U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Reverse Thrust and Propeller Pitch Settings Below the Flight Regime

Date: XX/XX/XXXX **AC No:** 25.1155-X
Initiated By: AIR-625

1 PURPOSE.

1.1 This advisory circular (AC) describes acceptable means for showing compliance with the requirements of title 14, Code of Federal Regulations (14 CFR) 25.1155, *Reverse thrust and propeller pitch settings below the flight regime.* The rule requires a means to prevent the flightcrew on propeller-powered airplanes from inadvertently or intentionally placing the power lever below flight idle while in-flight, unless the airplane has been certified for that type of operation. The rule also requires a similar provision for turbojet-powered airplanes with thrust reverser systems that are designed for use only on the ground.

2 APPLICABILITY.

2.1 The guidance provided in this AC is for airplane manufacturers, modifiers, foreign regulatory authorities, Federal Aviation Administration (FAA) transport airplane type certification engineers, and FAA designees.

2.2 **This is a guidance document. Its content is not legally binding in its own right and will not be relied upon by the Department as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with the guidance document is voluntary only. Nonconformity will not affect rights and obligations under existing statutes and regulations**.

2.3 The FAA will consider other means of demonstrating compliance that an applicant may elect to present. Terms such as “should,” “may,” and “must” are used only in the sense of ensuring the applicability of this particular method of compliance when the acceptable method of compliance in this document is used. If the FAA becomes aware of circumstances in which following this AC would not result in compliance with the applicable regulations, the FAA may require additional substantiation or design changes as a basis for finding compliance.

2.4 The material contained in this AC does not change or create any additional regulatory requirement, nor does it authorize changes in, or permit deviations from existing regulatory requirements.

2.4.1 The guidance provided in this document applies to reverse thrust and propeller pitch settings on transport category airplanes that are subject to the requirements of § 25.1155, amendment 25-** (** FR **, **), which states: Each control for selecting propeller pitch settings below the flight regime (reverse thrust for turbojet-powered airplanes) must have the following:

(a) A means, such as a positive lock or stop, that requires a separate and distinct operation by the flightcrew to displace the control from the flight regime (forward thrust regime for turbojet-powered airplanes), and it must only be possible to make this separate and distinct operation once the control has reached the flight idle position.

(b) A means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime, or of reverse thrust for turbojet-powered airplanes, when out of the approved in-flight operating envelope for that function. Override of this means by the flightcrew is prohibited.

(c) A level of reliability such that the loss of the means required by paragraph (b) of this section is remote.

(d) An alert for the flightcrew, in accordance with § 25.1322, when the prevention means required by paragraph (b) of this section is lost.

(e) An alert for the flightcrew, in accordance with § 25.1322, when a flightdeck control is displaced from the flight regime (forward thrust regime for turbojet-powered airplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbojet-powered airplanes) outside the approved in-flight operating envelope. This flightcrew alert need not be provided if the means required by paragraph (b) of this section is a mechanical balk that prevents movement of the control.

3 RELATED MATERIAL.

3.1 Title 14, Code of Federal Regulations (14 CFR).

The following part 14 CFR regulations are related to this AC. You can download the full text of these regulations from the Federal Register website at www.ecfr.gov.

- Section 25.777, *Cockpit controls*.
- Section 25.779, *Motion and effect of cockpit controls*.
- Section 25.781, *Cockpit control knob shape*.
- Section 25.901, *Installation*.
- Section 25.903, *Engines*.

- Section 25.933, *Reversing systems*.
- Section 25.1141, *Powerplant controls: general*.
- Section 25.1143, *Engine controls*.
- Section 25.1149, *Propeller speed and pitch controls*.
- Section 25.1155, *Reverse thrust and propeller pitch settings below the flight regime*.
- Section 25.1305, *Powerplant instruments*.
- Section 25.1309, *Equipment, systems, and installations*.
- Section 25.1322, *Flightcrew alerting*.
- Section 25.1337, *Powerplant instruments*.

3.2 FAA Advisory Circulars.

The following ACs are related to the guidance in this AC. The latest version of each AC referenced in this document is available on the FAA website at FAA Advisory Circulars and on the Dynamic Regulatory System.

- AC 25.901-1, *Safety Assessment of Powerplant Installations*, dated August 30, 2024.
- AC 25.933-1, *Unwanted In-flight Thrust Reversal of Turbojet Thrust Reversers*, dated August 30, 2024.
- AC 25.1309-1B, *System Design and Analysis*, dated August 30, 2024.
- AC 25.1322-1, *Flightcrew Alerting*, dated December 13, 2010.

