FAA Aviation Rulemaking Advisory Committee
FTHWG Topic 22
Derated / Reduced Takeoff Thrust

Recommendation Report
24 June, 2024

Table of Contents

Executive Summary

The Flight Test Harmonization Working Group was tasked with providing recommendations for harmonization and clarification of guidance on derated and reduced takeoff thrust certification, in particular regarding the maximum permitted thrust reduction from maximum approved takeoff thrust, and to consider the use of reduced thrust on contaminated runways.

The group has not identified any immediate safety concerns with existing guidance, but notes that existing lack of harmonization increases the workload and complexity when seeking approval from multiple certification agencies.

A gain in safety may be achievable by permitting the use of reduced thrust (also known as assumed temperature method or Flex) on contaminated runways. The group had identified in Topic 30, dealing with low-speed engine failure during takeoff, that the use of reduced thrust would improve controllability in these scenarios on contaminated runways. Furthermore, for operators being exposed to long periods of winter operations with aircraft without fixed derates, when maximum approved takeoff thrust is not necessary, the use of reduced thrust would significantly reduce the engine stress, thus improving engine reliability and thus safety.

This report recommends:

- Updated text for the FAA AC 25-13 that can serve as a basis for a harmonized text with the corresponding EASA guidance in CS-25 AMC 25-13.
- Updated text for Automatic Takeoff Thrust Control System (ATTCS) guidance in AC 25-7D Chapter 23.3
- Updated text for EASA CS-25 Appendix I that can serve as a basis for a harmonized text with the corresponding FAA 14 CFR part 25 Appendix I for installation of ATTCS. This proposal is based on “Federal Aviation Administration Aviation Rulemaking Advisory Committee, Transport Airplane and Engine Issue Area, Powerplant Installation Harmonization Working Group Task 10 – Continuous Airworthiness Assessments [DOCID:fr27de00-139]” proposals and conclusions.

Background

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

There is no safety issue arising from the current regulations, as intended.

The group proposes in this task to make changes to the associated guidance material, considering the following:

- Performance margins beyond those required by regulation, stemming from higher excess thrust for maximum approved takeoff thrust, should not be considered as mitigation means for potential errors at dispatch such as incorrect data entry by flight crew in the performance computation software or the Flight Management Computer, incorrect runway line-up or pilot decision to stop after V_1. These issues are not specific to operations with derated or reduced thrust and should be addressed at their root by various means (procedures or airplane systems) rather than by requiring arbitrary margins,

- For operations at reduced thrust/power, 14 CFR 25.101(c) and paragraph 4.1.2.4 of AC 25-7D assure that the mathematical model of the engine thrust/power is substantiated over the range of thrust/power for which approval is sought.
- Testing by several manufacturers indicated that there was no marked difference seen in engine failure recognition and pilot reaction time in case of derated/reduced takeoff thrust,
- The long-standing methods for the derivation of contaminated runway performance models are empirical and not based on testing with the actual airplane type. Some manufacturers do calibrate the standing water contaminant drag models with actual water trough tests. The group continues to recommend the application of these models in the report for Topic 32 “Codification of TALPA”. In particular, simulation on slippery runways by manufacturers shared during Topic 30 discussions indicated that, disregarding any potential adverse impact on the longitudinal takeoff distances or exposure time at low speed, the use of 10% derate thrust instead of maximum approved takeoff thrust resulted in approximately 20% lower lateral deviations. The group extensively discussed the validity of V_{MCG} on contaminated runways but recognizes that V_{MCG} determined on a dry runway with nosewheel free to caster has historically fulfilled the safety requirements. Airplane performance should remain consistent for a given thrust level, be it achieved at maximum approved takeoff thrust or using derate.
- Since 2021, the Global Reporting Format of runway conditions is applicable, which is built around the principle of correlating airplane performance with reported runway surface condition. There is thus less room for interpretation of the report for performance computations, which should as a result better reflect the actually achievable performance.
- The original AC 25-13 prohibited takeoffs with reduced thrust on contaminated runways. The standing water, slush, wet snow and dry snow contaminants can cause displacement drag and impingement drag retarding forces that reduce the airplane acceleration during the takeoff run. If an engine failure occurs, the aircraft acceleration is further reduced between the decision speed, V_1, and the rotation speed, V_R. However, the authorities generally did not prohibit the use of derated thrust for takeoff on contaminated runways. The manufacturers did consider contaminant drag retarding forces in the derated thrust takeoff performance calculations using the JAA/EASA methodology. Nonetheless, a takeoff with derated thrust or a takeoff with reduced thrust both result in the same airplane acceleration capability for the same thrust reduction vs. maximum approved thrust, assuming the same calculation methodology is used. In both cases, the aircraft manufacturer can calculate takeoff performance for the specified thrust reduction using methodology that duly accounts for the effects of contaminant drag forces, for all-engines operating or for engine failure considerations. This is also applicable to accelerate-stop scenarios using the appropriate braking coefficients and reverse thrust. Therefore, derated thrust and reduced thrust takeoffs on contaminated runways can be permitted as long as the manufacturer calculates contaminant drag effects in order to get representative takeoff speeds and distances. Some manufacturers have imposed $V_1=V_R$ for derated thrust takeoffs on contaminated runways since this removes the risk of reduced acceleration capability between V_1 and V_R.

Some aspects were identified and mitigated by procedures or specific conditions, which require consideration in the proposals developed for this topic:

- Service history indicates that mis-set thrust and throttle push after an engine failure during derated takeoffs have occurred.

The group considers that a safety improvement can be achieved by the proposal,

- By reducing the asymmetry of thrust in case of an engine failure on slippery runways at low speed (see Topic 30 report),
- By reducing the exposure to engine failures during takeoff due to reduced engine stress,

What is the task?

The task of the FTHWG is to:

1) Harmonize and clarify the requirements and guidance material from various agencies
    - AC/AMC 25-13
    - AC 25-7D Chapter 23.3
    - 14 CFR part 25 and CS-25 Appendix I
    - FCAR

2) Assess Means of Compliance or alternate Means of Compliance for
    - Fixed derates
    - Reduced thrust, assumed temperature (Flex)
3) Define criteria for use of reduced and derated thrust on contaminated runways
4) Harmonize the allowable thrust limit percentages
5) Clarify the use of ATTCS combined with reduced and/or derated thrust

Note: The wording above reflects the tasking from the workplan, refined for improved readability.

Why is this task needed?

The latest engine technology, with its superior fuel efficiency and minimal CO_2 emissions, elevates aircraft operations, aiding airlines in meeting emissions and sustainability goals. The engine time on wing and associated maintenance costs are significantly influenced by the percentage of derated/reduced thrust used during operations. Operators are encouraged to achieve higher percentages of derated/reduced thrust takeoff, but currently AC 25-13 limits thrust reduction to 25%, while AMC 25-13 authorizes up to 40% reduction.

Harmonizing agency advisory material, such as FAA and EASA AC/AMC 25-13, is essential for consistency in reduced thrust capabilities.

In 14 CFR part 25 Appendix I, using ATTCS, the initial thrust setting for takeoff must not fall below 90% of the maximum approved takeoff thrust. In contrast, EASA places no limit on the initial takeoff thrust setting but restricts thrust for compliance with CS-25 performance requirements to 111% of the initial thrust setting. This discrepancy may limit the takeoff weight for FAA-certified airplanes, potentially leading to revenue loss and reduced payload compared to EASA-certified counterparts.

The lack of comprehensive guidance in current AC/AMC 25-13 on derated takeoff thrust has led to regulatory disparities. Some authorities issue Certification Review Items or Certification Memoranda, creating an uneven playing field in the industry.

Both AC 25-13 and AMC 25-13 prohibit reduced takeoff thrust on contaminated runways. However, for operators facing extended winter operations without fixed derates, utilizing reduced thrust on slippery runways can significantly decrease engine stress, enhancing reliability and safety by avoiding unnecessary maximum approved takeoff thrust takeoffs.

Who has worked the task?

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

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

Also included in discussions were two members of the Society of Aircraft Performance and Operations Engineers (SAPOE).

Any relation with other topics?

Topic 30 – Controllability during Low Speed OEI RTO,
Topic 32 – Codification of Takeoff and Landing Performance Assessment (TALPA)
Powerplant Installation Harmonization Working Group DocId fr27de00-139

Historical Information

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

<u>EASA</u>
AMC 25-13
CS-25 Appendix I
CRIs on maximum thrust reduction
CS 25.1591 & AMC 25.1591

<u>FAA</u>
AC 25-13
14 CFR part 25 Appendix I
AC 25-7D paragraph 23.3 Automatic Takeoff Thrust Control System
AC 25-7D paragraph 42.2 Reduced and Derated Power or Thrust Takeoff Operations
FAA IP on maximum thrust reduction and transition to climb thrust

<u>TCCA</u>
Discussion Paper dp34
Certification Memorandum FT-21

<u>ANAC</u>
FCAR (ELOS) “Performance Credit for Use of ATTCS during Open Reduced Thrust Takeoffs”

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

The primary difference between FAA AC 25-13 and EASA AMC 25-13 is the maximum permitted thrust reduction from maximum approved takeoff thrust, which is 25% for the FAA and 40% for EASA.

