Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Engine Harmonization Working Group

Task 10 – Auxiliary Power Unit

Task Assignment

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of a new task assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Michael H. Borfitz, Manager, Engine and Propeller Standards Staff, Engine and Propeller Directorate, ANE–110, FAA, Aircraft Certification Service, 12 New England Executive Park, Burlington, MA 01803, telephone (617) 238–7110.

SUPPLEMENTARY INFORMATION:

Background

The FAA has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the FAA Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the FAA's rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the FAA's commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine issues. These issues involve the airworthiness standards for transport category airplanes in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135.

The Task

This notice is to inform the public that the FAA has asked ARAC to provide advice and recommendation on the following harmonization task:

Auxiliary Power Unit (APU) Approval Procedures: (1) Examine the adequacy of existing APU approval procedures; (2) Resolve technical differences in approval procedures between Joint Aviation Regulation APU and Technical Standard Order C–77, and review the adequacy of requirements in the light of possible APU usages, e.g., ETOPS; (3) Coordinate these tasks, as appropriate, with other relevant bodies, e.g., the Powerplant Installation Harmonization Working Group; (4) Technical agreement should be reached within 24 months following publication of the notice of task in the **Federal Register**.

The FAA also has asked that ARAC determine if rulemaking action (e.g., NPRM, supplemental NPRM, final rule, withdrawal) should be taken, or advisory material should be issued. If so, ARAC has been asked to prepare the necessary documents, including economic analysis, to justify and carry out its recommendation(s).

ARAC Acceptance of Task(s)

ARAC has accepted the task(s) and has chosen to assign it to the existing Propulsion Harmonization Working Group. The working group will serve as staff to ARAC to assist ARAC in the analysis of the assigned task. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group's recommendations, it forwards them to the FAA as ARAC recommendations.

Working Group Activity

The Propulsion Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the task, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider Transport Airplane and Engine Issues held following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with the work stated in item 3 below.
3. For each task, draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations.
4. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

Participation in the Working Group

The Propulsion Harmonization Working Group is composed of experts having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the tasks, and stating the expertise he or she would bring to the working group. The request will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of ARAC will be open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the

Propulsion Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on May 30, 1996

Chris Christie,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 96–14042 Filed 6–4–96; 8:45 am]

BILLING CODE 4910–13–M

Recommendation Letter

400 Main Street
East Hartford, Connecticut 06108

Pratt & Whitney
A United Technologies Company

September 30, 1999

Federal Aviation Administration
Department of Transportation
800 Independence Ave. S.W.
Washington, D.C. 20591

Attn: Mr. Anthony Fazio, Office of Rulemaking

Subject: Request for Formal Legal and Economic Review – APU TSO-C77b

Dear Tony:

The ARAC TAEIG is pleased to submit the attached APU TSO-C77b to the FAA for formal economic and legal review. This document has been prepared by the Engine Harmonization Working Group. Please contact us if additional information is required.

Craig R. Bolt

Craig R. Bolt
Assistant Chair, TAEIG
boltcr@pweh.com
(Ph: 860-565-9348/Fax: 860-557-2277)

CRB/amr

Attachment

cc: Marc Bouthillier – FAA-NER
Kristin Larson – FAA-NWR
Jerry McRoberts - Allison
Judith Watson – FAA-NER

Acknowledgement Letter

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

NOV 19 1999

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

Thank you for your September 30, 1999, letter transmitting a draft technical standard order (TSO) for gas turbine auxiliary power units. Discussions with staff in the Federal Aviation Administration's (FAA) Aircraft Certification Service Engine and Propeller Directorate revealed the proposed TSO satisfied all the requirements for a recommendation. Further, unlike a proposed rulemaking, no formal economic or legal reviews are warranted. Therefore, the FAA is accepting the TSO as a recommendation and is closing out Task 10, Auxiliary Power Unit Approval Procedures, which had been assigned to the Engine Harmonization Working Group.

Let me thank the Aviation Rulemaking Advisory Committee and, in particular, the members of the Engine Harmonization Working Group for their efforts in completing the task assigned by the FAA.

Sincerely,

for Thomas E. McSweeny
Associate Administrator for Regulation
and Certification

Recommendation

Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C77b

Effective Date:

Technical Standard Order

Subject: *Gas Turbine Auxiliary Power Units*

1. PURPOSE. This Technical Standard Order (TSO) prescribes the minimum performance standards (MPS) that gas turbine Auxiliary Power Units (APUs) must meet to be identified with the applicable TSO marking.

2. APPLICABILITY.

a. This TSO is effective for new applications submitted after the effective date of this TSO. All prior revisions to this TSO are no longer effective and applications will not be accepted after the effective date of this TSO.

b. APUs approved under a previous TSO authorization may continue to be manufactured under the provisions of their original approval. However, major design changes to APUs approved under previous versions of this TSO require a new authorization under this TSO, per 14 CFR 21.611(b).

