ARAC AVIATION RULEMAKING ADVISORY COMMITTEE

September 12, 2022

Brandon Roberts
Executive Director, Office of Rulemaking, ARM-1
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Re: Recommendation Report - Flight Test Harmonization Working Group, Topic 32, Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)

Dear Mr. Roberts,

On behalf of the Aviation Rulemaking Advisory Committee (ARAC), I am pleased to submit the enclosed Recommendation Report from the Transport Airplane and Engine (TAE) Subcommittee's Flight Test Harmonization working group on the codification of Part 25 TALPA.

At the September 8, 2022, ARAC meeting in Washington, DC, Mr. Keith Morgan presented an overview of the report which recommends updates to the performance aspects of the airworthiness standards which will require information to be provided in the Airplane Flight Manual (AFM) for contaminated runway takeoff data and time-of-arrival landing data. Codifying these standards will promote harmonization in this area of aircraft operation.

ARAC members who attended the September 8 meeting, in-person and virtually, accepted the report, as presented. With that, I would welcome the agency's timely review and actions to implement the working group's recommendations.

I want to thank the members of TAE's Flight Test Harmonization working group for their work in response to the agency's tasking, consideration of the ARC recommendations and efforts to promote global harmonization.

Sincerely,

David Oord
ARAC Chair

Enclosure: Recommendation Report - Flight Test Harmonization Working Group, Topic 32, Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)

FAA Aviation Rulemaking Advisory Committee
FTHWG Topic 32
Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)

Recommendation Report
July 20, 2022

TABLE OF CONTENTS

Table of Contents 2
Executive Summary 4
Background 6
- **What is the underlying safety issue addressed by the EASA CS/FAA CFR?** 6
- **What is the task?** 8
- **Why is this task needed?** 8
- **Who has worked the task?** 8
- **Any relation with other topics?** 9

Historical Information 9
- **A. What are the current regulatory and guidance material in CS 25 and 14 CFR part 25?** 9
- **B. What, if any, are the differences in the existing regulatory and guidance material CS 25 and 14 CFR part 25?** 10
- **C. What are the existing CRIs/IPs (SC and MoC)?** 10
- **D. What, if any, are the differences in the Special Conditions (SC and MoC) and what do these differences result in?** 11

Recommendation 11
- **A. Rulemaking** 11
- **1. What is the proposed action?** 11
- **2. What should the harmonized standard be?** 11
- **3. How does this proposed standard address the underlying safety issue?** 12
- **4. Relative to the current 14 CFR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.** 12
- **5. Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.** 13
- **6. What other options have been considered, and why were they not selected?** 13
- **7. Who would be affected by the proposed change?** 13
- **8. Does the proposed standard affect other HWGs and what is the result of any consultation with other HWGs?** 13
- **B. Advisory Material** 13
- **1. Is existing FAA advisory material adequate? If not, what advisory material should be adopted?** 13
- **2. To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?** 14

Economics 15
- **A. What is the cost impact of complying with the proposed standard)?** 15
- **B. Does the HWG want to review the draft NPRM prior to publication in the Federal Register?** 16

Consensus/Comment/Dissent 16
Appendix 1 - Proposed Standards and Rationale 23
- **NEW RECOMMENDED 14 CFR PART 25 REGULATIONS** 23
- **RECOMMENDED 14 CFR PART 121 OPERATING STANDARDS** 25

Appendix 2 – Revised Advisory Material - AC 25-31X (Takeoff) 30
- **1 PURPOSE.** 32
- **2 APPLICABILITY.** 32
- **3 CANCELLATION.** 32
- **4 RELATED DOCUMENTS.** 32
- **5 BACKGROUND.** 33
- **6 DEFINITIONS.** 33
- **7 CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.** 36
- **8 DETERMINATION OF CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.** 38
- **9 ACCOUNTING FOR THE DRAG OF LOOSE CONTAMINANTS.** 40
- **10 CREDIT FOR REVERSE THRUST.** 42
- **11 GUIDANCE FOR EXISTING TYPE DESIGNS.** 43
- **12 DOCUMENTATION.** 44

Appendix 3 – Revised Advisory Material - AC 25-32X (Landing) 47
1 PURPOSE. 49
2 APPLICABILITY. 49
3 CANCELLATION. 49
4 RELATED DOCUMENTS. 49
5 BACKGROUND. 50
6 TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS. 51
7 DEFINITIONS. 53
8 TIME-OF-ARRIVAL PERFORMANCE DATA. 56
9 DETERMINATION OF LANDING DISTANCE FOR TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS. 59
10 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS. 63
11 CREDIT FOR REVERSE THRUST. 64
12 GUIDANCE FOR EXISTING TYPE DESIGNS. 66
13 DOCUMENTATION. 67
Appendix 4 – New Advisory Material - AC 25.1591 (Takeoff) 69
1 PURPOSE. 71
2 APPLICABILITY. 71
3 CANCELLATION 71
4 RELATED DOCUMENTS 71
5 BACKGROUND. 72
6 DEFINITIONS. 72
7 CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA. 75
8 DETERMINATION OF CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA. 76
9 ACCOUNTING FOR THE DRAG OF LOOSE CONTAMINANTS. 79
10 CREDIT FOR REVERSE THRUST. 81
11 GUIDANCE FOR EXISTING TYPE DESIGNS. 82
12 DOCUMENTATION. 82
Appendix 5 – New Advisory Material - AC 25.1592 (Landing) 85
1 PURPOSE. 87
2 APPLICABILITY. 87
3 CANCELLATION. 87
4 RELATED DOCUMENTS. 87
5 BACKGROUND. 88
6 TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS. 89
7 DEFINITIONS. 90
8 TIME-OF-ARRIVAL PERFORMANCE DATA. 94
9 DETERMINATION OF LANDING DISTANCE FOR TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS. 97
10 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS. 100
11 CREDIT FOR REVERSE THRUST. 102
12 GUIDANCE FOR EXISTING TYPE DESIGNS. 103
13 DOCUMENTATION. 103
Appendix 6 - Revised Advisory Material - AC 25-7X 105

EXECUTIVE SUMMARY

The Flight Test Harmonization Working Group was tasked with providing recommendations for codification of the 14 Code of Federal Regulations (CFR) part 25 Federal Aviation Administration (FAA) Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) recommendations, which were published for voluntary implementation in Advisory Circular (AC) 25-31 and AC 25-32 in December of 2015. These ACs, along with Airport, Air Traffic Control (ATC) and the Flight Standards guidance, resulted in the voluntary full implementation of the FAA TALPA program starting in October 2016.

The timing is considered favorable to harmonize the airworthiness aspects of TALPA as the International Civil Aviation Organization (ICAO) Global Reporting Format (GRF), which is reasonably consistent with FAA TALPA runway condition reporting standards, committed to operational implementations in November of 2021. This has caused multiple national aviation authorities to move ahead with equivalent airport reporting programs, flight operations standards and in some cases airworthiness standards associated with this subject.

What is TALPA and ICAO GRF? These programs, initiated in the early 2000's, addressed issues identified by investigation of non-dry runway overrun excursions. Specifically the concern was lack of timely airport and ATC reporting of runway conditions that could affect braking for operations of aircraft and inconsistencies caused by a lack of requirements in some countries for providing contaminated runway takeoff performance data and Time-Of-Arrival (TOA) landing distance data.

The specific accident which led to the creation of the FAA TALPA ARC was the Southwest Airlines 1248 overrun at Chicago Midway Airport December 8th 2005, which resulted in a Boeing 737 coming to rest on a city street impacting a car and causing one death. Further to investigation of this accident, the National Transportation Safety Board issued eight safety recommendations that led to an FAA team evaluating all facets of operation on non-dry runways. The result of this investigation was an Aviation Rulemaking Committee that addressed all issues associated with non-dry runway operations including Airworthiness (14 CFR part 23 and 25), Flight Operations (14 CFR part 121, 135, 91K), Airports (14 CFR part 139) as well as ATC, training and Notices to Airmen (NOTAM's).

These various entities met over a 15-month period in 2008 and 2009 for approximately 50 meeting days plus numerous teleconferences. The purpose was to create a cohesive set of recommendations that addressed reporting of runway condition, creation of airplane performance, and implementation of flight operations on non-dry runways. A key element of this effort was using consistent descriptions, assumptions, and language across all the stakeholders that dealt with flight operations on non-dry runways. This activity also included two winter trials in 2010 and 2012 verifying and refining the recommendations for the reporting methods.

TALPA considers both takeoff and landing flight phases, however the bulk of the effort was focused on time-of-arrival landing performance. This focus on landing performance was because takeoff had already been studied in the late 80’s to early 90’s for the Joint Aviation Administration (JAA) requirements for takeoff on contaminated runways, including consideration of engine failure. The existence of this JAA data led many manufacturers to provide data certified to JAA requirements to operators who were not subject to the JAA requirements out of convenience. These JAA requirements evolved into European Aviation Safety Agency (EASA) requirements when that organization assumed responsibility for the JAA regulatory environment (28 Sep 2003).

Therefore, much of the focus of TALPA was on Time-of-Arrival landing performance data. In particular, understanding the variation in assumptions used to compute TOA landing performance data for use by operators. The variation in assumptions used by manufacturers for TOA performance data included air distance, speed bleed off during the flare, transition from landing configuration to stopping configuration, friction characteristics covered, use of reverse thrust, and methods of describing the wheel braking capability. Manufacturers had provided data based on Pilot Reports of Braking Action and contaminant type and depth.

When the TALPA ARC finished its work, it had a cohesive set of recommendations that was workable for airports, ATC, aircraft operators, manufacturers and other data providers. The TALPA ARC followed this up with two winter trials, which led to the refinement of the recommendations and the final information that the FAA eventually published.

The TALPA ARC transmitted the rulemaking recommendations to the FAA; however, the FAA did not implement the rulemaking recommendations, instead publishing information for voluntary implementation of the TALPA recommendations. This implementation effort involved a team representing all the appropriate FAA lines of business.

Starting in 2012 there was partial implementation, as some manufacturers began providing takeoff and landing performance data to operators based on TALPA recommendations and some operators began using this performance data. Other manufacturers provided guidance for methods to adjust existing data to provide levels of performance functionally similar to TALPA.

In October 2016, the FAA mandated that airports that had 14 CFR part 121 operations or received federal funding were to start reporting runway conditions using TALPA terminology. The NOTAM system used TALPA terminology to promulgate airport reports and ATC provided feedback to flight crew based upon reports from landing pilots (PIREPs) updated with the conditions flight crew could expect.

In parallel, the ICAO initiated a Friction Task Force (FTF) through their Airport Design and Operations Panel (ADOP). The FTF was cognizant of the FAA TALPA activity and eventually modified the ICAO Standards and Recommended Practices (SARPs) in several Annexes in a way that preserved most of the language, nomenclature and intent of the FAA TALPA initiative. The ICAO eventually named this the Global Reporting Format.

EASA took these ICAO GRF SARPs and revised their regulations and advisory material between August 2020 and November 2021 supporting full implementation of the initiative that started with the FAA TALPA program.

This report recommends updates to the performance aspects of the airworthiness standards which will require information to be provided in the Airplane Flight Manual (AFM) for contaminated runway takeoff data and time-of-arrival landing data. Codifying these standards will promote harmonization in this area of aircraft operation.

BACKGROUND

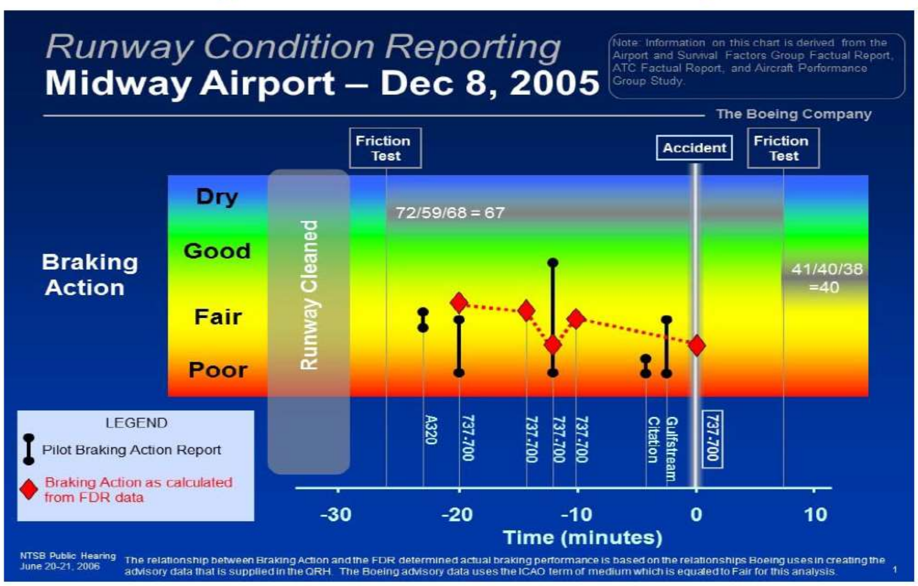
What is the underlying safety issue addressed by the EASA CS/FAA CFR?

Following the Southwest Airlines runway excursion at Chicago Midway (MDW) in December of 2005 the FAA identified a significant deficiency in the way runway braking capability was reported during winter operations and the data manufacturers provided to airplane operators. There were inconsistencies in technical assumptions for performance parameters including assumed wheel braking for a given runway description.

As part of the MDW accident investigation, the NTSB, the FAA, and Boeing conducted a complete analysis that demonstrated the changing nature of the braking action experienced by landing aircraft over the 25 minutes from the time the runway was cleared until the accident.

The following graphic shows the change in measured friction, pilot reports and measured aircraft stopping performance deterioration during this time. During the 25-minute time between the initial friction measurements and the accident, it was snowing heavily.

From Boeing NTSB Sunshine Hearing Testimony



The initial friction report when the runway was cleared and re-opened indicated very **good** braking action. The pilot of the first airplane that landed on the runway a few minutes later gave a report of **fair** braking action and every pilot who provided a report after that always used the word **poor** in some context of their braking action report. The analysis of data recorded by airplanes during roll-out after the accident indicated **fair** braking action deteriorating to **poor** braking action conditions. Finally, within 10 minutes of the overrun event, airport personnel performed another friction measurement. The values from this post-accident friction measurement would have resulted in a reported braking action of **Good**.

Note: The airplane braking action information above is based on normal Boeing relationships for providing aircraft wheel braking performance data in their operational publications. The friction measurement braking action is based on normally accepted industry relationships in use at the time that were based on ICAO SNOWTAM reporting formats. ICAO defines SNOWTAM as a special series NOTAM notifying the presence, or removal, of hazardous conditions due to snow, ice, slush or standing water on the movement area, by means of a specific format.

The issues of timeliness and accuracy of information made available to flight crew, as well as the inconsistency of methods used for computing the data operators used to make the land/no land decision were identified as contributing factors in the accident. The task given to the TALPA ARC by the FAA was to resolve these issues. This report and related FTHWG activity address the result of the TALPA ARC specific to the recommendations to include a consistent set of guidelines for computing takeoff and time-of-arrival landing performance data as part of 14 CFR part 25.

For various reasons, the FAA did not codify the TALPA ARC recommendations but did request voluntary implementation by manufacturers to provide the performance information in order to reduce the number of runway overruns on non-dry runways as soon as possible and therefore contribute to aviation safety.

In 2015, the ICAO proposed modifications to its SARPs for Meteorology, Airworthiness, Flight Operations, Airport Reporting, NOTAMs, and ATC that were based upon the TALPA ARC recommendations. The ICAO SARPs were implemented worldwide starting in November 2021. Because of these ICAO recommendations, EASA has updated their airworthiness and operational requirements.

Until the publication of the TALPA ARC ACs in December 2015, the FAA did not have advisory material to provide manufacturers an appropriate set of assumptions for the creation of takeoff performance data on contaminated runways and landing performance data for use at time of arrival. As such, manufacturers' methods, terminology, etc. varied.

While EASA did have a certification requirement for publication of takeoff and landing performance data for contaminated runways since 1988 with some evolution over time, the EASA material was not consistently applied across all manufacturers. Some of the performance assumptions were in need of updating to reflect the state of the industry knowledge and to align with recommendations of the TALPA ARC. Also, a mechanism for timely reporting of the aircraft stopping capability during changing conditions was needed.

What is the task?

The task of the FTHWG is to codify and publish guidance material on the part 25 aspects recommended by the Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC) for computing landing distances to use at the time-of-arrival; and to codify and provide guidance material on the part 25 aspects recommended by the TALPA ARC for computing takeoff distances on contaminated (non-dry, non-wet runways).

As FAA, ICAO, Transport Canada Civil Aviation (TCCA) and EASA have already addressed most of the technical issues, this task primarily consists of refining the regulatory language and advisory material to recommend a harmonized set of requirements. EASA AMC 25.1591 and AMC 25.1592 are similar to FAA AC 25-31 and AC 25-32, respectively, but some differences exist and part of this task is to minimize these differences. The main difference is due to the fact that EASA operational rules require the operator to consider expected runway contamination at the destination at time of dispatch. While in that context the build-up of the landing distances is the same both for use at dispatch and time of arrival, dispatch must also ensure availability of the unfactored runway length required with one engine inoperative.