Another aspect is that the FAA does not permit to take performance credit from an Automatic Takeoff Thrust Control System (ATTCS) for takeoff with reduced thrust while EASA does.

Appendix I for ATTCS reflects a different philosophy between FAA and EASA, as the FAA considers that maximum approved takeoff thrust must be available to the pilot at all times.

TCCA has historically raised concerns regarding the validity of V_{MCG} on contaminated runways and the conservatism of contaminant drag models, which have led to forbidding the use of derated thrust on runways affected by loose contaminants.

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

Several CRIs were applied to designs for type certification by EASA based on the draft material now published in AMC 25-13 (starting at Amendment 13) to permit up to 40% thrust reduction. The FAA has applied similar issue papers.

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

Not applicable

Recommendation

A. *Rulemaking*

1. What is the proposed action?

The FTHWG recommends harmonizing FAA 14 CFR part 25 and EASA CS-25 Appendix I based on the proposal in Appendix 1 of this report.
The changes addressed are based on doc [DOCID:fr27de00-139] from the Powerplant Installation Harmonization WG. The WG recommendations are:

- **Harmonization of editorial differences**. As an editorial change, the current § I25.3, "Performance and System Reliability Requirements" would be split into two sections: § I25.3 "Performance Requirements," and § I25.4 "Reliability Requirements". The remaining current §§ I25.4 through I25.6 would be renumbered as §§ I25.5 through I25.7. For the most part, the harmonized standard would be based on the current EASA standard. Miscellaneous editorial changes are proposed to improve clarity.
- **Thrust or power setting**. The proposed harmonized standard would replace the FAA limitation that the initial thrust or power setting must not be less than 90 percent of the thrust or power set by the ATTCS system after an engine failure

with the EASA requirement that the thrust used to show compliance with the applicable one-engine-inoperative climb requirements not be greater than 111 percent of the thrust obtained at the initial thrust or power setting. Both standards are intended to ensure an adequate climb capability with all engines operating and to limit the degradation of performance if the critical engine fails and the ATTCS system fails to apply maximum takeoff thrust or power on the operating engine(s).

The proposed harmonized standard would allow performance credit for a thrust or power increase limited to 111 percent of the initial thrust or power set at the beginning of the takeoff. A thrust or power increase of 111 percent is equivalent to the increase achieved in going from an initial setting of 90 percent to 100 percent of the thrust or power set by the ATTCS system after an engine failure.

- **Inadvertent operation**. The proposed harmonized standard would include the additional EASA requirement regarding the potential for inadvertent operation. The current EASA I25.4(c) would be adopted as harmonized § I25.4(c).
- **Means to deactivate**. In recognition that modern FADEC controls have the ATTCS system as an integral part of the engine control and hence abnormalities or apparent inadvertent operation indicates a basic control function fault or failure, a dedicated means to deactivate the ATTCS system may not be required. Reducing power or thrust to idle or shutting down the engine may be the appropriate action. In the proposed harmonized standard, current § I25.5(b)(4) (new § I25.6(c)(2)) would be revised to indicate that a means to deactivate the automatic function need not be provided if it can be shown that such a means is unnecessary for safety. Typically, this would involve substantiation that the ATTCS system without a switch can comply with §25.1301 and §25.1309 and that a deactivation means will never be needed in order to maintain the same level of safety as would be present if a switch was available.

The group recommends applying these conclusions to the current EASA CS-25 Appendix I. The proposal in Appendix 1 of this document is a consolidated proposal from the initial [DOCID:fr27de00-139] and the FTHWG proposals. This can serve as a basis for a harmonized text with the corresponding FAA 14 CFR part25 Appendix I.

The group also recommends modifying FAA AC 25-13 as proposed in Appendix 2 to:

- Update definitions of wet and contaminated runways based on AC 25-31X from the Topic 32 recommendation report
- Add a definition of slippery wet runway
- Add Reduced Thrust Acceptable Means of Compliance to:
  (1) Integrate a minimum 60% of the maximum approved takeoff thrust
  (2) Give credit for ATTCS on performance computations
  (3) Give credit for MCT thrust above reduced thrust for Final Takeoff Segment (FTO) performance computations
  (4) Authorize the use of reduced thrust and derated thrust on all runway conditions provided that takeoff performance duly accounts for contaminant drag effects

(5) Provide means to verify the availability of reduced takeoff thrust or derated takeoff thrust not only based on periodic maximum approved takeoff thrust demonstrations

- Add Derated Thrust Acceptable Means of Compliance to:
  (1) Integrate a minimum 60% of maximum approved takeoff thrust
  (2) Provide new criteria similar to reduced thrust guidance.
  (3) Consider throttle push during derated thrust takeoff

2. What should the harmonized standard be?

The 14 CFR part 25 Appendix I should also be harmonized with CS-25 Appendix I to avoid differences in system design requirements and operational impacts.

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

Harmonization of 14 CFR part 25 Appendix I continues to ensure that incorporation of such a system provides a level of safety intended by the basic Part 25 requirements, by adopting the appropriate existing FAA/EASA standards and adding safety standards from applicable special conditions issued for capabilities added since the standards were adopted.

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

The proposed 14 CFR part 25 Appendix I standard maintains the level of safety by incorporating existing accepted regulatory requirements and adds the EASA requirement relative to inadvertent operation of the system.

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

The proposed standard maintains the level of safety (see Section above).

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

The group did not consider other options than what is presented in this 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. The manufacturers will need to update the AFM and Performance Software to allow operations with derated thrust and reduced thrust per the new proposed standard (contaminated runways operations, allowable thrust reduction percentage, credit for ATTCS with reduced thrust, etc.).
Manufacturers of the engines and engine power control systems for those airplanes that automatically reset thrust or power on the operating engine(s) in the event of the failure of an engine could be affected by the proposed change.

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

The proposed changes overlap with recommendation made by PIHWG [DOCID:fr27de00-139].

B. ***Advisory Material***

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

The existing FAA AC 25-13 advisory material is technically adequate but not fully harmonized with other certification agencies. The proposed harmonized draft AC 25-13X presented in Appendix 2 is updated to reflect current systems design and latest aircraft certification standards thereby avoiding the use of IP or CRI.

The proposed AC 25-13X standards maintain the level of safety by incorporating accepted CRI/IP/CM and maintain/improve the level of safety by authorizing the use of reduced thrust on contaminated runways.

An update is proposed to FAA AC 25-7D paragraph 23.3 to align with the proposed changes to 14 CFR part 25 Appendix I.

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 would reduce the burden of demonstrating compliance to different certification agencies, it is expected that the proposal will reduce the financial burden on OEMs of multiple certifications from different agencies. However, manufacturers will have additional costs for producing the new performance data taking credit of the derated thrust and reduced thrust updated methodologies.

For operators, usage of derated thrust and reduced thrust on contaminated runways will reduce engine maintenance costs since maximum approved takeoff thrust will not be required each time a takeoff is performed on a contaminated runway. Engine maintenance costs are directly proportional to the use of maximum approved takeoff thrust. In addition, fuel consumption and therefore fuel cost will be reduced during takeoff.

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

Yes

Consensus/Comment/Dissent

Consensus

There is a consensus on the harmonization of the minimum thrust used for takeoff permitted by EASA AMC 25-13.
Some discussions not to limit the maximum cumulative thrust reduction to 40% from maximum approved takeoff thrust in case of use of reduced thrust on top of a derate took place but the group agreed to retain the minimum 60% thrust restriction from maximum approved takeoff thrust published in AMC 25-13. During EASA AMC drafting process, the first EASA proposal was to remove the 75% limitation and propose an unlimited takeoff thrust reduction. After a TCCA comment showing concerns on this lack of thrust limitation, EASA agreed "with the proposal to limit the reduced thrust setting such that it should not be less than 60% of the maximum approved takeoff thrust as this will harmonize with TCCA/FAA standards". The FAA standard was considered to come from an FAA Issue Paper allowing reduced thrust down to 60%.

There is a consensus on updating AC 25-13 wet runway definition and adding slippery wet and contaminated runway definitions based on AC 25-31X from the Topic 32 recommendation report.

There is a consensus on authorizing the use of reduced thrust and derated thrust takeoff on contaminated runways, provided appropriate limitations, procedures and performance information are established and are included in the AFM. On contaminated runways covered by loose contaminants (standing water, slush, wet snow or dry snow), contaminant effects (displacement drag, impingement drag and reduced braking friction) should be considered in evaluating the takeoff speeds and distances in accordance with AC 25.1591 from the Topic 32 recommendation report. The reduced thrust and derated thrust procedures must also comply with 14 CFR 25.101(f) and (h). The group decided to remove the following limitation from *AC 25-13: 5.f. (1) Are not authorized on runways contaminated with standing water, snow, slush, or ice, and are not authorized on wet runways unless suitable performance accountability is made for the increased stopping distance on the wet surface.*

There is a consensus on the possibility to take credit of certified ATTCS system on reduced takeoff thrust performance compliance demonstration. This was possible in AMC 25-13 and not possible in AC 25-13.