3. GENERAL REQUIREMENTS. TSO qualification programs for new models of APUs, or for previously approved models undergoing a major change, that are to be so identified and that are manufactured on or after the effective date of this TSO, must be in accordance with the following requirements:

a. Functionality. The standards of this TSO apply to gas turbine engines intended to provide auxiliary electrical, pneumatic, or mechanical power to support airplane systems operations. These standards do not apply to gas turbines intended for aircraft propulsion, nor do they address the integration of the APU into the design of the airplane.

b. **Minimum Performance Standards.** The design and construction of the APU must be shown to meet the MPS of Appendix 1.

c. Deviations. The FAA has provisions for using alternative or equivalent means of compliance to the criteria set forth in the MPS of this TSO. Applicants invoking these provisions shall demonstrate that an equivalent level of safety is maintained and shall apply for a deviation in accordance with 14 CFR 21.609.

4. MARKING. In accordance with 14 CFR 21.607(d), each article manufactured under this TSO must be marked in accordance with the following requirements:

a A fireproof identification plate must be permanently and legibly marked with:

(i) Name and address of the manufacturer.
(ii) Part number, serial number, and model designation.
(iii) Maximum allowable dry weight to the nearest pound.
(iv) Applicable TSO number (TSO-C77b)
(v) Fuel type and specification.
(vi) Lubricating oil type and specification.
(vii) Category 1 or Category 2 APU Type, whichever applicable

b. Each separate component that is easily removable and each separate subassembly of the article must be permanently and legibly marked with at least the part number.

c. If the APU includes a digital computer, the part number must include hardware and software identification, or a separate part number may be utilized for hardware and software. Either approach must include a means for showing the modification status. Note that similar software versions which have been approved to different software levels must be differentiated by part number.

5. DATA REQUIREMENTS The manufacturer must furnish the FAA ACO, having purview of the manufacturer's facilities, one copy each of the following data items to support the FAA design and production approval:

a. TSO Program Data. In addition to the requirements of 14CFR 21.605, the following data must be submitted. Items 1 through 3 must be submitted with the application for TSO approval and item 4 must be submitted upon completion of the program:

1. A plan describing the methods of compliance to the MPS requirements specified in Appendix 1 for new applications or for major changes to an existing previously approved article. This plan must identify any new and/or novel design features that will require a deviation from the MPS in accordance with paragraph 3.c of this TSO , and must identify qualification data and specifications that will be submitted to the FAA ACO, having purview of the manufacturer's facilities in accordance with 5.b of this TSO.

i. The plan will identify any additional performance requirements, such as analyses or tests, that are deemed necessary by the FAA ACO, having purview of the manufacturer's facilities.

ii. The plan will identify tests performed in accordance with the compliance plan to be witnessed by the FAA ACO, having purview of the manufacturer's facilities.

2. A description of the procedures utilized to ensure qualification test hardware is in compliance with the TSO design.

3. A description of production design change control procedures to the FAA ACO, having purview of the manufacturer's facilities. These procedures must address all levels of design changes.

4. A compliance checklist that documents satisfactory completion of all of the requirements specified in 5.a.1 above.

b. TSO Technical Data. In accordance with 14 CFR 21.605(a)(2), the following data must be submitted and evaluated for compliance to the TSO MPS upon completion of the TSO design approval program:

1. Manufacturer's TSO qualification data, such as test reports or analyses, that were designated for submittal in the Compliance Plan of paragraph 5.a.1 of this TSO.

2. Material and process specifications that were designated for submittal in the Compliance Plan of paragraph 5.a.1 of this TSO.

3. A list of all the parts and equipment, including references to the relevant drawings and software design data, which defines the qualified design configuration of the APU.

4. A Model Specification, that specifies the APU ratings and operating limitations established when demonstrating compliance with the requirements of this TSO. The Model Specification should include the data shown in Appendix 2, as appropriate.

5. Manual(s) that contain instructions for installing and operating the APU, that must include at least the following:

(a) The information specified in Appendix 3, as appropriate.
(b) These instructions shall be sufficient to ensure that the APU, when installed in accordance with them, continues to meet the requirements of this TSO. Any limitations shall also be sufficient to identify unique aspects of the installation and shall include the following:

(i) A note with the following statement: "The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those installing this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the TSO standards. TSO articles must be approved for installation per the applicable airworthiness requirements."

6. Manual(s) containing instructions for continued airworthiness of the APU. Updates are required, as necessary, according to changes of existing instructions or in APU definition. The manual(s) must include at least the following:

(a) A section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document(s). This section must set forth each mandatory replacement time, inspection interval and related procedure required to meet the requirements of this TSO.

(b) The information specified in Appendix 4 as appropriate.

(c) The instructions for continued airworthiness may be incomplete at the time of the TSO Authorization provided a program exists to ensure their completion prior to issuance of a standard Certificate of Airworthiness for the aircraft with the APU installed.

(d) Availability of some manual or portion of the instructions for continued airworthiness, dealing with overhaul or other forms of heavy maintenance, may be delayed until after the APU has entered service. In such cases, the APU Model Specification will incorporate a note prohibiting the corresponding heavy maintenance of APUs until the instructions are available.

7. The quality control system description required by 14 CFR 21.605(a)(3) and 21.143(a) including functional test specifications to be used to test each production article to ensure compliance with this TSO.

8. Nameplate drawing.

c. **Manufacturer Data.** In addition to the data that is to be furnished directly to the FAA, each manufacturer must have available for review by the FAA ACO and FAA Manufacturers Inspection District Office (MIDO) having purview of the manufacturer's facilities, the following technical data:

1. The functional test specifications to be used to accept each production article to ensure compliance with this TSO.

2. All drawings, specifications, software data, and information on dimensions, materials and processes, necessary to define the configuration and the design features of the product shown to comply with the MPS of this TSO.

