FAA Aviation Rulemaking Advisory Committee
FTHWG Topic 26
LANDING IN ABNORMAL CONFIGURATIONS

Recommendation Report
April 26, 2024

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Executive Summary

The Flight Test Harmonization Working Group (FTHWG) was tasked with providing recommendations for harmonization of the 14 Code of Federal Regulations (CFR) part 25 and guidance on determination of landing distances in abnormal configurations and what failure cases should be considered.

No FAA/ANAC/TCCA advisory material is available to provide guidance with respect to the scheduling of data for landing in abnormal configurations.
EASA has introduced in CS-25 Amdt 21 the requirement 25.1587(c) and its associated AMC, which was based on generic JAA/EASA CRI "Landing in abnormal configurations".

The group considers that Time-of-Arrival methodology to determine landing distance in normal configurations should be adapted to determine landing distances in abnormal configurations.

This report recommends the FTHWG proposed revisions to requirements and guidance as follows:

- Updated text for 14 CFR 25.1592 (based on the requirements recommended in Topic 32 - Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)), which will require information to be provided in the Airplane Flight Manual (AFM) for landing distances in abnormal configurations
- Updated AC 25.1592 (based on the AC recommended in Topic 32 - Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA) Recommendation Report) to incorporate advisory material for determination of landing distances in abnormal configurations
- EASA replacement of CS 25.1587(c) (resp. AMC 25.1587(c)) by CS 25.1592 (resp. AMC 25.1592)
- No update in 14 CFR / CS 25.1581 requirement and guidance
- No update in FAA AC 25-7X

Background

When an annunciated failure occurs in flight, the flight crew has to analyze the consequences of this failure on the landing. Some failures cause an increase in the landing distance, which must be evaluated. A diversion may be necessary if the destination airport runway is no longer appropriate due to the increased landing distance. For the production of AFM data, the applicant determines for all failures that can have an effect on landing distance whether landing performance would have to be provided in the AFM according to their probability. In addition, the question of the best presentation of the relevant data should be addressed.

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

The primary safety concern is for the flight crew not having appropriate landing distance information readily available when the airplane suffers an annunciated failure during flight. This information is needed so that the flight crew can decide whether to land on the destination runway or if a diversion is necessary.
This information should enable the crews to balance the risks between a possible hazardous diversion and a possible landing overrun.
This landing distance information should be operationally representative of an average pilot rather than being based on the maximum performance of the aircraft, and conversely, it should not be overly

conservative and cause unnecessary diversions and increase the exposure time of flying an aircraft impacted by systems failures.
This was discussed by the JAA Flight Steering Group and traced in Flight Working Paper 572 : *It was recognised that some of the failure cases which result in a need to land in an abnormal configuration or with certain normal services unavailable could be such that a significant diversion to a longer landing runway might not be prudent and, to cover these cases, the crews must be given sufficient information to enable them to balance the risks between a possible hazardous diversion and a possible landing over-run.*
In the same way, the use of safety factor on landing distance in abnormal configurations has to be appreciated regarding this safety concern.
This is also mentioned in AC 91-79B: *The FAA acknowledges that there are situations where the flight crew needs to know the absolute performance capability of the airplane. These situations include abnormal configurations of the airplane or during emergencies such as engine failure or flight control malfunctions. In such circumstances, the pilot must consider whether it is safer to remain in the air or to land immediately and should know the actual landing performance capability (without an added safety margin) when making these evaluations.*

No safety issue due to the lack of harmonization was raised.

What is the task?

This task is to develop recommended harmonized regulatory content and advisory material for determination of landing distances in abnormal configurations and how it should be presented in the Airplane Flight Manual together with guidelines as to which failure cases should be considered.

Why is this task needed?

The task is needed to harmonize requirements, and to provide guidance material consistent with up-to-date practices to determine operationally representative landing distances in abnormal configurations.

The FAA/TCCA/ANAC have no specific regulation or guidance for providing landing distances in abnormal configurations and rely on the operating procedures requirement 25.1585(a) which requires that the manufacturers provide non-normal procedures in the AFM.
CS/AMC 25.1587(c) was introduced in EASA regulatory material at Amdt 21 and was based on a JAA/EASA CRI.

Who has worked the task?

This task has been supported by flight test and performance specialists from the following:

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

Any relation with other topics?

Topic 32 – Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)

Historical Information

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

Current regulatory and guidance material are defined in:
- EASA: CS 25.1585(a) and CS/AMC 25.1587(c)
- FAA: 14 CFR part 25.1585(a)

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

14 CFR / CS 25.1585(a) requires the AFM to furnish operating procedures to include malfunction cases and failure conditions involving the use of special systems or alternative use of regular systems. This requirement is the same in CS-25 and 14 CFR part 25, and there is no corresponding guidance on how to determine landing distances in abnormal configurations.

CS 25.1587(c) (introduced in CS-25 at Amdt 21) requires performance information associated with abnormal landing configurations to be contained in the AFM. Associated AMC 25.1587(c) provides guidance and recommendations on how to determine and present in the Airplane Flight Manual (AFM) landing distance information appropriate to abnormal configurations and guidelines on which failure cases should be considered.
This EASA requirement has no comparable FAA regulations in 14 CFR part 25.

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

Several CRIs titled "Landing distance in abnormal configurations" were applied to designs for type certification by the JAA and then EASA based on the material now published in AMC 25.1587(c) at Amdt 21.

No FAA IP exists on this topic.

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

N/A

Recommendation

A. *Rulemaking*

1. What is the proposed action?

The FTHWG recommends changes to 14 CFR 25.1592 and the associated AC, that has been proposed in the Topic 32 final recommendation report.

The FTHWG recommends the removal of CS 25.1587(c) and associated AMC from CS-25, and changes in CS/AMC 25.1592 of Amdt 27.

2. What should the harmonized standard be?

The proposed harmonized standard should be a part 25 rule requiring landing distances in abnormal configurations to be provided in the AFM, with advisory material that provides a methodology to determine those distances to be operationally representative, covering an adequate list of failures, and accounting for the relevant parameters.
With the proposed action, full harmonization can be achieved across the regulatory agencies.

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

The proposed standard will ensure the relevant landing distance data are provided and clearly presented in the AFM to cope with the scenario of a failure being detected in flight, enabling the flight crew to decide whether to land at the destination airport or to divert to a more suitable runway.
The data presented in the AFM must be operationally representative, and presented without a safety factor to provide the absolute performance of the aircraft and enable the flight crew to balance the risks between a possible hazardous diversion and a possible landing overrun.

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

The current 14 CFR requirement does not explicitly require landing performance data in abnormal configurations, but current Section 25.1585(a) has been interpreted to provide relevant data in non-normal procedures. The lack of harmonized advisory material led the manufacturers to develop their own methodologies to determine landing distances in abnormal configurations, in particular adapting the Section 25.125 distance to the failure cases (which may not be operationally representative). Nevertheless, no specific safety event was identified that could be linked with this issue.
It is believed that the proposed standard would maintain the level of safety relative to the current 14 CFR standard with the main interest being to have a harmonized standard.

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

Some manufacturers provide abnormal landing distance data and AFM content consistent with the proposed standard, in particular considering Landing Distance at Time-of-Arrival (LDTA) principles. As stated above, no safety issue was raised that could be linked with the data adapted from Section 25.125 distances. Thus, the proposed standard would maintain the level of safety relative to the current industry practice.

