European Union Aviation Safety Agency	**Equivalent Safety Finding** Alternative Category A continued take-off and balked landing procedures	Doc. No.: ESF-G29.1587.01 Issue : 1 Date : 09 JUL 2021 Proposed ☐ Final ☒

SUBJECT	:	Alternative Category A continued take-off and balked landing procedures
REQUIREMENTS incl. Amdt.	:	**CS 29.1587 (a) (6) Amdt. 2**
ASSOCIATED IM/MoC	:	Yes☐ / No ☒
ADVISORY MATERIAL	:	FAA AC 29-2C dated September 30, 2008.

INTRODUCTORY NOTE:

The following Equivalent Safety Finding (ESF) has been classified as important and as such has been subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"*2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.*"

IDENTIFICATION OF ISSUE:

As prescribed by CS 29.59 and CS 29.60, the Category A take-off path must be such that a height of 1000 ft above take-off surface (ATS) is reached through 2 climb segments:

- The first climb segment starts when reaching V_{TOSS} (Take-off Safety Speed) and a positive rate of climb and ends when the rotorcraft reaches a height of 200 ft ATS. In compliance with CS 29.67 (a)(1), during this first climb segment, a minimum of 100 fpm rate of climb (RoC) is to be guaranteed with the 2 min One Engine Inoperative (OEI) power, with the landing gear down and a speed of V_{TOSS}.
- The second segment starts at a height of 200 ft ATS and ends at 1000 ft ATS. It is supposed to be flown at a speed selected by the applicant (that can depend on the rotorcraft weight and/or ambient conditions). In compliance with CS 29.67 (a)(2), during this second climb segment, at least 150 fpm RoC must be guaranteed at Maximum Continuous Power OEI (MCP OEI), with landing gear up and with a speed selected by the applicant. Typically, the selected speed is VY to maximize the climb performance.

Between the 2 climb segments a level flight or positive RoC acceleration phase is foreseen to reach the climb speed selected for the second segment.

The same sequence of segments and associated minimum RoC apply to a Category A balked landing procedure.

Accordingly, to allow the flight crew to determine the take-off and balked landing paths and guarantee obstacle clearance, paragraph CS 29.1587 (a) (6) requires the publication of the first and second segment climb gradients determined in accordance with the conditions described above in the performance section of the Rotorcraft Flight Manual (RFM).

This ESF proposes a way to meet the intent of CS 29.1587 (a) (6) for Category A continued take-off and balked landing procedures *alternative* to those prescribed in CS 29.59, CS 29.60 (continued take-off) and CS 29.85 (balked landing) requirements. These alternative procedures may complement or replace the procedures where the first segment is completed at a height of 200 ft ATS or, in the case of a balked landing, at the height selected by the applicant (hereafter called conventional procedures) and they may be adopted by the flight crew in case the need for obstacles clearance becomes a factor.

While for the continued take-off and balked landing *alternative* procedures are proposed as an alternative to the conventional ones, the All Engines Operating (AEO) take-off and landing and the landing OEI procedures remain unaltered.

In these *alternative* continued take-off or balked landing procedures:

1. Instead of accelerating to a speed of V_Y when 200 ft ATS or a height selected by the applicant is reached, the flight crew will continue climbing while maintaining V_{TOSS}. The climb at 2 min OEI power ends when a predefined height above 200ft ATS, or at a height of 1000 ft ATS - whichever occurs first - is reached making sure that at such a height there is always enough residual time, within the 2 min OEI rating, to accelerate from Vtoss to V_Y. This change in the procedure implies that the first climb segment is extended and a height greater than the height achievable with the conventional procedure can be reached.
2. Once the predefined height, above 200 ft ATS, is reached, the rotorcraft is then accelerated to a speed of V_Y in level flight.
3. When at a speed of V_Y, the MCP OEI is selected by the flight crew and the climb is continued until reaching a height of 1000 ft ATS.

These *alternative* procedures exploit the 2 min OEI power rating for a longer time period. The objective is to provide better obstacles clearance when compared to a conventional procedure due the fact that the level flight or positive RoC acceleration from a speed of V_{TOSS} to V_Y occurs at a higher height.

In summary, with these *alternative* continued take-off procedures:

1. The first segment climb gradients published in the RFM need to be extended to the predefined height above 200 ft ATS. Consideration should be given to human factors when presenting the pre-defined height (e.g. rounding down the pre-defined height for easier in-flight reference).
2. For the climb portion above 200 ft ATS and until the acceleration to a speed of V_Y is started, the published gradients will be based on the 2 min OEI power, instead of the OEI MCP, as required by CS 29.67 (a) (2);
3. Dedicated charts are necessary to determine the extra height and horizontal distance that is achieved when the climb is continued with the 2 min OEI rating above a height of 200 ft ATS.