4 DEFINITIONS OF KEY TERMS.

For the purposes of this AC, the following definitions apply:

- Approved In-flight Operating Envelope. An area of the normal flight envelope where a function has been accepted as suitable by the authorities.
- Below the Flight Regime. When the power levers on propeller-powered airplanes are moved to a position below flight idle while the aircraft is in-flight (i.e., beta mode of operation).
- Beta. A range of propeller pitch angles that are typically only intended to be accessed when the power lever is brought below the flight idle stop (i.e., during landing roll out and ground operation).
- Catastrophic. A failure condition that would result in multiple fatalities, usually with the loss of the airplane (see reference AC 25.1309-1B).
- Failure. An occurrence that affects the operation of a component, part, or element such that it no longer functions as intended. This includes both loss of function and malfunction (see reference AC 25.1309-1B).

Note: Errors and events may cause failures or influence their effects but are not considered to be failures.

- Flight Idle Position. The position of thrust/power lever corresponding to the minimum forward thrust, power, or propeller pitch setting authorized in-flight.
- Flightdeck Controls. The flightdeck controls, referenced in this AC, are the control devices used by the flightcrew to select the reverse thrust or the propeller pitch settings below the flight regime (see §§ 25.1141, 25.1143, and 25.1149).
- Hazardous. A failure condition that would reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions to the extent that there would be (see reference AC 25.1309-1B):

  (a.) A large reduction in safety margins or functional capabilities,

  (b.) Physical distress or excessive workload such that the flightcrew cannot be relied upon to perform their tasks accurately or completely, or

  (c.) Serious or fatal injuries to a relatively small number of people other than the flightcrew.
- Inadvertent. Action performed by the pilot without intent.
- In-flight. That part of airplane operation begins when the airplane is no longer in contact with the ground during the takeoff and ending when the airplane again contacts the ground during landing.
- Intentional. Action performed by the pilot purposely with intent.
- Normal Flight Envelope. An established boundary of parameters (e.g., velocity, altitude, angle of attack, attitudes, load factor) associated with the practical and routine operation of a specific airplane that is likely to be encountered on a typical flight and in combination with prescribed conditions of light turbulence and light crosswind.
- Propeller Pitch Control System. All system components that, working together and in concert, enable the flightcrew to command-and-control propeller pitch.
- Separate and Distinct. More than, or in addition to, a continuation of motion required for movement, and obvious to each member of the flightcrew.
- Thrust Reversal. A movement of all or part of the thrust reverser from the forward thrust position to a position that spoils or redirects the engine airflow.
- Thrust Reverser System. All system components that, working together and in concert, enable the flightcrew to command and control the thrust reverser.

5 DEMONSTRATING COMPLIANCE WITH § 25.1155, REVERSE THRUST AND PROPELLER PITCH SETTINGS BELOW THE FLIGHT REGIME.

5.1 Applicable Areas.

5.1.1 The basic provisions of § 25.1155 require that each control for reverse thrust and for propeller pitch settings below the flight regime must have a positive lock or stop at the flight idle position, and require a separate and distinct operation by the flightcrew to displace the control out of the flight regime. These basic provisions are applicable to all transport category airplanes (except as noted in paragraph 5.2 of this AC).

5.1.2 The specific provisions of § 25.1155 are applicable to the control system protecting against the intentional or the inadvertent in-flight selection of the thrust reverser for turbojet powered airplanes or propeller operation at pitch settings below the flight regime for propeller-powered airplanes.

5.2 Inapplicable Products.

Section 25.1155 is not applicable to the following products:

- A turbojet-powered airplane whose reverser was certified for in-flight use.
- A propeller-powered airplane whose propellers were certified for pitch settings below the normal in-flight operating regime.

6 BACKGROUND.

6.1.1 Requirement History.

The requirement to guard against inadvertent operation of both propeller and turbojet reverse control lever(s) in the flightdeck dates back to Civil Air Regulation (CAR) 4b (paragraph 4b.474). When part 25 was codified in 1965, only the turbojet reverse thrust section of the original requirement was retained as § 25.1155. In 1967, amendment 25-11 broadened § 25.1155 to once again include protection against inadvertent in-flight operation of thrust reversers and propeller pitch settings below the flight regime. That amendment required the flightdeck propeller control to incorporate positive locks or stops at the flight idle position. It also specified that the control means must require separate and distinct operation by the flightcrew to displace the propeller control from the flight regime.