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

One considered option was to introduce the current content of EASA CS 25.1587(c) (and associated AMC). However, the FTHWG converged on developing abnormal landing distance data based on the methodology used to determine the nominal LDTA, consistent with the methods recommended in the Topic 32 final recommendation report.

7. Who would be affected by the proposed change?

The proposed change will primarily affect manufacturers of 14 CFR part 25 aircraft and 14 CFR part 121, 125, 135, 91, 91(K) aircraft operators.

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

The proposed changes do not affect other HWGs.

B. ***Advisory Material***

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

There is no current FAA advisory material explicitly addressing landing distances in abnormal configurations. The draft AC 25.1592 recommended by the FTHWG in Topic 32 can be amended to introduce details on the methodology to determine landing distances in abnormal configurations.

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 consistent with manufacturers current or anticipated practices, there should not be significant increase in costs. However, for some manufacturers, there will be additional cost to consider the production and certification of the new proposed standard information compared to the methodology that was used on their previous airplane models.

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

Yes

Consensus/Comment/Dissent

Consensus

AFM data presentation

Landing distance in abnormal configurations must be provided in the AFM. A question was raised whether the AFM would contain distances only (either computed through first principle computation, or distance increments to be applied on a reference nominal distance), or if failure coefficients (factors) could be provided.

It was agreed that the existing methodologies reviewed by the FTHWG are suitable to compute the landing distances in abnormal configurations, if all necessary information is available and clearly expressed in the AFM.

Update of AC 25-32X

The question of updating AC 25-32X from the Topic 32 (TALPA) recommendation report consistently with the proposed AC 25.1592 was discussed. The AC 25-32X provides guidance for time-of-arrival landing performance data that may be furnished (LDTA in nominal configuration), whereas landing distance in abnormal configurations was already required, even if implicitly, by Section 25.1585(a)(2). In addition, for existing type designs, guidance material of the EASA CRI (Landing distance in abnormal configurations) was available and was not prescriptive in terms of methodology to be used to determine landing distances in abnormal configurations. It has been agreed to not update AC 25-32X as part of Topic 26.

Use of LDTA concept

Current EASA AMC 25.1587(c) is not prescriptive about how to determine the landing distance in abnormal configurations. This AMC is based on a generic CRI issued at the time of JAA when the only existing landing distance was the Section 25.125 landing distance.

LDTA (Landing Distance at Time of Arrival) concept is operationally representative and has already been adapted and used by some manufacturers to determine landing distances in abnormal configurations. It was planned to be used by the other manufacturers for future projects. So, it has been decided to provide guidance material consistent with LDTA methods, and to integrate this guidance in AC 25.1592 proposed by FTHWG Topic 32.

Input parameters & runway surface condition considerations

For a methodology using coefficients in conjunction with a reference nominal distance, accounting for all parameter combinations (wind, temperature, altitude, runway slope, speed additive (speed increment)) may generate too many coefficients and induce difficulties in the readability of the AFM. To reduce the number of coefficients, it would be possible to provide an enveloping coefficient but that method could lead to undue conservatism. This conservatism may be problematic if the resulting landing distances are too long for a crew to find a suitable runway. To address this undue conservatism, the guidance will allow sufficient flexibility, either to provide enveloping distances, or to account for the specific effect for each parameter, or provide landing restrictions in the AFM if the data are not provided in the AFM.

For the specific topic of the runway surface conditions, there is a consensus that landing distance in abnormal configurations must be provided for dry and wet runway surfaces whereas for contaminated runways, it is at the option of the applicant to provide approved data in the AFM. Non-approved data may be furnished in the AFM or in another operational manual. In all cases, the runway conditions for which approved data is furnished in the AFM must be clear in the AFM non-normal procedure section.

The group also discussed how the landing distance coefficients should be presented in order to cover the different runway conditions (if the coefficient method is used). It was concluded that the manufacturers may come-up with different solutions. For example, a single factor can conservatively cover all runway surfaces; or different factors can cover dry, wet and grouped contaminated surfaces; or individual factors can be prepared for each runway surface or RCC. All these solutions are acceptable as long as it is clear to the pilot what data to use for the reported runway condition at time of arrival.

Approach speeds additive

The topic of approach speed to be considered has been discussed and a consensus has been reached on several aspects:

- The distance is to be determined based on the speed reached at runway threshold, to cope with procedures that require the aircraft to be decelerated from approach to the runway threshold.
- The approach speed must consider the speed additive needed for the failure and for icing conditions.

Note: Both speed additives may not be cumulative

- Application of speed additives that are generally recommended to be applied for other reasons (auto-throttle, windy conditions …) remains at the discretion of the crew. So, the basic abnormal landing distance need not include these additives.
- The proposed guidance for approach speed states that the AFM should provide the effect of 10 knots overspeed (on top of the failure speed additive). Note that the addition of a 10 knots speed additive may not be appropriate, if the maximum speed resulting from the application of the failure speed additive +10 knots exceeds the maximum approach speed recommended in the AFM.

Landing distance safety factor

In order to align with the safety concerns described in FWP 572 and AC 91-79B, it was decided that providing the absolute (unfactored) landing distance of the airplane with the failure conditions is the most appropriate information for flight crews to evaluate the risk to land or to divert to a more suitable runway. Hence no safety factor is to be accounted for in the data provided in the AFM (additional safety margin can be added by the flight crew if necessary).

It is noted that this methodology also removes any ambiguity about abnormal landing distance factors that are less than the 1.15 operational factor that is applied to the normal landing LDTA. In this situation, the abnormal landing distance is less than the factored LDTA used to evaluate if enough runway is available for landing but the group concluded that this is acceptable since the absolute abnormal landing distance is required for the reasons explained above.

Credit for reverse thrust

As for LDTA in normal configurations, the consensus was that reverse thrust credit can be included, when available following the system failure being considered. This credit is currently permitted by EASA AMC 25.1587(c), with no system reliability criteria. It was agreed that the reliability criteria should not be as stringent as for nominal LDTA because, if the system failure being considered does not lead to loss of thrust reverser, not having reverse thrust for landing would be the result of a combination of independent failures. There was a discussion on having the reliability criterion dependent on the probability of the failure being considered. However, it was thought that it would introduce additional complexity by having two different reliability criteria for normal and abnormal configurations, and that it was not the objective to encourage poor thrust reverser designs using relatively low reliability objectives. Several options were proposed, either to keep the reliability criteria as for normal configurations, to have no reliability criteria at all or to have a reliability criterion less stringent than the one for nominal configurations. The group converged on the principle that no reliability criteria is needed to take credit of reverse thrust for landing distances in abnormal configurations.

Similarly, for other deceleration means, no reliability assessment is specified in EASA AMC 25.1587(c) when assessing abnormal landing distance.

Therefore, the consensus was to exclude a reliability criterion from the abnormal configurations' guidance for all deceleration means, including thrust reversers.

Criteria for failure selection to provide landing distance

EASA AMC 25.1587(c) has two criteria to select the failures for which landing distance should be provided in the AFM; one regarding landing distance impact (more than 10%) and one about failure probability (greater than 10^{-7}). Industry practices show that only the probability criterion was really used, and manufacturers have been providing landing distance for failures having less than a 10% impact. It was decided to simplify the criteria and remove the 10% criteria impact threshold. This is consistent with prior EASA CRIs that did not include the 10% threshold for airplanes that may be operated with no safety factors.

The group also discussed combinations of failures. Specific combinations can be covered through analysis with the appropriate effects of the considered failures in order to come-up with representative speed additive and factor on landing distance. Some manufacturers have also included a statement in the general section of the non-normal procedures stating that the individual distance factors may be multiplied together and the speed additives be added-up for combination of failures. While both methods are considered acceptable, the group decided not to be prescriptive on this subject and let the manufacturers come-up with appropriate non-normal procedure wording or analysis for possible combinations of failures.

