ARAC | AVIATION RULEMAKING ADVISORY COMMITTEE

September 22, 2023

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

Re: Recommendation Report – Landing Distance on Dry Runway

Dear Mr. Roberts,

On behalf of the Aviation Rulemaking Advisory Committee (ARAC), I am pleased to submit the enclosed Recommendation Report from the Flight Test Harmonization Working Group (FTHWG) on Topic 33 – Landing Distance on Dry Runway.

At the September 21, 2023, ARAC meeting at FAA's Washington, DC headquarters, Mr. Brian Lee presented an overview of the report with recommendations for updating the 14 CFR part 25 regulations for establishing landing distance on dry runways.

ARAC members who attended the meeting, in-person and virtually, voted to accept the recommendation report. With that, I would welcome the agency's timely review, acceptance, and actions to implement the working group's recommendations. I would especially like to highlight and support the working group's recommendation that rulemaking should combine the contents of Topics 9, 32 and this report, 33. Doing so will help achieve the shared objective of building consistent methods for calculating landing distances for use at dispatch and at time of arrival.

I thank the chair and members of the FTHWG for their thorough and diligent work in response to the agency's tasking. The recommendations, once implemented, stand to further improve commercial aviation's safety record.

Sincerely,

David Oord
ARAC Chair

Enclosure: FTHWG Topic 33 Recommendation Report – Landing Distance on Dry Runway

FAA Aviation Rulemaking Advisory Committee
FTHWG Topic 33
Landing Distance on Dry Runway

Recommendation Report
July 31, 2023

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Executive Summary

The Flight Test Harmonization Working Group (FTHWG) was tasked with providing a methodology for determining dry runway 14 CFR part 25 / CS-25 landing distance for use at the time of dispatch planning that is harmonized with the landing distance methodology provided in FTHWG Topic 9 Wet Runway Stopping Performance. The task includes determining and recommending new landing distance operational factors to be used at the time of dispatch for basic 14 CFR part 121 and 135 landing operations on dry runways.

The FTHWG Topic 9 final report recommends a new method for determining 14 CFR part 25 wet runway landing distance, based on operationally achievable air distances and a reasonable landing distance operational factor for dispatch planning. This new method differs from the current part 25 dry runway landing air distance methods permitted by AC 25-7D which were utilized by some manufacturers because the applicable operating regulations require a large operational factor applied to the dry landing distance. This difference in principle led to a need for harmonization between the dry and wet runway landing distance methods used for dispatch planning to avoid confusion for the operators. While some manufacturers have provided more realistic and operationally achievable dry runway landing distances, the current operationally unrealistic unfactored dry runway landing distances that may be provided based on current advisory material is considered a potential safety risk for operations with a reduced operational factor.

For operations with a reduced landing distance operational factor, the group recognizes that some ACOs have already required applicants to consider more conservative assumptions for the determination of the airborne and stopping distance.

The timing of this report is considered favorable for promoting consistency, since operational assumptions to define an updated part 25 landing distance can be connected with the assumptions for landing distances at Time of Arrival (TOA), which were reviewed by the group for codification in the FTHWG Topic 32. The group's objective was to build consistent methods for calculating landing distances for use at dispatch and at time of arrival. Therefore, it is recommended that rulemaking should combine the contents of Topics 9, 32 and this report. Especially, implementing the recommendation of Topic 32 is a pre-requisite to this topic, because of the safety benefit of implementing landing distances for use at time of arrival.

The group concluded that more consistency between 14 CFR part 25 landing distances for dispatch to dry and wet runways could be achieved, considering that both distances may differ only by their braking coefficient. It also appeared that more consistency between unfactored § 25.125 landing distances and unfactored TOA landing distances was desirable, both for a simplification of the data to be derived by the manufacturers and for an easier understanding by the operators.

In this spirit, each landing distance component was examined, including air distance, speed bleed off during the flare, derotation, transition from landing configuration to stopping configuration, runway friction characteristics, and use of reverse thrust.

This report recommends updating the 14 CFR part 25 regulations for establishing landing distance on dry runways, resulting in the following:

- A more homogeneous stopping distance margin across the entire aircraft altitude and temperature operating envelope,
- Greater consistency with part 25 landing distances used at time of dispatch on wet runways as per FTHWG Topic 9 recommendations and landing distance on dry runways at TOA per FTHWG Topic 32 recommendations,
- Establishment of one set of part 25 unfactored dry runway landing distances with realistic operational hypotheses, which can be used as a common reference for application of the different operational factors associated to the different types of operations,
- Consideration of an engine failure occurring during the landing flare in deriving the stopping distance,
- Improved understanding by flight crews of the operational margins required for the dispatch landing distance calculations when the unfactored distances consider operational hypotheses and are more consistent with TOA calculations.

This report recognizes that the operational rules related to landing distances are impacted by the changes made in 14 CFR part 25 / CS-25 25.125 leading to:

- A new recommended landing distance operational factor for basic part 121 and 135 operations equal to 1.20,
- New recommended landing distance operational factors for part 91K Fractional Ownership and part 135 Eligible on Demand operations (operations with reduced landing distances factors) equal to 1.09.

There will be some portions of the operational envelope where the proposal results in factored dry runway landing distance less than the current factored distances intended to be used for dispatch, which is to be expected because the proposed standard is based upon more realistic assumptions. Considering the current good safety record of operations on dry runways, the proposed factored landing distances (Required Landing Distance) do not need to be greater than the current landing distances, and generally will not be greater than the current dispatch requirements, except in some corners of the flight envelope (very hot day conditions for example).

Background

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

The objective of the current § 25.125 requirement is that the landing distance of the airplane should be established and made available to the operator/pilot in order to determine that sufficient runway length is available for a safe landing.
Although there is no safety issue linked to current 14 CFR part 25 landing distance on dry runway standard, the guidance (FAA AC 25-7D) associated with current requirements for landing performance data intended for use at time of dispatch compensates for an operationally unrealistic 14 CFR 25 / CS-25 landing distance on dry runway when combined with a large landing distance operational factor (1.67). The primary cause that drives this operationally unrealistic unfactored landing distance is the Parametric Analysis Data Reduction method from §§ 4.11.8 of AC 25-7D

which allows to mathematically extrapolate the landing flare time from flight test data to assume a 3.5 degree glideslope and an 8 ft/sec sink rate at touchdown.

In addition, the current certification standard does not require accounting for the temperature expected at landing, nor for the runway slope.

This situation presents several drawbacks:

- For some operations, a landing distance operational factor is not mandatory (14 CFR part 91 for example). This situation is generally mitigated by the manufacturers providing more operationally realistic unfactored data, or by regulators requiring more realistic data through CRIs or IPs. Nonetheless, there remains a risk of unknowingly conducting a flight using operationally unrealistic landing distances, wrongly showing some margins versus the landing distances available whereas there was none. Note that this situation has been somewhat operationally mitigated by the introduction of operationally-representative TOA landing distances, introduced by the TALPA-ARC and proposed to be codified in the FTHWG Topic 32 report and already in force in Europe via EU regulation (Air Operations CAT.OP.MPA.303).
- Other landing distances (landing distances for dispatch to a wet runway and landing distances at TOA) as defined in FTHWG reports use more operational hypotheses including accounting for temperature effects for 14 CFR part 25 / CS-25 associated with a reasonable landing distance operational factor. Also, it can be confusing for the operator when dry runway landing distances are not developed in the same way. The consideration of the temperature expected at destination when preparing the dispatch will also ensure a more homogeneous margin according to the temperature of the day.

Modifying the landing distance on dry runways considering an operationally achievable part 25 distance along with a "reasonable" landing distance operational factor will:

- Eliminate the risk of conducting a flight using an operationally unrealistic landing distance
- Provide a better understanding of the actual operational margin for the pilot
- Provide opportunity to maximize the consistency of reference distances for both dispatch and TOA
- Allow the manufacturer to provide a single set of reference distances both for dispatch and for TOA

B. ***What is the task?***

There are two tasks:

1) During elaboration of FTHWG Topic 9 Wet Runway Stopping Performance (non-TALPA) recommendations, which has introduced an improved physics-based rational computation for wet runway landing distance that is based on realistic operational procedures, it was recommended that a harmonized methodology to determine dry runway 14 CFR part 25 / CS-25 landing distance and

dispatch requirements be made consistent with the recommended wet runway landing distance standards, i.e., "the group recognizes the need to further harmonize 14 CFR part 25 / CS-25 landing distance standards on dry and wet runways".

2) New landing distance requirements to be applied at the time of dispatch to a dry runway, including new operational factors for basic 14 CFR part 121 and 135 operations when applying the new dry runway required landing field length, must be developed by the FTHWG, consistent and compatible with wet runway dispatch and time of arrival computations.

Note: The wording above reflects the tasking from the work plan refined for improved readability.

C. *Why is this task needed?*

For task 1:
Although no safety issue linked to current 14 CFR part 25 dry runway landing performance standards was apparent from in-service operations, the different certification methods between 14 CFR part 25 / CS-25 dry and wet runway landing distances could make the overall set of data for landing performance requirements at dispatch difficult to understand for operators as they are currently facing the following situation:

- An operationally unrealistic short 14 CFR part 25 / CS-25 dry runway landing distance provided by some manufacturers for some airplanes combined with a large landing distance operational factor.
- An improved physics-based 14 CFR part 25 / CS-25 wet runway landing distance combined with a reasonable landing distance operational factor resulting from Topic 9 recommendations.
- Physics-based TOA dry and wet runway landing distances combined with a reasonable safety margin resulting from Topic 32 recommendations.

In addition, the operationally unrealistic short distances permitted by the existing guidance related to 14 CFR part 25 dry runway landing distance used by some manufacturers for some airplanes generates risks in flight tests (even if AC25-7D limits the flight tests to a touch down sink rate of 6ft/s, a risk of unintended high sink rate at touch down remains), as shown by the historical record. The risk was aggravated by the use of specific flight test procedures, inconsistent with procedures used by operational flight crews.

Note: One of the reasons why the parametric method was introduced was to allow for some extrapolation in order to mitigate the flight test risk of high sink rate at touch down.

For task 2:
The results of task 1 led to the review and revision of the landing distance operational factors under task 2. Task 2 was a direct consequence of task 1.

The work plan considered it possible to use the existing operational factors of 14 CFR part 135 (EOD – Eligible On Demand) operations for basic 14 CFR part 121 operations when applied to new 14 CFR part 25 dry runway landing distance without creating unintended safety consequences or creating major unjustifiable changes in the competitive situation between aircraft.

Alternatively, similarity with the EASA Opinion 02-2019 and Regulation (EU) 2019/1387 which became the final rule resulting from EASA NPA 2016-11 and introduced AIR OPS CAT.POL.A.255, could be considered. Refer to the Historical Information, section B.

Note: The wording above reflects the tasking from the work plan refined for improved readability.

As a result, as each element of the dry runway landing distance was considered by the Working Group, it was always done with the view that the factored distances used for dispatch in operations should not be appreciably affected. By adopting more consistent, more physics-based methods for the unfactored landing distance, those will, in general, get longer. This will necessarily require a review of the operational factors of 14 CFR part 121, part 135, and part 91(K) concomitantly (to keep the new total factored distances on par with the current factored distances).

The above description of "why task 2 is needed" may be interpreted as to suggest that the currently existing reduced landing distance operational factor of 1.25 implemented under 14 CFR part 135 (and EU Air Operations CAT.POL.A.255) could in the future apply also to all Commercial Air Transport (14 CFR part 121) provided that the actual landing distance was operationally representative.

This group believes it was not part of the group's task to review the operational context in which those landing distance operational factors are applied. Such a review would require attendance of regulatory authorities' experts with appropriate expertise of developing the operational rules. Such an enlarged attendance was not foreseen in the work plan of Topic 33. How to implement the revised landing distance operational factors proposed in this report within the operational context will have to be reviewed by a competent working group or body as a subsequent activity.

Nonetheless, the FTHWG proposes to offer its expertise to the Flight Standards communities of the authorities. First, to share the proposed methods (now more consistent, more physics-based) for generating the § 25.125 landing distances, the rationale for proposing such changes, and to describe how the proposed accompanying operational factors were generated. Second, to assist, as required, in developing a transition plan for adoption of new operational factors as the new § 25.125 landing distance methods and new operational factors are interdependent.

D. *Who has worked the task?*

This task has been worked by the FTHWG, including specialists on landing performance flight testing and certification, and flight operations from the entities involved. The primary individuals and organizations working this issue were:

- 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 participated in Topic 9 and Topic 32 discussions and one who is performance manager at Norwegian airline as well as a line pilot.

E. ***Any relation with other topics?***

FTHWG Topic 9 Wet Runway Stopping Performance
FTHWG Topic 32 Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)

Possible tangential considerations for:
Topic 10 – Runway Excursion Hazard Classification
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 – 25.125 ; AMC 25.125(b)(3), AMC 25.125(c), AMC 25.125(c)(2)
CS 25 – 25.1592 ; AMC 25.1592

Regulation (EU) Air Operations

Land within 60% or 70% of the landing distance available:

- CAT.POL.A.230 and associated AMCs & GMs– Landing – dry runways: for turbojet aircraft, land within 60% of the landing distance available; for turbopropeller aircraft land within 70% of the landing distance available

Land within 80% of the landing distance available:

- CAT.POL.A.255 and associated AMCs – Approval of reduced required landing distance operations: Land within 80% of the landing distance available

No defined percentage of the landing distance available

- NCC.POL.120(c) and NCC.POL.135

Time of Arrival

- CAT.OP.MPA.303 In-flight check of the landing distance at time of arrival — aeroplanes

<u>FAA</u>
14 CFR 25.125

Takeoff and Landing Performance Assessment Advisory Rulemaking Committee (TALPA ARC) Transmittal Files, November 2009

AC 25-32 (future version as proposed in Topic 32)
AC 25-7D
AC 25.1581-1
AC 25-25A

Operational Regulation for dispatch grouped by percentage of Landing Distance Available (LDA) that may be used:

Land within 60% of the landing distance available:

- §91.1037 (b) Large transport category airplanes: Turbine engine powered; Limitations; Destination and alternate airports.
- §121.195 (b) Airplanes: Turbine engine powered: Landing limitations: Destination airports.
- §121.197 (b) Airplanes: Turbine engine powered: Landing limitations: Alternate airports.
- §135.385 (b) Large transport category airplanes: Turbine engine powered: Landing limitations: Destination airports.
- §135.387 (a) Large transport category airplanes: Turbine engine powered: Landing limitations: Alternate airports.

Land within 70% of the landing distance available:
(turbopropeller powered airplanes only)

- §121.195 (c) Airplanes: Turbine engine powered: Landing limitations: Destination airports.
- §121.197 (b) Airplanes: Turbine engine powered: Landing limitations: Alternate airports.
- §135.385 (c) Large transport category airplanes: Turbine engine powered: Landing limitations: Destination airports.
- §135.387 (a) Large transport category airplanes: Turbine engine powered: Landing limitations: Alternate airports.

