

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 23

[Docket No. CE310; Special Conditions No. 23-250-SC

Special Conditions: Diamond Aircraft Industry Model DA-40NG; Diesel Cycle Engine

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions; request for comments.

SUMMARY: These special conditions are issued for the Diamond Aircraft Industry (DAI) GmbH model DA-40NG with the Austro Engine GmbH model E4 aircraft diesel engine (ADE) using turbine (jet) fuel. This airplane will have a novel or unusual design feature(s) associated with the installation of a diesel cycle engine utilizing turbine (jet) fuel. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. 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.

DATES: The effective date of these special conditions is April 1, 2011.

We must receive your comments by [INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Mail two copies of your comments to: Federal Aviation Administration, Regional Counsel, ACE-7, Attn: Rules Docket No. CE310, 901 Locust, Kansas City, MO 64106. You may deliver two copies to the Regional Counsel at the above address. Mark your

comments: Docket No. CE310. You may inspect comments in the Rules Docket weekdays, except Federal holidays, between 7:30 a.m. and 4:00 p.m.

FOR FURTHER INFORMATION CONTACT: Peter L. Rouse, Federal Aviation Administration, Small Airplane Directorate, Aircraft Certification Service, ACE-111, 901 Locust, Kansas City, Missouri, 816-329-4135, fax 816-329-4090.

SUPPLEMENTARY INFORMATION:

The FAA has determined that notice and opportunity for prior public comment hereon are impracticable because these procedures would significantly delay issuance of the design approval and thus delivery of the affected aircraft. In addition, the substance of these special conditions has been subject to the public comment process in several prior instances with no substantive comments received. The FAA therefore finds that good cause exists for making these special conditions effective upon issuance.

Comments Invited

We invite 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. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel about these special conditions. You can inspect the docket before and after the comment closing date. If you wish to review the docket in person, go to the address in the ADDRESSES section of this preamble between 7:30 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays.

We will consider all comments we receive by the closing date for comments. 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.

If you want us to let you know we received your comments on these special conditions, send us a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it back to you.

Background

On May 11, 2010 Diamond Aircraft Industry GmbH applied for an amendment to Type Certificate No. A47CE to include the new model DA-40NG with the Austro Engine GmbH model E4 ADE. The model DA-40NG, which is a derivative of the model DA-40 currently approved under Type Certificate No. A47CE, is a fully composite, four place, single-engine airplane with a cantilever low wing, T-tail airplane with the Austro Engine GmbH model E4 diesel engine and an increased maximum takeoff gross weight from 1150 kilograms (kg) to 1280 kg (2535 pounds (lbs) to 2816 lbs).

In anticipation of the reintroduction of diesel engine technology into the small airplane fleet, the FAA issued Policy Statement PS-ACE100-2002-004 on May 15, 2004, which identified areas of technological concern. Refer to this policy for a detailed summary of the FAA's development of diesel engine requirements.

The general areas of concern involve the power characteristics of the diesel engines, the use of turbine fuel in an airplane class that is typically powered by gasoline fueled engines and the vibration characteristics and failure modes of diesel engines. A review of the historical record of diesel engine use in aircraft and part 23 identified these concerns. The review

identified specific regulatory areas requiring evaluation for applicability to diesel engine installations. These concerns are not considered universally applicable to all types of possible diesel engines and diesel engine installations. However, after reviewing the DAI installation, the Austro engine type, the Austro Control GmbH (ACG) requirements, and Policy Statement PS-ACE100-2002-004, the FAA issues these fuel system and engine related special conditions. The Austro engine has a Full Authority Digital Engine Control (FADEC), which also requires special conditions. The FADEC special conditions will be issued in a separate notice.

