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

# Advisory Circular

**Subject:** Initial Maintenance Inspection (IMI), 14 CFR 33.90, Test for Turbine Engines

**Date:** 04/13/2016
**Initiated By:** ANE-111

**AC No:** 33.90-1A
**Change No.:** N/A

This advisory circular (AC) provides guidance to demonstrate compliance with Title 14 of the Code of Federal Regulations (14 CFR) 33.90, Initial Inspection Test.

This document complies with the formatting requirements of FAA Advisory Circular System Order No. 1320.46D.

For Ann C. Mollica,
Acting Manager, Engine and Propeller Directorate,
Aircraft Certification Service

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# CHAPTER 1. INTRODUCTION

## 1.1 Purpose.

This AC provides guidance to demonstrate compliance with Title 14 of the Code of Federal Regulations (14 CFR) Section 33.90, Initial Maintenance Inspection Test.

## 1.2 Change or Cancellation Statement.

### 1.2.1 Change.

Not Applicable.

### 1.2.2 Cancellation.

AC 33.90-1, Initial Maintenance Inspection (IMI), 14 CFR 33.90, Test for Turbine Engines, dated March 05, 2004, is cancelled.

## 1.3 Applicability.

### 1.3.1 Audience.

This AC is directed to engine manufacturers, modifiers, and Federal Aviation Administration (FAA) engine type certification designees.

### 1.3.2 Compliance Methods.

This AC describes an acceptable means, but not the only means, to make a regulatory showing of compliance. If you (the applicant) use the means described in the AC, you must follow it in all respects. Terms such as “should,” “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 AC is used.

If you use a different means, we (the FAA) will evaluate what you provide to determine if you have demonstrated regulatory compliance. We will consider your proposed method(s) and what you present to show that your alternate method demonstrates compliance. If we determine you have demonstrated compliance to the regulation, we will accept your alternate method.

We are not bound by this AC if we find that following it will not result in compliance with the regulations. Also, we may require additional testing before we conclude you have shown compliance, even if you are using the means described in this AC.

### 1.3.3 Regulatory Impact.

This AC is not mandatory and it does not constitute a regulation. While not mandatory, the guidance in this AC is derived from FAA and industry experience in determining compliance with the applicable regulations.

This AC does not change, authorize changes to, or permit deviations from, existing regulatory requirements. This AC also does not create any additional regulatory requirements.

1.4 **Suggestions for Improvement.**

Use the advisory circular feedback form in APPENDIX A of this AC to:

- Suggest improvements or changes.
- Request clarification.
- Report deficiencies.

1.5 **Related Reference Material.**

1.5.1 Regulations.

Table 1-1 lists regulations that apply to this AC.

**Table 1-1. Regulations**

| Number | Title | Date |
|---|---|---|
| 14 CFR 33.19 | Durability | - - |
| 14 CFR 33.201 | Design and Test Requirements for Early ETOPS Eligibility | - - |
| 14 CFR 33.3 | General | - - |
| 14 CFR 33.4 | Instructions for Continued Airworthiness | - - |
| 14 CFR 33.5 | Instruction Manual for Installing and Operating the Engine | - - |
| 14 CFR 33.90 | Initial Maintenance Inspection Test | - - |
| 14 CFR 33.201 | Design and Test Requirements for Early ETOPS Eligibility | - - |

1.5.2 FAA Documents.

Table 1-2 lists FAA documents that apply to this AC.

**Table 1-2. FAA Documents**

| Number | Title | Date |
|---|---|---|
| AC 33.201-1 | Extended Operations (ETOPS) Eligibility for Turbine Engines | 01/21/2010 |

1.5.3 Industry Documents.

Table 1-3 lists industry documents that apply to this AC.

**Table 1-3. Industry Documents**

| Number | Title | Date |
|---|---|---|
| (RESERVED) | - - | - - |
| (RESERVED) | - - | - - |

1.6 **Definitions.**

Table 1-4 lists definitions that apply to this AC.

