



[4910-13]

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 33**

**Docket No. FAA-2017-0537; Notice No. 33-17-02-SC**

**Special Conditions: General Electric Company, GE9X Engine Models; Endurance Test Special Conditions.**

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Notice of proposed special conditions.

**SUMMARY:** This action proposes special conditions for the General Electric turbofan engine models GE9X-105B1A, -105B1A1, -105B1A2, -105B1A3, -102B1A, -102B1A1, -102B1A2, -102B1A3, and -93B1A. These engine models will be referred to as “GE9X” in these special conditions. The engines will have a novel or unusual design features associated with the engine design. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These proposed special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** Send your comments on or before **[insert a date 45 days after the date of publication in the Federal Register]**.

**ADDRESSES:** Send comments identified by docket number **FAA-2017-0537** using any of the following methods:

- Federal eRegulations Portal: Go to <http://www.regulations.gov> and follow the online instructions for sending your comments electronically.
- Mail: Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE, Room W12-140, West Building Ground Floor, Washington, D.C., 20590-0001.
- Hand Delivery or Courier: Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, D.C., between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- Fax: Fax comments to Docket Operations at 202-493-2251.

*Privacy*: In accordance with 5 USC 553(c), DOT solicits comments from the public to better inform its rulemaking process. DOT posts these comments, without edit, including any personal information the commenter provides, to [www.regulations.gov](http://www.regulations.gov), as described in the system of records notice (DOT/ALL-14 FDMS), which can be reviewed at [www.dot.gov/privacy](http://www.dot.gov/privacy).

*Docket*: Background documents or comments received may be read at <http://www.regulations.gov> at any time. Follow the online instructions for accessing the docket or go to the Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

**FOR FURTHER INFORMATION CONTACT:** Dorina Mihail, ANE-111, Engine and Propeller Directorate, Aircraft Certification Service, 1200 District Avenue, Burlington, Massachusetts, 01803-5213; telephone (781) 238-7153; facsimile (781) 238-7199; e-mail [Dorina.Mihail@faa.gov](mailto:Dorina.Mihail@faa.gov).

**SUPPLEMENTARY INFORMATION:**

## **Comments Invited**

We invite interested people to participate in this rulemaking by sending written comments, data, or views. The agency also invites comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposed special conditions, explain the reason for any recommended change, and include supporting data. To ensure the docket does not contain duplicate comments, commenters should send only one copy of written comments, or if comments are filed electronically, commenters should submit only one time.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed after the comment period has closed if it is possible to do so without incurring expense or delay. We may change these special conditions based on the comments we receive.

**Proprietary or Confidential Business Information:** Commenters should not file proprietary or confidential business information in the docket. Such information must be sent or delivered directly to the person identified in the FOR FURTHER INFORMATION CONTACT section of this document, and marked as proprietary or confidential. If submitting information on a disk or CD ROM, mark the outside of the disk or CD ROM, and identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), if the FAA is aware of proprietary information filed with a comment, the agency does not place it in the docket. It is held in a separate file to which the

public does not have access, and the FAA places a note in the docket that it has received it. If the FAA receives a request to examine or copy this information, it treats it as any other request under the Freedom of Information Act (5 U.S.C. 552). The FAA processes such a request under Department of Transportation procedures found in 49 CFR part 7.

## **Background**

On January 29, 2016, General Electric Company (GE) applied for type certificate application for GE's GE9X turbofan engine models. The GE9X engine models are high-bypass-ratio engines that incorporate novel and unusual design features. The GE9X engine models incorporate new technologies such that it cannot run the endurance test conditions prescribed in § 33.87 without significant test-enabling modifications, making the test vehicle non-representative of the proposed type design. An alternative endurance test cycle has been developed that provides a level of safety equivalent with that intended by § 33.87. The proposed alternate endurance test provides the test conditions that allow the engine to be run in type design configuration and demonstrate engine operability and durability as well as systems functionality to a level intended by the current § 33.87 rule.

