is neither wet nor contaminated. For purposes of condition reporting and airplane performance, a runway can be considered dry when no more than 25 percent of the runway surface area (within the reported length and the width being used) is covered by visible moisture or dampness, frost, slush, snow (any type), or ice.

6.2 **Wet Runway.**

A runway is wet when it is neither dry nor contaminated. For purposes of condition reporting and airplane performance, a runway can be considered wet when more than 25 percent of the runway surface area (within the reported length and the width being used) is covered by any visible dampness or water that is $\frac{1}{8}$ inch (3 mm) or less.

Note: A damp runway that meets this definition is considered wet, regardless of whether or not the surface appears reflective.

6.3 **Contaminated Runway.**

For purposes of condition reporting and airplane performance, a runway is considered contaminated when more than 25 percent of the runway surface area (within the reported length and the width being used) is covered by frost, ice, and any depth of snow, slush, or water. Definitions for each of these runway contaminants are provided in paragraphs 6.3.1 through 6.3.8 of this AC.

Note: The definition of water in the context of condition reporting and airplane performance is the definition in paragraph 6.3.6 of this AC, which is a depth of greater than $\frac{1}{8}$ inch (3 mm). This terminology is consistent with the definitions used in NOTAMs as published in AC 150/5200-28E and Order JO 7930.2Q (or later revisions).

6.3.1 Dry Snow.

Snow that has insufficient free water to cause it to stick together. This generally occurs at temperatures well below 32 °F (0 °C). If when making a snowball, it falls apart, the snow is considered dry.

6.3.2 Wet Snow.

Snow that has grains coated with liquid water, which bonds the mass together, but that has no excess water in the pore space. A well-compacted, solid snowball can be made, but water will not squeeze out.

6.3.3 Slush.

Snow that has water content exceeding a freely drained condition such that it takes on fluid properties (for example, flowing and splashing). Water will drain from slush when a handful is picked up. This type of water-saturated snow will be displaced with a splatter by a heel and toe slap-down motion against the ground.

6.3.4 Compacted Snow.

Snow that has been compressed and consolidated into a solid form that resists further compression such that an airplane will remain on its surface without displacing any of it. If a chunk of compressed snow can be picked up by hand, it will hold together or can be broken into smaller chunks rather than falling away as individual snow particles.

6.3.5 Frost.

Frost consists of ice crystals formed from airborne moisture that condenses on a surface whose temperature is below freezing. Frost differs from ice in that the frost crystals grow independently and, therefore, have a more granular texture.

6.3.6 Water.

Water in a liquid state. For purposes of condition reporting and airplane performance, water is greater than 1/8 inch (3 mm) in depth.

6.3.7 Ice.

The solid form of frozen water.

6.3.8 Wet Ice.

Ice that is melting or ice with any depth of water on top.

6.4 Loose Contaminants.

Loose contaminants are those contaminants that an airplane's tire will not remain on the surface of without breaking through. Water, slush, wet snow, and dry snow are loose contaminants. For loose contaminants, the depth of the contaminant can affect both the airplane's acceleration and deceleration capability.

6.5 Pilot-Reported Braking Action.

Pilot-reported braking action is a subjective assessment of runway slipperiness. The pilot bases the assessment on observations of braking deceleration and directional controllability during landing rollout. Since the type of runway contaminant is not identified in a pilot braking action report, landing performance data based on pilot-reported braking action should not include any effects of contaminant drag. Braking action can be categorized with the terms provided in paragraphs 6.5.1 through 6.5.6 of this AC.

6.5.1 Good.

Braking deceleration is normal for the wheel braking effort applied, and directional control is normal.

6.5.2 Good-to-Medium.²

Braking deceleration or directional control is between good and medium² braking action.

6.5.3 Medium.²

Braking deceleration is noticeably reduced for the wheel braking effort applied, or directional control is noticeably reduced.

6.5.4 Medium-to-Poor.²

Braking deceleration or directional control is between medium² and poor.

² The braking action term "FAIR" is in the process of being changed to "MEDIUM" throughout the FAA. Until an official change is published, the term "FAIR" may be used.

6.5.5 Poor.

Braking deceleration is significantly reduced for the wheel braking effort applied, or directional control is significantly reduced.

6.5.6 Nil.

Braking deceleration is minimal to non-existent for the wheel braking effort applied, or directional control is uncertain.