Land within 80% of the landing distance available:

- §91.1037 (c)(2)(d) Large transport category airplanes: Turbine engine powered; Limitations; Destination and alternate airports.
- §135.385 (f) Large transport category airplanes: Turbine engine powered: Landing limitations: Destination airports.
- §135.387 (b) Large transport category airplanes: Turbine engine powered: Landing limitations: Alternate airports.

No defined percentage of the landing distance available

- §91.605 (b)(2) Transport category civil airplane weight limitations.

<u>TCCA</u>
AWM 525.125
AWM 525.1587(b)(3)(iii), (b)(4), (b)(7)

Operational Regulation for dispatch grouped by percentage of Landing Distance Available (LDA) that may be used:
Land within 60% of the landing distance available:
- CAR 704.49 Commuter Operations:
  - Turbojet powered aeroplanes: Destination.
  - Turbojet powered aeroplanes: Alternate.
- CAR 705.60 Airline Operations:
  - Turbojet powered aeroplanes: Destination
  - Turbojet powered aeroplanes: Alternate

Land within 70% of the landing distance available:
- CAR 704.49 Commuter Operations:
  - Propeller driven: Destination.
  - Propeller driven: Alternate.
- CAR 705.60 Airline Operations:
  - Propeller driven: Destination
  - Propeller driven: Alternate

Land within 80% of the landing distance available:
- CAR 704.49 Commuter Operations (under specific conditions):
  - Propeller driven with reverse thrust: Destination
  - Propeller driven with reverse thrust: Alternate

No defined percentage of the landing distance available:
- CAR 604 Private Operators
- CAR 703 Air Taxi Operations

Also related document is ICAO annex 8 “Airworthiness of Aircraft”.

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

There are no differences between the existing CS-25 and 14 CFR part 25 regulations related to the smooth, dry runway landing distance calculation. FAA AC 25-7D provides the guidance material regarding determination of landing distance, including several alternative methods for determining air distance. EASA does not have guidance equivalent to FAA AC 25-7D (FTG). In practice, EASA has accepted applicant data, which followed the FAA guidance of AC 25-7D when not in conflict with CS-25 AMCs or when guidance is not provided.

TCCA and ANAC have similar certification requirements to CS/14 CFR 25.125. In addition, TCCA and ANAC adopt FAA guidance AC25-7D.

In CS-25 at Amendment 27, paragraph 25.1592 specifying "Performance information for assessing the landing distance" exists, while 14 CFR part 25 does not have any comparable regulation. AMC 25.1592 is similar to FAA AC 25-32 (dated 22 December 2015), but some differences exist.

Considering operating standards, there are some differences in classification/operations:
- The basic operating standards are similar, i.e. the 60% rule for a dry runway is common;
- For turbo-propeller powered aircraft, EU Air Operations (CAT.POL.A.230) apply the 70% rule to destination and alternate airports whereas FAA operational rules (14 CFR parts 121/135) apply the 70% rule only to alternate airports;
- The 80% rule for dry runway has been released for application in EU AIR OPS 2020/1176 ("CAT.POL.A.255 Approval of reduced required landing distance operation") providing harmonization of the operational factor with 14 CFR part 135 Eligible on Demand operations (80% rule). Whilst EASA introduced CAT.POL.A.255 to create a level playing field with the already existing FAA part 135 (EOD) operations, eligibility is tied to a number of conditions, including an eligibility statement in the airplane's AFM, which are different from what is required by the FAA; and,
- Fractional operations 14 CFR part 91K do not exist in EASA operating rules.

TCCA does not have an equivalent operating standard to 14 CFR part 135(EOD) operations.

ANAC has provisions for the 80% rule for dry runway at destination and alternate landings in RBAC 135 and 91K, but the requirements for an operator eligibility are different than the FAA. These modifications originated from ANAC resolution 606 of February 11, 2021, which also included Subpart 91K.

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

Some IPs exist for manufacturers of airplanes that can be operated under regulations with reduced or no specified landing distance operational factors, which provide guidance to ensure operationally representative landing distances.
The proposed new part 25 landing distance is intended to be operationally representative, hence removing the need for such an IP in the future.

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 the following:

- Modify the dry runway landing distance regulation in 14 CFR part 25, §25.125, based on the same hypotheses as those proposed in the FTHWG Topic 9 report, but considering the wheel braking on a dry runway.
- Recommend modification of appropriate operational factors for dispatch planning in the Operating Requirements to reflect the modified actual landing distance defined in Task 1.
- Recommend a follow-on review by an appropriate working group or body of this proposed 14 CFR part 25, § 25.125 landing distance in the context of the various operating standards existing today.

In addition, the group identified the need to align the Topic 9 final report with improvements developed during Topic 32 (codification of TALPA) and this topic. It is recommended that rulemaking simultaneously consider the contents of Topic 9, Topic 32 and this report, especially since implementing the recommendation of Topic 32 is a pre-requisite to this topic.

Also, it is recommended that the operational requirements should be adjusted with modified landing distance operational factors at the same time as part 25 is revised, to avoid inconsistency and minimize confusion in the industry.

The proposals in this report have been reviewed and found to be consistent with ICAO Annex 8 “Airworthiness of Aircraft”.

2. *What should the harmonized standard be?*

The harmonized standard should be a 14 CFR part 25 rule based on a dry runway landing distance that is operationally achievable by a pilot of average skill applying published procedures, using hypotheses consistent with the Topic 9 Wet Runway Stopping Performance report.

The Proposed Standard for this is in Appendix 1 – Proposed Standard and Rationale.
Appendix 2 – Advisory Material contains the recommended advisory material.

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

There is no safety issue, considering the accident record for landings on dry runways.

The proposed standard will lead to a consistent set of landing data, that is more operationally representative, by:

- Providing operationally representative landing distances built with common assumptions for dispatch to dry and wet runways that are largely similar to the assumptions for unfactored TOA landing distances.
- Providing a better understanding for the operators of the published landing distances

In terms of flight tests for certification, the new advisory material will further decrease the risk of unintended high sink rate at touch down.

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

The FTHWG understands that the intent of the current 14 CFR 25.125 is that manufacturers provide unfactored landing distances in the AFM that represent the performance capability of the aircraft, achievable by a pilot of average skill in accordance with § 25.101(h)(1). However, it does not consider several significant influence parameters, such as pilot technique, ambient temperature, and operational approach speed.

This means that outside of the assumed conditions, published landing distances meeting the minimum standard may not be conservative and thus require large landing distance operational factors to be applied in order to cover all operations within the certified envelope.

Some manufacturers of smaller aircraft, which are more frequently used in private operations that do not require landing distance operational factors to be applied, have provided published landing distances that include influence factors not required by the minimum standard for certification. As application of large landing distance operational factors to these distances can be overly-conservative, this has driven some manufacturers to provide additional sets of landing performance, tailored to specific operating rules.

The proposed standard keeps the intent as stated above, but imposes a more physically-representative derivation of the landing distances, considering more operationally representative conditions. This requires an adjustment (reduction) of the landing distance operational factors such that the factored distances provide a consistent minimum margin in the complete operational domain. The resulting factored landing distances are equivalent to the current ones in hot day conditions.

The proposed standard would maintain today's level of safety for dry runway landing distance. However, it is recommended to be implemented concurrently with the recommendations from Topic 9 (Wet Runway Stopping Performance) and Topic 32 (Codification of Part 25 TALPA) which address more critical runway conditions and are expected to increase the level of safety for landing.

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

Meeting the minimum standard set forth in 14 CFR 25.125, based on applicable guidance, could lead to an unfactored landing distance that is not operationally realistic. Examples of the techniques allowed by existing guidance and used to compensate for large operational factors include:

- Parametric method with extrapolation of vertical speed at touchdown up to 8ft/s and 3.5° approach angle,
- Demonstration of maximum braking coefficient on a cleaned runway,
- Excessive pitch inputs at touchdown

In the FTHWG's understanding, these practices, while complying with the existing standard and following FAA guidance material, have deviated from the intent of the requirement stated in paragraph 4 above.

To compensate for this situation, the certification of landing distances has evolved differently in various parts of the industry:

- For aircraft potentially operating with reduced landing distance operational factors, some Issue Papers have been applied so that unfactored distances are operationally representative.
- Some manufacturers with aircraft operating with reduced landing distance operational factors include caveats in their documentation so that landing distances are not used without appropriate factors. This is now formally introduced in the proposed standard.
- Some certification offices have required conservative flight test data reduction or expansion methods, or have imposed a stricter means of compliance than provided in the associated guidance material.

The new proposed guidance is intended to ensure that the resulting landing distances are operationally achievable, in particular by specifying flight test techniques more representative of operations, covering air, transition and ground braking phases.

Thus, relative to the current industry best practices, the proposed standard will improve or at least maintain the same level of safety.

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 part 25 requirements and advisory material with landing distance on wet runways proposed in FTHWG Topic 9 report, and with time of arrival landing distances as proposed for codification in FTHWG Topic 32 report.

Nonetheless, the group debated the dry runway wheel to ground braking coefficient to consider. Several alternatives were discussed:

1- Considering performing tests "operationally", i.e. targeting the normal runway touch down area and consider the resulting coefficient measured as it is for the AFM
2- Considering targeting a clean part of the runway and potentially downgrading the result from the flight tests
3- Providing the option to use one or the other methods. Each of the methods have pro's and con's.

The group finally voted for the third option, that is to say, give the capability for a manufacturer to perform the landings in flight test targeting the normal touch down zone, or intentionally targeting a clean part of the runway. The main rationale was harmonization with TOA data, which offers the same options. Nonetheless, the braking coefficient reduction (in the anti-skid limited area) in case of landing on the clean part of the runway was limited to 5%, instead of the 10% specified in the original TALPA ARC recommendations from 2009. For consistency, the option to reduce the measured braking coefficient by 5% (i.e. using 95% of the demonstrated friction) was previously specified in Topic 32 report (Codification of TALPA). This reduction to a 5% degradation of braking coefficient was supported by some manufacturers' data. It is aimed at covering a plausible operational degradation of the runway friction.

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

The proposed change will primarily affect manufacturers of Part 25 aircraft, aircraft operators and data providers.
The operational branches of National Aviation Authorities will have to adapt the operating rules to enable operators to use the landing distance data certified using this standard.

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?***

An update is proposed to FAA AC 25-7 advisory material for dry landing distance (§ 25.125) to include consideration of:
- Airborne distance
- Derotation
- Thrust reversers
- Engine failure
- Runway cleanliness, braking coefficient adjustment

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

As recommended in the Topic 9 Wet Runway Stopping Performance report 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.

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.

Indeed, the intent was to set the factored distances of the new standard consistent with the current standard, involving nearly no impact on the aircraft operability. For part 91 operations, the new standard is not expected to restrict operations beyond the landing distance requirements recommended by the Topic 32 (Codification of TALPA) report.

Considering the effort for harmonizing hypotheses between dry runway (Topic 33) and wet runway (Topic 9) landing distances at dispatch, implementing within the rule Topic 33 and Topic 9 proposals will further minimize the incremental cost. This applies also to Topic 32 (Codification of TALPA) introduction.
Indeed, for some manufacturers, data may be produced using only one performance modeling, differing by their braking coefficient only. Those unfactored data may be then adjusted by the appropriate operational factor for dispatch or TOA.

For determining the air phase, the applicant may choose the default parameters ("7s air time formula") or the same methods as today (flight test measurement or parametric analysis) differing only by the approach angle and sink rate at touch down. Since the acceptable sink rate at touch down is reduced versus existing guidance, the risk of a hard landing during flight test demonstration and any associated cost is reduced.

Even if guidance has been adjusted concerning the transition phase for the piloting technique, this does not generate additional cost; on the contrary it is minimizing the risk of overload of the nose landing gear during flight tests and any associated cost.

Concerning the braking coefficient determination, the proposal provides the option for manufacturers to test on a representative runway (with justification) instead of the burden of cleaning the runway for certification testing.

Reverse thrust credit is allowed and therefore, depending on current OEMs practices, additional certification testing may be required to determine high-lift configuration dependent reverse thrust effects. Currently, some manufacturers must already determine the high-lift configuration dependent thrust reverser effects to satisfy EASA requirements (CS 25.1592).

For the operator, the effect on landing field length limited weight at dispatch is expected to be minimal for dry runways. Indeed, the recommended operational factors have been chosen to avoid longer distances compared to the current standard, except in corners of the flight envelope (very hot day conditions, for example) where the true airspeed is significantly faster than for standard day temperatures.

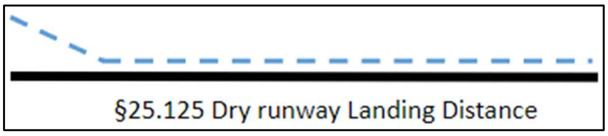
B. ***Does the HWG want to review the draft NPRM prior to publication in the Federal Register?***

Yes

Visualization of Recommendation

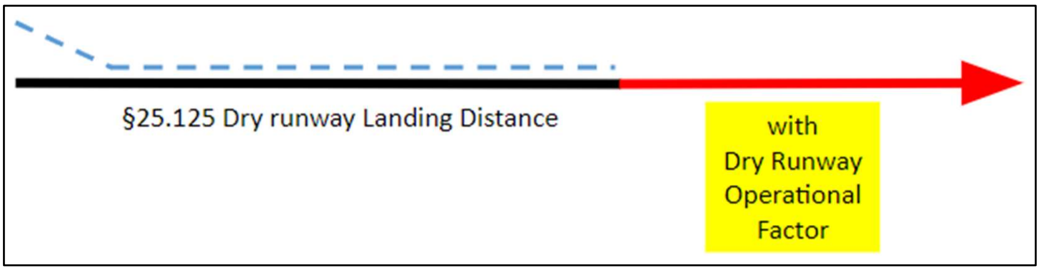
A. Current combination of §25.125 dry runway landing distance and operating standards

§ **25.125 Dry Runway Landing Distance:**



- Air distance from 50 ft height at threshold to TD may be normalized to 3.5° glideslope and 8 ft/s touchdown sink rates (considering parametric method) if the landing distances are to be used in conjunction with adequate operational factors.
- Stopping segment based on maximum manual braking on a dry runway
- No Reverse Thrust
- ISA temperature, smooth, level runway (temperature & slope accountability not required, but provided today by some manufacturers)
- Reference landing speed (V_{REF}) at threshold

Dry Runway operating standards:



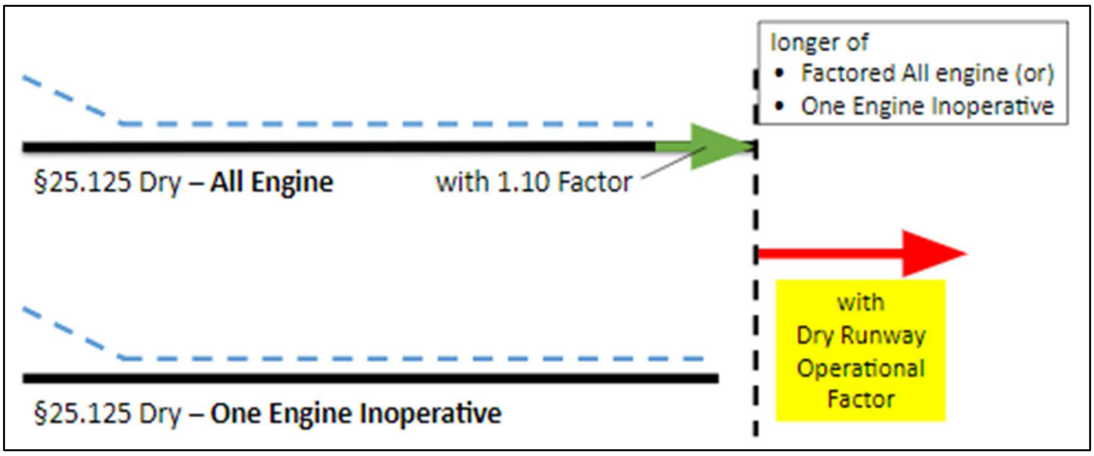
Dry runway landing distance operational factors

- 1/0.6 for part 121/135
- 1/0.7 for part 121/135 turboprops at alternate airports
- 1/0.8 for part 135EOD/91K

Note: Current certifications methods for air distance, temperature and speed accountability vary by manufacturer.