Why is this task needed?

The existing FAA ACs 25-31 and 25-32 for voluntary application have become the de-facto global standard for the creation of aircraft performance data based on a consistent set of assumptions and reporting terminology. This standard has been referenced by ICAO in the Doc 10064 Aeroplane Performance Manual and is the basis for the changes introduced in EASA AMCs 25.1591 and 25.1592 at Amdt 27 of CS-25. This task is needed to codify the standards in FAA regulation, harmonize with EASA material as appropriate, and incorporate feedback from the global implementation.

The eventual success of this activity will result in achieving harmonization of the Brazilian National Civil Aviation Agency (ANAC), EASA, FAA and TCCA requirements to enable the manufacturers to publish a uniform set of performance data for takeoff on slippery wet and contaminated runways and landing performance data for use at time of arrival on dry, wet, slippery wet and contaminated runways that are consistent with industry best practices and consistent with standardized reporting methods. This will provide aircraft operators an approved source of takeoff performance data for slippery wet/contaminated runway and time-of-arrival landing performance data for all runway conditions.

Who has worked the task?

Historically, the work was initiated by the UK Civil Aviation Authority (CAA) following an aircraft accident involving an aircraft carrying the Manchester United Football team in Munich Germany in 1958. Over the years, there have been various initiatives from different safety organizations and regulatory bodies to improve the understanding of the underlying physics and consistency of performance assumptions. Much of the current understanding and methods was developed from the work of the Joint Aviation Authorities (JAA) in the 80’s and 90’s. These methods were adopted by EASA and further refined and updated by the TALPA ARC and subsequent EASA Certification Review Items (CRI) and ICAO SARPs.

In the case of the FTHWG Topic 32, this task has been supported by performance specialists from the following:

- Manufacturers: Airbus, Airbus Canada, ATR, Boeing, Bombardier, Dassault, de Havilland, Embraer, Gulfstream, Textron Aviation
- Regulatory agencies: ANAC, EASA, FAA, TCCA
- Industry groups: ALPA

Also included in discussions were two members of the Society of Aircraft Performance and Operations Engineers (SAPOE): one who was an original TALPA Part 25 workgroup member and one who is performance manager at a Nordic airline as well as a line pilot.

In total 7 individuals who were part of the original TALPA Part 25 workgroup participated in this task.

Any relation with other topics?

For takeoff performance there is no direct relationship with other FTHWG topics, however there are tangential considerations for topics such as Topic 10 – Runway Excursion Hazard Classification, Topic 14 – Crosswind & Tailwind, Topic 21 – Narrow Runway, Topic 30 – Controllability during Low Speed OEI RTO.

For TOA landing, there is a relationship with Topic 9 – Wet Runway Stopping Performance, Topic 33 – Dry Runway Stopping Performance, and possible tangential considerations for Topic 10 – Runway Excursion Hazard Classification, Topic 12 – Steep Approach Landing, Topic 14 – Crosswind & Tailwind, and Topic 20 – Return Landing Capability.

HISTORICAL INFORMATION

A. *What are the current regulatory and guidance material in CS 25 and 14 CFR part 25?*

<u>EASA</u>
CS 25 – 25.1581, 1583, 1587, 1591, 1592
AMC 25.1583(k), AMC 25.1591, AMC 25.1592
Regulation (EU) No 965/2012 Air Operations

- CAT.OP.MPA.303 and associated AMCs
- CAT.OP.MPA.230 and associated AMCs
- CAT.OP.MPA.235 and associated AMCs

<u>FAA</u>
Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC) Transmittal Files, November 2009
AC 25-31 and AC 25-32
AC 91-79A (or later revision)
AC 150/5320-12C (or later revision)

SAFO 19001

TCCA
AWM 525.1581 Aeroplane Flight Manual: General
AC 525-001 Methodology for Establishing Takeoff and Landing Performance on Contaminated Runways
AC 700-057 Global Reporting Format (GRF) for Runway Surface Conditions; Guidance for Flight Operations
AC 700-060 Braking Action Reports

ANAC
Oficio Circular no 09/2015/GCTA/121/SP/SPO

B. ***What, if any, are the differences in the existing regulatory and guidance material CS 25 and 14 CFR part 25?***

The primary difference is that in CS-25 at Amendment 27 specifications 25.1591 and 25.1592 exist while 14 CFR part 25 does not have any comparable regulations. AMC 25.1591 and 25.1592 are similar to FAA AC 25-31 and AC 25-32, respectively, but some differences exist.

Another major difference is that CS 25.1592 “Performance information for assessing the landing distance” prohibits operations on contaminated runways for which no landing performance data is furnished. This difference originates in the fact that EASA operating rules have a dispatch requirement for contaminated runway landing distances using a physics-based computation. This operational requirement creates a need for such physics-based landing distances to be furnished. When creating CS 25.1592 for the implementation of the GRF, the EASA introduced a mechanism for accountability for an engine failure in landing performance data for contaminated runways to be used at time of dispatch. The FAA does not have a specific dispatch requirement using a computed contaminated runway landing distance but rather has an operational requirement for dispatching to wet and slippery runways, which is applied for dispatch to all non-dry runway surfaces. During the TALPA ARC, this was extensively discussed and it was decided that this aspect of the FAA dispatch requirement did not need to change. The FTHWG supports this decision, along with the other recommendations of the TALPA ARC regarding changes to operational regulation, shown in Appendix 1. Consequently, the engine failure accountability has not been introduced in the proposed ACs 25-32 and 25.1592.

C. ***What are the existing CRIs/IPs (SC and MoC)?***

Several CRIs were applied to designs for type certification by EASA based on the draft material now published in AMCs 25.1591/1592 Amdt 27. The FAA has not applied similar issue papers.

D. ***What, if any, are the differences in the Special Conditions (SC and MoC) and what do these differences result in?***

Not applicable

RECOMMENDATION

A. ***Rulemaking***

1. What is the proposed action?

The proposed action is that the FAA create 14 CFR part 25 standards equivalent to the EASA CS 25.1591 (takeoff) and CS 25.1592 (time-of-arrival landing distance) standards addressing takeoff on slippery wet and contaminated runways and landing performance at time of arrival. The proposed standards will not be identical to the current CS standards for reasons of form, and in the case of landing distance data, the proposed standard will address TOA landing distance calculation only and will not include a specific 14 CFR part 25 requirement for establishing contaminated runway dispatch landing distance data.

To ensure that the intended positive safety impact takes effect, it is recommended that associated changes are made to regulations in other domains. The original recommendations of the TALPA ARC have already been fully implemented by the FAA in the area of runway condition reporting by the airports, and the timely transmission of this information to airplane operators. The standards proposed herein ensure appropriate performance data will be provided by manufacturers for future designs. A gap remains with regards to operational regulation. The TALPA ARC part 121 working group had recommended changes, which the FTHWG supports. They have been included in Appendix 1 of this report.

The FTHWG recommends that the FAA reviews if changes to part 135.385 and 91.605/1037 consistent with the recommendations of SAFO 19001 and AC 91-79A (or later revision) are required to ensure a positive safety impact for operations other than part 121.

2. What should the harmonized standard be?

The original TALPA ARC recommended creation of a 14 CFR part 25 sub-part B Flight – Performance takeoff on slippery wet/contaminated runways (as a modification of § 25.109) and TOA landing requirements (as a modification of § 25.125). The EASA method is to have a CS 25 Subpart G – Operating Limitations and Information - Supplementary Information requirement in CS 25.1591 and CS 25.1592. The harmonized standard proposes that the requirements state that takeoff performance data for slippery wet/contaminated runways may be furnished in the AFM, or a limitation specified to prohibit operations for which the performance data is not provided. The harmonized standard proposes that the requirements state that TOA landing performance data for dry, wet, slippery wet and contaminated runways must be furnished in the AFM.

The FTHWG considered these two methods and decided the EASA method was acceptable.

Therefore, the FTHWG recommendation is that the harmonized standard be based on current EASA CS 25.1591 and CS 25.1592; however as noted in Recommendation A.1., it is not identical to the EASA regulations. Another benefit of following the EASA method is that historically, TCCA has pointed to the EASA regulations as an acceptable means to address contaminated runway operations.

The FTHWG also reviewed sub-part G – Airplane Flight Manual § 25.1581, General and § 25.1587, Performance Information and decided that no changes were necessary.

Sub-part G – Airplane Flight Manual § 25.1583, Operating Limitations was reviewed to determine whether the 14 CFR regulation should be amended to include the CS 25.1583(k) requirement for a limitation on the maximum depth of runway contaminants for takeoff operation. It was decided this was not required because the recommendation for 14 CFR 25.1591 includes language for AFM information that must be provided and the language in AMC 25.1583(k) supporting CS 25.1583(k) could be incorporated into the appropriate FAA ACs. It is recommended that EASA remove CS 25.1583(k) as it is covered by AMC 25.1091(d)(2) and CS 25.1591/AMC 25.1591.

The proposed regulatory standards are in Appendix 1 - Proposed Standards and Rationale.

3. ***How does this proposed standard address the underlying safety issue?***

The proposed standard addresses the underlying safety issue by ensuring that aircraft operators have approved performance data available for takeoff slippery wet/contaminated runway and TOA landing. It further addresses the underlying safety issue by ensuring this information is based on consistent assumptions relating to

- The physics of flight,
- The standards for reporting of runway conditions, and
- The assumed wheel braking capability.

4. ***Relative to the current 14 CFR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.***

As there is no current 14 CFR standard requiring aircraft performance information addressing takeoff on slippery wet/contaminated runway or time-of-arrival landing performance, the proposed standard increases safety. The proposed standards further increase safety by ensuring that the information is based on harmonized standard methods, assumptions and terminology.

This proposed standard is particularly important when Pilot Reports or quantitative reports of aircraft wheel braking capability are transmitted to aircraft whose flight crews are preparing performance assessments prior to takeoff or before landing.

A consistent wheel braking standard for all airplanes also allows airports to better understand when their runway maintenance methods are not keeping up with active precipitation events and the runway capability to produce adequate wheel braking is becoming compromised (based on Pilot Reports or quantitative reports of aircraft wheel braking capability).

5. ***Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.***

   Relative to the current industry best practices the proposed standard will maintain the same level of safety. Many manufacturers and operators have accepted TALPA/GRF recommendations and provide data consistent with the current runway condition reporting systems. Going forward, as older aircraft are retired from service the level of safety will improve, as the percentage of operations following these best practices will increase.

6. ***What other options have been considered, and why were they not selected?***

   The FTHWG did not consider other options as the group focused on the harmonization of 14 CFR requirements and advisory material with TALPA ARC and ICAO GRF recommendations as implemented by EASA. Those industry efforts went through an extensive vetting process.

7. ***Who would be affected by the proposed change?***

   The proposed change will primarily affect manufacturers of Part 25 aircraft and aircraft operators.

8. ***Does the proposed standard affect other HWGs and what is the result of any consultation with other HWGs?***

   The proposed changes do not affect other HWGs.

B. *Advisory Material*

1. ***Is existing FAA advisory material adequate? If not, what advisory material should be adopted?***

   The existing FAA AC 25-31 and AC 25-32 advisory material is technically adequate but its application is voluntary. This guidance needs to be revised to harmonize to the greatest degree possible with ICAO Doc 10064 Aeroplane Performance Manual and EASA AMCs in anticipation of harmonized FAA rules.

   An update is proposed to FAA AC 25-7 to include consideration of the airborne distance of steep approach landings in time of arrival landing performance assessments.

   The FTHWG made the following recommendation in the final report for Task 9 Wet Runway Stopping Performance:

   > *It is recommended to convene a group of industry experts to produce a* ***Landing Safety Training Aid (LSTA)****. This training aid would be a suggested comprehensive training program on the subject of landing procedures and performance data.*
   >
   > *The group should include representatives from aircraft operators, airport operators, aircraft manufacturers, regulatory agencies, flight safety organizations, and pilot unions.*

The goal is to minimize, to the greatest extent practical, the probability of a landing accident or incident due to misinformation or ignorance of landing performance.

This effort would be FAA and/or EASA sponsored and become the definitive source for airplane landing performance similar to what the Takeoff Safety Training Aid (TOSTA) has become for takeoff performance. Similar to the TOSTA, it would provide a vetted resource in many cases dispelling incorrect interpretations and myths as to landing performance.

The intended audience for the LSTA would be 14 CFR part 121, 135, and 91K operators. However, many of the principles, concepts, and procedures would equally apply to other aircraft operators and would be recommended for use by those operators when applicable.

It is expected that a LSTA would reduce landing accidents and incidents in the same way that the Takeoff Safety Training Aid reduced takeoff accidents and incidents.

The group would like to emphasize the importance of this recommendation to the reduction of runway excursion events.

2. ***To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?***

None of the existing guidance material applicable to aircraft certification needs to be elevated to rule text. The existing guidance is not suitable for the preamble.

That being said, FAA AC 25-31 - Takeoff Performance Data for Operations on Contaminated Runways and AC 25-32 Landing Performance Data for Time-of-Arrival Landing Performance Assessments were published in December of 2015. Their publication is not based on an existing regulation but rather on industry best practices as defined by FAA TALPA and since confirmed by ICAO/GRF project and EASA rulemaking.

At the time of original publication, the ICAO GRF project had not published the final SARPs nor had EASA rulemaking based on updated ICAO SARPs commenced. Therefore, no harmonization of the FAA ACs with other industry material was needed. It is noteworthy that both the ICAO SARPs and EASA AMCs 25.1591 and 25.1592 refer to the FAA ACs. The FAA ACs need updating at a minimum to improve consistency with ICAO and EASA information. It is recommended to update the ACs to account for the harmonization activity as soon as practical. For the purpose of this report, these updated ACs will be designated AC 25-31X and AC 25-32X, which are included in Appendix 2 and 3 of this report, respectively.

Once rulemaking occurs to introduce 14 CFR 25.1591 and 25.1592, it is recommended that the ACs be updated to account for the new regulations. This change is minimal and related to verbiage appropriate for alignment with the new regulations. For the purpose of this report, these ACs are designated as AC 25.1591 and AC 25.1592, included in Appendix 4 and 5 of this report, respectively.

ECONOMICS

A. ***What is the cost impact of complying with the proposed standard)?***

An economic study has not been performed, but as the proposed standard is for future certified airplanes, for which there are no additional testing requirements, and does not include retroactivity, the incremental cost is expected to be minimal. This is consistent with the conclusions of the analysis performed for EASA NPA 2016-11. However, should the FAA decide to conduct an economic impact analysis, the FTHWG would like to be consulted and contribute to such a study.

The applicant may choose the default parameters allowed for air distance calculation when determining Landing Distances at Time of Arrival (LDTA) and may choose the same methods used to determine transition distances for dry runway landing distance certification. The recommended takeoff and LDTA guidance provides standard analytical wheel braking coefficients for contaminated runways and the same analytical methods to determine wet runway wheel braking as used today for compliance with 14 CFR 25.109(c) Accelerate-stop distance.

Reverse thrust credit is allowed and therefore additional certification testing may be required to determine landing flap configuration dependent reverse thrust effects. Some manufacturers currently must determine the landing flap dependent thrust reverser effects to satisfy EASA requirements.

For the operator, the effect is dependent on the airports they choose to service and the airplane they choose to operate. As these methods have been in use by EASA for takeoff calculations and strongly recommended as LDTA best practices for a number of years, there should be no unexpected requirements for training and no more stringent performance requirements when these standards are applied to new airplane designs.

The proposed standards change the status of LDTA from advisory to approved information. This may also be the case for contaminated runway performance for takeoff if the manufacturer had not previously provided data in line with EASA requirements. Many manufacturers provide approved performance data in the form of software and databases that require development to rigorous quality standards. Although not harmonized across the industry, some OEM's are required to apply DO200B/DO178 standards. The enlarged scope of this software may incur additional work-load and costs for manufacturers.

The manufacturers may have a financial cost if they choose to re-certify existing airplanes under the new regulations. However, the TALPA, ICAO/GRF and EASA implementations all allow manufacturers to analytically adjust existing operational data which can be done in a way that incurs a minimal cost.

B. ***Does the HWG want to review the draft NPRM prior to publication in the Federal Register?***

Yes

CONSENSUS/COMMENT/DISSENT

Consensus

There is consensus that harmonized part 25 regulations to address the recommendations of TALPA ARC and EASA's implementation of the ICAO GRF are appropriate and needed. This will ensure, going forward, that the takeoff and TOA landing performance data will be based on consistent assumptions, verbiage and wheel braking assumptions etc. This results in manufacturers (or data providers) being able to use the same information for most, if not all, certifications which may require this information. The proposed harmonized regulations are presented in Appendix 1.

There is also consensus that the technical content of FAA AC 25-31 (Takeoff Performance Data for Operations on Contaminated Runways) and FAA AC 25-32 (Landing Performance Data for Time-of-Arrival Landing Performance Assessments) are generally acceptable.

