Billing Code

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. FAA-2015-4220; Special Conditions No. 33-017-SC]

Special Conditions: CFM International, LEAP-1B engine model; Incorporation of Woven Composite Fan Blades

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions; request for comments; amendment.

SUMMARY: This action amends Special Condition No. 33-017-SC for the CFM International (CFM) Model LEAP-1B engines. These engines have a novel or unusual design feature associated with the engine fan blades—incorporation of woven composite fan blades. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions, as amended, 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: This action is effective on CFM International on [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]. Send comments on or before [INSERT DATE 45 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Send comments identified by Docket No. FAA-2015-4220 using any of the following methods:

- *Federal eRegulations Portal:* Go to 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, DC, 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, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

Docket: Background documents or comments received may be read at www.regulations.gov at any time. Follow the online instructions for accessing the docket or go to 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: Philip Haberlen, Engine and Propulsion Section, AIR-625, Technical Policy Branch, Policy and Standards Division, Federal Aviation Administration, FAA AIR Office, 1200 District Ave, Burlington, MA 01803; telephone (781) 238-7770; email Philip.haberlen@faa.gov.

SUPPLEMENTARY INFORMATION:

The substance of these special conditions has been published in the ***Federal Register*** for public comment in several prior instances with no substantive comments received. Therefore, the FAA finds, pursuant to 14 CFR 11.38(b), that new comments are unlikely, and notice and comment prior to this publication are unnecessary.

Privacy

Except for Confidential Business Information (CBI) as described in the following paragraph, and other information as described in title 14, Code of Federal Regulations (14 CFR) 11.35, the FAA will post all comments received without change to www.regulations.gov, including any personal information you provide. The FAA will also post a report summarizing each substantive verbal contact received about these special conditions.

Confidential Business Information

Confidential Business Information (CBI) is commercial or financial information that is both customarily and actually treated as private by its owner. Under the Freedom of Information Act (FOIA) (5 U.S.C. 552), CBI is exempt from public disclosure. If your comments responsive to these special conditions contain commercial or financial information that is customarily treated as private, that you actually treat as private, and that is relevant or responsive to these special conditions, it is important that you clearly designate the submitted comments as CBI. Please mark each page of your submission containing CBI as "PROPIN." The FAA will treat such marked submissions as confidential under the FOIA, and the indicated comments will not be placed in the public docket of these special conditions. Send submissions containing CBI to the individual listed in the For Further Information Contact section above. Comments the FAA receives, which are not specifically designated as CBI, will be placed in the public docket for these special conditions.

Comments Invited

The FAA invites interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data.

The FAA will consider all comments received by the closing date for comments. The FAA may change these special conditions based on the comments received.

Background

On June 27, 2012, CFM International (CFM) applied for a new type certificate (TC) to include the LEAP-1A and -1C engine models. Additionally, on May 9, 2013, CFM applied for a new TC to include the LEAP-1B engine models. The LEAP engine models are high-bypass-ratio engines that incorporate a novel and unusual design feature—new woven composite fan blades. The woven composite fan blades will have significant differences in material property

characteristics when compared to conventionally designed fan blades using non-composite metallic materials.

The FAA issued Special Condition No. 33-017-SC for the LEAP-1B engines with this design feature on October 30, 2015. Special Condition No. 33-017-SC became effective on December 21, 2015 (80 FR 72561, November 20, 2015). The FAA issued TC E00088EN on May 4, 2016. Subsequently, CFM highlighted an error in these Special Condition and submitted a type design change request on July 18, 2024. The FAA is proposing changes to Special Conditions No. 33-017-SC based on CFM's application.

Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, CFM must show that the Model LEAP-1B engines meet the applicable provisions of the applicable regulations in effect on the date of application, except as detailed in paragraphs 21.101(b) and (c). The FAA has determined the following certification basis for the LEAP-1B engine models**:**

Title 14 CFR part 33, "Airworthiness Standards: Aircraft Engines," dated February 1, 1965, with Amendments 33-1 through 33-33, dated September 20, 2012.