B. Recommended new §25.125 Dry runway landing distance and operating standards

Proposed § 25.125 Dry Runway Landing Distance:



- Air distance from 50 ft height at threshold to TD may be based on 3° glideslope and 3 ft/s touchdown sink rates (considering parametric method)
- Stopping segment based on brake application on a dry runway (covering maximum braking)
- Credit for Reverse Thrust
- Full temperature envelope accountability
- Runway slope not considered
- AFM provides distances for range of operating threshold speeds above reference landing speed (V_{REF})

The factor K= 1.10 on the all-engines-operating distance covers the following:
- Downhill runway slope (uphill slope reduces distance). Typically, a downhill runway slope of 2% will increase the landing distance by a factor of 1.02 to 1.03.
- Ensure a minimum safety margin for part 91 dry runway operations for which no operational factors are required

The addition of a 1.10 factor for the all-engines-operating landing distance makes the dry landing distance definition similar to the wet runway landing distance calculation per Topic 9 (and similar to the takeoff distance calculation), where a factored all-engines-operating distance is compared to an unfactored one-engine-inoperative distance.
The one-engine-inoperative distance is un-factored in the proposed § 25.125 since there is a very low probability of losing an engine on final approach and landing on a significant downhill slope.

Recommended landing distance operational Factors (referred to as "K2"):
- 1.20 recommended for part 121/135
- 1.09 recommended for part 121/135 turboprops at alternate airports
- 1.09 recommended for part 135EOD/91K

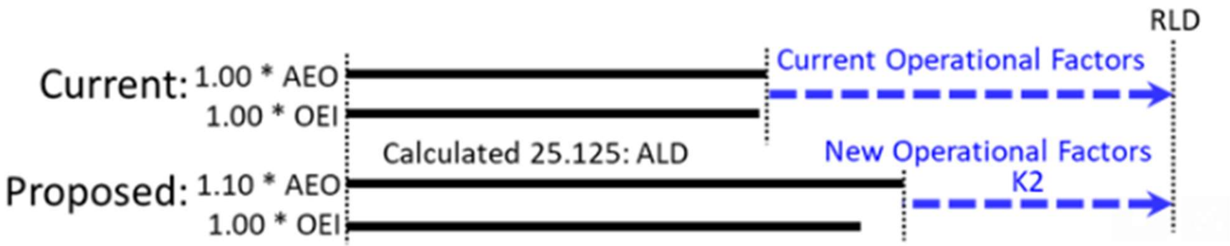
Justification of the new operational factors is provided in the following sections C/D/E/F/G.

C. *Overview of the relative positions between current and proposed landing distances*

The schemes hereunder show the relative position between the current and proposed landing distances, at dispatch and time of arrival, illustrating some of the deliberations leading to the FTHWG proposed operational factors identified as "K2". The following abbreviations are used:

- AEO – All engines operating
- OEI – One engine inoperative
- OLD – Operational Landing Distance
- FOLD – Factored Operational Landing Distance (equivalent to LDTA, Landing Distance at Time of Arrival, with 15% safety margin)
- ALD – Actual Landing Distance (§ 25.125)
- RLD – Required Landing Distance (§ 25.125 with operational factors)

Proposed RLD relative to Current RLD



Currently, the Actual Landing Distance (ALD) may be based on:

- reference landing speed (V_{REF}) at threshold
- performance flare (-3.5° glide slope, 8 ft/s sink rate at touchdown)
- demonstrated pilot transition times
- demonstrated braking mu
- no reverse thrust
- standard-day temperature

The proposed ALD is based on:

- actual landing speed at threshold per AFM procedure
- operational flare (-3.0° glide slope, 3 ft/s sink rate at touchdown)
- demonstrated pilot transition times
- 95% demonstrated braking mu (if test done on a clean portion of the runway)
- reverse thrust credit permitted
- temperature accountability

The proposed ALD includes a factor of 1.10 on the AEO distance. 1.10 times the all-engines-operative distance can generally be expected to be longer than the unfactored OEI distance, unless the specific design of the airplane produces large engine-dependent effects on the deceleration capability.

Proposed RLD relative to Time of Arrival

The current Operational Landing Distance (OLD) is based on (TALPA ARC recommendations or FAA AC25-32):

- actual landing speed at threshold per AFM/operational procedure
- operational flare (7 s and 4% speed bleedoff or other if test operationally representative)
- operational pilot transition times
- 90% demonstrated braking mu (if test done on a clean portion of the runway)
- reverse thrust credit permitted
- actual temperature accountability
- runway slope accountability

The current OLD (from TALPA ARC recommendations or FAA AC 25-32) approximately matches the proposed ALD based on the AEO distance factored by 1.10.

The proposed OLD from Topic 32 is about 6% shorter than the current OLD. This proposed OLD is based on:

- actual landing speed at threshold per AFM/operational procedure
- operational flare (7 s and 4% speed bleedoff or other if test operationally representative, up to -3° glide slope and 3ft/s sink rate at touchdown, see Note 2)
- operational pilot transition times
- 95% demonstrated braking mu (if test done on a clean portion of the runway)
- reverse thrust credit permitted
- actual temperature accountability
- runway slope accountability

The current and the proposed OLD are factored by 1.15 (as per TALPA ARC part 121 subcommittee transmitted files, AC 91-79A, SAFO 19001, FAA order 8900.1 CHG 470 or FTHWG Topic 32 report) to determine the Factored Operational Landing Distance (FOLD).

Note 1:
An excerpt of the TALPA ARC part 121 subcommittee transmittal files providing a rationale for the 1.15 factor is given in Appendix 3.

Note 2:

The following is stated in FTHWG Topic 32 report, revised advisory material for determination of the proposed OLD airborne distance:
"If the air distance is determined directly from flight test data (…) the flight test data should meet the following criteria:
(…) 9.2.4.3 The touchdown rate of descent should be in the range of 1 to 4 feet per second"
Therefore, the criteria retained for the proposed ALD air phase (-3.0° glide slope, 3 ft/s sink rate at touchdown) fit with the proposed OLD airborne distance criteria from Topic 32, enabling to potentially retain the same airborne distance for the proposed ALD and OLD.

The estimated 6% distance reduction of the proposed OLD in comparison to the current OLD is composed of the two following elements:

- -4% coming from an air distance determined considering operational flight tests with data reduction to -3° glide slope and -3ft/s touchdown sink rate, instead of considering 7s duration and 4% speed bleedoff
- -2% coming from considering 95% of the demonstrated braking mu instead of 90%

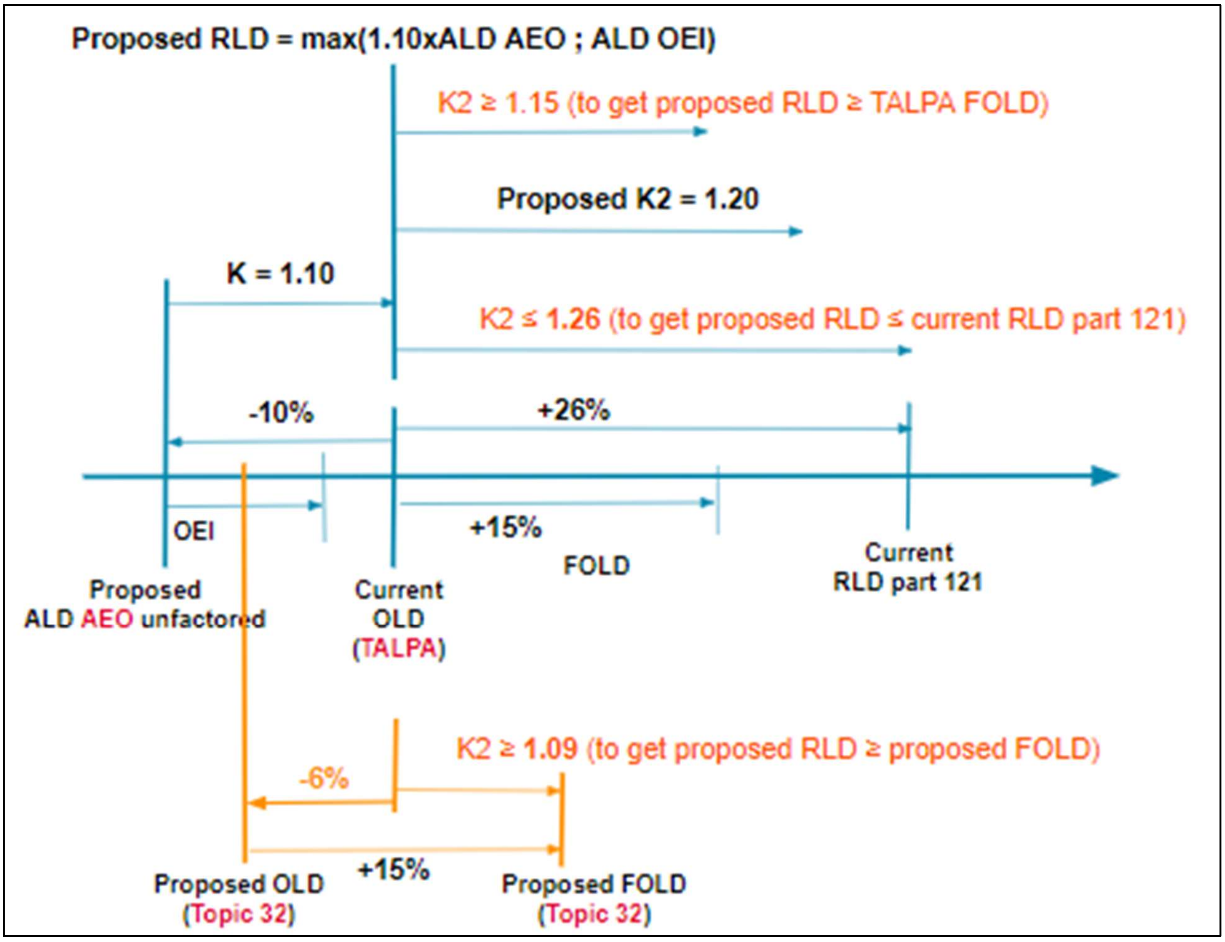
D. Overview of the ALD, RLD, OLD, FOLD relative positions

Considering that the landing distance at dispatch should be determined to ensure a safe landing for anticipated landing conditions, it would be expected that the conditions to satisfy for dispatch should be at least as demanding as landing conditions which may be adjusted at time of arrival.
If the assumption is made that the landing distance at dispatch (factored RLD) is to be longer than the landing distance at TOA (proposed FOLD) based on the proposals from Topic 32, this leads to a minimum value of K2 factor of 1.09 (see figure below).

In addition, for part 121/135 operations, considering an objective to maintain the current factored required landing distances (RLD) at dispatch, this would lead to a K2 factor of not more than 1.26 (and a minimum of 1.15) for standard-day temperatures. Finally, considering also that the current 1.67 operational landing distance factor is intended to cover temperature effects and runway threshold speeds faster than V_{REF} (which are not required to be accounted for in current § 25.125 landing distances, but is accounted for in the proposed standard), a new landing distance operational factor of 1.20 is proposed, leading to factored RLD being consistent with current RLD for hot-day conditions.

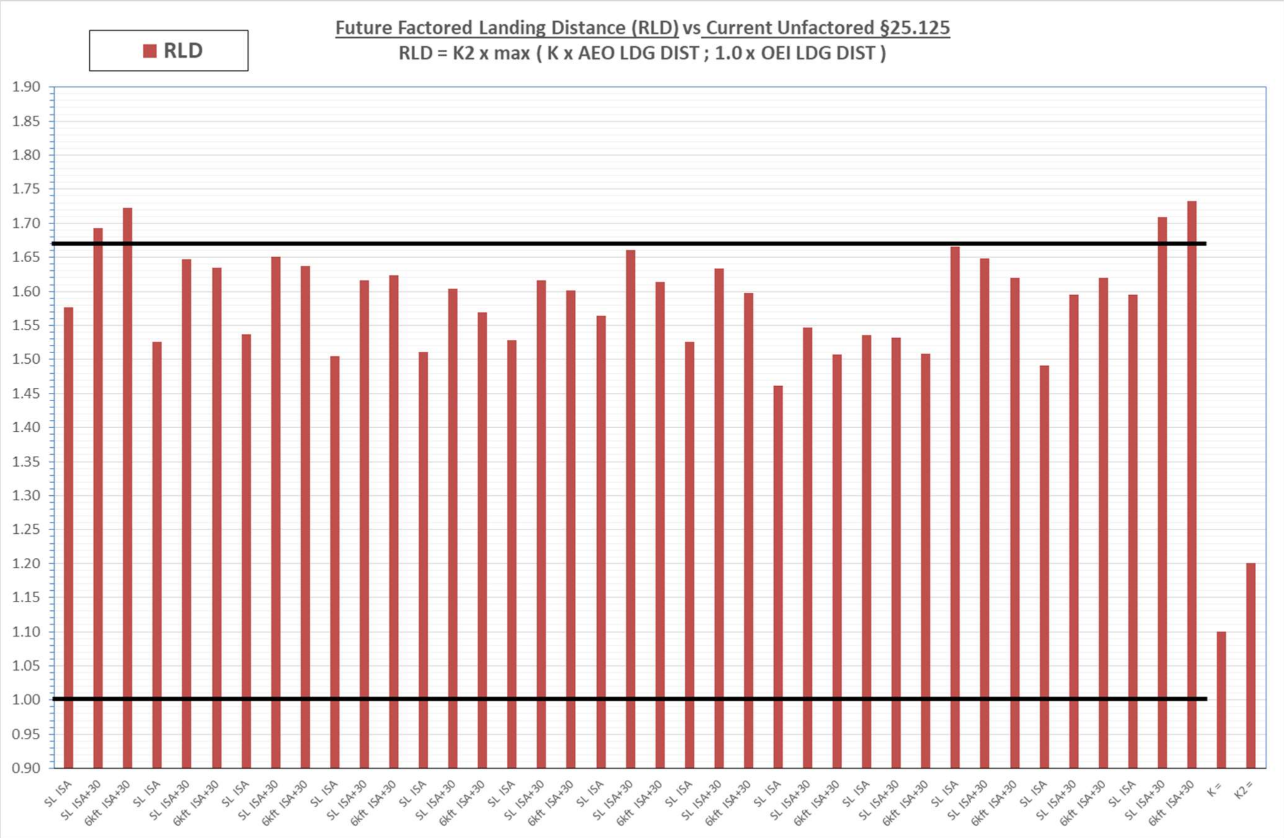
For turbopropeller airplanes and alternate airport dispatch planning currently using an operational landing distance factor of 1/0.7 = 1.43, this same objective would lead to a K2 factor around 1.05. This value is lower than the minimum 1.09 factor which ensures distances at dispatch are longer than new factored operational landing distances at TOA. Therefore, for those operations, a K2 factor of 1.09 is proposed.