3. All qualification data including test plans, test reports, test hardware configuration control data, and analyses specified in the Compliance Plan of paragraph 5.a.1 and Compliance Checklist of paragraph 5.a.4 of this TSO.

4. All design changes, with evidence of required approvals, processed in accordance with the procedures specified in paragraph 5.a.3 of this TSO.

d. Furnished Data.

1. One copy of the technical data and information specified in paragraphs 5.b.4 through 5.b.6 of this TSO and any other data or information that is necessary for the proper installation, certification, use, and/or for continued airworthiness of the APU must be furnished to each person receiving for use one or more APUs manufactured under this TSO.

6. AVAILABILITY OF REFERENCED DOCUMENTS.

a. Copies of RTCA Document Nos. DO-160D and DO-178B may be purchased from the RTCA Inc., 1140 Connecticut Avenue, N.W., Suite 1020, Washington, D.C. 20036.

b. Federal Aviation Regulations 14 CFR Part 21, Subpart O, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325. AC 20-110 , "Index of Aviation Technical Standard Orders," and AC 20-115 may be obtained from the U.S. Department of Transportation, Utilization and Storage Section, M-443.2, Washington, DC 20590.

Jay J. Pardee
Manager, Engine and Propeller Directorate
Aircraft Certification Service

APPENDIX 1.
FEDERAL AVIATION ADMINISTRATION MINIMUM PERFORMANCE STANDARD FOR GAS TURBINE AUXILIARY POWER UNITS

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1.0 Purpose. This appendix provides the Minimum Performance Standards (MPS) for gas turbine APUs.

2.0 Scope. This appendix covers Category 1 and Category 2 APUs, defined as follows:

2.1 A Category 1 APU is any APU that meets the requirements of Sections 4.0, 5.0, 6.0, and 7.0 of this Appendix.

2.2 A Category 2 APU is any APU that meets the requirements of Sections 4.0, 5.0, and 6.0 of this Appendix.

3.0 Definitions. The following are definitions of terms applicable to this standard:

3.1 Accessory drives. Any drive shaft or utility mounting pad, furnished as a part of the auxiliary power unit, that is used for the extraction of power to drive accessories, components, or controls essential to the operation of the auxiliary power unit or any of its associated systems.

3.2 Auxiliary Power Unit (APU). Any gas turbine-powered unit delivering rotating shaft power, compressor air, or both which is not intended for direct propulsion of an aircraft.

3.3 Blade. An energy transforming element of the compressor on turbine rotors whether integral or attached design.

3.4 Compressor air. Compressed air that is provided by the APU to do work whether it is extracted or bled from any point of the compressor section of the gas turbine engine or produced from a compressor driven by the APU.

3.5 Containment. Retention within the APU of all high energy rotor fragments resulting from the failure of a high energy rotor.

3.6 Critical rotor stage. The compressor and turbine stages whose rotors have the smallest margin of safety under the conditions of speed and temperature shown in paragraph 6.8.2 , Appendix 1, of this TSO.

3.7 Demonstrate. To prove by physical test under the conditions specified in this standard.

3.8 High energy rotor. A rotating component or assembly which, when ruptured, will generate high kinetic energy fragments.

3.9 Major part. A part whose failure might adversely affect the operational integrity of the unit.

3.10 Maximum allowable speed. The maximum rotor speed which the APU would experience under overload or transient conditions and is limited by installed safety devices.

3.11 Maximum allowable temperature. The maximum exhaust gas temperature (EGT) or turbine inlet temperature (TIT) which the APU would experience during overload or transient conditions and is limited by installed safety devices.

3.12 Minor part. A part which is not a major part.

3.13 Model. Each unique configuration of a specific APU type.

3.14 Output provisions. Any drive pad or compressed air output flange intended for aircraft use to extract usable shaft or pneumatic power from the APU.

3.15 Rated output. The approved shaft power or compressed air output or both, that is developed statically at standard sea level atmospheric conditions for unrestricted periods of use.

3.16 Rated temperature. The maximum turbine inlet or exhaust gas temperature at which the engine can operate at rated output and speed.

3.17 Rated Speed. The maximum approved speed at which the engine can operate at rated output.

3.18 Rotor. A rotating component or assembly including blades with the exception of accessory drive shafts and gears.

3.19 Start. An acceleration from the initiation of operation or starter torque to a stabilized speed and temperature in the governed ranges without exceeding approved limits.

3.20 Substantiate. To prove by presentation of adequate evidence obtained by demonstration or analysis or both.

3.21 Type. All of a series of units each one of which was developed as an alternate configuration or refinement of the same basic unit.

4.0 Requirements: General

4.1 APU Ratings and Operating Limitations: The APU ratings and operating limitations must be substantiated by test or analysis and included in the APU Model Specification.

4.2 Materials: Each material must conform to approved specifications. The suitability and durability of the materials used in manufacturing the APU must be established by testing or on the basis of experience or both.

4.3 Durability: All parts of the APU must be constructed, arranged, and installed so as to ensure their continued safe operation between inspection intervals specified in Appendix 4 of this TSO, Instructions for Continued Airworthiness.

4.4 Operating Characteristics

4.4.1 The overall range for APU operating characteristics must be substantiated. This includes the envelopes within which the APU can be started and operated without detrimental effects (such as stall, surge, or flame-out).