## **Type Certification Basis**

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, GE must show that the GE9X engine models meet the applicable provisions of part 33, as amended by Amendments 33-1 through 33-34.

If the FAA finds that the applicable airworthiness regulations do not contain adequate or appropriate safety standards for the GE9X engine models because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the engine model for which they are issued. Should the type certificate for that engine model be amended later to include any other engine models that incorporate the same or similar novel or unusual design features, the special conditions would also apply to the other engine models under § 21.101.

In addition to complying with the applicable product airworthiness regulations and special conditions, the GE9X engine models must comply with the fuel venting and exhaust emission requirements of 14 CFR part 34.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type-certification basis under § 21.17(a)(2).

### **Novel or Unusual Design Features**

The GE9X engine models will incorporate the following novel or unusual design features: Technological advances that reduce noise and emissions while improving fuel efficiency and increasing thrust, when compared to previous similar certificated GE engine models.

The GE9X series engine type design incorporates new technologies such that it cannot run the endurance test conditions prescribed in § 33.87 without significant test-enabling modifications, making the test vehicle non-representative of the proposed type design. The modifications needed to run the § 33.87 endurance test have become increasingly complex over time, and reconciling the test results to the proposed type design has also become increasingly difficult.

For past certifications, GE has shown that the proposed engine design, as modified, still represented the durability and operating characteristics of the intended type design but the

modifications needed to the GE9X engine model to run the § 33.87 endurance test cannot be reconciled and would affect the test outcome.

## **Discussion**

These proposed special conditions provide the necessary conditions for verification of engine-level and component-level effects as intended by the current § 33.87 endurance test. The special conditions include a demonstration for the oil, fuel, air bleed, and accessory drive systems as required in the current § 33.87 endurance test.

The level of severity is provided by an engine test demonstration at the gas path limiting temperature and at shaft speed redlines and at the most extreme shaft speeds as determined through a critical point analysis (CPA). In addition, times on condition and cycle counts were developed to allow additional challenges to the new and novel features that would not have been as challenged by the current § 33.87 test schedule. The alternate test demonstrates no potential safety issue will develop while operating in service.

The proposed cycles dwell time duration reflect that GE9X does not have a 10-minute OEI extension for the takeoff rating.

The special conditions for § 33.4 and § 33.29 are added to support an equivalent compliance by means of mandatory inspections prescribed in paragraph (b)(3) of the § 33.87 special conditions.

These special condition requirements maintain a level of safety equivalent to the level intended by the applicable airworthiness standards in effect on the date of application.

## **Applicability**

As discussed above, the proposed special conditions are applicable to the GE9X engine model(s). Should GE apply at a later date for a change to the type certificate to include another

model on the same type certificate incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

### **Conclusion**

This action affects only certain novel or unusual design features on the GE9X turbofan engine models. It is not a rule of general applicability and applies only to GE, who requested FAA approval of this engine feature.

### **List of Subjects in 14 CFR Part 33**

Aircraft, Engines, Aviation Safety, Reporting and Recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

### **The Proposed Special Conditions**

Accordingly, the FAA proposes the following special conditions as part of the type certification basis for the GE9X engine models: GE9X-105B1A, -105B1A1, -105B1A2, -105B1A3, -102B1A, -102B1A1, -102B1A2, -102B1A3, and -93B1A.

#### **1. PART 33 REQUIREMENTS.**

##### **§ 33.4 Instructions for Continued Airworthiness.**

(a) The Airworthiness Limitations section must prescribe the mandatory post-flight inspections and maintenance actions associated with any exceedance required by § 33.87, paragraph (b)(3), of these special conditions.

##### **§ 33.29 Instrument connection.**

(a) The engine must have means, or provisions for means, to automatically record and alert maintenance personnel for each occurrence of any exceedance required by § 33.87 paragraph (b)(3), of these special conditions.