For operations with a reduced operational factor, this same objective would lead to a K2 of not more than 1.06. This value is lower than the minimum 1.09 value to be considered to ensure that landing distances at dispatch are longer than new factored landing distances at TOA. Therefore, for those operations, a K2 factor of 1.09 is proposed.



E. *Comparison of recommended operating standard (1.20)*Proposed § 25.125 to current 121/135 1.67*§ 25.125 dry runway landing distance*

The graph hereunder is based on a selection of aircraft for which current §25.125 distances have been built following AC25-7D guidance leading to short distances.
Some aircraft in this data set include a temperature effect in the AFM, leading to a rather flat distance trend with increasing temperature, while other aircraft do not include such a temperature effect, leading to a positive trend with temperature.



A column extending above the 1.67 line means that the proposed new landing distance at dispatch including the Operational Factor (1.20) results in a longer dry runway field length required for dispatch when compared to the current requirement based on § 25.125 landing distance with an operational factor of 1.67 (dry runway) which is the standard used for 14 CFR 121/135.

A column short of the 1.67 line means that the proposed new landing distance at dispatch including the Operational Factor (1.20) results in a shorter dry runway field length required for dispatch when compared to the current requirement based on § 25.125 landing distance with an operational factor of 1.67 (dry runway) which is the standard used for 14 CFR 121/135.

Reasons for the new distance being longer

- Certification methods– operationally unrealistic air distance certification method currently used by some manufacturers to show compliance with § 25.125
- No temperature accountability beyond ISA for current 25.125 compliance

Reasons for the new distance being shorter

- Certification methods – more operationally realistic air distance certification method currently used by some manufacturers to show compliance with § 25.125
- Current AFM may include temperature accountability beyond ISA

F. *Comparison of recommended operating standard (1.09)*Proposed § 25.125 to current 121/135 1.43*§ 25.125 dry runway landing distance for turbopropellers at alternate airport*

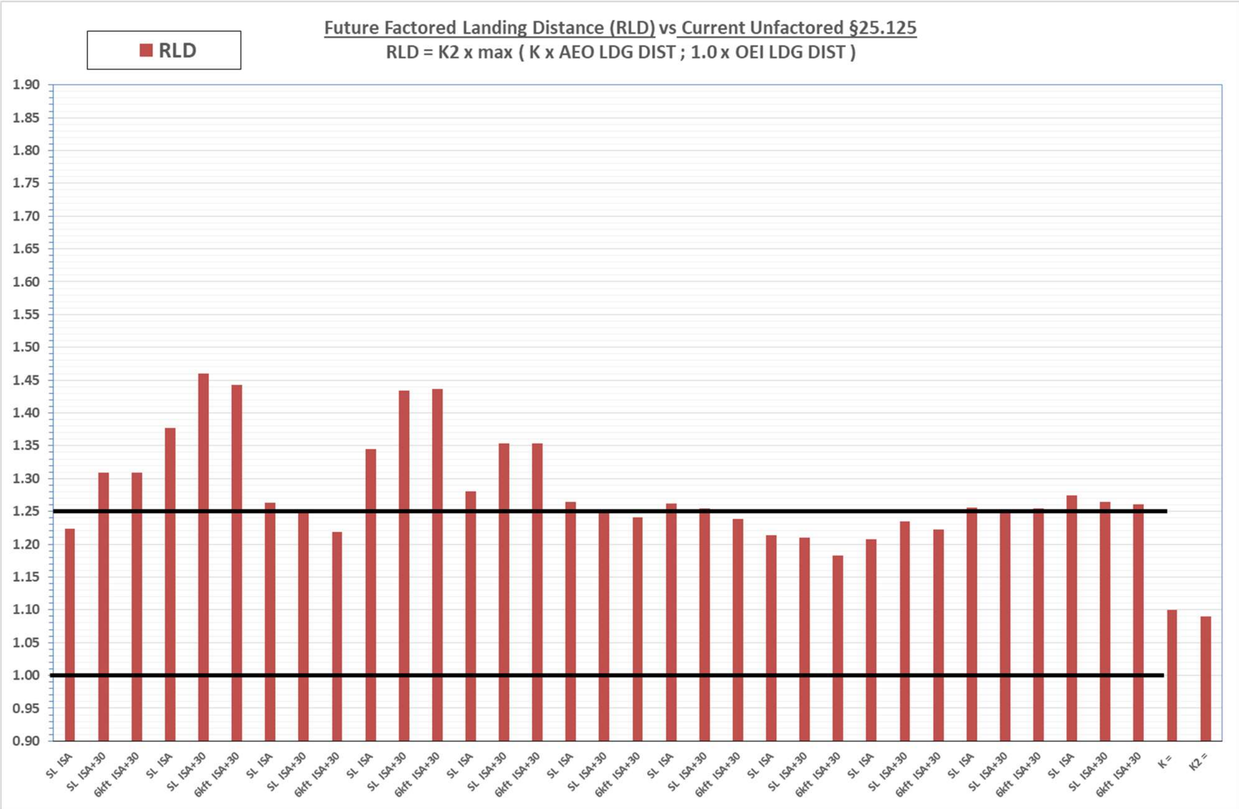
The graph hereunder is based on a limited selection of aircraft for which current §25.125 distances have been built following AC25-7D guidance leading to short distances.

Similarly, a column extending above (or short of) the 1.43 line means that the proposed new landing distance at dispatch including the Operational Factor (1.09) results in a longer (or shorter) dry runway field length required for dispatch when compared to the current requirement based on §25.125 landing distance with an operational factor of 1.43 (dry runway) which is the standard used for 14 CFR 121/135 turbopropellers at alternate airport.

The reasons for the new distance being longer or shorter are identical to the ones proposed in § E.

G. *Comparison of recommended operating standard (1.09)*Proposed § 25.125 to current 91K/135EOD 1.25*§ 25.125 dry runway landing distance*

The graph hereunder is based on a selection of aircraft (business jets typically) for which current § 25.125 distances have been built for some of them following more operational hypotheses than proposed in AC25-7D guidance leading to unfactored distances longer than in § E and § F. In addition, most aircraft in this data set include a temperature effect in the AFM, leading to a rather flat distance trend with increasing temperature.



A column extending above (or short of) the 1.25 line means that the proposed new landing distance at dispatch including the Operational Factor (1.09) results in a longer (or shorter) dry runway field length required at dispatch when compared to the current requirement based on § 25.125 landing distance with an operational factor of 1.25 (dry runway) which is the standard used for 14 CFR 91K/135EOD.

For the majority of the cases, columns are close to the 1.25 line, meaning that the new landing distance at dispatch is close to the current dispatch landing field length requirement. The peak columns correspond to a few aircraft for which a reduced operational factor was applied to an operationally unrealistic § 25.125 distance.

Consensus/Comment/Dissent

Consensus

There is consensus that an improved dry runway landing distance regulation with more operationally representative assumptions is appropriate and is needed to align with the principles adopted in the FTHWG recommendations for wet runway landing distance, as already stated in the Topic 9 report.

There is also a consensus, for the sake of simplification and understanding, there should be an option to use consistent unfactored landing distance data at dispatch and time of arrival, considering that the new proposed § 25.125 landing distance used for dispatch planning will be an operationally achievable landing distance as is the landing distance at time of arrival.

The recommended changes to the § 25.125 dry runway landing distance requirements are presented in Appendix 1.

The FTHWG highlights the fact that there are common assumptions in the 3 following FTHWG topics dealing with landing performance:
- Topic 9 – Wet Runway Stopping Performance
- Topic 32 – Codification of Part 25 TALPA
- Topic 33 – Landing Distance on Dry Runway

Those common assumptions are described as follows:

It is proposed to keep the same structure as for the proposed wet runway landing distance as in the Topic 9 report, that is to say the dry landing distance is to be the result of the longer of an all-engine operating landing distance (multiplied by a factor of 1.1) and a one engine inoperative landing distance (unfactored). Consistent with the Topic 9 proposal, the effect of ambient temperature on landing distance is to be included in the furnished landing distance data, but not the runway slope.

Concerning the airborne distance, the group agreed that the same proposal as the wet landing distance from Topic 9 should be used, considering that the air phase distance does not depend on whether the runway is dry or wet.

The transition times for application of manual deceleration devices were reviewed, in particular further to the possibility to take credit of the thrust reversers for the § 25.125 landing distance (see after). The current and proposed guidance show different transition times for AFM data expansion:
- FAA AC 25-7D calls for considering the selection of each device in sequence, and take for AFM data expansion the longer of 1 second and the tested time for the § 25.125 landing distance
- FTHWG Topic 9 recommends, for the proposed RLD wet, to keep the FAA AC 25-7D guidance, except for the thrust reversers. The time for the reverse thrust selection will depend on the landing procedure. If the procedure is to deploy the reversers at nose gear touch down,

the time to consider is the longer of 1 second and the tested time. If it is to deploy the reversers prior to nose gear touch down, the time to consider should be the demonstrated time plus 1 second.
- FTHWG Topic 32 recommends for the TOA landing distances to consider the time sequence to depend on the procedure relative to nose gear touch down for all the deceleration devices. If the procedure is to select the device at nose gear touch down, the time to consider is the longer of 1 second and the tested time. If it is to select the device prior to nose gear touch down, the time to consider should be the demonstrated time plus 1 second.

The group decided to propose the guidance provided in FAA AC 25-7D to be applied also to the time sequence for the thrust reverser selection (longer of 1 second and the demonstrated time). Even if this may not be harmonized with the TOA landing distances, it was considered that this maintains consistency with the current guidance given in AC 25-7D and avoids adding complexity related to nose landing gear touchdown. In addition, it corresponded to the assumptions used to decide on the operational factors which were considered adequate without a need for longer transition times for the deceleration device selections. The group also considered that Topic 9 may need to be re-opened to make recommendations consistent with this topic.

Moreover, for the landings with brake application prior to nose gear touch down, some manufacturers considered that the current AC 25-7D wording is not adequate. The group agreed to recommend modification of the AC 25-7D guidance to reflect the fact that the aircraft should be consistently derotated, using a normal piloting technique, avoiding an excessive nose gear touch down rate.

The level of the braking coefficient for dry runway landing distance calculations was subject to significant discussion, associated to the question of how to perform the tests. Two test practices were identified, either test on a clean part of a runway or test "operationally", i.e. test on a part of the runway with representative amount of rubber and paint stripes. Four different options were discussed, and were proposed for a vote:
- Perform the tests on a clean part of the runway and keep 100% of the tire-to-ground braking coefficient from the flight tests
- Perform the tests on a clean part of the runway and apply 5% or 10% of conservatism of the tire-to-ground braking coefficient from the flight tests
- Perform the tests on a part of the runway with representative amount of rubber and paint stripes and keep 100% of the tire-to-ground braking coefficient from the flight tests
- Perform the tests on a clean part of the runway and apply 5% or 10% of conservatism to the tire-to-ground braking coefficient from the flight tests, OR perform the tests on a part of the runway with representative amount of rubber and paint stripes and keep 100% of the tire-to-ground braking coefficient from the flight tests (called "TALPA" option)

The vote led to tight results, but the last option was retained with a 5% conservatism on the braking coefficient, since it was the only option that would not lead to any dissent in the group.

Thus, the level of the braking coefficient for the landing distance calculation is proposed to be the following:
- Landing distance data should be calculated with a 5% conservatism applied to the friction-limited dry runway tire-to-ground braking coefficient when that braking coefficient was

determined through testing on a clean runway, or by intentionally avoiding rubber contaminants and paint stripes. The torque-limited portion of the braking performance curve does not vary with the specific runway condition and need not be adjusted.

- 100% of the measured tire-to-ground braking coefficient may be used if the testing was conducted on portions of runways containing operationally representative amounts of rubber contamination and paint stripes.

This is in line with the recommendations from the original TALPA ARC in 2009, but with the difference that the TALPA ARC selected an arbitrary value of 10% conservatism in the friction-limited braking coefficient instead of 5% being recommended. It was considered by the TALPA ARC that its proposal would not have any significant economic impact. While no economic study has been conducted for this report, the group has indications that the same cannot be said for the economic and operational impacts for this topic since the level of performance at dispatch on dry runways can be important commercially as it may limit the payload capability for a given mission. Therefore, further investigation of the effects of rubber contaminants and paint stripes on dry runway braking performance was undertaken.

Airbus was able to provide several examples of the incremental effects of rubber contamination and paint stripes on effective dry runway braking. 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, and 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 to be a substitute for overall operational factors intended to address operational variability in landing distance.

The Topic 32 recommendation report was harmonized with Topic 33 after reviewing the above industry data, changing the 10% factor from the TALPA ARC proposal to 5%, for simplification and commonality between the dry runway landing distance used for dispatch with that used at TOA. This proposal will offer simplification and commonality of dispatch and TOA braking 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.

There was consensus that deceleration credit for available thrust reversers should be allowed, so as to be consistent with landing distances defined in the recommendation reports for Topics 9 and 32.

Nonetheless, there was significant discussion regarding the criteria to be satisfied in order to allow the deceleration credit for thrust reversers.