The one technical item that is updated from the original TALPA ARC recommendations is the wheel-braking coefficient assigned to ice covered runways. The original TALPA ARC assigned a wheel braking coefficient of 0.08, the FTHWG agreed to accept the ICAO GRF/EASA value of 0.07. Part of the TALPA ARC concept is if additional information becomes known it will be considered. Airbus certification with EASA resulted in the use of wheel braking coefficient of 0.07 for Ice Cold and Dry after considerable discussion. The FTHWG accepts this recommendation. Operational data indicates that this slightly lower value of 0.07 is reasonable.

There was considerable discussion regarding the verbiage associated with a Slippery Wet Runway. During the TALPA ARC the FAA accepted the ICAO concept of 'Slippery when Wet' when a runway is known to provide significantly less friction than the nominal expected level when it is wet. The quantitative measure of this threshold is when a runway falls below the minimum friction level associated with the runway maintenance procedures using Continuous Friction Monitoring Equipment (CFME). For further information, refer to AC 150/5320-12C (or later revision). During the ICAO GRF deliberations, the ICAO term 'Slippery when Wet' changed to 'Slippery Wet' as the ICAO considered this to be better language for usage in a runway surface condition report to indicate the current validity of the slippery state. The recommendation from the FTHWG is that the FAA should consider this change in terminology. Regardless, a note is placed in the Definitions section of both recommended revisions to AC 25-31 and AC 25-32 that the terms 'Slippery Wet' and 'Slippery when Wet' be considered equivalent.

Regarding guidance material for takeoff, while it was agreed by TALPA ARC that generally the material only applies to paved runways, some Aviation Authorities found that the guidance material for some types of contaminants such as Compacted Snow can also be applicable for unpaved surfaces on which the airplane is eligible to operate. The FTHWG, however, decided that this was an operational consideration outside of the scope of the guidance on the derivation of contaminated runway performance data. The FTHWG does however consider it acceptable that operational regulation and guidance could permit the use of such performance data for conditions where winter contamination creates a hard surface on top of an unpaved runway. However, not all of the authorities represented on FTHWG have the operating rules and aerodrome rules available to enable that operation.

The original AC 25-31 does not provide guidance for maximum contaminant depth, while EASA CS 25.1591 sets maximum depths for each contaminant type. It was decided to introduce these same limits in the basic guidance while allowing applicants to exceed these limits if shown to be safe.

The FTHWG discussed a proposal to address operational issues encountered on contaminated runways when the Runway Condition Code was either downgraded or upgraded. Due to the detrimental effect of loose contaminant drag on the acceleration segment at takeoff, a performance assessment for a given contaminant is mandatory. EASA AMC 25.1591 recognizes that actual performance capabilities in the real world may differ from those reflected by the performance models for winter contaminants, and EASA operational regulation recommends that when operations on contaminated runways are conducted regularly, additional mitigations should be put into place to ensure a consistent level of safety. The FTHWG recognizes the operational need but does not recommend mandating the publication of data that permits combining contaminant drag of the reported contaminant with any of the six levels of friction coefficient characteristics defined by the TALPA ARC, because of the complexity associated with managing a large number of combinations, in particular when performance data is published “on paper.” Instead, recommendations are made for manufacturers to provide data that allows operators to address downgrades and upgrades satisfactorily with available data and operational tools.

One essential change recommended by the FTHWG is that the FAA AC 25-32 be revised to consider the publication of performance data for the Runway Condition Code reported in Field Condition (FICON) NOTAMS. The original AC 25-32 did not include this, as the FAA legal department was not satisfied with the performance data classifications using terminology that was not in use and at that time was at least 20 months away from implementation. The recommended revisions to AC 25-32 include this change and are therefore consistent with both the current FAA methods of reporting runway conditions as well as ICAO GRF standards of reporting runway condition.

It was discussed whether AC 25-32 should address wet grooved and wet PFC surfaces. There is a consensus to not include this as it was the object of a concurrent rewrite of AC 121.195(d)-1a.

The FTHWG concurs that reference to ASTM Standards E3188-19 for definitions relating to aircraft braking, and E3266-20 relating to Aircraft Braking Action Report generating systems are useful in the context of introducing Runway Condition Code as a parameter against which to publish landing performance.

There is currently text in AC 25-32 that casts doubt on the airborne portion of the AFM landing distance being operationally representative and calls into question some provisions of § 25.125. In reality, the issue of airborne distances used in this context being un-achievable in operations had risen from some specific industry practices allowed in applying the rule. Some manufacturers have used more realistic and operational distances between 50ft and touchdown in their AFM landing distances, and objected to the general dismissal of the validity of existing landing distance data. The relevant AC text is consequently proposed to be simplified and corrected.

In harmonizing with EASA AMC 25.1592, the need was considered for specific provisions for consideration of the airborne distance of steep approach landings in time of arrival landing performance assessments. AMC 25.1592 states that the flight test demonstrated distance could be used without changes. The FTHWG concluded by large majority that this specific subject should not be addressed in the AC for time of arrival landing distances. An update to the AC 25-7X is proposed in Appendix 6 of this report to discuss the time of arrival distances for steep approach landing, while the AC 25-32X and AC 25.1592 include only a reference to the appropriate section of the AC 25-7X.

The FTHWG reached a consensus that there should be a 5% conservatism for LDTA calculations applied to dry runway tire-to-ground braking coefficient (braking mu used to comply with § 25.125) when that braking mu was determined on a clean runway. The option also remains to use 100% of the tire-to-ground braking coefficient 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. During the original TALPA ARC activity there was an understanding that typical operational dry runways would have various levels of accumulated rubber and paint and there was an agreement to apply an arbitrary 10% conservatism if the braking mu was determined on a clean runway. Part of the justification was that this would not be economically impacting, because dry runway performance is generally not limiting and the resulting LDTA, including a 1.15 factor, remained shorter than the dispatch landing distances based on the AFM multiplied by the appropriate operational factor.

During FTHWG Topic 33 Landing Distance on Dry Runway there was an effort to substantiate the effect of non-clean runways on braking mu (e.g. built-up rubber and paint). Airbus was able to provide several examples of the incremental effects of rubber and paint. Analysis of operational data from one landing during which braking occurred at the end of a runway has evidenced a degradation of up to 7%, believed to be linked to rubber contamination. Moreover, analysis of braking directly on paint markings during flight tests showed transient braking mu degradation reaching 20%. However, paint markings and accumulated rubber are typically localized to certain parts of the runway, so the overall degradation should be considered for the entire measured braking segment. Boeing analyzed data from a series of tests on a smooth dry runway at Roswell New Mexico comparing a cleaned (swept) vs. dirty (un-swept) runway which showed an average braking mu degradation of 5%. Some of the FTHWG members believed that a 10% reduction in braking mu was too large and not representative of the capability of the airplane, but that any variations due to pavement characteristics should rather be considered to be accounted for in the operational factor.

The proposed braking mu reduction is intended to be a simple representation of a typical operational dry runway degradation for predictive performance calculation and is not meant to represent the worst case or a substitute for overall operational factoring. The 10% dry runway mu reduction in the original TALPA ARC activity was proposed as an engineering estimate, but not substantiated with data nor was it heavily debated because it was only being considered for time of arrival and not anticipated to be an economic burden in the scope of the larger TALPA ARC activity. The proposal to use a 5% braking mu reduction is intended to avoid the burden of substantiating that a specific non-cleaned test runway is representative of operational conditions. This proposal is consistent with Topic 33 and will offer simplification and commonality of AFM and TALPA methodology for landing performance which will reduce confusion in the operational community (operators and pilots). Simplification can be expected to reduce cost of compliance for applicants and ultimately promote safety.

The FTHWG noted the difference in the way the reliability requirement for reverse thrust credit for rejected takeoff is expressed in AC 25-31 / 25.1591 compared to EASA AMC 25.109(f). EASA AMC 25.109 (f) provides a minimum reliability criterion of 1 per 1000 selections. FAA AC 25-31 provides a minimum reliability criterion of 10^{-4} or less per takeoff in line with the TALPA ARC report and the FTHWG Topic 9 report. The FTHWG decided not to propose changes to the reliability criteria in the ACs, because the group considered that the intent was the same. The FTHWG discussed the issue of reverse thrust accountability for landing and found that the guidance in AC 25-32 was adequate, but may be revised depending on the outcome of FTHWG Topic 33 Dry Runway Stopping Performance.
The following options have been considered by the FTHWG:

- Replacement of the existing guidance on reverse thrust credit in the ACs with a reference to AC 25-7, similar to what was adopted by EASA for AMC 25.1591 and 25.1592, which references AMC 25.109(f),
- Reversion to the guidance from AC 25-7A (prior to Change 1) which was identical to current EASA AMC 25.109(f),
- Adopt criteria to state that the failure of each individual thrust reverser to provide the expected level of thrust (without prior crew awareness) should be on the order of 10^{-4} or less per landing or rejected takeoff (according to the flight phase in consideration).

The FTHWG recommends the last option as reasonable criteria because it is closely aligned with the ACs 25-31 and 25-32 released 21 Dec 2015 and the TALPA ARC recommendations.

The FTHWG also recommends that the FAA updates AC 25-22, *Certification of Transport Airplane Mechanical Systems*, § 48.d.(3) regarding the definition of safe and reliable. The group considers that a definition that impacts the performance capabilities of the airplane should rather reside in AC 25-7. Furthermore, this definition should be updated for consistency with current practices for compliance with § 25.109, and harmonized between FAA and EASA.

EASA CS 25 Amdt 27, AMC 25.1591, provides the option to the applicant of providing data for a new “deterministic” runway state named Specially Prepared Winter Runway. This runway state may be reported in conjunction with a Runway Condition Code (RWYCC) of 4 by an aerodrome if it has been demonstrated statistically based on aircraft data that this braking action capability can be achieved and verified consistently with specific runway treatment. The AMC states that a wheel braking coefficient no higher than 0.20 may be assumed for fully modulating anti-skid systems when providing data for this runway state. The group has decided to harmonize with this concept and included paragraph 7.5 in AC 25-31X / AC 25.1591. It is however noted that the very substantial framework for approval of the reporting of a Specially Prepared Winter Runway exists only in EASA and TCCA aerodrome certification specifications, and that in the absence of such a provision on the US regulations, a risk of misuse of the data is created. These provisions are out of the scope of this FTHWG topic, but could be addressed in the Preamble of the future NPRM.

Consensus was also reached for recommended revisions to the existing FAA AC 25-31 and AC 25-32. The FTHWG recognizes the FAA process to add recommended regulations can be a longer process than revisions to existing AC advisory material. It is important to implement a revision to these ACs as soon as practicable, likely in advance of the also-recommended new rulemaking in this report. There are two significant reasons to expedite this interim AC 25-31 and AC 25-32 revision:

1) As noted above the original AC 25-31 and AC 25-32 do not reflect the final implementation of TALPA runway condition reporting as they were published 22 months prior to the implementation of TALPA recommended reporting terminology in October 2016. This was done intentionally so manufacturers could create data for operators to use at the time the E-NOTAM system was revised and TALPA reporting methods initiated.
2) ICAO GRF implementation and EASA rulemaking and implementation have occurred, and they both refer to AC 25-31 and AC 25-32 in their advisory material. It is advisable that the ACs reflect the final harmonized positions as soon as possible.

The proposed ACs for revision prior to implementing the recommended rulemaking are referred to as AC 25-31X and AC 25-32X for the FTHWG/ARAC purposes and are presented in Appendix 2 and 3 respectively.

Once the rule-making process has been completed, AC 25.1591 and AC 25.1592 should be released to align with the new standards. These proposed ACs are presented in Appendix 4 and 5 respectively.

Comments

EASA Comment:

EASA have completed rulemaking to implement the TALPA ARC recommendations by means of NPA 2016-11 entitled “Review of aeroplane performance requirements for commercial air transport operations”. This NPA had two complementary main parts:

- Changes to the Air OPS Regulation, introducing a requirement to perform LDTA, effective on 12 August 2021
- Changes to Certification Specification CS-25, revising 25.1591 and adding 25.1592, published as amendment 27, effective on 24 November 2021.

The motivation and history of this action is part of the history and overall regulatory context described in this report. This European rulemaking activity was set up well before the launch of FTHWG Topic 32.

EASA’s NPA had a larger scope than the FTHWG topic 32 and was built on the pre-existing difference in the operating rules. Air OPS CAT.POL.A.235 (b) requires using contaminated runway landing distance data to dispatch to a runway when it is forecasted that the runway may be contaminated. The new CAT.OP.MPA.303 for LDTA has no regulatory equivalent in 14 CFR part 121.

This pre-existing difference cannot be removed by the FTHWG topic 32, since the FTHWG task is limited to recommend revisions to 14 CFR part 25 and related guidance. EASA notes that FTHWG supports revisions to §§ 121.195 and 121.197 as already recommended by the TALPA ARC (refer to Historical Information of this report). EASA supports FTHWG recommendation for addition of a regulation to require a Time-of-Arrival landing distance assessment that applies a 1.15 safety factor to the Time-of-Arrival landing distances consistent with the TALPA ARC recommendations, recommendations in the ICAO Airplane Performance Manual and EASA CAT.OP.MPA.303 to reduce the existing regulatory differences (refer to page 23 of this report).

EASA supports the outcome of the group's work and is contemplating to launch a new NPA to align CS-25 with 14 CFR part 25 resulting from implementing the recommendations of this report regarding the reliability objective of the thrust reverser.

Concerning the term "on the order of…" in relation to numerical safety objectives, EASA's interpretation is provided in AMC 25.1309 paragraph 11.e (4) which reads:

11. ASSESSMENT OF FAILURE CONDITION PROBABILITIES AND ANALYSIS CONSIDERATIONS.

e. Calculation of Average Probability per Flight Hour (Quantitative Analysis).

(4) It is recognized that, for various reasons, component failure rate data are not precise enough to enable accurate estimates of the probabilities of failure conditions. This results in some degree of uncertainty, as indicated by the wide line in Figure 1, and the expression 'on the order of' in the descriptions of the quantitative probability terms that are provided above. When calculating the estimated probability of each failure condition, this uncertainty should be accounted for in a way that does not compromise safety.

ANAC Comment:

ANAC cannot provide an official position on the TALPA ARC Recommendations to 14 CFR part 121 included in Appendix 1 of this report for several reasons. First, Brazilian RBAC 121 is not harmonized with 14 CFR part 121 as RBAC 25 and 14 CFR part 25. Second, ANAC member in the FTHWG is not part of the branch responsible for such regulation. Finally, the responsible ANAC branch has already started discussions to incorporate Time of Arrival requirements in RBAC 121.

Dassault Comment:

In reference to AC 25-32X paragraph 9.2.6 concerning air distance and runway slope:

We have no guidance about how to cope with downhill slopes if the air distance is determined directly from flight test data instead of the analytical method provided in paragraph 9.2.3. This subject will not be discussed in Topic 33 since runway slope is not considered for future LDdry @time of dispatch. If we consider pure geometrical impact of -2% slope, it leads to extremely long air distances. According to operational inputs, it seems that runway slope does not have significant impact on air distance since pilot is adapting flare technic according to visual feedback.

Paraphrased by Group: Dassault Proposes to state that runway slope effects can be assumed to only impact ground portions of the landing distance and may be assumed negligible for the air distance regardless of method used.

Group Response to Dassault Comment:

It is acknowledged that the relevant sections of AC 25-32X and 25.1592 in this report do not offer guidance to clarify this point and it would be up to the applicant to propose the effect of runway slope on air distance for time of arrival calculations. The proposal for 9.2.6 aligns with the recommendations from TALPA ARC when using the 7 second calculation-based air distance. The Topic 9 FTHWG report on Wet Runway Stopping Performance, Appendix 1 Page 7 rationale for §25.126 (e) addresses this topic: "In the FTHWG there was extensive discussion as to the effect of an air distance contribution to …. lengthened touchdown point with downhill slope. After much discussion it was determined that there was a lack of measurable data and agreement among the participants quantifying the effect of runway slope on air distance and coupled with the relatively minor effect of slope on on-ground distance it was decided to not require specific slope accountability in the AFM calculation." The Group believes that the Dassault proposal is consistent with the discussions during FTHWG Topic 9 and should be considered as an acceptable alternative to the proposed text in Section 9.2.6 of AC 25-32X and AC 25.1592.

Dissents

None.

Appendix 1 - Proposed Standards and Rationale

NEW RECOMMENDED 14 CFR PART 25 REGULATIONS

Regulation	Comments
§ 25.1591 Takeoff Performance Information for Operations with Slippery Wet and Contaminated Runway Surface Conditions (a) Supplementary takeoff performance information applicable to airplanes operated on slippery wet or runways contaminated with standing water, slush, snow (dry and wet), compacted snow, or ice may be provided at the discretion of the applicant. If provided, this information must be furnished in the AFM and include the expected performance of the airplane during takeoff on hard-surfaced runways covered by these contaminants, including the effect of depth if applicable. (1) The AFM must contain a statement prohibiting takeoff on any one or more of the above contaminated runway surfaces for which information is not furnished (2) Additional performance information covering operation on contaminated surfaces other than the above may be provided at the discretion of the applicant. (3) The AFM performance information may be established by calculation or by testing.	Section (a)(1), (2) and (3) are the same content as CS 25.1591(a) and (b) but separated into individual items that are more consistent with FAA norms.
Rationale: Separation into specific items makes it easier to follow and is more consistent with FAA norms.	

