

Exemption No. 11686

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
BURLINGTON, MA 01803-5229

In the matter of the petition of

ROLLS-ROYCE plc

for an exemption from § 33.27(f)(6)
of Title 14, Code of Federal
Regulations

Regulatory Docket No. FAA-2015-0156

PARTIAL GRANT OF EXEMPTION

On January 23, 2015, Ms. Rebecca Peacock, Airworthiness Specialist, Rolls-Royce plc, ML-52, PO Box 31, Derby, DE24 8BJ, England, petitioned the Federal Aviation Administration (FAA) on behalf of Rolls-Royce, plc for an exemption from § 33.27(f)(6), Amendment 33-31 of Title 14, Code of Federal Regulations (14 CFR). The proposed exemption, if granted, would allow some high-pressure (HP) shafts to be exempted from 14 CFR § 33.27(f)(6).

The petitioner requests relief from the following regulation:

Section 33.27(f)(6), Amendment 33-31 prescribes that:

“(f) Failure of a shaft section may be excluded from consideration in determining the highest overspeed that would result from a complete loss of load on a turbine rotor if the applicant:

(6) Does not exclude the entire shaft.”

The petitioner supports its request with the following information:

The petitioner requests the FAA grant the exemption based on two points. The petitioner’s first point is that the design of the HP shaft system in each of the Trent 1000 engine models it identifies, is not amenable to analysis by shaft section. The petitioner’s second point is that they are not able to show compliance with § 33.27 without an exemption from § 33.27(f)(6). However, the petitioner claims to be able to show compliance, with at least an equal level of safety to that required to meet § 33.27, if we grant the exemption.

The petitioner requests exemption from 14 C.F.R. § 33.27(f)(6) for the HP shaft system of the following new Trent 1000 engine models:

ANE-15-574-E

Model	Rating x 1000 lbs.
Trent 1000-AE	64
Trent 1000-CE	70
Trent 1000-AE2	64
Trent 1000-CE2	70

The petitioner asserts that, as demonstrated in its substantiating report, the level of safety afforded by compliance with § 33.27 for the HP shaft system will be unaffected by granting an exemption from § 33.27(f)(6). The petitioner also states that granting this exemption will promote and serve the public interest, and petitioner identified those benefits in its package.

Finally, petitioner asserts that granting its petition will have no adverse effect on safety. The petitioner provided the following in support of that contention.

1. The HP shaft system design used across the Trent engine family differs significantly from conventional shaft systems. A Failure Mode and Effect Analysis has determined that there are no known or potential environmental threats to the integrity of the HP shaft system components that could lead to a failure from a loss of load.
2. The special controls applied to the torque transmitting components (i.e., the HP Compressor Rear Drum and the HP Turbine disc of the HP shaft system) are of a higher standard to ensure a higher level of integrity than those of many other shaft systems in the past.
3. The service experience of the Rolls-Royce three-shaft family of engines, all of which incorporate the similar design style for the HP shaft system as the Trent 1000 engine models that are the subject of this petition, support the theoretical assessment of points 1) and 2) above. Over the course of more than 256 million service flight hours, no HP shaft system torque paths have failed on the Trent family of engines. This performance reflects an extremely remote potential failure rate of less than 2.7×10^{-9} failures per flight hour.

Federal Register Publication

The FAA determined that publishing the petitioner's request for exemption in the Federal Register for public comment was necessary, per 14 CFR 11.87. We published a summary of the petition in the Federal Register on March 31, 2015 (80 FR 17138), for a 10 day period. We received one comment acknowledging the exemption which referenced an FAA request to form a separate advisory group for review of overspeed standards. The complete petition is available at the Department of Transportation's Federal Docket Management System at <http://regulations.gov> under Docket No. FAA-2015-0156.

The FAA's analysis is as follows:

We reviewed the data provided by the petitioner, and find all known failure modes were identified and considered that can lead to an overspeed condition. The compensating factors that the petitioner demonstrated through good service experience of similar three-shaft design systems are acceptable except one. The historical data (good experience) regarding the low-cycle fatigue (LCF) failure mechanism is not applicable to this design. The life-limited location for some of the Trent 1000 engine models is on the torque path, which is different than the petitioner's experience. The LCF lives for the last stage of the HPC and HPT disks for the Trent 1000 engines models are much lower than the previous experience. The new Trent 1000 engines models are operating at higher stress conditions and burst margins are lower than previous experience.

Based on our finding, an additional compensating factor is needed to show an equivalent level of safety. Therefore as a compensating factor any feature on the HP shaft system that has a predicted safe cyclic life less than 150 percent of the declared safe cyclic life (DSCL) limit must be eddy current inspected within 150 cycles of two-thirds of the DSCL limit of the part. Based on the compensating factors that the petitioner demonstrated through good service experience of similar three-shaft design systems, the additional compensating factor listed above, and evaluation of all known failure modes, we conclude that an exemption to § 33.27(f)(6) for the Trent 1000-AE, Trent 1000-CE, Trent 1000-AE2, and Trent 1000-CE2 engine models will have no adverse effect on safety.

The FAA's Decision

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 106(f), 40113 and 44701, delegated to me by the Administrator, Rolls-Royce plc, is granted an exemption from 14 CFR § 33.27(f)(6), subject to the conditions and limitations listed below.

Conditions and Limitations

1. Any feature on the HP shaft system that has a predicted safe cyclic life less than 150 percent of the DSCL limit must be eddy-current inspected within 150 cycles of two-thirds of the DSCL limit of the part.

Issued in Burlington, Massachusetts, on May 22, 2015.

/s/

Thomas A. Boudreau
Acting Manager, Engine and Propeller Directorate
Aircraft Certification Service