(a) Operation During Negative "g" Conditions. The maximum duration of time during which the APU can operate without hazardous malfunction during negative "g" conditions may be substantiated by test or analysis and must be specified in the model specification.

4.4.2 The effects of the inlet temperature, air bleed, exhaust back pressure, inlet pressure recovery, and ram pressure ratio upon performance parameters such as speed, power output, air flow, exhaust gas temperature, and pressure ratio must be provided for the operating envelope.

4.5 APU Control System

4.5.1 The APU control system must be designed to ensure that it performs its intended functions under the declared operating conditions and automatically maintain the APU speed(s) and gas temperature(s) within the declared limits.

4.5.2 The APU control system functioning must not be adversely affected by the declared environmental conditions, including Electromagnetic Interference (EMI), High Intensity Radiated Fields (HIRF) and lightning. The limits to which the system has been qualified shall be documented in the instructions for installation .

4.6 Provisions for Instruments

4.6.1 The APU must have provisions for providing a signal for any instrumentation necessary to ensure continued safe operation of the APU and that established APU limits are not exceeded.

4.6.2 In addition to the instrumentation provisions of paragraph 4.6.1, automatic features may be provided.

4.7 Extreme Attitude Operation: It must be demonstrated that the APU is capable of functioning satisfactorily within the attitude limits specified in the instructions for installation .

4.8 Mount Loads: The maximum static and dynamic loads, including those that result from APU seizure, imbalance under a failed blade condition, and the critical vibration amplitudes and

frequencies which could be transmitted by the APU from the mounting points to the airframe through the normal operating range of the APU must be established.

4.9 Flight Loads

The APU mounting attachments and related APU structure must be able to withstand:

4.9.1 The specified limit loads without permanent deformation; and

4.9.2 The specified ultimate loads without failure, but may exhibit permanent deformation.

4.10 Accessibility: The design of the APU must allow for the examination, adjustment or removal of each accessory required for APU operation.

5.0 Description: All APUs Design and Construction

5.1 Safety Analysis

It must be shown by analysis that any probable malfunction or any probable single or multiple failure, will not cause the APU to:

5.1.1 Catch fire;

5.1.2 Burst (release hazardous fragments through the APU case);

5.1.3 Generate loads greater than those ultimate loads specified in paragraph 4.8;

5.1.4 Lose the capability of being shut down, or;

5.1.5 Generate an unacceptable concentration of toxic products in the bleed air.

5.2 Fire Prevention

5.2.1 Design and construction of the APU and materials used must minimize the probability of the occurrence and spread of fire during either normal operation or failure conditions and must minimize the effects of such a fire.

5.2.2 Except as provided by 5.2.3 and 5.2.4, each external line, fitting, and other external component which contains or conveys flammable fluids, must be at least fire resistant. These components must be shielded or located to safeguard against ignition of leaking flammable fluid.

5.2.3 Flammable fluid tanks and any associated shut-off means and supports, which are part of and attached to the APU, must be fireproof either by construction or by protection, unless damage by fire will not cause leakage or spillage of flammable fluid.

5.2.4 If by construction an APU component acts as a firewall, this component shall be:

a) Fireproof;

b) Constructed so that no hazardous quantity of air, fluid, or flame can pass across the firewall;

c) Protected against corrosion.

5.2.5 Those features of the APU which form part of the mounting structure or APU attachment points must be Fireproof, either by construction or by protection.

5.2.6 When parts of the APU control system are located in a designated fire zone, it must be substantiated that a fire affecting these parts will not lead to effects identified under paragraph 5.1.

5.2.7 Unintentional accumulation of hazardous quantities of flammable fluid and vapor within the APU shall be prevented by draining and venting.

5.2.8 Any components, modules, equipment and accessories which are susceptible to or are potential sources of static electricity, induced currents, lightning discharges or other electrical currents must be designed and constructed so as to be electrically bonded to minimize the risk of ignition in external areas where flammable fluids or vapors could be present.

5.3 Air Intake:

5.3.1 Flammable fluid carrying lines, fitting or components located in the air intake within the APU must be designed such that leakage from the lines, fittings, or components cannot enter the intake air stream. Shrouds must have provisions for attaching external drains.

5.3.2 The effect of inlet air pressure drop and inlet blockage on APU operation must be substantiated. Inlet distortion limits must be specified in the instructions for installation.

5.3.3 If an air intake duct is provided as part of the APU, it must be fireproof.

5.4 Lubrication System:

5.4.1 The lubrication system must function satisfactorily at all the APU operating attitudes specified in paragraph 4.7 and throughout the operating envelope established in accordance with paragraph 4.4 of this standard. Approved APU lubricant(s) must be specified in the APU Model Specification.

5.4.2 The lubrication system when furnished as part of the APU must have at least one accessible drain that allows a safe drainage of the oil system and has manual or automatic means for positive locking in the closed position.