The FTHWG noted the difference in the way the "safe and reliable" requirement for reverse thrust credit is expressed between:

- EASA CS 25.109(e)(1) and AMC 25.109(f) [rejected takeoff], which provides a minimum reliability criterion of 1 per 1000 selections.
- FTHWG Topic 9 and 32 reports and the TALPA ARC report, which provide a minimum reliability criterion of 10^{-4} or less per landing.
- AC 25-7D for 25.109(f), which specifies that compliance with the requirements of §25.901 and §25.1309 is accepted as providing compliance with "safe and reliable" requirements.

The following options have been considered by the FTHWG for allowing reverse thrust credit:

- Provide a reference to AC 25-7 § 25.109(e)(f) guidance, similar to what was adopted by EASA for AMC 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. It is also closely aligned with the criteria used in some recent Part 25 certifications.

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.

The FTHWG also observed an inconsistency with the adoption of thrust reverser performance credit and the existing AC 25-7D Automatic Braking Systems material included in section 15.4.9 of AC 25-7D and referenced in section 4.11.6. The group recommends that the FAA updates AC 25-7D section 15.4.9 to be compatible with the intended thrust reverser landing performance credit proposed in this report, as well as that of the Topic 9 Wet Runway Stopping Performance and Topic 32 Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA) reports.

The group also discussed a potential introduction of guidance on acceptable surface texture of the runway used for the tests. It was considered that the state of the art on the micro-texture and macro-texture effect on the dry braking coefficient was not mature, but that heavily textured surfaces should be avoided. It was also concluded to not introduce any guidance on the possibility to perform the tests on a grooved or PFC runway. This is left to the local Authority decision.

There were discussions about the method used to fair (curve-fit) the braking test data, and it appeared to be different between manufacturers and their local Authorities, potentially leading to a non-level playing field. It seems that the guidance to fair the data on the conservative side of the test results from some Authorities was intended to address potential operations with reduced or no landing distance operational factor. Considering that the landing distances established in accordance with the recommendations of this report include operationally representative air distances and transition distances, it was considered appropriate that data may be faired based on a curve-fit close to an average of the test data. Some updates of AC 25-7D are proposed with this objective (Refer to Appendix 2).

The group also discussed accounting for speed additives to V_{REF} when calculating the dispatch landing distance. Current regulations only require accounting for the landing distance following an approach and landing at the speed based on § 25.125(b)(2), however, AFMs, training and other operational procedures may lead to landings at speeds above V_{REF}. The current landing distance operational factors have been sufficient to cover increased operational landing speeds that may or may not have been used to calculate the dispatch landing distance. Consistent with Topic 9, the proposed landing distance operational factors (recommended for use with the proposed operationally representative § 25.125 landing distance) are reduced, and are no longer intended to account for speed additives above V_{REF} at the threshold. Therefore, the AFM shall provide dry runway landing distances for speeds above non-icing V_{REF}, up to at least V_{REF}+10 kt. In addition, it is proposed that landing distances for higher speeds must be determined if speeds greater than V_{REF} +10 (considering non-icing and icing conditions) are recommended by normal procedures.

There was a consensus that some flight tests were needed to substantiate the speed effect on the air phase. Nonetheless, considering that 5 knots above V_{REF} is often considered in the regulation and guidance as something not significant, it was proposed to request flight tests only if the speed additive is more than 5 knots above the non-icing V_{REF} for reason other than wind. According to the current and proposed regulations, wind accountability for landing performance is conservative (both for tailwind and headwind). In addition, flight testing in high wind conditions and turbulence is contrary to performance test practices. The proposed advisory material for AC 25-7 in paragraph 4.11.1.3 of Appendix 2 identifies the need to conduct such testing for increased landing speeds that are more than 5 kt above the non-icing V_{REF}, including any V_{REF} speed increase required for landing in icing conditions. AC 25-7 does not address the means of compliance for Subpart B regulations in icing conditions; rather that advisory material is contained in AC 25-25A. AC 25-25A indicates that the landing distance for any V_{REF} speed increase in icing conditions can be determined by a suitable analysis, suggesting that no flight test validation of that analysis is needed. It is recommended that the FAA review and revise the content of AC 25-25A for determination of § 25.125 dry runway landing distance when increased landing speeds are required based on the recommendations made for AC 25-7 in paragraph 4.11.1.3. Additionally, the FAA should consider including wet runway and time-of-arrival landing distance considerations based on the recommendations of the Topic 9 and Topic 32 reports, respectively.

The group debated on how to accomplish task 2 as this task concerned operational rules. A review of the operational context in which those landing distances defined in task 1 are to be applied, would require attendance of regulatory specialists with appropriate expertise of the operating rules.

Such an enlarged attendance was not foreseen in the work plan of Topic 33. How the revised operating standards should be established and implemented will have to be determined by a competent working group or body as a subsequent activity.

Therefore, the group agreed to answer to task 2 by only proposing new operational factors, set to make new factored landing distances close to current ones.

Comments

TCCA comment

There is a variety of runway construction materials and surface treatments resulting in a range of runway surface textures. Runway surface texture (micro and macro) can have a significant effect on the tire/ground friction coefficient and consequently braking force. Consideration of runway surface texture should be part of the decision of where to conduct braking performance testing to ensure results representative of typical operations. Airport maintenance records can be reviewed to ascertain that a runway surface friction condition is appropriate for conducting braking evaluations. AC 150/5320-12C provides guidance for maintenance frequency to maintain adequate surface friction condition.

Gulfstream comment

The proposed § 25.125(d) requires that dry runway landing distance be determined for speeds from the non-icing V_{REF} to the maximum threshold speed recommended by normal AFM procedures (not less than 10 kt above the non-icing V_{REF}). The proposed § 25.125(c)(2)(ii) establishes the minimum V_{REF} speeds to be scheduled and used for landing in icing conditions (note that § 25.125(c)(2)(ii)(C) does not have a 5 kt threshold on the potential increase in V_{REF} for landing in icing conditions). Because the AFM procedures for operating in icing conditions are Normal Procedures, the effect of any increased landing threshold speed on landing distance when operating in icing conditions must be determined per the proposed § 25.125(d). The current and proposed § 25.125(a)(2), however state that landing distance need not be determined for landing in icing conditions if the threshold speed increases for icing conditions from § 25.125(c)(2)(ii) are within 5 kt of the non-icing V_{REF} at the maximum landing weight. This coverage for potential landing speed increases in § 25.125(a)(2), necessary for the current regulation where there is otherwise no speed accountability above V_{REF}, is no longer needed with the inclusion of the speed effect accountability in the proposed § 25.125(d) for any increase in landing threshold speed, including for icing conditions. Additionally, as § 25.125(d) has no 5 kt threshold where the effects of landing speed additives can be excluded from landing distance determination, the related content in § 25.125(a)(2) appears to be in conflict with the proposed § 25.125(d) for V_{REF} increases in icing conditions of 5 kt or less (at MLW). Gulfstream proposes the following change to § 25.125(a)(2) as an alternative to the majority position:

§ 25.125 Landing – (a) & (b)

(a) The horizontal distance necessary to land and to come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface must be determined (for ~~standard~~ ambient temperatures, at each weight, altitude, and wind within the operational limits established by the applicant for the airplane).

(1) In non-icing conditions; and
(2) In icing conditions with the most critical of the landing ice accretion(s) defined in Appendices C and O of this part, as applicable, in accordance with §25.21(g)~~, if V_{REF} for icing conditions exceeds V_{REF} for non-icing conditions by more than 5 knots CAS at the maximum landing weight.~~

Dissents

None.

APPENDIX 1 - PROPOSED STANDARDS AND RATIONALE

This section will provide the recommended 14 CFR part 25 airworthiness standard modifications, the specific topics that associated advisory material should address, and the rationale for the standard. When evaluating these recommendations, it is important to be cognizant that the certified landing distance data required by the proposed standards are to be used with landing distance operational factors that are proposed as recommendations by the working group for the 14 CFR parts 121/135/91K operating requirements and their equivalent for EASA, TCCA, and other civil aviation authorities. The operating requirements recommendations section immediately follows this initial section for the new 14 CFR part 25 regulation recommendation.

The proposed standard is in the first column shown as a markup of the current standard, while the second column documents the changes and any specific comments. Following the specific section are the rationales for the recommendations and need for advisory material. Note: new proposed regulations are shown in red text. Black text indicates existing 14 CFR verbiage.

It is proposed to modify § 25.125. This modification is based on the new § 25.126 proposed in the Topic 9 report, modified as appropriate for landing and stopping on a dry runway.

For this solution to be complete, significant information must be included in advisory material; for part 25 flight testing and accepted means of compliance, this is in AC 25-7X.

For dispatch planning purposes, the landing distance margin available is a function of both the part 25 requirements and the part 121, 135, and 91K operational factors. As such, it is important that a change to the part 25 is accompanied by a corresponding change to the operating requirements.

NEW RECOMMENDED 14 CFR PART 25 REGULATIONS

Regulation	Comments
§25.125 Landing	The requirements for seaplanes and skiplanes in 14 CFR part 25 are retained, which is not harmonized with the scope of CS-25 that does not include that content. Landing on wet runway case is separately covered in § 25.126 proposed by the Topic 9 – Wet Runway Stopping Performance report.
Rationale	

Regulation	Comments
§25.125 Landing – (a) & (b)	
(a) The horizontal distance necessary to land and to come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface must be determined (for ~~standard~~ ambient temperatures, at each weight, altitude, and wind within the operational limits established by the applicant for the airplane). (1) In non-icing conditions; and (2) In icing conditions with the most critical of the landing ice accretion(s) defined in Appendices C and O of this part, as applicable, in accordance with §25.21(g), if V_{REF} for icing conditions exceeds V_{REF} for non-icing conditions by more than 5 knots CAS at the maximum landing weight.	Ambient Temperature Standard temperature has been changed into ambient temperature to be closer to physics and be consistent with landing distance of wet runway recommendation of Topic 9. Some manufacturers have accounted for ambient temperature and slope in their Airplane Flight Manual to support operations that may not require a minimum operational factor for dispatch planning (14 CFR part 91). With this proposed change, manufacturers will have to provide data taking into account ambient temperature.
(b) The distance determined in paragraph (a) must be the longer of: (1) 110% of the landing distance with all engines operating. (2) The landing distance assuming the critical engine becomes inoperative during landing.	Landing Distance (b) is new to introduce a new standard for landing distance. The intention is to get a requirement consistent with the proposed § 25.126 in the Topic 9 – Wet Runway Stopping Performance report. It leads to a landing distance requirements structure similar to the takeoff distance requirements where a factored all engine distance is compared to an unfactored engine inoperative distance. This new distance definition addresses the engine failure accountability currently contained in § 25.125(g). Having a 110% factor on the all-engine landing distance on (b)(1) is consistent with the factor proposed in Topic 9. The part 25 calculation for landing distance with engine failure assumes an engine failure at or after the runway threshold (50 ft). This calculation takes into account any system effect on control and stopping devices whose effectiveness is reduced due to an engine failure. Examples are typically hydraulics and their effect on speed brakes, wheel braking and reverse thrust. Including this condition as a direct calculation removes the need for a paragraph similar to current § 25.125(g) which refers to accounting for the effect of a "noticeably increased" landing distance due to an engine failure.

	The airspeed and configuration of the one engine inoperative landing distance are the same as the all-engines landing distance.

Rationale

Temperature accountability:
The group consensus was that a physics-based dry runway rule should include ambient temperature accountability. This will result in a more consistent margin across the operating environment, consistent with the Topic 9 proposal.

Factoring the all-engines-operating calculation:
The addition of a 110% factor to the all engines landing distance makes the dry landing distance definition similar to the takeoff distance calculation where a factored all-engines distance is compared to an unfactored one engine inoperative distance.

In addition, the 110% all engines factor also provides partial coverage of downhill slope. Uphill slope reduces distance and does not need to be considered. Removing runway slope considerations simplifies the dry runway distance calculation (see section § 25.125(e)) and avoids related operational dispatch issues.

Including a 110% factor in part 25 also ensures a minimum safety margin for part 91 dry runway operations for which no operational factors are required.

Engine failure accountability:
Since the probability of an engine failure occurring during landing is very low, it was not necessary to have a specific part 25 factor on this calculation. There is still an operational factor that will be applied to the longer of the two landing distances of § 25.125(b) for operations other than part 91. Similarly, downhill slope effect does not need to be considered on the unfactored engine failure distance required for dispatch since the on-ground distance effect is very small and is typically covered by operational factors/margins.

Advisory material

Advisory material in AC 25-7X will establish the methods of determining air distance, transition distance, braking, reverse thrust accountability considerations, etc.

Regulation	Comments
§25.125 Landing – (c) & (d)	§ 25.125(b) was renumbered (c).
(c) In determining the distance in paragraph (a) of this section: (1) The airplane must be in the landing configuration. (2) A stabilized approach, with a calibrated airspeed of not less than V_{REF}, must be maintained down to the 50-foot height. (i) In non-icing conditions, V_{REF} may not be less than: (A) 1.23 V_{SR0}; (B) V_{MCL} established under §25.149(f); and (C) A speed that provides the maneuvering capability specified in §25.143(h). (ii) In icing conditions, V_{REF} may not be less than: (A) The speed determined in paragraph (c)(2)(i) of this section; (B) 1.23 V_{SR0} with the most critical of the landing ice accretion(s) defined in Appendices C and O of this part, as applicable, in accordance with §25.21(g), if that speed exceeds V_{REF} selected for non-icing conditions by more than 5 knots CAS; and (C) A speed that provides the maneuvering capability specified in §25.143(h) with the most critical of the landing ice accretion(s) defined in Appendices C and O of this part, as applicable, in accordance with §25.21(g). (3) Changes in configuration, power or thrust, and speed, must be made in accordance with the established procedures for service operation. (4) The landing must be made without excessive vertical acceleration, tendency to bounce, nose over, ground loop, porpoise, or water loop. (5) The landings may not require exceptional piloting skill or alertness.	No change in definition of the runway threshold speed.
(d) The dry runway landing distance must be determined from the V_{REF} defined to meet the requirements of §25.125(c)(2)(i) up to and including a minimum of 10 knots above the V_{REF} speed in non-icing conditions, V_{REF}+10. In addition, landing distances for higher speeds must be determined if speeds greater than V_{REF} +10 (considering non-icing and icing conditions) are recommended by normal procedures.	§ 25.125(d) Effect of Increased Threshold Speed Data must be provided for at least a 10 knot increase in airspeed at the threshold above the non-icing V_{REF}. In addition, if procedures recommend increases of speeds beyond 10 knots (e.g. for icing conditions, wind, auto-thrust etc.), data must be provided up to the maximum recommended landing speed. Some manufacturers provide

	guidance in non-certified documents which include increased threshold speed above V_{REF}. The proposed standard will require all manufacturers to provide this additional speed information in their AFM recognizing that the operator may choose to fly an airspeed above V_{REF} to the threshold either by the operator's policy or based on a recommendation by the manufacturer or per AFM procedure. An example of this would be a manufacturer who recommends flying a minimum airspeed of V_{REF} + 5kt for all operations or when autothrottle is engaged. Another example is adding speed in case of gusting wind.