There is a consensus on providing means to verify the availability of reduced takeoff thrust or derated takeoff thrust not only based on periodic takeoff demonstrations at maximum approved takeoff thrust. This was possible in AC 25-13, but AMC 25-13 only refers to periodic demonstration. The proposed harmonized AC 25-13X opens the door to other means that should be approved by authorities. The group considered an Engine manufacturer's comment and feedback:
EASA NPA 2011-09 comment 56:
An approved engine maintenance procedure or an approved engine condition monitoring program may be used to replace the periodic takeoff demonstrations. The rationale is that an appropriate condition monitoring program provides quantified margin between the engine's current condition and the published airworthiness limits. The engine health and thrust margin can be trended and accurate forecasts made to remove the engine before its performance becomes unacceptable. (Exceeds limits published in the instructions for continued airworthiness). This monitoring process is better controlled and gives more information than the individual demonstration to see whether the engine can / cannot make full takeoff on that occasion.
Airbus Engine OEM comment:

Engine monitoring should be sufficient and even more efficient. Periodic demonstrations may not identify engine deterioration in some specific corner points (Pressure altitude, temperature) where you may need [maximum approved takeoff] *thrust. Depending on aircraft operations, it may not be possible to have sufficient periodic demonstrations covering the potential range of operating conditions.*

§ 7.c. The group agreed to delete the limitation on considering thrust above initial thrust setting.
~~*7. c. ... However, the thrust settings used to show compliance with the takeoff flight path requirements of § 25.115 and the final takeoff climb performance requirements of § 25.12l(c) should not be greater than that established by the initial thrust setting.*~~
A new proposal authorizes credit given by ATTCS for 14 CFR 25.115 compliance demonstration. The rationale for the existing text provided by the FAA is that AC 25-13 is owned by the Propulsion group (AIR-625) under Policy & Standards. The idea of no configuration changes, other than retracting the gear, before 400 ft comes from the CARs. The specific language regarding no change in power/thrust setting by the pilot was introduced at Amendment 25-54. This is based on the belief that any increase in thrust that is necessary to meet the performance requirements during the critical portion of takeoff should be fully automatic.
For §25.115, since 1988, some ATTCS were certified with the consideration of increased thrust/power for performance computations.
EASA added this specific possibility in AMC 25.13.
TCCA: In the discussion paper about derated takeoff there is some credit for increased thrust / power for the Final Takeoff segment.
For compliance to §25.121(c), the group considers that the rationale above is not applicable.
As maximum continuous thrust cannot be selected below 400ft, the consideration of increased thrust/power above initial takeoff thrust/power does not contradict the interpretation of the requirement provided by the FAA. Looking at the PIHWG report on ATTCS, rationale not to rely on manual thrust change above 400ft was mainly for crew workload considerations. The proposal gives the possibility to permit credit of manual thrust increase above 400ft only if the thrust selection is included in the standard AFM engine failure procedure.

There is a consensus on 14 CFR part 25 Appendix I harmonization based on the previous PIHWG report with some improvements proposed by the FTHWG.

The group decided to propose Means of Compliance for derated thrust takeoff. The group considers that the current AC/AMC 25-13 are fully harmonized on this point, but the lack of detailed guidance induced EASA, TCCA, FAA to issue IP, CRI or Certification Memorandum and generated non-harmonized certification criteria. There is a group consensus on the derate thrust means of compliance § 8.a (1), (2), (4), (5), and (6) of the proposed AC 25-13X.

Comments

Comment 1:
TCCA is concerned with use of derated thrust on a contaminated runway. Because maximum takeoff weight may become limited by V_{1MIN} (as limited by V_{MCG}) on a contaminated runway, and a lower value of V_{MCG} can be determined with derated thrust, a situation arises in which the maximum permissible takeoff weight for a contaminated runway will be higher than would otherwise be obtained with maximum takeoff thrust.

TCCA recognizes a safety concern with the possibility of higher maximum takeoff weights on a contaminated runway for several reasons: with a lower V_{1MIN}, an aircraft must accelerate for a longer time to obtain V_R associated with this higher weight in the event of an engine failure; the performance modelling of increased rolling resistance due to loose contaminants may contain significant errors in the estimation of contamination drag due to semi-empirical methods; and the use of a V_{MCG} value as determined for dry/wet runway, corrected for derate, is probably not valid for contaminated runway. Of particular concern, minimum control speed on a contaminated runway is affected by reduced cornering friction, rutting in loose contaminants causing reduced directional control, and the effect of an adverse crosswind on V_{MCG} increases significantly as runway friction decreases.

As mitigation for these concerns, TCCA has prohibited use of derated thrust on runways contaminated with standing water, slush or snow but does allow use of derate for runways contaminated with compacted snow or ice.

Group discussions on this point:
The Proposed AC 25-13X § "8. Derated Thrust: Acceptable Means of Compliance" is fully consistent with the AC 25-13 1988 document on this point. It does not suppress any limitation from the current AC. The group position is not to restrict or limit operations on contaminated runways using derated thrust or reduced thrust. Derated thrust V_{MCG} considerations for contaminated runways should not be limited by this AC proposal. It is the current standard for aircraft certified under FAA and EASA.
This specific subject was also discussed during Topic 32 for draft AC 25-31X with the same conclusions.

Regarding the Topic 32 report for the draft AC 25-31X, Takeoff Performance Data for Operations on Contaminated Runways, one of the referenced regulations is 14 CFR 25.107 (Takeoff Speeds), which includes §25.107(a)(1) referring to V_{EF} not being less than V_{MCG} determined under §25.149(e). §25.149(e) for V_{MCG} is not listed in the draft AC, and thus not considered affected by operation on contaminated runways.

Relevant content in the proposed AC 25-31X includes:

1. Para 8.1: "*Contaminated runway takeoff performance data is determined by calculation, using the takeoff performance model developed from flight tests and used to show compliance with the takeoff performance requirements in subpart B, as modified by the guidance provided in this AC*." There is no modification of V_{MCG} for contaminated runway surfaces identified in this proposed AC.
2. Para 8.2: "*Except for the effects of the contaminant on braking friction and drag, **the takeoff performance requirements of subpart B applicable to a wet runway should be used in developing the contaminated runway takeoff performance data***." This could be considered to apply to V_{MCG} considerations for takeoff speeds.
3. Para 9.5: "*It is recommended that applicants consider the effects of directional controllability associated with crosswind and other factors, such as airplane gross weight, center of gravity position, and takeoff thrust setting. Recommendations or guidelines should be provided to operators to mitigate the effects of these items on directional controllability for different runway conditions. Minimum V1 and/or crosswind guidance may need to be adjusted in consideration of*

the reduced controllability following engine failure on a contaminated runway." This does suggest that guidance should be provided for crosswinds and engine failure considerations, including potential increases in V1, but doesn't explicitly say that a new V_{MCG} is to be determined for contaminated runways.

4. Para 12.2 says the following information should be provided in the AFM: "*The provision of performance information for contaminated runways should not be taken as implying that ground handling characteristics on these surfaces will be as good as those that may be achieved on dry or wet runways, in particular following engine failure, in crosswinds or when using reverse thrust*."

The bottom line is that this guidance applies regardless of the thrust rating (full/maximum approved thrust or derate thrust). If the reason a derate thrust setting can't be used on a contaminated runway is due to concerns regarding the validity of the V_{MCG} determined on a dry runway with nose wheel steering set to caster, then providing contaminated runway takeoff data at full/maximum approved thrust using the §25.107(a)(1) wet runway determined V_{EF} and V_1 speeds would be equally inappropriate. That is not what the proposed AC 25-31X says (reference item 2 above).

In Topic 32 the group agreed to the adoption of the contaminated runway modelling in line with what had been approved previously in line with JAA and EASA guidance. These methods were accepted by the TALPA ARC; in particular it was proposed to retain the V_{MCG} demonstrated on dry runway, in line with EASA standards, considering the short time exposure to engine failure around V_{MCG}. Don Stimson (FAA) and Jim Martin (TCCA), who were members of the part 25 group, drafted the following statement to complement this decision:

It is recommended that manufacturers consider the effects of directional controllability associated with crosswind and provide recommendations or guidelines to the operators for different runway conditions. Minimum V_1 and/or crosswind guidance may need to be adjusted in consideration of the reduced controllability following engine failure on a contaminated runway. This is an area where additional research may be necessary before a useful recommendation as to regulatory activity on Vmcg or crosswind considerations in conjunction with contaminated runway can be made.

EASA confirmed this decision during the implementation of the Global Reporting Format (GRF) in RMT.0296, which provided an opportunity for comment to the industry.