Regulation	Comments
§ 25.1592 Performance Information for Landing Distance Assessment at Time of Arrival	
(a) Landing performance information on dry, wet, slippery wet and contaminated runways must be furnished in the AFM by the applicant for landing performance assessment at time of arrival on hard-surfaced runways.	Same content as CS 25.1592 (a) and first sentence in (b) without reference to dispatch. § 25.1592 will only cover time-of-arrival.
(b) The information may be established by calculation or by testing.	Same information in CS 25.1592(b) second sentence
(c) The landing distance to be used for landing performance assessment at time of arrival consists of the horizontal distance from the point at which the main gear of the airplane is 50 ft above the landing surface to the point where the airplane comes to a complete stop.	Same basic content of CS 25.1592(c) first sentence
(d) The data to be used for landing performance assessment at time of arrival must allow computation of the landing distance based on runway conditions, winds, temperatures, average runway slope, pressure altitude, icing condition, planned final approach speed, airplane mass and configuration, and deceleration devices.	Same basic content of CS 25.1592(c) second sentence
Rationale: Separation into specific items makes it easier to follow and is more consistent with FAA norms.	

RECOMMENDED 14 CFR PART 121 OPERATING STANDARDS

At the same time as 14 CFR part 25 is revised for § 25.1592 the FTHWG proposes that the Federal Aviation Administration Flight Standards adopt a regulation to require a TOA landing distance assessment that applies a 1.15 safety factor to the LDTA consistent with the TALPA ARC recommendations, the ICAO Airplane Performance Manual and EASA CAT.OP.MPA.303.

The recommendations below are those made for changes to the 14 CFR part 121 regulation by the TALPA ARC.

Regulation	Comments
§ 121.195 Airplanes: Turbine engine powered: Landing limitations: Destination airports. (a) No person operating a turbine engine powered airplane may take off that airplane at such a weight that (allowing for normal consumption of fuel and oil in flight to the destination or alternate airport) the weight of the airplane on arrival would exceed the landing weight set forth in the Airplane Flight Manual for the elevation of the destination or alternate airport and the ambient temperature anticipated at the time of landing. (b) Except as provided in paragraph (c), (d), or (e) of this section, no person operating a turbine engine powered airplane may take off that airplane unless its weight on arrival, allowing for normal consumption of fuel and oil in flight (in accordance with the landing distance set forth in the Airplane Flight Manual for the elevation of the destination airport and the wind conditions anticipated there at the time of landing), would allow a full stop landing at the intended destination airport within 60 percent of the ~~effective length~~ **Landing Distance Available** of each runway described below from a point 50 feet above the intersection of the obstruction clearance plane and the runway. For the purpose of determining the allowable landing weight at the destination airport the following is assumed:	The Airport/Facility Directory now shows declared distances for each runway. The LDA is the more relevant criterion for this requirement.

Regulation	Comments
(1) The airplane is landed on the most favorable runway and in the most favorable direction, in still air. (2) The airplane is landed on the most suitable runway considering the probable wind velocity and direction and the ground handling characteristics of the airplane, and considering other conditions such as landing aids and terrain. (c) A turbopropeller powered airplane that would be prohibited from being taken off because it could not meet the requirements of paragraph (b)(2) of this section, may be taken off if an alternate airport is specified that meets all the requirements of this section except that the airplane can accomplish a full stop landing within 70 percent of the ~~effective length~~ **Landing Distance Available** of the runway. (d) Unless, based on a showing of actual operating landing techniques on wet runways, a shorter landing distance (but never less than that required by paragraph (b) of this section) has been approved for a specific type and model airplane and included in the Airplane Flight Manual, no person may takeoff a turbojet powered airplane when the appropriate weather reports and forecasts, or a combination thereof, indicate that the runways at the destination airport may ~~wet or slippery~~ **<u>not</u>** be **<u>dry</u>** at the estimated time of arrival unless the ~~effective runway length~~ **Landing Distance Available** at the destination airport is at least 115 percent of the runway length required under paragraph (b) of this section. (e) A turbojet powered airplane that would be prohibited from being taken off because it could not meet the requirements of paragraph (b)(2) of this section may be taken off if an alternate	Identify when the dispatch requirements must be extended beyond dry.

Regulation	Comments
airport is specified that meets all the requirements of paragraph (b) of this section. **(f) Except in accordance with § 121.627, no person may initiate an approach or land unless an assessment indicates that a safe landing can be made.** **(f)(1) An operational assessment must be performed in accordance with criteria and procedures in a program approved by the Administrator.** **(f)(1)(i) This assessment must consider the runway surface condition, aircraft landing configuration, and meteorological conditions, using approved operational landing performance data in the Airplane Flight Manual supplemented as necessary with other data acceptable to the Administrator.** **(f)(1)(ii) The landing distance required, as determined by this assessment, including a safety margin of 15%, must not be greater than the landing distance available.** **(f)(1)(iii) The Administrator will allow alternate means of compliance for aircraft which do not have operational landing data in the AFM, and are no longer supported by the Manufacturer.** **(f)(2) Alternatively, no further assessment is required if:** **i) The runway is dry and meets the requirements of paragraph (b) of this section, or,** **ii) The runway is wet, and grooved or PFC, and meets the requirements of paragraph (d) of this section.**	Introduce a requirement for a landing performance check at time of arrival. Note: Paragraphs (f)(1)(iii) and (f)(2) may alternatively be published as advisory material

Rationale:

- The declared distance should be used
- The term "slippery" is now used in the context of runways not fulfilling the friction requirements set by the state when wet.
- The flight crew should perform an assessment whether the runway length is sufficient for a safe stop in the prevailing conditions before beginning the approach. This assessment should be based on performance data established in line with the recommendations of this report and include a

Regulation	Comments
minimum margin of 15% of the calculated landing distance. This is fully in line with the provisions of EASA CAT.OP.MPA.303.	

The TALPA ARC concluded there was no need to change the dispatch standards based on the combination of 14 CFR 121.195(d) to a specific slippery wet/contaminated runway standard with the additional time-of-arrival requirement in place. However, the following amendment of paragraph 121.197 was proposed, which the FTHWG supports.

Regulation	Comments
§ 121.197 Airplanes: Turbine engine powered: Landing limitations: Alternate airports. No person may list an airport as an alternate airport in a dispatch or flight release for a turbine engine powered airplane unless (based on the assumptions in § 121.195 (b)) that airplane at the weight anticipated at the time of arrival can be brought to a full stop landing within 70 percent of the ~~effective length of the runway~~ **Landing Distance Available** for turbopropeller powered airplanes and 60 percent of the ~~effective length of the runway~~ **Landing Distance Available** for turbojet powered airplanes, from a point 50 feet above the intersection of the obstruction clearance plane and the runway. **<u>Consideration must be given to the anticipated runway conditions at the alternate airport at the estimated time of arrival.</u>** In the case of an alternate airport for departure, as provided in § 121.617, allowance may be made for fuel jettisoning in addition to normal consumption of fuel and oil when determining the weight anticipated at the time of arrival.	As above As above Introduce consideration for runway condition at alternate airport.
Rationale: In winter conditions, the effective state of the runway at time of arrival could not be forecast reliably, as Precipitation may continue during the flight The airport may clear or treat the runway There may be no reliable runway condition report at the destination airport at time of departure	

Penalizing payload due to an outdated runway surface condition report was considered unnecessarily penalizing. Furthermore, it was considered that the required landing performance assessment at time of landing had become a de-facto dispatch requirement and would naturally be considered at time of dispatch whenever the runway was expected to be other than dry at time of arrival.

As dispatch standards for the maximum landing mass are not proposed to be changed, the insertion of a new paragraph (d) was proposed to mitigate the risk that the landing performance check at time of arrival may not allow to proceed with the approach.

Regulation	Comments
§ 121.647 Factors for Computing Fuel Required Each person computing fuel required for the purposes of this subpart shall consider the following: (a) Wind and other weather conditions forecast. (b) Anticipated traffic delays. (c) One instrument approach and possible missed approach at destination. **(d) Anticipated Runway conditions and runway treatment processes available at the destination airport** (~~d~~**e**) Any other conditions that may delay landing of the aircraft. For the purposes of this section, required fuel is in addition to unusable fuel	

Rationale:

There is a possibility that the runway conditions upon arrival could be such that a safe landing cannot be made even though the weather conditions do not require an alternate. A systematic requirement for an alternate seems excessive. This provision ensures that at least sufficient holding fuel would be carried.

Appendix 2 – Revised Advisory Material - AC 25-31X (Takeoff)

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Takeoff Performance Data for Operations on Contaminated Runways

Date:

Initiated By: AIR-625

AC No: 25-31X

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 takeoff performance data for transport category airplanes for operations on contaminated runways. This AC also promotes the use of consistent terminology for runway surface conditions used among data providers and FAA personnel.

Jeffrey E. Duven
Manager, Transport Standards Branch
Aircraft Certification Service

(page numbering to be specified upon publication)

1 Purpose.
2 Applicability.
3 CANCELLATION
4 Related Documents.
5 Background.
6 Definitions.
7 Contaminated Runway Takeoff Performance Data.
8 Determination of Contaminated Runway Takeoff Performance Data.
10 Credit for Reverse Thrust.
11 Guidance for Existing Type Designs.
12 Documentation.

Tables

Table 1. Runway Surface Condition—Descriptions and Contaminant Categories ....
Table 2. Wheel Braking Coefficients as a Function of Runway Surface Condition ....
Table 3. Loose Contaminant Specific Gravity..

1 PURPOSE.

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 takeoff performance data for transport category airplanes for operations on contaminated runways. 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 material 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 contaminated runway 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 CANCELLATION.

3.1 This AC cancels AC 25-31, Takeoff Performance Data for Operations on Contaminated Runways, dated December 22, 2015.

4 RELATED DOCUMENTS.

4.1 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.

- Section 25.101, *General (Performance)*.
- Section 25.105, *Takeoff*.
- Section 25.107, *Takeoff speeds*.
- Section 25.109, *Accelerate-stop distance*.
- Section 25.111, *Takeoff path*.
- Section 25.113, *Takeoff distance and takeoff path*.
- Section 25.115, *Takeoff flight path*.

4.2 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 25-7X (or later revision), *Flight Test Guide for Certification of Transport Category Airplanes*, dated X XX, 20XX.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.

4.3 **Other Documents.**

- FAA Order JO 7930.2S (or later revision), *Notice to Airmen (NOTAM)*, dated 10 January, 2019.
- European Aviation Safety Agency (EASA), CS 25.1591 *Take-off performance information for operations on slippery wet and contaminated runways,* and associated Acceptable Means of Compliance (AMC)

5 **BACKGROUND.**

5.1 On August 6, 2007, the FAA tasked the Takeoff and Landing Performance Assessment (TALPA) ARC, among other tasks, to provide advice and recommendations for establishing airplane certification and operational requirements (including training) for takeoff and landing operations on contaminated runways.

5.2 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 takeoff performance data for operations on contaminated runways, the FAA did not initiate rulemaking. The FAA issued AC 25-31 in 2015 to support the voluntary implementation of the TALPA ARC recommendations which occurred on October 1, 2016.

5.3 Starting in 2015 the International Civil Aviation Organization published revisions to their Annexes and other documents incorporating their version of the TALPA recommendations named Global Reporting Format (GRF) implemented worldwide in November 2021.

5.4 In 2016 EASA published Notice for Proposed Amendment – NPA 2016-11. This NPA proposed revisions to Certification Specifications, airport and operating standards which reflected the ICAO GRF program.

5.5 In 2020 the FAA Aviation Rulemaking Advisory Committee (ARAC) tasked the Flight Test Harmonization Working Group (FTHWG) to harmonize the FAA TALPA 14 CFR part 25 regulatory recommendations and advisory material with EASA CS 25 rulemaking activity.

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 ⅛ inch (3 mm) or less in depth.

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 ⅛ inch (3 mm). This terminology is consistent with the definitions used in NOTAMs as published in AC 150/5200-28X and Order JO 7930.2S (or later revisions).

6.3.1 <u>Dry Snow.</u>

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

6.3.2 <u>Wet Snow.</u>

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 <u>Slush.</u>

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 <u>Compacted Snow.</u>

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 <u>Frost.</u>

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 ⅛ inch (3 mm) in depth.

Note: The term water is equivalent to standing water in the context used for condition reporting and airplane performance in ICAO Annex 14 and EASA CS 25.1591 for example.

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.

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 Runway Condition Code (RWYCC).

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.

6.6 Runway Surface Condition.

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

6.7 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 or deceleration capability.

6.8 Slippery When Wet.

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

Note: The phrase "Slippery When Wet" used for condition reporting is equivalent to "Slippery Wet" in the context of airplane performance in ICAO Annex 14, EASA CS 25.1591.

6.9 Specific Gravity.

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

6.10 **Tire-to-ground Braking Coefficient.**

Tire-to-ground 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 tire-to-ground 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 tire-to-ground braking coefficient is based on a fully modulating anti-skid controlled braked wheel/tire. The definition of a fully modulating anti-skid system is found in AC 25-7D.

7 CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.

7.1 If developed using the guidance in this AC, takeoff performance data should be furnished in terms of a runway surface condition description for the approved operational envelope for takeoff.

7.2 Data for the runway surface condition descriptions contained in Table 1 below should be included.

Table 1. Runway Surface Condition—Descriptions and Contaminant Categories

Runway Surface Condition Description	Contaminant Category	Range of Depths to be considered
Dry	—	
Wet	—	
Slippery Wet	—	
Ice	Solid contaminant	
Compacted snow	Solid contaminant	
Dry snow	Loose contaminant	More than 0.125 inches (3 mm)[1] to 4 inches (100 mm)
Wet snow	Loose contaminant	More than 0.125 inches (3 mm)[1] to 1 inches (25 mm)
Slush	Loose contaminant	More than 0.125 inches (3 mm)[1] to 0.5 inches (13 mm)

Water	Loose contaminant	More than 0.125 inches (3 mm)[1] to 0.5 inches (13 mm)

[1] At the option of the applicant, data with zero contaminant drag (e.g. zero depth) may be furnished for loose contaminants to facilitate the operators' consideration of downgraded Runway Condition Code or Pilot Reports. See paragraph 9.6.

7.3 For loose contaminants, data should be furnished for the range of contaminant depths listed in Table 1. It is recommended that the specific depths identified in FAA Order JO 7930.2S (or later revision) be considered in the presentation of the takeoff data.

Note: In establishing the maximum depth of runway contaminants it may be necessary to take account of the maximum depth for which the engine air intakes have been shown to be free of ingesting hazardous quantities of water or other contaminants in accordance with 14 CFR 25.1091(d)(2).

7.4 The requirements of paragraph 7.3 can be addressed using one of two methods, as described below.

7.4.1 Method 1.

If information on the effect of runway contaminants on the expected takeoff performance of the airplane is provided, it should be recommended to avoid takeoff operations beyond the contamination depths for which takeoff information is provided.

7.4.2 Method 2.

If information on the effect of runway contaminants on the expected takeoff performance of the airplane is not provided, it should be recommended to avoid takeoff operations where the depth of loose contamination exceeds 3 mm (0.125 inch).

7.5 At the option of the applicant, takeoff performance data may be provided for specially prepared winter runway surfaces. This may include icy surfaces that have been treated with sand or gravel in such a way that a significant improvement of friction may be demonstrated. It is recommended that a tire-to-ground braking coefficients not greater than 0.20 (for fully modulating anti-skid systems) should be assumed.

Note: Approval for operation on specially prepared winter runways requires demonstration of the effectiveness of such treatment with monitoring of actual braking action indicated by airplane data.

8 DETERMINATION OF CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.

8.1 Contaminated runway takeoff performance data is determined by calculation, using the takeoff performance model developed from flight tests and used to show compliance with the takeoff performance requirements in subpart B, as modified by the guidance provided in this AC.

8.2 Except for the effects of the contaminant on braking friction and drag, the takeoff performance requirements of subpart B applicable to a wet runway should be used in developing the contaminated runway takeoff performance data.

8.2.1 This includes the definitions of takeoff distance (§ 25.113(a)(2) and (b)) and takeoff run (§ 25.113(c)(2)) in terms of the height at the end of the takeoff distance and lack of credit for clearway.

8.2.2 This also includes assumptions associated with the accelerate stop transition and reverse thrust from 25-7X as pertaining to the wet runway requirements of 25.109. If the calculated accelerate-stop distance includes a stopway beyond the end of the TORA with surface characteristics worse than those of the runway, the takeoff data must include a means to adjust accelerate-stop distance appropriately.

Note: In general this should not be an issue at airports using declared distances. If a stopway was not cleared or treated with de/anti-icing fluid a NOTAM should have been published.

8.3 For all types of contaminants, the entire runway surface is assumed to be 100 percent covered by the contaminant.

8.4 For loose contaminants, the depth and specific gravity of the contaminant is assumed to be uniform.

8.5 The tire-to-ground braking coefficients that should be used for each type of contaminant are contained in Table 2 of this AC.

