EASA European Union Aviation Safety Agency	**Consultation paper** **Equivalent Safety Finding**	Doc. No. : ESF-D23.779-01 Issue : 1 Date : 27.07.2022 Proposed ☒ Final ☐ Deadline for comments: 17.08.2022

SUBJECT	:	**Motion and Effect of Cockpit Controls**
REQUIREMENTS incl. Amdt.	:	**CS 23.779(b)(1); 23.1143(c);**
ASSOCIATED IM/MoC	:	Yes☐ / No ☒
ADVISORY MATERIAL	:	**none**

INTRODUCTORY NOTE:

The following Equivalent Safety Finding (ESF) has been classified as important and as such shall be 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:

EASA has received an application for the approval of a major design change to a business jet that enables a new function, named Current Speed Control (CSC), which maintains aircraft speed via automatic thrust modulation. While CSC is in operation, there is no automatic movement of the thrust levers, which remain in the position they were left in at the moment when the function is engaged. Since the thrust levers do not move, the N1 Command remains unchanged during CSC operation.

The design of the CSC incorporates a fade-out feature to make a smooth N1 Command transition and synchronization when the CSC is disengaged. The fade-out logic gradually decreases the CSC Augmentation Command from its value to zero in two seconds. It only acts when the thrust levers are not moved.

The CSC is prevented from providing changes in N1 beyond the value corresponding to Maximum Cruise (or Maximum Continuous, depending on the active flight director mode) because it is limited (i.e. capped). When the CSC is operating with positive Augmentation Command such that the final N1 is at the maximum capped N1 authority (i.e. Maximum Cruise or Maximum Continuous N1, depending on the active flight director mode), and it is disengaged by a forward motion of the thrust lever (but not beyond the position corresponding to the maximum capped N1 authority), then the movement of the thrust lever will not initially result in a thrust change; after the thrust lever movement is stopped, the final N1 will result in an N1 value that is lower than the value before CSC disengagement.

In addition, if the CSC is engaged and its Augmentation Command is positive, the final N1 Command to the engine is greater than the N1 value that has been selected by the thrust lever position. In this case, if the CSC is disengaged by forward movement of the thrust lever, with an absolute value which is less than the CSC Augmentation Command, then the thrust lever command will initially result in an increase in thrust; however, after the movement of the thrust lever is stopped, the fade-out process will gradually decrease the CSC

Augmentation Command to zero and the final N1 will result in an N1 value that is lower than the value before CSC disengagement.

A similar effect occurs if the CSC Augmentation is negative and the CSC is disengaged by rearwards movement of the thrust lever with an absolute value less than the absolute value of the CSC Augmentation Command. In this condition, a rearwards movement of the thrust lever results, after the fade-out process ends, in a thrust increase.

As described above, for a specific scenario, the CSC function disegagement can occasionally result in a final thrust level opposite to the sense of operation of the thrust lever by the pilot, which is a non-compliance with requirements CS 23.779(b)(1) and CS 23.1143(c).

Therefore, the applicant has requested an Equivalent Safety Finding (ESF) with CS 23.779(b)(1) and CS 23.1143(c).

EASA considers that the ESF in Appendix A, combined with the presented descriptions and the fact that the assumption regarding the engine and aircraft behaviour during CSC disengament was validated during the dedicated flight tests of the Primary Certifying Authority, provides a level of safety equivalent to CS 23.779(b)(1) and CS 23.1143(c)), .

Appendix A

Equivalent Safety Finding (ESF)

Motion and Effect of Cockpit Controls

1. APPLICABILITY

This ESF is applicable to a Business Jet Aircraft equipped with CSC function.

1.1 AFFECTED CS

CS 23.779(b)(1) and CS 23.1143(c)

2. COMPENSATING FACTORS

1. Engine response to thrust lever movement

The fade-out logic gradually introduces the thrust command changes and the fade-out logic only starts after the thrust levers stops. Thereby ensuring that, firstly, the thrust lever forward motion, at the time it is being commanded, will never result in a decrease of engine thrust and a rearward thrust lever motion, at the time it is being commanded, will never result in an increase of engine thrust, and secondly, there will not be a sudden transition in N1 command avoiding then the effects that could create confusion or misleading regarding the engine and aircraft operation.

When engaging or disengaging the CSC, the crew is able to respect the engine limitations as indicated in the engine installation manual.

2. Disengagement effects at aircraft level

When manually moving the thrust lever (to perform a change in flight condition), the pilot monitors a controlled variable in order to determine if more control action is necessary or not (i.e. there is a manual feedback loop). For example, if a thrust lever movement is made in order to perform a speed change, the pilot will continuously monitor the behaviour of the aircraft speed to determine if more thrust lever movement is needed and in what direction, and keeps moving the thrust lever until the aircraft speed is stabilised in the new desired condition. Whilst continuously monitoring the aircraft speed , if a disturbance in aircraft speed occurs, the pilot will make a new movement of the thrust lever movement, until stabilisation is once again reached and so forth.

In the control process described, the detailed dynamics between thrust lever movement and engine N1 response is evident to the pilot.
This is one of the reasons why a thrust lever movement that results in CSC disengagement does not cause confusion to the crew. CSC authority value and the fade-out process are designed such that the dynamic effect on the aircraft level after system disengagement is no different than other transients already encountered in normal operation. Therefore, even if after a small increase in thrust lever position, with

the intent of changing the flight condition, CSC disengages and the actual N1 reduces after the lever stops, the pilot, monitoring a controlled variable, will naturally start providing additional forward motion to the lever, until the intended flight condition is reached, with the levers stopped.

Ultimately, if a fine adjustment of engine N1 is intended, the pilot needs to monitor the engine indications to perform it, whether CSC is engaged or not. As will be described in item (3), engine indications provide enough and clear information for the crew to perform a thrust lever movement that can precisely maintain or reach a desired N1 after stopping the levers, even upon CSC disengagement.

3. Indications and alerts of the function

The engine indications provide the crew with the means for monitoring the thrust changes during the operation of the CSC function and during the disengagement transient.

Both the current N1 and the lever-commanded N1 are always displayed.

An estimation of the N1 evolution is displayed to the crew to help anticipating the N1 evolution after engagement or disengagement of the CSC mode.

The status of the CSC engagement and disengagement is displayed to the crew.