6.1.2 Operational Experience: Turboprop-Powered Airplanes.

6.1.2.1 In-service experience of some turboprop-powered transport category airplanes during the late 1980s and 1990s has shown that intentional or inadvertent in-flight operation of the propeller control systems below flight idle has produced the following two types of hazardous, and in some cases, catastrophic conditions:

- Permanent engine damage and total loss of thrust on all engines when the propellers that were operating below the flight regime drove the engines to over-speed; and
- Loss of airplane control because at least one propeller operated below the flight regime during flight, creating asymmetric control conditions.

6.1.2.2 Because of this unsatisfactory service experience, the FAA retroactively required (via airworthiness directives) the installation of in-flight "beta lockout systems" on several models of transport category turboprop airplanes. The FAA mandated these beta lockout systems only after it determined that increased crew training, installation of flightdeck placards warning crews not to use beta during flight, and stronger wording in airplane flight manual (AFM) warnings and limitations did not preclude additional in-flight beta events.

6.1.2.3 In addition to the continued airworthiness issues noted above, the FAA also recognized the need to update § 25.1155 to require some form of beta lockout system on propeller-powered airplanes. Before the FAA amended § 25.1155 at amendment 25-XXX, the FAA used the "no unsafe feature or characteristic" provisions of 14 CFR 21.21(b)(2) to require installation of beta lockout systems on new transport category turboprop-powered airplanes.

6.1.2.4 Section 25.1155, at amendment 25-11, did not specifically address the intentional selection of beta mode/reverse in-flight for rapid aircraft deceleration. Also, § 25.933(b) had been interpreted as not requiring, for propeller-powered aircraft, an interlock or other automatic device to prohibit movement of the power lever by the flightcrew below the flight idle stop when the aircraft is in-flight. Consequently, initial FAA certification of transport category propeller-powered aircraft has not required an in-flight beta lockout device to prevent intentional selection of the beta mode/reverse in-flight.

6.1.2.5 As a result of these incidents and accidents, the FAA issued amendment 25-XXX, which requires a means to prevent the flightcrew on propeller-powered airplanes from inadvertently or intentionally placing the power lever below flight idle while in-flight, unless the airplane has been certified for that type of operation. Additionally, § 25.1155 includes a similar requirement for turbojet thrust reverser systems that are designed for use only on the ground.

6.1.2.6 Typical beta lockout systems currently use wheel spin-up, squat switch activation, gear-up switch activation, or combinations of these to prevent intentional selection of the beta mode/reverse in-flight. Certain airplanes, especially those with low wings and without ground spoilers, have a tendency to temporarily "float" above the runway during landing. In the case of these airplanes, the application of beta may be delayed on a wet runway because, while the airplane is floating, the ground logic or the wheel spin-up may not activate immediately.

6.1.2.7 Landing performance of propeller-powered airplanes is based on ground idle availability, which is part of the beta range. Propeller-powered airplanes landing on field length-limited runways with delayed beta

application present a potential hazard. Overruns are more likely to occur if operating under 14 CFR part 91 (un-factored field lengths); however, the risks are also present if operating under part 121 or part 135 (factored field lengths) on a wet runway. Section 25.1155(b) prohibits override of the means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime when out of the approved in-flight operating envelope for that function. However, there are several acceptable methods that may be used to overcome the deficiencies of the squat switch or wheel spin-up logic alone, such as the use of a radar altimeter or multiple air/ground logic inputs.

6.1.3 Operational Experience: Turbojet (Turbo-Fan)-Powered Airplanes.

6.1.3.1 The number of accidents associated with pilot initiated in-flight thrust reversal on turbojet-powered airplanes is limited when compared to that of turboprop-powered airplanes. However, accidents have occurred due to in-flight thrust reverser deployment initiated by the pilot. There have also been a number of reported cases where the thrust reversers were selected just prior to touch down in order to minimize the landing rollout. In these cases, the provision of a weight-on-wheels interlock as part of the thrust reverser design prevented the deployment of the reverser. However, the basic concern about the need to avoid a reversing condition, outside any approved operating regime, is the same for a thrust reverser-equipped aircraft as it is for a propeller-powered aircraft (i.e., the prevention of catastrophic failure conditions).

6.1.3.2 Section 25.933(a) and associated AC 25.933-1describe means by which the thrust reverser system can be shown to have sufficient system integrity needed to meet the required safety objectives. If the reliability method of compliance with § 25.933(a) is used, the probability of an unwanted reverser deployment in-flight should be shown to be <1E-09 per flight hour (less than 10^{-9}). In this case, where very low probabilities of system failures are demonstrated, it was considered inappropriate that a single event of pilot selection could cause the same effect—a reverser deployment. Recognition that occurrences of thrust reverser selection in-flight have occurred, reinforced by the growing recognition that human factors need to be considered, has resulted in thrust reverser controls being considered equally. This approach ensures consistency in the application of § 25.1155 to both propeller-powered and turbojet (turbofan) reversing systems.