Air distance for abnormal landing configurations

Air distance has been computed for LDTA in normal configurations in two ways: either with a 7 seconds time and 4% of speed decay between 50ft and touchdown, or based on a 14 CFR 25.125 methodology if it is operationally representative.

It has been agreed that the same methodology can be used for landing distances in abnormal configurations, but that for failures affecting the flare, the validity of this air distance should be further justified.

Delays for deceleration means application

A question was raised whether the additional time for application of deceleration means (braking, reverse thrust), introduced in the LDTA determination (paragraph 9.3.4 of proposed AC 25.1592 in Topic 32) could be reduced, as the pilot would be aware of a failure affecting landing performance, and should be focused on promptly applying the deceleration means.

The FTHWG agreed that it was more suitable to keep these additional delays, given that it is recommended that no arbitrary safety factor be included in the landing distance data.

Dry runway coefficient of friction

A question was raised whether the 95% factor applied to the flight-test determined dry runway friction coefficient, introduced in the LDTA determination (Table 1 in paragraph 8.2 of proposed AC 25.1592 in Topic 32) could be removed.

The FTHWG agreed that it was more suitable to keep this 95% factor, given that it is recommended that no arbitrary safety factor be included in the landing distance data.

Guidance on the way reference nominal distances are computed (when failure coefficients are used)

For methodologies relying on failure coefficients to be applied on a reference nominal distance, a question was raised about the methodology to compute this reference distance. Different methodologies exist within the manufacturers, either:

1) to consider the distance as a LDTA in the flight conditions of the day (temperature, approach speed with potential additives, altitude, winds, runway slope etc …) as the reference nominal distance. In this case, the failure coefficient would account only for the effect of the failure, or
2) to consider another landing distance (Section 25.125 for instance) in reference flight conditions (SL/ISA at V_{REF} on a level runway) as the reference nominal distance. In this case, the failure coefficient would account for the effect of the failure, the difference in terms of altitude/temperature, potential speed additives, and for the different methodologies between Section 25.125 and LDTA.

One difference between these two methodologies is that the failure coefficient may tend to be overly conservative in the second methodology, and it may increase the risk by extending a flight in an abnormal configuration to find a suitable runway.

A level of conservatism that could be acceptable for the second methodology was discussed and it was deemed impractical to be defined and described in the guidance, as it could depend on the aircraft design

(e.g. small aircraft land with shorter distances than large aircraft so they might find suitable runway more easily, even if the landing distance is over-conservative).
Nevertheless, the FTHWG did not identify a specific event of operators complaining about excessive distances in abnormal configurations landing data, which gave confidence that the current practices are suitable regarding this aspect.
Therefore, it was agreed to not define prescriptive guidance about how to compute nominal reference landing distance, provided it is sufficiently clear in the AFM how to determine the overall abnormal landing distances.

Maximum weight to be considered

A question was raised if it should be a requirement for all procedures to consider weights up to the maximum takeoff weight, or if it would be allowable for non-emergency procedures that do not require an immediate landing (such as a ground spoiler failure) to only consider weights up to the maximum landing weight. Since there is the possibility of combining failures (such as a failure that requires an immediate landing with one that does not) and the belief that it is better to give the flight crew all the relevant data available to handle other unforeseen events, it was agreed that all procedures should consider weights up to the maximum takeoff weight.
Additionally, it was noted that abnormal landing performance information above maximum landing weight is provided for the purposes of informing the flight crew of the impact of the failure to aid in their decision making and does not imply that landing with a non-emergency failure above maximum landing weight is recommended.
Addressing weights up to the maximum takeoff weight could lead to overly conservative coefficients or to duplicate the effect of coefficients already furnished in the AFM. In this regard, the proposed guidance specifies that maximum takeoff weight should be covered to a practicable extent, but should not induce or imply an undue need for a diversion.

Comments

Time of arrival go-around climb gradient with failure (Dassault, Airbus Canada and Airbus)

Topic 26 task is to harmonize the standards that require landing distance in abnormal configuration. But having go-around climb performance in case of a failure could be important information, including whether the landing weight should be reduced before landing. This topic being not part of the task, it has not been discussed and will not be part of the proposed standard.
Nevertheless, it is recommended to further work on this topic in the future to assess if it is worth requiring go-around performance data in abnormal conditions to be provided.

Brake energy and tire speed (Dassault, Airbus, Airbus Canada, Gulfstream)

Topic 26 task is to harmonize the standards that require landing distance in abnormal configurations. But having the information of the braking energy and tire speed at touchdown are important to know if landing weight or approach speed should be reduced before landing.
It was discussed that exceeding maximum brake energy or maximum tire speed may happen only in very limited conditions (high altitude/temperature with high-lift or wing ice protection system failures).
Nevertheless, some manufacturers have provided landing weight limitations to ensure maximum brake energy and maximum tire speed are not exceeded in case of failure affecting landing performance. It is recommended to further work on this topic in the future to assess if it is worth requiring landing weight

information be provided to ensure tire speed limits and maximum brake energy are not exceeded during the abnormal landing.

Nose wheel free to caster (TCCA)

The proposed guidance in this report for Section 12.1.3 of AC 25.1592 describes conditions for the use of deceleration devices for abnormal landing configurations and goes on in Section 12.1.3.2 to describe conditions for a controllability demonstration for landing in an abnormal configuration on a wet runway with a crosswind component of 10 knots from the adverse side. In lieu of having to conduct a demonstration on a wet runway, provision has been included in the guidance allowing the nose wheel to freely caster (i.e. nose wheel steering selected off) as a representation of the reduced friction of a wet runway. The guidance further extends the scope of this alternative technique to represent the reduced friction of a contaminated runway. However, directional control capability with the reduced friction of a contaminated runway may be significantly impaired especially in the presence of an adverse crosswind.
Although AC 25-7D contains a few references to nose wheel free to caster as a representation of reduced friction of a wet runway, there is no guidance that ascribes this technique to be representative of the reduced friction of a contaminated runway. While it is acknowledged that a free castering nose wheel may be an overly conservative representation of the reduced friction of a wet runway, there has been no technical justification supporting this technique as a representation of reduced friction of a contaminated runway for directional control capability. It is possible that a suitable investigation could provide this technical justification.

Answer to TCCA comment (Gulfstream, Boeing, Embraer, Airbus)
The group acknowledges that a suitable investigation to substantiate that a free castering nose wheel is a reasonable substitute for a contaminated runway surface controllability demonstration could be beneficial. It is also acknowledged that AC 25-7D does not provide guidance on contaminated runway surfaces.
However, the latter can be explained by the lack of existing FAA airplane performance requirements for contaminated runway surfaces. In fact, the recently concluded Topic 32 (Codification of Part 25 Takeoff and Landing Performance Assessment (TALPA)) is the first proposed rulemaking requiring performance data to be furnished in the AFM for takeoff and landing on contaminated runways. There it is acknowledged that recommendations or guidelines associated with crosswind landings, including maximum recommended crosswinds, should be provided for the runway surface conditions for which landing distance data is being provided. There are no documented castering nose wheel concerns present in that report, and the crosswind related guidance remains unchanged as part of the recommendations of this report. Finally, EASA has provided guidance (i.e., CRI titled Reverse Thrust Credit when Operating on Wet or Contaminated Runway Surfaces, and AMC 25.109(f)), where it has been acceptable to simulate contaminated runway surfaces with a castering nosewheel via flight test for the purposes of this controllability demonstration. Given the impractical nature of the alternative (i.e., controllability testing on a contaminated runway), and possible ground-tire simulation modelling issues on contaminated surfaces, the group accepts that this is the preferred guidance to date.