Rationale:

Speed for landing distance calculation:

To support flying at an airspeed above V_{REF}, data should be presented up to the maximum recommended speed to be flown to the runway threshold (50-foot height for the purpose of computing landing performance) following these procedures for operation, both in icing and non-icing conditions.
This increase of approach speed consideration is in line with the physics-based approach that has been the objective for the redefinition of the dry and wet runway landing distances.

Advisory material

Advisory material is included to elaborate on maximum speed for which data should be presented.
Additionally, advisory material is included on the flight tests to be performed to verify the speed effect.

Regulation	Comments
§25.125 Landing – (e) (f) (g) (e) For landplanes and amphibians, the landing distance on land must be determined on a level, smooth, dry, hard-surfaced runway. In addition— (1) ~~The pressures on the wheel braking systems may not exceed those specified by the brake manufacturer~~ Wheel brake limits as specified by the brake manufacturer must not be exceeded. (2) The brakes may not be used so as to cause excessive wear of brakes or tires; and (3) Means other than wheel brakes, including the effects of reverse thrust, may be used if that means (i) Is safe and reliable; (ii) Is used so that consistent results can be expected in service; and (iii) Is such that exceptional skill is not required to control the airplane. (f) For seaplanes and amphibians, the landing distance on water must be determined on smooth water. (g) For skiplanes, the landing distance on snow must be determined on smooth, dry, snow.	§ 25.125(c)(d)(e) were renumbered (e)(f)(g) § 25.125(e)(1): Wheel brake limits may come from maximum hydraulic pressure or other torque or energy limits. § 25.125(e)(3): Credit of reverse thrust is a major evolution in the requirements. It is important to specifically identify reverse thrust because of the long history of the FAA not allowing reverse thrust for landing calculations. There is regulatory precedent for including reverse thrust in the calculation of landing distance; for example, the original UK CAA regulations and the UK CAA national variant of the JAR's. Specifically including reverse thrust is consistent with the change proposed for Topic 9 wet runway and the change in § 25.109 when wet runway wheel braking considerations were introduced in Amdt 25-92.

Rationale

§ 25.125 (e)

Level runway consideration:

A pure physics-based landing distance would include a slope correction at least for the ground portion of the calculation. During FTHWG Topic 9, there was extensive discussion on the slope effect resulting in reduced air distance with uphill slope or lengthened flare with downhill slope. During Topic 33, it was reminded that there was a lack of measurable data, and it was decided consistently with Topic 9 to not require specific slope accountability in the AFM calculation, provided that landing operations are restricted to no more than 2% downhill slope.
It was reminded also that air distance accountability for slope is part of other airport variables such as location, approach path angle and threshold height of the approach guidance used such as ILS and PAPIs. All these items affect the airplane's height as it crosses the threshold and may vary significantly from runway to runway with an additional variation on whether airports are built to ICAO Standards and Recommended Practices or US FAA regulation and guidance. These airport/runway operational variabilities are intentionally addressed by the landing distance operational factors imposed by the 14 CFR part 121/135/91K operating regulations.

The ground distance adjustment for runway slope is small, especially on a dry runway, plus this is a dispatch criterion where the specific landing runway may not be known. It was felt that a direct accounting of slope was not required as a § 25.125 calculation, and was adequately covered by the time of arrival landing distance check established by the Topic 32 recommendations. As discussed in the § 25.125(b) section, there is also some coverage for downhill slope effects within the 110% factor on all-engines landing distance.

§ 25.125(e)(1)

The wording was made more general than in the current standard to cover wheel brake systems that are not hydraulically actuated. The wording "brake ratings" was initially proposed as in Topic 9 to cover electrical brakes. It was finally removed since potentially not being understood and considering it was deemed to be included in the wording, "brake limits".

§ 25.125(e)(3)

FTHWG discussions and decisions included credit for reverse thrust on dry runways similar to the Topic 9 proposal for wet runways, and similar to what was done with 14 CFR 25.109 (wet runway rejected takeoff) in Amendment 25-92. All-engines reverse thrust credit is acceptable when computing all-engines landing distances and allowing reverser availability on the operating engine(s) when considering the engine failure scenario. Part of the impetus for giving credit for thrust reversers is to encourage manufacturers to implement effective reversers as an additional deceleration device on airplanes and ensure airplanes without thrust reversers have longer landing distance than airplanes with thrust reversers.

Advisory material

§ 25.125(e) - Braking coefficient
The guidance material will specify that the dry runway braking coefficient used in meeting § 25.125(e), if not brake torque limited, will be multiplied by 0.95 if the tests from which the braking coefficient was derived were not performed on a runway with a representative amount of rubber and paint stripes.

§ 25.125(e)(3) - Thrust reversers:
Aspects of what is "safe and reliable", procedural requirements etc. need to be specified in the advisory material.

Regulation	**Comments**
§25.125 Landing – (h) (h) The landing distance data must include correction factors for not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing, and not less than 150 percent of the nominal wind components along the landing path in the direction of landing. ~~(g) If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of compensating means will result in a landing distance not more than that with each engine operating.~~	§ 25.125(f) is unchanged except renumbered (h). § 25.125(g) is removed, since the consideration of both all-engine and one-engine-inoperative cases are part of the proposed standard (see § 25.125(b)).
Rationale § 25.125 (g) deletion The credit for reverse thrust as proposed in the new requirement increases the relevance of this paragraph. Nonetheless, this is covered by the basic consideration of the one-engine-inoperative case in the calculation as described in § 25.125(b)(2). This paragraph is therefore proposed to be removed.	

All references to § 25.125 paragraphs throughout 14 CFR part 25 will need to be checked and corrected when implementing this new standard.

PROPOSED DRY RUNWAY OPERATING STANDARDS

The total margin in a dispatch landing distance calculation is a combination of the 14 CFR part 25 defined landing distance and the operational safety margin applied by operating regulations. With the exception of basic part 91 operation, this has historically been a dry runway §25.125 defined landing distance factored by 1.67, 1.43, or 1.25 depending on operating regulation to obtain the dry runway landing distance required at dispatch.

To estimate the margin in the factored dry runway landing distance, the unfactored dry runway landing distance defined in § 25.125 increased by the operational safety margin needs to be compared to the Landing Distance at Time of Arrival (calculated assuming a maximum effort stop).

Turbojet/Turbopropeller Aircraft

In the existing FAA operating regulations, turbojet and turbopropeller airplanes have been required to meet different dispatch landing field length requirements for alternate airports. The recommended §25.125 is not specific to turbojet and turbopropeller aircraft. However, this report proposes adapted landing distance operational factors specific to each type of airplane.

List of operating rules concerned by the modification

- 60% rule - destination airports:

§121.195 (b) - Transport: Turbine Engine
§135.385 (b) - Dry runway operational factor - Transport: Turbine Engine
§91.1037 (b) - Large Transport: Turbine Engine (subpart K)

- 60% turbojet - 70% turboprop rule - alternate airports

§121.197 Airplanes: Turbine engine powered: Landing limitations: Alternate airports
§135.387 (a) Large transport: Turbine engine powered: Landing limitations: Alternate airports

- 80% rule - destination airports

§135.385 (f) Eligible on Demand - Large transport: Turbine engine: Landing limitations: Destination airports.
§91.1037 (c) Subpart K – Fractional Ownership - Large transport: Turbine engine powered; Limitations; Destination and alternate airports.

- 80% rule - alternate airports

§135.387 (b) Eligible on Demand - Large transport category airplanes: Turbine engine powered: Landing limitations: Alternate airports.
§91.1037 (d) Subpart K – Fractional Ownership - Large transport: Turbine engine powered; Limitations; Destination and alternate airports.

Recommended operational safety margins associated to new § 25.125

Whereas current operating rules consider margins referring to the landing distance available, the FTHWG expresses the new margins as factors to be applied on the actual landing distances as per §25.125.

The following operational factors are proposed:
- 1.20 recommended for part 121/135 (to replace current "60% rule")
- 1.09 recommended for part 121/135 turboprops at alternate airports (to replace current "70% rule")
- 1.09 recommended for part 135EOD/91K (to replace current "80% rule")

In this report, this factor is referred as "landing distance operational factor" or "operational factor".

Proposing and implementing the new operating standard

It is essential that the proposed new § 25.125 standard is applied concurrently with the new proposed landing distance operational factors associated to the different operating rules.

The FTHWG is aware that synchronizing modifications for both regulations will require some coordination with operational standard organizations. In addition, current operating standards must be retained to support airplanes with a certification basis prior to the introduction of the new § 25.125 proposed in this report. This means that future operating standards will need to simultaneously accommodate two part 25 airworthiness standards with different landing distance operational factors to maintain equivalent safety margins.

Although it was outside of the scope of the group's task to draft a new operating rule, the FTHWG offers to provide its expertise for this task. Nonetheless, this report does propose new landing distance operational factors.

In addition, concerning operations with a reduced operational factor, even if operational factors are the same in 14 CFR part 91K/135EOD and AIR OPS CAT.POL.A.255, FAA and EASA standards differ in the sense that operations following AIR OPS CAT.POL.A.255 are subject to operational constraints which are not present in 14 CFR part 91K/135EOD. Defining the operational context associated to a given operation was not within the group's task and should be performed by a competent working group chartered for this objective as a subsequent activity, including the implementation of the landing distance operational factors proposed in this report.

Finally, beyond implementing new standards for landing on dry runways, there is a need to implement new standards as proposed in FTHWG Topic 9 for landing on wet runways since the recommendations are consistent with those in this report. Topic 32 report recommendations need also to be concurrently implemented, to get a consistent regulatory package.

APPENDIX 2 – REVISED ADVISORY MATERIAL

AC 25-7D

Proposed modifications are shown in RED.

4.11 **Landing—§ 25.125.**

4.11.1 Explanation.

This guidance is intended to ensure that the resulting landing distances are operationally achievable, in particular by specifying flight test techniques more representative of operations, covering air, transition and ground braking phases. This differs from the guidance provided in previous versions of this AC, which may result in landing distances that are not operationally representative (but for which a large landing distance operational factor was then applied, e.g. as required by 14 CFR part 121 operational regulation).

To the greatest degree reasonable there is maximum overlap between the guidance material for §§ 25.125 and 25.126. In particular, accountability of thrust reversers is permitted.

4.11.1.1 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) to the position of the nose gear when the airplane is brought to a stop. (For water landings, a speed of approximately 3 knots is considered "stopped.") The beginning of the landing distance is referenced to the main gear because it is the lowest point of the airplane when the airplane is 50 feet above the landing surface. The end of the landing distance is referenced to the nose gear because it is the most forward part of the airplane in contact with the landing surface, and it should not extend beyond the certified landing distance. In this AC, the landing distance is divided into two parts: the airborne distance from 50 feet to touchdown, and the ground distance from touchdown to stop. The latter may be further subdivided into a transition phase and a full braking phase if the applicant prefers this method of analysis.

4.11.1.2 The minimum ~~allowable~~ value of V_{REF} is specified in § 25.125(c)(2)(i) and (ii) and § 25.126(c)(2)(i) and (ii). ~~It~~ This requirement is intended to provide an adequate margin above the stall speed to allow for likely speed variations during an approach in light turbulence and to provide adequate maneuvering capability. If the landing demonstrations show that a higher speed is needed for acceptable airplane handling characteristics, the landing distance data presented in the AFM must be based upon the higher reference landing speed per § 25.125(c)(2) and § 25.126(c)(2).

4.11.1.3 Landing performance data, as specified in § 25.125(d), § 25.126(d), from V_{REF} in non-icing conditions up to a minimum of 10kt above that V_{REF} must be determined. In addition, landing distances for higher speeds must be determined if speeds greater than V_{REF} +10kt are recommended by normal procedures (including icing and additives for wind, auto-thrust etc.). If normal procedures recommend the use of threshold speeds that are higher than the non-icing V_{REF} by more than 5 knots for reasons other than wind, flight tests should be performed at speeds covering the corresponding speed range. Further, if normal procedures recommend the use of approach speeds that are higher than

V_{REF} for reasons other than wind and deceleration to a lower speed at the landing threshold, flight tests should be conducted to ~~determine whether~~ verify that the recommended ~~V_{REF}~~ speeds are readily achievable at the landing threshold. ~~If VREF is not readily achievable, then the AFM landing distances must include the effect of the excess speed at the landing threshold.~~

4.11.1.4 The engines should be set to the high side of the flight idle trim band, if applicable, for the landing flight tests. The effect of any variation in the idle fuel flow schedule due to trim for engines with electronic fuel controllers is typically negligible (but any such claim should be adequately substantiated). Changes to the idle setting from anti-ice systems or bleed are not considered as trims.

4.11.1.5 The intent of the one engine inoperative calculation as specified in § 25.125(b)(2) and §25.126(b)(2) is multiple.

(i) Recognition and accountability of a potential engine failure at/or beyond the threshold (50 ft point).

(ii) As this calculation is intended to only account for engine failure at or after the 50-foot point, there is no difference in the speed or flap configuration from the planned normal all engines operating speed and flap configuration for this calculation. For propeller powered airplanes, the propeller of the inoperative engine should be in the position it would normally assume without any action taken by the pilot following an engine failure.

(iii) Any system that is degraded due to an engine failure needs to be taken into account with this calculation (e.g. effect on the hydraulic system that reduces wheel braking or speed brake deployment).

4.11.2 Procedures for Determination of the Airborne Distance.

Three acceptable means of compliance are described in paragraphs 4.11.2.1, 4.11.2.2 and 4.11.2.3 on the following page. The methods are based on the expected operational landing procedures for the specific airplane as required by § 25.101 (f) and (h), § 25.125 (c), and § 25.126 (c).

Note: If it is determined that the constraints on approach angle and touchdown rate-of-sink described in paragraphs 4.11.2.2 and 4.11.2.3 below are not appropriate due to novel or unusual features of the airplane's design, new criteria may be established. Such a change would be acceptable only if it is determined that an equivalent level of safety to existing performance standards and operational procedures is maintained.

4.11.2.1 ~~Experience shows an upper bound to the part 25 zero-wind airborne distances achieved in past certifications and, similarly, a minimum speed loss.~~

~~4.11.2.1.1 These are approximated by the following:~~

$$(\quad) = 1.55(\quad - 80)^{1.35} + 800\, h$$

$$h \quad = \quad -3$$

~~4.11.2.1.2 An applicant may choose to use these relationships to establish landing distance in lieu of measuring airborne distance and speed loss. If an applicant chooses to use these relationships, the applicant should show by test or analysis that they do not result in air distances or touchdown speeds that are nonconservative.~~

An accepted method for establishing an air distance consistent with the manufacturer's recommended operational procedures is to use the following:

Air Distance (feet) = 0.5 * (V_{50} +V_{TD}) *7*1.6878
Where V_{50} is the speed at 50 feet at the threshold, V_{TD} is assumed touchdown speed, both in knots of ground speed
7 = 7 seconds assumed from threshold to touchdown
1.6878 is the conversion from knots to ft/sec

This method is one method recognized in historical AC 121.195-1A, Operational Landing Distances for Wet Runways; Transport Category Airplanes and also adopted in AC 25-32, Landing Performance Data for Time-of-Arrival Landing Performance Assessments.