Type Certification Basis

Under the provisions of § 21.101, DAI must show that the model DA-40NG meets the applicable provisions of the regulations incorporated by reference in Type Certificate No. A47CE or the applicable regulations in effect on the date of application for the change to the model DA-40. The regulations incorporated by reference in the type certificate are commonly referred to as the "original type certification basis." In addition, the certification basis includes special conditions and equivalent levels of safety for the following:

Special Conditions:

- Engine torque (Provisions similar to § 23.361, paragraphs (b)(1) and (c)(3))
- Flutter (Compliance with § 23.629, paragraphs (e)(1) and (2))
- Powerplant — Installation (Provisions similar to § 23.901(d)(1) for turbine engines)
- Powerplant — Fuel System — Fuel system with water saturated fuel (Compliance with § 23.951 requirements)
- Powerplant — Fuel System — Fuel system hot weather operation (Compliance with § 23.961 requirements)

- Powerplant — Fuel system — Fuel tank filler connection (Compliance with § 23.973(f) requirements)
- Powerplant — Fuel system — Fuel tank outlet (Compliance with § 23.977 requirements)
- Equipment — General — Powerplant Instruments (Compliance with § 23.1305 requirements)
- Operating Limitations and Information — Powerplant limitations — Fuel grade or designation (Compliance with § 23.1521(d) requirements)
- Markings And Placards — Miscellaneous markings and placards — Fuel, oil, and coolant filler openings (Compliance with § 23.1557(c)(1) requirements)
- Powerplant — Fuel system — Fuel-Freezing
- Powerplant Installation — Vibration levels
- Powerplant Installation — One cylinder inoperative
- Powerplant Installation — High Energy Engine Fragments

Equivalent level of safety for:

- | | |
|---|-----------|
| • Cockpit controls | 23.777(d) |
| • Motion and effect of cockpit controls | 23.779(b) |
| • Liquid Cooling — Installation | 23.1061 |
| • Ignition switches | 23.1145 |

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 23) do not contain adequate or appropriate safety standards for the model DA-40NG because of a

novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

In addition to the applicable airworthiness regulations and special conditions, the model DA-40NG must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the noise certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in § 11.19, under § 11.38, and become part of the type certification basis in accordance with § 21.101.

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 novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, the special conditions would also apply to the other model.

Novel or Unusual Design Features

The model DA-40NG will incorporate the following novel or unusual design features:
Installation of the Austro Engine GmbH model E4 ADE diesel engine utilizing turbine (jet) fuel.

Discussion

Several major concerns were identified in developing FAA policy. These include installing the diesel engine and noting its vibration levels under both normal operating conditions and when one cylinder is inoperative. The concerns also include accommodating turbine fuels in airplane systems that have generally evolved based on gasoline requirements, anticipated use of a FADEC to control the engine, and appropriate limitations and indications for a diesel engine

powered airplane. The general concerns associated with the aircraft diesel engine installation are as follows:

- Installation and Vibration Requirements
- Fuel and Fuel System Related Requirements
- Limitations and Indications

Installation and Vibration Requirements: These special conditions include requirements similar to the requirements of § 23.901(d)(1) for turbine engines. In addition to the requirements of § 23.901 applied to reciprocating engines, the applicant will be required to construct and arrange each diesel engine installation to result in vibration characteristics that do not exceed those established during the type certification of the engine. These vibration levels must not exceed vibration characteristics that a previously certificated airframe structure has been approved for, unless such vibration characteristics are shown to have no effect on safety or continued airworthiness. The engine limit torque design requirements as specified in § 23.361 are also modified.

An additional requirement to consider vibration levels and/or effects of an inoperative cylinder was imposed. Also, a requirement to evaluate the engine design for the possibility of, or effect of, liberating high-energy engine fragments, in the event of a catastrophic engine failure, requirements was added.

Fuel and Fuel System Related Requirements: Due to the use of turbine fuel, this airplane must comply with the requirements in § 23.951(c).

Section 23.961 will be complied with using the turbine fuel requirements. These requirements will be substantiated by flight-testing as described in Advisory Circular AC 23-8B, Flight Test Guide for Certification of Part 23 Airplanes.