Dissents

No dissenting opinion was shared.

APPENDIX 1 – PROPOSED STANDARDS AND RATIONALE

NEW RECOMMENDED 14 CFR PART 25 REGULATIONS

This section provides the recommended 14 CFR part 25 modifications, and the rationale for the standard. The black text indicates the regulation that has been proposed by the FTHWG in the Topic 32 recommendation report. Proposed changes versus this text are identified in *red italic characters*.

Regulation	Comments
Sec. 25.1592 Performance Information for Landing Distance Assessment at Time of Arrival (a) Landing performance information *associated with normal landing configurations* on dry, wet, slippery wet and contaminated runways must be furnished in the AFM by the applicant for landing performance assessment at time of arrival on hard-surfaced runways *(b) Landing performance information associated with abnormal landing configurations on dry and wet runways must be furnished in the AFM by the applicant for landing performance assessment at time of arrival on hard-surfaced runways. At the discretion of the applicant, supplementary landing performance information associated with abnormal landing configurations may be furnished in the AFM for airplanes landing on slippery wet runways and on runways contaminated with standing water, slush, snow, or ice. The runway conditions for which approved data is furnished in the AFM must be clear in the AFM non-normal procedure section* *(c)* The information may be established by calculation or by testing. *(d)* The landing distance to be used for landing performance assessment at time of arrival consists of the horizontal distance from the point at which the main gear of the airplane is 50 ft above the landing surface to the point where the airplane comes to a complete stop	This paragraph has been adapted to integrate landing distance in abnormal configurations. - Subparagraph (a) is about normal landing configurations and is consistent with Topic 32 requirement. Landing distance on all runway states must be furnished - Subparagraph (b) is added and is about landing in abnormal configurations. Only landing distance on DRY and WET must be furnished. For other runway states, the AFM must be clear whether landing distances are provided or not. - Subparagraph (c) & (d) are the same as Topic 32 subparagraphs (b) & (c). - Subparagraph (e) is based on Topic 32 subparagraph (d), adapted to abnormal configurations ("available deceleration devices") and modified for overall consistency with Part 25 wording and the Topic 33 – Landing Distance on Dry Runway final report (other modifications). As for the requirement, the guidance material for landing distance in abnormal configurations is proposed to be included in the AC 25.1592, see Appendix 2.

(e) The data to be used for landing performance assessment at time of arrival must allow computation of the landing distance based on runway conditions, winds, temperatures, average runway slope, pressure altitude, icing condition, *recommended speed at runway threshold*, airplane *weight* and configuration, *and available* deceleration devices, *within the operational limits established by the applicant for the airplane*.	

Rationale:
Landing distances in abnormal configurations are needed by flight crews to assess landing performance in the case of failure detected in-flight. This assessment can be done prior to the time-of-arrival to decide whether a diversion to a more suitable runway is necessary. Since an assessment at the time-of-arrival is already an expectation in normal operations, it was considered logical to include the landing distances in abnormal configurations as a form of landing distance at time of arrival (LDTA).
Therefore, the requirement 25.1592, proposed in the context of Topic 32, was considered the right section to introduce the abnormal configurations landing distance requirement.

APPENDIX 2 – REVISED ADVISORY MATERIAL – AC 25.1592 (PERFORMANCE INFORMATION FOR LANDING DISTANCE ASSESSMENT AT TIME OF ARRIVAL)

This section provides the recommended AC 25.1592 modifications. The black text indicates the part of the AC that has been proposed by the FTHWG in the Topic 32 recommendation report. Proposed changes versus this text are highlighted in yellow.

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Performance Information for Landing Distance Assessment at Time of Arrival

Date:

Initiated By: AIR-625

AC No: AC 25.1592

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

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Director, Policy and Innovation Division
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(page numbering to be specified upon publication)

Figures

Tables

1 PURPOSE.

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

In addition, this AC covers landing performance data for time-of-arrival landing performance assessments in abnormal configurations. For purposes of this AC, an abnormal configuration is an operational condition that results from any single failure or any combination of failures that affect landing performance.

Time-of-arrival is to be understood as in-flight assessment as opposed to dispatch assessment.

2 APPLICABILITY.

2.1 The guidance provided in this document is directed towards airplane manufacturers, modifiers, foreign regulatory authorities, FAA transport airplane type certification engineers, flight test pilots, flight test engineers, and their FAA designees.

2.2 The guidance in this AC is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The Federal Aviation Administration will consider other methods of demonstrating compliance that an applicant may elect to present.

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

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

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

3 CANCELLATION.

3.1 Not Applicable.

4 RELATED DOCUMENTS

4.1 Regulations.

The following Title 14, Code of Federal Regulations are referenced in this AC. These regulations are available at the U.S. Government Printing Office website.

- Section 25.101, *General (Performance)*.

- Section 25.125, *Landing*.
- Section 25.1585(a)(2)
- Section 25.1587, *Performance information*.
- Section 91.1037, *Large transport category airplanes: Turbine engine powered; Limitations; Destination and alternate airports*.
- Section 121.195, *Airplanes: Turbine engine powered: Landing limitations: Destination airports*.
- Section 135.385, *Large transport category airplanes: Turbine engine powered: Landing limitations: Destination airports*.
- Section 25.1592, *Performance Information for Landing Distance Assessment at Time of Arrival*.

4.2 **Advisory Circulars.**

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

- AC 25-7X (or later revisions), *Flight Test Guide for Certification of Transport Category Airplanes*, dated YY Y, 20YY.
- AC 25.939-1, *Evaluating Turbine Engine Operating Characteristics*, dated March 19, 1986.
- AC 91-79B, *Aircraft Landing Performance and Runway Excursion Mitigation*, dated August 28, 2023.
- AC 150/5200-28E, *Notices to Airmen (NOTAMs) for Airport Operators*, dated October 8, 2015.
- AC 150/5200-30D, *Airport Field Condition Assessments and Winter Operations Safety*, dated October 29, 2020.

4.3 **Other Documents.**

- ASTM E3188-19, *Standard Terminology for Aircraft Braking Performance*, published February 2019.
- ASTM E3266-20, *Standard Guide for Friction-Limited Aircraft Braking Measurements and Reporting*, published November 2020.
- FAA Order JO 7930.2S (or later revision), *Notice to Airmen (NOTAM)*, dated 10 January, 2019.
- European Aviation Safety Agency (EASA), CS 25.1592 *Performance information for assessing the landing distance*, and associated Acceptable Means of Compliance (AMC).
- ~~Safety Alert for Operators (SAFO) 19001, *Landing Performance Assessments at Time of Arrival.*~~
- Flight Steering Group Flight Working Paper 572/4, dated January 1999

5 **BACKGROUND.**

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

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

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

5.4 After the Committee delivered its recommendations to the FAA, the FAA worked with two airlines and 29 airports to validate the Runway Condition Codes of the contaminants on the Runway Condition Assessment Matrix (RCAM) and the feasibility of obtaining an accurate rating of the runway surface condition from airport operations personnel using the TALPA ARC recommended methods. This validation testing lasted two winter seasons (2009-2010 and 2010-2011). After the first season of validation testing, the validation team made modifications to the original RCAM based on the data collected from the airports and correlated pilot braking action reports. These modifications were re-validated the second winter season. The Committee then used this data as the basis for its final recommended RCAM.

