Federal Aviation Administration

Memorandum

Date: January 7, 2013

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 Resistance to Fire of Cowling on the Airbus Single Aisle New Engine Option Model Airplanes (FAA Project Number AT00949IB-T)

ELOS Memo#: AT00949IB-T-P-14

Reg. Ref.: §§ 25.1191 and 25.1193

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 Single Aisle (SA) New Engine Option (NEO) Model airplanes.

Background

Title 14 Code of Federal Regulations (14 CFR) 25.1193(e) requires that the airplane have fireproof skin in areas subject to flame if a fire starts in the engine power or accessory sections. Airbus has proposed that only a portion of the engine nacelle be fireproof while the remaining portion of the engine nacelle is fire resistant during ground operations. The entire engine nacelle will be fireproof in flight. This proposal does not directly comply with the fireproof requirements of § 25.1193(e).

Section 25.1193(e)(3) applies to the cowl and nacelle skin and it is the applicable fire resistance standard for cowls surrounding engine fire zones and any other airplane skin areas subject to flame during engine fire conditions. It prescriptively requires those parts of the airplane be fireproof, regardless of the level of hazard that might be judged to be created by burn through of those areas. The intent of § 25.1193(e)(3) is to prevent a fire from exiting the engine fire zones except as designed through intended ventilation openings, and to thereby allow the behavior of the fire control features (including fire

containment, fire detection, and fire extinguishing) to be reliably predicted based on the assumption that the engine cowls will remain intact and will not burn through. This serves to protect other parts of the airplane from unanticipated impingement of flames and hot gases, and to ensure that the fire detection and extinguishing systems will function as designed so that fire can be detected and controlled.

Historically, the early generations of civil transport airplanes had engine nacelle structures constructed with materials that were inherently fireproof. The more recent use of light alloys and composite materials has led to taking the effect of airflow characteristics data when demonstrating compliance to this requirement. Due to these changes in design construction the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC) Transport Airplane and Engine Issues Group (TAEIG) to recommend specific changes to § 25.1193(e)(3). On October 23, 2000 the Powerplant Installation Harmonization Working Group of the TAEIG submitted their recommendations to the FAA. Those ARAC recommendations have yet to be formally adopted by the FAA. The ARAC recommendations form the basis for alternative standards that provide an ELOS in lieu of direct compliance with the regulations.

Applicable regulation(s)

§ 25.1191 and 25.1193

Regulation(s) requiring an ELOS finding

§ 25.1193(e)(3)

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 alternative standards based on the ARAC recommendation are provided below:

1) FIRE WITHSTANDING REQUIREMENTS, OPERATING CONDITIONS AND POTENTIAL HAZARDS

   I. General
   The required level of ability to withstand the effects of fire varies with the potential hazard level associated with different flight and ground operating conditions, as follows:

   II. Flight Conditions
   For flight conditions from airspeed above minimum V1 until minimum touchdown speed in approved normal or abnormal operations, the cowling and nacelle skin in areas subject to flame if a fire starts in an engine or APU fire zone shall be demonstrated to be fireproof. The conditions for demonstrating the fireproof capabilities of the cowling should be consistent with the critical

operating conditions. Where engine power can affect conditions on the cowling (including max engine power, min engine power and propeller feathering), these should be examined and the most critical determined. These conditions should be applied for 5 minutes, with the remaining 10 minutes under windmilling conditions for engine and stopped conditions for the APU.

III. Ground conditions

i. Engine Operation - Requirements for ability of skin in areas subject to flame if a fire starts in an engine or APU fire zone to withstand the effects of fire under ground operating conditions apply with either the engine operating or not operating, whichever is the more critical.

ii. Nacelle areas where fireproof skins are required - The portion of cowling and nacelle skin in areas subject to flame if a fire starts in an engine or APU fire zone, and located so that not containing the effects of the fire could result in serious injuries to crew, passengers or ground personnel, should be fireproof under all conditions. Serious hazards include, but are not limited to, events such as fuel tank explosion, hazardous spread of fire to flammable fluid sources outside the fire zone or fuselage penetration.

A. Pod-mounted engines: The portion of the nacelle skin, which is required to be fireproof on ground, varies by installation. A design is considered acceptable when it is demonstrated that the fireproof area protects the pylon strut and other portions of the aircraft considered to be put at a serious hazard risk if burn through occurs. Factors to consider within the analysis and to use when substantiating the design are: the engine location - wing or aft mounted, the coupling distance of the nacelle to the wing, the airflow characteristics, the fluid migration scheme and the fire plume patterns. After the initial analysis, a similarity demonstration may be used when appropriate. Analyses have demonstrated that the typical area of concern ranges from 90° (±45°) to 180° (±90°). This area may increase or decrease depending on the analysis results. For example, most wing mounted engines not closely coupled to the wing have been found acceptable with a ±45° protection while more closely coupled installations and those with other unique design features have required ±90° protection. The symmetry of the protection may also vary. Wing mounted engines usually have symmetrical protection while aft mounted engines may have non-symmetrical protection in order to cover more of the inboard area.