6.1.3.3 The design objective of § 25.1155 has been a common design practice for many turbojet (turbofan) thrust reverser designs. This regulation establishes that a means to prevent crew selection or activation of reverse thrust or propeller pitch settings below the flight regime must be provided as the minimum required standard.

6.1.4 Override Systems.

6.1.4.1 Historically, some turbo-propeller systems have been provided with an override capability. Upon landing, if the selection of propeller pitch below flight idle is not successful—because of system failures or because signals used in the system may not have transitioned to the ground mode—the flightcrew could select the override function to enable use of propeller pitch below flight idle during ground operation.

6.1.4.2 As mentioned above, many turbojet-powered airplanes equipped with thrust reversers have used weight-on-wheels, or other air-ground logic, to prevent selection or activation of thrust reversers in-flight. Generally, these systems have been capable of successful operation, despite not being equipped with any form of override.

6.1.4.3 Section 25.1155, at amendment 25-XXX, should prevent any selection or activation of propeller pitch settings below the flight regime or reverse thrust in-flight. The provision of any override, which would allow selection or activation of propeller pitch settings below the flight regime or reverse thrust out of the approved in-flight operating envelope for that function, would not comply with § 25.1155. The design of the system to show compliance with § 25.1155 will need to take into account the safety objectives associated with maintaining the required landing performance.

7 COMPLIANCE WITH § 25.1155, AT AMENDMENT 25-XXX.

7.1.1 Flightdeck Controls.

The design of flightdeck controls must be adequate to permit the flightcrew to perform the handling of the aircraft and to follow the procedures in accordance with the AFM while mitigating crew errors.

7.1.2 Preventive Means.

An acceptable means to prevent intentional or inadvertent selection or activation of reverse thrust or propeller pitch settings below the flight regime can be:

- Devices to prevent movement of the flightdeck controls to the inappropriate position, or
- Logic in thrust reverser or propeller control that prevents activation of reverse thrust or beta mode.

7.1.3 Separate and Distinct.

7.1.3.1 Moving flightdeck control from the flight idle position must require a separate and distinct operation of the control to pass from the flight idle position to positions approved only for ground operation, as stated in

§ 25.1155(a). The control also must have features to prevent inadvertent movement of the control through the flight idle position. It must only be possible to make this separate and distinct operation once the control has reached the flight idle position.

7.1.3.2 "Separate and distinct" is more than, or in addition to, a continuation of motion required for movement to the flight idle setting, and it should be obvious to the flightcrew.

7.1.3.3 Examples of separate and distinct controls that the FAA has found acceptable for use in previous designs include:

- Physically separated forward/reverse (below flight idle) control levers or mechanisms;
- Manually actuated latches located on, or in the vicinity of, the control that cannot be actuated until flight idle; and
- A required change in direction of operation of the control from that needed for movement to flight idle.

7.1.3.4 Examples of separate and distinct control operation that would not be acceptable include:

- A separate operation that can be activated away from the flight idle position, so that movement of the control from forward thrust to below the flight regime or thrust reversal can be accomplished with a single action;
- Any separate operation, where latches or equivalent devices can be pre-loaded by the pilot so that single movement of the control enables movement below flight idle; and
- Any control arrangement where it can be ascertained that normal wear and tear could cause the separate and distinct action to be lost.

7.1.4 Reliability Considerations.

7.1.4.1 The intent of § 25.1155(b) is for the aircraft design to include a means to prevent the flightcrew from selecting (or activating) propeller pitch settings below the flight regime or reverser deployment, when the airplane is not in the approved in-flight operating envelope for that function. This requirement stems directly from a number of cases where such selection caused accidents.

7.1.4.2 Because of a large variability in the current perception of the future occurrence rate for this type of flightcrew error, a target reliability level for the prevention means is included in § 25.1155(c). This level of reliability is expected to give a high degree of protection from the unwanted selection or activation of low propeller pitch settings or reverser

deployment. The requirement of the alerts in § 25.1155(d) should provide the necessary safeguard on the few occasions when the prevention means fail. Additionally, this target reliability level of 25.1155(c) should not be inconsistent with the required availability of the reversing function for landing performance.

7.1.4.3 The safety assessment methods established by § 25.901(c) and § 25.1309(b) are appropriate for the determination of the reliability level required by § 25.1155(c) and for assessing the effects of any other failure conditions or malfunctions.