5.5 Although the Committee recommended adopting regulations requiring TC holders to produce landing performance data for time-of-arrival landing performance assessments, the FAA did not initiate rulemaking. The FAA issued AC 25-32 in 2015 to support the voluntary implementation of the TALPA ARC recommendations which occurred on October 1, 2016. The FAA published operational guidance in FAA order 8900.1 which eventually was published also in ~~SAFO 19001 (superseding SAFO 06012)~~ AC 91-79B

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

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

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

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

5.10 For the specific situations of landing in abnormal configurations, when an annunciated failure occurs in flight, the flight crew has to analyze the consequences of this failure on the landing. Some failures cause an increase in the landing distance, which must be evaluated. A diversion may be necessary if the destination airport runway is no longer appropriate due to the increased landing distance.

5.11 On this aspect, EASA had a generic certification review item (CRI) interpretative material (IM) document (the content of which was originally drafted by the Joint Aviation Authorities (JAA) Flight Steering Group). This CRI provided guidance, information and recommendations on how to determine and present in the AFM landing distance information appropriate to abnormal configurations; it also provided guidelines on what failure cases should be considered. In FWP 572, it was recognized that some of the failure cases which result in a need to land in an abnormal configuration or with certain normal services unavailable could be such that a significant diversion to a longer landing runway might not be prudent and, to cover these cases, the crews must be given sufficient information to enable them to balance the risks between a possible hazardous diversion and a possible landing overrun.

5.12 In AC 91-79B, the FAA acknowledges that there are situations where the flight crew needs to know the absolute performance capability of the airplane. These situations include abnormal configurations of the airplane or during emergencies such as engine failure or flight control malfunctions. In such circumstances, the pilot must consider whether it is safer to remain in the air or to land immediately and should know the actual landing performance capability (without an added safety margin) when making these evaluations.

5.13 In 2017, EASA published Notice for Proposed Amendment – NPA 2017- 12. This NPA proposed revisions to Certification Specifications, introducing the Section 25.1587(c) requirement and associated AMC (content of which is almost identical to the generic EASA CRI).

5.14 In 2022, the FAA Aviation Rulemaking Advisory Committee (ARAC) tasked the Flight Test Harmonization Working Group (FTHWG) to harmonize the FAA 14 CFR part 25 regulatory standards and advisory material with EASA CS-25 rulemaking activity, as published in March 2018 in CS-25 Amendment 21.

5.15 For the production of AFM non-normal landing distance data, the applicant considers all annunciated failures and assesses their probability of occurrence. In addition, the question of the best presentation of the relevant data should be addressed. This AC does not consider configuration deviation list (CDL) items or any unserviceabilities identified in the master minimum equipment list (MMEL) that are known prior to dispatch.

6 TIME-OF-ARRIVAL LANDING PERFORMANCE ASSESSMENTS.

6.1 Sections 91.605, 91.1037, 121.195, and 135.385 prescribe landing performance requirements that must be met at the time of takeoff. However, compliance with these requirements does not account for the time-of-arrival conditions of the runway that will be used for landing, when calculating whether the airplane can safely land within the distance available on that runway. The distance needed to safely complete the landing at the time of arrival may be different if the runway, runway surface condition, meteorological conditions, approach guidance, airplane configuration, airplane weight, approach speed, or use of airplane ground deceleration devices differs from that used to show compliance with ~~§~~ Section 91.605, ~~§~~ Section 91.1037, ~~§~~ Section 121.195, or ~~§~~ Section 135.385.

6.2 To enhance safety, procedures developed by airplane operators to assess landing performance at the time of arrival should include an adequate safety margin and should consider runway surface conditions/braking action, winds, temperatures, slope, pressure altitude, icing condition, final approach speed, airplane weight and configuration, and deceleration devices used.

6.3 To assist operators in performing this time of arrival landing performance assessment, Section 25.1592(a)(b)(e) requires landing performance data in normal and abnormal configurations to be furnished in the AFM within the operational limits established by the applicant for the airplane. Because of differences in the variables to be taken into account and how the data are to be used, the landing performance data for time-of-arrival landing performance assessments may be different from the landing performance data developed in accordance with ~~§~~ Section 25.125 and provided in the Airplane Flight Manual in accordance with ~~§~~ Section 25.1587(b).

6.4 ~~§~~ Section 25.125 dry runway landing distances are often determined in a way that represents the maximum performance capability of the airplane, which may not be representative of normal operations. For use in time-of-arrival landing performance assessments, where the conditions at the time of arrival are known and taken into account, it is beneficial if the landing performance data are representative of actual operations. The data for time-of-arrival landing performance assessments should represent expected landing performance by a trained flight crew of average skill following AFM operating procedures and training.

6.5 Like the landing distances defined in ~~§~~ Section 25.125, the landing distances for use for time-of-arrival landing performance assessments should consist of the horizontal distance from the point at which the main gear of the airplane is 50 feet above the landing surface to the position of the nose gear when the airplane is brought to a stop, as required by ~~§~~ Section 25.1592(d). See Figure 1 of this AC.

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

- Runway surface condition descriptions used in field condition reports originated by airports are provided in terms of runway condition code by thirds and contaminant type and depth by thirds,
- Braking action reports from pilots relayed by air traffic controllers,

- Development of airplane performance data for different runway surface conditions and runway condition reports,
- Use of field condition reports and airplane performance data by pilots and airplane operators to make their time-of-arrival landing performance assessments.

7 DEFINITIONS.

7.1 Dry Runway.

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

7.2 Wet Runway.

A runway is wet when it is neither dry nor contaminated. For purposes of condition reporting and airplane performance, a runway can be considered wet when more than 25 percent of the runway surface area (within the reported length and the width being used) is covered by any visible dampness or water that is ⅛ inch (3 mm) or less in depth.

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

7.3 Contaminated Runway.

For purposes of condition reporting and airplane performance, a runway is considered contaminated when more than 25 percent of the runway surface area (within the reported length and the width being used) is covered by frost, ice, and any depth of snow, slush, or water. Definitions for each of these runway contaminants are provided in paragraphs 7.3.1 through 7.3.8 of this AC.

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

7.3.1 <u>Dry Snow.</u>

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

7.3.2 <u>Wet Snow.</u>

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

7.3.3 <u>Slush.</u>

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

7.3.4 Compacted Snow.

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

7.3.5 Frost.

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

7.3.6 Water.

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

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

7.3.7 Ice.

The solid form of frozen water.

7.3.8 Wet Ice.

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

7.4 **Loose Contaminants.**

Water, slush, wet snow, and dry snow are loose contaminants. For loose contaminants, the depth of the contaminant can affect both the airplane's acceleration and deceleration capability.

7.5 **Runway Condition Reports.**

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

7.6 **Pilot-Reported Braking Action.**

Pilot-reported braking action is a subjective assessment of runway slipperiness. The pilot bases the assessment on observations of braking deceleration and directional controllability during landing rollout. Since the type of runway contaminant is not identified in a pilot braking action report, landing performance data based on pilot-reported braking action should not include any effects of contaminant drag. Braking action can be categorized with the terms provided in paragraphs 7.6.1 through 7.6.6 of this AC.

7.6.1 Good.

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

7.6.2 Good-to-Medium.

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

7.6.3 Medium.

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

7.6.4 Medium-to-Poor.

Braking deceleration or directional control is between medium and poor.