**Table 1-4. Definitions**

| Term | Definition |
|---|---|
| Engine Flight Cycle | Predicted average flight profile of engine parameters and conditions representative of the way the engine is expected to operate in service. |
| Initial Maintenance Inspection (IMI) | Inspections specified in the instructions for continued airworthiness (ICA) submitted under § 33.4 that are considered necessary to determine the airworthiness of the engine.<br>IMIs may be required by the type certificate (TC) holder in the ICA Airworthiness Limitations Section or may be recommended at certain intervals. |
| Initial Maintenance Inspection (IMI) Intervals | Maximum hours or cycles that an engine or engine module should be operated before an IMI is conducted. |
| Overhaul | Process to disassemble, clean, inspect, repair or replace (as necessary), reassemble, and test for return-to-service approval within the manufacturer's overhaul data specifications (see Appendix A33.3).<br>Relates to the periodic disassembly of the entire engine, rather than maintenance of individual parts or assemblies. |

1.7 **Background.**

14 CFR 33.90 requires that you test run each engine model for which you request a new TC. 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 the test run is to help establish entry-into-service (EIS) IMI intervals for that type design. The engine must remain in a serviceable condition, per the ICA and § 33.19, between required or recommended maintenance inspections, or overhaul periods. Therefore, this AC provides guidance on:

1. Test methods and procedures.
2. Test pass/fail criteria.
3. EIS IMI, overhaul requirements, or recommendations.

This revision (-1A) makes the AC consistent with § 33.201 and with AC 33.201-1, and brings the format into compliance with the requirements of FAA Order 1320.46D.

# CHAPTER 2. GUIDANCE

## 2.1 Initial Maintenance Inspection (IMI) Tests.

### 2.1.1 IMI Test Cycle Assessment.

#### 2.1.1.1 General.

You should provide an assessment of expected service operating conditions as part of the test plan. In your assessment, you should show that the proposed test cycle represents expected in-service engine flight cycle usage, including the following:

- Established power/thrust ratings.
- Reverse thrust use.
- Component stress and temperature.
- Exhaust gas temperature (EGT).
- Vibration.
- Cycle/operating time cumulative damage.
- Other critical factors.

For multiple aircraft applications, you should show that the test cycle adequately represents all identified or anticipated installations and engine flight cycles.

Test cycles that have been used in the past to demonstrate IMI interval(s) include:

- Full cycle (paragraph 2.1.1.2 of this AC).
- Accelerated severity cycle (paragraph 2.1.1.3 of this AC).
- Combinations of the above test cycle types.

If the test plan combines the IMI test with the § 33.201 early extended operations (ETOPS) test, you must successfully complete the early ETOPS test prior to EIS. See paragraph 2.1.7 of this AC.

#### 2.1.1.2 Full Cycle Test.

The full cycle test requires that you run the engine through the exact thrust or power setting sequences for the time period identified in the engine flight cycle. One complete cycle of a full cycle test includes:

- A typical engine flight cycle.
- The exact number of operating hours, from engine start through complete shutdown.

2.1.1.3 Accelerated Severity Cycle Test.

The accelerated severity cycle test provides a rigorous test of engines (or engine parts) whose durability is primarily affected by cyclic operation. This type of test allows you to vary from the engine flight cycle the following conditions:

- Time at various thrust or power settings.
- Sequence of thrust or power selections.

To determine the relationship between the accelerated severity cycle test and the full flight cycle, you must perform a complex analysis of:

- Stress.
- Temperature.
- Resulting life of each affected part of the engine.

The accelerated severity cycle test may include the equivalent of several flight cycles during a given portion of the overall engine test. This can result 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 engine parts whose durability is primarily affected by hours of operation rather than by cycles. For those cases, IMI interval substantiation may require other test or service experience data (including, if available, comparison of relevant past IMI demonstrations to successful entry-into-service engine experience).

The accelerated severity cycle test you choose should include engine start and shutdown.