A similar approach is followed for the balked landing procedure.

For the above reasons, this proposal would not be compliant with CS 29.1587(a)(6) (ii) as the first segment is extended, for the continued take-off, above a height 200ft ATS. In addition, the published gradients applicable to the extended climb will be based on the VTOSS and 2 min OEI power, instead of the VY and OEI MCP.

Nevertheless, according to 21.A.101(e)1.(i), it is possible to demonstrate that any airworthiness provisions not complied with are compensated for by factors that provide an equivalent level of safety. Considering all the above, the alternative procedures proposed in Appendix A are considered to provide an equivalent level of safety to CS 29.1587(a)(6) (ii).

Appendix A

Equivalent Safety Finding on CS 29.1587 (a)(6) Amdt 2

Alternative Category A continued take-off and balked landing procedures

The *alternative* Category A continued take-off and balked landing procedures exploit a longer portion of the 2 min One Engine Inoperative (OEI) power that would otherwise remain unused. They allow the rotorcraft to climb longer at a speed of V_{TOSS} (Take-off Safety Speed) with 2min OEI power applied than it would be possible with a conventional procedure where the acceleration to a speed of V_Y is carried out at a height of 200 ft (or at the height selected by the applicant in case of a balked landing) to continue the climb with MCP OEI. The alternative procedures are considered to provide better obstacles and terrain clearance when compared to a conventional continued take-off or balked landing procedure for the following reasons:

- At the minimum rate of climb, the *angle* of climb is steeper at a speed of V_{TOSS} than at V_Y;
- The acceleration from a speed of V_{TOSS} to V_Y, which is normally performed in level flight, will occur at a height higher than 200 ft ATS. The increased height will reduce the exposure to obstacles especially in urban or obstacle rich environments.

The alternative procedures extend the duration of the climb at a speed of V_{TOSS} and therefore provide additional time for the flight crew to properly establish the climb before accelerating to a speed of V_Y. This can reduce flight crew workload in the critical flight phases following an engine failure.

These *alternative* procedures are compliant with the Category A performance requirements laid down in CS 29 Subpart B as:

1. The take-off and landing envelope within which the alternative procedures can be carried out is defined. **It is paramount to consider for the envelope determination, the residual 2 min OEI time that remains available when crossing a height of 200 ft ATS in case of a continued take-off or when the flight crew is required to accelerate to a speed of V_Y in case of a balked landing**. This residual time must allow the rotorcraft to continue to climb in the same conditions and level flight acceleration to a speed of V_Y before the 2 min OEI power rating is used up in all combinations of ambient conditions and rotorcraft weights for which the approval is required. While determining the take-off and landing envelope, the effects of external kits or other installations that could affect the installed power should also be considered.

2. To fulfil CS 29.59 (d), the rate of climb between a height of 200 ft and 1000 ft ATS is not less than the rate of climb required by CS 29.67(a)(2). Consequently, when part of the climb between a height of 200 ft and 1000 ft ATS is performed at a speed of V_{TOSS} with OEI 2min power, the steady rate of climb must be at least 150 ft/min. To assure a continuous climb, this minimum RoC must be maintained in the entire first segment. **Therefore, the alternative procedures are only applicable for those Category A procedures for which the first segment RoC is not the limiting parameter in determing the take-off or landing weight and a minimum climb gradient equivalent, at least, to the one achievable at Vy and 150fpm is attainable.**

3. It is demonstrated that the alternative procedures can be flown without the need for exceptional piloting skill.

4. In the case of the continued take-off, it is demonstrated that the alternative procedures are defined as those being critical for obstacles clearance. The take-off flight path for a normal All Engines Operating (AEO) take-off does not descend below the flight path determined by the alternative climb procedure.

5. The set of RFM instructions and associated cockpit indications provided to the flight crew are evaluated so that likely errors in determining the correct time to accelerate to a speed of V_Y at the end of the extended first climb segment are assessed and they do not impair safety.

The intent of CS 29.1587 (a)(6) is met by the proposed alternative procedures that provide an equivalent level of safety, as:

1. The RFM emergency procedures section includes adequate instructions for the flight crew to fly the *alternative* procedures. Whenever the alternative procedures can be implemented, they replace the conventional ones.

2. Additional charts are provided in the RFM Performance Section to determine:

    - the extra height that is gained by the extension of the first climb segment. This extra height is based on the 2min OEI Power and V_{TOSS}. These charts clearly identify the conditions for which they are valid. Consideration should be given to human factors when presenting the pre-defined height (e.g. rounding down the pre-defined height for easier in-flight reference).

3. These additional performance charts, along with those provided for the acceleration up to V_{TOSS} and positive rate of climb, for the first and second climb segments allow the determination of the entire take-off and balked landing paths and obstacles clearance as per the conventional procedures.