##### **§ 33.87 Endurance Test.**

(a) General: The applicant must show that the endurance test schedule in combination with any prescribed mandatory actions provide an equivalent level of severity and demonstration of durability and operability as that intended by § 33.87(a) and (b) for a turbofan engine. When showing that the level of durability is equivalent with that intended by the rule, the applicant must consider the damage accumulated during the test for the limiting damage mechanisms for components and engine systems, up to and including the applicable limitations declared in the Type Certificate Data Sheets (TCDS). The test cycle content must create conditions in the engine for a sufficient amount of time to demonstrate no potential safety issue will develop from the limiting damage mechanisms while operating in service. The following minimum requirements apply:

(1) The tests in paragraphs (b), (c), and (d) of these special conditions, for total cumulative and dwell time duration between ground idle and the takeoff thrust prescribed in these special conditions. The test cycle durations must include all maximums allowed in the TCDS and expected service operation.

(2) Requirements of § 33.87(a)(1), (2), (4), and (6) applicable to turbofan engines.

(3) Requirements of § 33.87(a)(3) applicable to the temperature of external surfaces of the engine, if limited.

(4) Testing for maximum air bleed must be at least equal with the prescribed test required in § 33.87(a)(5). However, for these cycles, the thrust or the rotor shaft rotational speed may be less than 100 percent of the value associated with the particular operation being tested if the FAA finds that the validity of the endurance test is not compromised.

(5) Testing for engine fuel, oil, and hydraulic fluid pressure and oil temperature must be at least equal with the prescribed test required in § 33.87(a)(7).

(6) If the number of occurrences of either transient rotor shaft overspeed or transient gas over temperature is not limited, at least 155 accelerations must be made at the limiting overspeed or over temperature. If the number of occurrences is limited, that number of accelerations must be made at the limiting overspeed or over temperature.

(7) One hundred starts must be made, of which 25 starts must be preceded by at least a two-hour engine shutdown. There must be at least 10 false engine starts, pausing for the applicant's specified minimum fuel drainage time, before attempting a normal start. There must be at least 10 normal restarts with not longer than 15 minutes since engine shutdown. The remaining starts may be made after completing the endurance testing prescribed by these special conditions.

(8) Unless otherwise specified (i.e. (d)(2)), for accelerations from ground idle to takeoff, the throttle must be moved in not more than one second, except that, if different regimes of control operations are incorporated necessitating scheduling of the thrust-control lever motion in going from one extreme position to the other, a longer period of time is acceptable, but not more than two seconds.

(i) When operating with max oil temperatures the throttle movement may be 'stair-stepped' to allow for oil temperature stabilization for durations greater than two seconds.

(9) The applicant must validate any analytical methods used for compliance with these special conditions. Validation includes the ability to accurately predict an outcome applicable to the engine being tested.

(10) The applicant must perform the endurance test on an engine that substantially conforms to its type design. Modifications may be made as needed to achieve test conditions and/or engine operating conditions representative of the type design.

(b) Conduct the endurance test at or above the declared shaft speeds and gas temperatures limits, and at or above conditions representative of critical points (speeds, temperatures, rated thrust) in the operating envelope.

(1) Conduct the endurance test at or above the rated takeoff thrust and rated maximum continuous thrust and with the associated limits for rotor speeds and gas temperature (redlines), as follows:

(i) Either rotor speed or gas temperature, or concurrent rotor speed and gas temperature if analysis indicates a combination of redline operational conditions is possible to occur in service, must be at least 100 percent of the values associated with the engine rating being tested.

(ii) The cumulative test time duration and number of cycles must be representative of the rotor speed and gas temperature excursions to redlines that can be expected to occur in between overhauls.

(iii) The time durations for each takeoff or maximum continuous segment must include all maximums allowed in the TCDS and expected service operation and must include the following cycles:

(A) At least one (1) takeoff cycle of 5 minutes time duration at the low pressure rotor speed limit and gas temperature limit (redlines).

(B) At least one (1) takeoff cycle of 5 minutes time duration at the high pressure rotor speed limit and gas temperature limit (redlines).

