

# Memorandum

U.S. Department of Transportation

Federal Aviation Administration

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*Subject* **ACTION: Policy for Parts Manufacturer Approval (PMA)  
of Reciprocating Engine Critical, Highly Stressed or  
Complex Parts or Components**

*Date:* **4/10/97**

*From:* **Manager, Engine and Propeller Standards Staff, ANE-110**

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*To*

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- Manager, Brussels Aircraft Certification Staff, AEU-100
- Manager, Engine Certification Office, ANE-140
- Manager, Engine Certification Branch, ANE-141
- Manager, Engine Certification Branch, ANE-142
- Manager, Boston Aircraft Certification Office, ANE-150
- Manager, New York Aircraft Certification Office, ANE-170
- Manager, Airframe and Propulsion Branch, ANE-171
- Manager, Rotorcraft Directorate, ASW-100
- Manager, Rotorcraft Standards Staff, ASW-110
- Manager, Airplane Certification Office, ASW-150
- Manager, Rotorcraft Certification Office, ASW-170
- Manager, Special Certification Office, ASW-190
- Manager, Small Airplane Directorate, ACE-100
- Manager, Small Airplane Standards Office, ACE-110
- Manager, Atlanta Aircraft Certification Office, ACE-115A
- Manager, Propulsion Branch, ACE-140A
- Manager, Chicago Aircraft Certification Office, ACE-115C
- Manager, Propulsion Branch, ACE-118C
- Manager, Wichita Aircraft Certification Office, ACE-115W
- Manager, Propulsion Branch, ACE-140W
- Manager, Anchorage Aircraft Certification Office, ACE-115N
- Manager, Transport Airplane Directorate, ANM-100
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- Manager, Seattle Aircraft Certification Office, ANM-100S
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## **1. INTRODUCTION**

The Engine and Propeller Directorate was recently requested to provide written guidance regarding the requirements for PMA of reciprocating engine crankshafts. This memo establishes a standardized policy for Aircraft Certification Offices (ACOs) to evaluate PMA applications for reciprocating engine critical, highly stressed or complex parts, including, but not limited to crankshafts and cylinder heads. Critical parts are defined in FAA Order 8110.42, paragraph 5.c. PMA applications for these type of parts are considered significant projects in accordance with the intent of Order 8100.5 and Order 8110.42, and a Project Officer will be assigned by this Directorate to review the compliance program relative to the requirements specified in this memo. These requirements should be conveyed to the applicant as early as possible in the PMA process to allow the applicant ample opportunity to define an acceptable compliance program.

## **2. PMA BY IDENTICALITY**

Approval of aircraft engine replacement parts based on identity requires that the applicant substantiate that the design of the replacement part is identical to the design of the part covered under the type certificate (TC) and defined by FAR 21.31. The design of the PMA part is defined by FAR 21.303(c)(3)(i) to include the drawings and specifications, as well as subparagraph (ii) to include information on dimensions, materials, and processes necessary to define the structural strength of the part. For simple, not highly stressed, or non-critical parts, the data evaluation typically focuses only on subparagraph (c)(3)(i), and is usually accomplished by comparing the PMA applicant's drawings, material and process specifications to the TC holder's corresponding drawings and specifications issued in accordance with FAR 21.31(a) and (b). However, for critical, highly stressed and/or complex parts and components (e.g., crankshafts, cylinder heads) additional emphasis on the requirements of subparagraph (c)(3)(ii) is necessary. This would require the applicant submit detailed information on the materials and processes as described by Order 8110.42, paragraphs 8 c. through 8.c.(3). This data should include, but not be limited to: (1) all elements of the manufacturing cycle (raw material purchase, material chemistry and grain structure, fabrication, melt, forging, machining, surface treatments, other material properties, required inspections, etc.); (2) all the necessary characteristics required of the design in its intended application; and 3) any other data required to show identity to the type design of the part covered under the TC as defined in FAR 21.31 (a) through (e). Therefore, the applicant would need to provide appropriate details and compare every aspect of the manufacturing process, from raw material procurement and first article testing, through finished part, to substantiate identity. Also, the applicant would need to substantiate a level of engineering and manufacturing oversight of suppliers and vendors that is consistent with the TC holder's. This is a substantial task that requires significant engineering, manufacturing, and quality control resources and the cognizant ACO should ensure applicants seeking PMA by identity for these types of parts possess these necessary resources. Once approved under identity, the part would be subject to the same inspection and maintenance requirements as the part approved under the TC.