Note: The tire-to-ground 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 (e.g., 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. Tire-to-ground Braking Coefficients as a Function of Runway Surface Condition

Runway Surface Condition Description	Runway Condition Code (RWYCC) [3]	Tire-to-ground Braking Coefficient
• Frost • Wet (includes damp and ⅛″ (3 mm) depth or less of water) ⅛″ (3 mm) depth or less of: • Slush • Dry snow • Wet snow	5	Per method defined in § 25.109(c).
-15 °C and colder outside air temperature: • Compacted snow	4	0.20[1]
• Wet ("slippery when wet" runway) • Dry snow or wet snow (any depth) over compacted snow Greater than ⅛″ (3 mm) depth of: • Dry snow • Wet snow Warmer than -15 °C outside air temperature: • Compacted snow	3	0.16[1]
Greater than ⅛″ (3 mm) depth of: • Water • Slush	2	1) For speeds below 85% of the hydroplaning speed[2]: 50% of the Tire-to-ground braking coefficient determined in accordance with § 25.109(c), but no greater than 0.16; and 2) For speeds at 85% of the hydroplaning speed[2] and above: 0.05[1].
• Ice	1	0.07[1]

[1] These tire-to-ground 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 25-7D 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.

[2] 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/in^2.

[3] In addition, data may be provided at various tire-to-ground braking coefficients or Runway Condition Codes (RWYCC) to facilitate operators' consideration of downgraded Runway Condition Code or Pilot Reports. See paragraph 9.6.

9 ACCOUNTING FOR THE DRAG OF LOOSE CONTAMINANTS.

9.1 Loose contaminants (see Table 1 of this AC for classification of contaminants) result in additional 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 impeding acceleration during a takeoff, or assisting deceleration during a rejected takeoff. 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 7930.2S (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 Data should be provided for the specific gravities in 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

9.2 The applicant may account for contaminant drag for computation of the deceleration segment of the accelerate-stop distance. However, if the actual contaminant depth is less than the reported value, then using the reported depth to determine contaminant drag will result in a higher drag level than the one that actually exists, leading to a conservative takeoff distance and takeoff run, but a potentially optimistic accelerate-stop distance. It is assumed that these effects will offset each other; however, the applicant may consider:

• either using 100 % of the reported contaminant depth when determining the acceleration portion, and 50 % when considering the deceleration portion; or

• using 50 % of the reported contaminant depth when determining both the acceleration and the stop portion of the accelerate-stop distance. This should result in a conservative computation without being unduly penalizing. The applicant should check to ensure that using drag for half of the contaminant depth for the accelerate-stop computation is conservative for the applicant's airplane configuration.

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

9.4 The effect of contaminant drag between rotation and liftoff can be addressed using one of two methods, as described below or another method that has been validated by suitable analysis. There are advantages and disadvantages with each method, but either may be used if supported by an analysis that includes the assumptions used and rationale.

9.4.1 Method 1.

Retain the rotation speed (V_R) used for an uncontaminated runway, but adjust the distance from V_R to the end of the takeoff distance due to the increase in distance needed for attaining the takeoff safety (V_2) speed. With this method, there may be a reduction in the speed difference between the liftoff speed (V_{LOF}) and the minimum unstick speed (V_{MU}). Therefore, it should be verified that compliance with § 25.107(e) is maintained.

9.4.2 Method 2.

Increase V_R to ensure that the normal V_{LOF} speed is attained. With this method, the V_{LOF} speed margins to V_{MU} are maintained.

9.5 It is recommended that applicants consider the effects of directional controllability associated with crosswind and other factors, such as airplane gross weight, center of gravity position, and takeoff thrust setting. Recommendations or guidelines should be provided to operators to mitigate the effects of these items on directional controllability for different runway conditions. Minimum V_1 and/or crosswind guidance may need to be adjusted in consideration of the reduced controllability following engine failure on a contaminated runway.

9.6 It is recognized that the observation and reporting of the type and depth of contaminants (water, slush, dry snow and wet snow) is limited in terms of the accuracy and timeliness with which it can be made and relayed to the flight crew. Also airport reporting procedures allow the downgrading and upgrading of expected wheel braking as described by Runway Condition Code (RWYCC) and/or Pilot Report (PIREP). Optional consideration should be given to providing the ability to compute Loose Contaminant performance based on no contaminant drag (e.g. zero depth) for wheel braking levels associated with different RWYCC's/PIREPs when providing accelerate-stop information for Loose Contaminants.

10 CREDIT FOR REVERSE THRUST.

Accelerate-stop distances associated with contaminated runway takeoff performance data may include credit for the stopping force provided by reverse thrust, subject to meeting the following criteria:

10.1 Procedures for using reverse thrust during a rejected takeoff on a contaminated runway should be consistent with the normal procedures for use of reverse thrust during a rejected takeoff on an uncontaminated runway. 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.

10.2 Using reverse thrust during a rejected takeoff on a contaminated runway 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.

10.3 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.

10.4 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.

10.5 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.

10.6 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 takeoffs, including maximum recommended crosswinds, should be provided to operators for the runway surface conditions for which takeoff performance data are provided. A suitable simulation may be used to develop these guidelines for operation on contaminated runways.

10.7 If the data provider, in using the process described in this AC, applies credit for asymmetric reverse thrust, 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.

10.8 The failure of each individual thrust reverser to provide the expected level of thrust (without prior crew awareness) should be on the order of 10^{-4} or less per rejected takeoff. This specific reliability criterion applies to both single and combinations of failures and takes into account interlock features intended to prevent inadvertent in-flight deployment.

10.9 The effective stopping force provided by reverse thrust in each, or at the option of the data provider, the most critical takeoff configuration, should be established 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 accelerate-stop distances are based in order to calculate those distances and ensure that no adverse combination effects are overlooked. These tests may be conducted on a dry runway.

10.10 For turbopropeller powered airplanes, the guidance in paragraphs 10.1 through 10.9 above remain generally applicable. Additionally, the propeller of the inoperative engine should be in the position it would normally assume without any action on the propeller taken by the pilot following an engine failure. 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 (for example when the design provides no 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 Contaminated runway takeoff performance data approved by either the Joint Aviation Authorities or EASA in compliance with either their contaminated runway type certification or operating requirements are acceptable when using the optional process identified in this AC, with the caveats provided in paragraphs 11.2.1 and 11.2.2 below. The FAA recognizes that such data may not be consistent with the guidance provided in this AC in terms of braking coefficients associated with each runway surface condition description and the magnitude of the contaminant drag for loose contaminants.

11.2.1 Data developed for takeoff from contaminated runways should be provided for all of the runway surface condition descriptions identified in Table 1 of this AC. Data does not need to be provided for runway surface conditions for which operations are not recommended.

11.2.2 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 Reverse thrust credit may be included without any demonstration of reliability or controllability beyond that required for initial certification, as applicable. 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.

Contaminated runway takeoff performance data developed using acceptable methods may be furnished in the Airplane Flight Manual, flight crew operating manual, quick reference handbook, electronic flight bag, and/or other appropriate locations. If the data provided is not certified or approved by a certification agency, it should be labelled as advisory data in accordance with AC 25.1581-1 Change 1.

12.2 Other Information.

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

- Instructions for use of the data.
- Definitions of the different runway surface conditions.

  Note: It is recognized that FAA and ICAO descriptions have minor variations in the definition of runway surfaces. It is acceptable to use differing definitions when describing the different runway surface conditions as long as the variation is minor and it is easily recognizable which performance data is applicable.
- Recommendations to avoid taking off on runways with contaminants and depths not covered in the performance data (see paragraph 7.3, 7.4, and 11.2.1).
- Any other recommendations associated with use of the contaminated runway takeoff performance data.
- Statements addressing the following:
  - Operation on runways contaminated with water, slush, snow, ice or other contaminants implies uncertainties with regard to runway friction and contaminant drag and, therefore, to the achievable performance and control of the airplane during landing since the actual conditions may not completely match the assumptions on which the performance information is based; where possible, every effort should be made to ensure that the runway surface is cleared of any significant contamination;
  - The performance information assumes any runway contaminant to be of uniform depth and density (for loose contaminants) and uniform coverage of a layer of contaminant with uniform properties throughout; and
  - The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good

as those that may be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust.

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: Click here to enter text. Date: Click here to enter text.

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph Click here to enter text. on page Click here to enter text.

☐ Recommend paragraph Click here to enter text. on page Click here to enter text. be changed as follows:

Click here to enter text.

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

Click here to enter text.

☐ Other comments:

Click here to enter text.

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

Submitted by: ________________________________ Date: _________________________

Appendix 3 – Revised Advisory Material - AC 25-32X (Landing)

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Landing Performance Data for Time-of-Arrival Landing Performance Assessments	**Date:** **Initiated By:** AIR-625	**AC No:** 25-32X

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 for operations on dry, wet, slippery wet and contaminated runways. This AC also promotes the use of consistent terminology for runway surface conditions used among data providers and FAA personnel.

Jeffrey E. Duven
Manager, Transport Standards Branch
Aircraft Certification Service

(page numbering to be specified upon publication)

1 Purpose.
2 Applicability.
3 CANCELLATION
4 Related Documents.
5 Background.
6 Time-of-Arrival Landing Performance Assessments.
7 Definitions.
8 Time-of-Arrival Performance Data.
9 Determination of Landing Distance for Time-of-Arrival Landing Performance Assessments.
10 Accounting for Drag of Loose Contaminants
11 Credit for Reverse Thrust.
12 Guidance for Existing Type Designs.
13 Documentation.

Figures

Figure 1. Landing Distance Segments …………………………………………………………...

Tables

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Table 2. Wheel Braking Coefficients as a Function of Runway Surface Condition.................
Table 3. Loose Contaminant Specific Gravity ....

1 PURPOSE.

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 for operations on dry, wet, slippery wet and contaminated runways. 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 12 of this AC for additional information on applying the guidance in this AC to previously certificated airplane designs.

3 CANCELLATION.

This AC cancels AC 25-32, Landing Performance Data for Time-of-Arrival Landing Performance Assessments dated December 22, 2015.

4 RELATED DOCUMENTS.

4.1 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.

- 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*.

4.2 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 25-7X (or later revisions), *Flight Test Guide for Certification of Transport Category Airplanes*, dated YY Y, 20YY.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.
- AC 91-79A, Aircraft Landing Performance and Runway Excursion Mitigation, dated September 17, 2014.
- AC 150/5200-28E, *Notices to Airmen (NOTAMs) for Airport Operators*, dated October 8, 2015.
- AC 150/5200-30D, *Airport Field Condition Assessments and Winter Operations Safety*, dated October 29, 2020.

4.3 **Other Documents.**

- ASTM E3188-19, *Standard Terminology for Aircraft Braking Performance*, published February 2019.
- ASTM E3266-20, *Standard Guide for Friction-Limited Aircraft Braking Measurements and Reporting*, published November 2020.
- FAA Order JO 7930.2S (or later revision*), Notice to Airmen (NOTAM)*, dated 10 January, 2019.
- European Aviation Safety Agency (EASA), CS 25.1592 *Performance information for assessing the landing distance*, and associated Acceptable Means of Compliance (AMC)
- Safety Alert for Operators (SAFO) 19001, *Landing Performance Assessments at Time of Arrival.*

5 **BACKGROUND.**

5.1 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.

5.2 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 flight crews 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.

5.3 The TALPA ARC completed its actions and delivered its recommendations to the FAA on July 7, 2009.

5.4 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) 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.

5.5 Although the Committee recommended adopting regulations requiring TC holders to produce landing performance data for time-of-arrival landing performance assessments, the FAA did not initiate rulemaking. The FAA issued AC 25-32 in 2015 to support the voluntary implementation of the TALPA ARC recommendations which occurred on October 1, 2016. The FAA published operational guidance in FAA order 8900.1 which eventually was published also in SAFO 19001 (superseding SAFO 06012).

5.6 Starting in 2015 the International Civil Aviation Organization published revisions to their Annexes and other documents incorporating their version of the TALPA recommendations named Global Reporting Format (GRF) implemented worldwide in November 2021.

5.7 In 2016 EASA published Notice for Proposed Amendment – NPA 2016-11. This NPA proposed revisions to Certification Specifications, airport and operating standards which reflected the ICAO GRF program.

5.8 In 2020 the FAA Aviation Rulemaking Advisory Committee (ARAC) tasked the Flight Test Harmonization Working Group (FTHWG) to harmonize the FAA TALPA 14 CFR part 25 regulatory recommendations and advisory material with EASA CS 25 rulemaking activity, as published in November 2021 in CS 25 Amendment 27.

5.9 This AC provides guidance and standardized methods that applicants can use to develop landing performance data for time-of-arrival (or en route) landing performance assessments. The created data would also be consistent with the terminology used for airport reporting of runway conditions.

6 TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS.

6.1 Sections 91.605, 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 § 91.605, § 91.1037, § 121.195, or § 135.385.

6.2 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.

6.3 Appropriate landing performance data assists operators in performing these time-of-arrival landing performance assessments. Because of differences in the 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 from the landing performance data developed in accordance with § 25.125 and provided in the Airplane Flight Manual in accordance with § 25.1587(b).

6.4 § 25.125 dry runway landing distances are often 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 is beneficial if the landing performance data are representative of actual operations. The data for time-of-arrival landing performance assessments should represent expected landing performance by a trained flight crew of average skill following normal flight procedures and training.

6.5 Like the landing distances defined in § 25.125, the landing distances for use for time-of-arrival landing performance assessments 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 of this AC.

6.6 An important portion of the TALPA ARC's recommendations concern the use of a common set of terms for runway condition reports which have also been accepted by ICAO and EASA. The FAA agrees with the ARC that it is 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. ICAO recommendations and standards on runway condition reporting and recommended time-of-arrival performance computations, while not identical to the FAA's, are consistent with the FAA recommended terminology and performance definitions and methods. The common terminology and methods are based on:

- Runway surface condition descriptions used in field condition reports originated by airports are provided in terms of runway condition code by thirds and contaminant type and depth by thirds,
- Braking action reports from pilots relayed by air traffic controllers,
- Development of airplane performance data for different runway surface conditions and runway condition reports,
- Use of field condition reports and airplane performance data by pilots and airplane operators to make their time-of-arrival landing performance assessments.

7 DEFINITIONS.

7.1 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.

7.2 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 ⅛ inch (3 mm) or less in depth.

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

7.3 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 7.3.1 through 7.3.8 of this AC.

Note: The definition of water in the context of condition reporting and airplane performance is the definition in paragraph 7.3.6 of this AC, which occurs at a depth of greater than ⅛ inch (3 mm). This terminology is consistent with the definitions used in NOTAMs as published in AC 150/5200-28E and Order JO 7930.2S (or later revisions).

7.3.1 <u>Dry Snow.</u>

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

7.3.2 <u>Wet Snow.</u>

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.

7.3.3 <u>Slush.</u>

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.

7.3.4 <u>Compacted Snow.</u>

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.

7.3.5 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.

7.3.6 Water.

Water in a liquid state. For purposes of condition reporting and airplane performance, water is greater than ⅛ inch (3 mm) in depth.

Note: The term water is equivalent to standing water in the context used for condition reporting and airplane performance in ICAO Annex 14 and EASA CS 25.1591 for example.

7.3.7 Ice.

The solid form of frozen water.

7.3.8 Wet Ice.

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

7.4 **Loose Contaminants.**

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.

7.5 **Runway Condition Reports.**

A comprehensive standardized report relating to the condition(s) of the runway surface and their effect on the airplane landing and takeoff performance. (See ICAO Annex 14 Vol 1, 8th Edition)

7.6 **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 7.6.1 through 7.6.6 of this AC.

7.6.1 Good.

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

7.6.2 Good-to-Medium.

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

7.6.3 Medium.

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

7.6.4 Medium-to-Poor.

Braking deceleration or directional control is between medium and poor.

7.6.5 Poor.

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

7.6.6 Nil.

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

7.7 **Aircraft Braking Action Report.**

A report describing a level of braking action using data from the aircraft. See ASTM standard E3188-19 and E3266-20.

7.8 **Runway Condition Code (RWYCC).**

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.

7.9 **Runway Surface Condition.**

The runway surface condition is a description of the contaminants (if any) on the surface of a runway.

7.10 **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 deceleration capability.

7.11 **Slippery When Wet.**

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

Note: The phrase "Slippery When Wet" used for condition reporting is equivalent to "Slippery Wet" in the context of airplane performance in ICAO Annex 14, EASA CS 25.1591, etc.

7.12 **Specific Gravity.**

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

7.13 **Tire-to-ground Braking Coefficient.**

Tire-to-ground 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 tire-to-ground 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 tire-to-ground 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 25-7D.

8 TIME-OF-ARRIVAL PERFORMANCE DATA.

8.1 Landing performance data should be provided based on the normal terminology of Runway Condition Reporting. Terms normally used are:

- Runway Condition Code,
- Runway Surface Condition description, type and depth of contamination.
- Pilot-reported Braking Action

Table 1 provides the relationship between runway condition code, runway surface condition descriptions, pilot-reported braking action and tire-to-ground braking coefficient that should be used when creating Time-of-Arrival landing distance information as described in Section 9.