B. Turboprops and APUs and other non-pod-mounted engines: Due to the wide variations in installation configurations each installation should be evaluated to determine if not containing the effects of a fire would cause a serious hazard such as the examples above. If so the affected area of the fire zone skin should be fireproof.

iii. Other nacelle areas: - For the remaining portions of skin in areas subject to flame, if a fire starts in an engine or APU fire zone, the degree of fire resistance can be lower than “fireproof” due to less serious or less probable hazard to the crew, passengers and ground personnel under the critical operating conditions.

A. Fire-resistant skins provide adequate fire protection for those areas in that they provide sufficient time to stop the aeroplane and evacuate it.

B. A lower than “fire-resistant” degree of fire protection has been used by applicants in the past without adverse service experience and can be considered under the following conditions:
   a. Cowling/nacelle skin should have the ability to withstand fire at least equivalent to 0.040" (1 mm) aluminum;
   b. Applicants must substantiate that this lower fire protection level will not lead to hazardous effects such as:
      1. Upon burn through of the lower than “fire-resistant” area, both the fire resistant and/or fire-proof areas shall not have their fire withstanding capability affected;
      2. Liberation of parts that would affect the evacuation procedure or reduce the efficiency of fire protection means
      3. Reduction in flammable fluid drainage capability such that fire severity would be increased (magnitude, residual presence, propagation to surrounding area);
      4. Reduction in evacuation capability due to proximity to escape routes or due to the visibility of the fire hindering the ability of the passengers to evacuate the aeroplane in a rapid and orderly manner.
      5. Note: There is some hazard involving passenger evacuation even in the absence of burn through, due to such concerns as smoke and flaming liquids exiting from openings. Burn through of nacelle skin should not significantly increase these hazards.
      6. Reduction in fire detection capability such that the flight crew would not be aware of the fire, especially in a situation involving taxiing prior to takeoff.
      7. Reduction in fire extinguishing capability which could cause or aggravate one of the potential hazards listed above.

2) SPECIFIC CONFIGURATION CONSIDERATIONS

I. Multiple Skin Layers: For some specific fire zones, a fire originating in that zone will have to pass through several layers of skin or cowling before burning through the nacelle external skin. This may be the case, for example, for the core zone of some turbofan installations. In such cases, credit may be taken for multiple layers, having regard to the location of the fire source and the likely direction of propagation from that location, providing burn through of the inner layer does not

produce other hazardous effects as well as does not invalidate other certification requirements such as fire extinguishing capability. The corresponding compliance substantiation should take into account particular geometrical configuration with respect to risk of flame propagation, as well as critical systems or structures.

II. Inlet Skins: External inlet skins, which enclose fire zones, should meet the same criteria discussed. Inlet ducts should meet the requirements of § 25.1103.

III. Openings: The following considerations are applicable to openings in a fire zone skin, whether the openings are of fixed size, variable or controllable size, or normally closed, such as access or inspection doors, or pressure relief doors.

i. Openings should be located such that flame exiting the opening would not enter any other region in where it could cause a hazard in flight or a serious hazard per sub-paragraph 1).III on the ground. Exception is made for covered openings which meet the same criteria for ability to withstand the effects of fire as the surrounding cowl skin, and which are not expected to become open under fire conditions. Since pressure relief doors may open during some fire conditions, they should be located so that flames exiting the door will not cause a hazard. However, doors that will remain closed during most fire conditions, or will tend to re-close following initial opening, have traditionally been assumed to be closed for the purposes of evaluating fire detection and extinguishing.

ii. Openings should have the same ability to withstand the effects of fire as the adjacent skin with respect to becoming enlarged under fire conditions. Some enlargement, such as burning away of louvers or doublers surrounding the opening or gapping of covered openings, is acceptable providing that the hazard is not significantly increased by a reduction in fire extinguishing or detection capability, increased airflow causing increase in fire size or intensity, or increase in probability of a hazardous spread of fire to other regions.

IV. Hinges, Fittings and Latches: Fitting means attaching the nacelle/cowling between them or to the aircraft/engine/APU structure shall have the same ability to withstand the effect of fire, as the surrounding skin.

3) COMPLIANCE DEMONSTRATION

Compliance should be substantiated per § 25.1207. Substantiation involving airflow patterns may include analytical methods such as Computational Fluid Dynamics, test methods or other flow visualization methods or a combination. Fire testing should be accomplished per the guidance of Advisory Circular (AC) 20-135, or another method acceptable to the FAA, with considerations of applications of representative conditions (airflow, loads, vibrations) and establishment of appropriate pass/fail criteria (burn through, elongation, dislocation).

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

Although noncompliant with the regulation, the alternative standards based on the TAEIG recommendation to the ARAC in October 2000 is considered to provide an equivalent level of safety to demonstrating that the SA NEO model airplanes complies with § 25.1193(e)(3).

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS finding in the SA NEO model airplanes project issue paper P-14, titled "Cover Issue Paper for EASA CRI E-40, Resistance to Fire of Cowling." 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 of the type certificate (TC) or the amended TC in accordance with the statement below:

The FAA has made an ELOS Findings for the following regulation(s):
14 CFR 25.1193(e), Cowling and nacelle skin (documented in TAD ELOS Memo AT00949IB-T-P-14)

Original signed by Victor Wicklund — January 7, 2013

Manager, Transport Airplane Directorate, Aircraft Certification Service — Date

ELOS Originated by Transport Standards Staff	Project Engineer Douglas Bryant	Routing Symbol ANM-112