(C) In lieu of the separate cycles specified in paragraphs (A) and (B) of this section, the applicant may run the low pressure and high pressure rotor speeds and gas temperature limits (redlines) in the same cycle. However in this case, the applicant must run at least 2 cycles of 5 minutes time duration each.

(2) Conduct the endurance test at or above the rated takeoff thrust and the rated maximum continuous thrust with rotor speeds at or above those determined by a critical point analysis (CPA) and with gas temperature redline conditions as follows:

(i) The applicant must determine through a CPA the highest rotor shaft rotational speeds (CPA speeds) expected to occur for each rotor shaft system within the declared operating envelope. The CPA must be conducted for the takeoff and maximum continuous rated thrust and must consider the declared operating envelope, engine deterioration, engine-to-engine variability, and any other applicable variables that can cause the engine to operate at the extremes of its performance ratings.

(ii) Except as provided in paragraph (b)(3)(ii) of these special conditions, conduct a cyclic test between ground idle and combined takeoff and maximum continuous thrust ratings, as follows:

(A) Eighteen hours and forty five minutes (18.75 hours) cumulated time duration at or above the rated takeoff thrust, the gas temperature limit for takeoff (redline), and the CPA rotor speeds for takeoff determined per paragraph (b)(2)(i) of these special conditions.

(B) Forty five (45) hours cumulated time duration at or above the rated maximum continuous thrust, the gas temperature limit for maximum continuous (redline), and the CPA rotor speeds for maximum continuous determined per paragraph (b)(2)(i) of these special conditions.

(C) The time durations for each takeoff or maximum continuous segments must include all maximums allowed in the TCDS and expected service operation, and must include at least one maximum continuous cycle of 30 minutes run continuously.

(3) If the cyclic shaft speed excursions specified in paragraphs (b)(1) or (b)(2) of these special conditions cannot be demonstrated in the test, then an alternative equivalent with the rule intent must be provided. Alternatives may include alternate means of test demonstration, mandatory actions, or other means found acceptable to the FAA. The applicant must prescribe a mandatory action plan for engine operation between the shaft speeds demonstrated for a minimum of cumulated 18.75 hours at or above rated takeoff and 45 hours at or above rated maximum continuous, respectively, and the declared speed limits (redlines), as follows:

(i) Prescribe post-event actions or operating limitations acceptable to the FAA for operation below the declared speed limits (redlines) and above the CPA speeds.

(ii) If the test required by (b)(2)(ii) of these special conditions can only be accomplished at a rotor shaft speed lower than the CPA speed, prescribe post-event actions or operating limitations acceptable to the FAA for operation below that CPA speed and above the value demonstrated during the test.

(c) Conduct the endurance test at the incremental cruise thrust that must be at least equal with the prescribed test required in § 33.87(b)(4). The 25 incremental test cycles must be uniformly distributed throughout the entire endurance test.

(d) Conduct at least 300 cycles between ground idle and combined takeoff and maximum continuous thrust, as follows:

(1) Each cycle to include acceleration to or above rated takeoff thrust, deceleration from takeoff to ground idle, followed by 5 to 15 seconds at ground idle, acceleration to or above rated maximum continuous thrust, and deceleration to ground idle.

(2) The throttle movement from ground idle to rated takeoff or maximum continuous thrust and from rated takeoff thrust to ground idle should be not more than one (1) second,

except that, if different regimes of control operations are incorporated necessitating scheduling of the thrust-control lever motion in going from one extreme position to the other, a longer period of time is acceptable, but not more than two seconds. The throttle move from rated maximum continuous thrust to ground idle should not be more than five (5) seconds.

(3) The time durations for each cycle associated with either takeoff or maximum continuous thrust segments must include all maximums allowed in the TCDS and expected service operation, and must include the following cycles:

(i) Three (3) cycles of 5 minutes each and one (1) cycle of 10 minutes at the takeoff thrust.

(ii) Three (3) cycles of 30 minutes each at the maximum continuous thrust.

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