Federal Aviation Administration

Memorandum

Date: August 3, 2012

To: Manager, Transport Standards Staff, International Branch, ANM-116

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Douglas Bryant, ANM-112

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for use of a digital-only presentation of engine fan speed (N1), intermediate pressure rotor speed (N2), and high pressure rotor speed (N3) for the Airbus Model A350 airplane (FAA Project Number TC0544IB-T)

ELOS Memo #: TC0544IB-T-F-16

Reg. Ref.: §§ 25.901, 25.1305, 25.1309, 25.1321, 25.1322 and 25.1549

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for the Airbus Model A350 airplane.

Background

Title 14, Code of Federal Regulations (14 CFR) 25.1549(a) through (c) presume the use of analog instruments. Airbus has proposed a digital-only presentation of engine fan speed (N1), intermediate pressure rotor speed (N2), and high pressure rotor speed (N3) for the Airbus Model A350 airplane. The digital-only presentation of engine parameters do not directly comply with the marking requirements of § 25.1549(a), (b) and (c) and may unacceptably limit the flight crew's ability to properly monitor and operate the engines.

The primary engine displays on turbine engine powered transport aircraft have traditionally displayed the engine rotor speeds required by § 25.1305(c)(3) in an analog-only or an analog and digital format. An increasing demand to conserve primary display space has led to digital-only primary displays for those rotor speeds not normally used for power setting. This situation may result in a small, cluttered, low resolution primary display.

In addition, it is generally accepted that digital-only displays are often less effective than conventional analog displays at providing the crew with: discernible indication of the parameter during a rapid transient; and quick intuitive indication of the parameters approximate level, direction and rate of change, proximity to limits, and relationship to other parameters on the same engine or the same parameter on other engines. This is why Advisory Circular (AC) 20-88A, paragraph 4(c), states that: "digital indicators are most valuable when integrated with an analog display."

Applicable regulation(s)

§§ 25.901, 25.1305, 25.1309, 25.1321, 25.1322 and 25.1549

Regulation(s) requiring an ELOS finding

§ 25.1549(a), (b), and (c)

Description of compensating design features or alternative standards which allow the granting of the ELOS (including design changes, limitations or equipment need for equivalency)

The Airbus Model A350 is equipped with Rolls-Royce Trent XWB engines that are each controlled by a Full Authority Digital Engine Control (FADEC) system. The parameter nominally used in the cockpit for thrust setting and monitoring is the THR, which is displayed in analog and digital format. The N1, N2 and N3 speeds are secondary engine parameters not used in the thrust setting process. The N1 is a back-up thrust control parameter and will be displayed in both analog and digital format in situations where the primary thrust control parameter (THR) is not available. The N2 and N3 speeds are mainly monitored to detect engine abnormalities during the engine starting sequence.

Automatic FADEC monitoring of N1, N2, and N3 is provided to prevent any gradual exceedance of the redline limit during normal engine operation. Continuous monitoring of N1, N2, and N3 by the FADEC ensures a prompt fuel flow cutback if the limits are reached.

If, for any reason, the N1, N2, or N3 speed is allowed to reach or exceed the redline limit, the N1, N2, or N3 digital indication for the affected engine will be framed with an amber attention getting box and the digits will turn red, providing limit exceedance information to the crew. In addition a dedicated ECAM warning “ENGx Nx OVERLIMIT” will be displayed to the crew. A relatively rapid intervention is necessary to avoid prolonged operation above the redline limit. The level and duration of the exceedance will impact engine parts life and the extent of the maintenance action due. The engine integrity and the aircraft continued safe flight and landing is not jeopardized.

If, for any reason, the flight crew does not intervene, the engine rotor integrity is protected by another fully automated control logic which will trigger an engine automatic

shutdown (immediate fuel flow cut-off) if a shaft speed reaches the 'over-limit shutdown' level. This level is set below the rotor integrity limit and is higher than the redline level in order to protect the engine from exceeding it. There is no expectation for flight crew intervention in order to prevent the engine shaft speeds to exceed the rotor integrity limit level.

Explanation of how design features or alternative standards provide an ELOS to the level of safety intended by the regulation

Section 25.1549 is intended to ensure engine limits are not exceeded and to ensure that engine abnormalities that could lead to engine failure or other undesirable engine behaviors are identified by the flight crew and addressed in a timely manner. At the time this rule was promulgated, the available technology primarily relied on flight crew awareness and direct action to respond to engine abnormalities. Analog instrumentation was required to provide appropriate crew awareness. Since that time, the development of FADEC systems has relieved the flight crew of much of the burden of monitoring engine indications, particularly for secondary engine parameters not directly used for power setting.

Although noncompliant with the regulation, the FADEC continuous monitoring in-flight of the operating condition of the engine rotor speeds (N1, N2 & N3), automatic generation of warnings to the cockpit, with associated crew procedures, and engine automatic shutdown if a limit is exceeded are considered to provide an ELOS as that established by providing analog displays.

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS finding in the Model A350 airplane Issue Paper F-16, titled "Digital Only Display of the Turbine Engine High (N3), Intermediate (N2) and Fan (N1) Rotor Speeds." This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The TAD has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number should be listed in the type certificate data sheet under the Certification Basis section. An example of an appropriate statement is provided below:

ELOS Findings have been made for the following regulation(s):
14 CFR 25.1549(a), (b) and (c), Powerplant and Auxiliary Power Unit Instruments (documented in TAD ELOS Memo TC0544IB-T-F-16)

Original signed by
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Manager, Transport Airplane Directorate,
Aircraft Certification Service

October 5, 2012
Date

ELOS Originated by: Propulsion/Mechanical Systems Branch	Project Engineer Douglas Bryant	Routing Symbol ANM-112