7.6.5 Poor.

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

7.6.6 Nil.

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

7.7 Aircraft Braking Action Report.

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

7.8 Runway Condition Code (RWYCC).

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

7.9 Runway Surface Condition.

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

7.10 Solid Contaminants.

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

7.11 Slippery When Wet.

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

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

7.12 **Specific Gravity.**

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

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

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

8 **TIME-OF-ARRIVAL PERFORMANCE DATA.**

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

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

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

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

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

Runway Condition Code	**Runway Surface Condition Description**	**Pilot-Reported Braking Action**	**Tire-to-ground Braking Coefficient**
6	• Dry	—	95% of certified friction limited part of the model used to comply with § Section 25.125[1].
5	• Frost • Wet (includes damp and ⅛″ (3 mm) depth or less of water) ⅛″ (3 mm) depth or less of: • Slush • Dry snow • Wet snow	Good	Per method defined in § Section 25.109(c).
4	-15 °C and colder outside air temperature: • Compacted snow	Good to Medium	0.20[2]
3	• Wet ("slippery when wet" runway) • Dry snow or wet snow (any depth) over compacted snow Greater than ⅛″ (3 mm) depth of: • Dry snow • Wet snow Warmer than -15 °C outside air temperature: • Compacted snow	Medium	0.16[2]
2	Greater than ⅛″ (3 mm) depth of: • Water • Slush	Medium to Poor	(1) For speeds below 85% of the hydroplaning speed[3]: 50% of the tire-to-ground braking coefficient determined in

Runway Condition Code	Runway Surface Condition Description	Pilot-Reported Braking Action	Tire-to-ground Braking Coefficient
			accordance with § Section 25.109(c), but no greater than 0.16; and (2) For speeds at 85% of the hydroplaning speed[3] and above: 0.05[2].
1	• Ice	Poor	0.07[2]
0	• Wet Ice • Water on top of compacted snow • Dry snow or wet snow over ice	Nil	Not applicable. (No operations in Nil conditions.)

[1] 100% of the tire-to-ground braking coefficient used to comply with § Section 25.125 may be used

- If the braking coefficient used to comply with § Section 25.125 already includes the 0.95 factor, or
- If the testing from which that braking coefficient was derived was conducted on portions of runways containing operationally representative amounts of rubber contamination and paint stripes.

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

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

[3] The hydroplaning speed, V_P, may be estimated by the equation $V_P = 9\sqrt{P}$, where V_P is the ground speed in knots and P is the tire pressure in lb/in^2.

8.3 Time-of-Arrival Landing distance data should cover all normal operations with all engines operating within the operational limits established by the applicant for the airplane. The effect of each of the parameters affecting landing distance should be provided, and should take into account the following:

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

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

8.3.3 Pressure altitudes within the operational limits established by the applicant for the airplane;
8.3.4 Weights up to the maximum takeoff weight;
8.3.5 Expected airspeeds at the runway threshold, including speeds up to the maximum recommended final approach speed considering possible speed additives, e.g. for winds and icing conditions;
8.3.6 Temperatures within the operational limits established by the applicant for the airplane;
8.3.7 Winds within the operational limits established by the applicant for the airplane (1) not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing; and (2) not less than 150 percent of the nominal wind components along the landing path in the direction of landing;
8.3.8 Runway slopes within the operational limits established by the applicant for the airplane; and
8.3.9 Icing conditions, if required to provide the landing distances required under ~~§~~ Section 25.125 in icing conditions.

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

8.5 Specific guidance relative to landing distances for abnormal configurations is described in ~~§~~ paragraph 12.

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

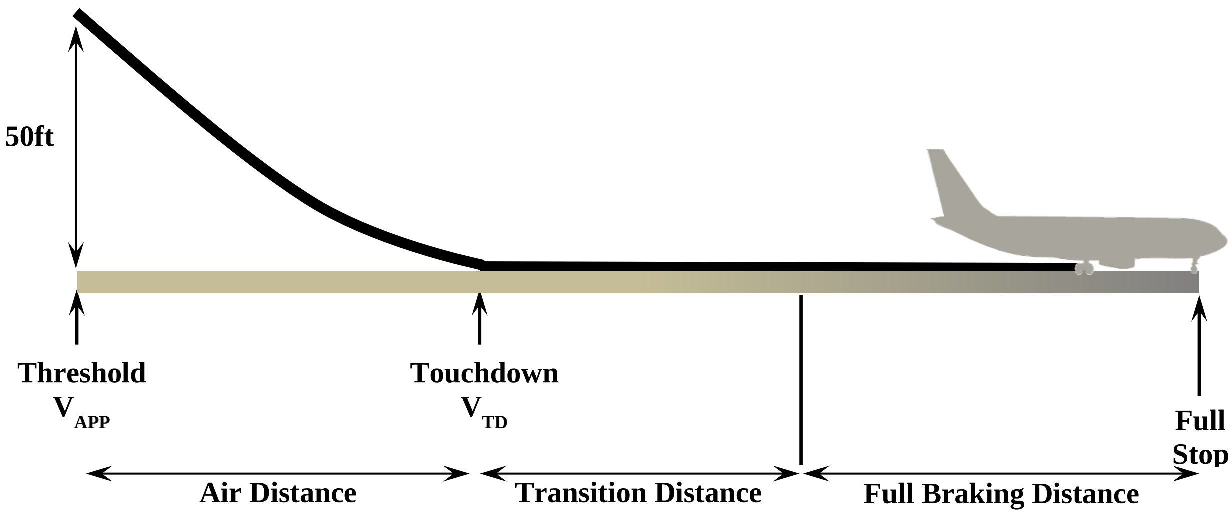
Note: Approval for operation on specially prepared winter runways requires demonstration of the effectiveness of such treatment with monitoring of actual braking action indicated by airplane data.

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

9.1 Landing Distance.

9.1.1 The landing distance consists of three segments: an airborne segment, a transition segment, and a final stopping configuration (full braking) segment, as shown in Figure 1 below.

Figure 1. Landing Distance Segments



9.1.2 The landing distance for a time-of-arrival landing performance assessment may be determined analytically from the landing performance model developed to show compliance with § Section 25.125. For the purposes of determining landing distance for time-of-arrival assessments, the model should be modified as described in the following paragraphs.

9.1.3 Changes in the airplane's configuration, speed, power, and thrust used to determine the landing distance for time-of-arrival landing performance assessments should be made using procedures (normal or non-normal as appropriate) established by the data provider for operation in service. These procedures should—

- Be able to be consistently executed in service by flight crews of average skill;
- Use methods or devices that are safe and reliable; and
- Include allowance for any time delays that may reasonably be expected in service. (See paragraphs 9.3.2, 9.3.3, and 9.3.4 of this AC.)

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

9.2 **Air Distance.**

9.2.1 As shown in Figure 1 of this AC, the air distance is the distance from a height of 50 feet above the landing surface to the point of main gear touchdown. In the context of the determination of Landing Distances at Time of Arrival, this definition of the air distance assumes that the airborne distance for compliance with § Section 25.125 was determined by one of the methods described in AC 25-7X or later in § paragraph 4.11.2.

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

9.2.2 The air distance used for any individual landing at any specific runway is a function of the runway approach guidance, runway slope, use of any airplane features or equipment (for example, heads-up guidance, autoflight systems, etc.), pilot technique, and the inherent flare characteristics of the specific airplane.

