[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. FAA-2014-0637; Notice No. 33-14-02-SC]

Special Conditions: CFM International, LEAP-1A and -1C Engine Models; Incorporation of Woven Composite Fan Blades.

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed special conditions.

SUMMARY: This action proposes special conditions for the CFM International (CFM), LEAP-1A and -1C engine models. These engines will have a novel or unusual design feature associated with the engine fan blades—new woven composite fan blades. 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 date of publication in the Federal Register].**

ADDRESSES: Send comments identified by docket number [FAA-2014-0637] 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, S.E., 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: Docket Operations will post all comments it receives, without change, to http://regulations.gov, including any personal information the commenter provides. Using the search function of the docket web site, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the Federal Register published on April 11, 2000 (65 FR 19477-19478), as well as at http://DocketsInfo.dot.gov.

Docket: You may read background documents or comments received 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, D.C., between 9 a.m., and 5 p.m., Monday through Friday, except federal holidays.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning these proposed special conditions, contact Alan Strom, ANE-111, Engine and Propeller Directorate, Aircraft Certification Service, 12 New England Executive Park, Burlington, Massachusetts,

01803-5213; telephone (781) 238-7143; facsimile (781) 238-7199; email alan.strom@faa.gov. For legal questions concerning this proposed rule, contact Vincent Bennett, ANE-7, Engine and Propeller Directorate, Aircraft Certification Service, 12 New England Executive Park, Burlington, Massachusetts, 01803-5299; telephone (781) 238-7044; facsimile (781) 238-7055; email vincent.bennett@faa.gov.

SUPPLEMENTARY INFORMATION:

Comments Invited

We invite interested people to participate in this rulemaking by submitting 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 it receives, 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 comments filed late if it is possible to do so without incurring expense or delay. We may change these special conditions based on the comments we receive.

Background

On June 27, 2012, the FAA received the type certificate application for CFM's LEAP-1A and -1C turbofan 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.

Special conditions are required to ensure that the LEAP-1A and -1C 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.

These special conditions are necessary because the applicable airworthiness regulations do not contain adequate or appropriate safety standards for the new woven composite design fan blades.

Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, CFM must show that the LEAP-1A and -1C engine models 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-1A and -1C engine models:

1. 14 CFR part 33, "Airworthiness Standards: Aircraft Engines," dated February 1, 1965, with Amendments 33-1 through 33-32, dated September 20, 2012.

If the FAA finds that the regulations in effect on the date of the application for the change do not provide adequate or appropriate safety standards for the LEAP-1A and -1C 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 type certificate for that model be amended later to include any other model that incorporates the same or similar 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 product airworthiness regulations and the requirements of these special conditions, the LEAP-1A and -1C 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-1A and -1C engine models will incorporate the following novel or unusual design feature:

The LEAP-1A and -1C 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/or crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

The woven composite fan blades are a novel and unusual design feature that requires additional airworthiness standards for type certification of the LEAP-1A and -1C engine models.

Discussion

The woven composite fan blades are a novel and unusual design feature that requires additional airworthiness standards for type certification of the LEAP-1A and -1C 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.

It is expected that CFM will 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/or 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 be marked with a part and serial number, and that additional integrity requirements be applied to the blade below the inner annulus flow path line.

These 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, these special conditions are applicable to the LEAP-1A and -1C engine models. Should CFM apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

Conclusion

This action affects only the woven composite fan blade feature on the LEAP-1A and -1C engine models. It is not a rule of general applicability and applies only to CFM, who requested FAA approval of this engine feature.

List of Subjects in 14 CFR Part 33

Aircraft, Engines, Aviation Safety, Reporting, and Record Keeping.

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 CFM, LEAP-1A and -1C engine models.

1. Part 33, Requirements.

In addition to the airworthiness standards in 14 CFR part 33, effective February 1, 1965, with Amendments 33-1 through 33-32 applicable to the CFM, LEAP-1A and -1C 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 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.

(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 Burlington, Massachusetts, on November 06, 2014.

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Kimberly K. Smith
Acting Manager, Engine and Propeller Directorate
Aircraft Certification Service

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