U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: INITIAL MAINTENANCE INSPECTION (IMI), 14 CFR §33.90, TEST FOR TURBINE ENGINES

Date: 3/5/04 **AC No:** 33.90-1
Initiated By: ANE-110 **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance and acceptable methods, but not the only methods, for demonstrating compliance with the test requirements of §33.90 of Title 14 of the Code of Federal Regulations (14 CFR §33.90), Initial maintenance inspection. The information provided in this AC replaces the guidance in paragraph 61, §33.90 IMI, of AC 33-2B, Aircraft Engine Type Certification Handbook.

2. APPLICABILITY.

a. The guidance provided in this document is directed to engine manufacturers, modifiers, Federal Aviation Administration (FAA) engine type certification engineers, and FAA designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. Terms such as “should,” “shall,” “may,” and “must” are used only in the sense of ensuring applicability of this particular method of compliance when the method of compliance in this document is used. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if the FAA becomes aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation as the basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from existing regulatory requirements.

3. RELATED REGULATION. 14 CFR §33.90.

4. DEFINITIONS. For the purposes of this AC, the following definitions apply:

a. Initial Maintenance Inspection (IMI). IMIs are those inspections specified in the instructions for continued airworthiness (ICA) submitted under §33.4 that are considered necessary to determine the serviceability of the engine. IMIs may be required by the type certificate (TC) holder in the ICA Airworthiness Limitations Section or may be recommended at certain intervals.

b. IMI Intervals. IMI intervals are the maximum hours or cycles that an engine or engine module should be operated in service before a hardware serviceability IMI is conducted on engine static and rotating assemblies, systems, and controls.

> NOTE: The results of this test run should support the specified engine IMI interval or module/system-level IMI intervals, as required or recommended by the applicant for the type design. Other sources of information may also play a role in IMI interval determination. The results of the §33.90 testing should also support the IMI methods and serviceability limits specified in the ICA.

c. Engine Flight Cycle. An engine flight cycle is the predicted average flight profile of engine parameters and effects representative of the way the engine is expected to operate in service.

d. Overhaul. Overhaul refers to the process of disassembling, cleaning, inspecting, repairing as necessary, reassembling**,** and testing for approval for return-to-service within the specifications of the manufacturer's overhaul data.

e. Serviceable. An engine part, component, or assembly is serviceable if it is in a physical condition acceptable for continued service operation in accordance with the ICA submitted under §33.4.

5. BACKGROUND. Section 33.90 requires the applicant to perform a test run for each engine model for which a new TC is required. The test run must simulate the conditions under which the engine is expected to operate in service, including start-stop cycles that are typical of expected service use. The primary purpose of this test requirement is to help establish any entry-into-service (EIS) IMI intervals for that type design. The engine must remain in a serviceable condition between the required or recommended maintenance inspections, or fixed overhaul periods. Therefore, this AC provides guidance on test methods and procedures, test pass/fail criteria, and EIS IMI or overhaul requirements or recommendations. The applicant should also consider the suitability of manual serviceability limits as part of this overall evaluation.

6. CONDUCT OF IMI TESTS.

a. IMI Test Cycle Assessment. The applicant should provide an assessment of expected service operating conditions as part of the overall test plan. In the assessment, the applicant should show that the proposed test cycle represents the expected engine flight cycle regarding established power/thrust ratings, reverse thrust usage, component stress and temperature, exhaust gas temperature (EGT), vibration, and cycle/operating time cumulative damage or other critical factors. For multiple aircraft applications, the applicant should show that the test cycle adequately represents all identified or anticipated installations. Two types of test cycles have been used in the past to demonstrate the IMI interval(s).

(1) Full Cycle Test. This method requires the engine to be run through the exact sequences of thrust or power settings for the period of time identified in the engine flight cycle. One complete cycle of a full cycle test involves the exact number of operating hours as a typical engine flight cycle and includes engine start and shutdown.

(2) Accelerated Severity Cycle Test. This method is structured to provide a rigorous test of engines (or engine parts) whose durability is primarily affected by cyclic operation. This type of test may vary the time at various thrust or power settings and the sequence of thrust or power selections from that of the engine flight cycle. Determining the relationship between the accelerated severity cycle test and the full flight cycle involves a complex analysis of stress, temperature, and resulting life for each affected part of the engine. The accelerated severity cycle test may include several major stress cycles during a given portion of overall engine test, resulting in a small number of engine hours in comparison to the number of engine flight cycles demonstrated. The accelerated severity cycle test is generally not considered ideal for substantiating those engine parts whose durability is primarily affected by hours of operation rather than by cycles. For those cases, other test or service experience data may be required to substantiate the IMI intervals when using this test method. The accelerated severity cycle test should include engine start and shutdown.