This special condition specifically requires testing to show compliance to § 23.961 and adds the possibility of testing non-aviation diesel fuels.

To ensure fuel system compatibility and reduce the possibility of misfueling, and discounting the first clause of § 23.973(f) referring to turbine engines, the applicant will comply with § 23.973(f).

Due to the use of turbine fuel, the applicant will comply with § 23.977(a)(2), and § 23.977(a)(1) will not apply. "Turbine engines" will be interpreted to mean "aircraft diesel engine" for this requirement. An additional requirement to consider the possibility of fuel freezing was imposed.

Due to the use of turbine fuel, the applicant will comply with § 23.1305(c)(8).

Due to the use of turbine fuel, the applicant must comply with § 23.1557(c)(1)(ii). Section 23.1557(c)(1)(ii) will not apply. "Turbine engine" is interpreted to mean "aircraft diesel engine" for this requirement.

Limitations and Indications

Section 23.1305(a) and § 23.1305(b)(2) will apply, except that propeller revolutions per minute (RPM) will be displayed. Sections 23.1305(b)(4), 23.1305(b)(5), and 23.1305(b)(7) are deleted. Additional critical engine parameters for this installation that will be displayed include:

- (1) Power setting, in percentage, and
- (2) Fuel temperature.

Due to the use of turbine fuel, the requirements for § 23.1521(d), as applicable to fuel designation for turbine engines, will apply.

Applicability

As discussed above, these special conditions are applicable to the model DA-40NG. Should DAI 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 certain novel or unusual design features on one model of airplanes. It is not a rule of general applicability, and it affects only the applicant who applied to the FAA for approval of these features on the airplane.

The substance of these special conditions has been subjected to the notice and comment period in several prior instances and has been derived without substantive change from those previously issued. It is unlikely that prior public comment would result in a significant change from the substance contained herein. Therefore, because a delay would significantly affect the certification of the airplane, which is imminent, the FAA has determined that prior public notice and comment are unnecessary and impracticable, and good cause exists for adopting these special conditions upon issuance. The FAA is requesting comments to allow interested persons to submit views that may not have been submitted in response to the prior opportunities for comment described above.

List of Subjects in 14 CFR Part 23

Aircraft, Aviation safety, Signs and symbols.

Citation

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113 and 44701; 14 CFR 21.16 and 21.17; and 14 CFR 11.38 and 11.19.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Diamond Aircraft Industry GmbH Model DA-40NG with the installation of the Austro Engine GmbH Model E4 aircraft diesel engine.

1. Engine torque (Provisions similar to § 23.361, paragraphs (b)(1) and (c)(3)):

a. For diesel engine installations, the engine mounts and supporting structure must be designed to withstand the following:

(1) A limit engine torque load imposed by sudden engine stoppage due to malfunction or structural failure.

(a) The effects of sudden engine stoppage may alternatively be mitigated to an acceptable level by utilization of isolators, dampers clutches, and similar provisions, so unacceptable load levels are not imposed on the previously certificated structure.

b. The limit engine torque to be considered under § 23.361(a) must be obtained by multiplying the mean torque by a factor of four for diesel cycle engines.

(1) If a factor of less than four is used, it must be shown that the limit torque imposed on the engine mount is consistent with the provisions of § 23.361(c). In other words, it must be

shown that the use of the factors listed in § 23.361(c)(3) will result in limit torques on the mount that are equivalent to or less than those imposed by a conventional gasoline reciprocating engine.

2. Flutter – (Compliance with § 23.629 (e)(1) and (e)(2) requirements):

The flutter evaluation of the airplane done in accordance with 14 CFR § 23.629 must include –

(a) Whirl mode degree of freedom which takes into account the stability of the plane of rotation of the propeller and significant elastic, inertial, and aerodynamic forces, and

(b) Propeller, engine, engine mount and airplane structure stiffness and damping variations appropriate to the particular configuration, and

(c) The flutter investigation will include showing the airplane is free from flutter with one cylinder inoperative.