If the Administrator finds that the applicable airworthiness regulations do not contain adequate or appropriate safety standards for the LEAP-1B 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 model for which they are issued. Should the TC for that model be amended later to include any other model that incorporates the same novel or unusual design feature, the special conditions would also apply to the other model under § 21.101.

In addition to complying with the applicable airworthiness regulations and special conditions, the CFM LEAP-1B engine models must also 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 LEAP-1B engine models will incorporate the following novel or unusual design feature:

The LEAP-1B engine models will incorporate woven composite fan blades. The woven composite fan blades will have significant differences in material property characteristics when compared to conventionally designed fan blades using non-composite metallic materials. Composite material design provides the capability to incorporate multiple load paths and crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

Discussion

The woven composite fan blades are a novel and unusual design feature that require additional airworthiness standards for type certification of the LEAP-1B engine models. The current requirements of § 33.94 are based on single-load path metallic fan blade characteristics and service history and are not appropriate for the unusual design features of the woven composite fan blade found on the CFM LEAP series turbofan engines.

The properties of a composite blade are highly dependent of the composite ply configuration, matrix material, and manufacturing methods. The CFM LEAP engine incorporates 3-D woven resin transfer molding (RTM) technology in the design and manufacture of the blade.

FAA requires that CFM conduct the required material testing per § 33.15 to determine material characteristics that include the effects of defects, manufacturing variations, contamination, environmental effect, and service damage on the material capability and blade life.

Composite material design provides the capability to incorporate multiple load paths and crack arresting features that prevent delamination or crack propagation to blade failure during the

life of the blade. The probability of failure that an appropriately designed composite fan blade will fail below the inner annulus flow path line may be highly improbable. The airworthiness regulations of 14 CFR part 33 do not contain adequate or appropriate safety standards for an aircraft engine incorporating these novel or unusual design features i.e., woven composite fan blades, including release of the fan blade under § 33.94(a)(1) at the inner annulus flow path line (only the airfoil) instead of the outermost retention feature.

Instead of blade failure at the outermost retention groove currently required by § 33.94(a)(1), the FAA has determined that a more realistic blade-out test can be achieved with a fan blade failure at the inner annulus flow path line i.e., releasing only the airfoil.

Additionally, the FAA considers any change to the design, manufacturing, materials, or service management to the blade below the inner annulus flow path to be a change that could affect the blade integrity. Therefore, the FAA has determined that the blade must be marked with a part and serial number, and that additional integrity requirements must be applied to the blade below the inner annulus flow path line.

Special conditions are necessary to ensure that the LEAP-1B woven composite design fan blades account for the differences in material properties and failure modes relative to conventional single-load path metallic blades. In addition, different containment requirements may be applied provided CFM shows that the blade design below the inner annulus flow path line provides multiple load paths and/or crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

The FAA, GE, and CFM recently found that the LEAP-1B proposed special conditions as they appeared in the applicable certification issue paper and the published special conditions do not accurately reflect one of the agreed-upon criterion for the proposed woven fan blade composite design. The FAA and CFM intended, as reflected in the compliance data for the LEAP-1B TC and certification issue paper, that the total probability of hazardous engine effects should be accounted for rather than the probability of an individual blade retention system failure

as stated in paragraph (e), of the original special conditions. These amended special conditions correct this error in the published special conditions for the CFM LEAP-1B engines and are in line with CFM and FAA's intention.

Paragraph (e) as originally issued for Special Condition No. 33-017-SC reads as follows:

(e) Substantiate that during the service life of the engine, the total probability of an individual blade retention system failure resulting from all possible causes, as defined in § 33.75, will be extremely improbable with a cumulative calculated probability of failure of less than 10^{-9} per engine flight hour.

