



# Federal Aviation Administration

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## Memorandum

Date: June 27, 2011

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

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Robert Jones, ANM-112

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for the Airbus Model A350 series Slat Geared Rotary Actuator Failure (FAA Project Number TC0544IB-T)

ELOS Memo#: TC0544IB-T-SF-6

Reg. Ref.: § 25.671(c)(1)

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

### Background

Airbus has declared that the A350 aircraft will not demonstrate compliance with airworthiness requirement § 25.671(c)(1) that requires aircraft to be shown by analysis, test, or both, to be capable of continued safe flight and landing after any single failure in the flight control system, excluding jams, without requiring exceptional piloting skill or strength. Airbus has identified a potential failure mode in the Gear Rotary Actuators (GRA) used to drive the slats on the A350 aircraft that could lead to a slat departing the wing and impacting the empennage.

The A350 features six slats per wing, the five inner slats are driven by two Gear Rotary Actuators (GRA), one on each track, the outermost slat being driven by three tracks. All the actuators, on each wing, are driven by a single torque shaft, which is connected through one actuator to the next. The actuator internal gears take the input torque from the torque shaft and transform it into a surface movement via an output shaft and pinion (down-drive). The actuators on each slat are therefore synchronized by the torque shaft.

Each slat GRA contains a Torque Limiter (TL) protection device at its input side whose function is to limit the input loads to the slat and protect the downstream parts in case of a jam condition.

When a jam is detected, the torque limiter prevents an asymmetric slat deployment/retraction (skew) by stopping the slat motion and triggering a flight deck warning.

A potential Down Drive Disconnect / Through Drive Maintained (DDD/TDM) failure mode exists in the TL protection device. In this failure mode, one GRA torque limiter could be disconnected leading to an asymmetric slat deployment if no over torque is seen by the remaining GRA torque limiter protection device.

**Applicable regulation(s)**

§§ 25.671(c)(1), 25.1309

**Regulation(s) requiring an ELOS finding**

§ 25.671(c)(1)

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

Airbus considers that the A350 GRA design provides an Equivalent Level Of Safety to the regulatory requirement of §25.671(c)(1) for the DDD/TDM failure modes based on the following:

- The torque limiter protection device failure mode is considered as not realistic to occur,
- The internal torque limiter parts under consideration have structural capability significantly exceeding the maximum internal GRA load conditions,
- Fatigue analysis demonstrates that accidental damage does not lead to failure of the internal torque limiter concerned parts,
- Specific manufacturing/inspection processes are applied to concerned parts,
- The GRA design is well proven with an in-service experience of 2.4 billion GRA cycles without DDD/TDM failure reported,
- A slat asymmetric deployment (skew) effect on aircraft handling qualities is estimated to be no worse than major.

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

Through the five following compensating factors, the A350 GRA design provides an equivalent level of safety to the level of safety intended by the regulation.

A first compensating factor is provided through the use of ARAC recommendations in lieu of the current 14 CFR regulations as allowed per terms described in the policy letter 00-113-1034 and Notice of availability dated 4/29/2003. Airbus considers that

compliance to § 25.671(c)(1), and in general to § 25.1309 using the provision of the arsenal version section 11.b.2, can be established on the basis the DDD/TDM failure mode would not realistically and practically occur. DDD/TDM failure cases are considered very unlikely as resulting from non realistic failure or multiple sheared parts not creating a GRA jam.

A second compensating factor is provided through the significant structural robustness of the parts under consideration, featuring a significant static strength reserve factor (from 3 up to 300) and being tested in fatigue for 6 aircraft life cycles.

A third compensating factor is provided through a comprehensive approach for manufacturing/ operating processes and structural demonstration as described below:

- Identification of critical phases of manufacturing processes, in service operation/maintenance,
- Determination of the critical location, size and orientation of the accidental damage, based on the inspection methodology used during actuator manufacturing/repair,
- Perform fatigue demonstration with the determined accidental damage,
- Determination of the sensitivity and effect of corrosion on the affected parts.

In addition Airbus develops appropriate ways to enable traceability of GRA during manufacturing.

A fourth compensating factor is provided by the fact that the torque limiter is encased in the GRA and therefore is protected from corrosive effect of the environmental (water, salt..) and chemicals (cleaning and de-icing fluids).

Finally a fifth compensating factor is provided by the fact that the slat system fitted on A350 is of similar design than those flying on Airbus aircraft. GRAs benefit from a significant in-service experience with to date no DDD/TDM failure reported and no spare parts at stake ordered from suppliers over:

- 117,000 GRAs in-service,
- 2.7 billion Flight hours accumulated by more than 5000 aircraft in-service,
- 1.2 billion Aircraft flight cycles or 2.4 billion GRA cycles when considering 2 slat deployment/retraction per aircraft flight cycle.

### **FAA approval and documentation of the ELOS finding**

The FAA has approved the aforementioned equivalent level of safety finding in the A350 project issue paper SF-6, titled “Slat Geared Rotary Actuator Failure.” This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Transport Directorate 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 (TC’s & ATC’s) or in the Limitations and Conditions Section of the STC Certificate. An example of an appropriate statement is provided below:

Equivalent Level of Safety Findings have been made for the following regulation(s):  
§ 25.671(c)(1) Control Systems: General (documented in TAD ELOS Memo TC0544IB-T-SF-6)

*Robert Jones*

Transport Airplane Directorate,  
Aircraft Certification Service

June 29, 2011

Date

ELOS Originated by Transport Standards Staff:	Project Engineer Robert Jones	Routing Symbol ANM-112
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