6.6 Runway Condition Code.

The runway condition code is a number from 0 to 6 that is used to denote the category of slipperiness of a designated portion of a runway (that is, a specific one-third of the runway), with 0 being extremely slippery and 6 being a dry runway. Since runway condition code reflects only the runway slipperiness (that is, any effect of contaminant drag is not included), the runway condition code can be directly correlated with a pilot-reported braking action.

6.7 Runway Surface Condition.

The runway surface condition is a description of the contaminants (if any) on the surface of a runway. Takeoff and landing performance data based on runway surface condition may include the effects of the contaminant on braking friction and the effects of contaminant depth on drag as appropriate.

6.8 Solid Contaminants.

Solid contaminants are those contaminants that an airplane's tire will remain on top of and not break through. Compacted snow and ice are solid contaminants. For solid contaminants, the depth of the contaminant does not affect the airplane's acceleration and deceleration capability.

6.9 Slippery When Wet.

A wet runway where the surface friction characteristics would indicate diminished braking action as compared to a normal wet runway.

6.10 Specific Gravity.

The specific gravity of a contaminant is the density of the contaminant divided by the density of water.

6.11 Wheel Braking Coefficient.

Wheel braking coefficient is the ratio of the deceleration force from a braked wheel/tire relative to the normal force acting on the wheel/tire. The wheel braking coefficient is an all-inclusive term that incorporates effects related to the tire-to-ground interaction from braked wheels only, such as runway surface and airplane braking system (e.g., anti-skid efficiency, brake wear, tire condition, etc.). For the purposes of this AC, the wheel braking coefficient is based on a fully modulating anti-skid controlled braked wheel/tire. The definition of fully modulating anti-skid system is found in AC 25-7C.

7 TIME-OF-ARRIVAL PERFORMANCE DATA.

7.1 If developed using the guidance in this AC, landing performance data should be provided in terms of both runway surface condition descriptions and pilot-reported braking actions for the approved operational envelope for landing. The following runway surface condition descriptions and pilot-reported braking actions should be included:

7.1.1 Runway Surface Condition Description.

See table 1 of this AC.

Table 1. Runway Surface Condition—Descriptions and Contaminant Category

Runway Surface Condition Description	Contaminant Category
Dry	—
Wet	—
Ice	Solid contaminant
Compacted snow	Solid contaminant
Dry snow	Loose contaminant
Wet snow	Loose contaminant
Slush	Loose contaminant
Water	Loose contaminant

7.1.2 Pilot-Reported Braking Action.

See paragraph 6.5 of this AC for the definition of pilot-reported braking action. It can be categorized with the following terms, which are defined in paragraphs 6.5.1 through 6.5.6, respectively, of this AC:

- Good.
- Good-to-medium.³
- Medium.³
- Medium-to-poor.³

³ The braking action term “FAIR” is in the process of being changed to “MEDIUM” throughout the FAA. Until an official change is published, the term “FAIR” may be used.

- Poor.

Note: Landing performance data is not presented for Nil because this is not a performance category but rather a report from the flightcrew that flight operations should cease on this runway until the airport has taken an action to improve the braking action.

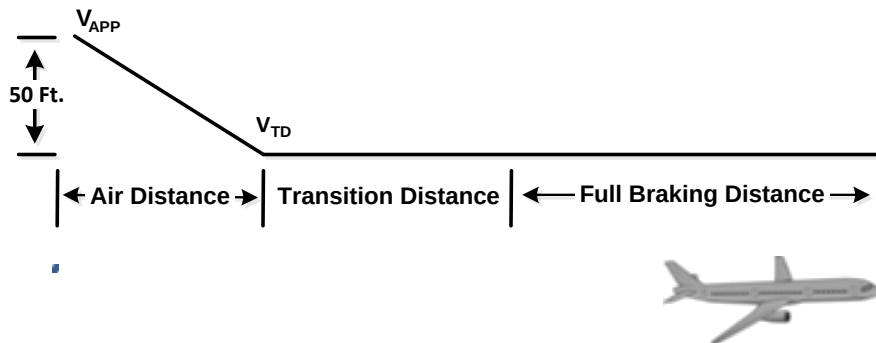
- 7.2 Landing distance data should cover all normal operations with all engines operating within the normal landing operating envelope. The effect of each of the parameters affecting landing distance should be provided, and should take into account the following:
 - 7.2.1 Approved landing configurations, including Category III landing guidance where approved;
 - 7.2.2 Approved deceleration devices (for example, wheel brakes, speedbrakes/spoilers, and thrust reversers);
 - 7.2.3 Pressure altitudes within the approved landing operating envelope;
 - 7.2.4 Weights up to the maximum takeoff weight;
 - 7.2.5 Expected airspeeds at the runway threshold, including speeds up to the maximum recommended final approach speed considering possible speed additives for winds and icing conditions;
 - 7.2.6 Temperatures within the approved landing operating envelope;
 - 7.2.7 Winds within the approved landing operating envelope (1) not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing; and (2) not less than 150 percent of the nominal wind components along the landing path in the direction of landing;
 - 7.2.8 Runway slopes within the approved landing operating envelope; and
 - 7.2.9 Icing conditions, if required to provide the landing distances required under § 25.125 in icing conditions.
- 7.3 Data providers should provide appropriate information for minimum equipment list and configuration deviation list items that affect landing distance.
- 7.4 Data providers are also encouraged to include landing distances for non-normal configurations.