3. Powerplant — Installation (Provisions similar to § 23.901(d)(1) for turbine engines):

Considering the vibration characteristics of diesel engines, the applicant must comply with the following:

a. Each diesel engine installation must be constructed and arranged to result in vibration characteristics that--

(1) Do not exceed those established during the type certification of the engine; and

(2) Do not exceed vibration characteristics that a previously certificated airframe structure has been approved for --

(i) Unless such vibration characteristics are shown to have no effect on safety or continued airworthiness, or

(ii) Unless mitigated to an acceptable level by utilization of isolators, dampers clutches, and similar provisions, so that unacceptable vibration levels are not imposed on the previously certificated structure.

4. Powerplant — Fuel System — Fuel system with water saturated fuel (Compliance with § 23.951 requirements):

Considering the fuel types used by diesel engines, the applicant must comply with the following:

a. Each fuel system for a diesel engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80° F and having 0.75cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

b. Methods of compliance that are acceptable for turbine engine fuel systems requirements of § 23.951(c) are also considered acceptable for this requirement.

5. Powerplant — Fuel System — Fuel system hot weather operation (Compliance with § 23.961 requirements):

In place of compliance with § 23.961, the applicant must comply with the following:

a. Each fuel system must be free from vapor lock when using fuel at its critical temperature, with respect to vapor formation, when operating the airplane in all critical operating and environmental conditions for which approval is requested. For turbine fuel, or for aircraft equipped with diesel cycle engines that use turbine or diesel type fuels, the initial temperature must be 110°F, -0°, +5° or the maximum outside air temperature for which approval is requested, whichever is more critical.

b. The fuel system must be in an operational configuration that will yield the most adverse, that is, conservative results.

c. To comply with this requirement, the applicant must use the turbine fuel requirements and must substantiate these by flight-testing, as described in Advisory Circular AC 23-8B, Flight Test Guide for Certification of Part 23 Airplanes.

6. Powerplant — Fuel system — Fuel tank filler connection (Compliance with § 23.973(f) requirements):

In place of compliance with § 23.973(e) and (f), the applicant must comply with the following:

For airplanes that operate on turbine or diesel type fuels, the inside diameter of the fuel filler opening must be no smaller than 2.95 inches.

7. Powerplant — Fuel system — Fuel tank outlet (Compliance with § 23.977 requirements):

In place of compliance with § 23.977(a)(1) and (a)(2), the applicant will comply with the following:

There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must, for diesel engine powered airplanes, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

8. Equipment — General — Powerplant Instruments (Compliance with § 23.1305 and 91.205 requirements):

In place of compliance with § 23.1305, the applicant will comply with the following:

Below are required powerplant instruments:

- (a) A fuel quantity indicator for each fuel tank, installed in accordance with § 23.1337(b).
- (b) An oil pressure indicator.
- (c) An oil temperature indicator.
- (d) A tachometer indicating propeller speed.
- (e) A coolant temperature indicator.
- (f) An indicating means for the fuel strainer or filter required by § 23.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with § 23.997(d).

Alternately, no indicator is required if the engine can operate normally for a specified period with the fuel strainer exposed to the maximum fuel contamination as specified in MIL-5007D. Additionally, provisions for replacing the fuel filter at this specified period (or a shorter period) are included in the maintenance schedule for the engine installation.

- (g) Power setting, in percentage.
- (h) Fuel temperature.
- (i) Fuel flow (engine fuel consumption).

In place of compliance to § 91.205, comply with the following:

The diesel engine has no manifold pressure gauge as required by § 91.205, in its place, the engine instrumentation as installed is to be approved as equivalent. The Type Certification Data Sheet (TCDS) is to be modified to show power indication will be accepted to be equivalent to the manifold pressure indication.