8.2 The terms and methods for airport reporting runway conditions are in section 5.3 Runway Condition Assessments of AC 150/5200-30D. This section contains the Runway Condition Assessment Matrix (RCAM) for Airport Operator’s usage. AC 91-79A (or later revision) provides the RCAM for Aircraft Operator usage. Table 1 presents the information consistent with the Airport and Aircraft Operators RCAMs for applicants to use when computing landing distances for Time-of-Arrival landing distance performance data.

Table 1. Runway Condition Reporting Surface Condition—Pilot-Reported Braking Action—Tire-to-ground Braking Coefficient Correlation Matrix

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Tire-to-ground Braking Coefficient
6	• Dry	—	95% of certified friction limited part of the model used to comply with § 25.125[1].
5	• Frost • Wet (includes damp and ⅛″ (3 mm) depth or less of water) ⅛″ (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	0.20[2]
3	• Wet ("slippery when wet" runway) • Dry snow or wet snow (any depth) over compacted snow Greater than ⅛″ (3 mm) depth of: • Dry snow • Wet snow Warmer than -15 °C outside air temperature: • Compacted snow	Medium	0.16[2]
2	Greater than ⅛″ (3 mm) depth of: • Water • Slush	Medium to Poor	(1) For speeds below 85% of the hydroplaning speed[3]: 50% of the tire-to-ground braking coefficient determined in

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Tire-to-ground Braking Coefficient
			accordance with § 25.109(c), but no greater than 0.16; and (2) For speeds at 85% of the hydroplaning speed[3] and above: 0.05[2].
1	• Ice	Poor	0.07[2]
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 tire-to-ground braking coefficient used to comply with § 25.125 may be used

-If the braking coefficient used to comply with § 25.125 already includes the 0.95 factor, or

-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.

Under conditions where braking performance is limited by available brake torque, 100% of the torque limited braking may be assumed.

[2] These tire-to-ground 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 25-7D 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.

[3] 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/in^2.

8.3 Time-of-Arrival 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:

8.3.1 Approved landing configurations, including Category III landing guidance where approved;

8.3.2 Approved deceleration devices (for example, wheel brakes, speedbrakes/spoilers, and thrust reversers);

8.3.3 Pressure altitudes within the approved landing operating envelope;

8.3.4 Weights up to the maximum takeoff weight;

8.3.5 Expected airspeeds at the runway threshold, including speeds up to the maximum recommended final approach speed considering possible speed additives, e.g. for winds and icing conditions;

8.3.6 Temperatures within the approved landing operating envelope;

8.3.7 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;

8.3.8 Runway slopes within the approved landing operating envelope; and

8.3.9 Icing conditions, if required to provide the landing distances required under § 25.125 in icing conditions.

8.4 Appropriate information for minimum equipment list should be provided and configuration deviation list items that affect landing distance.

8.5 Data providers are also encouraged to include Landing distances for non-normal configurations.

8.6 At the option of the applicant, landing performance data may be provided for specially prepared winter runway surfaces. This may include icy surfaces that have been treated with sand or gravel in such a way that a significant improvement of friction may be demonstrated. It is recommended that a tire-to-ground braking coefficients not greater than 0.20 (for fully modulating anti-skid systems) should be assumed.

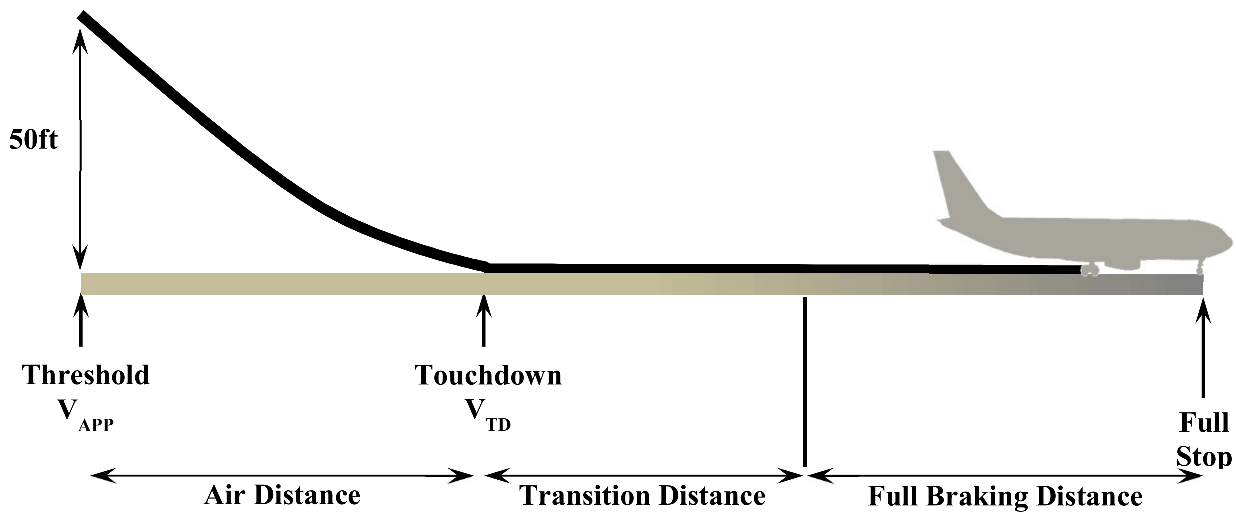
Note: Approval for operation on specially prepared winter runways requires demonstration of the effectiveness of such treatment with monitoring of actual braking action indicated by airplane data.

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

9.1 Landing Distance.

9.1.1 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



9.1.2 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.

9.1.3 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 9.3.2, 9.3.3, and 9.3.4 of this AC.)

9.1.4 The procedures and assumptions used to develop the operational landing distances should be documented in the appropriate reference material.

9.2 **Air Distance.**

9.2.1 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 25-7X, the air distances determined under § 25.125 may be shorter than the distance that the average pilot is likely to achieve in normal operations.

9.2.2 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 25-7X, 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 objective followed by some manufacturers during the certification process is to determine the maximum capability of the airplane.

Note: AC 25-7D states the air distance computed using the parametric method with these approach angles and touchdown sink rates and 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.

9.2.3 Unless the air distance used for compliance with § 25.125 is representative of an average pilot who is flying in normal operations (see paragraph 9.2.4 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.

9.2.4 If the air distance is determined directly from flight test data instead of the analytical method provided in paragraph 9.2.3 above, the flight test data should meet the following criteria:

9.2.4.1 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.

9.2.4.2 At a height of 50 feet above the runway surface, the airplane should be at an airspeed no slower than the recommended runway threshold airspeed consistent with section 8.3.5 of this AC.

9.2.4.3 The touchdown rate of descent should be in the range of 1 to 4 feet per second.

Note: The criterion of paragraph 9.2.4.3 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.

9.2.5 The air distance determined under paragraph 9.2.3 or 9.2.4 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 or low visibility guidance 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 or low visibility guidance system demonstrations may be used for computing the air distance when determining the autoland or low visibility guidance system landing distance. The autoland or 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.

9.2.6 The air distance based on 9.2.3 is considered acceptable for runways sloping downward as much as two percent (-2%). Note that no credit should be taken for an upward sloping runway.

Note: AC 25-7X 4.11.1.1 states the landing distance is the horizontal distance from the point at which the main gear of the airplane is 50 feet above the landing surface (treated as a horizontal plane through the touchdown point). This definition of airborne distances may not apply to landings based on runways with specific steep approach procedures. Refer to AC 25-7X.

9.3 Transition Distance.

9.3.1 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 9.2.3 of this AC, the speed at the start of the transition segment is 96 percent of the final approach speed.

9.3.2 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.

9.3.3 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.

9.3.4 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.

9.3.5 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.

9.3.6 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 1 in section 8.2 of this AC for the tire-to-ground braking coefficient).

Note: The tire-to-ground braking coefficients in Table 1 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.

9.4 Final Stopping Configuration Distance (Full Braking Distance).

9.4.1 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.

9.4.2 The calculation of the final stopping configuration distance should be based on the braking coefficient associated with the runway condition report including the effect of hydroplaning, if applicable, as described in Table 1 of Section 8.2. Credit may be taken for the use of thrust reversers as described in section 11. See Section 10 for information about taking into account contaminant drag from loose contaminants.

10 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS.

10.1 Loose contaminants 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 and are not included in the time-of-arrival landing distance based on Runway Condition Code or Pilot-Reported Braking Action. However additional time-of-arrival landing distance data for Runway Surface Condition which does take credit for the benefit of the drag associated with loose contaminants of snow, slush and water may be provided.

10.2 This contaminant drag associated with the loose contaminants 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:

10.2.1 Contaminant depths are reported in field condition reports using specific depth increments as specified in FAA Order JO 7930.2S (or later revision).

10.2.2 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.

10.2.3 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.

10.3 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.

Note: For Landing Distances at Time of Arrival presented against Runway Condition Codes, data must not include accountability for contaminant drag.

10.4 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 7930.2S (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.

10.5 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 2 below.

Table 2. Loose Contaminant Specific Gravity

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

10.6 The FAA finds acceptable the methods for calculating contaminant drag described in EASA AMC 25.1591. A method that was previously accepted by EASA or has been validated by suitable analysis or test data may also be used.

11 CREDIT FOR REVERSE THRUST.

11.1 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:

11.1.1 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.

11.1.2 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.

11.1.3 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.

11.1.4 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.

11.1.5 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.

11.1.6 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.

11.1.7 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.

11.1.8 The failure of each individual thrust reverser to provide the expected level of thrust (without prior crew awareness) should be on the order of 10^{-4} or less per landing. This specific reliability criterion applies to both single and combinations of failures and takes into account interlock features intended to prevent inadvertent in-flight deployment.

11.1.9 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.

11.1.10 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.

11.2 For turbopropeller powered airplanes, the guidance in paragraphs 11.1 through 11.1.10 above remains generally applicable. Unless the selection of reverse thrust is achieved by a single and continuous action to retard the power lever(s) from the flight idle setting (for example when the design provides no stop or lockout), it should be regarded as an additional pilot action for the purposes of assessing delay times.

12 GUIDANCE FOR EXISTING TYPE DESIGNS.

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

12.1 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.

12.2 The data may be presented in terms of runway surface conditions, pilot-reported braking actions, or Runway Condition Code or all 3 runway condition reporting methods.

12.2.1 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 condition code and runway surface condition description.

12.2.2 Table 1 of this AC can be used to relate runway surface condition descriptions to reported braking actions. If Data providers/applicants 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. 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 ⅛-inch depth of water or slush for a pilot-reported braking action of medium to poor.

12.3 Contaminated runway landing performance data approved by either the Joint Aviation Authorities or EASA in compliance with either their contaminated runway type certification or operating requirements are acceptable in lieu of landing distances for use at time of arrival developed in accordance with this AC, with the following caveats:

12.3.1 Data should be developed that accounts for all of the runway surface condition descriptions identified in this AC unless recommendations are made to avoid landing on runway surface conditions for which data are not provided.

12.3.2 The effects of runway slope, temperature, and speed over the threshold should be included.

12.3.3 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.

12.3.4 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.

12.4 Reverse thrust credit may be included without any demonstration of reliability or controllability beyond that required for initial certification, as applicable. However, reverse thrust credit should not be used if service history for a particular airplane model indicates unresolved reliability or controllability issues.

13 DOCUMENTATION.

13.1 Data Location.

Time-of-arrival landing performance data developed using acceptable methods may be furnished in the airplane flight manual, flight crew operating manual, quick reference handbook, electronic flight bag, and/or other appropriate locations. If the data provided is not certified or approved by a certification agency, it should be labeled as advisory data in accordance with AC 25.1581-1 Change 1.

13. 2 Other Information.

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

13.2.1 Instructions for use.

13.2.2 Definitions of runway surface condition and how to correlate runway surface condition descriptions, runway condition codes, and braking actions.

13.2.3 Recommendations to avoid landing on runway surface conditions for which landing distance time of arrival data are not provided.

13.2.4 Any other recommendation associated with use of the landing performance data.

13.2.5 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.

13.2.6 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 Date: Click here to enter text.

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph Click here to enter text. on page Click here to enter text.

☐ Recommend paragraph Click here to enter text. on page Click here to enter text. be changed as follows:

Click here to enter text.

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

Click here to enter text.

☐ Other comments:

Click here to enter text.

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

Submitted by: ________________________________ Date: _________________________

Appendix 4 – New Advisory Material - AC 25.1591 (Takeoff)

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Takeoff Performance Information for Operations with Slippery Wet and Contaminated Runway Surface Conditions	**Date:** **Initiated By:** AIR-625	**AC No:** AC 25.1591

This advisory circular (AC) describes an acceptable means of compliance which can be used when developing takeoff performance data for transport category airplanes for operations on contaminated runways in accordance with 14 CFR 25.1591. This AC promotes the use of consistent terminology for runway surface conditions used among manufacturers, airport and aircraft operators and FAA personnel.

Dr. Michael C. Romanowski
Director, Policy and Innovation Division
Aircraft Certification Service

(page numbering to be specified upon publication)

1 Purpose.
2 Applicability.
3 CANCELLATION
4 Related Documents.
5 Background.
6 Definitions.
7 Contaminated Runway Takeoff Performance Data.
8 Determination of Contaminated Runway Takeoff Performance Data.
9 Accounting for the Drag of Loose Contaminants.
10 Credit for Reverse Thrust.
11 Guidance for Existing Type Designs.
12 Documentation.

Tables

Table 1. Runway Surface Condition—Descriptions and Contaminant Categories ....
Table 2. Wheel Braking Coefficients as a Function of Runway Surface Condition ....
Table 3. Loose Contaminant Specific Gravity ....

1 PURPOSE.

This advisory circular (AC) describes an acceptable means of compliance which can be used when developing takeoff performance data for transport category airplanes for operations on contaminated runways in accordance with 14 CFR 25.1591. This AC promotes the use of consistent terminology for runway surface conditions used among manufacturers, airport and aircraft operators 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 material in this AC is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The Federal Aviation Administration will consider other methods of demonstrating compliance that an applicant may elect to present.

2.3 While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. If however, the FAA becomes aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

2.4 This material does not change or create any additional regulatory requirements, nor does it authorize changes in, or permit deviations from, regulatory requirements.

2.5 Terms used in this AC such as “shall” or “must” are used only in the sense of ensuring applicability of this method of compliance when the acceptable method of compliance described herein is used.

3 CANCELLATION

3.1 Not Applicable.

4 RELATED DOCUMENTS

4.1 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.

- Section 25.101, *General (Performance)*.
- Section 25.105, *Takeoff*.
- Section 25.107, *Takeoff speeds*.
- Section 25.109, *Accelerate-stop distance*.
- Section 25.111, *Takeoff path*.
- Section 25.113, *Takeoff distance and takeoff path*.
- Section 25.115, *Takeoff flight path*.
- Section 25.1591, *Takeoff Performance Information for Operations with Slippery Wet and Contaminated Runway Surface Conditions*

4.2 **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 25-7X (or later revision), *Flight Test Guide for Certification of Transport Category Airplanes*, dated X XX, 20XX.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.

4.3 **OTHER DOCUMENTS.**

- FAA Order JO 7930.2S (or later revision), *Notice to Airmen (NOTAM)*, dated 10 January, 2019.
- European Aviation Safety Agency (EASA), CS 25.1591 *Take-off performance information for operations on slippery wet and contaminated runways*, and associated Acceptable Means of Compliance (AMC).

5 **BACKGROUND.**

5.1 On August 6, 2007, the FAA tasked the Takeoff and Landing Performance Assessment (TALPA) ARC, among other tasks, to provide advice and recommendations for establishing airplane certification and operational requirements (including training) for takeoff and landing operations on contaminated runways.

5.2 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 takeoff performance data for operations on contaminated runways, the FAA did not initiate rulemaking. The FAA issued AC 25-31 in 2015 to support the voluntary implementation of the TALPA ARC recommendations which occurred on October 1, 2016.

5.3 Starting in 2015 the International Civil Aviation Organization published revisions to their Annexes and other documents incorporating their version of the TALPA recommendations named Global Reporting Format (GRF) implemented worldwide in November 2021.

5.4 In 2016 EASA published Notice for Proposed Amendment – NPA 2016- 11. This NPA proposed revisions to Certification Specifications, airport and operating standards which reflected the ICAO GRF program.

5.5 In 2020 the FAA Aviation Rulemaking Advisory Committee (ARAC) tasked the Flight Test Harmonization Working Group (FTHWG) to harmonize the FAA TALPA 14 CFR part 25 regulatory recommendations and advisory material with EASA CS 25 rulemaking activity.

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 ⅛ inch (3 mm) or less in depth.

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 ⅛ inch (3 mm). This terminology is consistent with the definitions used in NOTAMs as published in AC 150/5200-28X and Order JO 7930.2S (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 ºF (0 ºC). 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 ⅛ inch (3 mm) in depth.