7.1.5 Reverse Thrust/Propeller Pitch Settings Below Flight Regime Availability on Ground.

7.1.5.1 Landing or aborted takeoff distances on wet runways usually take credit for the braking effect created by reverse thrust or propeller pitch settings below flight idle. Therefore, availability of these systems when in the approved operating envelope should be maintained.

7.1.5.2 In order to comply with § 25.1155(b), applicants should show that failures in the system do not significantly degrade the availability of the reverse thrust or low propeller pitch selection while on the ground.

7.1.6 Flightdeck Indications.

The overall indications requirements for the thrust reverser control system and propeller pitch control system are in §§ 25.933, 25.1305(d)(2), 25.1309(c), 25.1322, and 25.1337(e), and their associated ACs. The following paragraphs provide specific guidance with respect to the flightcrew alerts required by § 25.1155(d) and (e):

7.1.6.1 Section 25.1155(d).

Section 25.1155(d) requires an alert be provided when the means "to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime, or reverse thrust for turbo-jet powered airplanes, when out of the approved in-flight operating envelope for that function" is lost. The purpose of this alert is to inform the flightcrew that a fault has occurred to the propeller pitch control system or the thrust reverser control system. This indicates that the protection means is no longer available, and any movement of the control below the flight regime (forward thrust regime) may cause a low pitch/high drag condition or thrust reverser deployment.

- With this information, the flightcrew will be able to take appropriate precautions, as advised by approved manuals and reinforced by their training, to minimize the possibility of a hazardous or catastrophic condition.

- Without this alert, a fault in the protection means could allow an unsafe condition to occur, whereby any inadvertent or intentional

movement of the control below the flight regime could cause a hazardous or catastrophic low pitch or reverse thrust condition.

7.1.6.2 Section 25.1155(e).

Section 25.1155(e) requires that an alert be provided when the flightdeck control is displaced from the flight regime (forward thrust for turbo-jet powered airplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbojet-powered airplanes) and the airplane is outside the approved in-flight operating envelope for that function. The purpose of this alert is as follows:

- On some anticipated system designs, the pilot will have the ability to move the flightdeck control below the flight regime (into reverse thrust for turbojet-powered airplanes) with no restriction, other than the "separate and distinct operation" required by § 25.1155(a). For this type of design, the means to prevent propeller pitch settings below the flight regime (reverse thrust for turbojet-powered airplanes), when out of the approved in-flight operating envelope for that function, will be a part of the propeller pitch control system or the thrust reverser system. While there is no immediate hazard at that point, the control is not in the proper position for flight operations. The flightcrew must be made aware of that situation so they can take the appropriate action.

- In some of the accidents, where the control had been moved into the "below flight regime," it was not clear whether this control movement had been inadvertent or intentional. Requiring this alert will give the flightcrew a clear indication of any incorrect placement of the control—regardless of intent.

- For any design where there is approval for selection of propeller pitch settings below the flight regime (reverse thrust for turbojet-powered airplanes), there will be no need to provide this alert when the aircraft is in the approved in-flight operating envelope for that function.

- There is no requirement to provide any alert for control movement when the airplane is on the ground.

8 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS.

8.1 Manufacturing/Quality.

Due to the criticality of the reverse thrust function or propeller pitch settings below the flight regime function, manufacturing and quality assurance processes should be assessed and implemented, as appropriate, to ensure the design integrity of the critical components.

8.2 Maintenance and Alterations.

Refer to §§ 25.901(b)(2) and 25.1529 as well as appendix H to part 25. The criticality of the control system requires that maintenance and maintainability be emphasized in the design process and derivation of the maintenance control program, as well as subsequent field maintenance, repairs, or alterations.

8.3 Manuals—Limitations/Procedures.

Prohibition of the use of reverse thrust or propeller pitch settings below the flight regime should be introduced in the AFM when outside the approved in-flight operating envelope for that function. Alerts, as described in § 25.1155(d) and (e) and their related procedures, should be included in the operations manual.

9 AC FEEDBACK FORM.

For your convenience, the AC Feedback Form is the last page of this AC. Note any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this AC on the Feedback Form.

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Aircraft Certification Service

OMB Control Number: 2120-0746
Expiration Date:12/31/2027

Advisory Circular Feedback Form

If you find an error in this Advisory Circular, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by emailing this form to _____or faxing it to the attention of _____ at _____.

Subject:_____ Date: _____

Please mark all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph _____on page __.

☐ Recommend paragraph _____ on page be changed as follows:

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

☐ Other comments:

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