EASA AMC 25.1591 The derivation and methodology of performance information for use when taking-off from slippery wet and contaminated runways

7.4.1 Minimum V1

For the purpose of take-off distance determination, it has been accepted that the minimum V1 speed may be established using the VMCG value established in accordance with ***CS 25.149(g).***

No adverse comment was raised then or in this group during the discussions on Topic 32. Topic 22 was considered not being the right place to deal with methodology itself and addressed the question to the chairmen on how the FTHWG might take this subject on. The doubt on V_{MCG} determination is not linked to thrust level. It may be due to runway condition. The group considered that interpretation of Amendment 42 intentions were to cover slippery runways. The way pre-amendment 42 was written and the associated comments could be interpreted as: Pre-amendment was for dry and wet (with demonstration on wet), and this was not OK beyond dry and wet, so the change of the amendment was to cover V_{MCG} beyond dry and wet (slippery).

Finally, regarding TCCA's concern for performance modelling of the contaminant drag, it is noted that the risk of insufficient acceleration between V_1 and V_R (after engine failure on the ground) can be mitigated by setting V_1 equal to V_R when operating on loose contaminants (standing water, slush, wet snow or dry snow). With reduced thrust or derated thrust on a contaminated runway, the aircraft will have lower acceleration capability than when using maximum approved takeoff thrust. However, the manufacturer's performance calculations will account for the contaminant drag forces (displacement drag and impingement drag) to calculate the required takeoff speeds and distances for the applicable thrust setting. The contaminant drag methodology recommended by EASA (and endorsed by TCCA and the FAA) is applicable for maximum approved thrust or for derated/reduced thrust as it is independent of engine thrust. Further imposing $V_1=V_R$ ensures that the aircraft rotates as the failed engine begins to spool-down therefore preventing a long acceleration distance between V_1 and V_R. The higher V_1 increases the accelerate-stop distance (reduced braking friction but credit for contaminant drag) but this is considered one acceptable means to allow operations with reduced thrust or derated thrust on contaminated runways.
Although such guidance was not proposed for AC 25-13, some guidance related to this concern should be included in AC 25-31X and AC 25.1591, from Topic 32 recommendation report.

Comment 2:
Throttle push consideration for derate takeoffs
EASA has shared arguments with the FTHWG to support why this action is a pilot error reasonably expected in service that can be considered under requirement §25.1302. Increasing thrust above the maximum derated thrust is a cognitive error resulting from a practice, or from previous training or experience. To expand on this point:

- For reduced thrust takeoff, the pilot is allowed to increase the thrust. It is at pilot discretion. It is not prohibited and in training is even presented as an option to improve aircraft climb performance. Use of Reduced and Derated thrust during consecutive takeoff operations can lead to a reasonable source of confusion.

- When combining Reduced thrust and Derated thrust, the increase of thrust from Reduced to Derated thrust is often not clearly defined in the throttle quadrant and can be overridden easily. This is a weak barrier to a reasonable crew error.

- The AFM imposes a limitation to prohibit increasing thrust above Derated thrust during takeoff, but sometimes with the caveat 'except in case of emergency'. This enhances the scope for pilot error by permitting the action as long as the pilot considers that there is an emergency. This caveat reduces even further the effectiveness of the limitation as a barrier to the crew error.

- The pilot will have his/her own perception of what constitutes an insufficient rate of climb, particularly on two-engine aircraft for which the crews are accustomed to relatively high climb rates when all-engines are operating. The significant reduction in climb rate after takeoff when an engine fails increases the risk that the pilot chooses to increase thrust, even if the aircraft is meeting the required minimum climb gradient.

25.1302 would provide the framework to assess the throttle push during derated thrust takeoff when the throttle quadrant design allows to do it and there is no aircraft design solution to prevent or mitigate the safety concern.

Comment 3
ATTCS – Contingency thrust.
The proposed guidance in this report aims at covering the concept of ATTCS in two ways, as a restoration system and as a boost system. Both concepts have been certified in the past. The discussions have highlighted the fact that CS-25.20(a)(1) is not harmonized with the other authority regulations. CS-25.20(a)(1) states:

> ‘The requirements of this Subpart B apply to aeroplanes powered with turbine engines –
> (1) Without contingency thrust ratings’

Contingency thrust is not defined in CS-25. Contingency thrust has been proposed as a thrust setting higher than the thrust that was set at the beginning of the take-off roll, if that thrust has a time limit less than the one found acceptable by authorities, intended for use with One Engine Inoperative (OEI). This definition is coherent with the history of the regulation, per JAA NPA 25B-208. NPA 25B-208 was published and commented in 1997. It was proposed to bring JAR-25.20 into line with the engine certification specifications (CS-E), which would allow OEI ratings to be established. An amended 25.20 was proposed, with details for the use of the OEI ratings in a new Appendix (Appendix L) and a cross-reference to Appendix I governing ATTCS. The NPA appears to have been mature but was never incorporated either into the JAR or the CS during the transition to EASA.

As a result, due to this regulation, EASA does not accept Contingency thrust Ratings (for use in OEI conditions) and the ATTCS cannot provide contingency thrust.

Response of the group: The FTHWG considers that the proposals in this report do not promote the use of contingency thrust. The group recommends this comment to be discussed in ARAC Engine and Powerplant Interface Working Group, with special attention to the definition of contingency thrust.

Dissents

(Refer to Boeing dissenting position in Appendix 3.)

Throttle push consideration.
AC 25-13 (1988) § 5. a. (3) includes considerations for a throttle push during reduced thrust takeoffs.

§ 5. a. (3) Enables compliance with the applicable engine operating and airplane controllability requirements in the event that takeoff thrust, or derated takeoff thrust (if such is the performance basis), is applied at any point in the takeoff path.

This paragraph dealing with reduced thrust takeoff is well understood and kept as is in the AC proposal § 7. a. (3).
During new § 8. Derated Thrust: Acceptable Means of Compliance drafting, the group discussed a similar means of compliance for derated takeoff thrust.

If this requirement is fully applicable in reduced thrust considerations, throttle push considerations may not be so obvious for derated thrust takeoff. The AC 25-13 (1988) contains a clear limitation on thrust selection during derated thrust takeoff.

6. The AFM limitations section should indicate that when operating with derated thrust, the thrust setting parameter should be considered a takeoff operating limit.

The new proposal maintains this requirement and reinforces it.

AC 25-13X proposal: *§ 8. a. (2) …The AFM limitations section should indicate that when operating with derated thrust, the thrust setting parameter should be considered a takeoff operating limit, in particular, in order for the crew not to intentionally select the thrust beyond the maximum thrust or power approved for use following engine failure during takeoff.*

The group debated about the need to consider this throttle push during a derated takeoff when it violates an AFM limitation.

EASA has issued a CRI where this demonstration is required:

Derated takeoff procedure assessment must consider the incorrect setting of the selected rating during takeoff ground roll, and the possible voluntary full rating [maximum approved takeoff thrust] *selection during other takeoff segments*.

TCCA also requested throttle push considerations in certification Memorandum FT-21, which required Airbus Canada (then Bombardier) to conduct pilot-in-the-loop simulations with throttle push at V_1 to determine the minimum runway width applicable for derated thrust takeoffs.

As there was no consensus, a first vote was organized to get a majority position for the group. The questions asked were:

Consideration of pilot abuse throttle push to maximum approved takeoff thrust from derated thrust takeoff:

- Shall not be covered in AC 25-13
- Shall be covered in AC 25-13 for takeoff climb segments only
- Shall be covered in AC 25-13 for takeoff ground roll and climb segments

A majority voted for option 3. The group decided to discuss this point and decide what could be the means of compliance to cover it.

Following additional intensive discussions, the FTHWG reached the following position:

Group discussions:

Throttle push at V_1 is considered as not realistic.

Pilots are trained to be Go-minded and procedures will ask not to change thrust at V_1 call-out (Pilots are trained to remove their hand from the throttle at V_1 call-out).

As a consequence, a throttle push may be decided some time after V_1.

Acceptable simulations could be:

- Engine failure at V_1 and xx sec of delay for the throttle push.
- Once the pilot recovers directional control following engine failure at V_1, then push.
- Assume engine failure at V_1 + 3 sec and throttle push at engine failure + 3 sec.
- Define the throttle push to a specific point on the runway (e.g., distance from end).

Analyzing all these options, the coverage of throttle push during takeoff roll is very limited (time between V_1+xx and V_{loff} is very short).

The group reopened the question about throttle push considerations during takeoff ground roll.

Is it reasonable to assume throttle push during takeoff roll? (probability)

Considering:

- pilot training,
- requirement from the regulation not to change thrust/power level below 400ft,
- feedback from ALPA, SAPOE and OEM pilots in the group, the group decided that throttle push during takeoff roll does not need to be assessed.