8 DETERMINATION OF LANDING DISTANCE FOR TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS.

8.1 Landing Distance.

- 8.1.1 The landing distance consists of three segments—an airborne segment, a transition segment, and a final stopping configuration (full braking) segment, as shown in figure 1 below.

Figure 1. Landing Distance Segments



- 8.1.2 The landing distance for a time-of-arrival landing performance assessment may be determined analytically from the landing performance model developed to show compliance with § 25.125. For the purposes of determining landing distance for time-of-arrival assessments, the model should be modified as described in the following paragraphs.
- 8.1.3 Changes in the airplane's configuration, speed, power, and thrust used to determine the landing distance for time-of-arrival landing performance assessments should be made using procedures established by the data provider for operation in service. These procedures should—
- Be able to be consistently executed in service by crews of average skill;
 - Use methods or devices that are safe and reliable; and
 - Include allowance for any time delays that may reasonably be expected in service. (See paragraphs 8.3.2, 8.3.3, and 8.3.4 of this AC.)
- 8.1.4 The procedures and assumptions used to develop the operational landing distances should be documented in the appropriate reference material.

8.2 Air Distance.

- 8.2.1 As shown in figure 1 of this AC, the air distance is the distance from a height of 50 feet above the landing surface to the point of main gear touchdown. This definition of the air distance is unchanged from that used for compliance with § 25.125. However, the air distance determined under § 25.125 may not be appropriate for use in making time-of-arrival landing performance assessments. Especially for airplanes for which the parametric method of determining the air distance was used as described in AC 25-7C, the air distances determined under § 25.125 may be shorter than the distance that the average pilot is likely to achieve in normal operations.

Note: AC 25-7C states the air distance computed using the parametric method should only be used in conjunction with the factor as described in § 121.195(b) or (c); § 135.385(b), (c), or (f); or equivalent.

- 8.2.2 There are reasons why the air distance determined under § 25.125 might be shorter than the distance the average pilot is likely to achieve in normal operations. First, the parametric method of determining the air distance presented in AC 25-7C, used by some manufacturers to provide landing distance in their AFMs allows the air distance to be based on a steeper-than-normal approach angle of -3.5° , followed by a flare in which the touchdown rate of descent can be as high as 8 feet per second. Second, the § 25.125 air distance is based on beginning at a speed of V_{REF} , whereas the operating procedures may recommend a higher speed, particularly when headwinds are present. Third, the philosophy followed by some manufacturers during the certification process is to determine the maximum capability of the airplane.
- 8.2.3 The air distance used for any individual landing at any specific runway is a function of the runway approach guidance, runway slope, use of any airplane features or equipment (for example, heads-up guidance, autoflight systems, etc.), pilot technique, and the inherent flare characteristics of the specific airplane.
- 8.2.4 Unless the air distance used for compliance with § 25.125 is representative of an average pilot who is flying in normal operations (see paragraph 8.2.5 below), the air distance used for time-of-arrival landing performance assessments should be determined analytically as the distance traversed over a time period of 7 seconds at a speed of 98 percent of the recommended speed over the landing threshold, also referred to as the final approach speed (V_{APP}). This represents a flare time of 7 seconds and a touchdown speed (V_{TD}) of 96 percent of V_{APP} . V_{APP} should be consistent with the TC holder's recommended procedures and training material, including any speed additives, such as may be used for winds or icing. The effect of higher speeds, to account for variations that occur in operations or through the operating procedures of individual operators, should also be provided.
- 8.2.5 If the air distance is determined directly from flight test data instead of the analytical method provided in paragraph 8.2.4 above, the flight test data should meet the following criteria:

- 8.2.5.1 Procedures should be used that are consistent with the TC holder's recommended procedures and training for operations in service. These procedures should address the recommended final approach airspeed, flare initiation height, thrust/power reduction height and technique, and target pitch attitudes.
- 8.2.5.2 At a height of 50 feet above the runway surface, the airplane should be at an airspeed no slower than the recommended final approach airspeed.
- 8.2.5.3 The touchdown rate of descent should be in the range of 1 to 4 feet per second.
- Note:** The criterion of paragraph 8.2.5.3 above should not be construed to mean that all of the landing data used to determine the air distance may have a touchdown rate of descent of 4 feet per second. The flight test data should contain a range of touchdown rates ranging from 1 to 4 feet per second.
- 8.2.6 The air distance determined under paragraph 8.2.4 or 8.2.5 of this AC also applies to autoland or similar low visibility guidance systems as long as the demonstrated average flare time and V_{TD}/V_{APP} from the autoland testing do not exceed the values of those parameters used in determining the manual landing distance. If they do exceed the values used in determining the manual landing distance, then the demonstrated average flare time and V_{TD}/V_{APP} from the autoland and/or low visibility guidance system demonstrations should be used for computing the air distance when determining the autoland and/or low visibility guidance system landing distance. The autoland/low visibility guidance system test data used for this determination should be from a representative set of airports and not include extreme glide path intercept points or runway slopes.
- 8.2.7 If the air distance is based on a time of 7 seconds at a speed of 98 percent of the recommended speed over the runway threshold, this air distance is considered valid for downhill runway slopes up to 1 percent in magnitude. (No credit should be taken for an uphill runway slope.)
- 8.3 **Transition Distance.**
- 8.3.1 As shown in figure 1, the transition distance is the distance traveled from the point of main gear touchdown to the point where all deceleration devices used in determining the landing distance are operating. For airplanes for which the air distance is determined using the guidance in paragraph 8.2.4 of this AC, the speed at the start of the transition segment is 96 percent of the final approach speed.
- 8.3.2 The transition distance should be based on the recommended procedures for use of the approved means of deceleration, both in terms of sequencing and any cues for initiation. Reasonably expected time delays should also be taken into account.

- 8.3.3 For procedures that call for initiation of deceleration devices beginning at nose gear touchdown, the minimum time for each pilot action taken to deploy or activate a deceleration means should be the demonstrated time, but no less than one second.
- 8.3.4 For procedures that call for initiation of deceleration devices beginning prior to nose gear touchdown, the minimum time for each pilot action taken to deploy or activate a deceleration means should be the demonstrated time plus one second.
- 8.3.5 For deceleration means that are automatically deployed or activated (for example, auto-speedbrakes or autobrakes), the demonstrated time may be used with no added delay time.
- 8.3.6 The distance for the transition segment, and the speed at the start of the final stopping configuration segment should include the expected evolution of the braking force achieved over the transition distance. The evolution of the braking force should take into account any differences that may occur for different runway surface conditions or pilot-reported braking actions as the airplane transitions to the full braking configuration. (See table 2 of this AC for the wheel braking coefficient for the full braking configuration of each runway surface condition and pilot-reported braking action.)

Note: The wheel braking coefficients in table 2 of this AC were determined by the TALPA ARC part 25 working group, based on their experience and accepted performance levels on different surfaces as defined by aircraft certification agencies (EASA). They were verified to the greatest degree possible by the latest industry flight testing as embodied by the Joint Winter Runway Friction Program, which was active from 1995 to 2004. This AC may be revised if future industry-level acceptance of new information becomes available.