9.2.3 Unless the air distance used for compliance with § Section 25.125 is representative of an average pilot who is flying in normal operations (see paragraph 9.2.4 below), the air distance used for time-of-arrival landing performance assessments should be determined analytically as the distance traversed over a time period of 7 seconds at a speed of 98 percent of the recommended speed over the landing threshold, also referred to as the final approach speed (V_{APP}). This represents a flare time of 7 seconds and a touchdown speed (V_{TD}) of 96 percent of V_{APP}. V_{APP} should be consistent with the TC holder's recommended procedures and training material, including any speed additives, such as may be used for winds or icing. The effect of higher speeds, to account for variations that occur in operations or through the operating procedures of individual operators, should also be provided.

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

9.2.4.1 Procedures should be used that are consistent with the TC holder's recommended procedures and training for operations in service. These procedures should address the recommended final approach airspeed, flare initiation height, thrust/power reduction height and technique, and target pitch attitudes.

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

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

Note: The criterion of paragraph 9.2.4.3 above should not be construed to mean that all of the landing data used to determine the air distance may have a touchdown rate of descent of 4 feet per second. The flight test data should contain a range of touchdown rates ranging from 1 to 4 feet per second.

9.2.5 The air distance determined under paragraph 9.2.3 or 9.2.4 of this AC also applies to autoland or similar low visibility guidance systems as long as the demonstrated average flare time and V_{TD}/V_{APP} from the autoland or low visibility guidance testing do not exceed the values of those parameters used in determining the manual landing distance. If they do exceed the values used in determining the manual landing distance, then the demonstrated average flare time and V_{TD}/V_{APP} from the autoland or low visibility guidance system demonstrations may be used for computing the air distance when determining the autoland or low visibility guidance system landing distance. The autoland or low visibility guidance system test data used for this determination should be from a representative set of airports and not include extreme glide path intercept points or runway slopes.

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

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

9.3 **Transition Distance.**

9.3.1 As shown in figure 1, the transition distance is the distance traveled from the point of main gear touchdown to the point where all deceleration devices used in determining the landing distance are operating. For airplanes for which the air distance is determined using the guidance in paragraph 9.2.3 of this AC, the speed at the start of the transition segment is 96 percent of the final approach speed.

9.3.2 The transition distance should be based on the recommended procedures for use of the approved means of deceleration, both in terms of sequencing and any cues for initiation. Reasonably expected time delays should also be taken into account.

9.3.3 For procedures that call for initiation of deceleration devices beginning at nose gear touchdown, the minimum time for each pilot action taken to deploy or activate a deceleration means should be the demonstrated time, but no less than one second.

9.3.4 For procedures that call for initiation of deceleration devices beginning prior to nose gear touchdown, the minimum time for each pilot action taken to deploy or activate a deceleration means should be the demonstrated time plus one second.

9.3.5 For deceleration means that are automatically deployed or activated (for example, auto-speedbrakes or autobrakes), the demonstrated time may be used with no added delay time.

9.3.6 The distance for the transition segment, and the speed at the start of the final stopping configuration segment should include the expected evolution of the braking force achieved over the transition distance. The evolution of the braking force should take into account any differences that may occur for different runway surface conditions or pilot-reported braking actions as the airplane transitions to the full braking configuration. (See Table 1 in section 8.2 of this AC for the tire-to-ground braking coefficient).

Note: The tire-to-ground braking coefficients in Table 1 of this AC were determined by the TALPA ARC Part 25 working group, based on their experience and accepted performance levels on different surfaces as defined by aircraft certification agencies (EASA). They were verified to the greatest degree possible by the latest industry flight testing as embodied by the Joint Winter Runway Friction Program, which was active from 1995 to 2004. This AC may be revised if future industry-level acceptance of new information becomes available.

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

9.4.1 As shown in Figure 1, the final stopping configuration (full braking) segment begins at the end of the transition segment, which is the point where all deceleration devices used in determining the landing distance are operating. It ends at the nose gear position when the airplane comes to a stop.

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

10 ACCOUNTING FOR DRAG OF LOOSE CONTAMINANTS.

10.1 Loose contaminants result in additional contaminant drag due to the combination of displacement of the contaminant by the airplane tires and impingement of the contaminant spray on the airframe and are not included in the time-of-arrival landing distance based on Runway Condition Code or Pilot-Reported Braking Action. However additional time-of-arrival landing distance data for Runway Surface Condition which does take credit for the benefit of the drag associated with loose contaminants of snow, slush and water may be provided.

10.2 This contaminant drag associated with the loose contaminants provides an additional force helping to decelerate the airplane, which reduces the distance needed to stop the airplane. Because contaminant drag increases with contaminant depth, the deeper the contaminant is, the shorter the stopping distance will be. However, the actual contaminant depth is likely to be less than the reported depth for the following reasons:

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

10.2.2 The procedure for reporting contaminant depths is to report the highest depth of the contaminant along the reported portion of the runway surface. Contaminant depths are unlikely to be uniform over the runway surface (or reported portion of the runway surface), so it is likely there will be areas of lesser contaminant depth.

10.2.3 In a stable weather environment (that is, no replenishment of the contaminant on the runway), the contaminant depth is likely to decrease as successive airplanes traverse through it and displace the contaminant.

10.3 If the actual contaminant depth is less than the reported value, using the reported value to determine contaminant drag will result in a higher drag level than actually exists, leading to an optimistic stopping distance prediction. Therefore, the FAA recommends not including the effect of contaminant drag in the calculation of landing distances for time-of-arrival landing performance assessments. If the effect of contaminant drag is included, it should be limited to no more than the drag resulting from 50 percent of the reported depth.

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

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

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

10.5 If the effect of contaminant depth is included in the landing distance data, then data should be provided for the specific gravities in the table 2 below.

Table 2. Loose Contaminant Specific Gravity

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

Runway Description	**Specific Gravity**
Water	1.0

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

11 **CREDIT FOR REVERSE THRUST.**

11.1 Landing distances used for time-of-arrival landing performance assessments may include credit for the stopping force provided by reverse thrust, consistent with the procedures established for its use and subject to meeting the following criteria:

11.1.1 Procedures used to calculate the landing distance should be consistent with normal procedures for use of reverse thrust during landing. The procedures should include all of the pilot actions necessary to obtain the recommended level of reverse thrust, maintain directional control and safe engine operating characteristics, and return the reverser(s), as applicable, to either the idle or the stowed position.

11.1.2 Using reverse thrust during a landing should comply with the engine operating characteristics requirements of § Section 25.939. The engine should not exhibit any of the adverse engine operating characteristics described in AC 25.939-1 (or later revision). The reverse thrust procedures may specify a speed at which the reverse thrust is to be reduced to idle in order to maintain safe engine operating characteristics.

11.1.3 The time sequence for the actions necessary for the pilot to select the recommended level of reverse thrust should be achievable by the average pilot. If the procedure is to deploy reverse thrust at nose gear touchdown, the time for the first action to select reverse thrust may not be less than one second. If the procedure is to deploy reverse thrust before nose gear touchdown, the time for the first action to select reverse thrust should be the demonstrated time plus one second.

11.1.4 The response times of the affected airplane systems to pilot inputs should be taken into account. For example, delays in system operation, such as thrust reverser interlocks that prevent the pilot from applying reverse thrust until the reverser is deployed, should be taken into account. The effects of transient response characteristics, such as reverse thrust engine spin-up, should also be included.

11.1.5 To enable a pilot of average skill to consistently obtain the recommended level of reverse thrust under typical in-service conditions, a lever position that incorporates tactile feedback (for example, a detent or stop) should be provided. If tactile feedback is not provided, a conservative level of reverse thrust should be assumed.