2.1.2 IMI Test Engine Configuration.

2.1.2.1 General.

Compliance with Section 33.90 specifies that you demonstrate the test with an engine that substantially conforms to its final type design. Note the following:

- Engine modification should not be required to complete the IMI test.
- If significant engine type design changes are expected, you should not perform the IMI test.

2.1.2.2 Consideration of Hardware Items Not Part of Engine Type Design.

You should consider for test inclusion other hardware items not normally part of the engine type design (for example, thrust reverser, air starter, engine build-up hardware). Including such hardware may:

- Produce more realistic engine loads.
- Increase test time for the non-engine components.

Consult the aircraft manufacturer for information on this hardware or installation configuration.

2.1.2.3 Engine Test Configuration.

You should conduct the IMI test when the engine is installed in a typical configuration, to the maximum extent possible. For example, you should:

- Connect and operate, in a way representative of service, airframe accessories and interfaces that load the engine.
- Schedule, throughout the test, typical accessory loads and bleed air extraction that would be experienced during the engine flight cycle.

2.1.2.4 Turboprop Applications.

For turboprop applications, perform the test run with an installation-eligible propeller installed. Incorporate into the test cycle applicable design features, such as:

- Propeller braking.
- Auxiliary power unit (APU)-mode operation(s).

2.1.2.5 Turboshaft Applications.

For turboshaft applications, you should load the test engine output shaft to simulate the appropriate rotor drive system characteristics of the intended installation. Potential rotor drive system characteristics include, but are not limited to, inertial and torsional vibration.

2.1.3 Test Parameters.

You may conduct the test at standard day conditions, if those conditions effectively represent the conditions expected during an engine flight cycle, including:

- Power/thrust.
- Stress.
- Component temperature.
- EGT.
- Unbalance vibration.

2.1.4 Test Duration.

The total number of test cycles and test duration should be equivalent to the anticipated initial on-wing life for the new engine model in a typical installation. At a minimum, you will need to:

- Run a suitable number of cycles to establish the IMI interval(s).
- Demonstrate that a type design engine remains in a serviceable condition between required maintenance inspections.

The regulation does not require a fixed number of cycles (i.e., the IMI is not a "1,000-cycle" test). However, you must correlate the number of cycles you propose for the test to the planned engine inspection intervals. See paragraph 2.1.6 of this AC.

2.1.5 Pass/Fail Criteria.

2.1.5.1 General.

The engine type design will meet the requirements of § 33.90 when the post-test, IMI hardware condition demonstrates that the engine will remain airworthy for the proposed intervals. The engine should comply with paragraph 2.1.5.2, paragraph 2.1.5.3, and paragraph 2.1.5.4 of this AC.

2.1.5.2 Test Duration.

Over the test duration, and when you follow normal ICA maintenance practices, the engine must:

- Meet all proposed thrust or power ratings without exceeding any operating limitations.
- Be free of significant anomalies (for example, surge, stall) when operated per the operating instructions provided in support of § 33.5.

2.1.5.3 Post-Teardown Inspection.

A post-test teardown inspection should demonstrate that each engine part:

- Conforms to the type design.
- Is eligible for continued operation in service.

You may find hardware serviceable if you include, within the ICA, appropriate inspections or limitations.

2.1.5.4 Certification Documentation.

The certification documentation should identify those parts of the engine that will have specific ICA requirements or recommendations that result from the IMI test. The final ICA should include these specific requirements and or recommendations, per the existing provisions of § 33.4, including:

- Life limits.
- Inspections.
- Intervals.
- Accept/reject criteria.

2.1.6 Determination of Time/Cycle IMI Intervals.

2.1.6.1 Full Cycle Test.

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

2.1.6.2 Accelerated Severity Cycle Test.

For a successful accelerated severity cycle test, you 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.

2.1.6.3 High Thrust Settings during Selected Test Cycle.

The test cycle you use (for example, accelerated severity cycle) may involve high thrust setting operation for durations that significantly exceed those of the engine flight cycle. If so, we may accept a field inspection interval longer than the IMI test length. This approach requires caution, because:

- Some engine parts will wear as a function of time at load, rather than from low-cycle fatigue.
- Life extrapolation based on material property data alone is imprecise, at best.