**Table 2. Runway Surface Condition—Pilot-Reported Braking Action—
Wheel Braking Coefficient Correlation Matrix**

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Wheel Braking Coefficient
6	Dry	—	90% of certified value used to comply with § 25.125 ¹ .
5	- Frost - Wet (includes damp and 1/8" (3 mm) depth or less or water) 1/8" (3 mm) depth or less of: - Slush - Dry snow - Wet snow	Good	Per method defined in § 25.109(c).
4	-15 °C and colder outside air temperature: Compacted snow	Good to Medium ²	0.20 ³
3	- Wet ("Slippery When Wet" runway) - Dry snow or wet snow (any depth) over compacted snow Greater than 1/8" (3 mm) depth of: - Dry snow - Wet snow Warmer than -15 °C outside air temperature: - Compacted snow	Medium ²	0.16 ³
2	Greater than 1/8" (3 mm) depth of: - Water - Slush	Medium ² to Poor	(1) For speeds below 85% of the hydroplaning speed ⁴ : 50% of the wheel braking coefficient determined in accordance with § 25.109(c), but no greater than 0.16 ³ ; and (2) For speeds at 85% of the hydroplaning speed ⁴ and above: 0.05 ³ .
1	Ice	Poor	0.08 ³
0	- Wet ice - Water on top of compacted snow - Dry snow or wet snow over ice	Nil	Not applicable. (No operations in Nil conditions.)

¹ 100% of the wheel braking coefficient used to comply with § 25.125 may be used if the testing from which that braking coefficient was derived was conducted on portions of runways containing operationally representative amounts of rubber contamination and paint stripes.

² The braking action term "FAIR" is in the process of being changed to "MEDIUM" throughout the FAA. Until an official change is published, the term "FAIR" may be used.

³ These wheel braking coefficients assume a fully modulating anti-skid system. For quasi-modulating systems, multiply the listed braking coefficient by 0.625. For on-off systems, multiply the listed braking coefficient by 0.375. (See AC 25-7C to determine the classification of an anti-skid system.) Airplanes without anti-skid systems will need to be addressed separately on a case-by-case basis.

⁴ The hydroplaning speed, V_p , may be estimated by the equation $V_p = 9\sqrt{P}$, where V_p is the ground speed in knots and P is the tire pressure in lb/in².

8.4 Final Stopping Configuration Distance (Full Braking Distance).

- 8.4.1 As shown in figure 1, the final stopping configuration (full braking) segment begins at the end of the transition segment, which is the point where all deceleration devices used in determining the landing distance are operating. It ends at the nose gear position when the airplane comes to a stop.
- 8.4.2 The calculation of the final stopping configuration distance should be based on the braking coefficient associated with the runway surface condition or pilot-reported braking action, including the effect of hydroplaning, if applicable. Credit may be taken for the use of thrust reversers as described in section 10. See section 9 for information about taking into account contaminant drag from loose contaminants.

9 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS.

- 9.1 Loose contaminants (see paragraph 7.1.1 of this AC for contaminant classification) result in additional contaminant drag due to the combination of displacement of the contaminant by the airplane tires and impingement of the contaminant spray on the airframe. This contaminant drag provides an additional force helping to decelerate the airplane, which reduces the distance needed to stop the airplane. Because contaminant drag increases with contaminant depth, the deeper the contaminant is, the shorter the stopping distance will be. However, the actual contaminant depth is likely to be less than the reported depth for the following reasons:
 - 9.1.1 Contaminant depths are reported in field condition reports using specific depth increments as specified in FAA Order JO 7930.2Q (or later revision).
 - 9.1.2 The procedure for reporting contaminant depths is to report the highest depth of the contaminant along the reported portion of the runway surface. Contaminant depths are unlikely to be uniform over the runway surface (or reported portion of the runway surface), so it is likely there will be areas of lesser contaminant depth.
 - 9.1.3 In a stable weather environment (that is, no replenishment of the contaminant on the runway), the contaminant depth is likely to decrease as successive airplanes traverse through it and displace the contaminant.
- 9.2 If the actual contaminant depth is less than the reported value, using the reported value to determine contaminant drag will result in a higher drag level than actually exists, leading to an optimistic stopping distance prediction. Therefore, the FAA recommends not including the effect of contaminant drag in the calculation of landing distances for time-of-arrival landing performance assessments. If the effect of contaminant drag is included, it should be limited to no more than the drag resulting from 50 percent of the reported depth.

- 9.3 If the effect of contaminant depth is included in the landing distance data, then data should be provided for the reportable contaminant depths identified in FAA Order JO 7930.2Q (or later revision) up to the maximum contaminant depth for each contaminant for which landing operations are permitted.