11.1.6 If the data provider chooses to develop data using the process described in this AC, the effects of crosswinds on directional controllability should be assessed and particular attention paid to the possibility of reverse thrust affecting airflow over the rudder and vertical tail surface. Thrust reverser use may even reduce directional controllability in combinations of crosswinds and low friction conditions. Recommendations or guidelines associated with crosswind landings, including maximum recommended crosswinds, should be provided to operators for the runway surface conditions/reported braking actions for which landing distance data are provided. A suitable simulation may be used to develop these guidelines for operation on contaminated runways.

11.1.7 If the data provider, in using the process described in this AC, applies credit for less than all thrust reversers, then controllability should be accounted for in that configuration. The reverse thrust procedures may specify a speed at which the reverse thrust is reduced to idle in order to maintain directional controllability.

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

11.1.9 For dispatch with one or more inoperative thrust reverser(s), or for an in-flight failure that affects thrust reverser operation, the effect on the landing performance data for time-of-arrival landing performance assessments should be provided.

11.1.10 The effective stopping force provided by reverse thrust in each, or at the option of the data provider, the most critical landing configuration, should be accounted for by flight test. (One method of determining the reverse thrust stopping force would be to compare unbraked runs with and without the use of thrust reversers.) Regardless of the method used to calculate the effective stopping force provided by reverse thrust, flight tests should be conducted using all of the stopping means on which the landing distances are based in order to calculate the landing distances and ensure that no adverse combination effects are overlooked. These tests may be conducted on a dry runway.

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

12 LANDING DISTANCE IN ABNORMAL CONFIGURATIONS

12.1 As required by 25.1592(b), landing performance information associated with abnormal landing configurations must be furnished in the AFM. This information should be established considering the guidance and methods described in paragraphs 8 to 11, except for the specificities of abnormal configurations described in this paragraph, with the following conditions:

12.1.1 The airplane is in the landing configuration appropriate to the failure case being considered;

12.1.2 The expected speed at runway threshold is not less than that recommended by the non-normal procedure, appropriate to the failure case being considered.

12.1.2.1 It is intended that in deriving the landing distance for the abnormal configuration, which is required by Section 25.1592(b) to be furnished in the AFM, the applicant should use procedures that are generally based on the application of conventional speed margins required by Section 25.125(b)(2). However, it is acknowledged that for failure cases, this is not always practical. Where the procedure uses less than the conventional margin, this should be based on flight evaluation. This should be stated in the AFM, or advice on how this might affect the way the approach is conducted should be provided (e.g. reduced pitch maneuvering capability and the ability to counteract wind shear). Nevertheless, when justified, a combination of simulation and analysis may be acceptable.

12.1.2.2 Where the AFM procedure specifies an approach and/or landing threshold speed for the abnormal configuration, if the AFM also recommends speed additives (e.g. for winds/gusts, autothrottle), it should clearly explain how they are to be applied and also indicate if there is a maximum total speed allowed.

12.1.2.3 The applicant should provide information on the effects of a 10 knots overspeed, in excess of the minimum approach speed recommended for the abnormal condition, or as limited by the maximum recommended final approach speed.

12.1.3 All deceleration devices with which the airplane is fitted, including reverse thrust (see paragraph 11), may be used during the on-ground part of the landing without consideration of the reliability criteria in paragraph 9.1.3 and paragraph 11.1.8, to an extent dependent both on the characteristics of the airplane and on the use of available deceleration devices, provided that the following are satisfied:

12.1.3.1 A practical procedure for their use has been established;

12.1.3.2 Directional control can be readily maintained during their use on a wet runway with a crosswind component of 10 knots from the adverse side. For wet runway conditions and for contaminated runway conditions (at the option of the applicant), directional controllability in this crosswind condition may be evaluated using a nose wheel free to caster on a dry runway.

Note: if asymmetric braking is necessary to maintain directional control in this condition, the effect on deceleration should be included in the landing distance.

12.1.3.3 They would be available, and their use not prohibited, for the failure case being considered.

12.2 As required by Section 25.1592(b), landing distances in abnormal configurations must be determined on dry and wet runways and furnished in the approved part of the AFM. At the option of the applicant, landing distances in abnormal configurations on contaminated runways may also be furnished in an approved part of the AFM.

If approved data is not provided on all runway surface conditions / RWYCC, it must be clear for which runway surfaces the data is approved in the non-normal procedure (in a general section or in each non-normal procedure).

The absence of approved data for a given runway surface condition(s) does not require a specific AFM restriction prohibiting operation in that condition(s).

Note: As described in paragraph 8.1, landing performance data should be provided based on the normal terminology of Runway Condition Reporting.

12.3 As required by Section 25.1592(e), landing distances in abnormal configurations must be provided for the range of wind, temperature, average runway slope, pressure altitude, and airplane weight within the operational limits of the airplane, for icing and non-icing conditions, unless otherwise restricted in the AFM by limitations or non-normal procedures associated with the failure condition.

For example, if landing with a brake system failure is restricted by AFM procedure to land on a runway with no tailwind component, performance data need not address tailwind conditions. Conversely, if performance data are provided only for headwind conditions, the AFM non-normal procedure should include restrictions for tailwind landings. “Avoid landing in tailwind conditions” or “Maximum tailwind: XX knots” have been considered suitable restrictions.

To the extent practicable, airplane weights above MLW and up to MTOW should be included.

12.4 The air distance determined in paragraph 9.2 is generally considered valid to compute abnormal air distances without further justification. For failures that significantly affect the air time and/or speed bleed off, it should be further justified, by engineering judgement, analysis, simulator and/or flight test.

12.5 The applicant should provide landing distance information, in the AFM, for abnormal configurations resulting from:

12.5.1 Single failures and combinations of failures that have a probability of occurrence greater than approximately 10^{-7} and that result in an increase in the landing distance; or

12.5.2 Failures that result in an increase in the landing distance and have a related non-normal procedure in the AFM, regardless of the probability of occurrence.

12.6 Landing distances in abnormal configurations should be determined and furnished in the AFM without incorporating a safety margin so that the crew would know the absolute performance capability of the airplane and evaluate whether it is safer to remain in the air or to land immediately. This is consistent with the AC 91-79B guidance.
The AFM should be clear that the landing distances in abnormal configurations do not contain a safety margin (the general section of the non-normal procedures may be used for this purpose).

12.7 The paragraph 12 of this AC does not consider configuration deviation list (CDL) or any unserviceabilities identified in the master minimum equipment list (MMEL) that are known prior to dispatch.

13 GUIDANCE FOR EXISTING TYPE DESIGNS.

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

14 DOCUMENTATION.

14.1 Data Location.

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

14.2 Other Information.

The following information should also be provided:

14.2.1 Instructions for use.

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

14.2.3 Maximum depth of contaminants.

14.2.4 Any other recommendation associated with use of the landing performance data.
In particular, for methodologies using failure coefficients to be applied on a nominal reference distance to compute landing distance in abnormal configurations, the AFM should be clear about how this reference distance is to be computed, especially which parameters and recommended speed additives at the runway threshold are accounted for. The AFM should also be clear about what runway surface conditions the coefficients are valid for.

14.2.5 Statements that the data are based on a uniform depth (for loose contaminants) and uniform coverage of a layer of contaminant with uniform properties throughout.

14.2.6 The procedures and assumptions used to develop the operational landing distances.

Advisory Circular Feedback

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

Subject: AC 25.1592 Date: Click here to enter text.

Please check all appropriate line items:

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

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