However, it was concluded that a throttle push during climb should be considered as a pilot may decide to go beyond the AFM limitations in case of absolute necessity. (e.g., avoidance maneuver, windshear alert) or by mistake.
The proposal in AC 25-13X provides requirements for throttle push considerations during takeoff climb at V_2.
After drafting of this proposal and following some strong positions not to cover this consideration in AC 25-13, two additional votes were organized.
First vote question: “Throttle push for derated thrust takeoff (including reduced thrust combined with derate)”

- Should NOT be addressed
- Should be addressed in the draft proposal

A majority voted for option 2 and decided to confirm that the draft should address this possibility.
Second vote question: “Throttle push for derated thrust takeoff (including reduced thrust combined with derate)”

- Should address takeoff climb phase only
- Should address takeoff roll AND takeoff climb phases
- Should address takeoff roll only (on ground assessment)

With this vote, the group validated the drafted proposal and confirmed that this proposal should include a demonstration of controllability for a throttle push during takeoff climb.
The FTHWG was not able to reach consensus on this position and Boeing submitted a dissent on this proposal.

Refer to Appendix 3 for the dissent letter from Boeing.

Note: Based primarily on the lack of a controllability related regulation to which the proposed maneuver is linked and lack of clear pass-fail criteria for the controllability assessment, Gulfstream, Embraer and Textron support the Boeing dissent.

Group Response to dissent.

The group recognizes the lack of consensus regarding which specific Part 25 regulations should be referenced in the AC guidance concerning parent regulations. Nevertheless, several proposals were discussed. EASA considers CS 25.1302 as an applicable regulation. The group proposed referencing §25.107, viewing a throttle push as a reasonably expected deviation from established procedures and training. Other Part 25 regulations discussed were §25.143 and §25.149. The group considers that there should be an applicable regulation and the AC draft does not constitute rulemaking by AC. The group decided to propose guidance 8.a.(3) in the report based upon the group majority position and let the Office of Rulemaking decide to keep or reject it.

Boeing believes that a limitation outlined in the Airplane Flight Manual is adequate to prevent pilot throttle push during derated thrust takeoff. Even if the group agrees that AFM limitation violations should not be addressed as a reasonably expected deviation from established procedures, the group considers a throttle push during derated thrust takeoff as a special case for the following reasons:
- For reduced thrust takeoff, pilots are permitted to increase thrust. The combined use of Reduced and Derated thrust can lead to confusion.
- When combining Reduced thrust and Derated thrust, the increase of thrust from Reduced to Derated thrust is often not clearly defined in the throttle quadrant and can be overridden easily.

- The AFM imposes a limitation to prohibit increasing thrust above derated thrust during takeoff, but if the thrust is available, pilots may consider this limitation not applicable in case of emergency. Some AFMs even contain the sentence ’except in case of emergency’.
- The significant reduction in climb rate after takeoff when an engine fails increases the risk that the pilot chooses to increase thrust, even if the aircraft is meeting the required minimum climb gradient.

Pilots committing the error to violate AFM limitations through omission or simple reflex can reasonably be expected in-service.

The group discussed the necessity of defining conditions for the demonstration and establishing clear pass/fail criteria to facilitate this compliance demonstration. The initial proposal suggested a very high-level approach without specific conditions or pass/fail criteria, akin to the current EASA CRI.
(3) is assessed considering the possible full rating selection through the power lever (when this selection remains available to the pilot), during climb take-off segments. Controllability should be assessed if the thrust goes beyond the thrust level used to determine V_{MC}.
This assessment should be made in the conditions of 25.121(b)(1) in non-icing conditions only. Acceptable controllability should be demonstrated. It should not require exceptional piloting skills and should not necessitate movement of the engine, propeller, or trim controls, and should not result in excessive control forces.

The initial proposal was deemed not sufficiently precise, leading to possible misinterpretations and potentially unfair evaluations among different regulators.

Subsequently, the group decided to propose certain conditions for the demonstration. Although these conditions do not establish explicit pass/fail criteria, they delineate the demonstration conditions and the evaluation process for throttle push.

The group acknowledged that clear pass/fail criteria could be delineated in the AC. However, due to the time constraints for delivering the report, the group opted to approve the proposal without these criteria.

APPENDIX 1 - PROPOSED STANDARDS AND RATIONALE

NEW RECOMMENDED 14 CFR PART 25 REGULATIONS

Regulation	Comments
PART 25 APPENDIX I	Delete current 14 CFR part 25 Appendix I and replace it with the proposed Appendix I based on EASA CS-25 Appendix I and Powerplant Integration HWG recommendations [DOCID:fr27de00-139]

Rationale:

The FTHWG recommends to harmonize 14 CFR part 25 and CS-25 Appendix I based on doc [DOCID:fr27de00-139] from the Powerplant Installation Harmonization WG (PIHWG).
The initial proposal was based on JAR 25 Appendix I. At this time, JAR and FAR were not using the same terminology to define the function. JAR (Appendix I December 1987) was using Automatic Performance Reserve (APR), FAR (Appendix I Nov. 9, 1987) was using Automatic Takeoff Thrust Control System (ATTCS). The PIHWG proposed to use APR for harmonization purpose. Since then (EASA ED Decision 2003/2/RM), EASA integrated JAR Appendix I in EASA CS-25 Appendix I and changed APR into ATTCS.
In this report, the FTHWG recommend to apply the PIHWG doc fr27de00-139 conclusions to current EASA CS-25 Appendix I (ED Decision 2003/2/RM). As such, both FAA and EASA Appendix I are proposed to use ATTCS terminology and not APR. This reflects current publications and this avoids changing other Part 25 requirements and guidance using ATTCS.
The proposal in Appendix 1 of this document is a consolidated proposal from the initial [DOCID:fr27de00-139] and the FTHWG proposals.
This can serve as a basis for a harmonized text with the corresponding FAA Part 25 Appendix I.

14 CFR part 25 Appendix I proposal:

Title 14—Aeronautics and Space
Chapter I —Federal Aviation Administration, Department of Transportation
Subchapter C—Aircraft
Part 25—Airworthiness Standards: Transport Category Airplanes

Note that the strikethrough text (indicating deletions) and grey highlighted text (indicating new or modified text) are relative to EASA CS-25 Appendix I.

1. Appendix I – Automatic Takeoff Thrust Control System (ATTCS)

I 25.1 General

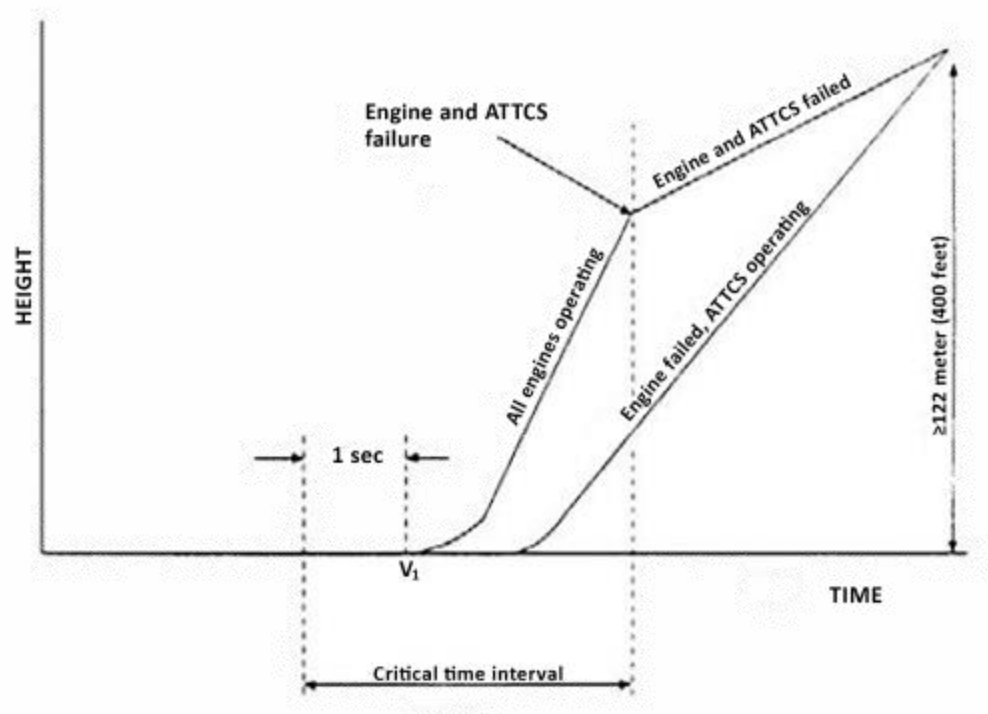
(a) This Appendix specifies additional requirements and limitations for airplanes equipped with an engine control system that automatically reset thrust or power on the operating engine(s) when any engine fails during take-off, and for which performance credit is limited to that of paragraph 25.3(b) of this Appendix. When performance credit is not so limited, Special Conditions will apply.

(b) With the ATTCS system and associated systems functioning normally as designed, all applicable requirements of Part 25, except as provided in this Appendix, must be met without requiring any action by the crew to increase thrust or power.