Note: Due to issues of potential structural damage from spray impingement and engine ingestion, the maximum recommended depths for landing operations for loose contaminants of slush and water are ½ inch (13 mm) unless greater depths are demonstrated to be free of structural damage and engine ingestion issues.

- 9.4 If the effect of contaminant depth is included in the landing distance data, then data should be provided for the specific gravities in the table 3 below.

Table 3. Loose Contaminant Specific Gravity

Runway Description	Specific Gravity
Dry Snow	0.2
Wet Snow	0.5
Slush	0.85
Water	1.0

- 9.5 The FAA finds acceptable the methods for calculating contaminant drag described in EASA AMC 25.1591. Data providers may also use a method that was previously accepted by EASA or has been validated by suitable analysis or test data.

10 CREDIT FOR REVERSE THRUST.

- 10.1 Landing distances used for time-of-arrival landing performance assessments may include credit for the stopping force provided by reverse thrust, consistent with the procedures established for its use and subject to meeting the following criteria:
- 10.1.1 Procedures used to calculate the landing distance should be consistent with normal procedures for use of reverse thrust during landing. The procedures should include all of the pilot actions necessary to obtain the recommended level of reverse thrust, maintain directional control and safe engine operating characteristics, and return the reverser(s), as applicable, to either the idle or the stowed position.
- 10.1.2 Using reverse thrust during a landing should comply with the engine operating characteristics requirements of § 25.939. The engine should not exhibit any of the adverse engine operating characteristics described in AC 25.939-1 (or later revision). The reverse thrust procedures may specify a speed at which the reverse thrust is to be reduced to idle in order to maintain safe engine operating characteristics.

- 10.1.3 The time sequence for the actions necessary for the pilot to select the recommended level of reverse thrust should be achievable by the average pilot. If the procedure is to deploy reverse thrust at nose gear touchdown, the time for the first action to select reverse thrust may not be less than one second. If the procedure is to deploy reverse thrust before nose gear touchdown, the time for the first action to select reverse thrust should be the demonstrated time plus one second.
- 10.1.4 The response times of the affected airplane systems to pilot inputs should be taken into account. For example, delays in system operation, such as thrust reverser interlocks that prevent the pilot from applying reverse thrust until the reverser is deployed, should be taken into account. The effects of transient response characteristics, such as reverse thrust engine spin-up, should also be included.
- 10.1.5 To enable a pilot of average skill to consistently obtain the recommended level of reverse thrust under typical in-service conditions, a lever position that incorporates tactile feedback (for example, a detent or stop) should be provided. If tactile feedback is not provided, a conservative level of reverse thrust should be assumed.
- 10.1.6 If the data provider chooses to develop data using the process described in this AC, the effects of crosswinds on directional controllability should be assessed and particular attention paid to the possibility of reverse thrust affecting airflow over the rudder and vertical tail surface. Thrust reverser use may even reduce directional controllability in combinations of crosswinds and low friction conditions. Recommendations or guidelines associated with crosswind landings, including maximum recommended crosswinds, should be provided to operators for the runway surface conditions/reported braking actions for which landing distance data are provided. A suitable simulation may be used to develop these guidelines for operation on contaminated runways.
- 10.1.7 If the data provider, in using the process described in this AC, applies credit for less than all thrust reversers, then controllability should be accounted for in that configuration. The reverse thrust procedures may specify a speed at which the reverse thrust is reduced to idle in order to maintain directional controllability.
- 10.1.8 The failure of the thrust reverser to function should be on the order of 10^{-4} or less per landing. This specific reliability requirement applies to both single and combinations of failures and takes into account interlock features intended to prevent inadvertent in-flight deployment.
- 10.1.9 For dispatch with one or more inoperative thrust reverser(s), or for an in-flight failure that affects thrust reverser operation, the effect on the landing performance data for time-of-arrival landing performance assessments should be provided.
- 10.1.10 The effective stopping force provided by reverse thrust in each, or at the option of the data provider, the most critical landing configuration, should be accounted for by flight test. (One method of determining the reverse thrust stopping force would be to compare unbraked runs with and without the use of thrust reversers.) Regardless of the method used to calculate the effective stopping force provided by reverse thrust, flight tests

should be conducted using all of the stopping means on which the landing distances are based in order to calculate the landing distances and ensure that no adverse combination effects are overlooked. These tests may be conducted on a dry runway.