9. Operating Limitations and Information — Powerplant limitations — Fuel grade or designation (Compliance with § 23.1521(d) requirements):

Instead of compliance with § 23.1521(d), the applicant must comply with the following:

The minimum fuel designation (for diesel engines) must be established so it is not less than required for the operation of the engines within the limitations in paragraphs (b) and (c) of § 23.1521.

10. Markings And Placards — Miscellaneous markings and placards — Fuel, oil, and coolant filler openings (Compliance with § 23.1557(c)(1) requirements):

Instead of compliance with § 23.1557(c)(1), the applicant must comply with the following:

Fuel filler openings must be marked at or near the filler cover with—

For diesel engine-powered airplanes—

(a) The words “Jet Fuel”; and

(b) The permissible fuel designations, or references to the Airplane Flight Manual (AFM)

for permissible fuel designations.

(c) A warning placard or note that states the following or similar:

"Warning — this airplane is equipped with an aircraft diesel engine; service with approved fuels only."

The colors of this warning placard should be black and white.

11. Powerplant — Fuel system — Fuel-Freezing:

If the fuel in the tanks cannot be shown to flow suitably under all possible temperature conditions, then fuel temperature limitations are required. These limitations will be considered

as part of the essential operating parameters for the aircraft. Limitations will be determined as follows:

(a) The takeoff temperature limitation must be determined by testing or analysis to define the minimum fuel cold-soaked temperature that the airplane can operate on.

(b) The minimum operating temperature limitation must be determined by testing to define the minimum acceptable operating temperature after takeoff (with minimum takeoff temperature established in (1) above).

12. Powerplant Installation — Vibration levels:

Vibration levels throughout the engine operating range must be evaluated and:

(a) Vibration levels *imposed on the airframe* must be less than or equivalent to those of the gasoline engine; or

(b) Any vibration level higher than that imposed on the airframe by the replaced gasoline engine must be considered in the modification and the effects on the technical areas covered by the following paragraphs must be investigated:

14 CFR part 23, §§ 23.251; 23.613; 23.627; 23.629 (or CAR 3.159, as applicable to various models); 23.572; 23.573; 23.574 and 23.901.

Vibration levels imposed on the airframe can be mitigated to an acceptable level by utilization of isolators, damper clutches and similar provisions so that unacceptable vibration levels are not imposed on the previously certificated structure.

13. Powerplant Installation — One cylinder inoperative:

Tests or analysis, or a combination of methods, must show that the airframe can withstand the shaking or vibratory forces imposed by the engine if a cylinder becomes

inoperative. Diesel engines of conventional design typically have extremely high levels of vibration when a cylinder becomes inoperative. Data must be provided to the airframe installer/modifier so either appropriate design considerations or operating procedures, or both, can be developed to prevent airframe and propeller damage.

14. Powerplant Installation — High Energy Engine Fragments:

It may be possible for diesel engine cylinders (or portions thereof) to fail and physically separate from the engine at high velocity (due to the high internal pressures). This failure mode will be considered possible in engine designs with removable cylinders or other non-integral block designs. The following is required:

(a) It must be shown that the engine construction type (massive or integral block with non-removable cylinders) is inherently resistant to liberating high energy fragments in the event of a catastrophic engine failure; or,

(b) It must be shown by the design of the engine, that engine cylinders, other engine components or portions thereof (fragments) cannot be shed or blown off of the engine in the event of a catastrophic engine failure; or

(c) It must be shown that all possible liberated engine parts or components do not have adequate energy to penetrate engine cowlings; or

(d) Assuming infinite fragment energy, and analyzing the trajectory of the probable fragments and components, any hazard due to liberated engine parts or components will be minimized and the possibility of crew injury is eliminated. Minimization must be considered during initial design and not presented as an analysis after design completion.

Issued in Kansas City, Missouri on April 1, 2011.



John Colomy
Acting Manager, Small Airplane Directorate
Aircraft Certification Service