5.4.3 An oil tank or integral oil sump, when supplied with the APU, must have the following features:

a) An expansion space of not less than 10 percent of the total tank capacity must be provided;

b) A tank filler located so that the expansion space cannot be inadvertently filled when the APU is serviced at the normal ground attitude;

c) A vent from the top part of the expansion space. The venting must be effective throughout the range of extreme attitude specified in paragraph 4.6 and throughout the normal operating envelope established in accordance with paragraph 4.3. The vent must be sized to accommodate the maximum anticipated rates of ascent and descent in flight;

d) The oil tank must be capable of withstanding the application of a differential pressure of at least 5 psi more than the maximum differential pressure which might be encountered during operations throughout the normal operating envelope established in accordance with paragraph 4.3 of this appendix, and under the maximum flight loads specified in paragraph 4.8.

e) Suitable means for determining the level of oil in the tank when the APU is in the normal ground attitude.

5.4.4 Where there is a filter in the APU lubrication system through which all the oil flows, it must be constructed and installed so that oil may flow at an acceptable rate through the rest of the system with the filter element completely blocked. An impending filter by-pass indication is required.

5.5 Fuel System:

5.5.1 The fuel specification, rate, pressure, and temperature range of fuel flow to the inlet of the APU fuel system and the degree of filtration necessary for satisfactory unit functioning must be established and listed in the APU Model Specification.

5.5.2 A drain must be provided in the APU to prevent accumulation of fuel in the event of a false start. APU drains in the fuel system must be suitable for connecting to overboard drain lines.

5.6 Exhaust System:

5.6.1 The exhaust system of the APU must be designed and constructed so as to prevent leakage of exhaust gases into the aircraft.

5.6.2 The exhaust piping must be constructed of fireproof and corrosion resistant materials.

5.7 Cooling: Operating temperature limits must be established for those components which require temperature limitations and provided in the instructions for installation .

5.8 Overspeed Safety Devices: For any safety device incorporated to prevent a hazardous overspeed condition, a means must be provided for ascertaining that these devices are functioning properly.

5.9 Rotor Containment: For each high-energy APU rotor, the APU must be designed to provide containment of either:

5.9.1 The largest blade section as specified in paragraph 6.8.3(a), or

5.9.2 Maximum kinetic energy fragments from the hub failure as specified in paragraph 6.8.3(b).

5.10 Vibration: The APU must be designed and constructed to function throughout its declared operating envelope, including the declared inlet air distortion limits, so that the compressor, turbine and other highly stressed parts are free from vibration stresses that could be harmful to these parts and other components.

5.11 Life Limitations: All APU rotors must have limitations established, by a procedure approved by the FAA ACO having purview of the manufacturer's facilities, which specify the maximum allowable number of start-stop stress cycles (low cycle fatigue) or hours representative of typical APU usage. A cycle includes, as a minimum, starting the APU, operating at specific power settings and stopping.

5.12 Bleed Air Contamination: For APUs which provide compressor bleed air, the applicant must:

5.12.1 Provide characteristics of APU generated bleed air contaminants in the instructions for installation .

5.12.2 Substantiate, if an air intake duct is provided as part of the APU, that under the fire requirement specified in paragraph 5.3.3, the duct will not release hazardous amounts of toxic gases into the bleed air.

5.13 Continued Rotation: Any limitations on APU continued rotation in either direction must be specified in instructions for installation .

6.0 Requirements: All APUs Type Substantiation

6.1 General: The requirements of Section 6 are applicable to both Category 1 and Category 2 APUs.

6.2 Calibration Tests:

6.2.1 The APU must be subjected to the calibration tests necessary to establish the APU's power (shaft and/or bleed) prior to the endurance test specified in paragraph 6.3.

6.2.2 An APU power (shaft and/or bleed) check must be accomplished on the APU after the endurance test of paragraph 6.3. Any change in power characteristics which occurs during the endurance test must be determined. This data must demonstrate that, at the rated output, the APU does not exceed its declared limits.

6.3 Endurance Test:

6.3.1 The APU must successfully complete the 150-hour endurance test specified in this section. The speed and gas temperature control devices must maintain these parameters within the specified tolerances during the rated output portions of this test. Rated output as used in this section is defined as maximum output of shaft power and compressor bleed air for which approval is sought.

6.3.2 *Test periods.* Twenty periods of seven and one-half hours each must be run using the following schedule.

(a) Five minutes at or above rated output, 5 minutes at no load, 1 hour at or above rated output, and 5 minutes at no load.

(b) Five minutes at or above rated output, 5 minutes at no load, 1 hour at 75% rated output, and 5 minutes at no load.

(c) Five minutes at or above rated output, 5 minutes at no load, 1 hour at or above rated output, and 5 minutes at no load.

(d) Five minutes at or above rated output, 5 minutes at no load, 1 hour at 50% rated output, and 5 minutes at no load.

(e) Five minutes at or above rated output, 5 minutes at no load, 1 hour at or above rated output, and 5 minutes at no load.

(f) Five minutes at or above rated output, 5 minutes at no load, 1 hour at 25% rated output, and 5 minutes at no load.

6.3.3 *Test conditions.* The following conditions must be observed during the endurance test:

(a) *Speed.* The speed of each rotor may not be less than the rated speed during the rated output portions of the tests. No specific rotor speed need be maintained during other portions of the endurance test.

(b) *Temperatures.* The specified temperature limits including the rated turbine inlet or exhaust gas temperature and oil temperature, must be substantiated by maintaining the temperatures of the affected components at or above these limits during all rated output portions of the endurance test. The temperature of the inlet air may be controlled to match the turbine temperature, speed, and power output to avoid exceeding temperature, speed, or power limits during this test.

