EASA European Union Aviation Safety Agency	**Consultation paper** **Equivalent Safety Finding**	Doc. No.: ESF-G23.1549-02 Issue : 1 Date : 23.01.2023 Proposed ☐ Final ☒

SUBJECT	:	**Powerplant Instruments - Normal Operating Range Colour and Current Speed Control Authority Indication**
REQUIREMENTS incl. Amdt.	:	**CS 23.1549(b)**
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 approval of a major design change to a business jet, where the colour coding of some powerplant instruments aircraft design is not fully compliant with CS 23.1549(b).

CS 23.1549(b) requires that each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits.

Differently, in the presented design change N1 and Interstage Turbine Temperature (ITT) are indicated through white arcs in the normal operating range with the use of yellow and red colours in the background when limits are exceeded.

Therefore the applicant has requested an Equivalent Safety Finding (ESF) to CS 23.1549(b) with the argument that the FAA AC 20-88A "Guidelines on the marking of aircraft powerplant instruments (displays)" and FAA AC 23.1311-1C "Installation of Electronic Display in Part 23 Airplanes" provides the basis for using a colour other than "green" to indicate normal engine operation.

In addition, the applicant submitted another design change for approval that enables a new functionality, named Current Speed Control (CSC), which maintains aircraft speed via automatic thrust modulation.

The Current Speed Control functionality uses a green arc on the N1 display, to indicate the N1 range in which the CSC may modulate thrust thru a delta_N1 added to the N1 commanded by the thrust levers (CSC authority).

The applicant has therefore requested another Equivalent Safety Finding (ESF) to CS 23.1549(b) since the arc to indicate the CSC authority uses a colour code envisioned to indicate the engine's normal operating range.

EASA considers that the ESF in Appendix A, combined with the presented descriptions, provides a level of safety equivalent to CS 23.1549(b).

Appendix A

Equivalent Safety Finding (ESF)

Powerplant Instruments - Normal Operating Range Colour and Current Speed Control Authority Indication

1. APPLICABILITY

Aircraft This ESF is applicable to CS-23aircraft with Current Speed Control (CSC) installed.

1.1 AFFECTED CS

CS 23.1549(b)

2. COMPENSATING FACTORS

In lieu of a direct compliance with CS 23.1549(b), and provided that the below compensating factors are complied with, powerplant instruments such as N1 and Interstage Turbine Temperature (ITT) can be indicated through white arcs in the normal operating range, using yellow and red colours in the background when limits are exceeded:

1. The analogical parameters are indicated with white arcs that highlight the yellow and red limit markings. The limit markings indicate the operational ranges.

The red and yellow lines stand out in the analog displays due to the use of the white arc and, therefore, are effective in indicating the operational range of the instruments. Hence the flightcrew have a clear indication of the current operational status of the engine through the display of the engine parameters as well as their proximity and rate of change to their indicated limits.

This compensating feature was already established in the ESF applicable to the aircraft without the CSC functionality. The CSC green arc will not affect this compensating design feature, since it will not overlap N1 limit marking and will not interfere in the visibility of the N1 limit. Regarding ITT indication, CSC functionality does not introduce any changes to the analogical indication.

2. Digital indications provided inside the dials are green in colour when the parameters are within their operational limits and are red or yellow in colour and the colour is inverted (i.e. the colour of the background changes) when parameters exceed their limits.

The colouring of the digital indications allows the flightcrew to notice, at a glance, if the engine is operating within its limits. Therefore any limit exceedences will still be easily detected by the flightcrew allowing them to take appropriate actions.

This compensating feature was already established in the ESF applicable to the aircraft without the CSC functionality. The CSC green arc will not affect this original compensating design feature, since the introduction of the CSC green arc has no relation with the digital indications.

3. When the parameter exceeds its yellow or red limits, the analogical dial background is coloured with the correspondent colour.

The white arc also enables the flightcrew to notice a colour change in the dial when the parameter exceeds any of its limits. The colour change is an essential alert to the flightcrew of a situation that demands action.

This compensating feature was already established in the ESF applicable to the aircraft without the CSC functionality. The CSC green arc will not affect this original compensating design feature, since the white arc remains indicating normal engine operating conditions and the CSC green arc is only displayed in part of the engine operating range. Moreover, if the N1 limit is exceeded, the green arc will not prevent the background of the N1 dial of changing to red and indicating that a limit has been exceeded.
Regarding the ITT indication, there is not any change due to the CSC functionality introduction.

For aircaft having a FADEC, this additional compensating factor applies:

4. The Full-Authority Digital Engine Controller is the primary responsible to maintain engine ITT and N1 within their operational limits.

CS 23.1549 assumes that the flightcrew is primarily responsible for ensuring the continuous and safe operation of the engines by monitoring, at a glance, that the engines instruments are within their operational limits. However, with the advent of the FADEC, a significant part of such control and monitoring was migrated into the highly automated controllers such that the primary means of preventing the engine to exceed its limits is the FADEC and no longer the flightcrew. The flightcrew acts only in case of the FADEC failing to keep the engine within the approved limitations. Since such automatism reduces the need for constant monitoring by the flightcrew, it can be concluded that it is a compensating factor if a FADEC is installed on an aircraft for which this ESF applies.

This compensating feature was already established in the ESF applicable to the aircraft without the CSC functionality. The CSC green arc will not affect this original compensating design feature, since the introduction of the CSC does not affect the FADEC System capability to control the N1 and ITT parameters within their limits.

Note: An assessment by Primary Certifying Authority shall be carried out that the colours used for the electronic powerplant displays shall be readily identifiable and distinguishable under all intensity settings and ambient light conditions.