## **3. PMA BY TEST AND COMPUTATIONS**

Applicable Airworthiness Requirements: Federal Aviation Regulation (FAR) 21.303 (c)(4) requires that if the applicant cannot substantiate that the design of the PMA part is identical to the design of the part covered by the type certificate, then he must provide test reports and computations necessary to show that the design of the part meets the airworthiness requirements of the FARs applicable to the product on which the part is to be installed. Order 8110.42 specifies that "the certification basis for the PMA part is the same as that for the product on which the part is to be installed". For engine parts, the applicable airworthiness requirements for test and computations would be CAR 13 or the applicable amendment level of FAR 33. Regardless of the certification basis, the compliance program should be established by

the cognizant ACO in conjunction with the applicant, the TC holder's ACO, and with this office and should substantiate a level of airworthiness that is consistent with the following requirements:

**FAR Subsection Requirement**

33.4 Instructions for Continued Airworthiness

33.15 Materials

33.19 Durability

33.33 Vibration

33.42 General

33.43 Vibration Test

33.45 Calibration Tests

33.49 Endurance Test

33.53 Component Test

33.55 Teardown Inspection

33.57 General Conduct of Block Tests

**Concurrent Introduction of Multiple Part Numbers:** If the applicant chooses to introduce several different P/Ns of a common type of part concurrently (e.g., several different crankshaft configurations), then a separate compliance plan must be developed for each these P/Ns describing the applicant's proposed method of compliance to each applicable airworthiness requirement. For each unique P/N, test and computations must be submitted to substantiate compliance to each requirement, unless substantiation can be accomplished by a similarity analysis. This analysis can be relative to either; 1) one of the applicant's multiple P/Ns; or 2) the part covered under the TC.

- **Relative to One of the Applicant Multiple P/Ns:** If the similarity analysis is relative to one of the applicant's multiple P/Ns that is being concurrently introduced, then it should be carefully scrutinized by the cognizant ACO to ensure that it addresses all aspects of the differences in design, installation, manufacturing, and operating environment of the parts. Generalized statements that relate qualitative comparisons of geometric or material differences between the parts to the horsepower ratings should be considered inadequate and not consistent with the comprehensive engineering analyses necessary substantiate compliance with airworthiness requirements.
- **Relative to the Part Covered Under the TC:** Comparative analyses relative to the TC holders parts are permitted in accordance with Order 8110.42, paragraph 8.d.2, but the applicant would be required to analyze the effect of all differences in design, manufacturing, and operation to the level of detail described in the Identity discussion above. The cognizant ACO must ensure that the applicant possesses the knowledge of the TC holders design and manufacturing process to the extent necessary to make a valid comparative analysis. As stated above, generalized or simple statements comparing features of the parts are inadequate.

In either case, the applicant's similarity analysis would be much more compelling if only one part is introduced initially, and the introduction of the remaining parts is delayed until a substantive level of experience is accumulated.

**Airworthiness Limitations:** A thoroughly substantiated compliance program by test and computations will assure all applicable regulatory requirements are met, but will not necessarily demonstrate the same tolerance to failure modes, or durability, as the design of the part covered under the TC has shown in service. The applicant must be able to substantiate that the PMA part is designed and constructed to

minimize the development of an unsafe condition between overhaul periods, as required by FAR 33.14 (Durability). However, Time Between Overhaul (TBOs) for reciprocating engines can be as lengthy as 2000 hours, which would be very difficult to substantiate by test and computations, or by comparative analysis (see above discussion). Substantiation to such lengthy overhaul intervals would also require that the applicant accumulate the service, test, and manufacturing experience necessary to develop knowledge on the statistical variability associated with the operating environment (e.g., stress, temperature, mission profile), material properties, and manufacturing processes, and establish a comprehensive continued airworthiness program (e.g., records, acquisition and analysis of field data, capability to support field corrective actions, etc.).

Therefore, critical, highly stressed and/or complex PMA parts (e.g., a crankshaft) to be installed in these engines cannot automatically or by default be substantiated to these lengthy intervals. It can then be concluded that the TC holder's service instructions relative to overhaul intervals are not adequate for the highly stressed and/or complex PMA part or component, and, in accordance with paragraph 8.g of Order 8110.42, the PMA applicant may be required to provide Instructions for Continued Airworthiness, in accordance with FAR 33.4, regardless of certification basis. The instructions for a more frequent inspection interval (relative to the engine TBO) should take the form of mandatory Airworthiness Limitations, to ensure compliance in accordance with FAR 43.16 and 91.403 (c). The FAA will, however, consider relieving this requirement if the certification testing program is expanded to substantiate the increased endurance and durability necessary for these longer TBOs.

All ACO's with such programs should submit a Certification Program Notice (CPN) to this office and review the project in detail with the assigned Project Officer.

Original Signed By:

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