



U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

**Subject: TYPE CERTIFICATION BASIS
FOR CONVERSION FROM
RECIPROCATING ENGINE TO
TURBINE ENGINE-POWERED
PART 23 AIRPLANES**

Date: 9/30/93

AC No: 23-14

Initiated By: ACE-100

Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance concerning an acceptable means, but not the only means of showing compliance with part 23 through amendment 23-45 of the Federal Aviation Regulations (FAR) applicable to replacing reciprocating engines with gas turbine engines (turbopropeller, turbojet, or turbofan). Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED REGULATIONS AND DOCUMENTS.

a. Sections 21.17, 21.19, 21.101(b), 21.113, and 21.115 of part 21 of the FAR; parts 34 and 36 of the FAR.

b. Refer to appendix 1 for a list of related AC's.

3. SCOPE. This AC provides guidance and criteria for establishing the certification basis for installation of gas turbine engines in place of reciprocating engines in general aviation type airplanes certificated to part 23 of the FAR, part 3 of the Civil Air Regulations (CAR), or earlier regulation. It is intended to be used to determine that the engine installation has an acceptable minimum level of safety. Installations that involve changes to primary structure, aerodynamics, airspeed, mass distribution (may induce whirl mode, flutter, and fatigue life changes), maximum weight, system changes, changes in center of gravity (c.g.) limits or power increases which affect high speed characteristics or airplane handling qualities may require additional substantiation and/or additional certification basis requirements that could exceed the scope of this AC. Also, projects such as commuter category or restricted category airplanes will require a more detailed analysis to establish the appropriate certification basis.

4. BACKGROUND. Applications for supplemental type certificates (STC's) and amended type certificates (TC's) for incorporation of gas turbine engines in certificated reciprocating engine airplanes are received by the Federal Aviation Administration (FAA). This guidance is issued because the certification requirements for gas turbine engine installation are substantially different from those for reciprocating engine installation.

5. DESIGNATION OF APPLICABLE REGULATIONS.

a. Type Certificates. In accordance with § 21.19(b)(2), a change from reciprocating engine propeller driven airplanes to turbojet or turbofan engine powered airplanes (not propeller driven), will require a new application for a type certificate. The certification basis will be established in accordance with the type certification procedures in Part 21 of the FAR. For the issuance of a type certificate, an airplane must be shown to comply with the certification basis established in accordance with § 21.17 of the FAR. If the regulations do not provide adequate or appropriate standards because of a novel or unusual design feature, special conditions may be prescribed in accordance with § 21.16.

b. Other Design Changes. For conversion to a turbopropeller driven airplane by the addition of a model to an existing type certificate (amended TC) or modification of an existing model (STC), the airplane must be shown to comply with the certification basis established in accordance with §§ 21.101(b) or 21.115. The engine conversion is a substantially complete redesign of the powerplant installation and compliance with current rules are prescribed in accordance with § 21.101(b). Special conditions may be prescribed in accordance with § 21.16.

c. Commuter Category. For commuter category airplanes, those sections pertaining to commuter category should be included in the certification basis.

d. Restricted Category. A separate AC (AC 21.25-X) for restricted category airplanes will be issued.

e. Environmental Considerations. Parts 34 and 36 of the FAR must be addressed.

6. MODIFICATION CONSIDERATIONS.

a. Before modifying the airplane, the applicant should become familiar with the existing airplane structural and systems characteristics and functions, and with the applicable certification requirements. To avoid structural and systems compatibility problems, an intimate knowledge of the airplane is essential. In particular, the applicant should determine the effects of the turbine engine(s) on payload, c.g., mass distribution induced flutter changes, system changes, airplane operations, and structural margins. An automatic pilot system, if installed should be compatible with the airplane/turbine engine installation and flight test will be required.

b. The applicant should be particularly aware that in the absence of structural substantiation, § 23.1505(c) requires the airspeed indicator red line (V_{MO}/MMO) not exceed V_C (usually top of the old green arc). This may limit operational usefulness of the airplane.

c. Turbine engine conversions typically require a certification flight test program. This may include handling qualities, performance, flutter (not part of FAA flight test), spins, hot fuel climb, engine cooling, engine operating characteristics, autopilot, etc.

d. The list of sections in paragraph 8, Certification Basis, is based on no power increase and no approval for flight in known icing conditions. However, the powerplant installation icing protection requirements are applicable (§ 23.1093).

e. If approval for flight in known icing conditions is requested, flight in icing conditions may have to be demonstrated (§ 23.1419).

f. The applicant should consult with the responsible FAA Aircraft Certification Office (ACO) early in the design program to avoid later changes.

g. Special conditions may be required for engines with electronic engine controls.