(c) *Pressures.* The minimum regulated oil and fuel pressures must be maintained during all rated output portions of the endurance test.

6.3.4 Adjustments and repair or replacement of parts. During the endurance test, repair and replacement of minor parts or infrequent adjustments not requiring disassembly of major parts may be made. Major parts may not be repaired or replaced during the endurance test.

6.3.5 *Starts.* At least 100 starts must be made. A minimum of 2 hours shutdown must precede each of at least 25 of the starts.

6.4 Teardown Inspection: After completing the endurance test of paragraph 6.3 and the recalibration test of paragraph 6.2.2:

6.4.1 The APU must be completely disassembled.

6.4.2 A detailed inspection must be made of each part, and critical dimensions must be reinspected, and

6.4.3 Each APU component must be eligible for incorporation into an APU for continued operation, in accordance with information required by paragraph 5.a.7 of this TSO.

6.5 Functional Test of Limiting Devices: If limiting devices are provided, the same APU device must be tested on an APU or representative test stand in such a manner that each is made to function satisfactorily 10 times without failure.

6.6 Overspeed Test: For APUs that contain rotors not complying with the containment requirements of paragraph 5.9.2, an APU test must demonstrate the ability of all compressor and turbine rotors to withstand operation for 5 minutes at the higher of the rotational speeds specified under the operating conditions listed in paragraphs 6.6.1 or 6.6.2. The test must be conducted at the turbine inlet or exhaust gas temperature which would prevail during operations under the fault conditions of paragraph 6.6.2.

6.6.1 A speed equal to 115% of the rated speed;

6.6.2 The speed resulting from (a) or (b), whichever is applicable:

(a) If overspeed limiting devices are incorporated, a speed of not less than 105% of the highest speed which would result from any single failure of the APU control system.

(b) If overspeed limiting devices are not incorporated, the highest speed which would result from (i) or (ii):

(i) any single failure of the APU control system.

(ii) any probable combination of failures of the APU.

6.7 Overtemperature Test: For APUs that contain rotors not complying with the containment requirements of paragraph 5.9.2, an APU test must demonstrate the ability of all turbine rotors to withstand operation for a minimum of 5 minutes at a turbine inlet temperature or exhaust gas temperature of not less than 75°F (42°C) greater than the rated turbine inlet temperature or exhaust gas temperature, while at or above the rated speed. This test may be combined with paragraph 6.6.

6.8 Containment:

6.8.1 Compliance with paragraph 5.9 of this appendix of each high-energy rotor, critical and non-critical, must be substantiated by test, analysis, or combination thereof as specified in paragraph 6.8.1(a)and 6.8.1(b), under the conditions of paragraphs 6.8.2, 6.8.3, and 6.8.4.

(a) The critical rotor of each compressor and turbine rotor assembly must be substantiated by APU test. Analyses and/or component or rig tests may be substituted only if they are validated by APU test.

(b) Non-critical rotors may be substantiated by validated analysis.

6.8.2 Containment must be demonstrated at the following speed and temperature conditions:

(a) the highest speed which would result from any single failure of the APU control system.

(b) the temperature of the containing components shall not be lower than the temperature during operation of the APU at rated output.

6.8.3 Containment must be substantiated in accordance with either (a) or (b) below:

(a) Blade containment under the following conditions:

(i) For centrifugal compressors and radial turbines, one whole blade unless it is substantiated that failure of a smaller portion of the blade is more likely to occur.

(ii) For axial compressor or turbine rotors, the blade fragment resulting from failure at the outermost retention groove, or, for integrally bladed rotor, at least 80 percent of the blade.

(b) Hub containment under the following condition:

(i) For all types of compressors and turbines, fragments resulting from a failure which produces the maximum translational kinetic energy.

6.8.4 It must be shown that the following requirements were met:

(a) the APU did not experience a sustained external fire

(b) the APU did not release hazardous fragments radially through the APU casings

(c) if debris was ejected from the APU inlet or exhaust, the maximum size, weight, energy, and trajectory of the debris must be defined in the APU instructions for installation.

6.9 Electronic Control Components: For APUs equipped with an electronic control system, the following must be provided for the components of that system:

6.9.1 The acceptability of the declared environmental conditions of paragraph 4.4 of this appendix must be substantiated to the test conditions specified in RTCA Document No. RTCA/DO-160D, "Environmental Conditions and Test Procedures for Airborne Equipment", Change 4, dated July 29, 1997 or the most current revision, or by a method acceptable to the FAA ACO having purview of the manufacturers facility.

6.9.2 Where applicable, all associated software must be developed in accordance with RTCA Document No. RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification", dated December 1, 1992 or the most current revision, or by a method acceptable to the FAA ACO having purview of the manufacturers facility consistent with the criticality of the functions performed

7.0 Requirements: Category I APUs Additional Requirements

7.1 General: The requirements of Section 7 are applicable only to Category 1 APUs.

7.2 Icing Protection :

7.2.1 The APU must be designed and constructed to prevent the accumulation of ice in quantities sufficient to cause a substantial loss of APU power or shutdown during operation throughout its operating range within the icing envelopes specified in appendix C of Part 25 of the Federal Aviation Regulations.

7.2.2 Operation of the APU under the conditions of paragraph 7.2.1 must be substantiated by test, analysis or combination thereof. Any limitations for operation must be documented in the instructions for installation.