I 25.2 Definitions

(a) *Automatic Takeoff Thrust Control System (ATTCS)*. An ATTCS system is defined as a system which automatically resets thrust or power on the operating engine(s) when any engine fails during take-off. For the purpose of the requirements in this Appendix, the ATTCS system comprises all elements of equipment necessary for the control and performance of each intended function, including all devices both mechanical and electrical that sense engine failure, transmit signals and actuate fuel controls or power levers of the operating engine(s) to achieve scheduled thrust or power increases, the engine control system and devices which furnish cockpit information on system operation.

(b) *Critical Time Interval*. When conducting an ATTCS take-off, the critical time interval is between one second before reaching V_1, and the point on the gross take-off flight path with all engines operating where, assuming a simultaneous engine and ATTCS system failure, the resulting flight path thereafter intersects the gross flight path, determined in accordance with §25.115, at not less than 400 feet above the take-off surface. This definition is shown in the following figure:



(c) *Maximum approved takeoff thrust or power* is the maximum takeoff thrust or power established for the airplane under Part 25. It may not exceed the takeoff thrust rating limits established for the engine under Part 33.

(d) *The maximum available takeoff thrust or power* is the thrust or power that the engine can achieve by the ATTCS system or by manual means in accordance with airplane flight manual procedures (versus the thrust or power that performance credit is based upon).

I 25.3 Performance requirements

All applicable performance requirements of Part 25 must be met with the ATTCS system functioning normally as designed, except that the propulsive thrust obtained from each operating engine after failure of the critical engine during take-off, and the thrust at which compliance with the one-engine-inoperative climb requirements in §25.121(a) and (b) is shown, must be assumed to be not greater than the lesser of –

(a) The actual propulsive thrust resulting from the initial setting of power or thrust controls with the ATTCS system functioning normally as designed, without requiring any action by the crew to increase thrust or power until the airplane has achieved a height of 400 feet above the take-off surface; or

(b) 111 percent of the propulsive thrust which would have been available at the initial setting of power or thrust controls in the event of failure of the ATTCS system to reset thrust or power, without any action by the crew to increase thrust or power until the airplane has achieved a height of 400 feet above the take-off surface.

Note 1. The limitation of performance credit for ATTCS system operation to 111 percent of the thrust provided at the initial setting is intended to:

(i) Assure an adequate level of climb performance with all engines operating at the initial setting of power or thrust controls, and

(ii) Limit the degradation of performance in the event of a critical engine failure combined with failure of the ATTCS system to operate as designed.

Note 2. For propeller-driven airplanes, propulsive thrust means the total effective propulsive force obtained from an operating engine and its propeller.

I 25.4 Reliability requirements

(a) The occurrence of an ATTCS system failure or a combination of failures in the ATTCS system during the critical time interval which –

(1) Prevents the insertion of the required thrust or power, must be shown to be Remote;

(2) Results in a significant loss or reduction in thrust or power, must be shown to be Extremely Improbable.

(b) The concurrent existence of an ATTCS system failure and an engine failure during the critical time interval must be shown to be Extremely Improbable.

(c) The inadvertent operation of the ATTCS system must be shown either to be Remote or to have no more than a minor effect.

(d) The safety analysis must include consideration, as applicable, of an ATTCS system failure occurring after the time at which the flight crew last verifies that the ATTCS system is in a condition to operate until the end of the critical time interval.

I 25.5 Thrust or power setting

The initial setting of thrust or power controls on each engine at the beginning of the take-off roll may not be less than the lesser of –

(a) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or

(b) That shown to be free of hazardous engine response characteristics when thrust or power is increased from the initial take-off thrust or power level to the maximum approved take-off thrust or power.

I 25.6 Powerplant controls

(a) *General*

(1) In addition to the requirements of §25.1141, no single failure or malfunction, or probable combination thereof, of the ATTCS system, including associated systems, may cause the failure of any powerplant function necessary for safety.

~~(2) The ATTCS system must be designed to perform accurately its intended function without exceeding engine operating limits under all reasonably expected conditions.~~

(2) The ATTCS system must be designed to apply thrust or power on the operating engine(s), following any one engine failure during takeoff, to achieve the maximum available thrust or power for use following engine failure during take-off without exceeding engine operating limits.

(b) *Thrust or Power Lever Control*. The ATTCS system must be designed to permit manual decrease or increase in thrust or power, in the all-engines operating and one- engine inoperative cases, up to the maximum available thrust or power approved for use following engine failure during take-off through the use of the normal thrust or power controls, except that, for airplanes equipped with limiters that prevent ~~engine operating limits from being exceeded~~ attaining such thrust or power via thrust/power control, other means may be used to increase thrust or power provided that the means is located in an accessible position on or close to the thrust or power levers, is easily identified, and operated under all operating conditions by a single action of either pilot with the hand that is normally used to actuate the thrust or power levers.

(c) *System Control and Monitoring.* The ATTCS system must be designed to provide –

(1) A means for checking prior to takeoff that the system is in an operable condition; and

(2) A means for the flight crew to deactivate the automatic function. This means must be designed to prevent inadvertent deactivation.

I 25.7 Powerplant instruments

(a) *System Control and Monitoring.* A means must be provided to indicate when the ATTCS system is in the armed or ready condition or, alternatively, to indicate only the failed or not operational condition.

(b) *Engine Failure Warning.* If the inherent flight characteristics of the airplane do not provide adequate warning that an engine has failed, a warning system which is independent of the ATTCS system must be provided to give the pilot a clear warning of engine failure during take-off.

(c) Engine indications must provide sufficient information during the takeoff to show whether or not the engine is capable of achieving the maximum available thrust or power without exceeding engine limits.

APPENDIX 2 – REVISED ADVISORY MATERIAL - AC 25-13 – AC 25-7D

Note that the strikethrough text (indicating deletions) and grey highlighted text (indicating new or modified text) are relative to FAA AC 25-13.

AC 25-13X proposal:

U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Reduced and Derated Takeoff Thrust (Power) Procedures

Date:

Initiated By: ANM-625

AC No: 25-13X

This advisory circular (AC) provides guidance for the certification and use of reduced thrust (power) for takeoff and derated takeoff thrust (power) on turbine powered transport category airplanes. It consolidates guidance concerning this subject and serves as a ready reference for those involved with airplane certification and operation. These procedures should be considered during airplane type certification and supplemental type certification activities when less than maximum approved takeoff thrust (power) is used for takeoff.

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

(page numbering to be specified upon publication)

1. Purpose

This advisory circular (AC) provides guidance for the certification and use of reduced thrust (power) for takeoff and derated takeoff thrust (power) on turbine powered transport category airplanes. It consolidates FAA guidance concerning this subject and serves as a ready reference for those involved with aeroplane certification and operation. These procedures should be considered during airplane type certification and supplemental type certification activities when less than maximum approved takeoff thrust (power) is used for takeoff.

2. Applicability

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

2.2 The guidance in this AC is neither mandatory nor regulatory in nature and does not constitute a requirement.

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

2.4 The guidance provided in this AC can be used both for new airplane designs and for previously certificated airplane designs.

3. Cancellation

This AC cancels AC 25-13, Reduced and Derated Takeoff Thrust (Power) Procedures, dated May 4, 1988.

4. Related Documents

The applicable regulations are §§ 25.101, 25.779, 25.904, 25.1521 and 25.1581 of 14 CFR part 25.

5. Background

Takeoff operations conducted at thrust (power) settings less than the maximum takeoff thrust (power) available may provide substantial benefits in terms of engine reliability, maintenance, and operating costs. These takeoff operations generally fall into two categories; those with a specific derated thrust (power) level, and those using the reduced thrust (power) concept, which provides a lower thrust (power) level that may vary for different takeoff operations. Both methods can be approved for use, provided certain limitations are observed. The subjects discussed herein do not pertain to in-flight thrust cutback procedures that may be employed for noise abatement purposes.

6. Definitions

Customarily, the terms "thrust" and "power" are used, respectively, in reference to turbojet and turboprop installations. For simplicity, only the term "thrust" is used throughout this AC. For turboprop installations, the term "power" should be substituted. For purposes of this AC the following definitions apply:

a. Takeoff Thrust

(1) Rated takeoff thrust, for a turbojet engine, is the approved engine thrust, within the operating limits, including associated time limits, established by the engine type certificate under the provisions of Part 33, and is limited to periods of not more than five minutes for takeoff operations. for use during takeoff operations.