An applicant may choose to use these relationships to establish landing distance in lieu of measuring airborne distance. If an applicant chooses to use these relationships, the applicant should show by test or analysis that V_{TD} = 0.96 V_{50} does not result in non-conservative touchdown speeds.

4.11.2.2 If an applicant chooses to measure airborne distance or time, at least six tests covering the landing weight range are required for each airplane configuration for which certification is desired. These tests should meet the following criteria:

4.11.2.2.1 A stabilized approach, targeting a glideslope of -3° and an indicated airspeed corresponding to the speed at 50ft (V_{50}) ~~of V_{REF}~~, should be maintained for a sufficient time prior to reaching a height of 50 feet above the landing surface to simulate a continuous approach at this speed. During this time, there should be no appreciable change in the power or thrust setting, pitch attitude, or rate of descent. The average glideslope of all landings used to show compliance should not be steeper than -3°. Some tests should be conducted at V_{REF} plus a speed additive (e.g. V_{REF} +10) if necessary as per 4.11.1.3 of this AC.

4.11.2.2.2 Below 50 feet, there should be no nose depression by use of the longitudinal control and no change in configuration that requires action by the pilot, except for reduction in power or thrust.

4.11.2.2.3 ~~The target rate of descent at touchdown should not exceed 6 feet per second~~. The average rate of sink at touchdown should not exceed 3 feet per second ~~Although target values may not be precisely achieved, the average touchdown rate of descent should not exceed 6 feet per second~~ and the maximum rate of sink at touchdown should not exceed 6 feet per second.

4.11.2.3 If the applicant conducts enough tests to allow a parametric analysis (or equivalent method) that establishes, with sufficient confidence, the relationship between airborne distance (or time) as a function of the rates of descent at 50 feet and touchdown, the ~~part 25~~ §25.125 and § 25.126 airborne distances may be based on an approach angle of ~~-3.5°~~ -3.0°, and a touchdown sink rate of ~~8~~ 3 feet per second. (See paragraph 4.11.8 for an example of this analysis method.) ~~The parametric analysis method with these approach angle and touchdown sink rate values should only be used for landing distances for which the operational safety margins required by § 121.195(b) or (c), § 135.385(b), (c), or (f), or equivalent will be applied~~.

~~4.11.2.3.1 At a given weight, the air distance or air time established by this method should not be less than 90 percent of the lowest demonstrated value obtained using the target values for approach angle and touchdown sink rate specified in paragraph 4.11.2.3.2 below. Test data with approach angles steeper than -3.5°, or touchdown sink rates greater than 8 feet per second, should not be used to satisfy this requirement.~~

4.11.2.3.~~2~~1 In order to determine the parametric relationships, it is recommended that test targets span approach angles from -2.5° to -3.5°~~, and sink rates at touchdown from 2 to 6 feet per second~~. Sink rates at touchdown ranging from 1 to 6 feet per second are acceptable, with a majority of landings with sink rates at touchdown from 1 to 4 feet per second. Target threshold speed for the tests should be V_{REF}. Some tests should be conducted at V_{REF} plus a speed additive (e.g. V_{REF} +10) if necessary as per 4.11.1.3 of this AC.

4.11.2.3.~~3~~2 Below 50 feet, there should be no nose depression by use of the longitudinal control and no change in configuration that requires action by the pilot, except for reduction in power or thrust.

4.11.2.3.~~4~~3 If an acceptable method of analysis is developed by the applicant, a sufficient number of tests should be conducted in each aerodynamic configuration for which certification is desired to establish a satisfactory confidence level for the resulting air distance. Autolands may be included in the analysis but should not comprise more than half of the data points. If it is apparent that configuration is not a significant variable, all data may be included in a single parametric analysis.

4.11.2.3.~~5~~4 If an applicant proposes any other method as being equivalent to a parametric analysis, that method should be based on a developed mathematical model that employs performance-related variables such as power or thrust, attitude, angle-of-attack, and load factor to adequately reproduce the flight test trajectory and airspeed variation from the 50-foot point to touchdown. Such a mathematical model should be validated by a sufficient number of tests to establish a satisfactory confidence level, and be justified by a comparison of tested and calculated landing airborne distances.

4.11.2.3.~~6~~5 For a derivative airplane with an aerodynamic configuration that has been previously certificated, if new tests are necessary to substantiate performance to a weight higher than that permitted by the extrapolation limits of § 25.21(d), two landings per configuration should be conducted for each 5 percent increase in landing weight (but no more than a total of six landings should be needed). These may be merged with previous certification tests for parametric analysis, regardless of whether the previous certification was conducted by this method or not. If a new aerodynamic configuration is proposed, the guidance described in paragraph 4.11.2.3.~~4~~3 above, should be used.

4.11.2.3.~~7~~6 In calculating the AFM landing distances, the speed loss from 50 feet to touchdown, as a percentage of V_{50} ~~V_{REF}~~, may be determined using the conditions described in paragraph 4.11.2.3.

4.11.2.4 Whichever method is chosen to establish airborne distances, satisfactory flight characteristics should be demonstrated in the flare maneuver when a final approach speed of V_{REF}-5 knots is maintained down to 50 feet.

4.11.2.4.1 Below 50 feet, the application of longitudinal control to initiate flare should occur at the same altitude as for a normal "on-speed" landing; no nose depression should be made and power or thrust should not be increased to facilitate the flare.

4.11.2.4.2 All power/thrust levers should be in their minimum flight idle position prior to touchdown.

4.11.2.4.3 The normal flare technique should be used, resulting in a touchdown speed approximately 5 knots less than the touchdown speed used to establish the landing distance. The rate of descent at touchdown should not be greater than 6 feet per second.

4.11.2.4.4 This demonstration should be performed over a range of weights (typically at maximum landing weight and near minimum landing weight), or at the most critical weight and CG combination as established by analysis or other acceptable means.

4.11.2.4.5 These V_{REF}-5 knots landing demonstrations should not require the use of high control forces or full control deflections.

4.11.3 Procedures for Determination of the Transition and Stopping Distances.

4.11.3.1 The transition distance extends from the initial touchdown point to the point where all approved deceleration devices are operating. The stopping distance extends from the end of transition to the point where the airplane is stopped. The two phases may be combined at the applicant's option.

4.11.3.2 If sufficient data are not available, there should be a minimum of six landings in the primary landing configuration. Experience has shown that if sufficient data are available for the airplane model to account for variation of braking performance with weight, lift, drag, ground speed, torque limit, etc., at least two test runs are necessary for each configuration when correlation for multiple configurations is being shown.

4.11.3.3 A series of at least six measured landing tests covering the landing weight range should be conducted on the same set of wheels, tires, and brakes in order to substantiate that excessive wear of wheel brakes and tires is not produced in accordance with the provisions of § 25.125(~~c~~e)(2). The landing tests should be conducted ~~with the normal operating brake pressures for which the applicant desires approval~~ without exceeding the wheel brake limits as specified by the brake manufacturer. The brakes may be in any wear state as long as an acceptable means is used to determine the landing distances with fully worn brakes for presentation in the AFM. The main gear tire pressure should be set to not less than the maximum pressure desired for certification corresponding to the specific test weight. ~~Longitudinal control and brake application procedures should be such that they can be consistently applied in a manner that permits the airplane to be de-rotated at a controlled rate to preclude an excessive nose gear touchdown rate and so that the requirements of § 25.125(b)(4) and (5) are met. Nose gear touchdown rates in the certification landing tests should not be greater than eight feet per second.~~ Longitudinal control and application of deceleration devices should be such that they can be consistently applied in a manner that permits the airplane to be de-rotated at a controlled rate to preclude an excessive nose gear touchdown rate and so that the requirements of § 25.125(c)(4) and (5) are met. Nose gear touchdown rates in the certification landing tests should not be greater than eight feet per second or adversely affect aircraft integrity including systems behavior, without the need of exceptional pilot skill and application of unusual pilot techniques, such as (but not limited to) large push then pull pilot inputs on the control column / stick. Certification practice has not allowed manually applied brakes before all main gear wheels are firmly on the ground. An automatic braking system can be armed before touchdown.

4.11.3.4 Describe the airplane operating procedures appropriate for determination of landing distance in the performance section of the AFM.

4.11.3.5 The test should be performed either targeting the normal runway aiming point with paint stripes and rubber contamination, or targeting a clean part of the runway. For data expansion, if the tests are performed on a runway with representative amounts of rubber and paint stripes, 100% of the measured tire-to-ground braking coefficient can be used. If not, a 5% conservatism should be applied to the measured dry runway tire-to-ground braking coefficient. When reducing the wheel braking coefficient, the brake torque limit remains unaffected. In addition, the runway surface for the test should not be heavily textured.

4.11.3.6 Typically, the modelling should be designed to reflect the physics and shown to be consistent with the test data. A review of all test points, especially of outliers (in any direction), should be performed in particular to ensure that the test points were executed consistently with § 25.101(h). If there is significant scatter, engineering judgment should be applied to ensure a consistent model on the overall distances.

4.11.3.7 Reverse thrust performance credit for dry runway landing distance.

For the landing distances used to comply with § 25.125, credit for the stopping force provided by reverse thrust is permitted if the requirements of § 25.101(h) are met. In addition, the procedures associated with the use of reverse thrust required by § 25.101(f), must also meet the requirements of § 25.101(h). The following criteria provide acceptable means of demonstrating compliance with these requirements:

4.11.3.~~5~~7.~~4~~1 ~~In accordance with § 25.101(f),~~ P~~p~~rocedures for using ~~propeller~~ reverse thrust during landing must be developed and demonstrated. These procedures should include all of the pilot actions necessary to obtain the recommended level of ~~propeller~~ reverse thrust, maintain directional control, ensure safe engine operating characteristics and ~~cancel propeller reverse thrust~~ return the reverser(s), as applicable, to either the idle or the stowed position.

4.11.3.~~5~~7.~~5~~2 It should be demonstrated that using ~~propeller~~ reverse thrust during a landing complies 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, "Evaluating Turbine Engine Operating Characteristics," dated March 19, 1986 (or later revision). The ~~propeller~~ reverse thrust procedures may specify a speed at which the ~~propeller~~ reverse thrust is cancelled in order to maintain safe engine operating characteristics.

4.11.3.~~5~~7.~~6~~3 The time sequence for the actions necessary to obtain the recommended level of ~~propeller~~ reverse thrust should be demonstrated by flight test. ~~The time sequence used to determine the landing distances should reflect the most critical case relative to the time needed to obtain selected propeller reverse thrust~~. For AFM data expansion, the time sequence to select the thrust reversers is subject to the time delays specified in 4.11.7.2. If more than one action is required to achieve the intended level of reverse thrust, for example if the design includes a stop (or gate) or lockout, each action is subject to the time delays specified in 4.11.7.2.

4.11.3.~~5~~7.~~7~~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 and power lever detents that prevent the pilot from immediately selecting ~~propeller~~ reverse thrust or prevent the pilot from applying reverse thrust until the reverser is deployed. The effects of transient response characteristics, such as ~~propeller~~ reverse thrust engine spin-up, should also be included.

4.11.3.~~5~~7.~~8~~5 To enable a pilot of average skill to consistently obtain the recommended level of ~~propeller~~ reverse thrust under typical in-service conditions, a lever position that incorporates tactile feedback (e.g., a detent or stop) should be provided. If tactile feedback is not provided, a conservative level of ~~propeller~~ reverse thrust should be assumed.

4.11.3.~~5~~7.~~9~~6 ~~The applicant should demonstrate that exceptional skill is not required to maintain directional control on a wet runway.~~ The applicant should demonstrate that exceptional skill is not required to maintain directional control on a dry runway with a ten-knot crosswind from the most adverse direction. Symmetric braking should be used during the demonstration, and both all-engines-operating and critical-engine-inoperative reverse thrust should be considered. The brakes and thrust reversers may not be modulated to maintain directional control. The ~~propeller~~ reverse thrust procedures may specify a speed at which the ~~propeller~~ reverse thrust is reduced to idle or cancelled in order to maintain directional controllability.

4.11.3.~~5~~7.~~10~~7 ~~Compliance with the requirements of §§ 25.901(b)(2), 25.901(c), 25.1309(b), and 25.1309(c) will be accepted as providing compliance with the "safe and reliable" requirements of §§ 25.101(h)(2) and 25.125(c)(3).~~ As stated in § 25.125(e)(3), credit for thrust reverser deceleration is allowed, provided it is considered reliable. For the purpose of § 25.125 the failure of each individual thrust reverser to provide the expected level of reverse thrust (without prior crew awareness) should be on the order of 10^{-4} or less per landing.

4.11.3.7.8 The number of thrust reversers used to determine the dry runway landing distance data furnished in the AFM should reflect the number of engines assumed to be operating during the landing, along with any applicable system design features. The all-engines-operating dry runway landing distances should be based on all thrust reversers operating. The one-engine-inoperative dry runway landing distances should be based on failure of the critical engine. For example, if the outboard thrust reversers are locked out when an outboard engine fails, the one-engine-inoperative dry runway landing distances can only include reverse thrust from the inboard engine thrust reversers.

4.11.3.7.9 For the engine failure case, it should be assumed that the thrust reverser does not deploy (i.e., no reverse thrust or drag credit for deployed thrust reverser buckets on the failed engine).

4.11.3.7.10 For approval of dispatch with one or more inoperative thrust reverser(s), the associated performance information should be provided in the AFM in accordance with the Master Minimum Equipment List.

4.11.3.7.11 The effective stopping force provided by reverse thrust in each or, at the option of the applicant, the most critical landing configuration, should be demonstrated by flight test. The effects of each deceleration device (e.g. brakes, …) may be obtained independently through dedicated flight tests. Nevertheless, flight test demonstrations should be conducted using all of the stopping means on which the AFM landing distances are based in order to substantiate the landing distances and ensure that no adverse combination effects are overlooked.

4.11.3.7.12 Reverse transient assumption: specific consideration should be made to ensure accurate accounting for the reverse thrust forces (both vertical and horizontal) during deployment/spool-up and spindown following cut-back. This is particularly true where low approach speed and high deceleration allows the airplane to decelerate to the reverser cutback speed prior to full reverse thrust being attained.