(3) Combination tests using full cycles and accelerated severity cycles have also been used.

b. Test Engine Configuration. Section 33.90 specifies compliance by test demonstration using an engine that substantially conforms to its final type design.

(1) The applicant should consider other hardware items not normally part of the engine type design (for example, thrust reverser, air starter, engine build-up (EBU) hardware) for inclusion in the test. For information on EBU hardware or installation configuration, the applicant should consult the installer.

(2) The test should also be performed with the engine in a typical installed configuration to the maximum extent possible, and with representative airframe accessories and interfaces connected and operating. The typical accessory loads and bleed air extraction that would be experienced during the engine flight cycle should be scheduled throughout the test to the maximum extent possible.

(3) For turboprop applications, the test engine should have a representative propeller installed. The applicant should incorporate applicable design features such as propeller braking and APU-mode operation into the test cycle.

(4) For turboshaft applications, the test engine output shaft should be loaded so as to simulate the appropriate characteristics of the main rotor of the intended installation. Potential main rotor characteristics include, but are not limited to, inertia and torsional vibration.

c. Test Parameters. The test may be conducted at sea level conditions if the test effectively reproduces the conditions of power/thrust, stress, component temperature, EGT, and unbalance vibration that would be experienced during an Engine Flight Cycle.

d. Test Duration. The total number of test cycles and overall test duration should be equivalent to the anticipated initial on-wing life for the new engine model in a typical installation. At a minimum, the applicant will need to run a suitable number of cycles to establish the IMI interval(s) and to show that a type design engine remains in a serviceable condition between required maintenance inspections.

e. Pass/Fail Criteria. The engine type design will have met the requirements of §33.90 when the post-test IMI hardware condition results support the proposed intervals. The following should be considered:

(1) Over the test duration and using normal maintenance practices contained in the ICA's, the engine can deliver rated takeoff thrust or power for a sea-level hot day corner point operating condition without exceeding any operating limitations. Further, the engine is free of surge or stall or other significant anomalies when operated in accordance with the operating instructions provided in support of §33.5.

(2) Following the test a teardown inspection should show that each engine part conforms to the type design and is eligible for continued operation in service in accordance with the ICA information submitted for compliance with §33.4. Hardware may be found serviceable if appropriate inspections or limitations are included within the ICA.

(3) Note that an alternative plan to replace a pre-Type Certificate full engine teardown inspection may be accepted by the FAA. Such a plan should include appropriate installed engine inspections and checks, along with a full engine teardown inspection prior to entry-into-service. Generally, this alternative should be supported by an extended number of test cycles completed before the full teardown. This type of proposal should be coordinated with the FAA well in advance of testing.

(4) The §33.90 certification documentation should identify those parts of the engine that will have specific IMI requirements or recommendations. A formal plan should exist to include this information, including life limits, inspections, intervals, and serviceability criteria, in the ICA in accordance with the existing provisions of §33.4.

f. Determination of Time/Cycle Intervals for Initial Maintenance Inspections.

(1) For a successful full cycle test, the applicant may use the full number of cycles and full number of hours demonstrated during the test as the IMI interval.

(2) For a successful accelerated severity cycle test, the applicant may use the full number of cycles for those engine parts for which the test cycle was shown to be equal to or more severe than the assumed engine flight cycle.

(3) The applicant would not normally be allowed to extrapolate to an interval in excess of those hours/cycles actually demonstrated. However, it may be acceptable to consider credit for additional hours if the cycle used (for example, accelerated severity cycle) involved operation at high thrust settings for durations well in excess of those of the engine flight cycle. This approach requires caution, as some parts of the engine will wear as a function of time at load, rather than from low cycle fatigue, and life extrapolation based on material property data alone is imprecise at best. Under these circumstances, it may be necessary to draw from other engine, component, or subassembly tests for supporting evidence.

7. FIXED ENGINE OVERHAUL PERIOD. If the engine is not intended to be covered by a structured inspection program, the TC holder may recommend a fixed overhaul period as the equivalent of an IMI. Under this approach, the applicant should conduct the §33.90 engine test in a similar manner to that described in paragraph 6 of this AC, and the test results should support the desired fixed overhaul period.

//signed by JJP on 3/5/04//
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