(2) Maximum approved takeoff thrust, for an airplane, is normally the engine rated takeoff thrust, corrected for any installation losses and effects, that is established for the airplane under 14 CFR part 25. Some airplanes use a takeoff thrust setting For some airplanes, maximum approved takeoff thrust is based on a takeoff thrust setting (engine nameplate setting) that is defined at a level that is less than that based on the engine rated takeoff thrust. Section14 CFR 25.1521 requires that the takeoff thrust rating established for the airplane must not exceed the takeoff thrust rating limits established for the engine under Part 33 the engine type certificate. The value of the takeoff thrust setting parameter is presented in the Airplane Flight Manual (AFM) and is considered a normal takeoff operating limit.

b. Derated takeoff thrust, for an airplane, is a takeoff thrust less than the maximum approved takeoff thrust, for which exists in the AFM a set of separate and independent, or clearly distinguishable, takeoff limitations and performance data that complies with all the takeoff requirements of 14 CFR part 25. When operating with a derated takeoff thrust, the value of the thrust setting parameter, which establishes thrust for takeoff, is presented in the AFM and is considered a normal takeoff operating limit.
c. Reduced takeoff thrust, for an airplane, is a takeoff thrust less than the maximum approved takeoff (or derated takeoff) thrust. The airplane takeoff performance and thrust setting are established by approved simple methods, such as adjustments, or by corrections to the takeoff or derated takeoff thrust setting and performance. When operating with a reduced takeoff thrust, the thrust setting parameter, which establishes thrust for takeoff, is not considered a takeoff operating limit.
d. A wet runway is one that 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.
e. A contaminated runway is, a runway where more than 25 percent of the required field length, within the width being used, is covered by standing water or slush more than 0.125 inch (3.2 mm) deep, or that has an accumulation of snow (or ice. However. in certain other situations it may be appropriate to consider the runway, contaminated. For example, if the section of the runway surface that is covered with standing water or slush is located where rotation and 1iftoff will occur, or during the high speed part of the takeoff roll, the retardation effect wil 1 be far more significant than if it were encountered early in the takeoff while at low speed. In this situation, the runway might better be considered "contaminated" rather than "wet."for purposes of condition reporting and airplane performance, a runway of which 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.

Note: The definition of water in the context of condition reporting and airplane performance is the definition in paragraph 6.d. 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).

f. <u>A slippery wet runway</u> is 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.

<u>7. Reduced Thrust: Acceptable Means of Compliance</u>

Under §§ 25.101(c), 25.101(f), and 25.101(h) of ~~the FAR~~ 14 CFR part 25, it is acceptable to establish and use a takeoff thrust setting that is less than the maximum approved takeoff or derated takeoff thrust if:

a. The reduced takeoff thrust setting:

(1) Does not result in loss of systems or functions that are normally operative for takeoff such as automatic spoilers, engine failure warning, configuration warning, systems dependent on engine bleed air, or any other required safety related system.

(2) Is based on ~~an~~ the maximum approved takeoff thrust ~~rating or derating~~, or a derated takeoff thrust, for which complete airplane performance data is provided.

(3) Enables compliance with the applicable engine operating and airplane controllability requirements in the event that maximum approved takeoff thrust, or derated takeoff thrust (if such is the performance basis), is applied at any point in the takeoff path.

(4) Is at least ~~75 percent of the takeoff thrust, or derated takeoff thrust if such is the performance basis~~ 60 percent of the maximum approved takeoff thrust (no derate) for the existing ambient conditions, with no further reduction below 60 percent resulting from Automatic Takeoff Thrust Control System (ATTCS) credit. Consequently, the amount of reduced thrust permitted is restricted when combined with the use of derated thrust so that it is at least 60 percent of the maximum approved takeoff thrust.

The effects of the maximum thrust reduction should be considered when showing compliance with the applicable performance and handling requirements of 14 CFR Part 25 subpart B.

(5) For turboprop installations, is predicated on an appropriate analysis of propeller efficiency variation at all applicable conditions. The selected level of power reduction should allow the arming of the auto-feather function.

(6) Enables compliance with 14 CFR part 25 Appendix I in the event of an engine failure during takeoff, for airplanes equipped with an ATTCS.

b. Relevant speeds (V_{EF}, ~~V_{MC},~~ V_{MCG}, V_{MCA}, V_1, V_R, and V_2) used for reduced thrust takeoffs are not less than those which will comply with the required airworthiness controllability criteria when using the maximum approved takeoff thrust (or derated takeoff thrust, if such is the performance basis) for the ambient conditions, including the effects of an Automatic Takeoff Thrust Control System (ATTCS). ~~It should be noted, however, that in determining the takeoff weight limits, credit~~

~~shou1d not be given for an operab1e ATTCS.~~ It should be noted, as stated in paragraph c. below, that in determining the takeoff weight limits, credit can be given for an operable ATTCS.

c. The airplane complies with all applicable performance requirements, including the criteria in paragraphs a. and b. above, within the range of approved takeoff weights, with the operating engines at the thrust available for the reduced thrust setting selected for takeoff. ~~However, the thrust settings used to show compliance with the takeoff flight path requirements of § 25.115 and the final takeoff climb performance requirements of § 25.12l(c) should not be greater than that established by the initial thrust setting.~~ The thrust settings used to show compliance with the takeoff flight path requirements of § 25.115 can be greater than the reduced thrust setting selected for takeoff if this thrust increase is automatic (ATTCS). The Maximum Continuous thrust setting used to show compliance with the final takeoff climb performance requirements of § 25.121(c) can be greater than the reduced thrust setting selected for takeoff if it results from AFM engine failure procedures or limitation established by the applicant for operation in service.

d. Appropriate limitations, procedures, and performance information, including for all runway states for which operations with reduced takeoff thrust are intended, are established and are included in the AFM. In particular, reduced thrust takeoff performance for operations on contaminated runways should account for contaminant drag effects (displacement and impingement drag forces, when applicable) and reduced braking friction in order to determine the corresponding takeoff speeds and distances (in accordance with AC 25.1591). The reduced thrust procedures must comply with 14 CFR 25.101(f) and (h).

e. ~~A periodic takeoff demonstration is conducted using the airplane's takeoff thrust setting and the event is logged in the airplane's permanent records. An approved engine maintenance procedure or an approved engine condition monitoring program may be used to extend the time interval between takeoff demonstrations.~~

e. The AFM states, as a limitation, that takeoffs utilizing reduced takeoff thrust settings:

~~(1) Are not authorized on runways contaminated with standing water, snow, slush, or ice, and are not authorized on wet runways unless suitable performance accountability is made for the increased stopping distance on the wet surface.~~

(1) Are not authorized ~~when the antiskid system, if installed, is inoperative.~~ when items affecting performance cause significant increase in crew workload.
Examples of these are:

- Inoperative Equipment: Inoperative engine gauges, reversers, anti-skid systems or engine systems resulting in the need for additional performance corrections.

- Engine Intermix: Mixed engine configurations resulting in an increase in the normal number of power setting values.
- Non-standard operations: Any situation requiring a non-standard takeoff technique.

(2) Are not authorized unless the operator establishes a means to verify the availability of maximum approved takeoff thrust or derated takeoff thrust to ensure that engine deterioration does not exceed authorized limits. One acceptable means is to perform periodic takeoff demonstration using the airplane's maximum approved all-engine operative takeoff thrust setting and the event is logged in the airplane's permanent records.

~~(4) Are authorized for airplanes equipped with an ATTCS, whether operating or not, provided no performance credit is allowed for the one-engine-inoperative thrust increase.~~

f. The AFM states that:

(1) Application of reduced takeoff thrust in service is always at the discretion of the pilot.

(2) When conducting a takeoff using reduced takeoff thrust, maximum approved takeoff thrust, or derated takeoff thrust if such is the performance basis, may be selected at any time during the takeoff operation.

g. Procedures for reliably determining and applying the value of the reduced takeoff thrust setting and determining the associated required airplane performance are simple (such as the assumed temperature method). Additionally, the pilot is provided with information ~~to enable him~~ to obtain both the reduced takeoff thrust and maximum approved takeoff thrust, or derated takeoff thrust if such is the performance basis, for each ambient condition.
h. Training procedures are to be developed by the operator for the use of reduced takeoff thrust.

8. Derated Thrust: Acceptable Means of Compliance

~~For approval of derated takeoff thrust provisions, the limitations, procedures. and other information prescribed by§ 25.1581 of the FAR, as applicable for approval of a change in thrust, should be included as a separate Appendix in the AFM. The AFM limitations section should indicate that when operating with derated thrust. the thrust setting parameter should be considered a takeoff operating limit. However, inflight takeoff thrust (based on the maximum takeoff thrust specified in the basic AFM) may be used in showing compliance with the landing and approach climb requirements of§§ 25.119 and 25.12l(d), provided that the availability of takeoff thrust upon demand is confirmed by using the thrust-verification checks specified in paragraph 5e above.~~

It is acceptable to establish and use a derated takeoff thrust setting if:

a. The derated takeoff thrust setting:

(1) Does not result in loss of systems or functions that are normally operative for takeoff such as automatic spoilers, engine failure warning, configuration warning, systems dependent on engine bleed air, or any other required safety related system.

(2) Is approved and the associated limitations, procedures and other information prescribed by § 25.1581 are published in the AFM. The AFM limitations section should indicate that when operating with derated thrust, the thrust setting parameter should be considered a takeoff operating limit, in particular, in order for the crew not to intentionally select the thrust beyond the maximum thrust approved for use following engine failure during takeoff.

(3) Unless mitigated by design or it has been demonstrated as not applicable, and accepted by authorities, derated thrust is assessed considering the possible selection of the maximum approved takeoff thrust through the thrust lever (when this selection remains available to the pilot), during climb takeoff segments.