7.3 Foreign Object Ingestion:

7.3.1 It must be substantiated that the ingestion of foreign matter such as water, ice, sand, gravel and other hard objects likely to enter the APU will not create hazardous effects on APU operation.

7.3.2 Any provision found to be necessary for adequate protection against ingestion of foreign objects or effects on operation must be documented in the instructions for installation.

7.4 Automatic Shutdown: If automatic features are provided, provision must be made to limit automatic shutdown in flight to those failure occurrences that could result in a potentially hazardous condition.

7.5 Ignition System: It must be substantiated by test or analysis, or combination thereof, that the ignition system operates satisfactorily between the inspections and maintenance actions specified in the instructions for continued airworthiness

APPENDIX 2.

GAS TURBINE AUXILIARY POWER UNIT
Model Specification

The following information must be considered, as appropriate, for inclusion into the Model Specification required by paragraph 5.a.(5):

1. Manufacturers name and address
2. Part number, serial number, and model designation.
3. Category for which approved
4. Maximum allowable dry weight to the nearest pound
5. The following performance information and limitations at standard sea level atmospheric conditions;
   (a) Rated output shaft power (if applicable).
   (b) Rated output speed (if applicable).
   (c) Maximum turbine inlet or exhaust gas temperature at rated output.
   (d) Maximum allowable speed.
   (e) Maximum Allowable turbine inlet or exhaust gas temperature.
   (f) Minimum compressor bleed airflow (if applicable).
   (g) Minimum compressor bleed air pressure ratio (if applicable).
   (h) Maximum fuel consumption at rated output.
6. The temperature and speed control tolerances at rated output.
7. The maximum duration of time the APU is capable of operating without hazardous malfunction when the APU is subjected to negative "g" conditions.
8. The following lubrication system specification;
   (a) Type, grade, and specification of oil.
   (b) Maximum oil consumption rate.
   (c) Maximum inlet oil temperature.
   (d) Minimum inlet oil pressure (if applicable).
   (e) Inlet oil flow rate (if applicable).
   (f) Maximum oil system outlet pressure (if applicable).
9. The following fuel system specifications;
   (a) Type, grade, and specification of fuel.
   (b) Minimum inlet fuel pressure.
   (c) Maximum and minimum fuel inlet temperatures.
   (d) Inlet fuel flow rate.
   (e) The type and degree of fuel filtering necessary for protection of the APU fuel system against foreign particles in the fuel.
   (f) Method of preventing filter icing (if applicable).
10. Maximum loads, including shear, axial, and overhang moment, that the exhaust attachment provisions are capable of withstanding.
11. The output shaft configuration, direction of shaft rotation, and maximum allowable overhang moment for the main power output pad (if applicable).

APPENDIX 2. (continued)

GAS TURBINE AUXILIARY POWER UNIT
Model Specification

12. Maximum loads, including shear, axial, and overhung moment, that the compressor bleed air attachment provisions are capable of withstanding (if applicable).
13. The following accessory drive specifications;
    (a) Configuration of drive shaft and mounting pad.
    (b) Direction of drive shaft rotation.
    (c) Maximum static torque.
    (d) Rated torque.
    (e) Ratio of accessory drive shaft RPM to power turbine RPM.
    (f) Maximum overhung moment the mounting pad is capable of withstanding.

APPENDIX 3.

GAS TURBINE AUXILIARY POWER UNIT
Installation and Operating Instructions

The following information must be considered, as appropriate, for inclusion into the manual(s) required by paragraph 5.a.(6)(a):

(a) Definitions of the physical and functional interfaces with the aircraft and the limiting conditions on those interface, including, but not limited to, the following:

(1) Performance
(2) Cooling System:
(3) Air inlet System
(4) Exhaust System
(5) Mounting System
(6) Fuel System
(7) Lubrication System
(8) Electrical System
(9) Starting System
(10) Bleed Air System
(11) Accessory Drives
(12) Cockpit Interface (instrumentation and controls)
(13) Safety and Protective Provisions

(b) The above sub-system sections should include, but not be limited to, the following:

(1) The APU operating envelope including extreme attitude limits and environmental conditions throughout which the APU may be started and operated for unrestricted periods of time.

(2) The limit and ultimate loads of the APU mounting structure and related APU structure.

(3) Maximum allowable component and surrounding ambient temperatures and heat rejection rates from components where such limits are established. If applicable, the type and location of each thermocouple used to meet installation requirement cooling tests must be specified and a description of ambient temperature sensing provisions must be provided.

(4) Maximum loads, including shear, axial, and overhand moment, that the air duct attachment provisions are capable of withstanding.

(5) The following inlet air specifications;
(a) Maximum inlet air pressure drop.
(b) Distortion limits across the APU inlet.
(c) Effect of inlet air pressure drop on rated power.
(d) Provisions for protection against ingestion of foreign objects.

(6) The type and degree of oil filtering necessary for protection of the APU lubrication system against foreign particles in the oil (if applicable).

(7) Maximum heat rejection rate.

(8) Useable oil capacity

(9) Oil pressure limits for normal and idle operation.

(10) Lubrication system specifications for components not supplied with the APU.

(11) Operating limitations for integral oil cooling (if applicable).

(12) The maximum exhaust system back pressure and the effect on power output of variations in back pressure.

