



Federal Aviation Administration

Memorandum

Date: March 7, 2016

To: Manager, Boeing Aviation Safety Oversight Office, ANM-100B

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Thomas Thorson, ANM-100B

Subject: INFORMATION: Equivalent Level of Safety Finding for the 787-8/-9 Rolls-Royce Trent 1000-TEN ETOPS Ground Test, FAA Project Number PS14-0470

ELOS Memo # PS14-0470-P-15

Regulatory Ref: 14 CFR part 25 appendix K25.2.2(d), Amendment 25-120

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 Boeing Models 787-8 and 787-9.

Background

The Rolls-Royce (R-R) Trent 1000-TEN engine will undergo a certification cyclic endurance test to show compliance to the requirements of Title 14, Code of Federal Regulations (14 CFR) 33.201(c). R-R is proposing a test of the engine configured with a slave nacelle to enable the engine ground test to achieve a broader range of fan (N1) speeds and to better represent fan speeds achieved during the climb flight phases. The FAA Engine & Propeller Directorate Standards Staff and the Engine Certification Office have concurred with the proposed methods of compliance with § 33.201.

The slave nacelle accepted for part 33 certification prevents the installation of the Boeing supplied nacelle components as required by K25.2.2(d)(1). The ETOPS test article will be configured with current production Boeing supplied engine-mounted equipment as required by the regulation. Because the engine-mounted equipment is largely unchanged from the hardware, which successfully passed the two previous Trent 1000 engine ETOPS cyclic ground tests and the installation environment with respect to loads, temperature exposure and vibration is equivalent. Boeing also seeks alleviation from the K25.2.2(d)(1)(ii) requirement to completely disassemble the engine build up (EBU) components after completion of the test (unless there are

findings during the cyclic endurance test or during the post-test acceptance test procedure conducted on each component).

Applicable regulation(s)

14 CFR K25.2.2(d)(1)

Regulation(s) requiring an ELOS finding

14 CFR K25.2.2(d)(1) and K25.2.2(d)(1)(ii)

Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including design changes, limitations or equipment needed for equivalency)

During accomplishment of the Trent 1000-TEN Early ETOPS cyclic endurance test, there are two requirements of § K25.2.2(d) where Boeing requested a finding of equivalent safety rather than direct compliance to the rule:

- Boeing proposed to conduct the testing required by § K25.2.2(d)(1) for the ETOPS propulsion validation testing without a complete airplane nacelle package as required by the rule. The following components will not be installed for the test:
 - a. Thrust reversers including translating sleeves
 - b. Fan Cowls
 - c. Engine Inlet
- Boeing also proposes not to directly comply with the § K25.2.2(d)(1)(ii) requirement to completely disassemble and inspect the EBU hardware after completion of the Trent 1000-TEN ETOPS test.

The following items were considered in our finding of equivalent safety:

1. The vibration environment during thrust reverse portion of the engine cycle is unchanged relative to the vibration environment with a production thrust reverser unit (TRU) installed and actuated. Included in this assessment, Boeing will substantiate that the absence of aerodynamic loads from thrust reverser deployment (opening and closing) did not impact the ETOPS test results.
2. The thermal environment, vibration environment, pressures, and mechanical loading environment for the part 25 components installed on the Trent 1000-TEN engine for the ETOPS missions cyclic endurance test are encompassed by the environment during the ETOPS endurance test previously conducted for the Trent 1000 Package A engine.

3. The fan cowl thermal environment differences due to the fan cowls not being installed will not affect the reliability of the fan cowl components, including assessment of the thermal conditions during the heat soak back following engine shutdown. Boeing will show the thermal environment of the fan compartment with fan cowls and in-flight fan compartment airflow is equivalent to not having fan cowls and simulated airflow in the test setup. Boeing will substantiate that the fan cowls provide negligible mass to the whole of the engine package and relatively no stiffness to the engine structure and therefore will have no effect on the test environment by not being installed.
4. The component inspection results for the airplane components of the Trent 1000 Package A ETOPS test must be shown to still be valid and applicable for the Trent 1000-TEN installation.
5. An analysis substantiated by test will show that the slave C-Duct installed instead of the production nacelle produces similar mass and stiffness properties to that of the production thrust reverser with respect to engine vibration.
6. A slave bell mouth inlet is installed to remove air flow instabilities. The slave bell mouth produced aero lines will be shown to be similar to those seen during airplane in-service operation. The slave bell-mouth configuration mass and stiffness differences versus an installed production inlet will be shown to be negligible. Boeing will substantiate that there is no impact to the test results with respect to the operation of the inlet anti-ice system.
7. The results of the Trent 1000 Package A ETOPS test must be shown to still be valid and applicable for the part 25 propulsion ETOPS significant components that are not installed for the test (including the thrust reverser LVDT and the pylon fire detector).
8. All Boeing-supplied components in support of the test will undergo a full visual inspection and be required to successfully complete the component acceptance test procedure following conductance of the cyclic endurance test. Any anomalies or test failures will require components to be fully disassembled and inspected as required by § K25.2.2(d)(ii).

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS finding in project issue paper P-15. 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 must be listed in the type certificate data sheet under the Certification Basis section. An example of an appropriate statement is provided below.

Equivalent Safety Findings have been made for the following regulation(s):
14 CFR part 25 K25.2.2(d)(1) and K25.2.2(d)(1)(ii) Early ETOPS method
(documented in TAD ELOS Memo PS14-0470-P-15).



Transport Airplane Directorate,
Aircraft Certification Service

7 MARCH 2016

Date

ELOS Originated by Boeing Aviation Safety Oversight Office	Thomas Thorson	ANM-100B
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