Controllability should be assessed when the scheduled V_2 speed for the derated thrust is less than V_{MCA} with maximum approved takeoff thrust.

This assessment should start at the critical speed and altitude conditions in a stabilized climb with gear up, critical engine failed, the other engine at the derated thrust setting that results in the maximum thrust reduction, in non-icing conditions.

At these conditions, maximum forward displacement of the thrust levers should be rapidly applied, not reaching over-torque warning for a turboprop, and should not result in an unsafe condition. This can be considered as achieved if the aircraft does not lose height during the maneuver while trying to maintain initial heading. Some transitory heading changes are acceptable.

Some increase of speed may be accepted during the maneuver without requiring an aggressive push over.

It should not require exceptional piloting skills, should not necessitate movement of the engine, propeller, or trim controls, and should not result in excessive control forces. It should be assessed at the critical takeoff flap setting at the initial one engine out climb speed with:

- Critical weight and CG conditions for the controllability demonstration
- One engine failed and other engine(s) operating at derated takeoff thrust prior to throttle push;
- Propeller controls in the derate thrust position;
- The landing gear retracted; and
- The airplane trimmed at the prescribed initial flight condition.

(4) Is at least 60 percent of the maximum approved takeoff thrust for the existing ambient conditions, with no further reduction below 60 percent resulting from Automatic Takeoff Thrust Control System (ATTCS) credit.

(5) For turboprop installations, is predicated on an appropriate analysis of propeller efficiency variation at all applicable conditions. The selected level of power reduction should allow the arming of the auto- feather function.

(6) Enables compliance with 14 CFR part 25 Appendix I in the event of an engine failure during takeoff, for airplanes equipped with an ATTCS.

b. The airplane complies with all applicable performance requirements, including the criteria in paragraph a. above, within the range of approved takeoff weights, with the operating engines at the thrust available for the derated thrust setting selected for takeoff. Although performance credit for pilot action to increase thrust below 400 feet above the takeoff surface is not permitted, performance credit is allowed for an operative ATTCS.

Note: Takeoffs utilizing derated takeoff thrust settings are authorized for airplanes equipped with an ATTCS, whether operating or not.

c. Appropriate limitations, procedures, and performance information, including for all runway states for which operations with derated takeoff thrust are intended, are established and are included in the AFM. In particular, derated thrust takeoff performance for operations on contaminated runways should account for contaminant drag effects (displacement and impingement drag forces, when applicable) and reduced braking friction in order to determine the corresponding takeoff speeds and distances (in accordance with AC 25.1591).

d. The AFM states, as a limitation, that takeoffs utilizing derated takeoff thrust settings:

(1) Are not authorized unless the operator establishes a means to verify the availability of maximum approved takeoff thrust to ensure that engine deterioration does not exceed authorized limits. One acceptable means is to perform periodic takeoff demonstration using the airplane's maximum approved all engine operative takeoff thrust setting and the event is logged in the airplane's permanent records.

e. Training procedures are to be developed by the operator for the use of derated takeoff thrust.

AC 25-7D proposal:

23.3.2.1
In order to comply with the part 25 airplane performance requirements, as required by section I25.3~~(c)~~ of appendix I to part 25, takeoff speeds, as limited by V_{MCG} and V_{MCA}, must reflect the effect of ATTCS operation following failure of the critical engine. It is permissible to publish two sets of takeoff performance data: one for ATTCS unarmed and one for ATTCS armed. In such cases, the AFM limitations, operating procedures, and performance information should clearly differentiate between the two sets of performance data.

23.3.2.3
Manual override of the ATTCS should be verified in flight test. This capability has been provided by the ability of the pilot to push the throttle levers to a higher power or thrust setting, for airplanes that use less than "full-throttle" for takeoff, and by activating an override switch for "firewall-type" fuel control systems. The override switch must be located on or forward of the power or thrust levers, and it must be easily accessible to the pilot's hand that normally controls the power lever or thrust position in accordance with section I25.6(b)~~5(b)(2)~~ of appendix I. It should also be demonstrated that the thrust/power level can be manually decreased at any time following ATTCS operation.

23.3.2.4
A critical time period must be determined during which the probability of concurrent engine and ATTCS failure must be shown to be extremely improbable (not greater than 10^{-9} per flight hour). This critical time period is defined in appendix I to part 25 as being from one second before the airplane attains V1, to a time where the actual takeoff flight path (i.e., no gradient reductions), following a simultaneous engine and ATTCS failure, would intersect the normal (i.e., engine failure at VEF and no ATTCS) one-engine-inoperative actual takeoff flight path at no less than 400 feet above the takeoff surface. The probability of failure of the ATTCS, itself, must be shown to be ~~improbable~~ Remote (not greater than 10^{-5} per flight hour).

23.3.2.5 ~~Performance credit for an operating ATTCS is not to be taken when operations are conducted using reduced takeoff power or thrust methods.~~ If the ATTCS is armed during derated or reduced power or thrust takeoffs, the relevant takeoff speeds should meet the required controllability criteria of part 25 at the power or thrust level provided by operation of the ATTCS. The applicant should demonstrate that the airplane has no adverse handling characteristics and the engine(s) do not exhibit adverse operating characteristics or exceed operating limits when the ATTCS operates.

23.3.2.5.2
Takeoff with an armed ATTCS ~~is not restricted~~ is permitted when airplane performance is based on an approved “derate” power or thrust rating that has corresponding airplane and engine limitations approved for use under all WAT conditions.

APPENDIX 3 – DISSENT

De-rate Throttle Push Demonstration Dissent
B. P. Lee
Boeing
3 April, 2024

The issue:

Proposed recommendation includes a controllability demonstration in Paragraph 8a(3) following a pilot-initiated throttle push to maximum approved takeoff thrust after an engine failure.

Background:

TCCA has a cert memo, has applied to C-series (A220), which refers to conditions “throughout the takeoff”, but focused mostly on the ground phase.

EASA has a CRI (applied to A350), focused on the in-air portion.

It is this latter condition which forms the basis for the proposal in the draft AC material

Dissenting Position:

Boeing disagrees with the proposal in paragraph 8a(3) of the proposed draft of AC 25.13X, included as Appendix 2 of the recommendation report in the following areas and for the following reasons. We believe paragraph 8a(3) should be removed.

Lack of an appropriate applicable regulation

This proposed AC draft purports to provide guidance for certification of reduced- or de-rated thrust for takeoff operations. The AC draft cites as pertinent regulations, 25.101, 25.1521, and 25.1581. None of these regulations relates to controllability of the airplane following an engine failure during takeoff, nor any presumed adverse pilot input on the controls in this event.

While a number of additional regulations have been discussed as potential parent regulations, we have not found a suitable regulation requiring controllability in the event the pilot violates an AFM limitation (which this report emphasizes should be required in Paragraph 8.a.(2)) or employs non-standard or non-approved procedures either deliberately or even inadvertently. Pilots are explicitly trained to respond to an engine out during takeoff by employing control inceptor inputs to fly the specified V2 at the specified thrust setting and maintain a reasonable flight path.

The lack of a regulation to which the proposed demonstration would show compliance constitutes, we believe, rulemaking by AC, which is noted in FAA Memorandum dated 16 December, 1997 (Doug Anderson Memo), identified as JAA Flight Working Paper 621, would not be appropriate, and would likely be rejected in Legal Review at the Office of Rulemaking.

Lack of safety case

Fixed de-rates (including re-setting of Vmc and V2) have been in use for decades. The FTHWG tried, but could not find compelling evidence of a safety case, even in light of a possible plausible crew error such as a very large throttle push.

While we acknowledge that a throttle advance by the pilots beyond the AFM limitation is a plausible action, it should not be treated differently than other plausible but erroneous pilot actions for which there is no evidence of a current or emergent safety case. The industry has historically agreed that, without such evidence, such pilot actions would be contrary to basic airmanship skills and thus do not require a controllability assessment as the outcome is a foregone conclusion.

Boeing is in favor of proactive rulemaking when safety gaps are identified, and would welcome the opportunity to participate in such discussions, however, we believe that this example of a large throttle push in violation of trained procedures and operating limitations (again as recommended in Paragraph 8.a.(s)) is not compelling in light of the service history.

Lack of specific pass/fail criterion

The proposed demonstration as well as the discussions around it have cast this in terms of a “qualitative assessment”. But even qualitative assessments need boundaries. We find that the proposed words “some transitory heading changes” and “some increase in speed” are ambiguous and ill-suited to a certification demonstration or for the applicant to be able to recommend confidently to the regulatory authority that their aircraft would meet such a requirement.

Conclusion

Boeing believes that this proposal represents rulemaking-by-AC, will likely be rejected by the Office of Rulemaking, and presents an undesirable precedent, in terms of policy (regulating controllability in the presence of presumed violations of both limitations and procedures), in terms of flight test safety (conducting a demonstration with maximum approved takeoff thrust from significantly below the full-thrust Vmc), and in terms airplane design (requiring a V2 for a thrust level higher than planned).

Boeing requests that paragraph 8a(3) be removed from the proposed AC draft.