Under these circumstances, you may need to draw supporting evidence from other:

- Engine tests.
- Component tests.
- Subassembly tests.

2.1.7 Using the Early ETOPS Test of § 33.201 to Demonstrate IMI Compliance.

2.1.7.1 General.

Section 33.90(b) allows you to use an approved test conducted per § 33.201, in lieu of a separate IMI test. Use of the Early ETOPs test allows you to demonstrate compliance with both regulations through a single test on one engine.

If you use this method, the following conditions apply:

1. After you complete the full number of test cycles required for an IMI test performed per § 33.90(a), you must interrupt the § 33.201 test to conduct a complete on-wing (or other) inspection. Note the following:
   a. The inspection must be acceptable to us, the FAA, in order to demonstrate compliance with § 33.90 requirements.
   b. An acceptable on-wing inspection must include, but is not limited to, the inspections and tests listed in paragraph 2.1.7.2 of this AC.
2. Prior to EIS, you must complete the § 33.201 test in its entirety. This will provide further evidence that no undiscovered engine fault exists during the IMI portion of the test.
3. If the IMI inspection is completed and the TC is issued, you must complete the remaining portion of the § 33.201 test in order to comply with § 33.90(b) requirements.
4. FAA review of the general pass/fail criteria defined in paragraph 2.1.5 of this AC must demonstrate that the engine is fully serviceable per the ICAs, unless otherwise accepted by us.

2.1.7.2 On-Wing Inspection.

2.1.7.2.1 Borescope Inspection.

Full borescope-inspect all accessible gas path stages or areas of the fan, compressor, combustor, and turbine modules, to the serviceable limits of the ICAs.

2.1.7.2.2 System Fault and Status Message Interrogation.

Evaluate all system fault and status messages, for electronic-control-equipped engines. Include both current and previously recorded messages, to the serviceable limits of the ICAs.

2.1.7.2.3 Oil System Chip Detector and Filter Inspection.

Inspect all oil system chip detectors and filters for contaminants.

2.1.7.2.4 Fuel System Filter Inspection.

Inspect all fuel system filters for contaminants.

2.1.7.2.5 Main Engine Oil Sample Test.

Test the engine oil (for example, spectrographic analysis) for contaminants that might indicate impending internal failure.

2.1.7.2.6 Visual Inspection.

Perform a complete visual inspection of the inlet, exhaust, and externals, to the serviceable limits of the ICAs. The engine must be serviceable.

2.1.7.2.7 Power Calibration.

Demonstrate that the engine can produce rated power or thrust at a sea-level, hot-day corner point condition within approved limits.

2.2 **Fixed Engine Overhaul Period.**

You may recommend a fixed overhaul period as the equivalent of an IMI , if you do not intend to cover the engine with a structured inspection program. If you use this approach, you should:

- Conduct the engine test under § 33.90 in a similar manner to that described in paragraph 1.7 of this AC.
- Determine if the test results support the desired fixed overhaul period.

# APPENDIX A. ADVISORY CIRCULAR FEEDBACK FORM

If you find an error in this document, or have recommendations to improve it or to add new subjects, you may complete this form and submit it as follows:

(1) Email: 9-AWA-AVS-AIR500-Coord@faa.gov

(2) Fax: 202-267-3983
Attention: AIR Directives Management Officer

Subject: _____
*(document number, subject)*

Date: _____
*(mm/dd/yyyy)*

Please check all appropriate line items:

☐ Error noted in paragraph _____ on page _____.
*(Check all that apply and provide brief description, below)*
☐ Editorial
☐ Procedural
☐ Conceptual

_____
_____
_____

☐ Recommend paragraph _____ on page _____ be changed as follows:
*(Provide brief description)*

_____
_____
_____

☐ Recommend the following subject be addressed in a future change to this AC:
*(Provide brief description)*

_____
_____
_____

☐ Other comments:
*(Provide brief description)*

_____
_____
_____

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____

Organization: _____

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