Note: The term water is equivalent to standing water in the context used for condition reporting and airplane performance in ICAO Annex 14 and EASA CS 25.1591 for example.

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.

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 Runway Condition Code (RWYCC).

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.

6.6 Runway Surface Condition.

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

6.7 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 or deceleration capability.

6.8 Slippery When Wet.

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

Note: The phrase "Slippery When Wet" used for condition reporting is equivalent to "Slippery Wet" in the context of airplane performance in ICAO Annex 14, EASA CS 25.1591.

6.9 Specific Gravity.

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

6.10 Tire-to-ground Braking Coefficient.

Tire-to-ground 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 tire-to-ground 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 tire-to-ground braking coefficient is based on a fully modulating anti-skid controlled braked wheel/tire. The definition of a fully modulating anti-skid system is found in AC 25-7D.

7 CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.

7.1 If developed using the guidance in this AC, takeoff performance data should be furnished in terms of a runway surface condition description for the approved operational envelope for takeoff.

7.2 Data for the runway surface condition descriptions contained in Table 1 below should be included.

Table 1. Runway Surface Condition—Descriptions and Contaminant Categories

Runway Surface Condition Description	Contaminant Category	Range of Depths to be considered
Dry	—	
Wet	—	
Slippery Wet	—	
Ice	Solid contaminant	
Compacted snow	Solid contaminant	
Dry snow	Loose contaminant	More than 0.125 inches (3 mm)[1] to 4 inches (100 mm)
Wet snow	Loose contaminant	More than 0.125 inches (3 mm)[1] to 1 inches (25 mm)
Slush	Loose contaminant	More than 0.125 inches (3 mm)[1] to 0.5 inches (13 mm)
Water	Loose contaminant	More than 0.125 inches (3 mm)[1] to 0.5 inches (13 mm)

[1] At the option of the applicant, data with zero contaminant drag (e.g. zero depth) may be furnished for loose contaminants to facilitate the operators' consideration of downgraded Runway Condition Code or Pilot Reports. See paragraph 9.6.

7.3 For loose contaminants, data should be furnished for the range of contaminant depths listed in Table 1. It is recommended that the specific depths identified in FAA Order JO 7930.2S (or later revision) be considered in the presentation of the takeoff data.

Note: In establishing the maximum depth of runway contaminants it may be necessary to take account of the maximum depth for which the engine air intakes have been shown to be free of ingesting hazardous quantities of water or other contaminants in accordance with 14 CFR 25.1091(d)(2).

7.4 The requirements of paragraph 7.3 can be addressed using one of two methods, as described below.

7.4.1 Method 1.

If information on the effect of runway contaminants on the expected takeoff performance of the airplane is furnished in accordance with the provisions of 14 CFR 25.1591, takeoff operations must be limited to the contamination depths for which takeoff information is provided.

7.4.2 Method 2.

If information on the effect of runway contaminants on the expected takeoff performance of the airplane is not provided, takeoff operations must be limited to runways where the depth of loose contamination does not exceed 3 mm (0.125 inch).

7.5 At the option of the applicant, takeoff performance data may be provided for specially prepared winter runway surfaces. This may include icy surfaces that have been treated with sand or gravel in such a way that a significant improvement of friction may be demonstrated. It is recommended that a tire-to-ground braking coefficients not greater than 0.20 (for fully modulating anti-skid systems) should be assumed.

Note: Approval for operation on specially prepared winter runways requires demonstration of the effectiveness of such treatment with monitoring of actual braking action indicated by airplane data.

8 DETERMINATION OF CONTAMINATED RUNWAY TAKEOFF PERFORMANCE DATA.

8.1 Contaminated runway takeoff performance data is determined by calculation, using the takeoff performance model developed from flight tests and used to show compliance with the takeoff performance requirements in subpart B, as modified by the guidance provided in this AC.

8.2 Except for the effects of the contaminant on braking friction and drag, the takeoff performance requirements of subpart B applicable to a wet runway should be used in developing the contaminated runway takeoff performance data.

8.2.1 This includes the definitions of takeoff distance (§ 25.113(a)(2) and (b)) and takeoff run (§ 25.113(c)(2)) in terms of the height at the end of the takeoff distance and lack of credit for clearway.

8.2.2 This also includes assumptions associated with the accelerate stop transition and reverse thrust from 25-7X as pertaining to the wet runway requirements of 25.109. If the calculated accelerate-stop distance includes a stopway beyond the end of the TORA with surface characteristics worse than those of the runway, the takeoff data must include a means to adjust accelerate-stop distance appropriately.

Note: In general this should not be an issue at airports using declared distances. If a stopway was not cleared or treated with de/anti-icing fluid a NOTAM should have been published.

8.3 For all types of contaminants, the entire runway surface is assumed to be 100 percent covered by the contaminant.

8.4 For loose contaminants, the depth and specific gravity of the contaminant is assumed to be uniform.

8.5 The tire-to-ground braking coefficients that should be used for each type of contaminant are contained in Table 2 of this AC.

Note: The tire-to-ground 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 (e.g., 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. Tire-to-ground Braking Coefficients as a Function of Runway Surface Condition

Runway Surface Condition Description	Runway Condition Code (RWYCC)[3]	Tire-to-ground Braking Coefficient
• Frost • Wet (includes damp and ⅛″ (3 mm) depth or less of water) ⅛″ (3 mm) depth or less of: • Slush • Dry snow • Wet snow	5	Per method defined in § 25.109(c).
-15 °C and colder outside air temperature: • Compacted snow	4	0.20[1]
• Wet (“slippery when wet” runway) • Dry snow or wet snow (any depth) over compacted snow Greater than ⅛″ (3 mm) depth of: • Dry snow • Wet snow Warmer than -15 °C outside air temperature: • Compacted snow	3	0.16[1]
Greater than ⅛″ (3 mm) depth of: • Water • Slush	2	1) For speeds below 85% of the hydroplaning speed[2]: 50% of the Tire-to-ground braking coefficient determined in accordance with § 25.109(c), but no greater than 0.16; and 2) For speeds at 85% of the hydroplaning speed[2] and above: 0.05[1].
• Ice	1	0.07[1]

[1] These tire-to-ground 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 25-7D 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.

[2] 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/in^2.

[3] In addition, data may be provided at various tire-to-ground braking coefficients or Runway Condition Codes (RWYCC) to facilitate operators' consideration of downgraded Runway Condition Code or Pilot Reports. See paragraph 9.6.

9 ACCOUNTING FOR THE DRAG OF LOOSE CONTAMINANTS.

9.1 Loose contaminants (see Table 1 of this AC for classification of contaminants) result in additional 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 impeding acceleration during a takeoff, or assisting deceleration during a rejected takeoff. 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 7930.2S (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 Data should be provided for the specific gravities in 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

9.2 The applicant may account for contaminant drag for computation of the deceleration segment of the accelerate-stop distance. However, if the actual contaminant depth is less than the reported value, then using the reported depth to determine contaminant drag will result in a higher drag level than the one that actually exists, leading to a conservative takeoff distance and takeoff run, but a potentially optimistic accelerate-stop distance. It is assumed that these effects will offset each other; however, the applicant may consider:

- either using 100 % of the reported contaminant depth when determining the acceleration portion, and 50 % when considering the deceleration portion; or
- using 50 % of the reported contaminant depth when determining both the acceleration and the stop portion of the accelerate-stop distance. This should result in a conservative computation without being unduly penalizing. The applicant should check to ensure that using drag for half of the contaminant depth for the accelerate-stop computation is conservative for the applicant's airplane configuration.

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

9.4 The effect of contaminant drag between rotation and liftoff can be addressed using one of two methods, as described below or another method that has been validated by suitable analysis. There are advantages and disadvantages with each method, but either may be used if supported by an analysis that includes the assumptions used and rationale.

9.4.1 Method 1.

Retain the rotation speed (V_R) used for an uncontaminated runway, but adjust the distance from V_R to the end of the takeoff distance due to the increase in distance needed for attaining the takeoff safety (V_2) speed. With this method, there may be a reduction in the speed difference between the liftoff speed (V_{LOF}) and the minimum unstick speed (V_{MU}). Therefore, it should be verified that compliance with § 25.107(e) is maintained.

9.4.2 Method 2.

Increase V_R to ensure that the normal V_{LOF} speed is attained. With this method, the V_{LOF} speed margins to V_{MU} are maintained.

9.5 It is recommended that applicants consider the effects of directional controllability associated with crosswind and other factors, such as airplane gross weight, center of gravity position, and takeoff thrust setting. Recommendations or guidelines should be provided to operators to mitigate the effects of these items on directional controllability for different runway conditions. Minimum V_1 and/or crosswind guidance may need to be adjusted in consideration of the reduced controllability following engine failure on a contaminated runway.

9.6 It is recognized that the observation and reporting of the type and depth of contaminants (water, slush, dry snow and wet snow) is limited in terms of the accuracy and timeliness with which it can be made and relayed to the flight crew. Also airport reporting procedures allow the downgrading and upgrading of expected wheel braking as described by Runway Condition Code (RWYCC) and/or Pilot Report (PIREP). Optional consideration should be given to providing the ability to compute Loose Contaminant performance based on no contaminant drag (e.g. zero depth) for wheel braking levels associated with different RWYCC's/PIREPs when providing accelerate-stop information for Loose Contaminants.

10 CREDIT FOR REVERSE THRUST.

Accelerate-stop distances associated with contaminated runway takeoff performance data may include credit for the stopping force provided by reverse thrust, subject to meeting the following criteria:

10.1 Procedures for using reverse thrust during a rejected takeoff on a contaminated runway should be consistent with the normal procedures for use of reverse thrust during a rejected takeoff on an uncontaminated runway. 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.

10.2 Using reverse thrust during a rejected takeoff on a contaminated runway 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.

10.3 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.

10.4 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.

10.5 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.

10.6 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 takeoffs, including maximum recommended crosswinds, should be provided to operators for the runway surface conditions for which takeoff performance data are provided. A suitable simulation may be used to develop these guidelines for operation on contaminated runways.

10.7 If the data provider, in using the process described in this AC, applies credit for asymmetric reverse thrust, 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.

10.8 The failure of each individual thrust reverser to provide the expected level of thrust (without prior crew awareness) should be on the order of 10^{-4} or less per rejected takeoff. This specific reliability criterion applies to both single and combinations of failures and takes into account interlock features intended to prevent inadvertent in-flight deployment.

10.9 The effective stopping force provided by reverse thrust in each, or at the option of the data provider, the most critical takeoff configuration, should be established 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 accelerate-stop distances are based in order to calculate those distances and ensure that no adverse combination effects are overlooked. These tests may be conducted on a dry runway.

10.10 For turbopropeller powered airplanes, the guidance in paragraphs 10.1 through 10.9 above remain generally applicable. Additionally, the propeller of the inoperative engine should be in the position it would normally assume without any action on the propeller taken by the pilot following an engine failure. 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 (for example when the design provides no 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.

Refer to the guidance in AC 25-31X which applies to data produced to support existing type designs.

12 DOCUMENTATION.

12.1 Data Location.

The applicant may choose to furnish approved contaminated runway takeoff performance data in the AFM. If the applicant chooses not to furnish this data, then an appropriate statement prohibiting takeoff on contaminated runways must be included in the AFM.

12.2 Other Information.

If an applicant develops contaminated runway takeoff performance data described in this AC, the following information should also be provided:

- Instructions for use of the data.
- Definitions of the different runway surface conditions.
- **Note:** It is recognized that FAA and ICAO descriptions have minor variations in the definition of runway surfaces. It is acceptable to use differing definitions when describing the different runway surface conditions as long as the variation is minor and it is easily recognizable which performance data is applicable.
- Prohibitions for taking off on runways with contaminants and depths not covered in the performance data (see paragraph 7.3, 7.4).
- Any other recommendations associated with use of the contaminated runway takeoff performance data.
- Statements addressing the following:

- Operation on runways contaminated with water, slush, snow, ice or other contaminants implies uncertainties with regard to runway friction and contaminant drag and, therefore, to the achievable performance and control of the airplane during landing since the actual conditions may not completely match the assumptions on which the performance information is based; where possible, every effort should be made to ensure that the runway surface is cleared of any significant contamination;
- The performance information assumes any runway contaminant to be of uniform depth and density (for loose contaminants) and uniform coverage of a layer of contaminant with uniform properties throughout; and
- The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good as those that may be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust.

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 25-31 Date: Click here to enter text.

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph Click here to enter text. on page Click here to enter text.

☐ Recommend paragraph Click here to enter text. on page Click here to enter text. be changed as follows:

Click here to enter text.

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

Click here to enter text.

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Submitted by: ________________________________ Date: _________________________

Appendix 5 – New Advisory Material - AC 25.1592 (Landing)

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Performance Information for Landing Distance Assessment at Time of Arrival	**Date:** **Initiated By:** AIR-625	**AC No:** AC 25.1592

This advisory circular (AC) describes an acceptable means of compliance which can be used when developing landing performance data for time-of-arrival landing performance assessments for transport category airplanes for operations on dry, wet, slippery wet and contaminated runways as required by 14 CFR 25.1592. This AC promotes the use of consistent terminology for runway surface conditions used among manufacturers, airport and aircraft operators and FAA personnel.

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Director, Policy and Innovation Division
Aircraft Certification Service

(page numbering to be specified upon publication)

1 Purpose.
2 Applicability.
3 CANCELLATION
4 Related Documents.
5 Background.
6 Time-of-Arrival Landing Performance Assessments.
7 Definitions.
8 Time-of-Arrival Performance Data.
9 Determination of Landing Distance for Time-of-Arrival Landing Performance Assessments.
10 Accounting for Drag of Loose Contaminants
11 Credit for Reverse Thrust.
12 Guidance for Existing Type Designs.
13 Documentation.

Figures

Figure 1. Landing Distance Segments..

Tables

Table 1. Runway Surface Condition—Descriptions and Contaminant Categories...........................
Table 2. Wheel Braking Coefficients as a Function of Runway Surface Condition..........................
Table 3. Loose Contaminant Specific Gravity ....

1 PURPOSE.

This advisory circular (AC) describes an acceptable means of compliance which can be used when developing landing performance data for time-of-arrival landing performance assessments for transport category airplanes for operations on dry, wet, slippery wet and contaminated runways as required by 14 CFR 25.1592. This AC promotes the use of consistent terminology for runway surface conditions used among manufacturers, airport and aircraft operators 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 regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The Federal Aviation Administration will consider other methods of demonstrating compliance that an applicant may elect to present.

2.3 While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. If however, the FAA becomes aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

2.4 This material does not change or create any additional regulatory requirements, nor does it authorize changes in, or permit deviations from, regulatory requirements.

2.5 Terms used in this AC such as “shall” or “must” are used only in the sense of ensuring applicability of this method of compliance when the acceptable method of compliance described herein is used.

3 CANCELLATION.

3.1 Not Applicable.

4 RELATED DOCUMENTS.

4.1 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.

- 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*.
- Section 25.1592, *Performance Information for Landing Distance Assessment at Time of Arrival*.

4.2 **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 25-7X (or later revisions), *Flight Test Guide for Certification of Transport Category Airplanes*, dated YY Y, 20YY.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.
- AC 91-79A, *Aircraft Landing Performance and Runway Excursion Mitigation*, dated September 17, 2014.
- AC 150/5200-28E, *Notices to Airmen (NOTAMs) for Airport Operators*, dated October 8, 2015.
- AC 150/5200-30D, *Airport Field Condition Assessments and Winter Operations Safety*, dated October 29, 2020.

4.3 **Other Documents.**

- ASTM E3188-19, *Standard Terminology for Aircraft Braking Performance*, published February 2019.
- ASTM E3266-20, *Standard Guide for Friction-Limited Aircraft Braking Measurements and Reporting*, published November 2020.
- FAA Order JO 7930.2S (or later revision), *Notice to Airmen (NOTAM)*, dated 10 January, 2019.
- European Aviation Safety Agency (EASA), CS 25.1592 *Performance information for assessing the landing distance*, and associated Acceptable Means of Compliance (AMC).
- Safety Alert for Operators (SAFO) 19001, *Landing Performance Assessments at Time of Arrival*.

5 **BACKGROUND.**

5.1 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.

5.2 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 flight crews 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.

5.3 The TALPA ARC completed its actions and delivered its recommendations to the FAA on July 7, 2009.

5.4 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) 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.

5.5 Although the Committee recommended adopting regulations requiring TC holders to produce landing performance data for time-of-arrival landing performance assessments, the FAA did not initiate rulemaking. The FAA issued AC 25-32 in 2015 to support the voluntary implementation of the TALPA ARC recommendations which occurred on October 1, 2016. The FAA published operational guidance in FAA order 8900.1 which eventually was published also in SAFO 19001 (superseding SAFO 06012).

5.6 Starting in 2015 the International Civil Aviation Organization published revisions to their Annexes and other documents incorporating their version of the TALPA recommendations named Global Reporting Format (GRF) implemented worldwide in November 2021.

5.7 In 2016 EASA published Notice for Proposed Amendment – NPA 2016- 11. This NPA proposed revisions to Certification Specifications, airport and operating standards which reflected the ICAO GRF program.