(13) Maximum conducted and radiated electromagnetic interference which may be generated by the APU during any normal continuous operation.

(b) Basic control and operating information describing how the APU components, systems and installations operate. Information describing the methods of starting, running, testing and stopping the APU and its parts including any special procedures and limitations that apply.

(c) Installation conditions which specify the airplane operating characteristics and parameters from which the data of (a) and (b) were derived.

(d) Proper procedures for uncrating, deinhibiting, acceptance checking, lifting, and attaching accessories, with any necessary checks.

(e) Acceptable conditions for installation of those aircraft parts and equipment that may be mounted on, or driven by, the APU, which are not part of the declared APU configuration, and substantiate that these conditions are acceptable for safe operation of the APU.

(f) The following APU drawings, as appropriate:

1. APU Installation Drawing, including overall dimensions, envelope definition, installation interfaces, service interfaces, and major component identification
2. Outline drawings of APU major external accessories , including overall dimensions
3. Electrical system schmatic, including interface connections
4. Other system schmatics, such as pneumatic, lubrication, fuel, and vent and drain systems.

APPENDIX 4.

GAS TURBINE AUXILIARY POWER UNIT
Instructions for Continued Airworthiness

The following information must be considered, as appropriate, for inclusion into the manual(s) required by paragraph 5.a.(7)(b):

(1) A description of the APU and its components, systems, and installations.

(2) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluid to be used, pressures applicable to the various systems, locations of lubrication points, lubricants to be used and equipment required for servicing.

(3) Scheduling information for each part of the APU that provides the recommended periods at which it should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. Necessary cross-references to the Airworthiness Limitations section must also be included. In addition, the applicant must include, if appropriate, an inspection program that includes the frequency of the inspections necessary to provide for the continued airworthiness of the APU.

(4) Troubleshooting information describing probable malfunctions, how to recognize those malfunctions and the remedial action for those malfunctions.

(5) Information describing the order and method of removing and replacing parts, the order and method of disassembly and assembly, with any necessary precautions to be taken. Instructions for proper ground handling, crating and shipping must also be included.

(6) Cleaning and inspection instructions that cover the material and apparatus to be used and methods and precautions to be taken. Methods of inspection must also be included.

(7) Details of repair methods for worn or otherwise substandard parts and components along with the information necessary to determine when replacement is necessary. Details of all relevant fits and clearances.

(8) Instructions for testing including test equipment and instrumentation.

(9) Instructions for storage preparation, including any storage limits.

(10) A list of the tools and equipment necessary for maintenance and directions as to their method of use.

FAA Action

[Federal Register: January 22, 2001 (Volume 66, Number 14)]
[**Notices**]
[Page 6753]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr22ja01-242]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

TSO-C77b, Gas Turbine Auxiliary Power Units

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of availability of technical standard order.

SUMMARY: This notice announces the availability of Technical Standard Order (**TSO**) C77b. This **TSO** prescribes the minimum performance standards that gas turbine auxiliary power units (APUs), commonly used in commercial aircraft, must meet in order to be identified with the **TSO** marking.

EFFECTIVE DATE: January 22, 2001.

FOR FURTHER INFORMATION CONTACT: Mr. Mark A. Rumizen, Engine and Propeller Standards Staff, ANE-110, Engine and Propeller Directorate, Federal Aviation Administration, 12 New England Executive Park, Burlington, MA 01803-5299, telephone (781) 238-7113, fax (781) 238-7199.

SUPPLEMENTARY INFORMATION:

Background

The standards of this **TSO** will apply to all APUs used for any new application submitted after the effective date of this **TSO**. APUs currently approved under **TSO**-C77 or **TSO**-C77a authorization may continue to be manufactured under the provisions of their original approval. However, under Sec. 21.611(b) of the Federal Aviation Regulations, any major design change to an APU previously approved under **TSO**-C77 or **TSO**-C77a would require a new authorization under this **TSO**. The general layout of this document complies with the updated **TSO** format.

How To Obtain Copies

A copy of the **TSO**-C77b may be obtained via Internet (http:/

www.faa.gov/avr/air/air100/100home.htm

) or by request from the office listed under FOR FURTHER INFORMATION CONTACT. Issued in Burlington, Massachusetts on December 20, 2000.
David A. Downey, Assistant Manager, Engine and Propeller Directorate

Aircraft Certification Service. [FR Doc. 01-1858 Filed 1-19-01; 8:45 am] BILLING CODE 4910-13-M

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

NOV 19 1999

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

Thank you for your September 30, 1999, letter transmitting a draft technical standard order (TSO) for gas turbine auxiliary power units. Discussions with staff in the Federal Aviation Administration's (FAA) Aircraft Certification Service Engine and Propeller Directorate revealed the proposed TSO satisfied all the requirements for a recommendation. Further, unlike a proposed rulemaking, no formal economic or legal reviews are warranted. Therefore, the FAA is accepting the TSO as a recommendation and is closing out Task 10, Auxiliary Power Unit Approval Procedures, which had been assigned to the Engine Harmonization Working Group.

Let me thank the Aviation Rulemaking Advisory Committee and, in particular, the members of the Engine Harmonization Working Group for their efforts in completing the task assigned by the FAA.

Sincerely,

for Thomas E. McSweeny
Associate Administrator for Regulation
and Certification