- 10.2 For turbopropeller powered airplanes, the guidance in paragraphs 10.1 through 10.1.10 above remains generally applicable. Additionally, the propeller of the inoperative engine should be in the position it would normally assume when an engine fails and the power lever is closed. Reverse thrust may be selected on the remaining engine(s). Unless this selection is achieved by a single action to retard the power lever(s) from the takeoff setting without encountering a stop or lockout, it should be regarded as an additional pilot action for the purposes of assessing delay times.

11 **GUIDANCE FOR EXISTING TYPE DESIGNS.**

The guidance in this section applies to data already produced to support airplane models already in service.

- 11.1 The following information is intended to facilitate the use of existing data to the maximum extent possible, in order to limit the burden associated with developing and producing new data packages.
- 11.2 The data may be presented in terms of runway surface conditions, pilot-reported braking actions, or both.
- 11.2.1 If data are provided in terms of only one of these parameters, instructions should be provided on how to use the data in terms of the other parameter. For example, when data are provided only in terms of pilot-reported braking actions, instructions should be provided on how to use the data to perform a time-of-arrival landing performance assessment in terms of a runway surface condition description.
- 11.2.2 Table 2 of this AC can be used to relate runway surface condition descriptions to reported braking actions. If data providers have landing performance data in terms of runway surface condition descriptions and credit is taken for drag from loose contaminants, there will not be a one-to-one correspondence between runway surface condition descriptions and pilot-reported braking actions.⁴ In this case, a conservative correction should be applied to the data to remove the effect of contaminant drag. For example, using data based on greater than 1/8-inch depth of water or slush for a pilot-reported braking action of medium to poor.
- 11.3 Contaminated runway landing performance data approved by either the Joint Aviation Authorities or EASA in compliance with either their contaminated runway type

⁴ Pilot-reported braking actions consider only the friction effects of the contaminants on wheel braking and directional controllability and, therefore, will not include the effects of any contaminant drag.

certification or operating requirements are acceptable when using the optional process identified in this AC, with the following caveats:

- 11.3.1 The data provider should develop data that accounts for all of the runway surface condition descriptions identified in table 2 of this AC (unless operating limitations prohibit operations on runway surface conditions for which data are not provided).
- 11.3.2 The effects of runway slope, temperature, and speed over the threshold should be included.
- 11.3.3 Definitions of the runway surface conditions should be consistent with the definitions provided in this AC. In particular, a damp runway is to be considered wet for airplane performance purposes.
- 11.3.4 It is recognized that such data may not conform to the guidance provided in this AC in terms of air distance, transition time assumptions, use of deceleration devices, braking coefficients associated with each runway surface condition description, and the amount of contaminant drag for loose contaminants.
- 11.4 Reverse thrust credit may be included without specifically accounting for reliability or controllability. However, reverse thrust credit should not be used if service history for a particular airplane model indicates unresolved reliability or controllability issues.

12 **DOCUMENTATION.**

12.1 **Data Location.**

The data provider may furnish the time-of-arrival landing performance data in the airplane flight manual, flightcrew operating manual, quick reference handbook, electronic flight bag, and/or other appropriate locations.

12.2 **Data Label.**

Wherever the data is provided, label the data as “Advisory Data Only” or use similar wording.

12.3 **Other Information.**

If a data provider develops the landing performance data described in this AC, the following information should also be provided:

- 12.3.1 Instructions for use.
- 12.3.2 Definitions of runway surface condition and how to correlate runway surface condition descriptions, runway condition codes, and braking actions.
- 12.3.3 Recommendations prohibiting landing on runways with contaminants and depths beyond those covered in the performance data.
- 12.3.4 Any other recommendation associated with use of the landing performance data.

- 12.3.5 Statements that the data are based on a uniform depth (for loose contaminants) and uniform coverage of a layer of contaminant with uniform properties throughout.
- 12.3.6 The procedures and assumptions used to develop the operational landing distances.

Advisory Circular Feedback

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by (1) emailing this form to 9-AWA-AVS-AIR500-Coord@faa.gov or (2) faxing it to the attention of the Aircraft Certification Service Directives Management Officer at (202) 267-3983.

Subject: AC 25-32, Landing Performance Data Date: _____

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph _____ on page _____.

☐ Recommend paragraph _____ on page _____ be changed as follows:

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

☐ Other comments:

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____