7. PROCEDURES. To avoid possible delays and redesign, it is recommended that the applicant follow these procedures after application for approval of the installation.

a. Submit a proposed overall certification plan that identifies the essential steps or actions and the sequence anticipated for submitting drawings, process specifications, reports, analyses,

tests, and other documentation to complete the installation approval. This program should include the proposed or target schedule for the required FAA approval tests and inspections.

b. Generate a certification test plan for each required test which describes the analytical procedures and/or certification testing to be used to demonstrate the airplane design. Each plan should list the applicable FAR and describe how each requirement will be met. In addition, the plan should include a description of the airplane or test articles to be used, drawings, method of production (if applicable), and the target date for installation and test. The certification test plan should be submitted for review and approval by the appropriate FAA Aircraft Certification Office (ACO) prior to initiation of tests, to prevent certification delays.

c. Obtain FAA approval of each certification test plan.

d. After the FAA has received the results of the applicants testing per the FAA approved test plans, a Type Inspection Authorization (TIA) will be issued to specify the required installation conformity inspection and official ground and flight tests.

e. Schedule FAA conformity inspection of the test article(s) and installation.

f. Schedule and conduct the ground and flight test(s) with FAA witnessing.

g. Submit final test reports describing all test results and obtain FAA approval.

h. It is recommended that a certification compliance checklist be utilized.

i. It is recommended that the AC index be examined at the time certification projects are initiated to check the available methods of determining compliance with individual regulation sections.

8. CERTIFICATION BASIS. For proper implementation of § 21.101(b) to an STC or amended TC application for turbopropeller engine installation, the type certification basis should include the applicable prior certification basis regulations of the airplane being modified plus at least the latest amendment (through amendment 23-45) of the following sections of part 23 as they apply to the airplane modifications:

	23.901	23.1145
23.25	23.903	23.1149
23.33	23.904	23.1153
23.45	23.905	23.1155
23.49	23.907	23.1163
23.65	23.925	23.1165
23.67	23.929	23.1181
23.77	23.933	23.1182
23.145(c)	23.937	23.1183
23.149	23.939	23.1189
23.155	23.943	23.1191
23.161	23.951	23.1193
23.175	23.953	23.1203
23.177	23.955	23.1301
23.201	23.959	23.1303
23.203	23.961	23.1305
23.205	23.965(b)	23.1309
23.221	23.973	23.1321(a), (b),
23.231	23.977	and (c)
23.233	23.991	23.1322
23.239	23.993	23.1329
23.251	23.994	23.1337
23.253	23.995	23.1351
23.301	23.997	23.1353(f) and (g)
23.305	23.1011	23.1357(b)
23.307	23.1013	23.1435
23.335	23.1015	23.1438
23.361	23.1017	23.1501
23.363	23.1019	23.1505
23.367	23.1021	23.1513
23.371	23.1023	23.1521
23.457(b)	23.1027	23.1527
23.479(d)	23.1041	23.1529
23.572(b)(3)	23.1043	23.1545
23.603	23.1045	23.1549
23.627	23.1091	23.1551
23.629(e)	23.1093	23.1555
23.735(b)	23.1103	23.1557
23.777(d)	23.1111	23.1583
23.781(b)	23.1121	23.1585
23.831	23.1123	23.1587
23.863	23.1141	
23.865	23.1143	

If engine power, airspeed limits, propeller rotational speed (revolutions per minute), or number of propeller blades are changed, the applicant should provide substantiating data showing that the vibratory response of the horizontal tail assembly to the propeller slipstream environment will not result in fatigue failures [§§ 23.251, 23.572(a)(1), and 23.572(b)(3)].

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APPENDIX 1. RELATED ADVISORY CIRCULARS

The advisory circulars (AC's) listed below may be obtained from the U.S. Department of Transportation, General Services Section, M-443.2, Washington, DC 20590:

AC 20-36R	Index of Articles (Materials, Parts, Processes and Appliances) Certified Under the Technical Standard Order System
AC 20-66	Vibration Evaluation of Aircraft Propellers
AC 20-73	Aircraft Ice Protection
AC 20-88A	Guidelines on the Marking of Aircraft Powerplant Instruments
AC 20-110G	Index of Aviation Technical Standard Orders
AC 20-116	Marking Aircraft Fuel Filler Openings with Color Coded Decals
AC 20-119	Fuel Drain Valves
AC 20-122A	Anti-misfueling Devices: Their Availability and Use
AC 20-124	Water Ingestion Testing for Turbine Powered Airplanes
AC 20-128	Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor and Fan Blade Failures
AC 20-135	Powerplant Installation and Propulsion System Component Fire Protection Test Methods Standards and Criteria
AC 23-2	Flammability Tests
AC 23-7	Substantiation for an Increase in Maximum Weight, Maximum Landing Weight, or Maximum Zero Fuel Weight
AC 23-8A	Flight Test Guide for Certification of Part 23 Airplanes

- AC 23-10 Auxiliary Fuel Systems for Reciprocating and Turbine Powered Part 23 Airplanes
- AC 23-12 Structural Substantiation of Part 23 Airplane Modifications Involving Increased Engine Power
- AC 23.629-1A Means of Compliance with Section 23.629, "Flutter"
- AC 23.955-1 Substantiating Flow Rates and Pressures in Fuel Systems of Small Airplanes
- AC 23.959-1 Unusable Fuel Test Procedures for Small Airplanes
- AC 23.961-1 Procedures for Conducting Fuel System Hot Weather Operation Tests
- AC 23.1011-1 Procedures for Determining Acceptable Fuel/Oil Ratio as Required by FAR 23.1011(b)
- AC 23.1309-1A Equipment, Systems, and Installations in Part 23 Airplanes
- AC 23.1329-2 Automatic Pilot Systems Installation in Part 23 Airplanes
- AC 23.1419-2 Certification of Part 23 Airplanes for Flight in Icing Conditions
- AC 36-4B Noise Certification Handbook