~~4.11.3.5 Propeller pitch position used in determining the normal all-engines-operating landing stopping distance should be established using the criteria of § 25.125(g) for those airplanes that may derive some deceleration benefit from operating engines. Section 25.125(g) states that if the landing distance determined using a “device” that depends on the operation of any engine would be “noticeably increased” when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative, unless a “compensating means” will result in one-engine-inoperative landing distances not greater than those with all engines operating. Acceptable interpretations of the terms “device,” “noticeably increased,” and “compensating means” are described below.~~

4.11.3.~~5~~7.~~1~~13 If, with the normal operational ground idle setting procedure, the propeller produces drag at any speed during the stopping phase of the normal all-engines-operating landing distance, the maximum drag from this “device” for which performance credit may be taken is that which results from a propeller pitch position that gives not more than a slight negative thrust at zero airspeed. A slight negative thrust is that which will not cause the airplane, at light weight and without brakes being applied, to roll on a level surface. If the normal operational ground idle setting produces greater negative thrust at zero airspeed, the all-engines-operating stopping distances should be determined using a special flight test power lever stop to limit the propeller blade angle.

~~4.11.3.5.2 Distances should be measured for landings made with the propeller feathered on one engine, and ground idle selected after touchdown on the operating engines. The airplane configuration for this test, including the ground idle power lever position, should be the same as that used for the all-engines-operating landing distance determination. Differential braking may be used to maintain directional control. This testing should be conducted at the critical weight/CG position and landing speed. The propeller/engine rigging should be at the most adverse allowable tolerance. If the resulting distance does not exceed the all-engines-operating landing distance by more than two percent (2 percent), it is not “noticeably increased” and no further testing is required to take performance credit for all-engines-operating ground idle drag in the certified landing distances~~.

~~4.11.3.5.3 If the distances determined in paragraph 4.11.3.5.2 above are more than two percent greater than the all-engines-operating landing distances, there should be a "compensating means" in order to take performance credit for the all-engines-operating ground idle drag. Reverse propeller thrust on the operating engines may be used is considered a "compensating means" if the resulting landing distances, with one propeller feathered, are demonstrated to be not longer than those determined for all-engines-operating with the ground idle setting. The airplane configuration for this test should be the same as that used for the all-engines-operating landing distance determination, except that the propeller reverse thrust position is used. The nose wheel should be free to caster, as in VMCG tests, to simulate wet runway surface conditions. Differential braking may be used to maintain directional control. Procedures for using propeller reverse thrust during the landing must be developed and demonstrated. The procedures associated with the use of propeller reverse thrust, required by § 25.101(f), must meet the requirements of § 25.101(h). The criteria outlined below may be applied to derive the levels of propeller reverse thrust consistent with recommended landing procedures and provide an acceptable means of demonstrating compliance with these requirements. This testing should be conducted at the critical weight/CG position and landing speed. The propeller/engine rigging should be at the most adverse allowable tolerance. If the "compensating means" do not allow performance credit for the all-engines-operating ground idle drag, a minimum of three weights that cover the expected range of operational landing weights and speeds should be tested.~~

4.11.4 Instrumentation and Data.

Instrumentation should include a means to record the airplane's glide path relative to the ground, and the ground roll against time, in a manner that permits determining the horizontal and vertical distance time-histories. The appropriate data to permit analysis of these time-histories should also be recorded.

4.11.5 Landing on Unpaved Runways.

Guidance material for evaluation of landing on unpaved runways is contained in chapter 42 of this AC.

4.11.6 Automatic Braking Systems.

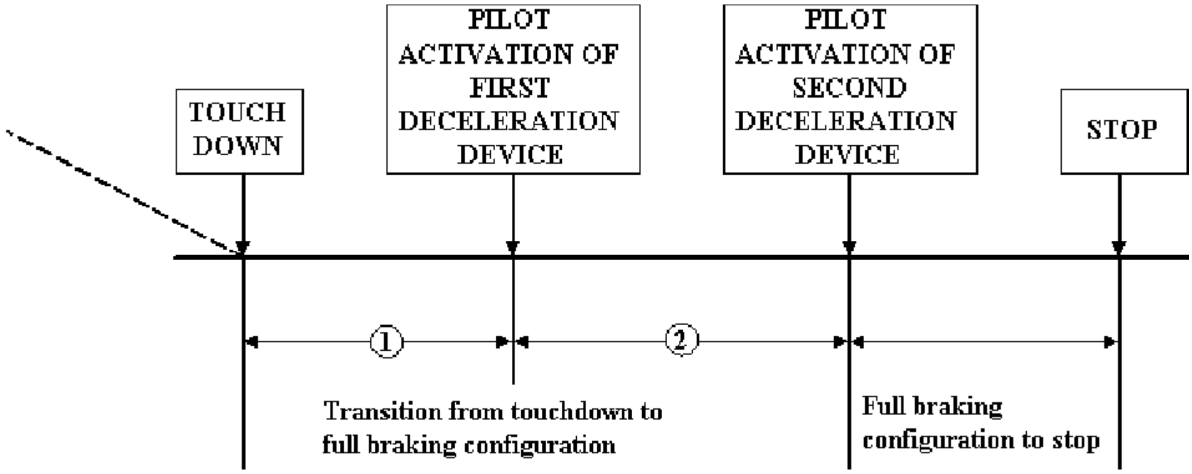
Guidance material relative to evaluation of auto-brake systems is provided in paragraph 15.4.9 of this AC.

4.11.7 AFM Landing Distances.

4.11.7.1 In accordance with § 25.101(i), AFM landing distances must be determined with all the airplane wheel brake assemblies at the fully worn limit of their allowable wear range. The brakes may be in any wear state during the flight tests used to determine the landing distances, as long as a suitable combination of airplane and dynamometer tests is used to determine the landing distances corresponding to fully worn brakes. Alternatively, the relationship between brake wear and stopping performance established during accelerate-stop testing may be used if it encompasses the brake wear conditions and energies achieved during the airplane flight tests used to establish the landing distances.

4.11.7.2 In deriving the scheduled distances, the time delays shown in figure 4-19 below should be assumed.

Figure 4-19. Landing Time Delays



4.11.7.2.1 Segment 1 represents the flight test measured average time from touchdown to pilot activation of the first deceleration device. For AFM data expansion, use the longer of 1 second or the test time.

4.11.7.2.2 Segment 2 represents the flight test measured average test time from pilot activation of the first deceleration device to pilot activation of the second deceleration device. For AFM data expansion, use the longer of 1 second or the test time.

4.11.7.2.3 Segment 2 is repeated until pilot activation of all deceleration devices has been completed and the airplane is in the full braking configuration.

4.11.7.3 For approved automatic deceleration devices (e.g., autobrakes or auto-spoilers, etc.) for which performance credit is sought for AFM data expansion, established times determined during certification testing may be used without the application of the 1-second minimum time delay required in the appropriate segment above.

4.11.7.4 It has been considered acceptable to expand the airborne portion of the landing distance in terms of a fixed airborne time, independent of airplane weight or approach speed.

4.11.7.5 Assumptions to be made in assessing the effect of wind on landing distance are discussed in paragraph 3.1 of this AC.

4.11.7.6 The time delays described in this section are applicable for any manual deceleration device. This includes ground idle selection (for turbopropeller powered aircraft) and reverse thrust selection.

4.11.8 <u>Parametric Analysis Data Reduction.</u>

The following is an acceptable method of converting the test data to a mathematical model for the parametric analysis method of air distance described in paragraph 4.11.2.3.

4.11.8.1 Test data for each test point:

$$R/S_{50} = Rate\ of\ sink\ at\ 50\ feet\ above\ landing\ surface\ (ft/sec)$$

$$R/S_{TD} = Rate\ of\ sink\ at\ touchdown\ (ft/sec)$$

$$V_{50} = True\ airspeed\ at\ 50\ feet\ above\ landing\ surface\ (ft/sec)$$

$$V_{TD} = True\ airspeed\ at\ touchdown\ (ft/sec)$$

$$t = Air\ time\ 50\ feet\ to\ touchdown\ (sec)$$

4.11.8.2 The multiple linear regression analysis as outlined below is used to solve for the constants in the following equation:

$$50/t = a + b(R/S_{50}) + c(R/S_{TD})$$

4.11.8.3 The form of the dependent variable being solved in the above equation is 50/t, rather than just t, in order to maintain the same units for all variables.

4.11.8.4 The test values of all the test points, 1 through n, are used to determine the constants a, b, and c in the above equation as follows, where n equals the number of test points and R1 through R13 are the regression coefficients:

$$R1 = \sum_{1}^{n} R/S_{50}$$

$$R2 = \sum_{1}^{n} (R/S_{50})^2$$

$$R3 = \sum_{1}^{n} R/S_{TD}$$

$$R4 = \sum_{1}^{n} (R/S_{TD})^2$$

$$R5 = \sum_{1}^{n} (R/S_{50})\,(R/S_{TD})$$

$$R6 = \sum_{1}^{n} (50/t)$$

$$R7 = \sum_{1}^{n} (R/S_{50})\,(50/t)$$

$$R8 = \sum_{1}^{n} (R/S_{TD})\,(50/t)$$

$$R9 = (n)(R2) - (R1)^2$$

$$R10 = (n)(R8) - (R3)(R6)$$

$$R11 = (n)(R5) - (R1)(R3)$$

$$R12 = (n)(R7) - (R1)(R6)$$

$$R13 = (n)(R4) - (R3)^2$$

$$c = [(R9)(R10) - (R11)(R12)]/[(R9)(R13) - (R11)^2]$$

$$b = [(R12) - (c)(R11)]/R9$$

$$a = [(R6) - (b)(R1) - (c)(R3)]/n$$

4.11.8.5 Using the same regression coefficient relationships, determine the values of the constants, a, b, and c, for the speed reduction between 50 feet and touchdown (V_{50}/V_{TD}) by using the value of (V_{50}/V_{TD}) for (50/t) for each test point.

4.11.8.6 After determining the values of the constants, use the above equation for (50/t) to calculate the time from 50 feet to touchdown for the target conditions of a -3.0° ~~-3.5°~~ flight path angle and R/S_{TD} = 3 ~~8~~ ft/sec. Use a value of (R/S50) calculated from the approach path and V_{50}. Then, using the same equation, but substituting (V_{50}/V_{TD}) for (50/t) and using the constants determined for (V_{50}/V_{TD}), calculate (V_{50}/V_{TD}).

4.11.8.7 After V_{TD} is determined (from V_{50}/V_{TD} and V_{50}), the air distance may be determined for the average flare speed and air time.

Example

Test Data:

Run	R/S_{50}	R/S_{TD}	V_{50}	V_{TD}	t
1	13.4	6.1	219	214	5.6
2	10.9	1.8	223	218	8.5
3	7.9	5.8	209	201	7.4
4	8.3	2.3	213	206	9.6
5	9.8	4.1	218	212	7.5

Results:

$50/t = 1.0432 + 0.3647(R/S_{50}) + 0.4917(R/S_{TD})$

$V_{50}/V_{TD} = 1.05508 - 0.003198(R/S_{50}) + 0.001684(R/S_{TD})$

For conditions of V_{50} = 220 ft/sec; flight path = -3.0~~3.5~~°; R/S_{TD} = 3.0~~8.0~~ ft/sec; the results are:

R/S_{50} = 11.51~~13.43~~ ft/sec

V_{50}/V_{TD} = 1.0233~~1.0256~~

t = 7.443~~5.063~~ sec

Air distance = 1619~~1100~~ ft

AC 25.1581-1 AIRPLANE FLIGHT MANUAL

Proposed modifications are shown in RED

2. Airplane Flight Manual Contents

…

d. Performance Section

…

(18) Landing Distance. In accordance with § 25.1587(b), the landing distance from a height of 50 feet must be presented either directly or with the factors required by the operating regulations, together with associated conditions and weights up to the maximum takeoff weight. For all landplanes, landing distance data must be presented for level, smooth, dry, hard-surfaced runways for ~~standard~~ ambient ~~day~~ temperatures for landing threshold speeds from V_{REF} to a minimum of 10 knots above the V_{REF} speed. Where increased landing speeds are recommended by a normal procedure beyond V_{REF} + 10kt at the threshold, data for higher speeds should be presented. At the option of the applicant, and with concurrence by the FAA, additional data may be presented for other ~~temperatures and~~ runway slopes within the operational limits of the airplane, or for operations on other than smooth hard-surfaced runways. For Category III operations, additional landing performance data may be required.

APPENDIX 3 - EXCERPT OF THE TALPA ARC PART 121 SUBCOMMITTEE TRANSMITTAL FILES

Proposed Standard and Rationale

This section will provide the recommended 14 CFR rule modifications, the specific topics that associated advisory material should address and the rationale for the standard modification. It is important when evaluating these recommendations to be cognizant that the data required by the proposed standards are to be developed by the working groups for the CFR parts 23/25/26 aircraft certification rules.

Proposed modifications to the rule or current rule verbiage will be in the first column, while the second column will document the recommended advisory material to support the rule. Following the specific section will be the rationale for the recommendation
Note: new proposed regulations will be in *red text.*

(…)

Regulation	**Advisory Material**
(f)(1) An operational assessment must be performed in accordance with criteria and procedures in a program approved by the Administrator.	
Rationale: It is recommended that the technical details of the landing distance assessment be contained in an approved program governed by the Operations Specification. This will allow more timely updates to methods of reporting and assessing contaminants as the science and technology improves. The alternative would be to include in the regulations specific definitions of contaminants and braking action which are expected to change as industry operational experience increases. The term "operational assessment" is intended to distinguish this requirement from the "dispatch requirements" for landing limitations addressed by the other paragraphs of this section. Due to the conservative nature of the air distance assumptions used in the operational landing performance data, an alternate procedure should be provided to operators conducting expanded training and quality assurance to allow for reduced air distances providing the equivalent level of safety.	

Regulation	Advisory Material
(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	
Rationale: This states the minimum requirements of what the approved program for the assessment must include and establishes the requirement for the use of "operational landing" performance data in the AFM. This terminology was used to distinguish from the "dispatch" dry and wet landing distance performance data currently in the AFM. It is anticipated that such data for aircraft operating at the time of this rule change may not be available in the AFM, so the use of supplementary data acceptable to the Administrator is provided as an alternate means of compliance with the current requirements of 121.173(d). **While auto brakes are a part of the aircraft's landing configuration, this landing distance assessment procedure is not intended to force higher than reasonable autobrake selection. For operations on a dry or wet runway if the manual braking distance provides a 15% safety margin then the braking technique may include a combination of autobrakes and manual braking even if the selected auto brake landing data does not provide a 15% safety margin.** ***(Recommend this text be included in the associated guidance or Operations Specifications)***	

Regulation	Advisory Material
(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.	
Rationale: This codifies the 15% safety margin contained in SAFO 06012 and uses the declared distance terminology for "landing distance available". The value of 15% was the subject of much debate within the industry and the FAA, but a consensus was reached that this is the most appropriate value. It is anticipated that the AFM data may or may not include the 15% margin, but would clearly state whether it does or does not. It is the operator's responsibility to assure that it is included in the assessment, but the rule intentionally does not prescribe how this is to be accomplished.	