The new paragraph will now read, (consistent with the TC compliance data and Special Conditions Nos. 33-007-SC, published April 24, 2009, and 33–018–SC, published March 30, 2017):

(e) Substantiate that, during the service life of the engine, the total probability of the occurrence of a hazardous engine effect defined in § 33.75 due to an individual blade retention system failure resulting from all possible causes will be extremely improbable, with a cumulative calculated probability of failure of less than 10^{-9} per engine flight hour.

These 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.

Applicability

As discussed above, these special conditions, as amended, are applicable to the model for which they are issued. Should the TC for that model be amended later to include any other model that incorporates the same novel or unusual design feature, or should any other model already included on the same TC be modified to incorporate the same novel or unusual design feature, these special conditions would apply to the other model as well.

Conclusion

This action affects only a certain novel or unusual design feature on the LEAP-1B engine models.

List of Subjects in 14 CFR Part 33

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

Authority Citation

The authority citation for these special conditions is as follows:

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

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following amended special conditions are issued as part of the type certification basis for CFM International (CFM) LEAP-1B engine models.

In addition to the airworthiness standards in 14 CFR part 33, effective February 1, 1965, with Amendments 33-1 through 33-33 applicable to the CFM, LEAP-1B engine models:

(a) Conduct an engine fan blade containment test with the fan blade failing at the inner annulus flow path line instead of at the outermost retention groove.

(b) Substantiate by test and analysis, or other methods acceptable to the FAA, that a fan disk and fan blade retention system with minimum material properties can withstand, without failure, a centrifugal load equal to two times the maximum load the retention system could experience within approved engine operating limitations. The fan blade retention system includes the portion of the fan blade from the inner annulus flow path line inward to the blade dovetail, the blade retention components, and the fan disk and fan blade attachment features.

(c) Using a procedure approved by the FAA, establish an operating limitation that specifies the maximum allowable number of start-stop stress cycles for the fan blade retention

system. The life evaluation must include the combined effects of high-cycle and low-cycle fatigue. If the operating limitation is less than 100,000 cycles, that limitation must be specified in Chapter 5 of the Engine Manual Airworthiness Limitation Section. The procedure used to establish the maximum allowable number of start-stop stress cycles for the fan blade retention system will incorporate the integrity requirements in paragraphs (c)(1), (2), and (3) of these special conditions for the fan blade retention system.

(1) An engineering plan, which establishes and maintains that the combinations of loads, material properties, environmental influences, and operating conditions, including the effects of parts influencing these parameters, are well known or predictable through validated analysis, test, or service experience.

(2) A manufacturing plan that identifies the specific manufacturing constraints necessary to consistently produce the fan blade retention system with the attributes required by the engineering plan.

(3) A service management plan that defines in-service processes for maintenance and repair of the fan blade retention system, which will maintain attributes consistent with those required by the engineering plan.

(d) Substantiate by test and analysis, or other methods acceptable to the FAA, that the blade design below the inner annulus flow path line provides multiple load paths and/or crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

(e) Substantiate that, during the service life of the engine, the total probability of the occurrence of a hazardous engine effect defined in § 33.75 due to an individual blade retention system failure resulting from all possible causes will be extremely improbable, with a cumulative calculated probability of failure of less than 10^{-9} per engine flight hour.

(f) Substantiate by test or analysis that not only will the engine continue to meet the requirements of § 33.75 following a lightning strike on the composite fan blade structure, but that the lightning strike will not cause damage to the fan blades that would prevent continued safe operation of the affected engine.

(g) Account for the effects of in-service deterioration, manufacturing variations, minimum material properties, and environmental effects during the tests and analyses required by paragraphs (a), (b), (c), (d), (e), and (f) of these special conditions.

(h) Propose fleet leader monitoring and field sampling programs that will monitor the effects of engine fan blade usage and fan blade retention system integrity.

(i) Mark each fan blade legibly and permanently with a part number and a serial number.

Issued in in Des Moines, Washington, on July 30, 2025.

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