5.8 In 2020 the FAA Aviation Rulemaking Advisory Committee (ARAC) tasked the Flight Test Harmonization Working Group (FTHWG) to harmonize the FAA TALPA 14 CFR part 25 regulatory recommendations and advisory material with EASA CS 25 rulemaking activity, as published in November 2021 in CS 25 Amendment 27.

5.9 This AC provides guidance and standardized methods that applicants can use to develop landing performance data for time-of-arrival (or en route) landing performance assessments. The created data would also be consistent with the terminology used for airport reporting of runway conditions.

6 TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS.

6.1 Sections 91.605, 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 § 91.605, § 91.1037, § 121.195, or § 135.385.

6.2 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.

6.3 Appropriate landing performance data assists operators in performing these time-of-arrival landing performance assessments. Because of differences in the 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 from the landing performance data developed in accordance with § 25.125 and provided in the Airplane Flight Manual in accordance with § 25.1587(b).

6.4 § 25.125 dry runway landing distances are often 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 is beneficial if the landing performance data are representative of actual operations. The data for time-of-arrival landing performance assessments should represent expected landing performance by a trained flight crew of average skill following normal flight procedures and training.

6.5 Like the landing distances defined in § 25.125, the landing distances for use for time-of-arrival landing performance assessments 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 of this AC.

6.6 An important portion of the TALPA ARC's recommendations concern the use of a common set of terms for runway condition reports which have also been accepted by ICAO and EASA. The FAA agrees with the ARC that it is 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. ICAO recommendations and standards on runway condition reporting and recommended time-of-arrival performance computations, while not identical to the FAA's, are consistent with the FAA recommended terminology and performance definitions and methods. The common terminology and methods are based on:

- Runway surface condition descriptions used in field condition reports originated by airports are provided in terms of runway condition code by thirds and contaminant type and depth by thirds,
- Braking action reports from pilots relayed by air traffic controllers,
- Development of airplane performance data for different runway surface conditions and runway condition reports,
- Use of field condition reports and airplane performance data by pilots and airplane operators to make their time-of-arrival landing performance assessments.

7 DEFINITIONS.

7.1 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.

7.2 **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 ⅛ inch (3 mm) or less in depth.

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

7.3 **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 7.3.1 through 7.3.8 of this AC.

Note: The definition of water in the context of condition reporting and airplane performance is the definition in paragraph 7.3.6 of this AC, which occurs at a depth of greater than ⅛ inch (3 mm). This terminology is consistent with the definitions used in NOTAMs as published in AC 150/5200-28E and Order JO 7930.2S (or later revisions).

7.3.1 <u>Dry Snow.</u>

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

7.3.2 <u>Wet Snow.</u>

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.

7.3.3 <u>Slush.</u>

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.

7.3.4 <u>Compacted Snow.</u>

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.

7.3.5 <u>Frost.</u>

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.

7.3.6 Water.

Water in a liquid state. For purposes of condition reporting and airplane performance, water is greater than ⅛ inch (3 mm) in depth.

Note: The term water is equivalent to standing water in the context used for condition reporting and airplane performance in ICAO Annex 14 and EASA CS 25.1591 for example.

7.3.7 Ice.

The solid form of frozen water.

7.3.8 Wet Ice.

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

7.4 Loose Contaminants.

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.

7.5 Runway Condition Reports.

A comprehensive standardized report relating to the condition(s) of the runway surface and their effect on the airplane landing and takeoff performance. (See ICAO Annex 14 Vol 1, 8th Edition)

7.6 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 7.6.1 through 7.6.6 of this AC.

7.6.1 Good.

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

7.6.2 Good-to-Medium.

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

7.6.3 Medium.

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

7.6.4 Medium-to-Poor.

Braking deceleration or directional control is between medium and poor.

7.6.5 Poor.

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

7.6.6 Nil.

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

7.7 Aircraft Braking Action Report.

A report describing a level of braking action using data from the aircraft. See ASTM standard E3188-19 and E3266-20.

7.8 Runway Condition Code (RWYCC).

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.

7.9 Runway Surface Condition.

The runway surface condition is a description of the contaminants (if any) on the surface of a runway.

7.10 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 deceleration capability.

7.11 Slippery When Wet.

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

Note: The phrase "Slippery When Wet" used for condition reporting is equivalent to "Slippery Wet" in the context of airplane performance in ICAO Annex 14, EASA CS 25.1591, etc.

7.12 Specific Gravity.

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

7.13 Tire-to-ground Braking Coefficient.

Tire-to-ground 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 tire-to-ground 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 tire-to-ground 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 25-7D.

8 TIME-OF-ARRIVAL PERFORMANCE DATA.

8.1 Landing performance data should be provided based on the normal terminology of Runway Condition Reporting. Terms normally used are:

- Runway Condition Code,
- Runway Surface Condition description, type and depth of contamination.
- Pilot-reported Braking Action

Table 1 provides the relationship between runway condition code, runway surface condition descriptions, pilot-reported braking action and tire-to-ground braking coefficient that should be used when creating Time-of-Arrival landing distance information as described in Section 9.

8.2 The terms and methods for airport reporting runway conditions are in section 5.3 Runway Condition Assessments of AC 150/5200-30D. This section contains the Runway Condition Assessment Matrix (RCAM) for Airport Operator’s usage. AC 91-79A (or later revision) provides the RCAM for Aircraft Operator usage. Table 1 presents the information consistent with the Airport and Aircraft Operators RCAMs for applicants to use when computing landing distances for Time-of-Arrival landing distance performance data.

Table 1. Runway Condition Reporting Surface Condition—Pilot-Reported Braking Action—Tire-to-ground Braking Coefficient Correlation Matrix

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Tire-to-ground Braking Coefficient
6	• Dry	—	95% of certified friction limited part of the model used to comply with § 25.125[1].
5	• Frost • Wet (includes damp and ⅛″ (3 mm) depth or less of water) ⅛″ (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	0.20[2]
3	• Wet ("slippery when wet" runway) • Dry snow or wet snow (any depth) over compacted snow Greater than ⅛″ (3 mm) depth of: • Dry snow • Wet snow Warmer than -15 °C outside air temperature: • Compacted snow	Medium	0.16[2]
2	Greater than ⅛″ (3 mm) depth of: • Water • Slush	Medium to Poor	(1) For speeds below 85% of the hydroplaning speed[3]: 50% of the tire-to-ground braking coefficient determined in

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Tire-to-ground Braking Coefficient
			accordance with § 25.109(c), but no greater than 0.16; and (2) For speeds at 85% of the hydroplaning speed[3] and above: 0.05[2].
1	• Ice	Poor	0.07[2]
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 tire-to-ground braking coefficient used to comply with § 25.125 may be used

- If the braking coefficient used to comply with § 25.125 already includes the 0.95 factor, or
- 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.

Under conditions where braking performance is limited by available brake torque, 100% of the torque limited braking may be assumed.

[2] These tire-to-ground 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 25-7D 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.

[3] 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/in^2.

8.3 Time-of-Arrival 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:

8.3.1 Approved landing configurations, including Category III landing guidance where approved;

8.3.2 Approved deceleration devices (for example, wheel brakes, speedbrakes/spoilers, and thrust reversers);

8.3.3 Pressure altitudes within the approved landing operating envelope;

8.3.4 Weights up to the maximum takeoff weight;
8.3.5 Expected airspeeds at the runway threshold, including speeds up to the maximum recommended final approach speed considering possible speed additives, e.g. for winds and icing conditions;
8.3.6 Temperatures within the approved landing operating envelope;
8.3.7 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;
8.3.8 Runway slopes within the approved landing operating envelope; and
8.3.9 Icing conditions, if required to provide the landing distances required under § 25.125 in icing conditions.

8.4 Appropriate information for minimum equipment list should be provided and configuration deviation list items that affect landing distance.

8.5 Applicants are also encouraged to include Landing distances for non-normal configurations.

8.6 At the option of the applicant, landing performance data may be provided for specially prepared winter runway surfaces. This may include icy surfaces that have been treated with sand or gravel in such a way that a significant improvement of friction may be demonstrated. It is recommended that a tire-to-ground braking coefficients not greater than 0.20 (for fully modulating anti-skid systems) should be assumed.

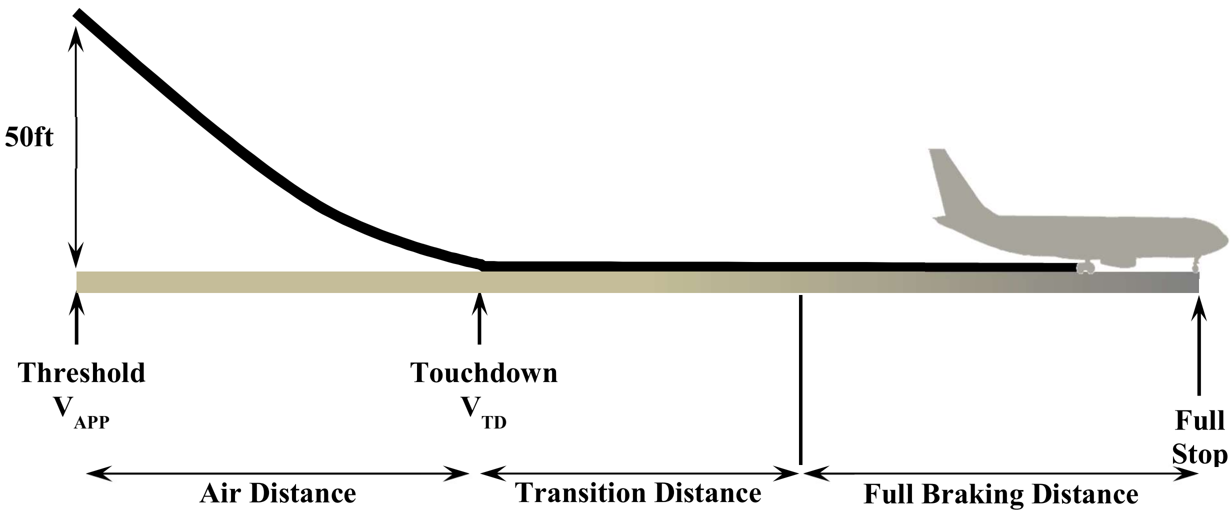
Note: Approval for operation on specially prepared winter runways requires demonstration of the effectiveness of such treatment with monitoring of actual braking action indicated by airplane data.

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

9.1 Landing Distance.

9.1.1 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



9.1.2 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.

9.1.3 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 9.3.2, 9.3.3, and 9.3.4 of this AC.)

9.1.4 The procedures and assumptions used to develop the operational landing distances should be documented in the appropriate reference material.

9.2 **Air Distance.**

9.2.1 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. In the context of the determination of Landing Distances at Time of Arrival, this definition of the air distance assumes that the airborne distance for compliance with § 25.125 was determined by one of the methods described in AC 25-7X or later in § 4.11.2.

Note: Prior practice to consider an air distance under § 25.125 that establishes the maximum performance capability of the aircraft when applying non-standard flying techniques means that it may not be appropriate for use in making time-of-arrival landing performance assessments.

9.2.2 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.

9.2.3 Unless the air distance used for compliance with § 25.125 is representative of an average pilot who is flying in normal operations (see paragraph 9.2.4 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.

9.2.4 If the air distance is determined directly from flight test data instead of the analytical method provided in paragraph 9.2.3 above, the flight test data should meet the following criteria:

9.2.4.1 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.

9.2.4.2 At a height of 50 feet above the runway surface, the airplane should be at an airspeed no slower than the recommended runway threshold airspeed consistent with section 8.3.5 of this AC.

9.2.4.3 The touchdown rate of descent should be in the range of 1 to 4 feet per second.

Note: The criterion of paragraph 9.2.4.3 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.

9.2.5 The air distance determined under paragraph 9.2.3 or 9.2.4 of this AC also applies to autoland or similar low visibility guidance systems as long as the demonstrated average flare time and VTD/VAPP from the autoland or low visibility guidance 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 VTD/VAPP from the autoland or low visibility guidance system demonstrations may be used for computing the air distance when determining the autoland or low visibility guidance system landing distance. The autoland or 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.

9.2.6 The air distance based on 9.2.3 is considered acceptable for runways sloping downward as much as two percent (-2%). Note that no credit should be taken for an upward sloping runway.

Note: AC 25-7X 4.11.1.1 states the landing distance is the horizontal distance from the point at which the main gear of the airplane is 50 feet above the landing surface (treated as a horizontal plane through the touchdown point). This definition of airborne distances may not apply to landings based on runways with specific steep approach procedures. Refer to AC 25-7X.

9.3 **Transition Distance.**

9.3.1 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 9.2.3 of this AC, the speed at the start of the transition segment is 96 percent of the final approach speed.

9.3.2 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.

9.3.3 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.

9.3.4 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.

9.3.5 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.

9.3.6 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 1 in section 8.2 of this AC for the tire-to-ground braking coefficient).

Note: The tire-to-ground braking coefficients in Table 1 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.

9.4 **Final Stopping Configuration Distance (Full Braking Distance).**

9.4.1 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.

9.4.2 The calculation of the final stopping configuration distance should be based on the braking coefficient associated with the runway condition report including the effect of hydroplaning, if applicable, as described in Table 1 of Section 8.2. Credit may be taken for the use of thrust reversers as described in section 11. See Section 10 for information about taking into account contaminant drag from loose contaminants.

10 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS.

10.1 Loose contaminants 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 and are not included in the time-of-arrival landing distance based on Runway Condition Code or Pilot-Reported Braking Action. However additional time-of-arrival landing distance data for Runway Surface Condition which does take credit for the benefit of the drag associated with loose contaminants of snow, slush and water may be provided.

10.2 This contaminant drag associated with the loose contaminants 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:

10.2.1 Contaminant depths are reported in field condition reports using specific depth increments as specified in FAA Order JO 7930.2S (or later revision).

10.2.2 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.

10.2.3 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.

10.3 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.

Note: For Landing Distances at Time of Arrival presented against Runway Condition Codes, data must not include accountability for contaminant drag.

10.4 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 7930.2S (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.

10.5 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 2 below.

Table 2. Loose Contaminant Specific Gravity

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

10.6 The FAA finds acceptable the methods for calculating contaminant drag described in EASA AMC 25.1591. A method that was previously accepted by EASA or has been validated by suitable analysis or test data may also be used.

11 CREDIT FOR REVERSE THRUST.

11.1 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:

11.1.1 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.

11.1.2 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.

11.1.3 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.

11.1.4 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.

11.1.5 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.

11.1.6 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.

11.1.7 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.

11.1.8 The failure of each individual thrust reverser to provide the expected level of thrust (without prior crew awareness) should be on the order of 10^{-4} or less per landing. This specific reliability criterion applies to both single and combinations of failures and takes into account interlock features intended to prevent inadvertent in-flight deployment.

11.1.9 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.

11.1.10 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.

11.2 For turbopropeller powered airplanes, the guidance in paragraphs 11.1 through 11.1.10 above remains generally applicable. Unless the selection of reverse thrust is achieved by a single and continuous action to retard the power lever(s) from the flight idle setting (for example when the design provides no stop or lockout), it should be regarded as an additional pilot action for the purposes of assessing delay times.

12 GUIDANCE FOR EXISTING TYPE DESIGNS.

Refer to the guidance in AC 25-32X which applies to data produced to support existing type designs.

13 DOCUMENTATION.

13.1 Data Location.

The applicant must furnish approved time-of-arrival landing performance data in the AFM.

13.2 Other Information.

The following information should also be provided:

13.2.1 Instructions for use.

13.2.2 Definitions of runway surface condition and how to correlate runway surface condition descriptions, runway condition codes, and braking actions.

13.2.3 Maximum depth of contaminants.

13.2.4 Any other recommendation associated with use of the landing performance data.

13.2.5 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.

13.2.6 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 25.1592 Date: Click here to enter text.

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph Click here to enter text. on page Click here to enter text.

☐ Recommend paragraph Click here to enter text. on page Click here to enter text. be changed as follows:

Click here to enter text.

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

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Submitted by: ________________________________ Date: _________________________

Appendix 6 - Revised Advisory Material - AC 25-7X

In order to ensure appropriate LDTA computations in the case of Steep Approach, the following new paragraph should be inserted in section 42.4:

42.4 Criteria for Approval of Steep Approach to Landing.

[…]

42.4.7 Landing Distance at Time of Arrival
Landing distances at time of arrival (LDTA) are furnished in accordance with AC 25-32X / AC 25.1592 to allow pilots to verify that a safe landing can be made on the intended runway based on the latest information regarding weather and runway surface condition.
For the purpose of the LDTA, the airborne distance as defined in AC 25-32X / AC 25.1592 §9.2 may not be appropriate for specific steep approach procedures, for which the applicant determines air distances that are achieved in steep approaches directly from flight tests performed in accordance with this section. The applicant may use those demonstrated air distances for assessing the landing distance at dispatch and at the time of arrival.
When using these demonstrated airborne distances for the LDTA, the applicant should ensure continuity, in terms of ground speed and pitch attitude at touchdown, to the transition phase.